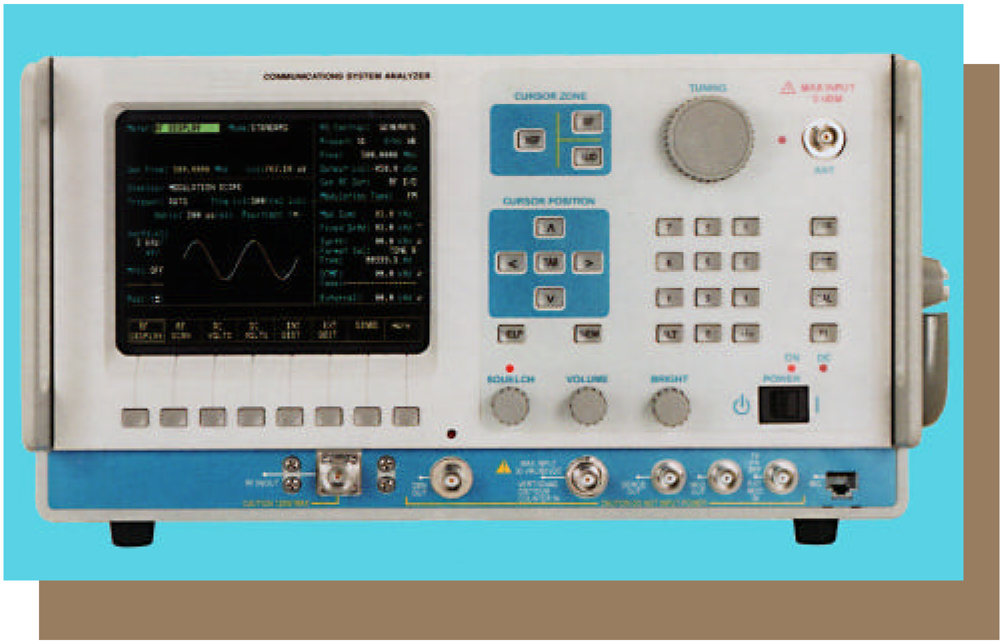
GENERAL DYNAMICS

R2670/R2625 Series

Communications System Analyzer



OPERATOR'S MANUAL

CG-1089 Rev. A

GENERAL DYNAMICS

R2670/R2625 Series

Communications
System Analyzer
OPERATOR'S MANUAL

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GENERAL DYNAMICS

COMMUNICATIONS TEST EQUIPMENT

R2670/R2625 Series
Communications System Analyzer

OPERATOR'S MANUAL

GENERAL DYNAMICS SATCOM TECHNOLOGIES
Communications Test Equipment
3750 W. Loop 281
Longview, TX
75604

CG-1089 Rev. A

Table of Contents

Section 1
INTRODUCTION

Table of Contents (CONT)

Section 1
INTRODUCTION (CONT)

Table of Contents (CONT)

Section 2
DESCRIPTION

Topic **Page**

Table of Contents (CONT)

Section 3
OPERATING INSTRUCTIONS

Table of Contents (CONT)

Section 3
OPERATING INSTRUCTIONS (CONT)

Topic **Page**

Table of Contents (CONT)

Section 4
APPLICATIONS

Table of Contents (CONT)

Section 5
TRUNKING INTRODUCTION

Table of Contents (CONT)

Section 6

TRUNKING OPERATING INSTRUCTIONS

Table of Contents (CONT)

Section 7

APPLICATIONS

Topic **Page**

Table of Contents (CONT)

Section 8

ASTRO TRUNKING INTRODUCTION

Table of Contents (CONT)

Section 9

ASTRO TRUNKING OPERATING INSTRUCTIONS

Table of Contents (CONT)

Section 10

ASTRO TRUNKING APPLICATIONS

Table of Contents (CONT)

Section 11

ASTRO TRUNKING INSTRUCTIONS

Table of Contents (CONT)

Section 12

SECURENET DESCRIPTION

Section 13

SECURENET OPTION OPERATING INSTRUCTIONS

Topic **Page**

Table of Contents (CONT)

Section 13

SECURENET OPTION OPERATING INSTRUCTIONS (CONT)

Table of Contents (CONT)

Section 14

SECURENET OPTION APPLICATIONS

Table of Contents (CONT)

Section 15

ASTRO OPTION INTRODUCTION

Table of Contents (CONT)

Section 16

ASTRO OPTION DESCRIPTION

Section 17

ASTRO OPTION OPERATING INSTRUCTIONS

Topic **Page**

Table of Contents (CONT)

Section 17

ASTRO OPTION OPERATING INSTRUCTIONS

Table of Contents (CONT)

Section 18

ASTRO APPLICATIONS

Table of Contents (CONT)

Section 19

PROJECT 25 INTRODUCTION

Topic **Page**

Table of Contents (CONT)

Section 20

PROJECT 25 DESCRIPTION

Topic **Page**

Table of Contents (CONT)

Section 21

PROJECT 25 OPERATING INSTRUCTIONS

Table of Contents (CONT)

Section 22

PROJECT 25 APPLICATIONS

Topic **Page**

Table of Contents (CONT)

Section 23

PROJECT 25 TRUNKING INTRODUCTION

Table of Contents (CONT)

Section 24

PROJECT 25 TRUNKING OPERATING INSTRUCTIONS

Topic **Page**

Table of Contents (CONT)

Section 25

PROJECT 25 TRUNKING APPLICATIONS

APPENDICES

Topic | **Page**

List of Figures

Page

List of Figures (CONT)

Page

List of Figures (CONT)

Page

List of Figures (CONT)

Page

List of Figures (CONT)

Page

List of Tables

Page

List of Tables (CONT)

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Section 1

INTRODUCTION

1-1 SCOPE OF MANUAL

This manual contains information for using the R2600 Series Communications System Analyzers. These Analyzers incorporate many devices and functions, permitting a technician to completely monitor and service radio communications equipment in the shop and in the field.

1-2 SAFETY SUMMARY

The following general safety precautions must be observed during all phases of operation, service and repair of this equipment. Failure to comply with these precautions or warnings violates safety standards of design, manufacture, and intended use of the equipment. General Dynamics. assumes no liability for the customer's failure to comply with these requirements.

The safety precautions and warnings listed below represent warnings of certain dangers of which General Dynamics is aware. You as the user of the product, should follow these warnings and all other safety precautions necessary for the safe operation of the equipment in your operating environment.

1-2.1 Grounding the Analyzer

To minimize shock hazard, the Analyzer enclosure must be connected to an electrical ground. This ground connection is provided via a three wire AC power cable. The power cable must be plugged into an approved three-contact electrical outlet. If the unit is not properly grounded while operating from an AC power source, the voltage potential between it and ground may cause an electrical shock.

1-2.2 Unit is Live When Plugged In

Internal circuits are live when the power cable is plugged in, although the front panel switch is in the STANDBY position. The input power plug is the disconnect device.

1-2.3 Keep Away From Live Circuits

Operating personnel must not remove equipment covers. Only Factory Authorized Service Personnel or other qualified maintenance personnel may remove equipment covers for internal subassembly or component replacement or any internal adjustment. Disconnect Analyzer from all voltage sources before removing covers for adjustments, maintenance or repairs. Capacitors inside may still be charged even if the Analyzer is disconnected from the voltage source.

Kapitel 1

EINFÜHRUNG

1-1 VERWENDUNGSZWECK

Dieses Handbuch enthält Informationen über den Umgang mit den Funkmeßplätzen der Serie R2600. Diese Geräte enthalten eine Vielzahl von Bausteinen und Funktionen, mit deren Hilfe der Techniker Kommunikationsgeräte sowohl in der Werkstatt als auch vor Ort vollständig überprüfen und warten kann.

1-2 SICHERHEITSHINWEISE

Die nachfolgenden allgemeinen Sicherheitshinweise sind während aller Phasen der Bedienung, Wartung und Reparatur dieses Gerätes zu befolgen. Die Nichtbeachtung dieser Hinweise bzw. Warnungen stellt ein Verstoß gegen die Sicherheitsstandards der Entwicklung, Herstellung und des bestimmungsgemäßen Gebrauchs des Gerätes dar. General Dynamics lehnt jede Haftung für die Nichtbeachtung dieser Vorschriften seitens des Kunden ab.

Die nachstehenden Sicherheits- und Gefahrenhinweise warnen vor bestimmten von General Dynamics erkannten Gefahren. Sie als der Benutzer des Produktes sollten diese Warnhinweise und sonstige sicherheitstechnische Vorsichtsmaßnahmen beachten, um einen zuverlässigen Betrieb des Gerätes innerhalb einer sicheren Betriebsumgebung zu gewährleisten.

1-2.1 Funkmeßplatz erden

Zur Verringerung der Gefahr eines elektrischen Schlages muß das Gerät elektrisch geerdet werden. Die Sicherheitserdung erfolgt über das dreiadrige Netzkabel. Der Netzstecker muß dazu in eine dreipolige Steckdose eines zugelassenen Typs gesteckt werden. Wird das Gerät beim Betrieb aus einer Wechselstromquelle nicht vorschriftsmäßig geerdet, so kann die Differenzspannung zwischen Gerät und Erde einen elektrischen Schlag hervorrufen.

1-2.2 Das Gerät steht auch in ausgeschaltetem Zustand unter Spannung

Die Schaltungen im Geräteinneren stehen bei gestecktem Netzkabel immer unter Spannung, auch wenn der Schalter auf der Frontplatte sich in Stellung STANDBY befindet. Eine vollständige Trennung vom Netz bewirkt nur das Ziehen des Netzsteckers.

1-2.3 Vorsicht vor spannungsführenden Teilen!

Das Betriebspersonal darf die Gehäuse-Abdeckungen nicht öffnen. Nur vom Werk autorisierte Techniker und sonstiges qualifiziertes Personal dürfen die Geräte-Abdeckungen öffnen, um Teile zusammenzubauen bzw. zu ersetzen oder Einstellungen vorzunehmen. Vor dem Öffnen, muß das Gerät von allen Spannungsquellen getrennt werden, damit Einstell-, Wartungs- und Reparaturarbeiten in spannungslosem Zustand durchgeführt werden. Kondensatoren im Gerät können auch nach der Trennung des Gerätes von der Spannungsquelle noch geladen sein.

1-2.4 Explosive Atmosphere

Do not operate the equipment in the presence of flammable gases or fumes. Operation of any electrical equipment in such an environment constitutes a definite safety hazard.

1-3 WARNINGS AND CAUTIONS

You should observe several precautions when handling this equipment.

WARNING

The Analyzer is designed to be operated with a ground connection to the chassis via a three-wire power connection. If the unit is not properly grounded while operating from an AC power source, the voltage potential between it and ground may cause an electrical shock.

CAUTION

This equipment contains parts that are subject to damage by static electricity. While there is normally no need for operator access to any internal components, take proper precautions in handling should the need arise. Refer to Appendix C for safe handling procedures.

1-3.1 Analyzer Operating Voltage

Before plugging in an AC power cable, verify that the selector switch located on the underside of the unit is set to the correct operating voltage. If using a battery pack, the cover must be removed and the internal voltage selector switch set to the correct position.

1-3.2 DC Power Source

The DC power input is intended to be connected to the Battery Pack accessory, or from a vehicle battery. Connecting the Analyzer DC input to a Power Supply can, in the event of a power supply fault, cause hazardous voltages to be present on the low voltage circuits of the Analyzer.

1-3.3 Maximum DVM Input Voltages

To ensure the safety of the user, the voltages being measured at the DVM input must be kept below Hazardous Live limits. The maximum input levels are: 30 V r.m.s and 42.4 V peak or 60 V d.c.

1-2.4 Betrieb in einer explosionsgefährdeten Umgebung

Das Gerät darf in einer explosionsgefährdeten Umgebung nicht betrieben werden. Brennbare Gase oder Dämpfe in der Nähe des Gerätes stellen ein großes Sicherheitsrisiko dar.

1-3 GEFAHRENHINWEISE

Beim Umgang mit dem Gerät sind folgende Gefahrenhinweise zu beachten.

VORSICHT!

Beim Betrieb des Funkmeßplatzes muß das Chassis über ein dreipoliges Netzkabel geerdet sein. Wird das Gerät bei Speisung aus einer Wechselstromquelle nicht vorschriftsmäßig geerdet, so kann die Differenzspannung zwischen Gerät und Erde einen elektrischen Schlag hervorrufen.

ACHTUNG!

Dieses Gerät enthält Bauteile, die durch statische Elektrizität beschädigt werden können. Normalerweise ist ein Zugriff auf die Bauteile im Inneren des Gerätes zwar nicht erforderlich, jedoch sind im Bedarfsfall die nötigen Vorsichtsmaßnahmen zu beachten. Einzelheiten dazu gehen aus Anhang C hervor.

1-3.1 Betriebsspannung

Vor dem Anschluß des Funkmeßplatzes an das Netz ist sicherzustellen, daß am Spannungswähler auf der Unterseite des Gerätes die richtige Netzspannung eingestellt ist. Bei Verwendung eines Akkusatzes muß die Abdeckung abgenommen und der interne Spannungswähler in die richtige Stellung gebracht werden.

1-3.2 Betrieb mit Gleichspannung

Über den Eingang DC POWER läßt sich der Funkmeßplatz mit Spannung aus dem als Option erhältlichen Akkusatz oder auch aus einem Kfz-Bordnetz speisen. Der Anschluß einer externen Stromversorgung kann im Falle eines Fehlers in dieser Stromversorgung dazu führen, daß die Niederspannungsteile im Funkmeßplatz gefährlich hohe Spannungen annehmen.

1-3.3 Maximale Eingangsspannung des Digitalvoltmeters

Damit die Sicherheit des Benutzers gewährleistet ist, dürfen die Spannungen am Eingang des Digitalvoltmeters bestimmte Werte nicht überschreiten. Die maximal zulässige Werte sind: 30 V eff. und 42,4 V Spitzenspannung oder 60 V Gleichspannung.

1-3.4 Replacement Fuses

For continuous protection against risk of fire, replace only with a fuse of the same type and rating. Part numbers for replacement fuses are shown in Tables 1 and 2.

Other fuses are located inside the Analyzer and should be replaced by Factory Authorized Service Personnel or other qualified maintenance personnel.

Table 1. Operator Replaceable Fuses

LOCATION	OPERATION	FUSE RATING VOLTS	FUSE RATING AMPS	FUSE TYPE	PART NUMBER
Rear Panel	115/230 VAC L	250V	2.5A	F	65-P30222C003
* Rear Panel	115/230 VAC N	250V	2.5A	F	65-P30222C003
Front Panel	ANT	125V	1/16A	F	65-P30277C002
Front Panel	GEN	125V	1/16A	F	65-P30277C002

Table 2. Internal Fuses

LOCATION	OPERATION	FUSE RATING VOLTS	FUSE RATING AMPS	FUSE TYPE	PART NUMBER
* Inside Rear Panel	12 VDC	250V	10A	F	F03A250V10A
Power Supply	115/230 VAC N	250V	1/4A	F	65-P30308C001
Battery Pack	115/230 VAC L	250V	0.5A	F	65-P30222C002
* Battery Pack	115/230 VAC N	250V	0.5A	F	65-P30222C002
Battery Pack	12 VDC	250V	15A	F	65-P26348A004

***Note:** For Analyzers with one AC fuse (F02A250V3A) and one DC fuse (F03A250V10A) on the rear panel, the neutral fuse (N) does not exist.

1-3.4 Ersatz von Sicherungen

Damit ein kontinuierlicher Schutz gegen Feuergefahr gegeben ist, darf eine Sicherung nur gegen eine solche des gleichen Typs und mit dem gleichen Sicherungswert ersetzt werden.

Teilenummern für Ersatzsicherungen gehen aus den Tabellen 1 und 2 hervor. Weitere Sicherungen im Inneren des Gerätes dürfen jedoch nur von autorisiertem bzw. qualifiziertem Personal gewechselt werden.

Tabelle 1. Sicherungen, die vom Benutzer gewechselt werden können

STELLE	BETRIEB	SICHERUNGSWERTE VOLT	AMP	TYP	TEILENUMMER
Rückwand	115/230 VAC L	250V	2,5A	F	65-P30222C003
* Rückwand	115/230 VAC N	250V	2,5A	F	65-P30222C003
Frontplatte	ANT	125V	1/16A	F	65-P30277C002
Frontplatte	GEN	125V	1/16A	F	65-P30277C002

Tabelle 2. Interne Sicherungen

STELLE	BETRIEB	SICHERUNGSWERTE VOLT	AMP	TYP	TEILENUMMER
* i. d. Rückwand	12 VDC	250V	10A	F	F03A250V10A
Netzgerät	115/230 VAC N	250V	1/4A	F	65-P30308C001
Akkusatz	115/230 VAC L	250V	0,5A	F	65-P30222C002
*Akkusatz	115/230 VAC N	250V	0,5A	F	65-P30222C002
Akkusatz	12 VDC	250V	15A	F	65-P26348A004

*** Hinweis:** Bei Geräten mit einer AC-Sicherung (F02A250V3A) und einer DC-Sicherung (F03A250V10A)auf der Rückwand gibt es keine neutrale Sicherung (N).

1-3.5 Other Cautions

Other cautions relating to the operation of the Analyzer are stated in *Italics* throughout this manual.

1-3.6 Replacement and Disposal of Batteries

Should the batteries contained in the Battery pack ever need replacing, this work should be performed by Factory Authorized Service personnel only. Replacement batteries should be of the same type and rating. The batteries contain toxic materials and therefore must be handled with care and transported to a disposal or recycling center.

1-3.7 User Maintenance

Clean only with a damp cloth and a mild detergent. Do not use abrasives, solvents or alcohol. If the Analyzer is used in a relatively dust free environment, no other periodic mainenance should be required.

1-4 SERVICE

The Motorola Test Equipment Service Centers service all R2600 Series Communications System Analyzers. The Centers maintain a stock of original equipment replacements parts and a complete library of service information. A list of worldwide service locations is found at the front of the manual.

1-5 REPLACEMENT PARTS ORDERS

Send orders for replacement parts to the nearest Motorola Test Equipment Service Center. Be sure to include the complete identification number located on the equipment. Also direct inquiries to the Test Equipment Service Center, including requests for part number identification and test equipment calibration or repair.

1-6 INSTALLATION

1-6.1 Packing

Foam pieces protect the Analyzer, which is packed inside a carton. Save the packing container and materials for future use.

1-6.2 Initial Set-up

1. Use the analyzer in accordance with the following:

   Pollution degree: II

   Installation category: 2

   Altitude: < 2000m

   Humidity: 80% rh. Max

   Electrical supply; 115/230 VAC, 50/60 Hz

   Indoor use

   Temperature: 5-40° C

2. Place the Analyzer on a workbench in the shop or mobile repair unit.

3. Lower the bail underneath to raise the Analyzer for easier viewing.

4. Remove the front cover by pressing in the spring loaded mechanism which snaps into the right front handle of the unit.

5. Before attempting to connect to AC power, set the two-position LINE switch (bottom of unit) to either the 115 or 230 position, as applicable. The factory initially sets the LINE switch for 115 VAC.

6. Take the power cord that is stored in the cover. Attach the cord's female connector to the appropriate connector on the Analyzer's rear panel. Connect the other end of the cord to the power source. For AC, use a grounded 3-wire 100-130 VAC or 200-260 VAC power source.

7. Remove accessories from the cover as needed.

1-3.5 Sonstige Vorsichtsmaßnahmen

Weitere wichtige Hinweise zum Betrieb des Funkmeßplatzes sind in diesem Handbuch durch *Kursivschrift* kenntlich gemacht.

1-3.6 Ersatz und Entsorgung von Akkus

Im Akkusatz enthaltenen Zellen dürfen - falls dies je erforderlich sein sollte - nur von autorisiertem Personal ausgewechselt werden. Ersatzzellen müssen vom gleichen Typ sein und die gleichen Leistungsmerkmale aufweisen. Akkus enthalten giftige Materialien, weshalb sie sorgfältig behandelt und ordnungsgemäß entsorgt werden müssen.

1-3.7 Reinigung

Reinigen Sie das Gerät nur mit einem leicht angefeuchteten Lappen und einem milden Reinigingsmittel. In keinem Fall dürfen Scheuer- oder Lösungsmittel oder Alkohol verwendet werden. Bei Benutzung des Gerätes in einem relativ staubfreiem Raum sollte eine weitere Wartung nicht erforderlich sein.

1-4 KUNDENDIENST

Die Wartung aller R26XX Communications System Analyzer werden vom regionalen Motorola Test Equipment Service Center durchgeführt. Diese Service Center führen ein Lager mit Original-Ersatzteilen und kompletten Serviceinformationen. Eine Liste der regionalen Service Center finden Sie auf der ersten Seite der Bedienungsanleitung.

1-5 ERSATZTEIL BESTELLUNGEN

Bestellungen für Ersatzteile sind unter Angabe der vollständigen Identifikationsnummer des jeweiligen Gerätes an das nächstgelegene Motorola Test Equipment Service Center zu richten. Hier erhalten Sie auch Antwort auf Ihre Fragen bezüglich Teilenummern, Kalibrierung und Reparatur von Testgeräten.

1-6 INSTALLATION

1-6.1 Verpackung

Im Verpackungskarton wird der Funkmeßplatz von Schaumstoffteilen geschützt. Verwahren Sie sämtliche Teile der Verpackung für eine eventuelle spätere Verwendung.

1-6.2 Erste Inbetriebnahme

1. Beachten Sie folgende Punkte bei der Inbetriebnahme des Gerätes:

   Verschmutzungsgrad: II

   Installationskategorie: 2

   Höhe über N.N.: < 2000m

   Max. rel. Luftfeuchtigkeit: 80%

   Versorgungsspannung: 115/230 VAC, 50/60 Hz

   Nur in geschlossenen Räumen verwenden.

   Umgebungstemperatur: 5-40 °C

2. Stellen Sie das Gerät in der Werkstatt oder im Servicewagen auf die Werkbank.

3. Stellen Sie den auf der Unterseite befindlichen Bügel hoch, um das Gerät besser bedienen zu können.

4. Entfernen Sie die Frontplatte durch Eindrücken der Raste, die im rechten Vordergriff des Gerätes einrastet.

5. Vor dem Anschluß an das Netz den Schalter LINE auf der Unterseite je nach der vorhandenen Netzspannung auf entweder 115V oder 230V setzen. Ab Werk ist der Schalter für 115 VAC eingestellt.

6. Das Netzkabel ist im Deckel untergebracht. Stecken Sie die Buchse des Netzkabels in den Kaltgerätestecker auf der Rückseite des Gerätes und verbinden Sie die andere Seite des Netzkabels mit der Stromquelle. Für Netzbetrieb ist ein dreiadriger Anschluß für 100-130 oder 200-260 Volt erforderlich.

7. Entnehmen Sie das benötigte Zubehör aus dem Deckel.

7. Insert the whip antenna into the ANT port, located to the right of the tuning knob on the front panel.
8. Press the power switch ON. The Analyzer is now ready for use. Before operating the Analyzer, review the operating procedures described in this manual.

CAUTION

When installing the Analyzer in a vehicle, fuse the DC supply line close to the vehicle's battery. The DC-10A fuse (located on the Analyzer's rear panel) protects the Analyzer against overload but does not protect the vehicle.

1-6.3 Battery Pack Operation

The optional battery pack (RPN-4000A) is designed to conveniently mount to the back of the Analyzer. Containing an internal battery charger, the battery pack is automatically recharged whenever connected direct to an ac receptacle. Battery charging is independent of the main equipment.

NOTE

The battery pack has an internal switch allowing the user to switch operation of the battery pack to 115 VAC or 230 VAC. Before attempting to plug the battery pack into the ac line for charging, ensure this switch is set to the correct position for your line voltage. This switch is accessible by removing six screws attaching the cover to battery pack chassis as shown in figure 1-1.

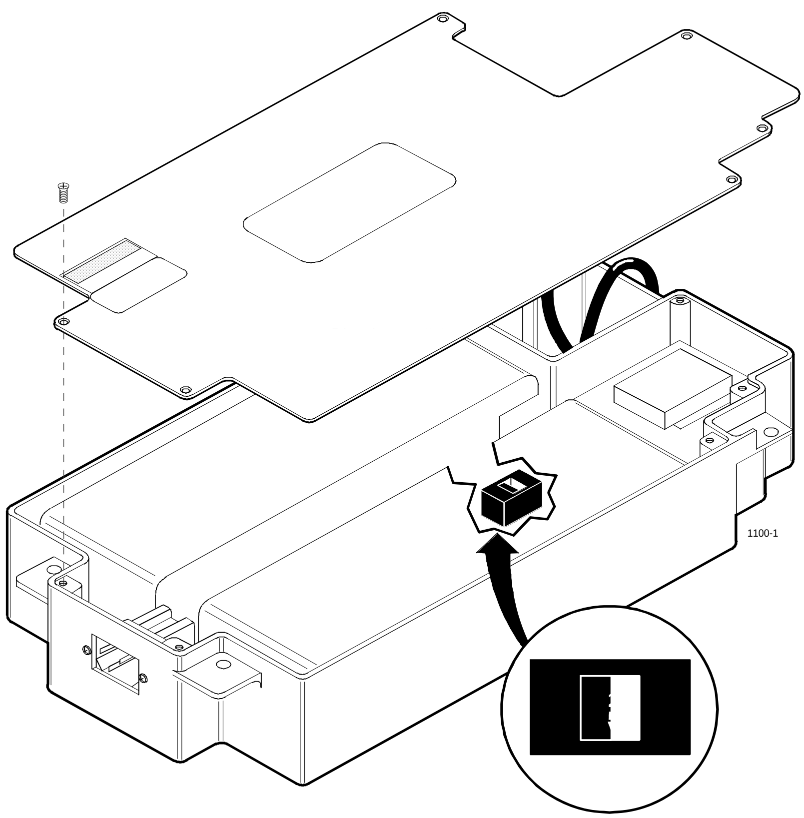


Figure 1-1. 115 VAC/230 VAC Selection Switch

7. Stecken Sie die Stabantenne in die ANT-Buchse rechts neben dem Abstimmknopf auf der Frontplatte.
8. Drücken Sie den Netzschalter auf ON. Der Funkmeßplatz ist jetzt betriebsbereit. Lesen Sie die mitgelieferte Bedienungsanleitung, bevor Sie das Gerät bedienen.

ACHTUNG!

Vor der Installation des Funkmeßplatzes in einem Fahrzeug ist das Speisekabel in unmittelbarer Nähe der Kfz-Batterie abzusichern. Die Sicherung von 10 A (im Inneren des Gerätes oder auf der Rückwand) schützt den Funkmeßplatz zwar gegen Überlastung, nicht jedoch das Fahrzeug.

1-6.3 Betrieb mit Akkusatz

Der als Option erhältliche Akkusatz (RPN-4000A) läßt sich bequem an der Rückseite des Funkmeßplatzes anflanschen. Da der Akkusatz über ein integriertes Ladegerät verfügt, wird er automatisch aufgeladen, sofern er an einer Netzsteckdose angeschlossen ist. Der Ladevorgang verläuft unabhängig vom Hauptgerät.

HINWEIS

Der Akkusatz verfügt über einen eingebauten Spannungswähler für 115 V bzw. 230 V Wechselspannung. Bevor Sie den Akkusatz mit dem Netz verbinden, ist darauf zu achten, daß die Stellung des Spannungswählers der örtlichen Netzspannung entspricht. Zugänglich ist dieser Spannungswähler nach Lösen von 6 Schrauben, mit denen die Abdeckung mit dem Chassis des Akkusatzes verschraubt ist. Siehe dazu Abb. 1-1.

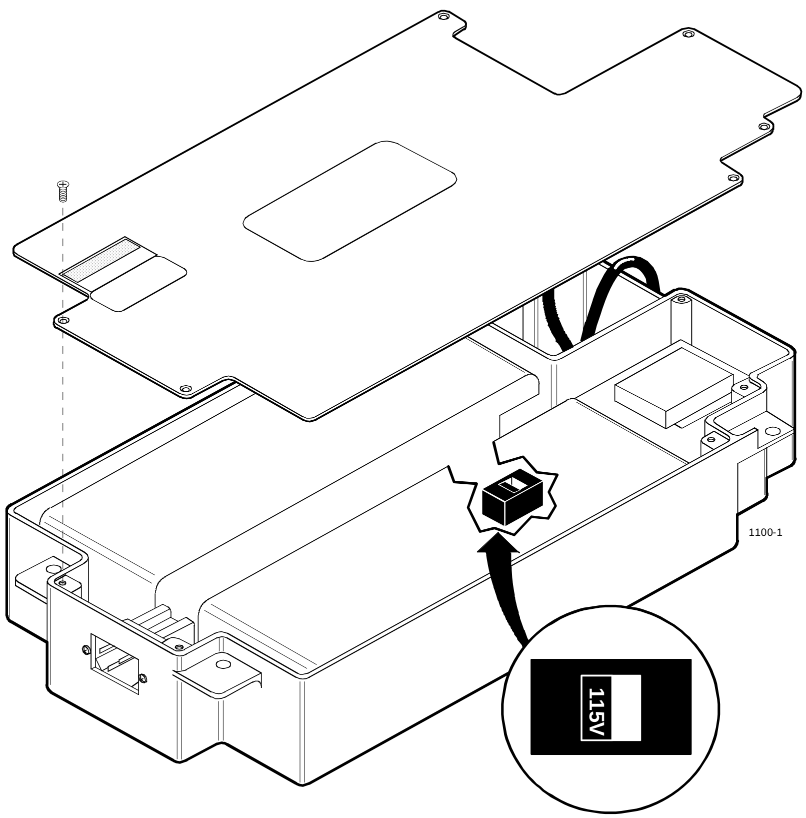


Abb. 1-1. Spannungswähler für 115 / 220 VAC

1-6.4 Battery Pack Installation

1. Set the Analyzer in an inverted vertical position on a table with the back of the unit facing upward.
2. Lay battery pack on the back surface of the Analyzer such that the cut out in the battery, will match the locations of the power plug on the Analyzer. Do not engage the attachment screw yet.
3. Plug four-pin connector from battery pack to four-pin connector on back of Analyzer labeled DC POWER.
4. Plug AC cord from battery pack to AC power plug on back of Analyzer.
5. Dress cabling into retaining area and slide battery into position to align with mounting screws
6. Align and tighten the four slotted mounting screws.

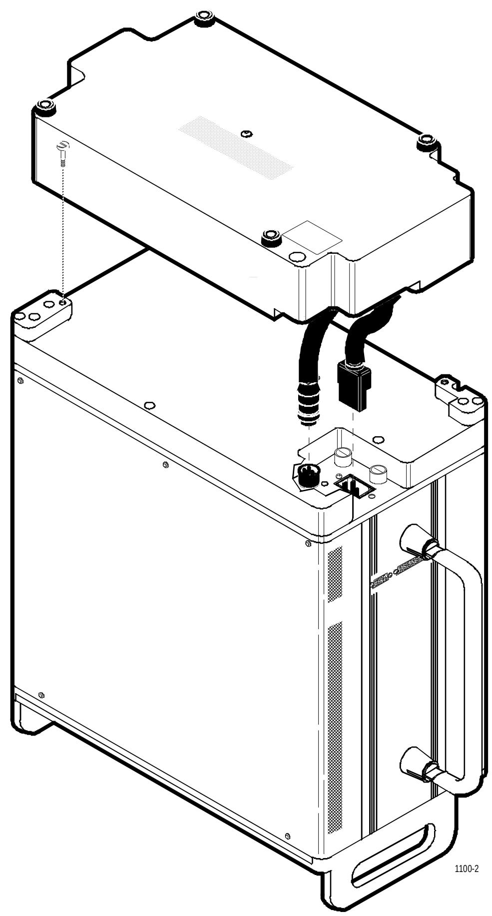


Figure 1-2. Battery Pack Installation

1-6.4 Installation des Akkusatzes

1. Stellen Sie den Funkmeßplatz kopfüber auf einem Tisch mit der Rückseite nach oben.
2. Legen Sie den Akkusatz auf die Rückseite des Gerätes so daß die Bohrung im Akkusatz auf den Netzstecker des Funkmeßplatzes ausgerichtet ist. Befestigungsschraube noch nicht anziehen.
3. Verbinden Sie den vierpoligen Anschlußstecker des Akkusatzes mit dem vierpoligen Anschluß DC POWER auf der Rückseite des Funkmeßplatzes.
4. Stecken Sie das Netzkabel des Akkusatzes in den Netzstecker auf der Rückseite des Funkmeßplatzes.
5. Legen Sie das Kabel in die entsprechende Aussparung und verschieben Sie den Akkusatz so, daß sich die Befestigungsschrauben anziehen lassen.
6. Befestigen Sie den Akkusatz mit den vier Schlitzschrauben.

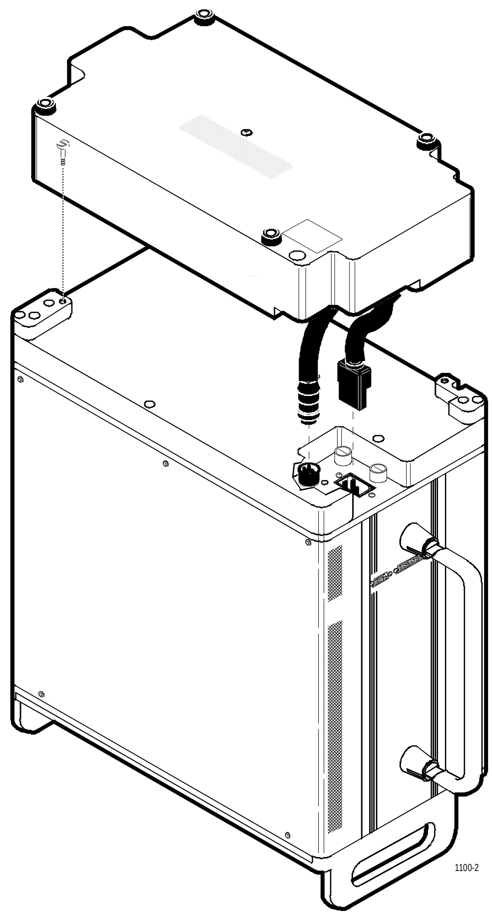


Abb. 1-2. Installation des Akkusatzes

Section 2

DESCRIPTION

2-1 DESCRIPTION

R2600 Series Communication System Analyzers are portable test instruments designed to monitor and service radio communications equipment over the frequency range of 400 Hz to 999.9999 MHz. figures 2-1 and 2-2 show the analyzer's controls, indicators, and connectors, and lists their functions. The analyzer generates signals, measures modulation and frequency, and performs a variety of tests normally associated with the following devices:

- RF Signal Generator
- Sensitive Measurement Receiver
- Spectrum Analyzer
- Duplex Offset Generator
- Oscilloscope
- Frequency Counter
- AC/DC Voltmeter
- RF Wattmeter
- Sweep Generator
- Signaling Encoder/Decoder
- Signal Strength Meter
- SINAD Meter
- Distortion Analyzer

2-2 OPERATOR CONTROLS

2-2.1 Keys & Indicators

Power Switch

Press ON to energize all circuitry. The unit automatically selects AC power if line power is available. Otherwise, the unit looks for a DC source. Switching is automatic upon cycling of the POWER switch.

ON LED

Illuminates when power switch is pressed ON.

DC LED

Illuminates when equipment uses DC power.

Cursor Zone Keys (RF, AUD, & DISP)

Determines the zone of the display that the cursor will be active in. When changing zones, the cursor moves to the same cursor location occupied the previous time it was in that zone.

Cursor Position Keys (Up, Down, Left, Right, TAB)

The five cursor movement keys are used to move the cursor to the left, right, up, down, or tab.

HELP Key

Displays help instructions for the present screen.

MEM Key

Accesses the Memory screen for nonvolatile memory presets.

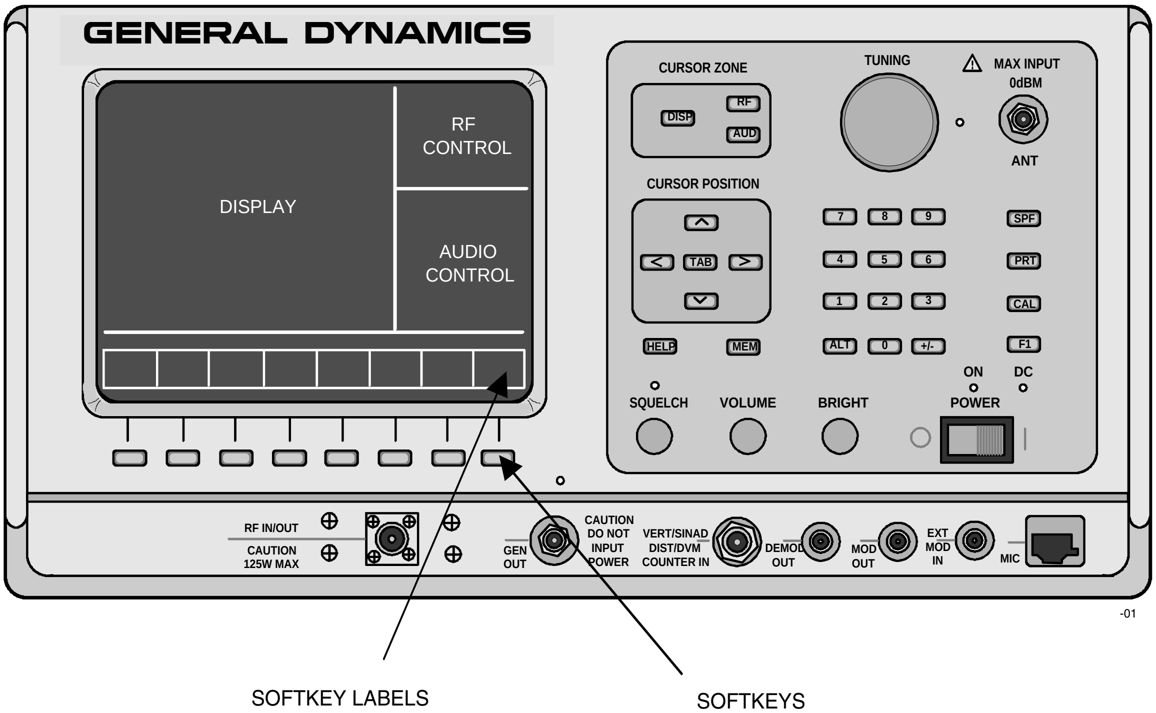


Figure 2-1. Front Panel Controls, Indicators, and Connectors

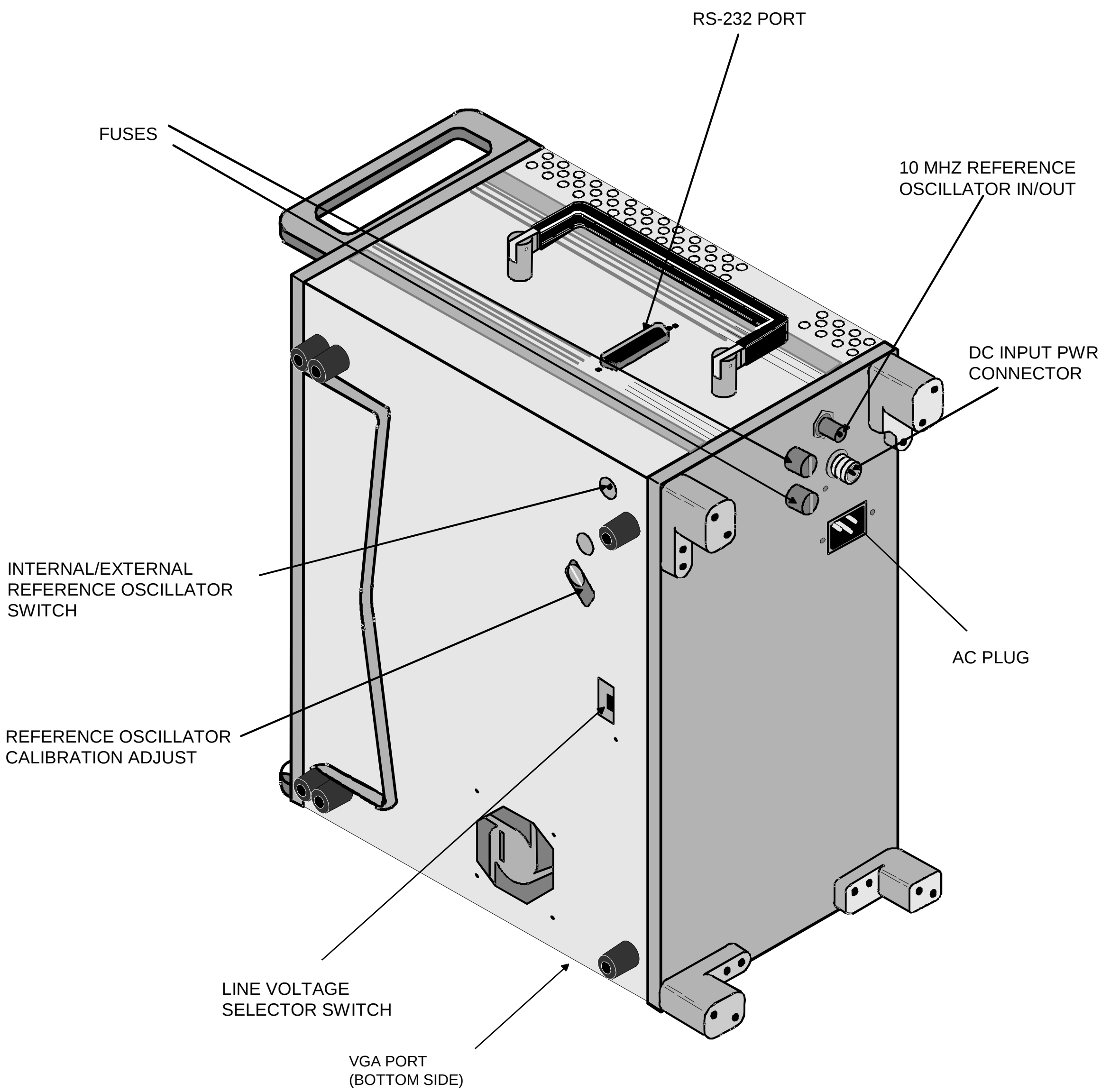


Figure 2-2. Side, Rear, and Bottom Panels

Keys (0-9)

For entering numeric information into the analyzer. When a key is pressed, the existing display numeral (where the cursor is sitting) is replaced with the numeral represented by the keypress. The analyzer then reacts to the new information just entered. When an invalid numeric entry is attempted, the analyzer ignores the keypress and the numeral on the screen remains unchanged.

+/- Key

Toggles the displayed sign from its present value to the negative of its present value.

ALT Key

Enables the alternate functions on the keypad. Upon pressing the ALT key, the message `ALT` appears on the message line. Pressing any other key following the ALT key will cause the `ALT` message to disappear.

SPF Key

Displays the special functions menu of the display.

PRT Key

Sends the data contents of the displayed screen to a printer.

CAL Key

Instructs the processor to perform a self calibration on the system.

F1 Key (Optional Function)

Permits access to additional functions. Currently used to return to local mode from remote mode.

Softkeys

Located below the display, the softkeys provide a menu function to indicate all possible values or entries for the current cursor position. If the cursor moves, the softkey functions change.

2-2.2 Knobs

Squelch

Squelch control. Clockwise rotation increases the receiver threshold signal level above which the squelch opens.

Volume

Controls volume of the speaker audio.

Bright

Intensity adjustment of the display. Clockwise rotation results in higher intensity.

Tuning

Incrementally changes the digit over which the cursor is currently sitting. Clockwise rotation of the tuning knob increases the number; counter-clockwise rotation decreases the number. This provides the equivalent of an analog control for numeric cursor entry locations.

2-2.3 DISPLAY

9 cm x 11 cm bit-mapped LCD. Provides data, operating controls, and instructional information. Displays in digital, analog, and bar graph forms.

NOTE

The LCD has a screen saver feature that reduces intensity after approximately 30 minutes of inactivity. Press any key to restore the display.

2-2.4 Connectors

2-2.4.1 Front Panel Connectors

RF IN/OUT

Provides RF input signal to the analyzer's internal monitor or output signal from the analyzer's internal generator. Also provides combined input/output in DUPLEX mode. Contains the RF wattmeter load. This is the only front panel connector to which RF power may be applied.

GEN OUT

Provides a high level generator RF output port isolated from the Monitor input. **DO NOT APPLY RF POWER.**

ANT

Input port for sensitive monitor receiver. Useful for off-the-air measurements. **DO NOT APPLY RF POWER.**

NOTE

The GEN OUT and ANT connectors are protected from overload by an RF fuse installed in the front panel connector. This fuse may be accessed by unscrewing the front portion of the BNC connector from the panel using a 7/16 inch deep socket wrench. Replacement fuse part number is GG-6530277C002.

CAUTION

The RF fuse leads must be trimmed to a length of .48 ±.02 inches and the tips cut to a point to facilitate installation.

VERT/SINAD DIST/DVM COUNTER IN

Combined input port for oscilloscope vertical, SINAD meter, DVM/counter, Distortion meter, DVM, and frequency counter inputs.

DEMOD OUT

Recovered (demodulated) audio output (MONITOR or DUPLEX mode).

MOD OUT

Composite output of internally generated modulation signals.

EXT MOD IN

External modulation input connector. Requires a fixed input level of $1V_{pk}$ for accurate level displays.

MIC

Connector for external accessory microphone.

2-2.4.2 Side Panel Connectors

VGA Port (15 pin)

Provides connection to external VGA format color monitor.

RS-232 PORT (25 pin)

Provides input/output for printer or control interface.

2-2.4.3 Back Panel Connectors

10 MHZ STD

BNC connector provides input/output for 10 MHz reference frequency. Input impedance is 50 ohms. Input level requirement is 70 mV to 1 Vrms. Output level is approximately 250 uVrms.

AC POWER Connector

Primary AC power input port.

DC POWER Connector

Primary DC power input port.

2-3 BOTTOM CONTROLS

Internal/External Oscillator Micro-Switch

Used to switch between input and output configurations for the rear panel 10 MHz reference oscillator BNC connector.

CAUTION

The analyzer will not function properly if this switch is set to external without a 10 MHz reference signal applied to the rear 10 MHz reference BNC connector.

Internal Reference Oscillator Adjustment Access

Provides convenient external access to recalibrate reference oscillator frequency setting.

CAUTION

Use a reliable and accurate frequency standard when making this adjustment.

115/230 VAC Selector Switch

Used to switch the unit's internal power supply for either 115V or 230V operation.

Section 3

OPERATING INSTRUCTIONS

3-1 GENERAL

R2600 Series Communications System Analyzers are designed specifically for the service and monitoring of radio communications equipment. This product represents a breakthrough in simplicity of operation. In place of numerous meters, keys and controls, the analyzer employs an LCD display which simultaneously presents control and data displays. A simplified front panel, utilizing soft keys, cursor movement keys, a numeric key pad, an analog tuning control and other dedicated function keys all combine to make the unit extremely easy to learn and very efficient to use.

Primary operating modes of the unit are MONITOR, GENERATE, DUPLEX and SWEEP GENERATOR. They are accessed through the RF Control display area at the upper right of the screen (figure 3-1). Within these modes of operation, various measurement functions may be selected in order to measure and diagnose many types of radio equipment under test.

RF data display, voltmeters, distortion meter, SINAD meter, frequency counter and modulation decoder functions are available through the Meter display area at the upper left of the screen.

Spectrum analyzer, oscilloscope and bar graph displays are available through the Display area at the lower left of the screen.

Control of the internal modulation synthesizer and level selection for externally applied modulation are provided through the Audio area at the lower right of the screen.

Further explanation of the function of each of these screen areas can be accessed through use of the HELP key to the lower right of the screen.

3-2 BASIC OPERATION

Control of the unit and selection of data to be displayed are done through the use of three main windows which simultaneously appear on this screen.

These three main windows, or cursor zones, are accessed simply through a cluster of three CURSOR ZONE keys at the top center of the unit. The location where the cursor rests within each zone is known as a cursor field. To control the unit and enter data, all operator inputs are made at highlighted cursor field locations (brighter-face type).

For further simplicity, softkeys, with customized on-screen labels interact with the screen to provide a unique menu of entry options for each cursor field. This greatly reduces the number of keys and having to search through unrelated controls to find the one that's needed.

3-2.1 Remote Operation

All R2600 Series Communications System Analyzers are equipped with a standard RS-232 interface. Optionally, the R2600 is equipped with an IEEE 488 (HP-IB / GPIB) interface. Either of these interfaces may be used to remotely control the analyzer using a set of commands, queries, and responses that are defined in the General Dynamics R2600 Series Communications System Analyzer Programming Reference Manual (68-80309E55).

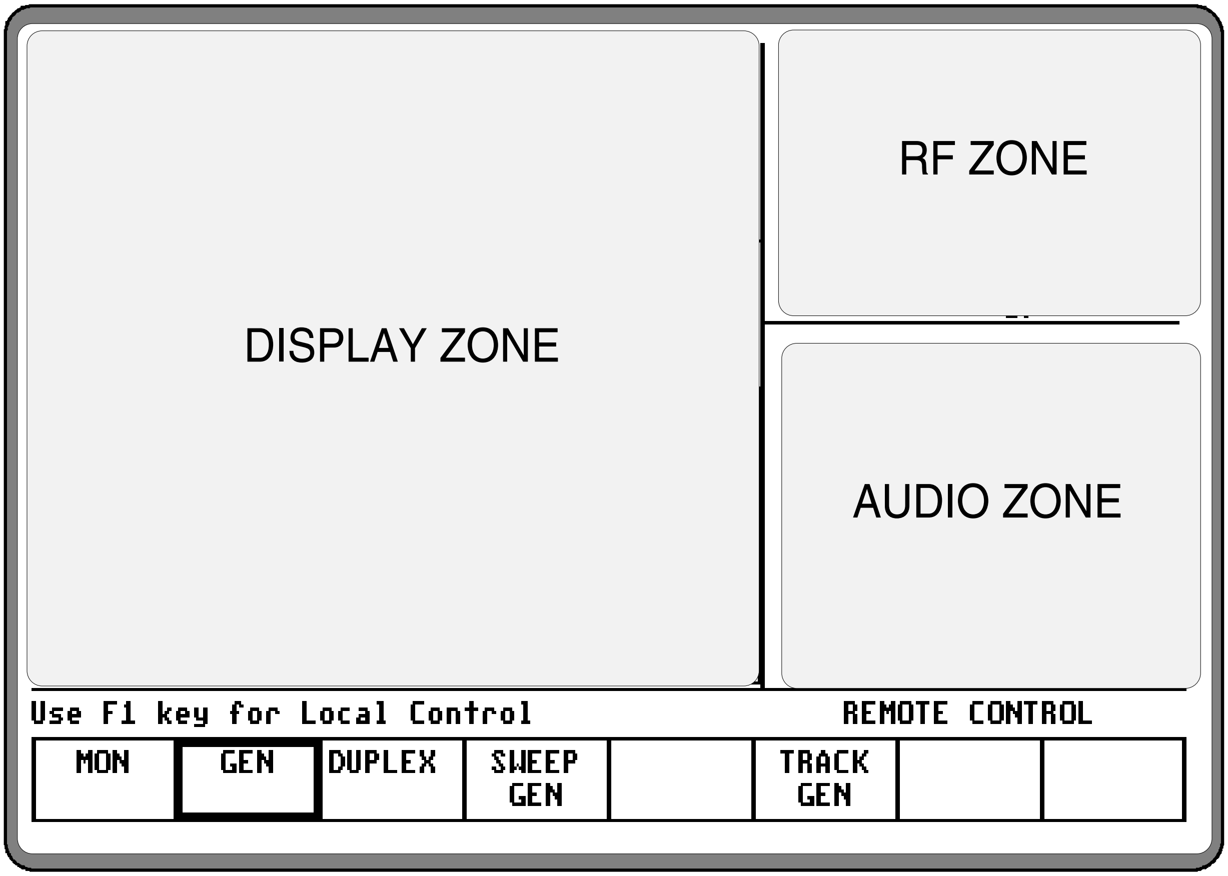


Figure 3-1. Screen Zone Arrangement

To control the cursor location and input information by:

- Use the CURSOR ZONE keys to move the cursor among the three zones.
- Use the CURSOR POSITION keys to move the cursor from field to field within a zone.
- Once at the desired field, use either the TUNING knob or the numeric keys to enter numeric information. Use the soft keys for other menu selections.

3-2.2 Expanded Display

Some fields have the ability to expand their contents and overwrite other display areas. These consist of the following:

- Spectrum analyzer, scope waveforms, bargraph displays
- Decode tables
- Encode tables
- Dedicated keys

3-2.2.1 Spectrum Analyzer, Scope Waveforms or Bargraph Display

By pressing the expand softkey within these displays, the entire screen (with the exception of the message line and softkey area) is overwritten and replaced by an enlarged version of the display section to enable a more detailed analysis of displayed data. A return softkey causes the screen to be restored to its original size.

3-2.2.2 Display Tables

Decode Tables are selected from the "Meter:" field. Selection of General Sequence, 5/6 Tone, or Select V decode modes causes the system to overwrite the meter and display zones with the display tables.

NOTE

To escape from a decode display table, return the cursor to the "Meter:" field and make an alternate selection.

Encode Tables are selected from the "Audio Mod Sum:/Mod Sum:" field. Selection of General Sequence or A/B Sequence encode modes and pressing the display table softkey causes the system to overwrite the meter and display zones with the display tables. Use the return softkey to exit to previous screen.

3-2.2.3 Dedicated Keys

Refer to the Other Functions portion of this manual (paragraph 3-8) for an explanation of expanded screens in the HELP, MEM, SPF, and CAL modes.

3-3 HELP

The analyzer provides on-screen operating instructions via the dedicated HELP key. Help screens are organized such that each display area has an associated help screen pertaining to that area of the screen. System help (figure 3-2) is available via a softkey within each help screen. Use the return softkey to return to the function in progress.

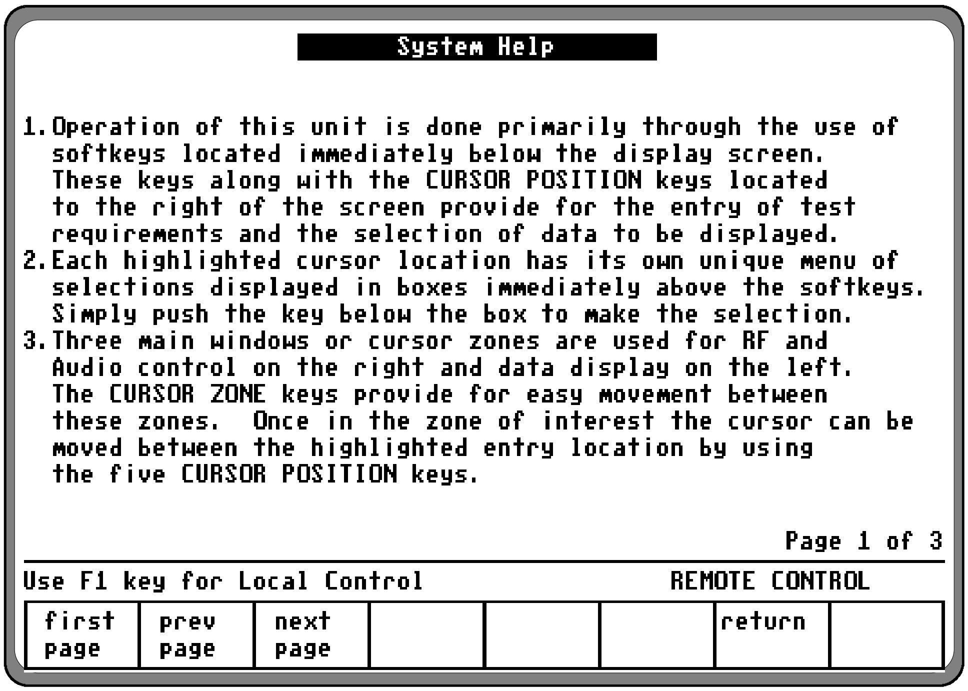


Figure 3-2. System Help

3-4 WARNINGS

The system provides warnings for the following operating conditions, which are considered detrimental to the proper functioning of the analyzer:

- RF Overload

  (Input level to monitor too great for accurate measurement)

- Recalibrate

  (Indicates that the unit's internal temperature has changed more than 10º C from where it was last self-calibrated. This may affect the accuracy of the generator output level, monitor input level below +20 dBm, and modulation level. Refer to paragraph 3-8.3 for further information.

- RF Overtemperature

  (Excessive power to RF load)

- Optional Battery Pack Voltage Low

If any of these conditions exist:

- A warning will be displayed on the warning line of the LCD for RF overload, recalibrate, and low battery voltage.
- A continuous audible warning tone along with an overwrite of the screen with a warning message will be presented for RF overtemperature (figure 3-3). This condition may occur when the intermittent power rating of the 125 watt internal load is exceeded. Both the display and the warning tone remain on and all operator input is ignored until the condition is corrected. The Analyzer then resumes normal operation.

CAUTION

Remove RF power immediately to correct the RF overtemperature condition. Otherwise damage to the unit may occur.

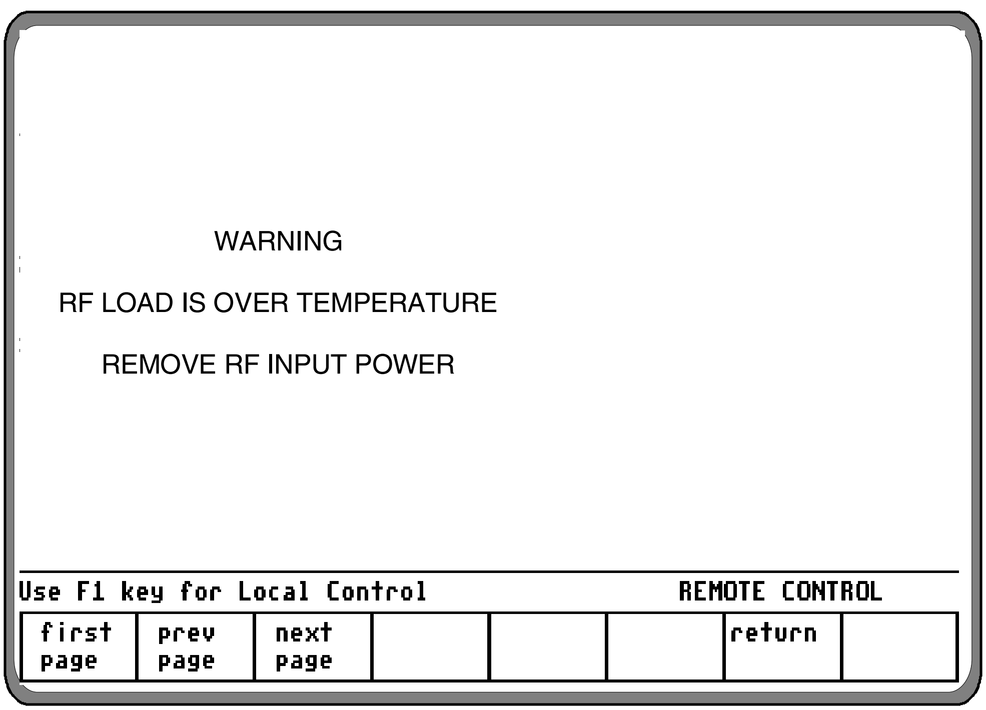


Figure 3-3. RF Overtemperature Warning Message

3-5 PRIMARY OPERATING MODES

Select the operating mode by placing the cursor in the "RF Control:" field in the RF zone. Use the desired softkey to make selection. Primary operating modes are:

- MONITOR
- GENERATE
- DUPLEX
- SWEEP GENERATE

3-5.1 MONITOR Mode

The Monitor mode (figure 3-4) provides the analyzer's test receiver function which is used in the testing of radio transmitters. It is capable of monitoring RF input through it's antenna or a direct connection to the transmitter to accurately determine the frequency, power level, and modulation characteristics. It monitors signals from 400 kHz to 999.9999 MHz. Center frequency is set in 100 Hz increments.

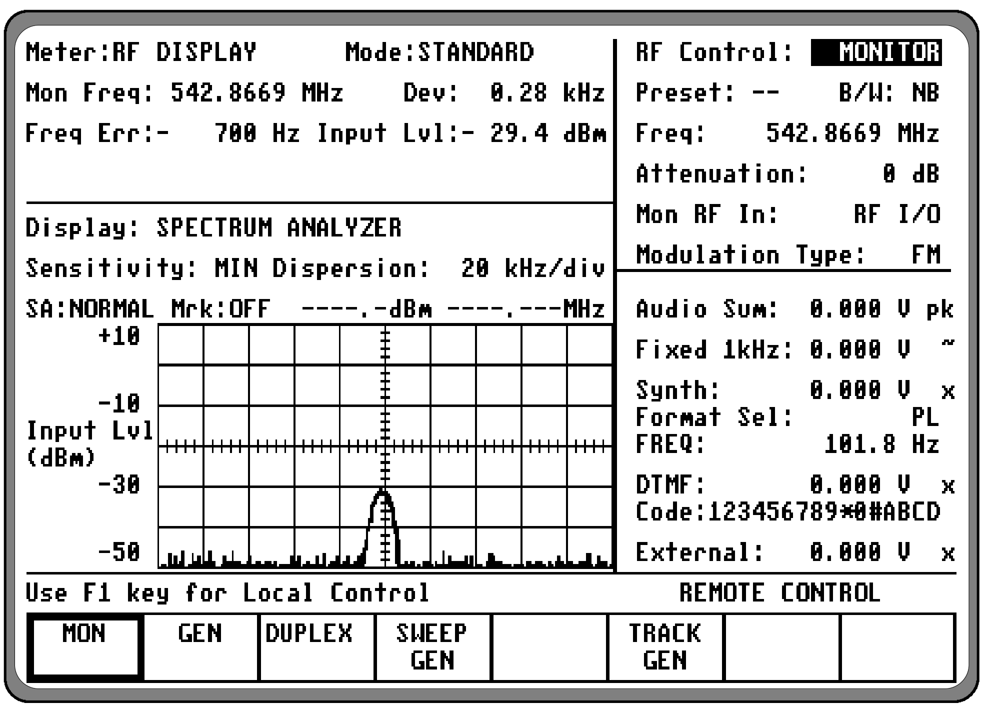


Figure 3-4. Monitor Mode

Specific controls which further configure the MONITOR mode are located within the RF zone when MONITOR is first selected. The specific entry fields are as follows.

Preset

The preset entry field provides a convenient way to enter a bandwidth, frequency, modulation type, and code synthesizer format for the unit by recalling preset data from non-volatile memory. If a preset is not to be used, enter the desired information at each of the fields.

NOTE

If a preset had been selected and changes are made to any of the preset values, the "Preset:" field will have dashes through it, indicating the preset is no longer selected.

B/W

Selects either wide or narrow IF bandwidth of the unit via softkey selection.

Freq

Enter the desired monitor frequency using keypad or tuning knob.

Attenuation

Selects the amount of attenuation at the RF input to the monitor receiver using softkeys. Selectable input attenuation is useful in adjusting displays for a wide range of input levels, as well as for use in high RF field environments where intermodulation may cause desensitization of the receiver.

Mon RF In

Selects the RF input port via softkeys. The RF I/O port contains an RF load and should be used for direct connection to the radio under test. The ANT port accesses the unit's sensitive receiver and should be used with an antenna for "off-the-air" reception. Selection of the ANT port is indicated by a red LED adjacent to the ANT connector.

CAUTION

Do not apply input power to the ANT input port. In the event RF power is inadvertently applied, the port is protected by an in-line RF fuse. This fuse may be accessed by unscrewing the front of the BNC connector out of the front panel. Refer to paragraph 2-2.4.1 for additional detail.

Modulation Type

Selects the type of modulation via softkeys. AM and FM are standard selections. Phase modulation (option) is selected by pressing the sofkey labeled PM, and provides the cpability to generate and monitor PM signals.

3-5.1.1 Phase Modulation

Phase Modulation provides the capability to generate and monitor PM signals. This is an additional softkey selection in the RF Control zone for the modulation type (figure 3-5).

In Generate mode, narrow-band operation provides user control of the audio signal deviation from 0.50 to 2.00 radians in 0.01 radian steps. In wideband operation, the audio signal deviation ranges from 2.0 to 10.0 radians in 0.a radian steps. Tones generated from the Audio zone are limited in frequency from 300 Hz to 3000 Hz for phase modulation

NOTE

Phase Modulation is a hardware option that is installed at the factory. To determine if Phase Modulation is available in the Analyzer, examine the Standard Options display screen (accessed via SPF/Version

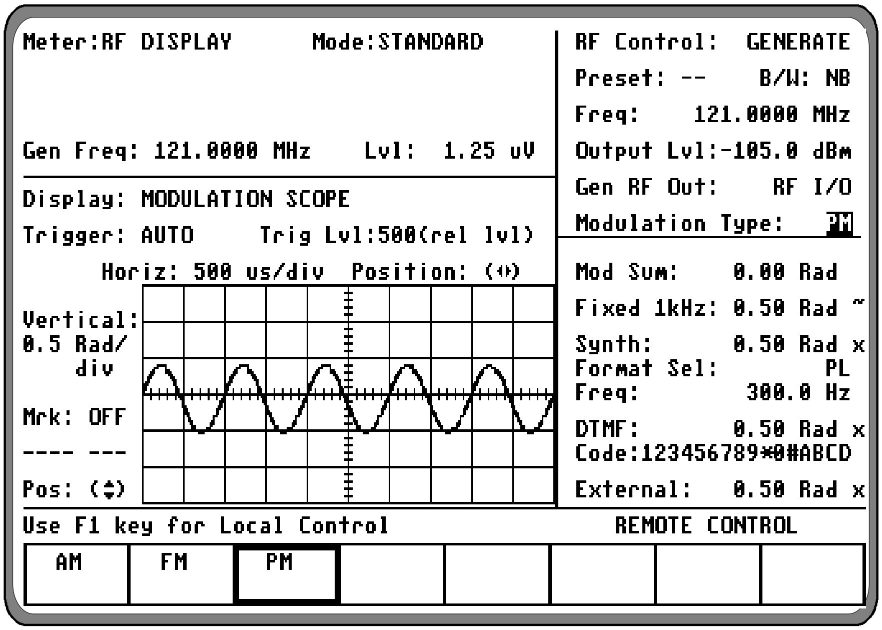


Figure 3-5. Phase Modulation

3-5.2 GENERATE Mode

The GENERATE mode (figure 3-6) configures the Analyzer to generate an RF signal at a controllable output level to provide for a wide range of receiver testing. Multiple internal andexternal modulation signals can be simultaneously impressed on the carrier frequency to generate composite signals for servicing. Signals from 400 kHz to 999.9999 MHz may be generated. Center frequency is set in 100 Hz increments.

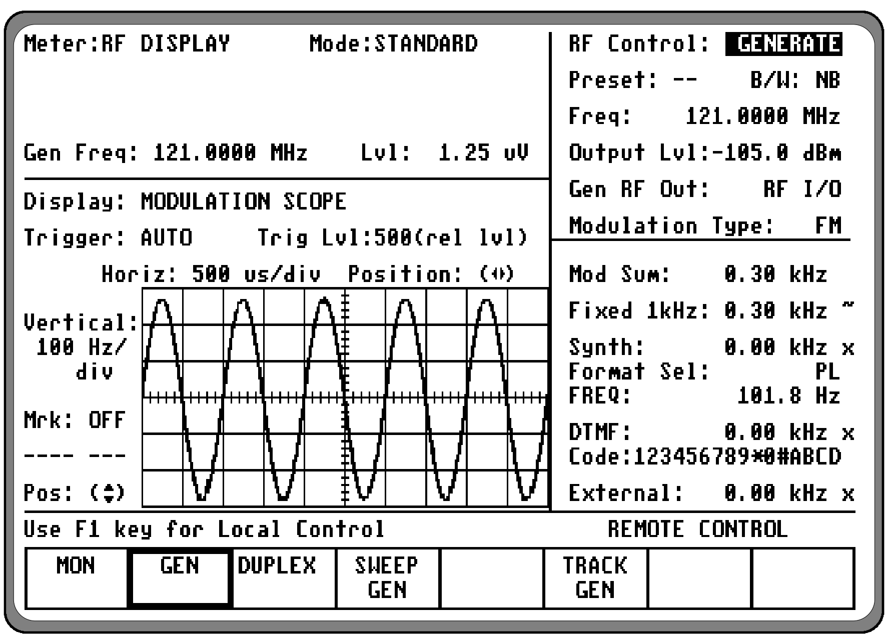


Figure 3-6. Generate Mode

Specific controls which further configure the GENERATE mode are located within the RF Control zone when GENERATE is first selected.

The specific entry fields are as follows:

Preset

The preset function is the same as in the MONITOR mode.

B/W

Selects either wide or narrow bandwidth of the unit via softkey selection.

Freq

Enter the desired generate RF frequency using keypad or tuning knob.

Output Lvl

Selects generator output level in 0.1 dBm steps over the range of -130 dBm to 0 dBm. An alternate display of generate level in microvolts is available in the "Meter:" area of the display zone. Output level is available in two ranges depending upon which output port is selected:

- The range of -80 dBm to 0 dBm is available when the high level GEN output port is selected.
- The range of -130 dBm to -50 dBm is available when the RF I/O output port is selected.

NOTE

If AM modulation is selected, the maximum output at the GEN port is reduced to -6 dBm; the maximum output at the RF I/O port is reduced to -56 dBm.

Gen RF Out

Selects the RF output port via softkeys. The RF I/O port is recommended for most applications where GEN and MON ports are combined for a single connection to the radio under test. The GEN port is recommended where higher levels are needed. Selection of the GEN port is indicated by a red LED adjacent to the GEN OUT connector.

CAUTION

Do not apply input power to the GEN output port. In the event RF power is inadvertently applied, the port is protected by an in-line RF fuse. This fuse may be accessed by unscrewing the front of the BNC connector out of the front panel.

Modulation Type

Selects the type of modulation via softkeys.

3-5.3 DUPLEX Mode

The DUPLEX Mode (figure 3-7) provides a simultaneous RF generator output that is offset in frequency from the monitor center frequency and fully adjustable in output level.

This capability provides for servicing full duplex radio equipment as well as repeaters and radios operating with offset transmit and receive frequencies.

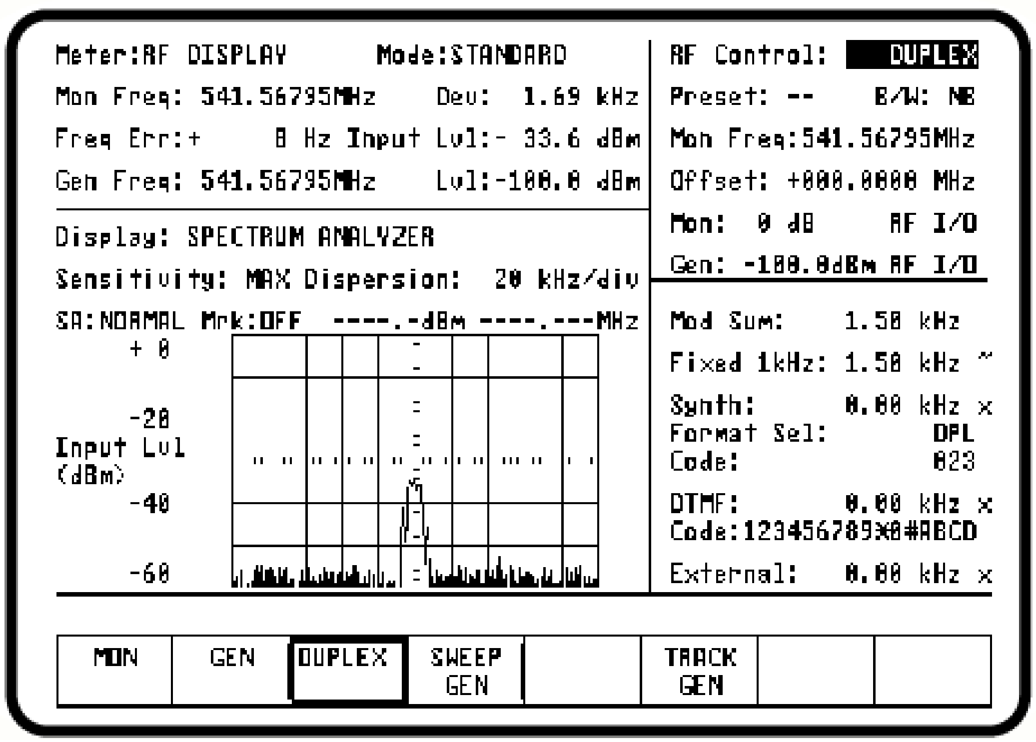


Figure 3-7. Duplex Mode

Specific controls which further configure the DUPLEX mode are located within the RF Control zone when DUPLEX is first selected.

The specific entry fields are as follows:

Preset

The preset function is the same as in the MONITOR mode.

B/W

Selects either wide or narrow bandwidth of the unit via softkey selection.

Mon Freq

Enter the desired monitor frequency using keypad or tuning knob

Wide Offset

Enter the generator frequency offset relative to the monitor frequency entered. Offset frequencies of –999.99975 to +999.99975 MHz are allowed, but the final generate frequency will be constrained to 000.40000 MHz through 999.99995 MHz. The offset frequency is set in 2.5 kHz steps.

Mon

This field actually contains two separate fields, one for monitor input attenuation and one for monitor port selection. Refer to the MONITOR description for further details.

Gen

This field actually contains two separate fields, one for generate output level and one for generate output port selection. Refer to the GENERATE description for further details.

NOTE

Only FM modulation is provided for the duplex generator. Either FM or AM demodulation may be selected. Selection must be done in MONITOR Mode within the RF control zone. The RF I/O port combines monitor and generate signals for the duplex function. However, either the ANT or GEN ports may be independently selected.

3-5.4 SWEEP GENERATE Mode

The SWEEP GENERATE Mode (figure 3-8) provides a sweep generator function with variable level, rate, and bandwidth. A sweep generator is invaluable when measuring and troubleshooting many types of RF filters and frequency variable networks such as IF filters, RF preselectors, duplexers and cavity resonators.

To sweep test connect the GEN output port to the input of the network under test.

To facilitate display of swept responses of networks under test, the units built-in scope display can be accessed by selecting SWEEP GENERATE within the "Display:" field. A suitable RF detector probe should be used to connect from the output of the circuit under test to the VERT/SINAD/DIST input port (refer to ordering instructions provided in the front portion of this manual for recommended accessory RF detectors). The scope's horizontal sweep tracks the sweep of the RF Generator, thus allowing a frequency domain analysis of filterfilters, RF front ends, duplexers, etc.

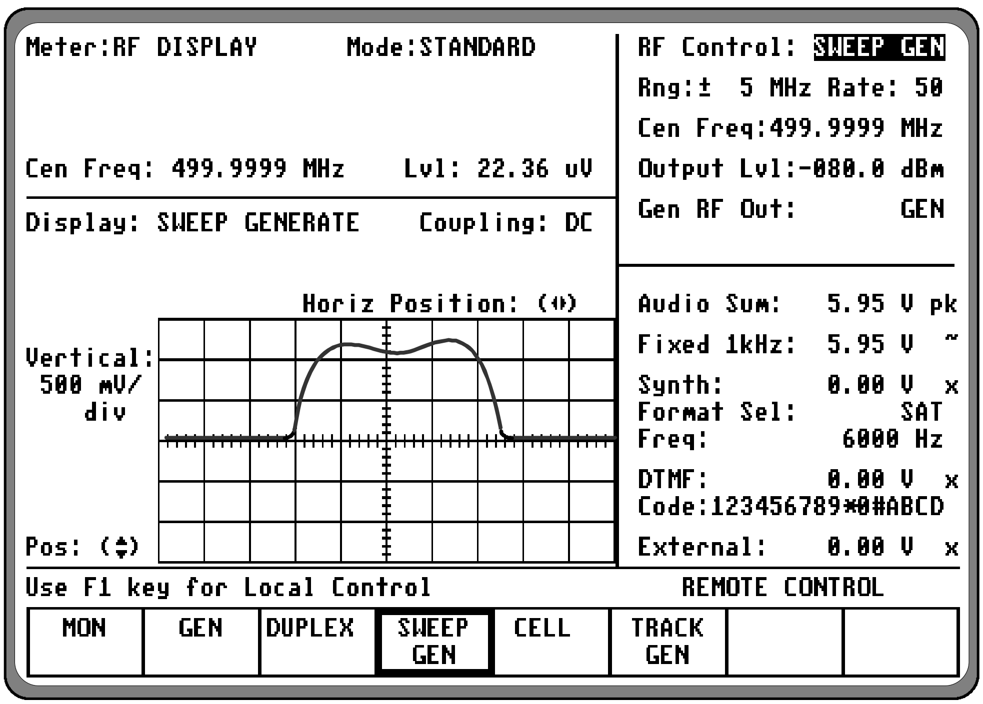


Figure 3-8. Sweep Generator Mode

Specific controls which further configure the SWEEP GENERATE mode are located within the RF Control zone when SWEEP GENERATE is first selected. The specific entry fields are as follows:

Rng

Selects the RF frequency range over which the generator will sweep. Specific ranges are selectable via softkeys.

Rate

Selects the sweep rate for the generator and corresponding scope display. Sweep rate is selectable using softkeys.

Cen Freq

Refer to the GENERATE mode, "Freq:" field.

Output Lvl

Refer to the GENERATE mode.

Gen RF Out

Refer to the GENERATE Mode.

3-5.5 TRACKING GENERATOR Mode (if equipped)

The TRACK GENERATOR mode (figure 3-9) sets up the units signal generator in a sweeping mode for use with the optional Tracking Generator display. This provides a valuable capability for measuring and servicing a wide variety of RF filtering and combining networks.

To operate the Tracking Generator simply select TRACK GEN via softkey in the "RF Control:" field in the RF Control zone. Connect the GEN OUT port to the input of the network under test.

Connect the output of the network under test to the ANT port. Be sure to activate the ANT port thru the "Mon:" field in the RF Control zone. If input attenuation is needed as part of the measurement procedure, 20 or 40 dB attenuation may similarly be selected thru the "Mon:" field in the RF Control zone.

The Tracker display is selected through softkeys at the "Display:" field of the DISP zone at the left center of the screen. The display is a 10 dB/div scale. By adjusting the generator level and selecting 20 or 40 dB of input attenuation, the usable measurement range is approximately 100 dB at frequencies below 500 MHz and 80 dB above 500 MHz.

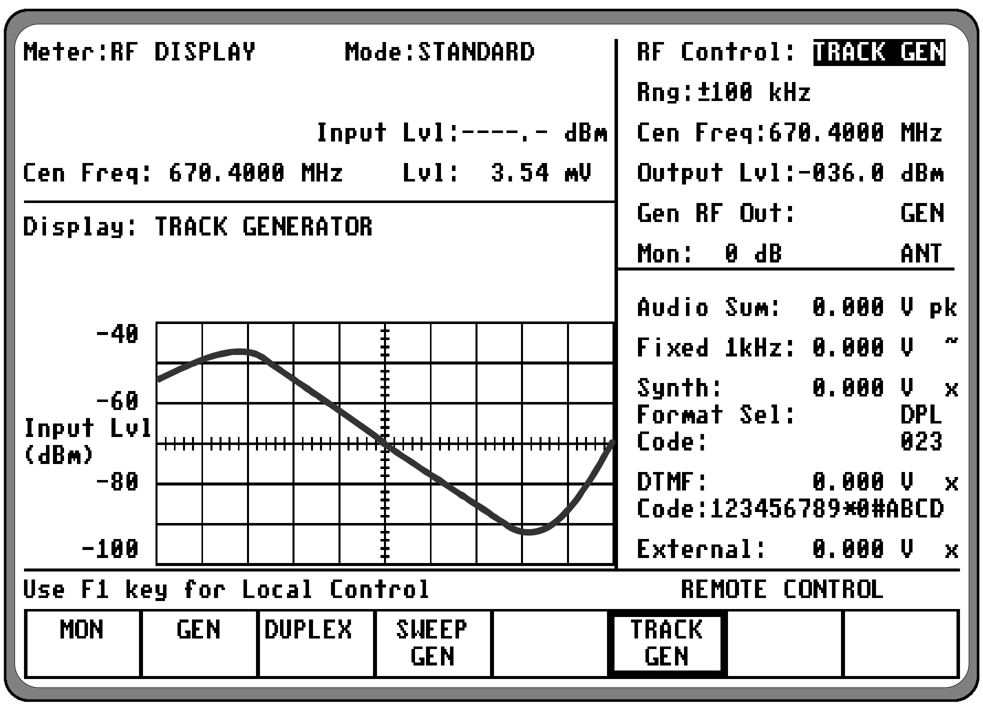


Figure 3-9. Tracking Generator Mode

All adjustments of center frequency, frequency range and generator level are made thru the RF zone at the upper right of the screen. The TUNING control is especially useful in tuning center frequency and generator level. These may all be adjusted as follows, thru softkeys or numeric entry, for the desired display, depending on the type of network being tested.

Rng

Selects the RF frequency range over which the generator will sweep. These are expressed in ± full screen deflection ranges that are selectable via softkeys. The sweep rate of the tracking generator is fixed at approximately 50 ms/sweep.

Cen Freq

Selects the center frequency of the Tracking Generator display. Refer to the GENERATE mode for more detail on frequency entry.

Output Lvl

Refer to GENERATE mode.

Gen RF Out

Refer to GENERATE mode.

3-6 AUDIO/MODULATION SYNTHESIZER

The Audio zone located at the lower right of the screen is used to control the multi-purpose audio synthesizer section of the unit. Signals generated by the audio synthesizer are coupled internally to the generator modulation input as well as to the MOD OUT front panel connector.

In the GENERATE and DUPLEX modes, levels entered in the Audio zone are shown as modulation (either deviation or % AM). The composite sum of modulation, only for those modulation sources enabled, is displayed at the top of the zone at the "Mod Sum:" location.

In the MONITOR and SWEEP GENERATE modes, levels entered in the Audio zone are shown as peak voltage values. The composite sum of the voltage value (only for those modulation sources enabled) is displayed at the top of the zone at the "Audio Sum:" location.

Each of the following modulation signals has a cursor field for entering it's desired level. Use the keypad or TUNING knob to enter the desired level.

An additional cursor field, adjacent to each level entry, is used to enable or switch each selection on and off using softkeys. This field is located at the extreme right side of the zone. There are three possible conditions for this softkey selection.

- CONT activates continuous ON condition, or continuous cycling if a sequence has been selected. A ~ symbol is indicated at the extreme right, adjacent to the level to indicate continuous ON.

- OFF switches off the modulation source. Off is indicated by an "X" at the extreme right, adjacent to the level.

- BURST provides a single timed sequence of modulation only for DTMF, TONE A, TONE B, 5/6 TONE, A/B SEQUENCE, GENERAL SEQUENCE, and TONE REMOTE. A single burst sequence is shown by the "*" symbol.

For DPL, select the START DISC TN (*) softkey to produce a continuous disconnect tone. (Select CONT then "*" softkeys to simulate a complete DPL transmission with disconnect tone.)

The composite sum at the top of the zone will not indicate the burst condition. To set the composite level to include bursts of signaling, temporarily select CONT for those modulation sources which will be "burst" enabled.

3-6.1 Fixed 1 kHz

The analyzer has a fixed 1 kHz modulation source, which can be selected independently from the other audio synthesizers. Level control and on-off selection previously described.

3-6.2 Synth

Level control and on-off selection are selectable via softkey selection. The synthesizer function encodes a broad selection of signaling formats, which are softkey selected through the "Format Sel:" field adjacent to "Syth:" level field. Use of the more softkey accesses three different menu levels for the following signaling formats.

PL

This softkey selects Motorola Private-Line tone coded squelch signaling. This selection produces two additional fields on the line below the "Format Sel:" field (figure 3-10). The first allows for softkey selection of either frequency or code entry. The second is the value corresponding to the frequency or code. Valid PL codes are found in Appendix B. All frequency entries are accepted, but only valid codes can be entered.

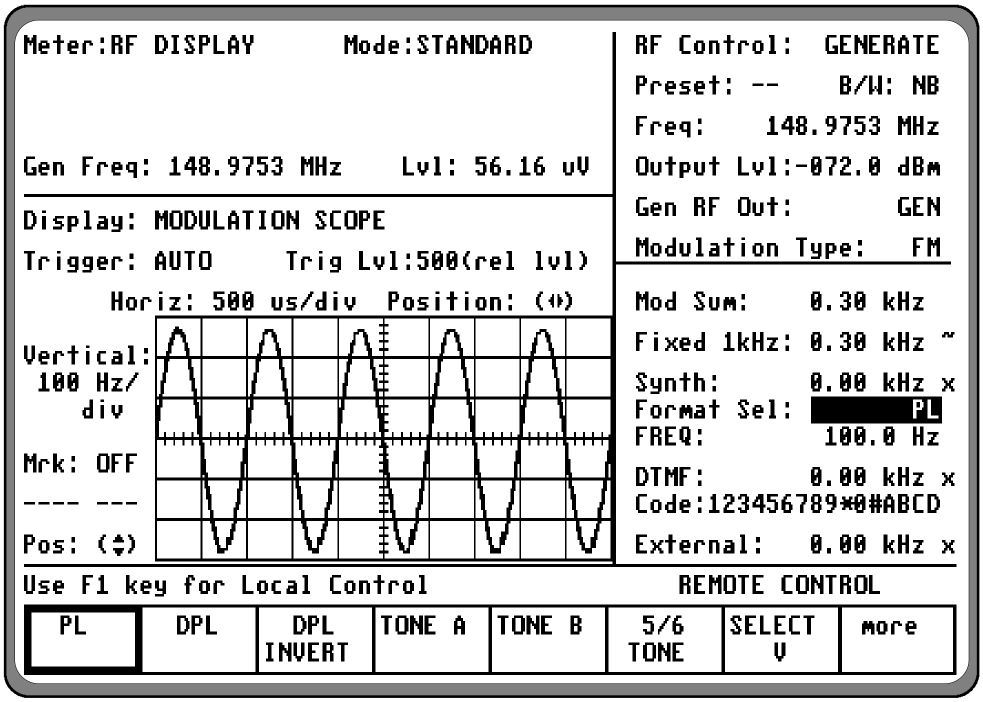


Figure 3-10. PL Format Selection

DPL/DPL Invert

This softkey selects standard or inverted Motorola Digital Private-Line coded squelch. A single cursor field is located below the "Format Sel:" field for entry of code. Only valid DPL codes should be entered per Appendix B.

Tone A/Tone B

This softkey selects either of two continuous audio tones. Tone frequencies may be entered either from the "Freq:" field or from the A/B Sequence tables.

5/6 Tone

This softkey selects 5/6 tone sequences for high-capacity tone paging systems. Only code entry is required in the "Code:" field.

Select V

This softkey selects a number of international formats for five-tone sequential signaling. This selection produces two additional fields on the "Code:" line below the "Format Sel:" field. The first allows a choice of format, selectable by soft-keys. The second selects the numeric code entered by keypad or softkeys.

A/B SEQ

Selects the two-tone sequential paging format, with a choice of four timing sequences selectable through the "Sequence:" field on the line below. An expanded display table can be selected from softkeys to allow entry of A and B frequencies, select a sequence number, and view the tone and delay timing for each sequence. Sequences 1 and 2 are fixed timing for standard "tone" and "tone/voice" pagers, while sequences 3 and 4 may be customized through numeric entries by the user.

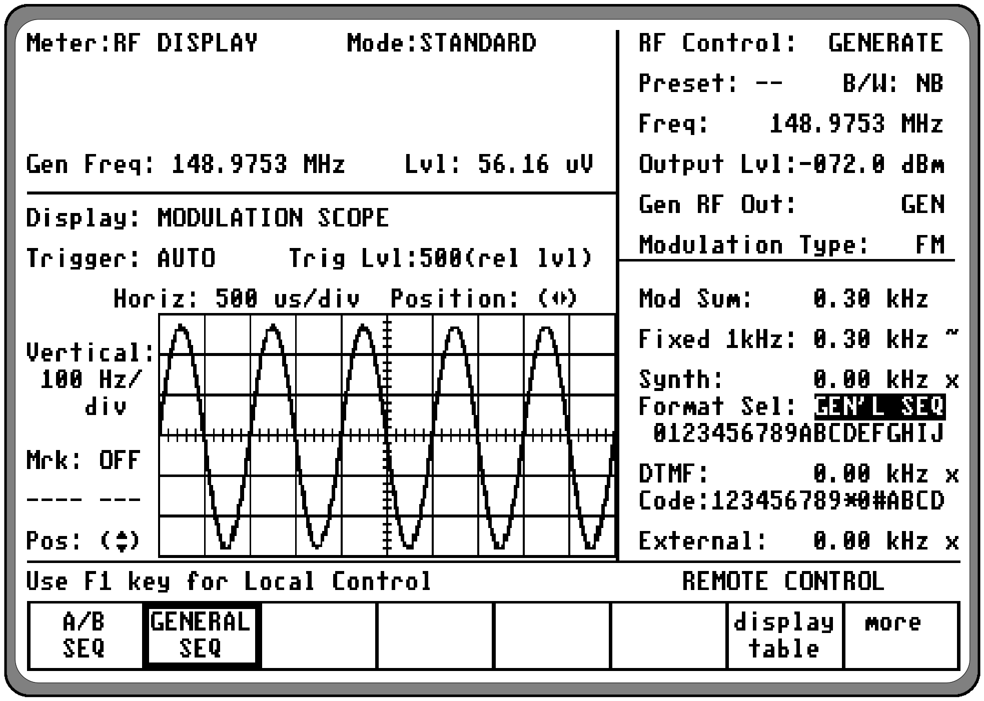
General SEQ

Selects a free-form 20-tone sequence encoding which has full flexibility to enter unique frequency and time duration for each of the 20 tone slots. The single field below the "Format Sel:" field is used to enter the frequency code sequence. An expandable display table is selectable by softkey to allow entry of frequency and time duration data (figure 3-11). Frequencies and durations are tabulated corresponding to a given "code number" (i.e. 1], 2], 3], etc.).

Frequency and times are each selected independently. This is done through entry of independent "Code Sequence:" and "Dur Sequence:" (for example, Code 1] may be selected along with Dur 8] for the first tone slot in the sequence).

Tone Remote

Selects the specialized tone sequence used in control of tone remote equipment. The frequencies used are the same as those for the A/B sequence with timing predetermined per Motorola Tone Remote specifications. Changes to the A and B frequencies can be made from the A/B Sequence table or directly from the Tone A and Tone B "Freq:" fields.



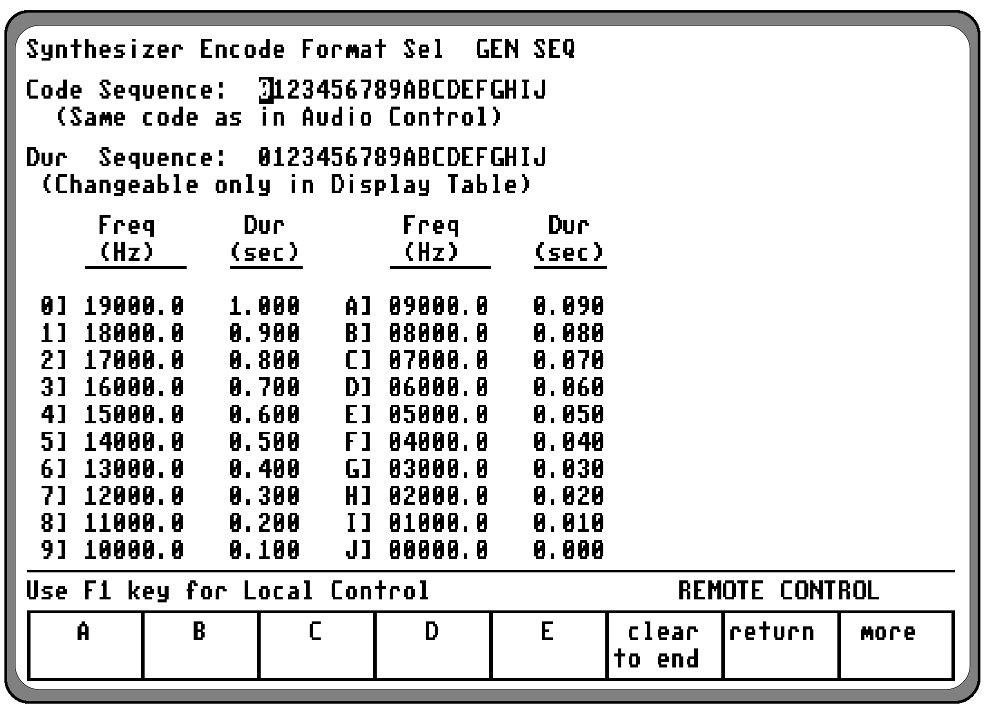


Figure 3-11. General Sequence Mode Select

3-6.3 DTMF

Provides a means for encoding DTMF (Dual-Tone Multi-Frequency) signaling for testing telephone interface systems. Enter level as previously described and enter "Code:" in the field immediately below the "DTMF:" field.

3-6.4 External

Used to set the level and enable externally applied signals from both the MIC and the EXT MOD IN front panel connectors.

NOTE

In the case of external signals applied to the EXT MOD connector, the accuracy of this level displayed is dependent on applying a fixed signal level of 1 Vpk (2 Vpkpk) to the EXT MOD IN connector.

3-7 METER AND DISPLAY

The display of metered data is presented both digitally and graphically within the Display zone in the left portion of the screen (figure 3-12). This zone is divided into two separate display areas: Meter area and Display area.

3-7.1 Meter

Select a measurement display from the following, using softkeys from the "Meter:" cursor field.

3-7.1.1 RF Display

This area displays the RF test data for the radio under test, subject to the mode selected (MONITOR, GENERATE, DUPLEX, TRACK GENERATE, or SWEEP GENERATE).

When the GENERATE mode is selected, the RF Display area shows generator center frequency as well as generate level per the RF Control zone entry. A single cursor field at this location allows selection by softkey of either millivolts/ microvolts (mV/uV), dBu, or dBm units of display.

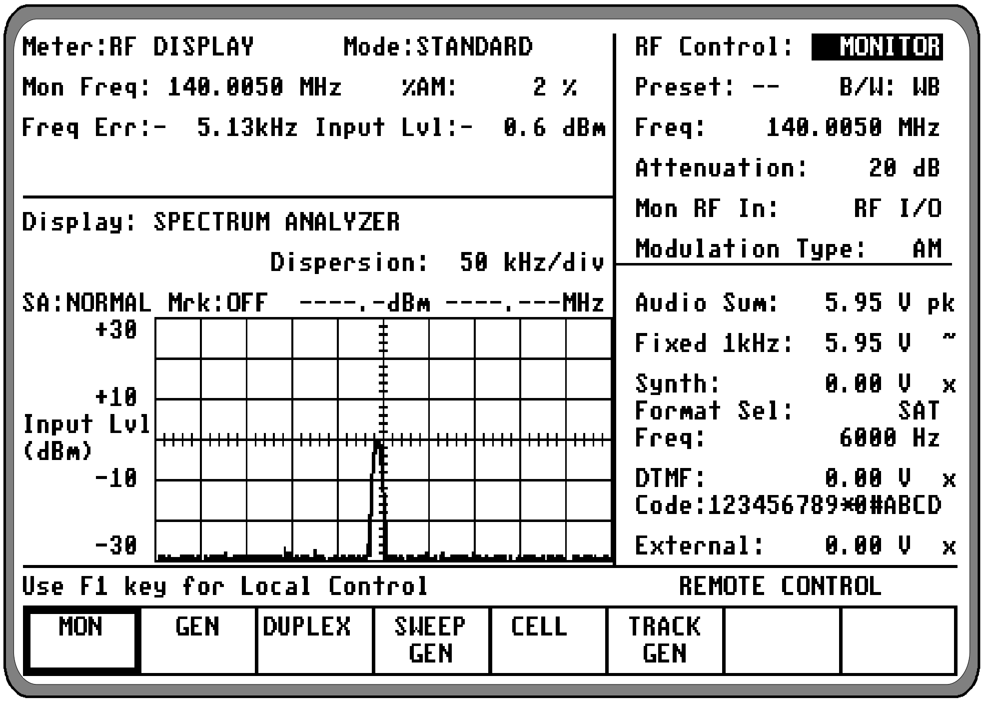


Figure 3-12. RF Display Zone

When DUPLEX mode is selected, the RF Display area reflects a combination of the monitor and generator data, as previously described.

When SWEEP GENERATE mode is selected, the RF Display area reflects the same data as in GENERATE mode. Refer to the previous discussion.

In the MONITOR Mode, the following data is displayed in the RF Display area.

Mon Freq

Center frequency of the radio under test as entered in the RF Control zone.

Freq Err

This area displays the plus or minus frequency offset (error) of the received carrier relative to the center frequency entered above. If the receive phase modulation option is installed and selected in the RF Control zone, this location will display in radians.

Dev/%AM

Indicates the modulation level of the received carrier, dependent upon the modulation type selected in the RF Control zone. If the receive phase modulation option is installed and selected in the RF Control zone, this location will display in radians.

Input Lvl

Displays the signal level received at the selected front panel connector. This area displays transmitter power for high levels of input as well as lower levels of field strength.

Data is displayed only for "on channel" carrier frequencies. A single cursor field at this location allows selection by softkey of either microvolts/watt or dBm units of display.

3-7.1.2 RF Scan

The "Meter:" RF SCAN display (figure 3-13) provides an alternate form of monitor frequency display from the main RF display.

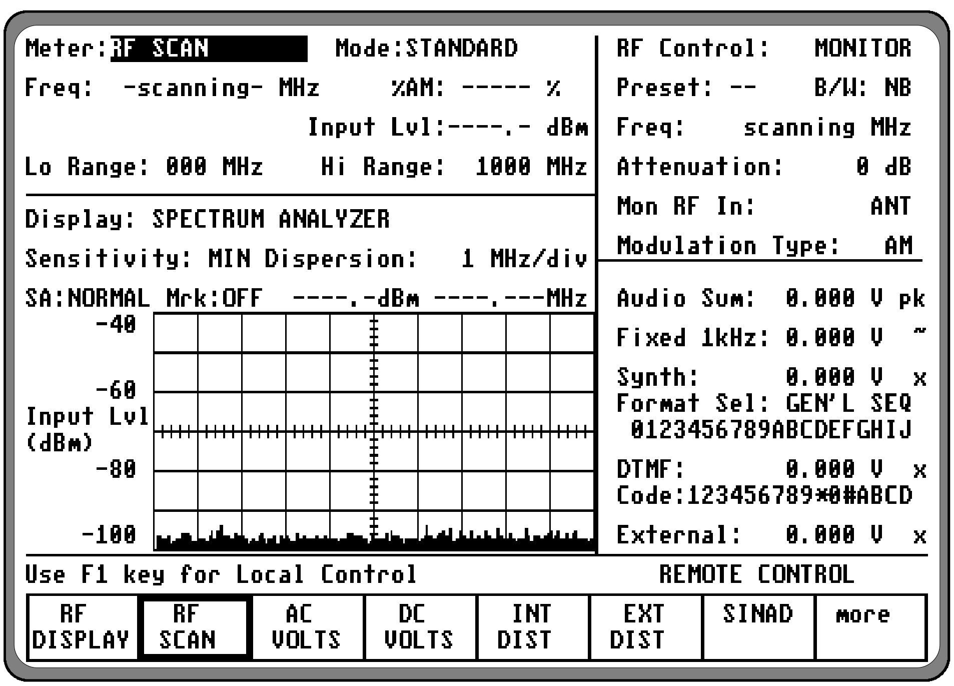


Figure 3-13. RF Control Zone; Scan Mode

It provides an RF frequency counter function where the monitor scans over a selected frequency range and locks on to the carrier that is applied to its input. The direct frequency is then displayed, eliminating the need to first enter the carrier frequency and read its error. The acquired signal is measured to a frequency resolution of 1 Hz.

The RF signal input, either from the ANT or from the RF I/O port, may be displayed. The analyzer scans a specified frequency range to automatically acquire and tune to an input signal from 20 MHz to 999.9999 MHz.

Tuning typically occurs within 5 seconds. For faster acquisition, limit the scan range to 100 MHz increments. This is done by setting the High and Low range limits to narrow the scan range. Move the cursor to the desired Hi or Lo range field in the Meter portion of the screen. Select the range desired either by using the numeric keypad or the optical TUNING knob.

NOTE

The range of values for the low range setting is from 0 to 9 (x 100 MHz). The range of values for the high range setting can be from 0 to 10 (x 100 MHz), with the 10 implying maximum frequency range, or 999.9999 MHz.

Minimum input signal level for automatic frequency acquisition is -30 dBm at the antenna port and +20 dBm at the transceiver port. When the input signal is removed, the scanning operation will resume.

When scanning, the "Freq:" field within the RF Control zone indicates **scanning**. When a carrier is acquired, this changes to **metering**. The actual measured frequency is displayed in the Meter zone along with modulation and level data as described above for RF Display.

3-7.1.3 AC/DC Voltmeter

The analyzer provides a general purpose AC/DC digital voltmeter (figure 3-14). The voltmeter input is the same front panel BNC port that also serves as the input for the SINAD/DIST meter, the VERT oscilloscope input, and the frequency COUNTER IN.

Move the cursor to the "Range:" field. Select either auto-ranging or a specific voltage range (AUTO, 1V, 10V, or 100V DC) by pressing the applicable softkey. Maximum AC range is 70 VAC. If the optional battery pack is installed, an additional selection is available to read the battery voltage.

CAUTION

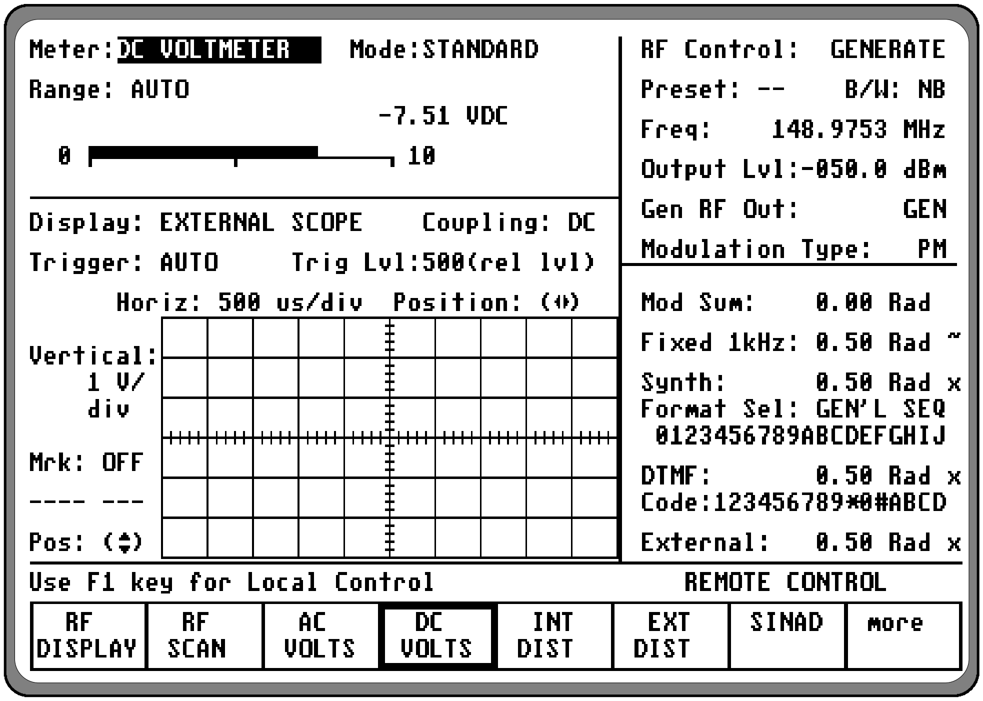
The maximum analyzer input voltage is 42.4 volts peak AC or 60 volts DC.

The data portion of this screen will show a horizontally oriented bar graph for an analog indication along with a digital readout of the measured voltage (up to 4 digits resolution).

In the AC mode, the measured input is also displayed in dBm, referenced to 1mW into 600 ohms.

NOTE

Optional "C" message or CCITT filters, along with a 600 ohm load, are available for selection at the ACVM, SINAD, and Distortion meter inputs. If your unit is equipped with one of these, they are selectable through the Special Function screen (refer to section 3-8.5). If one of these is selected an appropriate message will appear on the message line just above the softkey labels. ***CAUTION: Selection of either filters or load can affect readings within these meter functions.***



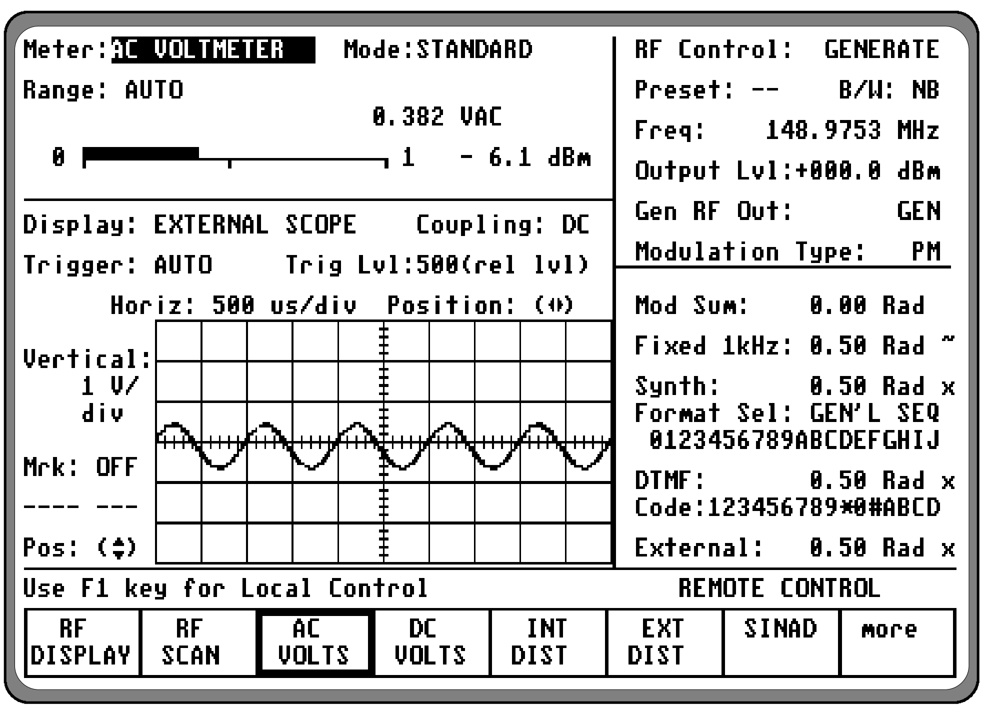


Figure 3-14. Digital Voltmeter Screens

3-7.1.4 INT DIST/EXT DIST Meter

The internal and external distortion meter are selectable via softkeys located within the "Meter:" field in the Display zone. Display consists of a digital readout and bar graph. Distortion is used to measure the audio quality of the transmitter and receiver modulation. The distortion meter is selectable via softkey between internal (coupled from the monitor demodulated signal) and external (through the DIST input on the front panel).

The distortion meter operates only at the fixed frequency of 1 kHz.

3-7.1.5 SINAD Meter

The SINAD meter is selected within the "Meter:" field in the Display zone. Display consists of a digital readout and bar graph. SINAD is used in making receiver sensitivity measurements per EIA specifications using a fixed 1 kHz modulation frequency.

Internal coupling for SINAD is not provided; input is always via the external BNC port on the front panel.

NOTE

Optional "C" message or CCITT filters, along with a 600 ohm load, are available for selection at the ACVM, SINAD, and Distortion meter inputs. If your unit is equipped with one of these, they are selectable thru the Special Function screen (refer to section 3-8.5). If one of these is selected an appropriate message will appear on the message line just above the softkey labels. ***CAUTION: Selection of either filters or load can affect readings within these meter functions.***

3-7.1.6 Counter and Decoding Functions

The following are all accessed via softkey through the "Meter:" field within the Display zone. Their inputs are all normally internally coupled to the monitor demodulated signal for either direct or "off-the-air" testing. If use of these functions is needed for an externally applied signal, the Special Functions screen, under SYSTEM FUNCTIONS, provides a means of switching the input of the Counter/decoder from Internal to External.

These screens contain a "Sensitivity:" field where MIN or MAX may be selected via softkey. This provides a means to desensitize the counter/decoder circuits, if needed to properly measure very high level signals. Under normal operation, this field should be set to MAX.

Cursor fields are provided to access the units low-pass and high-pass baseband filter sections. Filters may be used to remove unwanted voice modulation, etc. which may interfere with decoding the PL signals. Baseband filters apply only to internal coupling.

CAUTION

Entries into the high and low pass areas of this screen write information into the Special Functions screen and memory. To avoid problems with other modulation measurements, make sure settings are set to original values before leaving these screen areas.

The display exhibits a digital frequency and equivalent PL code if applicable. Refer to Appendix B for valid codes.

PL/PER Counter

This softkey provides a convenient means of measuring the frequency of Motorola Private-Line (PL) or any other low frequency audio tones with 3 digit resolution. Period measurement makes it possible to measure low frequencies down to high resolution without the need for the long gate times associated with frequency counting.

CAUTION

Do not input frequencies above 400 kHz to the period counter. Slow down of system operations will result.

DPL Decode

This softkey provides decoding for valid Motorola Digital Private-Line (DPL) codes. Refer to Appendix B for applicable codes. Selection of high and low pass filters may be made from this screen as previously described.

DTMF Decode

This softkey provides a means of decoding DTMF (Dual Tone Multi Freq) signaling for testing telephone interfaced systems. A "reset" softkey clears the display.

FREQ CNTR

This softkey provides a general purpose frequency counter (figure 3-15) for Audio and IF frequency measurements up to 500 kHz. For RF frequency measurements, use the MON function.

The "Resolution:" field provides selection of auto ranging or selectable gate times which provides up to 0.1 Hz resolution (0.1 Hz resolution requires 20 sec gate time). The symbol to the right of the display is an indication of when gating occurs.

NOTE

Selection of any of the General Sequence, 5/6 or Select V decoding functions produces an overwrite display table. To exit this display an alternate selection must be made from the "Meter:" field of the Display zone.

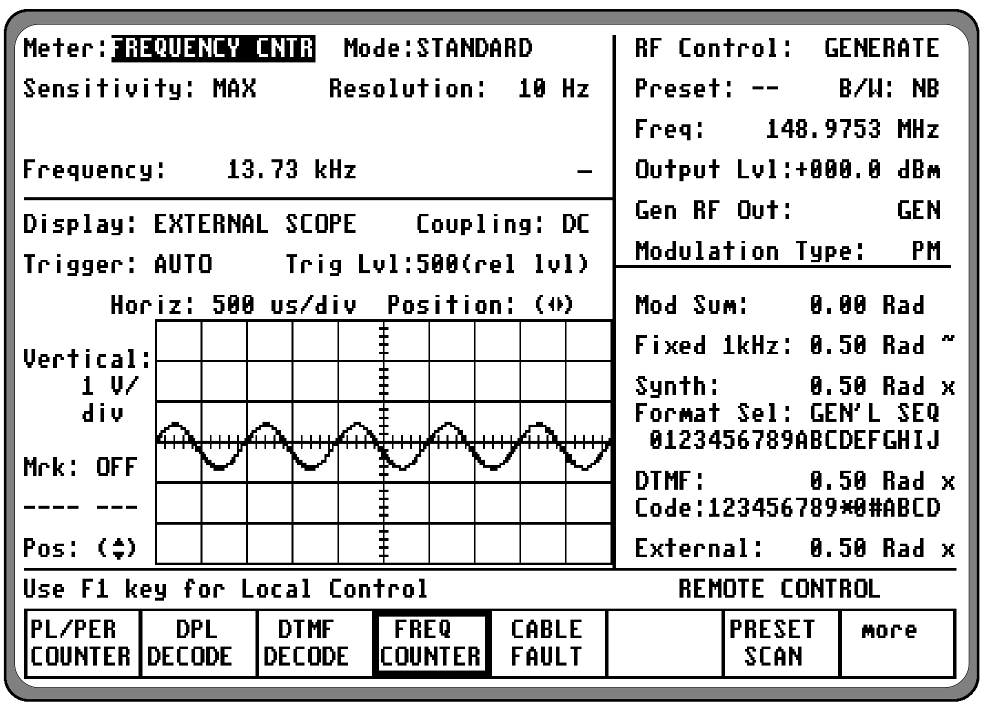


Figure 3-15. Frequency Counter

3-7.1.7 CABLE FAULT (if equipped)

This feature provides the capability to test 50 ohm RF cables for damage or mis-terminations through a simple connection to the input of the cable. It employs the analyzer's Sweep Generator capability to sweep the cable under test and observe any standing wave pattern caused by mis-termination. Analysis of this standing wave pattern on the scope display and the marking of two adjacent nulls in this pattern allows the analyzer to compute the distance to a fault or mis-termination. The cable fault feature is accessed by softkey from the "Meter:" field location in the Display zone as shown in figure 3-16. This automatically selects the appropriate displays in the RF Control and Display zone. The main operation of this feature is controlled thru the "Meter:" field, but the "Rng:", "Output Lvl:" and "Vertical:" fields from the other zones must be adjusted for a proper sized screen display depending on the test frequency and type of fault under test. When these have been adjusted, the test is run from the "Cen Freq:" field in the "Meter:" zone. Refer to section 4-3 in the applications section for a more detailed description of running the test.

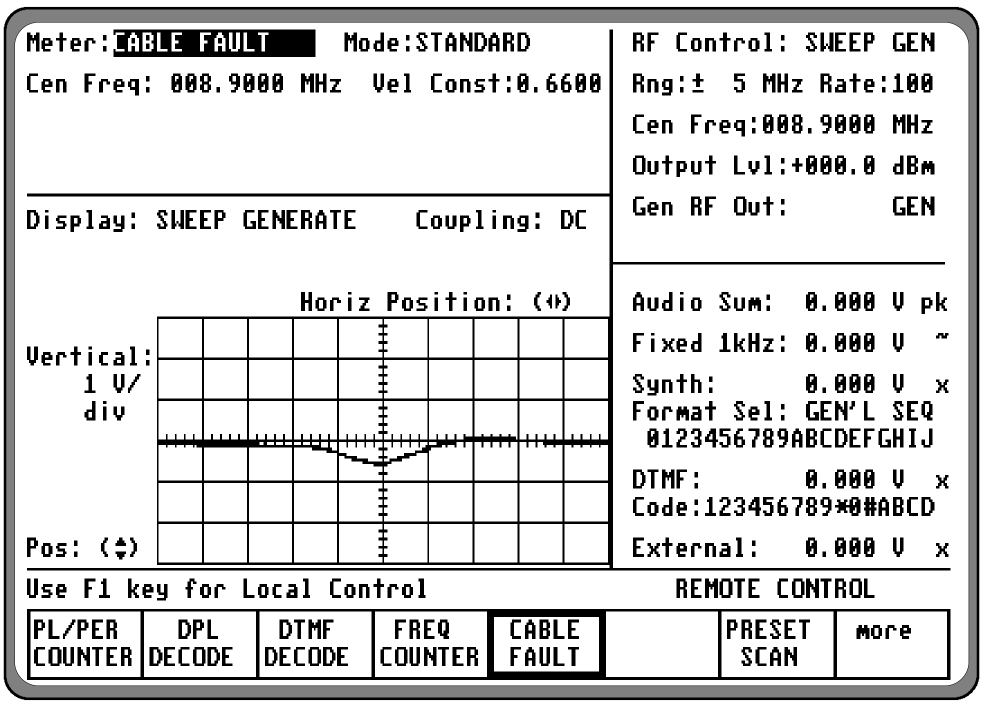


Figure 3-16. Cable Fault Screen

3-7.1.8 GENERAL SEQ DECODE

This softkey provides a free-form decoding function for individual frequency and time duration of tone sequences up to 20 tones. Selection of this mode overwrites the entire display section of the screen and provides a detailed display of data. Start and stop softkeys are used to control the decoding function.

5/6 Decode

This softkey provides a decoding function for 5/6 tone high capacity tone paging systems. Selection of this mode overwrites the entire display section of the screen and provides a detailed display of data. Start and stop softkeys are used to control the decoding function.

SEL V Decode

This softkey provides a decoding function for a number of standard international Select V sequential tone signalling formats. Selection of this mode overwrites the entire display section of the screen and provides a detailed display of data. A "Sequence Select:" field is provided within formats (ZVEI, ZVEI MOD, ZVEI FRENCH, CCIR STD, CCIR 70ms, EEA) which are selected by softkey. Start and stop softkeys are used to control the decoding function.

Handshake

Handshake testing is also provided through an additional start HANDSHK softkey. This links the SELECT V encode sequence selected in the Audio zone to the decode screen. Pressing the start HANDSHK key will send a SELECT V tone burst from the decode screen which will then decode the resulting response from the radio.

3-7.1.9 Preset Scan (if equipped)

The analyzer provides a preset scan function in which the preset monitor frequencies stored in the RF memory are continually scanned. The analyzer scans through the preset frequencies, stopping and dwelling on a channel whenever the receiver squelch is broken. When the receiver becomes squelched again, scanning resumes. All 30 preset monitor frequencies, or a subset consisting of a continuous block of frequencies, can be scanned. When no signals are detected, the analyzer scans through all 30 preset frequencies in less than 1/2 second. If the number of frequencies is reduced, the scanning process is faster. RF signals to be scanned can be input from either the ANT or RF I/O ports.

To activate the Preset Scan function, press the **PRESET SCAN** softkey (figure 3-17). This key not only begins the preset scanning but also serves as a "continue key" to temporarily skip past a channel with heavy radio traffic. When the analyzer is locked on a preset frequency and you wish to continue scanning, although the signal is preset, press the **PRESET SCAN** softkey again. This continues the scanning with the next preset frequency in the memory table. Pressing the **PRESET SCAN** softkey only skips over the frequency once; if radio traffic is still present on that frequency the next time that it is scanned, the analyzer will stop and dwell once again.

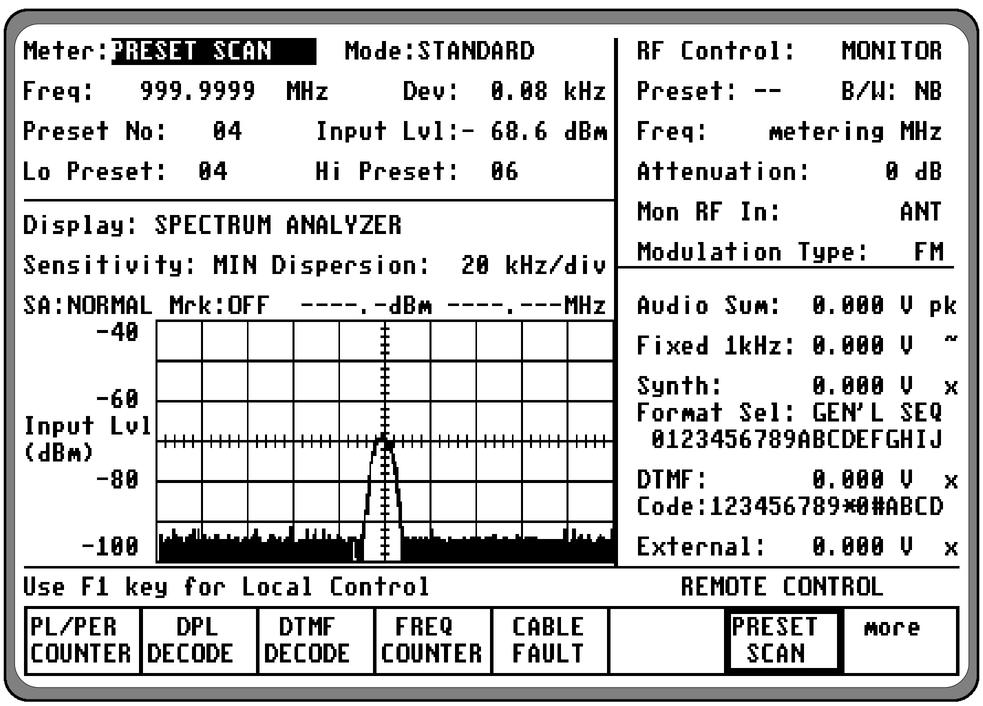


Figure 3-17. Preset Scan

The number of preset frequencies to be scanned can be limited by using the Low Preset and High Preset fields in the meter zone. Entries in these fields will cause the analyzer to only scan from the low preset number to the high preset number. By carefully arranging the preset frequencies in the RF memory into related groups, you can make maximum use of the Low Preset and High Preset scan limiters. For example, a particularly busy preset frequency which is causing the analyzer to stop scanning and dwell for long periods of time can be removed from the scan list by moving it within the RF memory table to a location just above or below the preset numbers being scanned.

It is recommended that frequencies in the RF memory table be grouped according to their modulation type and bandwidth because these parameters must be manually changed in the analyzer's RF Control zone. If an AM frequency (e.g. aircraft band) is intermixed with FM frequencies (e.g. public service band) in the scan list and the analyzer is set to FM mode, radio traffic on the AM frequency will cause the scanner to lock, but the received audio will be unintelligible and the modulation measurement meaningless.

Because breaking the receiver squelch causes the analyzer to stop scanning, it is important to properly adjust the squelch control. If the squelch is adjusted too loosely (counterclockwise rotation of the squelch knob), it is possible that desired signals will not be strong enough to break the squelch and the analyzer will not stop and dwell on the channel. To adjust the squelch control for proper scanning operation, turn the squelch control fully counterclockwise and activate the Preset Scan mode. The analyzer will not scan because it will lock on the first frequency due to the squelch being open. Now slowly rotate the squelch control clockwise, just until the squelch light goes out, the noise in the speaker stops and the unit begins to scan. If an actual signal is received while the squelch is being adjusted, wait until it ends before resuming the adjustment. For maximum sensitivity, the squelch level should be adjusted as loose as possible (counterclockwise) without being broken by receiver noise.

To halt the scanning operation at any time, press the **RF DISPLAY** softkey. This stops the scanning process and leaves the analyzer locked onto the last scanned frequency prior to the key press.

NOTE

When the unit is in the Preset Scan mode, the response time to key presses will be somewhat slower than normal. For best results, it is recommended that you do not leave Preset Scan active when it is not being used.

3-7.2 Display

Any of the following graphic data displays can be selected for simultaneous display along with the previously discussed meter displays. Select using softkeys from the "Display:" field in the Display zone.

3-7.2.1 Spectrum Analyzer

The Spectrum Analyzer (figure 3-18) is active in the MONITOR or DUPLEX modes. Move the cursor to the "Display:" field within the Display zone.

Select SPECTRUM ANALYZER by pressing the softkey. The input frequency spectrum is displayed in a frequency-versus-amplitude (dBm) graph. Either the ANT or RF I/O port may be selected for input from the "RF Control:" zone. The amount of input attenuation may also be selected within the zone to vary the sensitivity of the Spectrum Analyzer.

If a larger display area is desired, press the expand softkey. (A return softkey is available in the expanded mode allowing return to the normal display).

NOTE

If SPECTRUM ANALYZER is selected while "RF Control:" is in the GENERATE mode, the spectrum analyzer will be disabled and the background will show the message Spectrum Analyzer Disabled in Generate Mode. If SPECTRUM ANALYZER is selected while RF CONTROL is in the SCAN mode, the spectrum analyzer will be disabled and the background will show the message scanning.

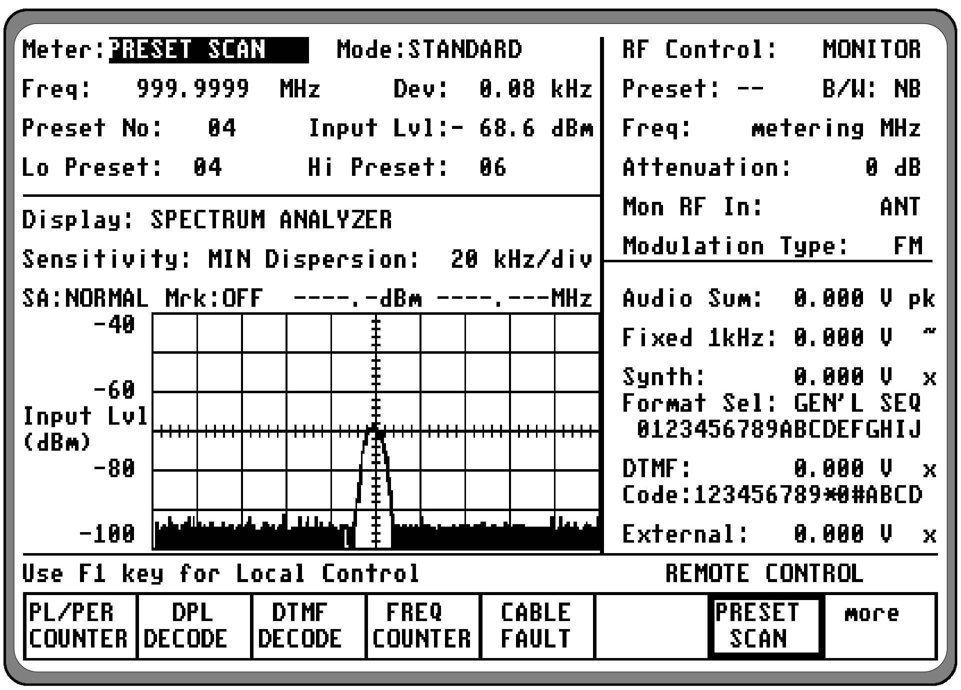


Figure 3-18. Spectrum Analyzer

Sensitivity

The SA "Sensitivity: MIN/MAX" field shifts the baseline reference of the display by 10 db. This is valid only for 0 db input attenuation. Changing the input attenuation or changing from ANT to RF I/O port in the RF Control zone will change the vertical scale of the Spectrum Analyzer display. Calibration is maintained between the display and the signal level present at the input port so there is no need to compensate for added attenuation.

Dispersion

Select the band width (20 kHz, 50 kHz, 100 kHz, 200 kHz, 500 kHz, 1 MHz, 2 MHz [optional], 5 MHz [optional], or 10 MHz [optional] per division) by first moving the cursor to the dispersion field, then pressing the desired soft-key. When operating in the optional wider dispersion settings, it is normal for the response time of the analyzer to slow down somewhat. Center frequency is entered from the RF Control zone and may be conveniently varied with the TUNING knob.

NOTE

When operating in dispersions greater than 1 MHz/div, the normal monitor metering functions including "see and hear" audio monitoring are disabled.

Storage (if equipped)

Optional Storage modes (FREEZE, MAX HOLD, and PEAK HOLD) are selected by moving the cursor to the "SA:" field, then pressing the desired softkey.

Freeze -

Pressing this softkey provides immediate storage of a spectrum display. This allows capture of intermittent transmissions etc. for more detailed analysis. To return to normal "real time" analysis, simply press the NORMAL softkey.

Max Hold -

This softkey provides a cumulative storage of peak levels displayed over time. The time duration is indefinite subject to reset by pressing the NORMAL softkey.

The Max-Hold display can be frozen by switching to the Freeze mode. To re-start the max-hold operation, re-select the Max-Hold mode. In any case, this causes the Max-Hold feature to re-initialize and begin collecting input samples.

Peak Hold -

This key provides a cumulative storage capability similar to MAX HOLD. It differs in that in addition to peak responses, the lower portions of the display are also shown to permit observation of "real time" activity.

Average Mode -

Operation in the Average mode continuously averages the previous 100 spectrum analyzer measurements and displays the averaged value. After averaging has been selected, the number of frames used in the averaging calculation will be displayed in the "Cnt:" field.

Markers (if equipped)

Select marker operation by moving the cursor to the "Mrk:" field, then pressing the desired softkey (OFF, DELTA, or ABS). Selection of DELTA (Δ) provides two markers on the SA screen (refer to figure 7-19). These permit relative measurement, between selected points on the display, of both level and frequency. The dotted marker line represents one that is movable using the Tuning Knob. Set this marker to a point of interest on the display and then press the "toggle marker" softkey to make the other marker movable for similar positioning with the Tuning Knob. Digital displays adjacent to "Mrkr:" continuously show the relative level and frequency difference between the two points selected. Selection of ABS (absolute) mode provides one marker set using the TUNING knob. Absolute frequency and power level of the marker location is displayed.

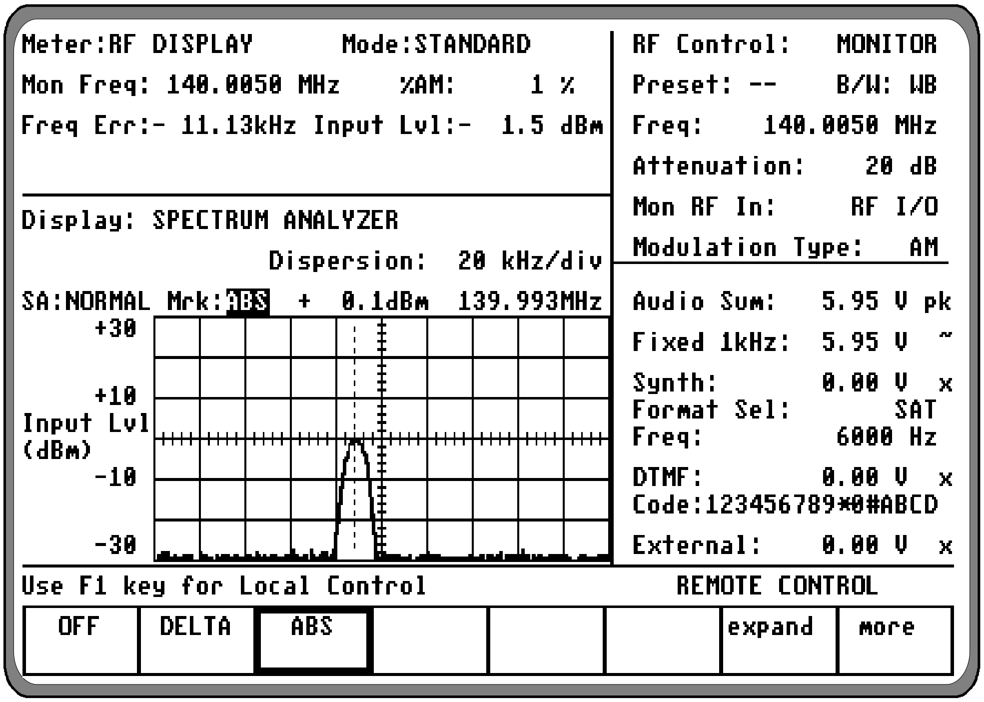


Figure 3-19. Spectrum Analyzer Markers (Option)

In conjunction with the markers are a set of softkey controls that allow the dashed marker to be moved depending upon the information displayed on the graph. These controls are available for both the DELTAT and ABS marker selections by pressing the more softkey.

The spectrum analyzer mode and marker functions are available in the expanded display graph. The provided functions are identical to those found in the normal size display. Normal to expanded screen selections may require readjustment of the markers positions.

left peak

Finds the next highest peak to the left of the current position of the dashed marker.

max peak

Find the maximum peak on the graph.

right peak

Find the next highest peak to the right of the current position of the dashed marker.

next peak

Find the next highest peak to the left or right of the current position of the dashed marker.

center freq

Move to the center frequency of the spectrum analyzer. This is equivalent to centering the dashed marker on the monitor frequency.

3-7.2.2 Modulation Scope

The Modulation Scope (figure 3-20) displays the internal modulation waveforms. It automatically switches between generator or monitor modulation depending on which mode is selected.

In DUPLEX mode, select either generate or monitor modulation displays by first moving the cursor to the "Select:" field within the Display area, then pressing the desired softkey.

The Display area of the screen will indicate MODULATION SCOPE with the input signal displayed in a time-versus-frequency graph.

NOTE

Because the analyzer has a fully digital oscilloscope (storage scope), it inherently has some characteristics which are different from the "real-time" analog scopes familiar to most users. For best overall results, it is recommended that the trigger level be set to 500 and the triggering be set to AUTO.

To change triggering, horizontal position, horizontal range, vertical position, or vertical range, use the cursor control keys to highlight the appropriate cursor fields as follows:

Trigger

Press the AUTO, NORMAL, or SINGLE SWEEP softkey to select the type of triggering desired. The trigger level synchronizes the horizontal time base to the vertical input signal.

In AUTO mode, the scope will trigger continuously. In this mode, the analyzer will always re-sweep the display even if there is no signal present. The rate will be about 1 per second with no signal present and about 10 per second with signal present.

In NORMAL mode, the scope will trigger when the vertical signal exceeds the trigger level set. In NORMAL mode the analyzer will re-sweep at a rate of 10 per second, with the last screen display remaining after removal of the signal.

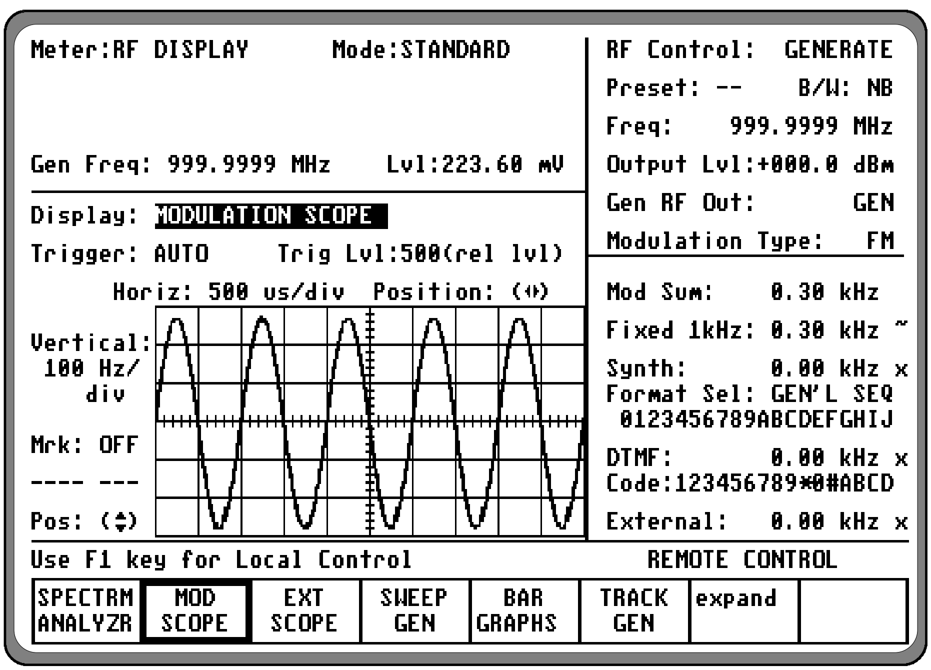


Figure 3-20. Modulation Scope

In SINGLE SWEEP mode, the scope will trigger one time for each softkey press, subject to the trigger level setting (triggering always occurs on the rising portion of the applied waveform). Messages on the line just above the softkeys indicate the status of the single sweep. The single sweep is useful in measuring one-time events, such as a tone burst at the beginning of a transmission. Such bursts may be followed by other modulation which would over-write the screen if measured in the NORMAL trigger mode.

Level

Adjust the TUNING knob to select the desired trigger level. The trigger level is a relative level setting between the values of 0 and 999 (full scale) where 0 is the most negative and 999 is the most positive voltage.

NOTE

To achieve the fastest update rate of the display a trigger level setting of 500 is recommended for most applications.

Horiz

Press the desired softkey to select the Horizontal Sweep rate (20 us to 1 sec/div). Since all ranges cannot be shown on one screen, press the **more** softkey for additional selections.

NOTE

If horizontal sweep rates of greater than 10 msec/div are selected, the update rate will slow down. A good overall setting for most applications is 200 usec per division.

Horizontal Position

Adjust the horizontal position through the (◀▶) cursor field either by using the desired softkey (MOVE LEFT, MOVE RIGHT) or by using the rotary TUNING knob.

Vertical Sensitivity

Press the desired softkey to select the Vertical Sensitivity (AM: 1%, to 50% per division, FM: 100 Hz to 50 kHz per division, dependent on bandwidth selected). When all ranges cannot be shown on one screen, press the more softkey for additional selections.

NOTE

The vertical scales and softkeys for FM deviation will change automatically between wideband and narrowband.

Vertical Position

Adjust the vertical position through the (▲▼) cursor field either by using the desired softkey (MOVE UP, MOVE DOWN) or by using the rotary TUNING knob.

Press the expand softkey from any field in the scope display window to enlarge the display for more detailed analysis. Use the return softkey to get back to the normal size display.

NOTE

Scale and positioning adjustments are not possible for stored waveforms that are displayed through the use of single sweep or triggering on single non-periodic signals.

Marker (if equipped)

Select marker operation by moving the cursor to the "Mrk:" field, then pressing the desired softkey (ΔV, ΔT, or 1/ΔT). Selection provides two markers on the Modulation Scope screen (refer to figure 3-21). Function of the "toggle marker" softkey and Tuning Knob for positioning of markers is similar to that described in section 3-7.2.1.

ΔV -

This softkey selection provides markers that are horizontally located to permit relative readings along the scope vertical axis. The display adjacent to the "Mrk:" field shows the relative vertical deflection between the two marker positions.

ΔT -

This key selection provides markers that are horizontally located to permit relative readings along the scope vertical axis. The display adjacent to the "Mrk:" field shows the relative horizontal deflection between the two marker positions in units of time.

1/ΔT -

This softkey selection provides markers that are also vertically located to permit relative readings along the scope horizontal axis. This selection however inverts the time reading to display the relative difference in terms of frequency.

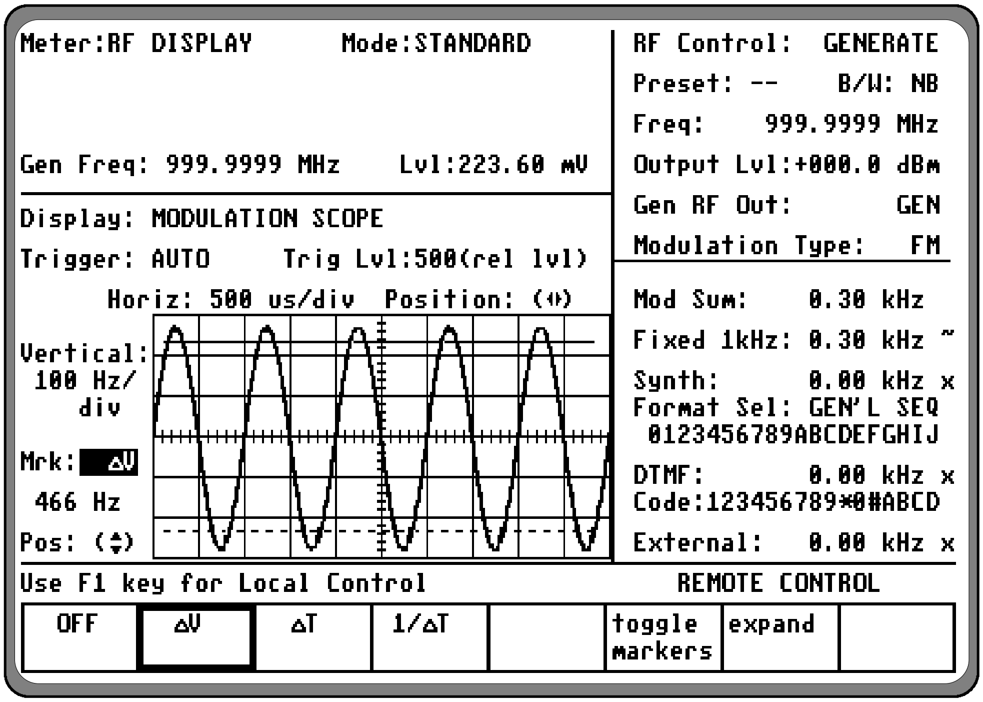


Figure 3-21. Modulation Scope Markers (Option)

3-7.2.3 EXT'L SCOPE

The analyzer provides a general purpose oscilloscope with calibrated vertical input sensitivities and automatic or triggered horizontal sweep rates. Use the scope to analyze waveforms, detect asymmetric modulation or audio distortion, trace signals, and troubleshoot.

The vertical (VERT) input is the same BNC port that also serves as the input for DVM, SINAD/DIST meter, and COUNTER IN.

The EXT'L SCOPE mode has an additional cursor field to select "Coupling:" AC or DC via softkey selection. Operation of triggering, ranges, trace positioning and optional markers are the same as described in MODULATION SCOPE above. Vertical ranges will always display in voltage per division in the EXT'L SCOPE mode.

3-7.2.4 SWEEP GENERATE

This display provides a graphic display in conjunction with the SWEEP GENERATE mode of the unit which is selected in the RF Control zone or selection of the optional cable fault test feature.

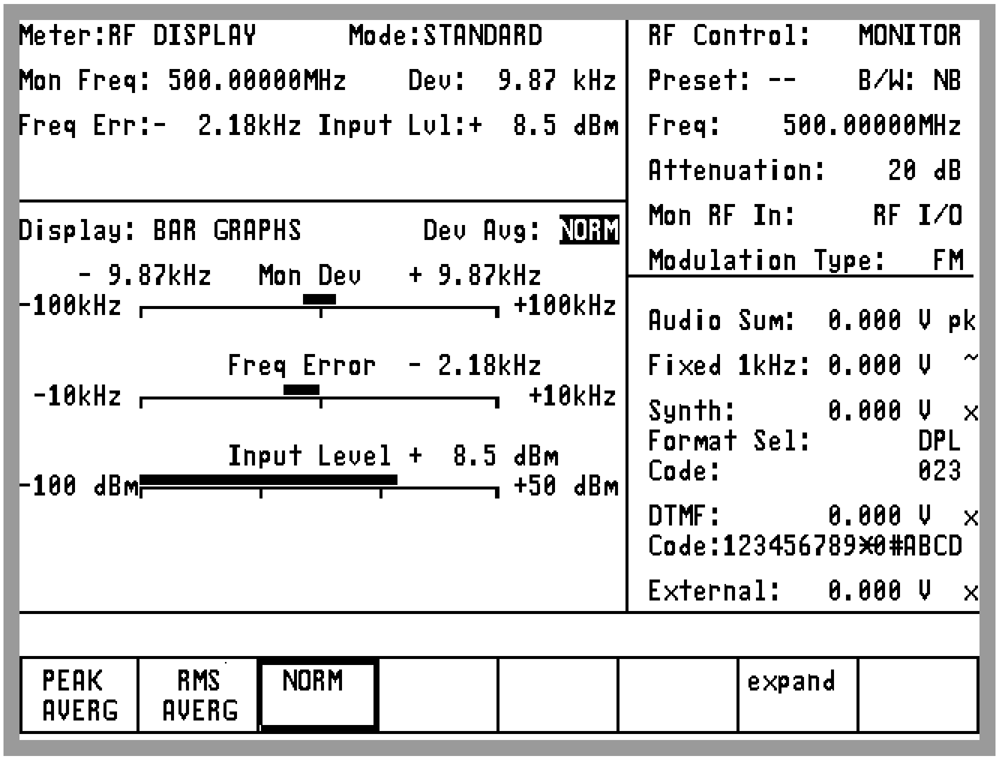
Refer to Sweep Generator description under Primary Operating Modes (paragraph 3-5.4).

To change coupling from AC to DC, or vary horizontal position, vertical position, or vertical sensitivity, move the cursor to highlight that selection. Use the softkeys or TUNING knob, as applicable to each selection.

3-7.2.5 Bar Graphs

The bar graphs (figure 3-22) provide a graphical display of the RF Display data from the Meter area of the screen.

Press the expand softkey to expand the bar graphs to the full display area of the LCD (figure 3-22). If the modulation type is FM, the BAR GRAPHS mode has an additional cursor field to select “Dev Avg:” PEAK AVERG, RMS AVERG or NORM via softkey selection. The setting activates either the Peak averaging or RMS meter or normal peak detection on the deviation measurements. The PEAK AVERG computes a numerical average of peak detection measurements, the RMS AVERG uses a RMS meter to compute the deviation, the NORM use a instaneous peak detection measurement. Note the “Dev Avg:” cursor is not available in modulation types, AM or PM.



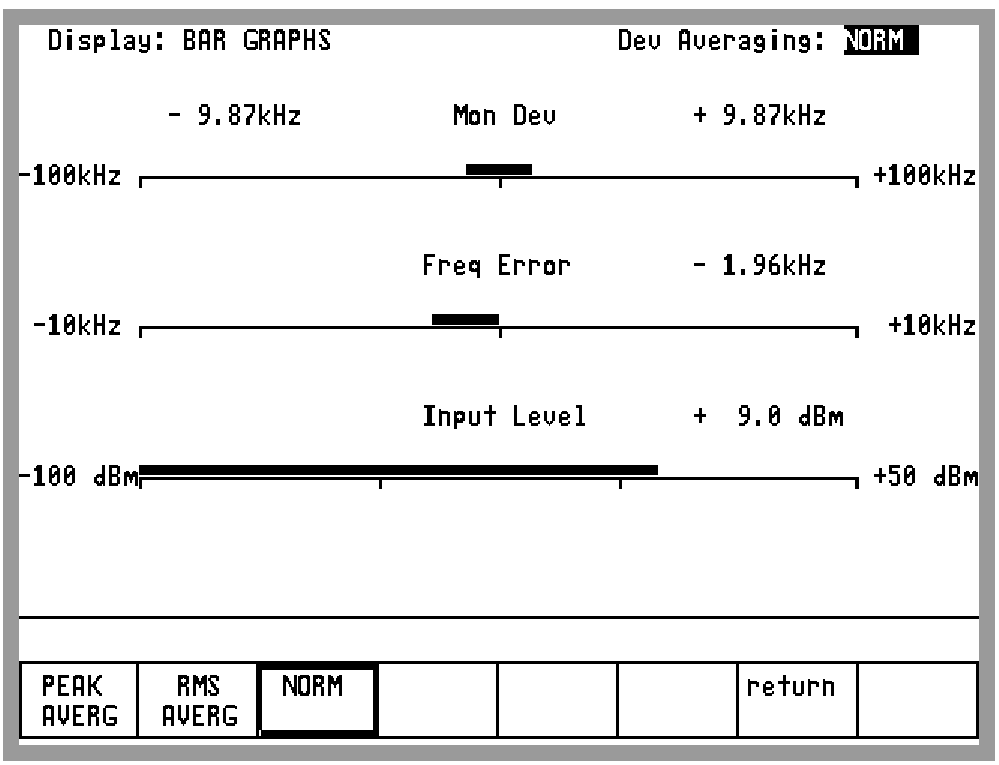


Figure 3-22. Bar Graphs

NOTE

The Freq. Error bar graph is not available if RF SCAN, PL/PER COUNTER, DPL DECODE or FREQ COUNTER are selected in the "Meter:" field area. Selection of the expand key restores the Freq. Error Bar Graph under the above condition.

3-7.2.6 Tracking Generator (if equipped)

This display must work in conjunction with the TRACK GENERATE mode which is selected thru the "RF Control:" field of the RF zone. Refer to section 3-5.5 for a full description of Tracking Generator operation.

3-8 OTHER FUNCTIONS

3-8.1 Audio Monitor

The Analyzer has a speaker for the purpose of audibly monitoring the recovered baseband signal in the MONITOR and DUPLEX modes and the modulating signal in the GENERATE mode. Switching between the two is automatic.

Using the VOLUME control, the input signal to the speaker is adjustable to a maximum level of 0.5 watts rms.

The speaker is also used for audible warnings, such as RF overtemperature.

3-8.2 Calibration

Calibration of the Analyzer is performed by the following steps.

1. Press the CAL key to instruct the processor to perform a self-calibration on the system. The CAL function provides a self calibration of the unit's RF generator output level, the monitor input level and the modulation level. All other parameters are not subject to this self-calibration.

   This assures the unit's specification accuracy under conditions of ambient temperature extremes and aging. Re-calibration is recommended at weekly intervals or when the re-calibrate warning appears on the screen.

CAUTION

Before starting self-calibration be sure that the 50 ohm load, attached by chain to the front panel, is connected to the GEN OUT port. This provides the termination which is essential to proper calibration. Also ensure all connections to the RF I/O and ANT connectors are removed.

2. Press the START softkey to begin the calibration. While the calibration is active, the message **calibrating** appears.

3. When the calibration has been performed, the message **complete** appears. Press the return softkey or a cursor control key to return to the previous screen.

3-8.3 Print Function

Press the PRT key to send the data contents of the displayed screen to a compatible RS-232 serial format printer or to a compressed graphics file stored on a PC. ASCII character (faster printing), EPSON/IBM printer graphics, or compressed graphics print can be selected.

If ASCII is selected (refer to Special Functions Menu to select REMOTE SETUP and Display Table), all ASCII characters currently on the display are stored in a buffer and serially output to an RS-232 printer. Selection of IBM/EPSON results in a graphic printout of the screen (requires a graphic printer and takes longer to print). If GRAPHIC DUMP is selected, a compressed file of the screen can be generated. This print mode is used with a special print application executing on a PC. Once the compressed file is captured by PC, the file can be printed using the PC's printer resources.

NOTE

Subsequent presses of the PRT key before printing is complete will overwrite the printer buffer.

If using the LX-810S/220 (220 volt operation) serial/parallel printer with the Analyzer, refer to paragraph 4-5 for a special application note.

3-8.4 Special Functions Menu

The Special Function mode (figure 3-23) accessed by pressing the SPF key, provides control over various system conditions as follows:

Version

Accesses a display table which provides the internal software version and checksum for the system and any options present.

Remote Setup

Accesses a display table which allows configuration of the RS-232 and printer interface.

System Functions

Accesses softkeys to select the following:

NVM Clear

This softkey erases the entire RF Preset memory area and front panel CAL memory. The Analyzer must be recalibrated after this key has been pressed.

NVM Reset

This softkey provides a less extensive system reset than NVM Clear. CAL and preset memory are not erased.

Save State

Sets the current condition and settings of the unit as the power up state.

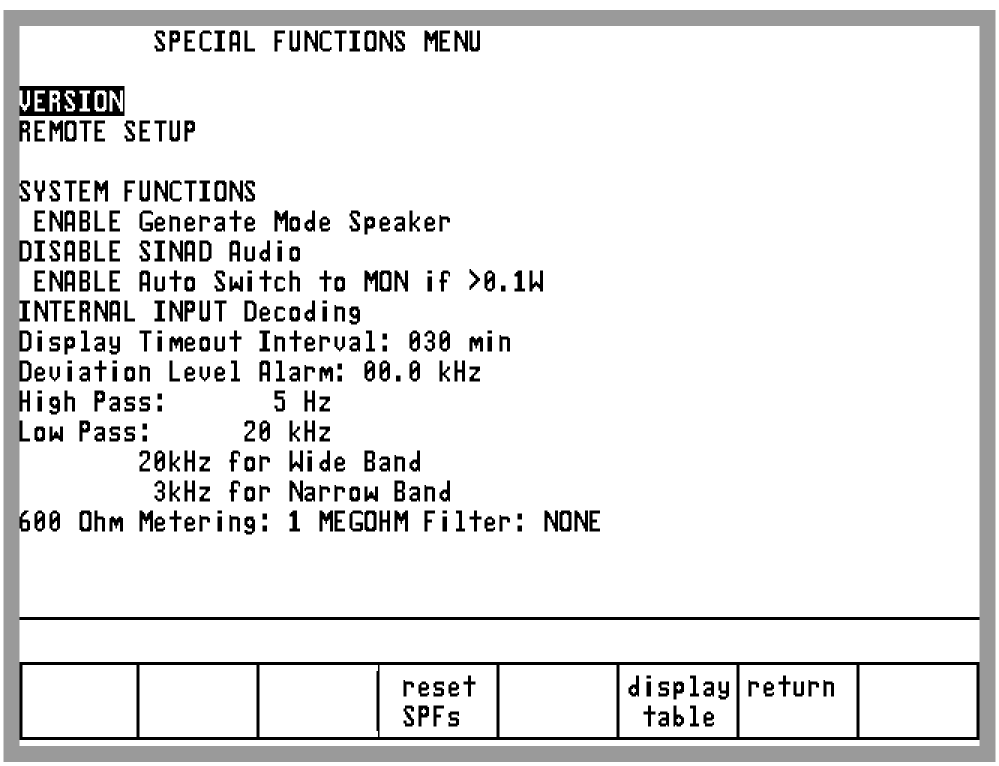


Figure 3-23. Special Functions Menu

NOTE

When any of the following special functions are selected, the normal operating screens will flash a warning SPF Enabled at the lower right of the screen. This serves as a reminder since special functions inadvertently left enabled can adversely effect normal operation of the unit.

SPF Reset

This softkey appears throughout the Special Function screen as a convenience in resetting of all special functions from System Functions through Low Pass Filter to the factory standard state. This will switch all decoding to internal and provide the widest filter bandwidth.

Enable/Disable Generate Mode Speaker

Provides the means to disable the internal speaker during generate mode.

Enable/Disable Sinad Audio

Permits the routing of the signal at the VERT/SINAD connector to the speaker while in sinad metering and generate mode. Note that if both Sinad Audio and Generate Mode Speaker Audio are enabled, the summed audio is routed to the speaker.

Enable/Disable Auto Switch to MON if >0.1 W

Allows the unit to automatically switch to the MONITOR mode when power levels greater than 0.1 watt are applied to the RF IN/OUT front panel connector.

Internal/External Input Decoding

Switches the decoder function between the internal monitor demodulated signal and the signal at the VERT/SINAD front panel connector.

Display Timeout Interval

Permits the entry of the timeout interval to blank the screen after a period of no inputs (key or tuning knob) from the operator.

Deviation Level Alarm

Allows entry of the deviation level for the audible deviation limit alarm in MONITOR mode.

High Pass

Provides softkey selection of monitor baseband high pass filter frequency.

Low Pass

Provides softkey selection of monitor baseband low pass filter frequency.

600 Ohm Metering(Option)

Allows the user to select input impedance (1 megohm or 600 ohm) of the ACVM, SINAD, and Distortion functions.

CAUTION

When the 600 ohm load is selected, the maximum allowable input to these metering functions is reduced to approximately 25 VAC maximum due to power dissipation limits. Overload protection is provided by means of a reset circuit that monitors input leveland switches the 600 ohm load when the maximum input level is exceeded. If this occurs, simply remove the overload and activate the OVERLOAD RESET softkey located at the "600 ohm metering:" field of the Special Function Screen.

Filter (if equipped)

Allows the user to enable/disable internal C-MSG or CCITT filters.

3-8.4.1 Special Function Selection

To select a special function follow the following procedure.

1. Press the SPF key to display the special functions menu on the display.
2. Move the cursor to highlight the field of the function desired. Applicable softkeys
3. Use the softkeys to make selections. Levels may be set using the TUNING knob or key-pad.
4. Press the return key to return to the previous screen.

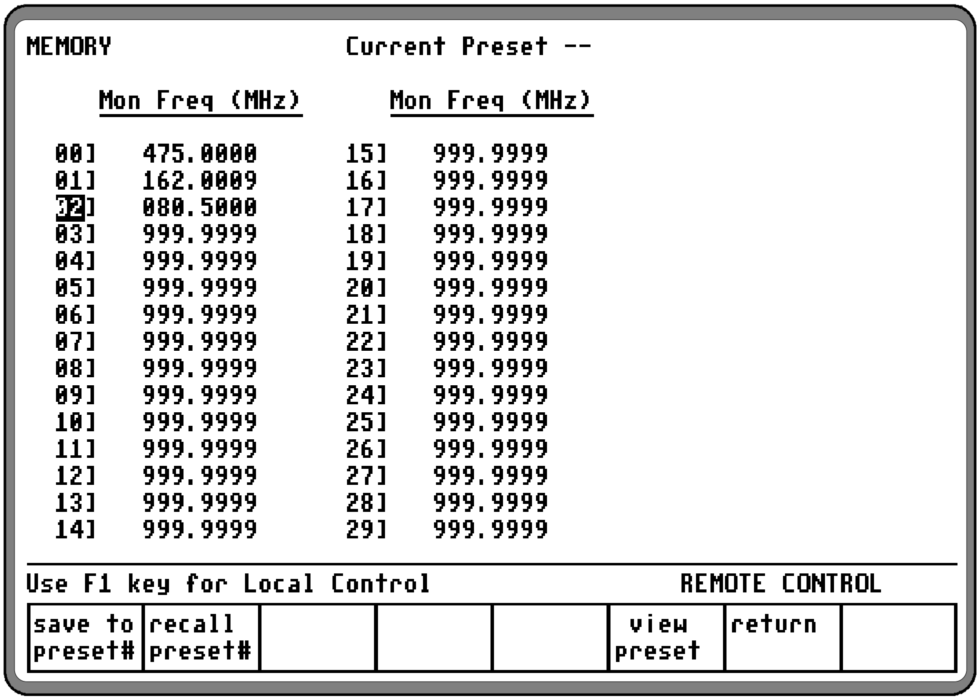
3-8.5 Memory Screens

The Memory screens provide for viewing and entry of preset data into non-volatile memory. The actual selection of a preset number for operation of the system can only be done from the RF Control zone.

Pressing the MEM key accesses the top-level memory display (figure 3-24) which shows the 30 presets (00-29) and the monitor frequency associated with each. A second level screen provides an expanded detail of the settings stored within each preset.

To change the preset memory information, perform the following steps:

1. Press the MEM key to access the special Memory screen.
2. Move the cursor to the desired preset number. When the cursor is over the preset number, press the view preset softkey to display all of the preset's parameters. When a preset has been expanded, the operator may change:
   - The preset number being viewed
   - Monitor frequency
   - Generate frequency
   - Modulation type
   - Bandwidth
   - Duplex offset frequency
   - Audio synthesizer format with applicable frequency, code or sequence
   - DTMF code
3. To clear a particular memory field (except the monitor frequency) press the 'don't care' softkey. The value associated with that cursor location become a "-", and will not affect the current setting when that preset is selected from the RF Control zone.
4. All entries made to the expanded preset table are automatically entered into non-volatile memory. The save to preset soft key provides an added convenience allowing all of the applicable settings entered into the RF Control and Audio Control zones to be copied into the preset number selected. This will erase and overwrite all previously entered settings within that preset.
5. Press the 'return' key to return to the previous screen.



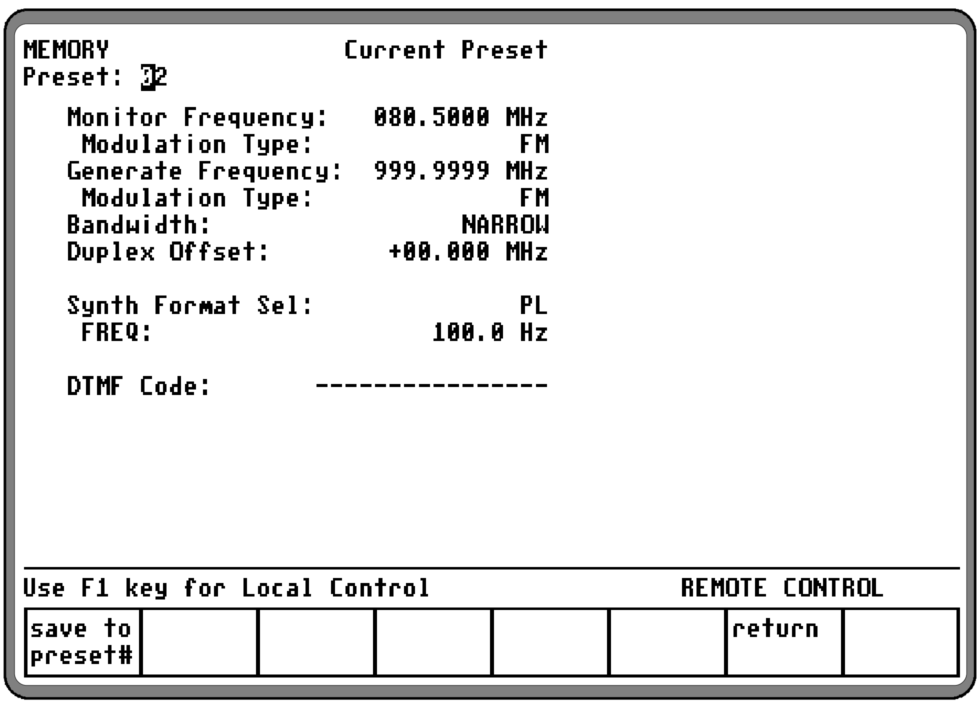


Figure 3-24. Memory Screens

3-8.6 Test Setups (if equipped)

Test Setups provide the capability to save the entire state of the analyzer in a preset. Fifteen additional presets numbered 30 through 44 are available for this purpose. When delivered from the factory, the analyzer is configured with default information in the Test Setups:

NOTE

Test setups are installed at either the factory or in the field using the Field Installation Software. To determine if test setups are available, examine the Standard Options display screen (refer to Special Function Selection paragraph 3-8.5)

TEST SETUP	LABEL	DESCRIPTION
30	Tx Test	"RF Control:" is set to MONITOR and "Display:" is set to SPECTRUM ANALYZER; other parameters are factory default.
31	Rx Test	"RF Control:" is set to GENERATE and "Meter:" is set to SINAD. "Fixed 1kHz:" is switched on with a 3.00 kHz deviation; other parameters are factory default.
32	Dpx Test	"RF Control:" is set to DUPLEX; other parameters are factory default.
33-44	Factory Default	All configuration parameters (except those saved in the standard presets) are set to the factory preset value, which is equivalent to the power-on state of the analyzer from the factory.

NOTE

The default Test Setup values are provided as a convenience and may be overridden at any time.

Each Test Setup also saves the cursor location for later recall. For example, if the analyzer is placed in the generate mode with the cursor on the tens digit of the Output Level and this Test Setup is saved, later recall of this preset will place the cursor back on the tens digit of the Output Level.

The Test Setups work in conjunction with the standard presets (labeled 00 through 29). Each standard preset stores the following information in the non-volatile memory:

- Monitor Frequency
- Monitor Modulation Type
- Generate Frequency
- Generate Modulation Type
- Bandwidth
- Duplex Offset
- Synthesizer Format Selection
- DTMF Code

The Test Setups store all other configuration information in non-volatile memory. This allows a Test Setup to be used for a set of frequencies and audio signals as defined in the separate standard presets.

Full Test Setups are accessed from either the preset cursor location or the MEMORY screen (figure 3-25). To create a test setup, modify the configuration of the analyzer to the test setup to be saved. Press the MEM hardkey to access the MEMORY screen and then move the cursor to one of the 15 Test Setup locations. Use the Save To Preset# softkey to save the analyzer configuration into the Test Setup.

A Test Setup can be recalled from the MEMORY screen using the Recall Preset# softkey or from the preset cursor location in the RF Control Zone.

Each Test Setup has a 15 character label in which alpha-numeric information can be entered to describe that Test Setup. Characters not on the front panel keypad can be entered using the rotary knob.

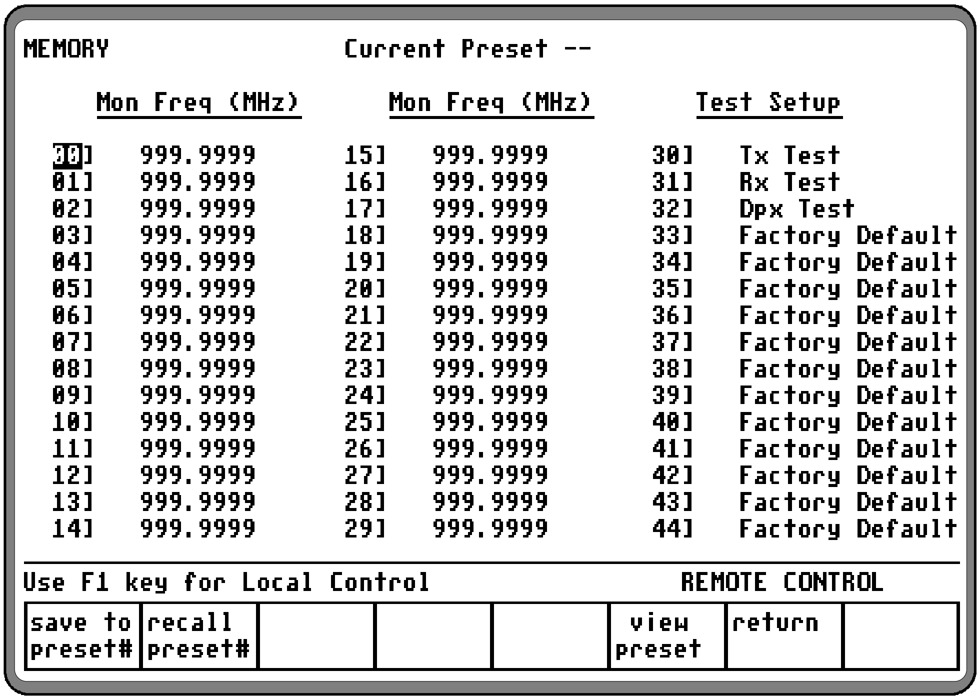


Figure 3-25. Memory Screen with Full Test Setups Option

Section 4

APPLICATIONS

4-1 BASIC FM TRANSMITTE TESTING

This section of the manual contains information on typical test setups to perform some of the more common radio tests using R2600 Series Communications System Analyzers.

General Dynamics takes no responsibility for application accuracy, applicability, or safety. Always refer to your own transceiver's service manual for recommended test methods and specifications

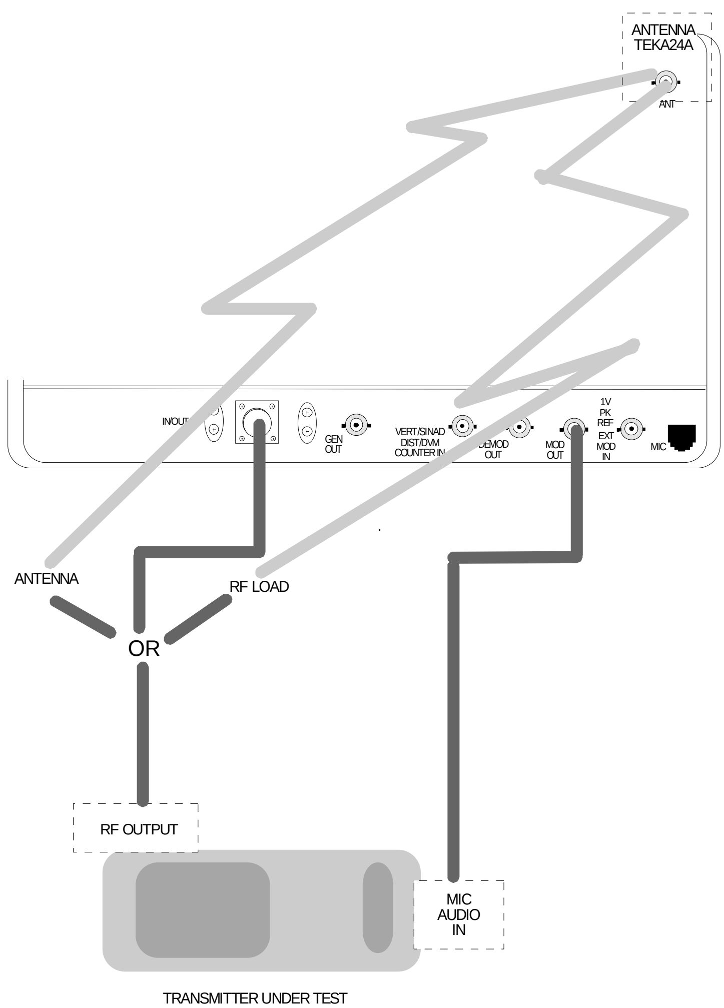


Figure 4-1. Basic FM Transmitter Testing Setup

4-1.1 Basic FM Transmitter Testing Setup

Refer to figure 4-1. Connect the analyzer's RF I/O port to the RF output of the transmitter under test. Connect the analyzer's MOD OUT jack to the mic audio input of the transmitter under test.

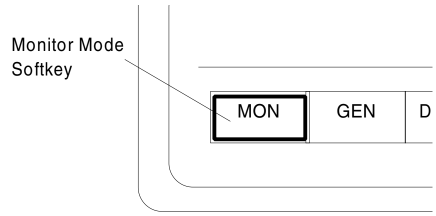
CAUTION

For transmit power output measurements, connect the transmitter under test only to the analyzer's RF I/O port. Do not connect it to the ANT port. The ANT port is used with an antenna for "off-air-" reception.

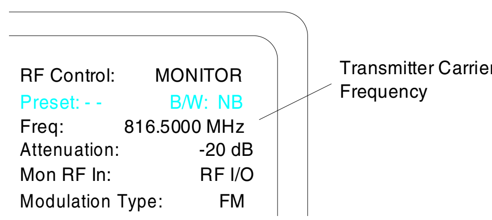
*The built-in RF load dissipates up to 50 W for three minutes and up to 125 W for one minute. If a high-power transmitter is keyed into the analyzer for a time long enough to threaten overheating the power measuring circuitry, the system's audible alarm sounds and the display changes to the **RF LOAD OVERTEMPERATURE** warning, signaling the operator to unkey (refer to paragraph 3-4).*

4-1.2 Transmit Power, Frequency, and Frequency Deviation Measurements

1. With the cursor located within the RF Control zone (refer to paragraph 3-2), press the **MON** softkey to place the analyzer into its Monitor mode of operation.

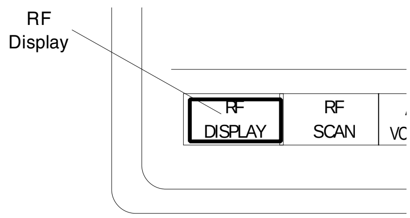


2. Within the RF Control zone, set as follows:

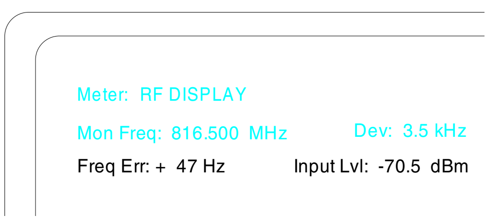


3. Set the SQUELCH control to threshold. For low-power transmitters, may be necessary to use a lower attenuation value in order to unsquelch the monitor (refer to paragraph 3-5.1). Too high of an attenuation setting or too tight a squelch setting inhibits the frequency error reading (refer to paragraph 3-7.1.1). Accurate measurements require sufficient signal level from the radio to fully quiet the analyzer's receiver. Use good quality cable of minimum length to prevent cable-loss which can be a significant factor in RF power measurements, especially at UHF and above.

4. With the cursor located within the Display zone "Meter:" location, press the **RF DISPLAY** softkey:



5. Key the transmitter and read the power (Input Level) and frequency error (Freq Err). Refer to your radio's service manual to determine if power and frequency are within specified limits and determine if any adjustments are required.



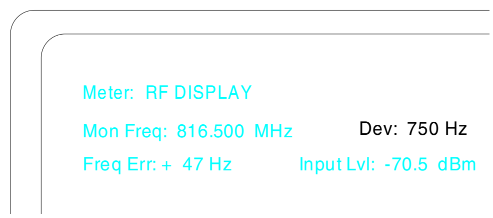
4-1.3 Modulation Measurements

1. Key up the transmitter with appropriate PL (or DPL) enabled.

NOTE

If mic pickup results in deviation errors, install the internal 300 Hz lowpass filter as detailed in paragraph 3-8.5 before making the following measurements and verifications.

2. When monitoring the PL (or DPL) deviation as follows, refer to your radio's service manual to determine if any adjustments are required.



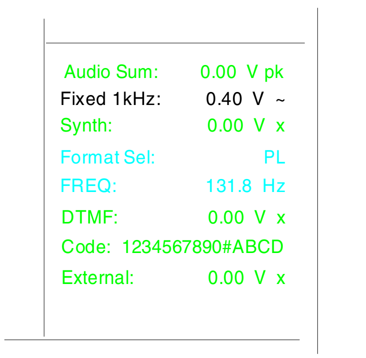
3. Remove the internal 300 Hz lowpass filter if installed.

   Introduce a 1 kHz audio modulating signal from the MOD OUT connector located on the front panel of the analyzer to your radio. Check your radio's service manual to determine the minimum audio signal level required for proper MIC sensitivity as well as the maximum level required to ensure proper IDC (Instantaneous Deviation Control) function.

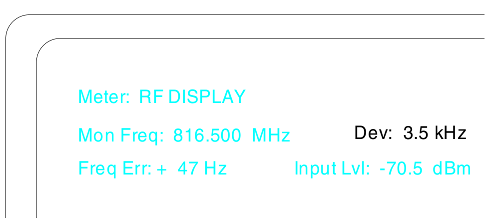
NOTE

The voltage levels displayed in the Audio Control zone are peak open circuit voltages. Source impedance of the MOD OUT port is 100 ohms.

4. Turn the 1kHz signal on, and set for minimum level as determined in step 3.

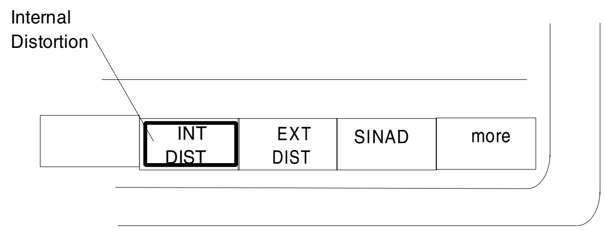


5. Verify proper MIC sensitivity by reading the deviation. Refer to your radio's service manual to determine maximum rated system deviation to determine if any adjustments are required.

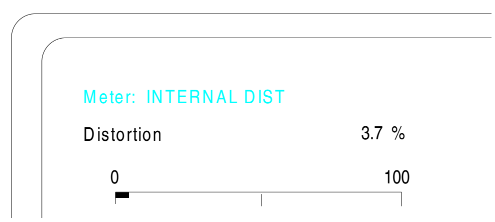


6. Set the 1 kHz audio modulating signal for maximum level as determined in step 3. Repeat steps 4 and 5.

7. To measure the percentage of distortion, locate the cursor within the Display Control zone, at the "meter:" field. Press the **INT DIST** softkey to measure percentage of distortion.

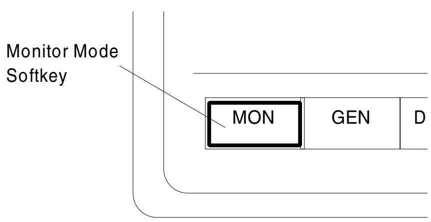


8. Refer to the displayed digital readout and bar graph. Refer to your radio's service manual to determine if any adjustments are required.

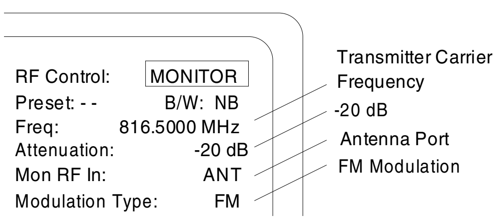


4-1.4 Off-The-Air Measurements

1. Connect the supplied antenna to the analyzer's ANT port. Operate the transmitter under test either into its own antenna or into a dummy RF load.
2. With the cursor located within the RF Control zone, press the **MON** softkey to place the analyzer into its Monitor mode of operation.



3. Set the SQUELCH control to threshold. Within the RF Control zone, set as follows:



4. Check transmitter frequency and modulation as detailed in paragraphs 4-1.2 and 4-1.3.

NOTE

This method may be used to verify frequency and modulation of a remotely located transmitter by reducing the attenuation setting to fully realize the sensitivity of the analyzer "Off-The-Air" monitor function.

4-2 BASIC FM RECEIVER TESTING

This section of the manual contains information on typical test setups to perform some of the more common radio tests using the analyzer.

The analyzer's DVM input is unbalanced (ground referenced). Use an appropriate interface to measure balanced circuits, such as certain receiver audio outputs or telephone lines.

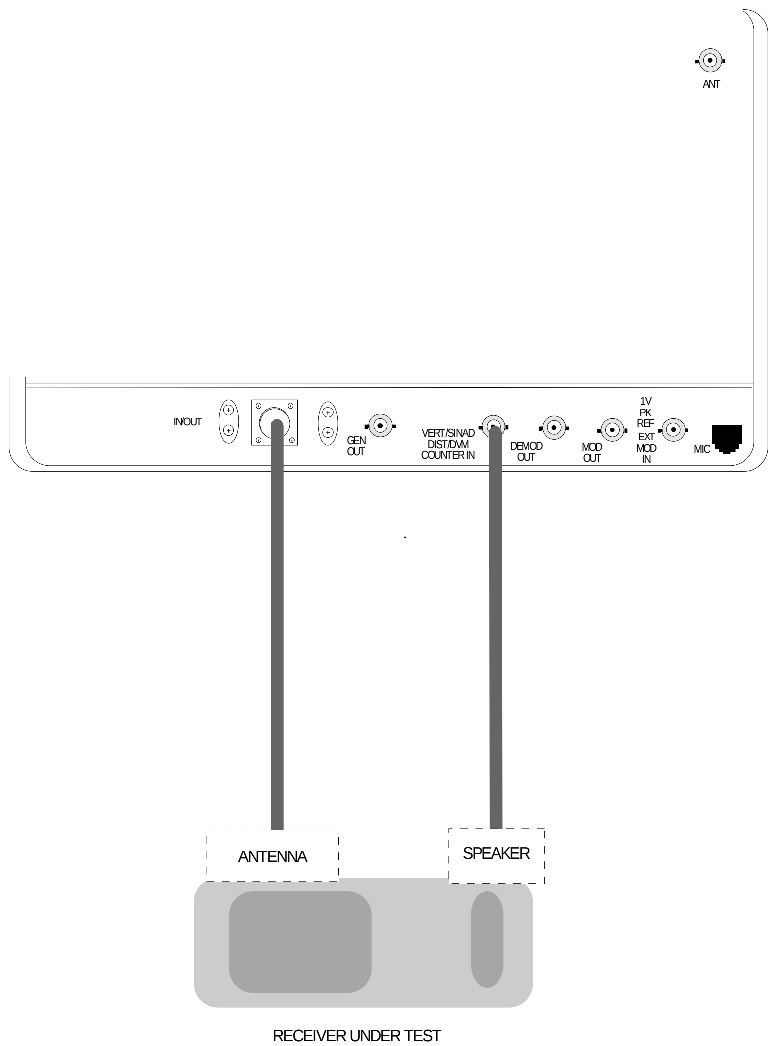


Figure 4-2. Basic FM Receiver Testing Setup

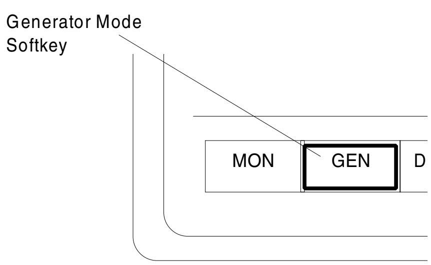
4-2.1 Basic FM Receiver Testing Setup

Refer to figure 4-2. Connect the analyzer's RF I/O port to the radio antenna connector. Connect the radio audio output to VERT/SINAD port of the analyzer.

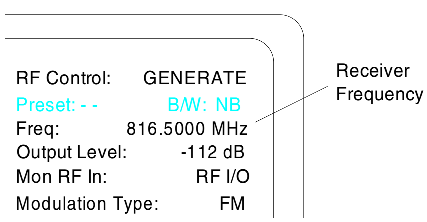
CAUTION

With some radios, grounding the speaker leads will damage the audio circuitry. Use isolation techniques on these radios.

1. With the cursor located within the RF Control zone (refer to paragraph 3-2), press the **GEN** softkey to place the analyzer into its Generator mode of operation.



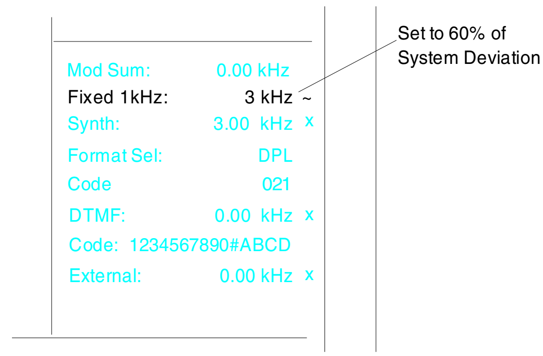
2. Within the RF Control zone, set as follows:



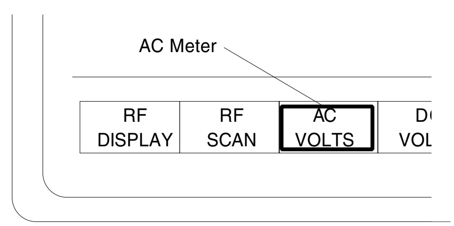
NOTE

For setup and distortion measurements, set output level to at least 30 dB above sensitivity threshold (-80 dBm recommended).

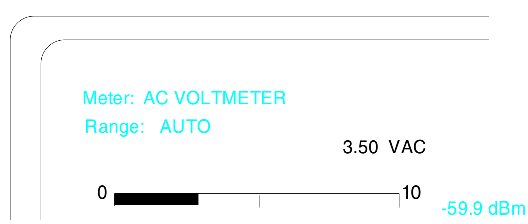
3. Within the Audio Control zone, set as follows:



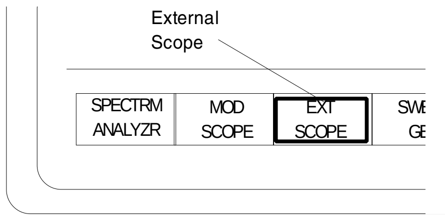
4. With the cursor located within the Display Control zone, press the **AC VOLTS** softkey to display the ac voltmeter:



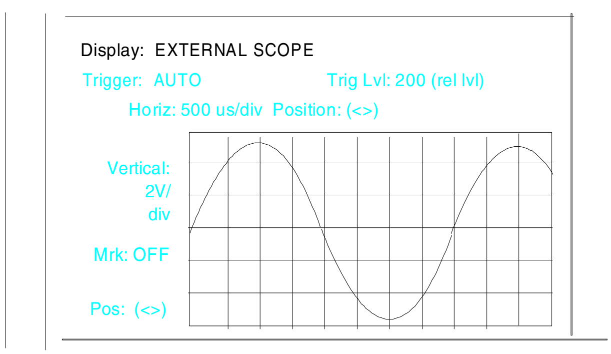
5. Adjust the radio for rated power output by computing voltage needed for rated power with load resistor/speaker in use, and setting the radio volume to produce required voltage.



6. With the cursor located within the Display Control zone (at Display:), press the **EXT SCOPE** softkey.

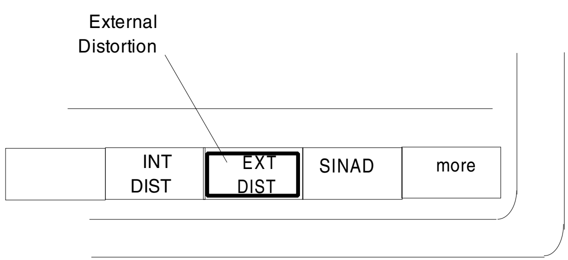


7. Set scope vertical and horizontal deflection to observe sine wave from receiver audio.

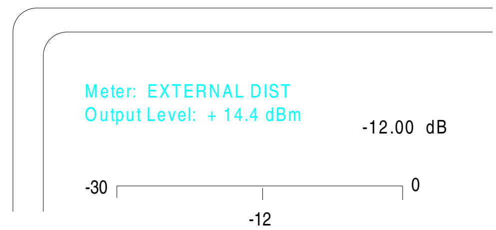


4-2.2 Receiver Distortion Measurement

1. With the cursor located within the Display Control zone, press the **EXT DIST** softkey to measure percentage of distortion.

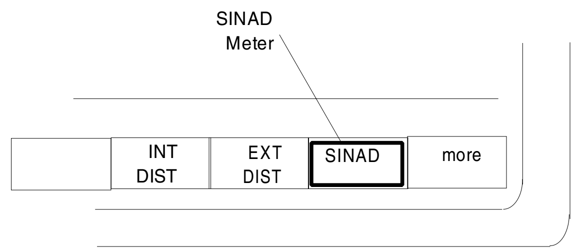


2. Refer to the displayed digital readout and bar graph. Refer to your radio's service manual to determine if any adjustments are required.

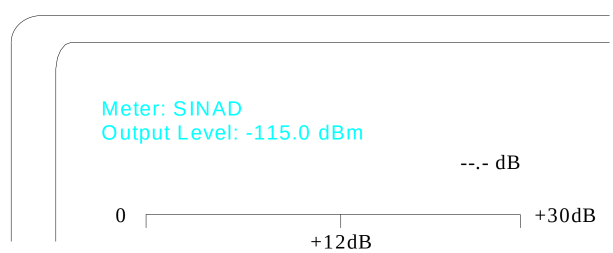


4-2.3 SINAD Measurement

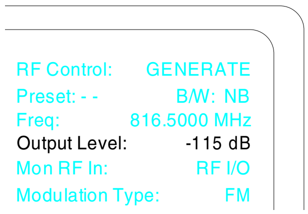
1. With the cursor located within the Display Control zone, press the **SINAD** softkey.



2. Refer to the displayed digital readout and bar graph.



3. Within the RF Control zone, adjust the selected RF level until the SINAD reading on the SINAD meter averages 12 dB (instantaneous reading will vary several dB).



4. Note RF output level required for SINAD reading of 12 dB (-115 dBm typical dependent on manufacturers specifications).

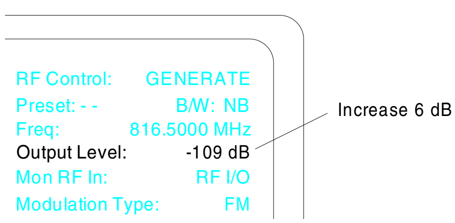
NOTE

RF output level can be referenced to mV, uV, dBu, or dBm. Selection of units is available within the Display Control zone (Output Level:).

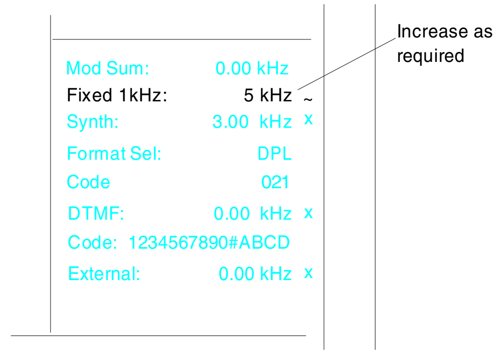
4-2.4 Modulation Acceptance Bandwidth

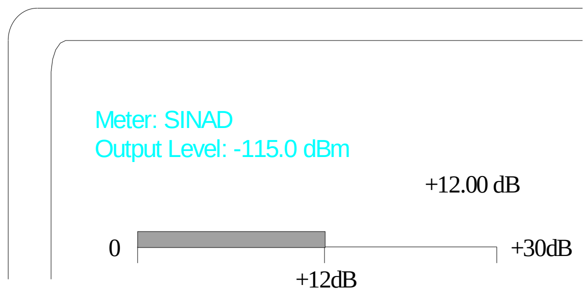
1. Set the volume control of the radio to 10% of its rated audio output level.

2. Set the RF output level 6 dB (doubles the voltage, i.e. 0.35 uV increased 6dB = 0.7 uV) above the RF output level required in paragraph 4-2.4 to achieve the SINAD reading of 12 dB.

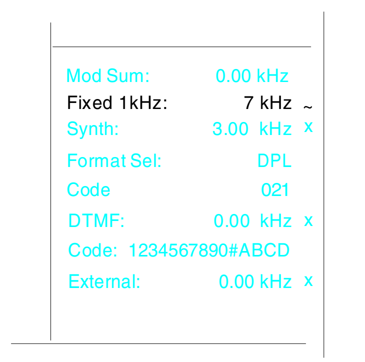


3. Increase the deviation level until the SINAD meter display returns to 12 dB.



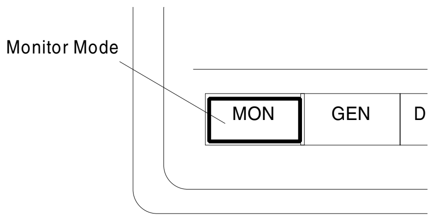


4. Read the deviation level required in step 3. A typical modulation acceptance bandwidth of a 5 kHz receiver is 7 to 8 kHz. Refer to your radio's service manual to determine if any adjustments are required.

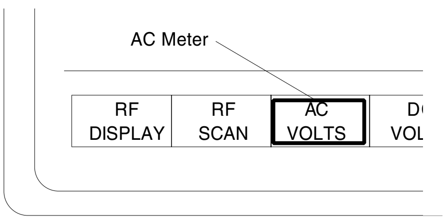


4-2.5 Receiver Sensitivity Testing (20 dB Quieting)

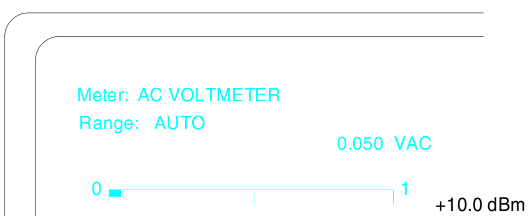
1. With the cursor located within the RF Control zone, press the **MON** softkey to remove input signal from the radio.



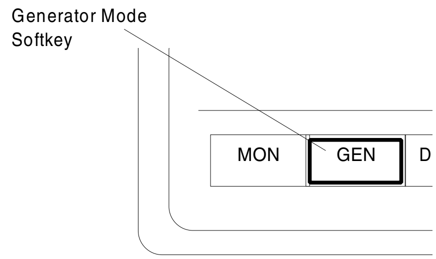
2. With the cursor located within the Display Control zone, press the **AC VOLTS** softkey to display the ac voltmeter:



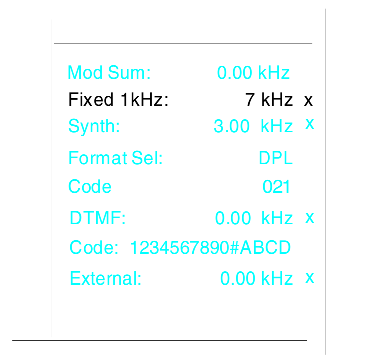
3. Turn on the receiver (unsquelched). Increase the receiver volume control to feed audio noise to the analyzer (at least 1/4 the rated audio power). Record the noise reading in dBm.



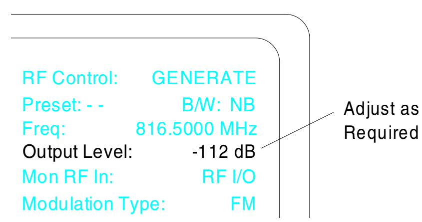
4. With the cursor within the RF Control zone, press the **GEN** softkey.



5. Within the Audio Control zone, set the modulation off.



6. Within the RF Control zone, adjust the RF output level until the noise reading is less than 20 dB from the value recorded in step 3. Refer to your radio's service manual to determine if any adjustments are required.

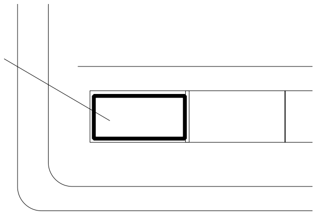


NOTE

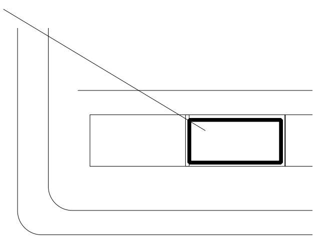
*To convert the RF output level to uV or dBV, locate the cursor within the Display Control zone and press the **RF DISPLAY** softkey. Locate the cursor to units used for Lvl: and select the required unit using the softkeys.*

4-2.6 Squelch Sensitivity Test

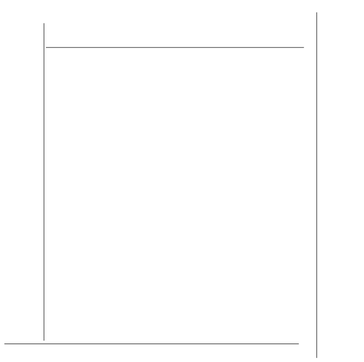
1. With the cursor located within the RF Control zone, press the **MON** softkey.



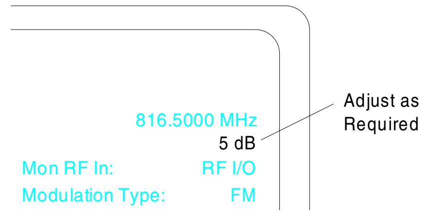
2. Disable the PL/DPL squelch if so equipped. Set the radio's squelch control to the point where the receiver barely quiets.
3. With the cursor located within the RF Control zone, press the **GEN** softkey.



4. Within the Audio Control zone, set the modulation off.



5. Within the RF Control zone, increase the RF output level until the receiver just unsquelches. This is the threshold squelch sensitivity of the radio.

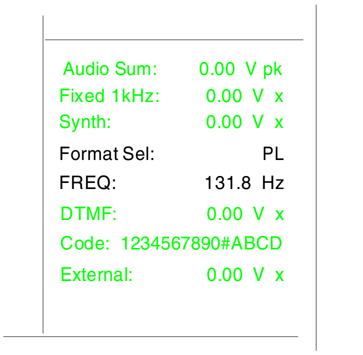


NOTE

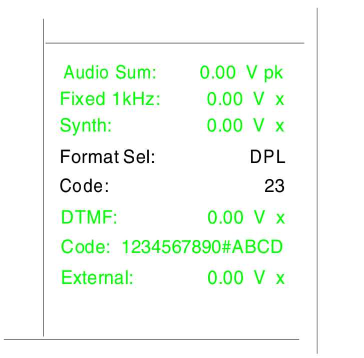
To convert the RF output level to uV or dBV, locate the cursor within the Display Control zone and press the ***RF DISPLAY*** *softkey.*

6. Repeat step 5 with the radio's squelch level set to maximum tightness to determine the tight squelch sensitivity of the radio.

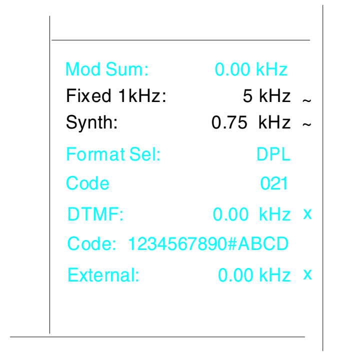
7. To check PL/DPL squelch sensitivity, locate the cursor within the Audio Control zone and enter the proper PL frequency or DPL code per Appendix B.



or

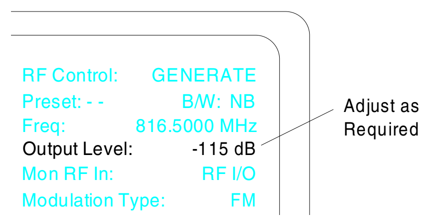


8. With the cursor located within the Audio Control zone, turn on the modulation and set the analyzer synthesizer to provide a nominal 750 Hz (500 - 1 kHz) deviation or to the radio's manufacturer's specifications.



9. Enable the radio's PL/DPL squelch circuit. Fully open the carrier squelch control.

10. Within the RF Control zone, increase the RF output level until the receiver just unsquelches. This is the coded squelch sensitivity.



4-3 CABLE TESTING (if equipped)

4-3.1 Overview

The analyzer cable fault test system can be used to find the distance to a fault in a cable under test such as an open or shorted connector, a damaged (pinched) area of the cable, etc.

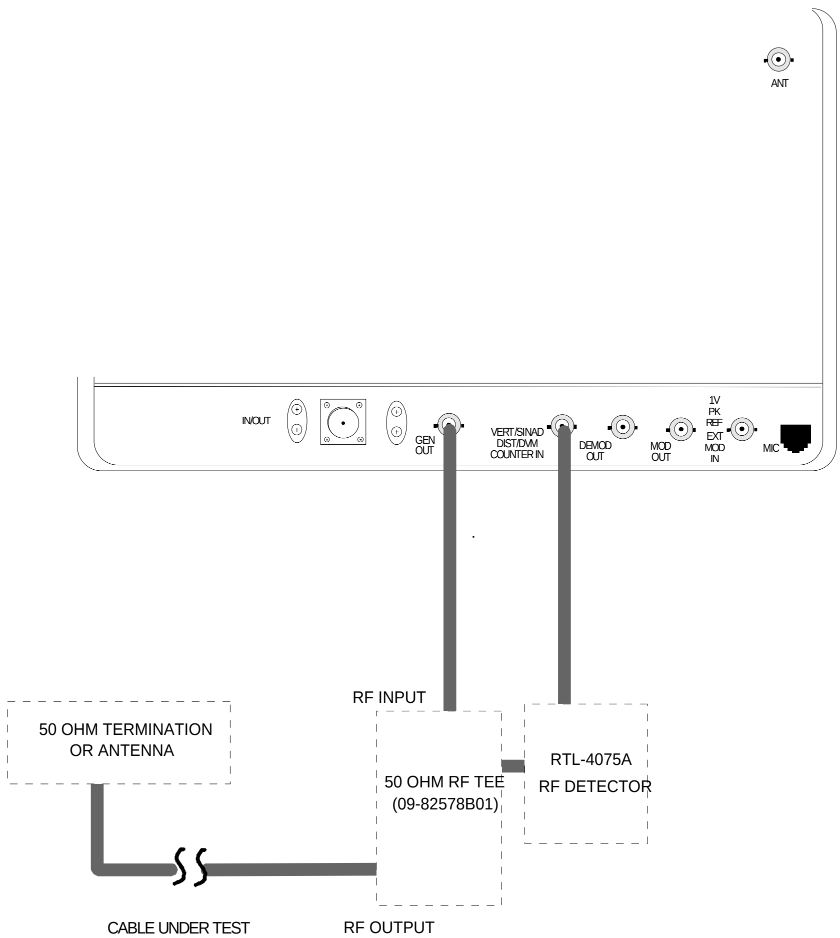


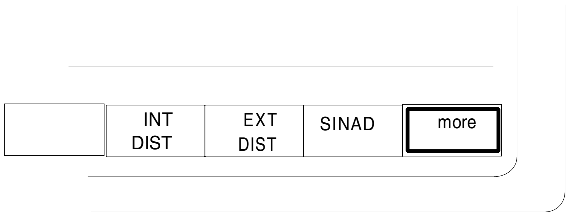
Figure 4-3. Basic Cable Testing Setup

4-3.2 Measuring Fault Distance

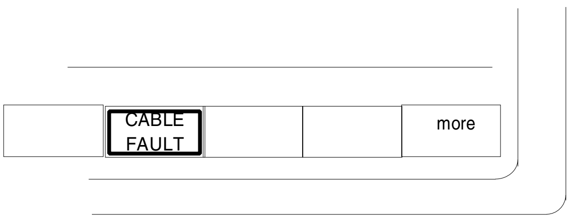
- To measure fault distance, terminate the free end of the cable with a 50 ohm load or the antenna
- To measure cable length, leave the free end of the cable open

Refer to figure 4-3. Connect the output of the RF Detector Probe (RTL-4075A) to the VERT/SINAD connection of the R2600 Analyzer. Attach a 50 ohm Tee (09-82578B01) to the GEN OUT/IN connection of the analyzer, and connect the RF input of the detector probe to the RF Tee. Connect the cable under test to the RF Tee.

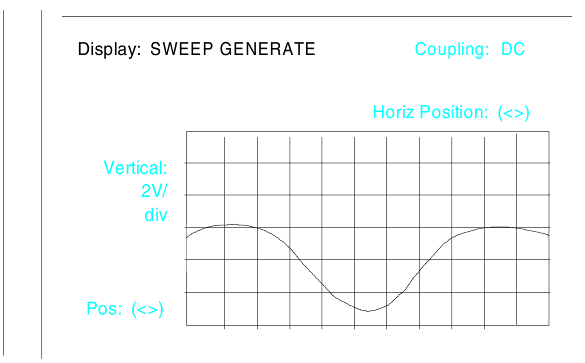
1. With the cursor located within the Display Control zone, press the **more** softkey, then press the **CABLE FAULT** softkey.



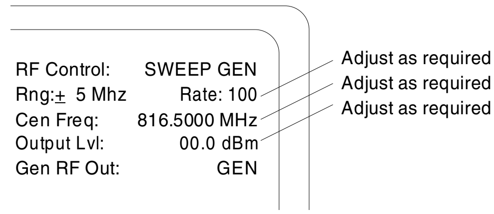
then



2. The sweep generator scope displays the standing wave pattern of the cable.



3. With the cursor located within the RF Control zone, set the range, output level and center frequency for the best display of the standing wave pattern.

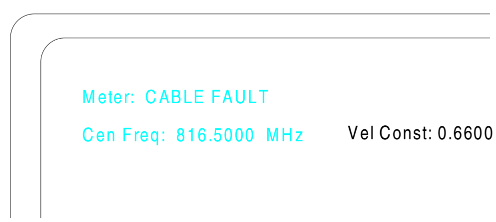


NOTE

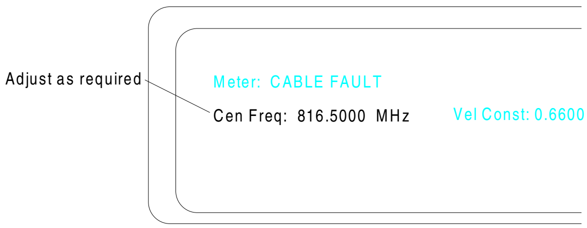
This measurement generally works best with the range set between 10 and 100 MHz. When measuring fault distance, with an antenna attached to the cable, the first and second nul frequencies should be within the operating frequency range of the antenna.

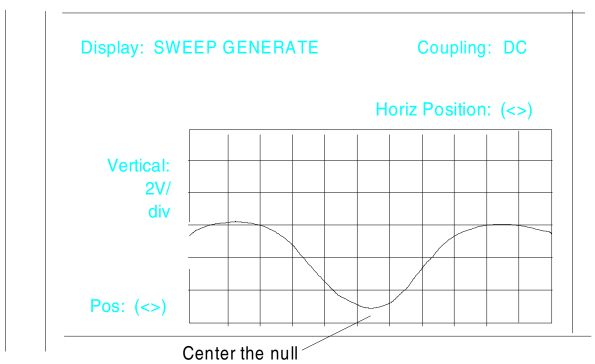
4. Within the Display zone, enter the velocity constant of the cable as required in the "Vel Const: " field.

Polyethylene	0.66
Cellular Polyethylene	0.78
Semi-Solid Polyethylene	0.84

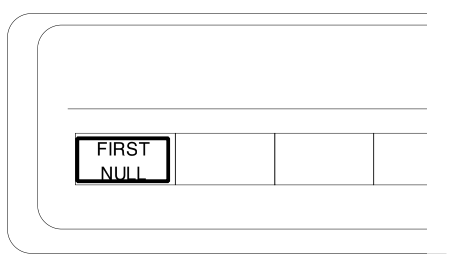


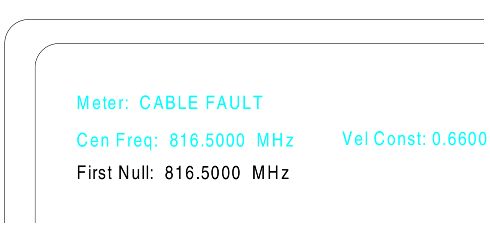
5. With the cursor located within the Display Control zone (Cen Freq:), use the tuning knob to center any null on the sweep generator scope.





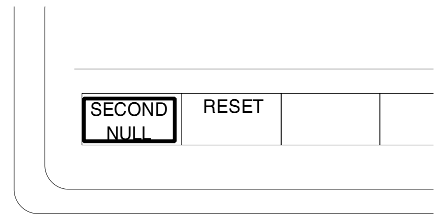
6. With the cursor located within the Display Control zone (Cen Freq:), press the **FIRST NULL** softkey to display the frequency of the first null.

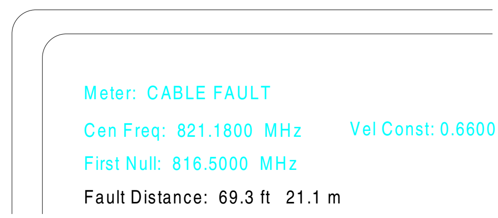




7. With the cursor still located within the Display Control zone (Cen Freq:), use the tuning knob to center an adjacent null to the same location on the sweep generator scope.

8. Press the **SECOND NULL** softkey. The cable fault distance (or cable length) will be displayed.





4-4 TONE REMOTE TESTING

The tone remote function allows the analyzer to generate the required function tones and timing for tone controlled equipment. Specific tones are sent to remote equipment via phone lines that are connected to remotes or control consoles. Base stations and repeaters are examples of equipment using tone control commands. For example, tone commands can command transmitters and receivers to change frequencies or disable PL. The analyzer can simulate the tones and appear to the base station or repeater as a console or desk remote.

The most common use for the tone remote feature is commanding tone remote bases in order to measure all the main transmitter parameters. The main parameters would be power, frequency and system deviation. Without this capability, a technician must rely on personnel at the remote console or carry a tone remote to the base site. This can be impractical and time consuming.

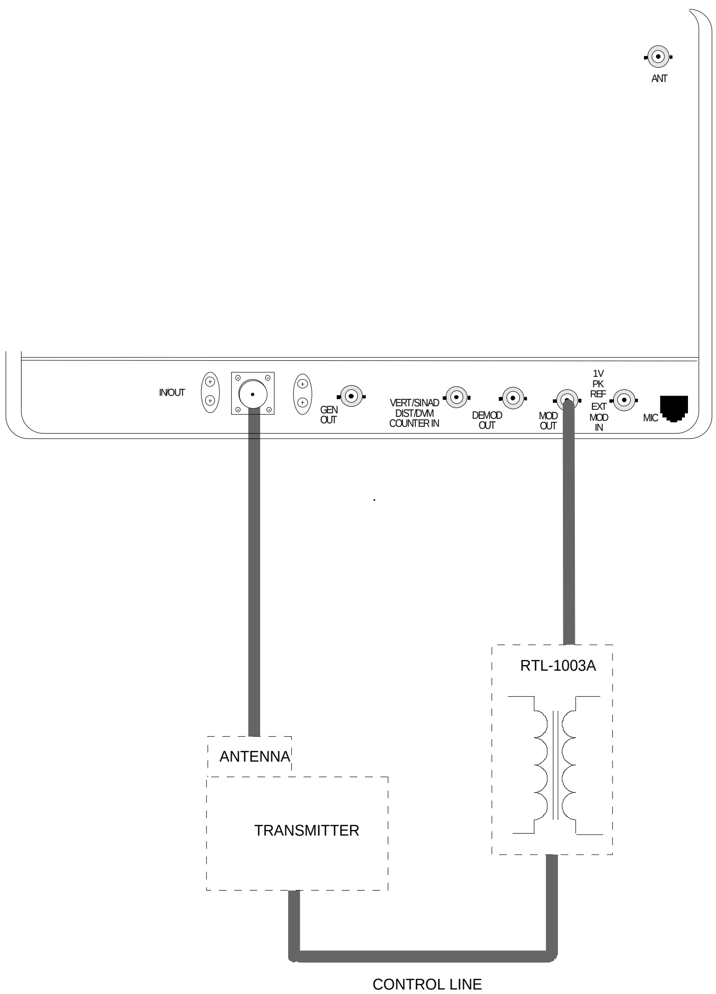


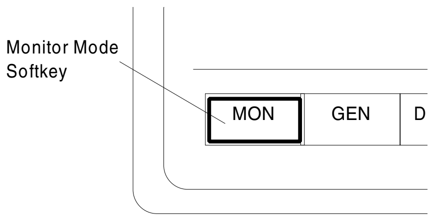
Figure 4-4. Tone Remote Testing Setup

4-4.1 Tone Remote Testing Setup

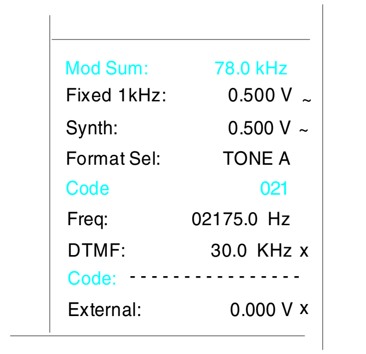
Refer to figure 4-4. Connect the analyzer RF I/O port to the radio antenna connector. Connect the phone lines, using a RTL-1003A matching transformer, to the analyzer's MOD OUT connector.

4-4.2 Checking for Proper Tone Remote Operation

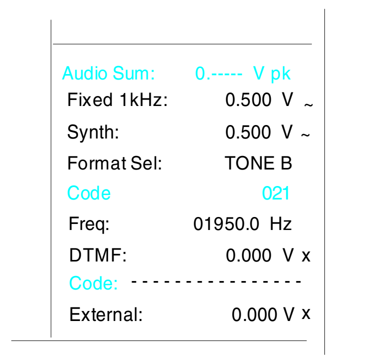
1. With the cursor located within the RF Control zone, press the **MON** softkey to place the analyzer into its Monitor mode of operation.



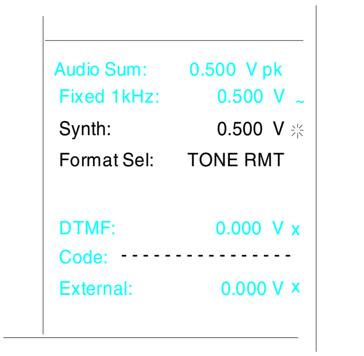
2. Tone Remote frequencies are programmed via the Tone A and Tone B memory. Set up the Audio Control zone, as follows:

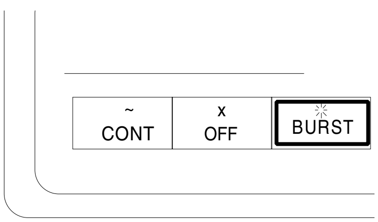


or

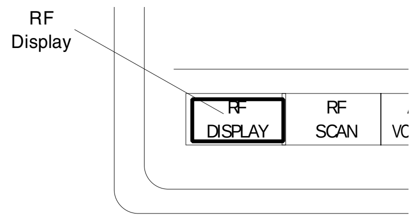


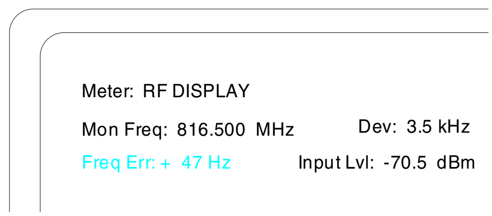
3. Set the "Format Sel:" to **TONE RMT**. The base transmitter is activated when the SYNTH is turned on by pressing the **BURST** key. The level of the fixed 1 kHz tone and "Synth:" field will vary depending on the base specifications.





4. With the cursor located within the Display zone ("Meter:" field), press the RF DISPLAY softkey. Monitor the base frequency, power and deviation.





4-5 Analyzer Setup for Printing

The analyzer must use null modem cable to properly print with any serial printer. **Do not use a standard serial cable; it will not work!**

This is due to the fact that the RS-232 port also is used as a control port to remotely operate the analyzer in computer controlled applications. Different cables are required to activate each function.

To set up the port for printer operation press the **SPF** key. When in this screen, move the highlighted cursor to **RS232 SETUP** and press the softkey labeled **display table**. This table gives you the ability to configure the RS-232 output from the analyzer. Move the cursor to each field and choose the appropriate softkey entry to match the printer setup.

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Section 5

TRUNKING INTRODUCTION

5-1 INTRODUCTION

The General Dynamics R2670 Digital Communications System Analyzer tests the unique requirements of radios supporting Motorola trunked radio protocols. All R2600 Series capabilities are retained with the trunked test sequences accessed via the LCD display, numeric keypad, screen-defined softkeys, cursor movement keys, and the optical tuning knob. The trunking option functions also may be accessed through the remote control interface port.

The trunking option simulates the functions of a central controller of a trunked radio system by providing control channel and voice channel signaling protocols. Testing with the trunked radio option provides dynamic call processing and direction to a voice channel. Once on the voice channel, the general purpose RF test capabilities of the analyzer can be used to measure the radio performance. Trunk option testing provides proof of basic inbound and outbound signaling and displays specification compliance data.

Throughout this manual, the "system" refers to the fixed-end central controller. Thus, a system initiated call is the analyzer simulating the central controller calling the radio under test.

5-2 CAPABILITIES

Trunking option capabilities are as follows:

Dynamic Call Processing

Test trunked mobile and portable radios under actual signaling conditions by simulating the function of the central controller. The trunking analyzer provides separate screens for inbound (radio initiated) and outbound (system initiated) calling modes.

Closed Cover Measurements

The analyzer measures and displays transmitter power, frequency error, and frequency deviation while in the dynamic calling mode. While the radio is on the voice channel, the operator can make additional measurements using other functions of the analyzer.

Radio ID Decoding

The ISW data received from the radio is decoded and displayed on the analyzer. The following defines the data that is decoded and displayed.

TRUNK I AND TRUNK I EP II	TRUNK II
Fleet	
Subfleet	Talkgroup
Unit	Unit
Call Type	Call Type

Manual Mode

The trunking analyzer supports a mode where the operator can exit from the trunking screens and access standard displays of the analyzer while the test sequence is in progress.

Storage of Ten Fleet Maps

For Type 1 systems, the trunking analyzer allows for the storage of 10 unique System ID's and Fleet Maps.

Radios with Message Trunking

The trunking analyzer supports the testing of message trunked radios.

Radios with Message Trunking and PTT ID Enabled

The trunking analyzer supports the testing of message trunked radios with PTT-ID enabled.

Transmission Trunked Radios

The trunking analyzer testing of transmission trunked radios is somewhat limited due to the nature of the radio. Test sequences can be performed on transmission trunked radios by pressing the PTT of the radio and keeping the radio keyed while switching to other display screens to make measurements and observe waveforms. Once the PTT button on the radio is released, the transmission trunked radio returns to the control channel and the test must be re-started in order to rekey the radio.

Dispatch Call

The analyzer supports dispatch call processing where the radio, or the system, initiates the call sequence. The dispatch type call is where one radio is communicating through a repeater with several other radios assigned to the same group.

Phone Interconnect Call

The trunking analyzer supports the testing of phone interconnect call service. The trunking analyzer simulates the signaling required for the radio to initiate, and to receive a phone interconnect call. Phone Interconnect service is where the radio can initiate or receive calls over the local phone system.

Call Alert

The analyzer supports the testing of call alert service. The analyzer simulates the signaling for the radio to initiate, or to receive a call alert.

Failsoft

The analyzer simulates an inoperative central controller by not transmitting OSWs on the control channel, and sending the failsoft word on the failsoft channel.

5-3 WHAT IS TRUNKING?

Trunking is the automatic sharing of a few communication paths (trunks) among many users. Its most important asset is the ability to increase channel capacity and reduce channel waiting times compared to the waiting times in conventional systems. Trunked systems efficiently distribute the message traffic equally among the available channels because:

- the percentage of times a user requires the communications link is small
- the probability that many users will require a channel at the same instant is extremely small

Two-way radio systems use the same techniques of trunking that are used in telephone applications. In a trunked radio system, the mobile radios and fixed equipment operate under the control of a central controller.

The trunked system usually has a single centralized site instead of multiple sites or cells. Trunked systems are usually used for dispatch operations where one dispatcher is communicating with many users. The sharing of channels is a more efficient way to gain spectrum efficiency and provide better service.

The central controller directs operation of the trunked radio system and manages the flow of communications including selection and assignment of voice channels among the system users. The central controller ensures privacy and eliminates interference by assigning only one group to a voice channel at one time. This results in reliable, simple and automatic two-way radio communications.

The central controller assigns a communications path through a repeater to the party that initiates the transmission. If all channels are busy, the radio gives a busy tone. When a channel becomes available, the central controller automatically assigns the radio to that channel and sends a talk permit tone.

When the conversation ends, the channel is free for assignment to other users. This automatic sharing of frequencies through the use of multiple repeaters and a central controller is the heart of a trunked system. Trunked systems offer other advantages including elimination of frequency selection, squelch controls, and channel monitoring.

The main purpose of trunked radio systems is to improve efficiency be sharing resources among many users.

5-3.1 Trunk Signaling Types

Trunk I (Type I)

Trunk I was the first signaling defined for trunked radios. The individual radio units contain preprogrammed fleet, subfleet, and unit ID information. The code plug of each radio in a particular system contains this pre-programmed information. Also included in the code plug are the RF channel identifiers and various system constants.

When a Trunk I radio requests service from the controller, it sends an ISW on the control channel. The central controller receives the request and directs the requesting radio along with other radios in that fleet or subfleet to move to a voice (traffic) channel. Through a process of high-speed and low-speed handshaking on the voice channel, the central controller determines that the radio has indeed switched, and keeps that voice channel reserved for the duration of the call. When the call is completed, the central controller releases the channel to be used by other groups of radios.

Trunk I EP II (Type I EP II)

The reference to Trunk I signaling throughout this manual also apply to Trunk I EP II Signaling, except where noted. Trunk I EP II differs from Trunk I in that the high-speed handshake sequence on the voice channel is eliminated. When the radio is assigned to the voice channel by the controller the radio switches and starts transmitting immediately.

Trunk II (Type II)

Trunk II signaling breaks away from the fleet/subfleet format used in Trunk I. As a result, fleet maps and size codes are eliminated. Each radio on a given system has a unique unit ID and can belong to one or more talk groups. Trunk II signaling also has eliminated the high-speed handshake sequence on the voice channel.

Some Trunk II radios have an automatic affiliation option. Auto affiliation allows a radio to automatically register on a system. Radios with auto affiliation enabled will find a control channel and execute a handshake sequence that identifies the radio and its talk group to the central controller.

Section 6

TRUNKING OPERATING INSTRUCTIONS

CAUTION

When testing a radio, the analyzer generates a control channel signal. Take care to prevent this signal from unintentionally capturing other radios in the area. Observe the following precautions:

- ***Do not*** *use an antenna on the analyzer for over-the-air testing.*
- ***Use*** *double-shielded cables on the analyzer to carry signals to and from the radio.*
- ***Locate*** *the analyzer at least 35 feet from the antenna of a unit that is working in the same system that the analyzer is testing.*
- ***Adjust*** *the squelch to where the LED indicator for squelch just turns off or is closed. When the signal from the radio is present, the squelch LED will illuminate indicating that squelch has been detected and there is a signal present.* ***When testing Type 1 radios, it is advisable to set the squelch control to the open position (fully counter clockwise with squelch LED illuminated).***

6-1 INTRODUCTION

The R2670 Digital Communications System Analyzer is an enhancement of the R2600 Series Communications System Analyzer. Refer to sections 5, 6, and 7 of the General Operation section of this manual for general installation information, a description of the control functions, and general operational information. The following sections of this manual contain information on how to connect trunked radios under test to the analyzer and how to set controls and indicators to obtain the correct screen display.

Error/Warning Messages

Refer to Appendix E for a listing and description of setup and radio error messages. Messages common to all the R2600 Series equipment are detailed in paragraph 6-4 of the General Operation section of this manual.

6-2 TEST SETUP

6-2.1 Connecting a Radio

Use a 50 ohm BNC cable and an N to BNC adaptor to connect from the RF I/O port of the trunking analyzer to the antenna port of the radio as shown in figure 6-1.

CAUTION

Observe the input power ratings and warnings of the analyzer to insure that no damage occurs to the analyzer.

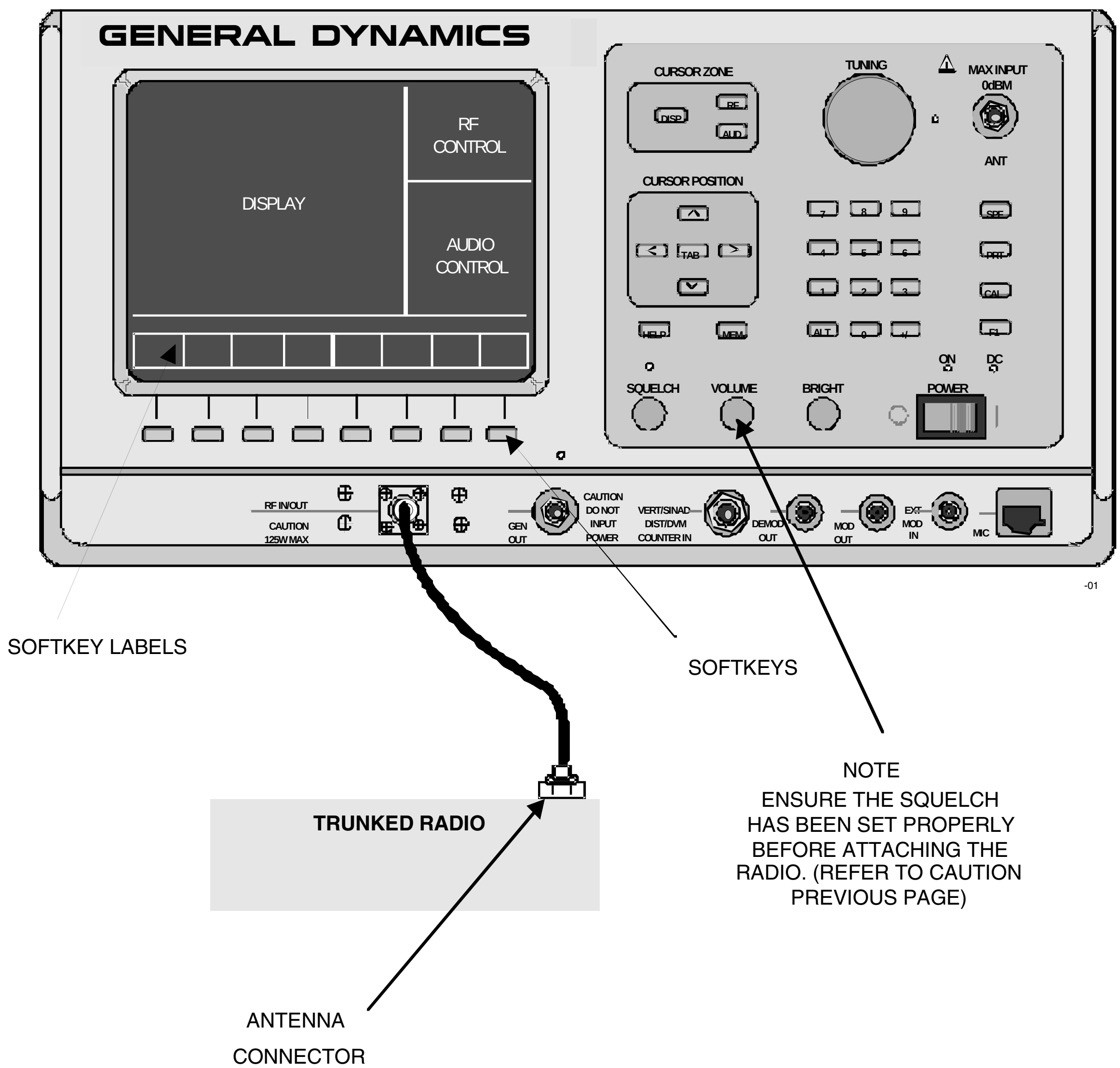

Figure 6-1. Trunked Radio Test Setup

6-3 TRUNKING ANALYZER SOFTWARE VERSION SCREEN

To confirm installation of the Trunking Option, press the **SPF** hard key, move the cursor to "VERSION," and select the display table softkey. This will configure the trunking analyzer to generate a screen that displays the standard and option platform screens. Move the cursor to the TRUNKING position and select the display table softkey. A screen similar to figure 6-2 will be displayed if the analyzer contains the R2670 Trunking Option.

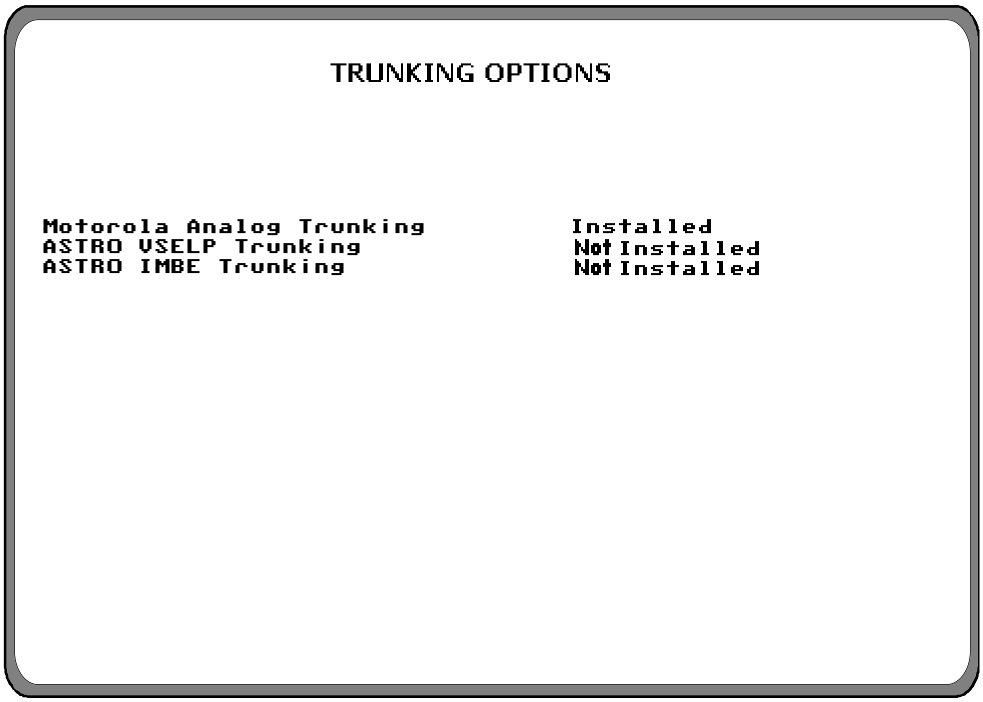

Figure 6-2. Trunking Analyzer Option Screen

6-4 GENERAL OPERATION

The display screen is divided into three major zones: 1) the Display Zone, 2) the RF Zone, and 3) the Audio Zone. The top portion of Display Zone shows the status and selections for the current test sequence. The bottom portion of the Display Zone shows the data about the radio under test.

The RF Zone is used for the selection of trunking frequency bands, for control and voice channels, and port selections.

The Audio Zone is unchanged from the standard system.

A status thermometer is displayed in the Display Zone during the performance of the test. Appendix F identifies all of the signaling events identified in the status thermometer display.

6-4.1 Access to Standard System Test Screens During Trunking Testing

The analyzer must remain in the main trunking test screen during the initial call processing sequence. Once this has been completed and the radio under test is on the voice channel, other standard system screens may be entered from the "Meter:" position of the Display zone. Simply press the more softkey to cycle through the available menus and make the selection accordingly. To end the test it is necessary to return to the trunking test screen from which the test was initiated.

6-4.2 Spectrum Analyzer Dispersion Limit While in Trunked Test Mode

While the trunked test mode is active, the spectrum analyzer maximum dispersion is limited to 1 MHz per division. To use the higher dispersion selections of 2, 5 and 10 MHz per division, it is necessary to set the "Mode:" field of the Display zone to STANDARD.

6-4.3 Remote Operation

All R2600 Series Communications System Analyzers are equipped with a standard RS-232 interface. Optionally, the R2670 is equipped with an IEEE 488 (HP-IB / GPIB) interface. Either of these interfaces may be used to remotely control the analyzer using a set of commands, queries, and responses that are defined in the General Dynamics R2600 Series Communications System Analyzer Programming Reference Manual (68-P80309E55).

6-5 ACCESSING TRUNK MODE

Select the Trunk mode by placing the cursor in the "Mode:" field in the Display Zone located at the top of the screen. Use the **TRUNK** softkey to select the trunk mode. The "Meter:" field must be set to a trunking test. Use the "more" softkey to access the Trunking selections. After selecting **RADIO INIT**, a screen similar to figure 6-3 appears.

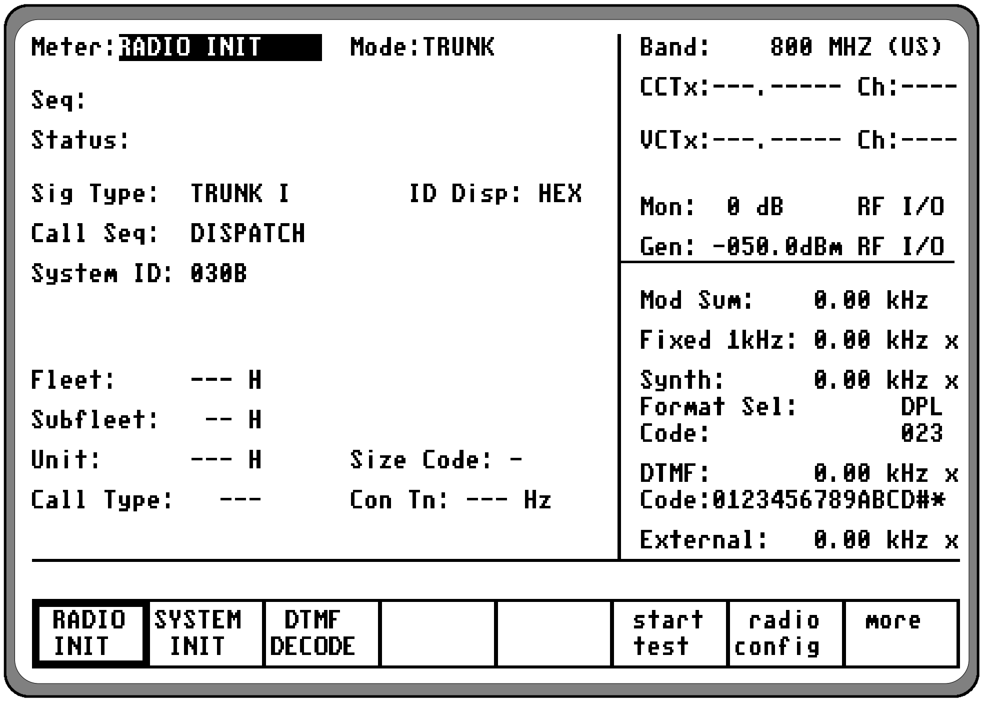

Figure 6-3. Trunk Mode Screen – Radio Initiated Trunk I

6-6 RADIO INITIATED TRUNKING

The **RADIO INIT** softkey configures the analyzer to display the current data and test status for the radio initiated trunked test sequence. When the test is started, the analyzer will blank out decoded ISW data from the previous test sequence and generate idle channel signaling on the control channel. The analyzer will wait for the operator to initiate a transmission from the radio. When a transmission from the radio is detected, the analyzer will execute the test sequence defined by the parameters on the trunking screen.

In the following subsections, the call sequence selected is Dispatch. For details on testing Radio Initiated Phone Interconnect and Call Alert call sequences, refer to Section III, Applications, in this manual.

6-6.1 Radio Initiated Dispatch Trunk I Testing

The radio receives the channel assignment and switches to the voice channel. The analyzer sends a high-speed data word on the voice channel transmit and monitors the voice channel receive for a high-speed acknowledge tone from the radio. Once the high-speed acknowledge is detected, the trunking analyzer transmits low-speed data on the voice channel. When the radio detects the low-speed data from the analyzer, it sends a connect tone and voice on the voice channel. Once the connect tone from the radio is measured and displayed, the analyzer enables its modulation and unmutes its speaker. A status thermometer in the Display zone shows the major signaling events based on the metering selection, the signaling type, and the call sequence. Refer to Appendix F for a description of the status thermometer signaling events for each test sequence.

To set up testing, select the Trunk mode by placing the cursor in the "Mode:" field in the Display Zone, and selecting the **TRUNK** softkey. Within the Display zone, place the cursor in the "Meter:" field and press the softkey **RADIO INIT** to view current data and test status for a radio initiated trunked test sequence. Within the Display zone, place the cursor in the "Sig Type:" field and press the softkey **TRUNK I** to select Trunk I signaling. A screen similar to figure 6-4 appears.

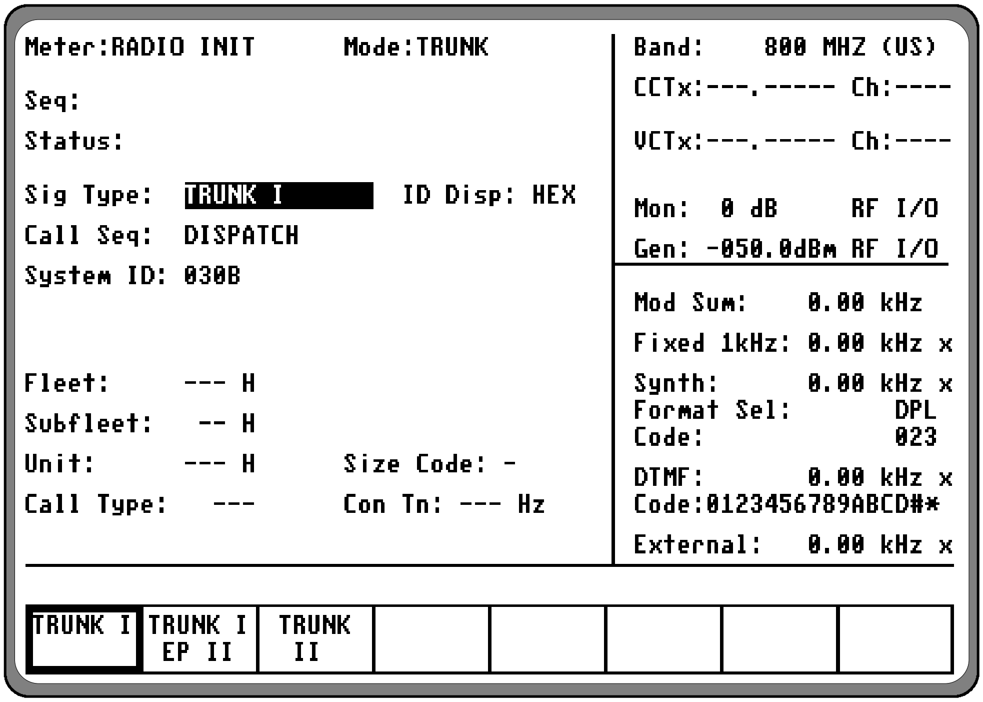

Figure 6-4. Dispatch Test Screen – Radio Initiated Trunk I Signaling

With the above screen displayed, use the cursor control keys to position the cursor, and the softkeys to select the following parameters.

ID Disp:

ID Display is entered with the softkeys. ID Display selects the format of the ISW data that is decoded. The format of the decoded ISW data is either hexadecimal or decimal format.

For Radio Initiated Trunk I and Trunk I EP II test sequences with ID DISP set for DEC, the six digit unit ID decoded from the ISW is the personality ID of the radio and NOT the unit ID. When ID DISP is set for HEX, the unit ID is displayed in hexadecimal format. The Fleet and Subfleet IDs are always displayed in hexadecimal independent of the ID DISP selection.

For System Initiated Trunk I and Trunk I EP II test sequences with ID DISP set for DEC, the six digit unit ID field is used to enter the decimal version of the unit ID only.

Call Seq:

Call Sequence configures the trunking analyzer with the test sequence to be executed. dispatch, Phone Interconnect, Call Alert, and Failsoft call sequences are supported.

System ID:

Enter the system ID as a four-digit hexadecimal number. Use the numeric keypad, the soft keys or tuning knob to make this entry. If the screen already displays a system ID and it requires a change, enter the new system ID over the old.

NOTE

The System ID must match one of the system IDs in the Radio Configuration screen in order to decode radio information. Refer to paragraph 6-8.

Call Type:

Move the cursor to the "Call Type" field and enter Fleet or Subfleet.

Fleet:, Subfleet:, Unit:

If a radio initiated dispatch test has been executed prior to the system initiated test, the fleet, subfleet, and unit ID decoded from the ISW will be displayed.

6-6.2 RF ZONE

Band:

Band selects the frequency channel plan for the analyzer. Enter the Frequency Band with softkeys.

800 MHz (US)

Selection of the 800 MHz (US) band configures the analyzer for the frequency and channel plan described in table 6-1. This table shows the analyzer transmit frequency ranges.

800 MHz (Int'l)

Selection of the 800 MHz (Int'l) band configures the trunking analyzer for the frequency and channel plan described in table 6-2. This table shows the analyzer transmit frequency.

JSMR

Selection of the JSMR band configures the trunking analyzer for the frequency and channel plan described in table 6-3. This table shows the analyzer transmit frequency.

900 MHz

Selection of the 900 MHz band configures the analyzer for the frequency and channel plan described in table 6-4. This table shows the analyzer transmit frequency.

Table 6-1. Available Transmit Frequency Ranges and Channel Plans (800 MHz Selection)

	Frequency Range (MHz)	Channel Range	Channel Spacing (kHz)	Xmit/Rcv Offset (MHz)
800 MHz (US) Standard	851.01250 - 865.98750	000 - 599	25	+45
800 MHz (US) Splinter	851.00000 - 865.97500	000 - 599	25	+45
800 MHz (US) Block 1	866.01250 - 868,98750	600 - 719	25	+45
800 MHz (US) Block 2	866.00000 - 866.97500	720 - 759	25	+45
800 MHz (US) Block 3	867.00000 - 867.40000	815 - 831	25	+45
800 MHz (US) Block 4	867.42500 - 868.97500	961 - 1022	25	+45
800 MHz (US) Block 5	868.97500	958	25	+45

Table 6-2. Available Transmit Frequency Ranges and Channel Plans, 800 MHz (Int'l)

	Frequency Range (MHz)	Channel Range	Channel Spacing (kHz)	Xmit/Rcv Offset (MHz)
800 MHz (Int'l) Standard	851.01250 - 869.98750	000 - 759	25	+45
800 MHz (Int'l) Splinter	851.00000 - 869.97500	000 - 759	25	+45

Table 6-3. Available Transmit Frequency Ranges and Channel Plans, 800 MHz (JSMR)

	Frequency Range (MHz)	Channel Range	Channel Spacing (kHz)	Xmit/Rcv Offset (MHz)
JSMR	850.01250 - 859.98750	001 - 400	25	–55
	850.01875 - 859.96875	001 - 399	25	–55
	850.02500 - 859.97500	001 - 399	25	–55
	850.03125 - 859.98125	001 - 399	25	–55

Table 6-4. Available Transmit Frequency Ranges and Channel Plans (900 MHz Selection)

	Frequency Range (MHz)	Channel Range	Channel Spacing (kHz)	Xmit/Rcv Offset (MHz)
900 MHz	935.01250 - 940.98750	000 - 479	12.5	+39

VHF/UHF

Selection of the VHF/UHF band configures the trunking analyzer for the VHF or UHF frequency band. The operator enters the frequency and channel configuration of the radio to be tested from the Trunk II Radio Configuration screen. The VHF/UHF band does not have a constant offset between the transmit and receive pairs as found in other trunking bands. The operator must enter the Transmit and Receive frequencies for both the control channel and the voice channel.

CCTx:

CCTx is the control channel transmit frequency of the analyzer. The control channel frequency can be changed by moving the cursor into the CCTx cursor field and changing the value with the keypad or with the tuning knob. When the control channel frequency is changed, the corresponding channel number is also updated. If the frequency selected is out of range of the frequency channel plan, the corresponding channel number is dashed out.

As a convenience, the control channel can also be entered by moving the cursor to the associated channel position on the display and selecting a channel number with the keypad or tuning knob. When the channel number is changed, the corresponding frequency value is changed. If the channel number selected is out of range of the frequency channel plan, the corresponding frequency is dashed out.

Splinter channels can only be entered by frequency. Standard channels can be entered by frequency or channel number (channel numbers only map to standard channel frequencies).

CCRx:

The cursor position for CCRx appears only when the band selection is VHF/UHF. CCRx sets the analyzer control channel frequency to receive control channel signaling from the radio. The control channel frequency can be changed by moving the cursor into the CCRx cursor field and changing the value with the keypad or with the tuning knob. When the control channel frequency is changed, the corresponding channel number also is updated. If the frequency selected is out of range of the frequency channel plan, the corresponding channel number is dashed out.

The control channel can also be changed by moving the cursor to the associated channel position on the display and selecting a channel number by the keypad or tuning knob. When the channel number is changed, the corresponding frequency value is changed. If the channel number selected is out of range of the frequency channel plan, the corresponding frequency is dashed out.

VCTx:

VCTx sets the voice channel transmit frequency of the analyzer. The voice channel frequency can be changed by moving the cursor into the VCTx cursor field and changing the value with the keypad or with the tuning knob. When the voice channel frequency is changed, the corresponding channel number is also updated. If the channel number selected is out of range of the frequency channel plan, the corresponding frequency is dashed out.

As a convenience, the voice channel can also be entered by moving the cursor to the associated channel position on the display and selecting a channel number by the keypad or tuning knob. When the channel number is changed, the corresponding frequency value is changed. If the channel number selected is out of range of the frequency channel plan, the corresponding frequency is dashed out.

Splinter channels can only be entered by frequency. Standard channels can be entered by frequency or channel number (channel numbers only map to standard channel frequencies).

VCRx:

The cursor position for VCRx appears only when the band selection is VHF/UHF. VCRx lets the operator set the voice channel frequency for the reception of signaling from the radio. The voice channel frequency can be changed by moving the cursor into the VCRx cursor field and changing the value with the keypad or with the tuning knob. When the control channel frequency is changed, the corresponding channel number is also updated. If the channel number selected is out of range of the frequency channel plan, the corresponding frequency is dashed out.

The voice channel can also be changed by moving the cursor to the associated channel position on the display and selecting a channel number by the keypad or tuning knob. When the channel number is changed, the corresponding frequency value is changed. If the channel number selected is out of range of the frequency channel plan, the corresponding frequency is dashed out.

Mon:

Enter the monitor input attenuation value with softkeys. The operator has the option of selecting 0, 20, or 40 dB attenuation.

Monitor Port

Enter the port selection with softkeys. In most cases, the operator will select the monitor port to **RF/IO**.

CAUTION:

Do not input RF power into the antenna port of the analyzer. Damage to the analyzer may result.

Gen:

Enter the generator output level with the keypad or the tuning knob.

Generator Port

Enter the generator port selection with softkeys. In most cases, the operator will select the port to **RF/IO**.

Audio Zone

At the start of the test sequence, all audio sources within the Audio zone are automatically reset to the "off" condition so as not to interfere with the call signaling. Once the call has been processed and the radio is on the voice channel, audio tones may be activated for audio testing.

CAUTION

If the radio is being tested in a noisy area, it is possible that noise pickup by the radio microphone can interfere with the call processing and result in Connect Tone measurement errors. If this occurs, simply covering the radio microphone during call processing should correct the problem.

6-6.3 Radio Initiated Dispatch Trunk I EP II Testing

At the same time that channel grants are being sent on the control channel, the analyzer is sending low-speed data on the voice channel. The radio receives the channel assignment and switches to the voice channel and transmits connect tone and voice. Once the connect tone from the radio is measured and displayed, the analyzer enables its modulation and unmutes its speaker. Throughout the handshaking sequence, the trunking analyzer updates the status thermometer at the appropriate time. Refer to Appendix F for a description of the status thermometer signaling events for each test sequence.

To set up testing, select the Trunk mode by placing the cursor in the "Mode:" field in the Display Zone, and selecting the **TRUNK** softkey. Place the cursor in the "Meter:" field and press the softkey **RADIO INIT** to view current data and test status for a radio initiated trunked test sequence. Place the cursor in the "Sig Type:" field and press the softkey **TRUNK I EP II** to select Trunk I EP II signaling. A screen similar to figure 6-5 appears.

Parameter selection is the same as Radio Init Dispatch Trunk I described in paragraph 6-6.1.

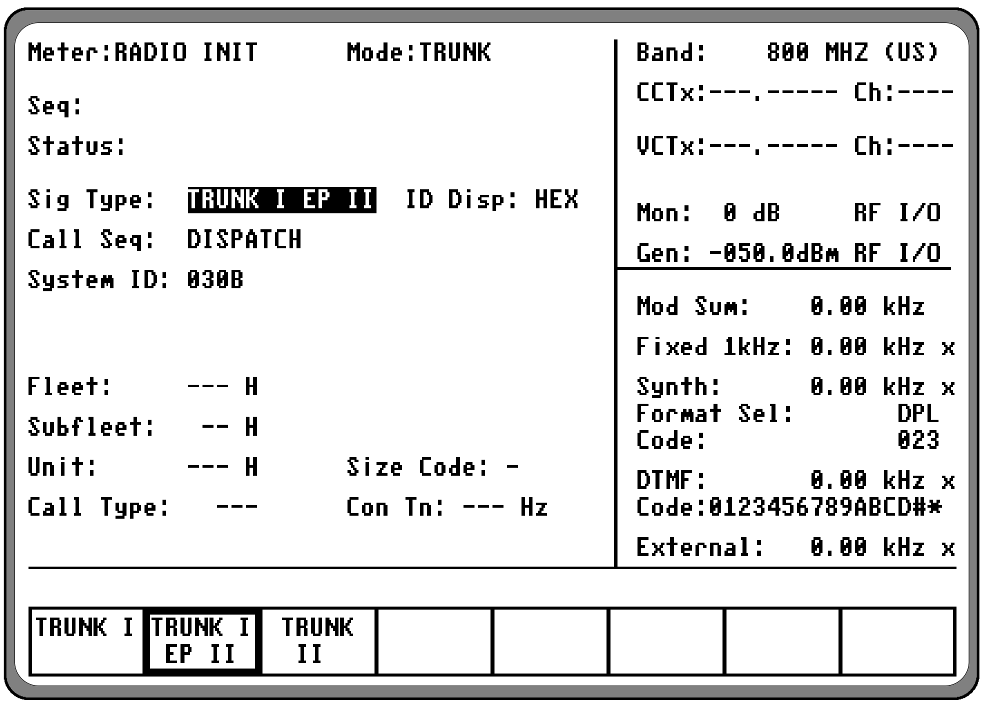

Figure 6-5. Dispatch Test Screen – Radio Initiated Trunk I EP II Signaling

6-6.4 Radio Initiated Dispatch Trunk II Testing

The Trunking Analyzer performs an ISW decode sequence on the control channel that provides talkgroup and unit ID information instead of fleet and subfleet information. Once the ISW data is decoded, the trunking analyzer sends channel grant OSWs on the control channel and low-speed data on the voice channel. The radio detects the channel grant OSWs, switches to the voice channel, and begins transmitting connect tone and voice. The trunking analyzer detects the connect tone and enables its modulation and unmutes its speaker. Throughout the handshaking sequence, the trunking analyzer updates the status thermometer at the appropriate time. Refer to Appendix F for a description of the status thermometer signaling events for each test sequence.

In addition to the information already on the screen, the trunking analyzer calculates and displays the connect tone frequency. After the analyzer displays the connect tone frequency, it remains unchanged for the rest of the test sequence.

The thermometer display progresses rapidly through the signaling events and stops after the Connect Tone Received on VC step. At this point, the radio has sent a connect tone on the voice channel. The connect tone stays on the voice channel as long as the radio is keyed.

In testing a radio from Type II hybrid systems where one signaling type is actually employed while the radio ID information is mapped over to the other signaling types ID format, the trunking analyzer will always display the ID information per the signaling type selected. EXAMPLE: If the radio is actually signaled with Trunk II, yet its ID is defined in terms is Trunk I, it must be tested as a Trunk II radio and the displayed ID information will be in the Trunk II format. For such hybrid radios, verification of the mapped identify may be done via Radio Service Software testing or by manual conversion.

To set up testing, select the Trunk mode by placing the cursor in the "Mode:" field in the Display Zone, and selecting the **TRUNK** softkey. Place the cursor in the "Meter:" field and press the softkey **RADIO INIT** to view current data and test status for a radio initiated trunked test sequence. Within the Display zone, place the cursor in the "Sig Type:" field and press the softkey **TRUNK II** to select Trunk II signaling. A screen similar to figure 2-6 appears.

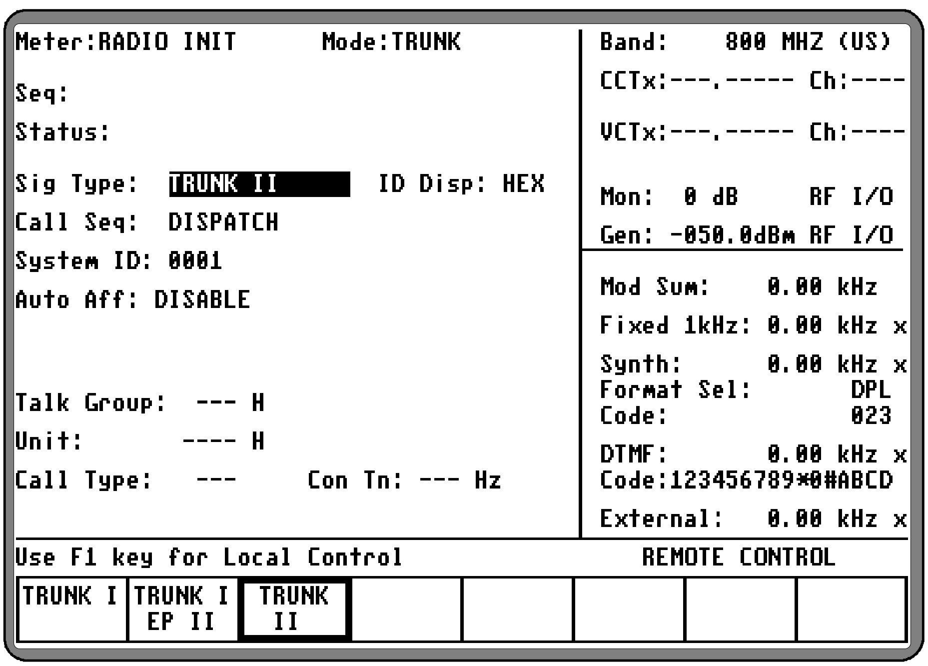

Figure 6-6. Dispatch Test Screen – Radio Init Trunk II Signaling

Parameter selection is similar to Radio Initiated Dispatch Trunk I described in paragraph 6-6.1, with the addition of the following parameter:

Auto Aff

The Auto Aff: selection on the analyzer configures the analyzer to respond to the SMARTZONE registration sequence. The Auto Aff: selection is only available when Trunk II signaling has been selected. The operator has the option of disabling the auto affiliation sequence, or selecting the SMARTZONE affiliation sequence. If the radio is not capable of SMARTZONE auto affiliation, the selection should be set to DISABLED. If auto affiliation is disabled, the analyzer transmits idle data on the control channel until the radio initiates the test sequence.

6-6.5 Radio Initiated Dispatch Trunk II Testing Testing the Auto Affiliation Feature

After setting up the test conditions, with the radio turned "off", press the start test softkey to activate control channel signaling. Turn the radio "on" when the prompt message appears so it can lock to the control channel and register. Successful registration will be indicated by seeing the squelch indicator LED flash briefly followed by the presence of decoded radio ID parameters. The call type M1 should be displayed to indicate that an auto affiliation sequence has been received. At this time, the radio may be keyed to proceed with the radio initiated calling sequence. The radio will remain registered as long as it remains powered up and there have been no changes in basic test configuration. Stopping and re-starting the test requires re-registration as long as SMARTZONE is selected at the "Auto Aff:" field on the screen.

NOTE

If changes to the test setup entries are made after a test has been started, even though theses changes appear on the screen, they will not be entered as part of the test until the test is ended and restarted. Similarly, if invalid entries are made for frequency or other parameters, they may be accepted until a final validity check is done by the system at the time the "start test" softkey is pressed.

6-7 SYSTEM INITIATED TRUNKING

The **SYSTEM INIT** softkey in the "Meter:" field configures the analyzer to display the current data and test status for the system initiated trunked test sequence. The analyzer simulates the central controller (the "system") calling the radio under test.

In the following subsections, the call sequence selected in Dispatch. For details on testing System Initiated Phone Interconnect, Call Alert, and Failsoft call sequences, refer to Section III, Applications, in this manual.

NOTE

Fleet, Subfleet, and Unit ID information must be entered before the execution of a System Initiated test. If a Radio Initiated test is executed prior to the System Initiated test, these fields are automatically updated. If required, refer to 6-8.1 for information related to entry and storage of system/fleet map configurations.

When the test is started, the analyzer generates an idle OSW pattern on the control channel selected for a short period of time so the radio can acquire the control channel. After the time has elapsed, the analyzer directs the radio to the voice channel and provides the voice channel handshake signaling required by the type of Trunk Signaling used. Throughout the signaling process the status thermometer is updated at the appropriate time.

6-7.1 System Initiated Dispatch Trunk I Signaling

The radio receives the control channel message to move to a voice channel and switches to that channel. When the radio detects the high-speed data word and low-speed data word, the radio unmutes and stays on the voice channel until the test is terminated.

To set up testing, select the Trunk mode by placing the cursor in the "Mode:" field in the Display Zone, and selecting the **TRUNK** softkey. Place the cursor in the "Meter:" field and press the softkey **SYSTEM INIT** to view current data and test status for a system initiated trunked test sequence. Within the Display zone, place the cursor in the "Sig Type:" field and press the softkey **TRUNK I** to select Trunk I signaling. A screen similar to figure 6-7 appears.

Parameter selection is similar to Radio Init Dispatch Trunk I described in paragraph 6-6.1.

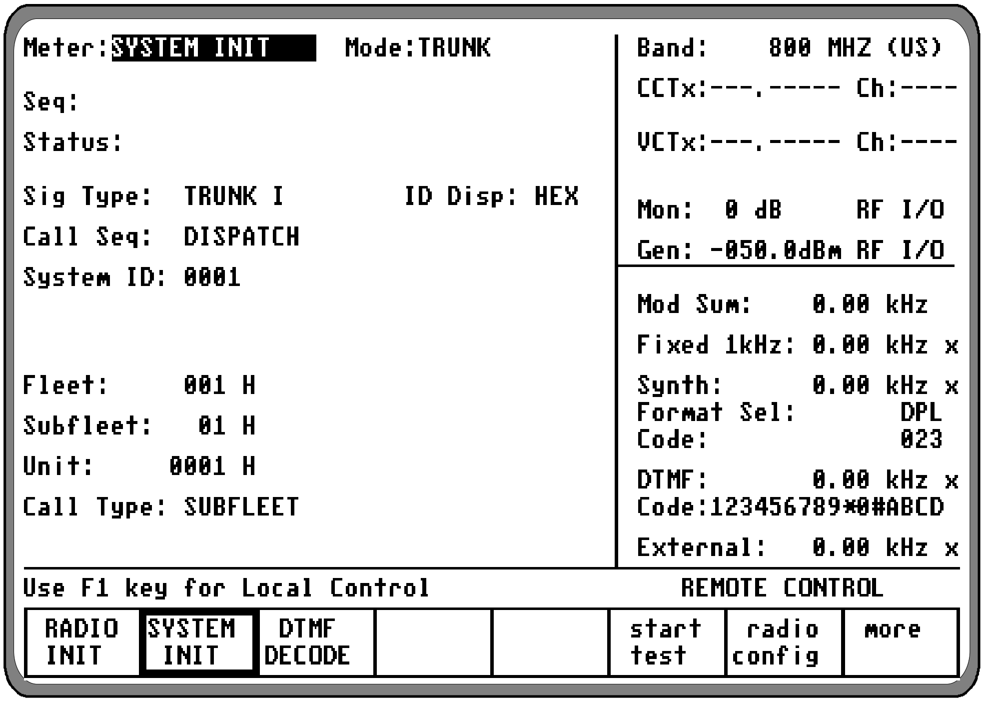

Figure 6-7. Dispatch Test Screen – System Init Trunk I and Trunk I EP II Signaling

6-7.2 System Initiated Dispatch Trunk I EP II Signaling

The radio receives the control channel message to move to a voice channel, and switches to that voice channel. When the radio detects the low-speed data word, the radio unmutes and stays on the voice channel until the test is terminated.

To set up testing, activate the Trunk mode per paragraph 6-5, place the cursor in the "Meter:" field and press the softkey **SYSTEM INIT** to view current data and test status for a system initiated trunked test sequence. Within the Display zone, place the cursor in the "Sig Type:" field and press the softkey **TRUNK I EP II** to select Trunk I EP II signaling. A screen similar to figure 6-7 appears.

Parameter selection is similar to Radio Initiated Dispatch Trunk I described in paragraph 6-6.1.

6-7.3 System Initiated Dispatch Trunk II Signaling

The trunking analyzer sends a low-speed data word on the voice channel frequency. The radio receives the control channel message to move to the voice channel and switches to that voice channel. When the radio detects the low-speed data word, the radio unmutes and stays on the voice channel until the test is terminated.

To setup testing, activate the Trunk mode per paragraph 6-5, place the cursor in the "Meter:" field and press the softkey **SYSTEM INIT** to view current data and test status for a system initiated trunked test sequence. Within the Display zone, place the cursor in the "Sig Type:" field and press the softkey **TRUNK II** to select Trunk II signaling. A screen similar to figure 6-8 appears.

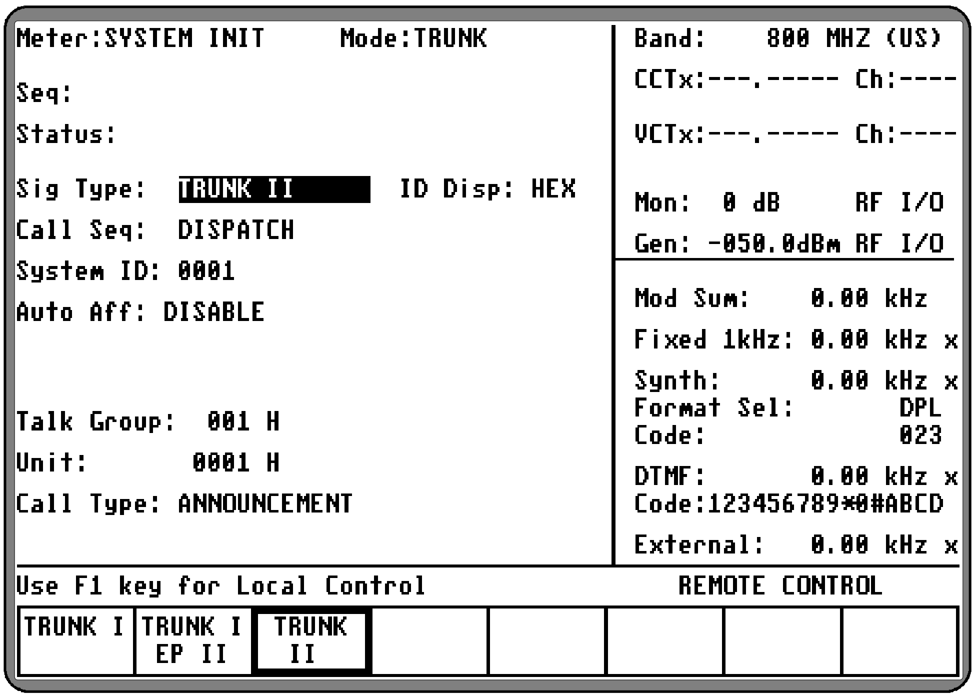

Figure 6-8. Dispatch Test Screen – System Init Trunk II Signaling

Parameter selection is similar to Radio Initiated Dispatch Trunk I described in paragraph 6-6.3, with the addition of the following parameter:

Call Type

Radios in Trunk II systems monitor an announcement talk group in addition to their own talk group. If the operator is making an announcement call to the radio, the announcement talk group must be entered.

Move the cursor to the "Call Type:" location and select **ANNOUNCEMENT** for announcement calls, and **TALK GROUP** for standard talk group calls.

NOTE

SMARTZONE Auto Affiliation may be tested in the system initiated call by selecting SMARTZONE at the "Auto Aff:" field. This requires power cycling the radio at the start of each test as described in paragraph 6-6.3.

6-8 RADIO CONFIGURATION

Data displayed on the Radio Configuration screen depends on the signaling type. The values for Control Channel Transmit Deviation, the SMARTZONE Connect Tone, and the Trunk I, Trunk I EP II fleet maps are entered through this screen.

6-8.1 Radio Configuration Trunk I and Trunk I EP II

The Trunk I and Trunk I EP II Radio Configuration Screen allows the fleet map of the radio being tested and the transmit deviation level for the control channel to be entered. Ten system/fleet map configurations can be stored in the analyzer.

With the Trunk mode activated per paragraph 6-5, place the cursor in the "Sig Type:" field and press the softkey **TRUNK I** (or **TRUNK I EP II**) to select the desired signaling. Place the cursor in the "Meter:" field and press the softkey **RADIO CONFIG**. A screen similar to figure 6-9 appears.

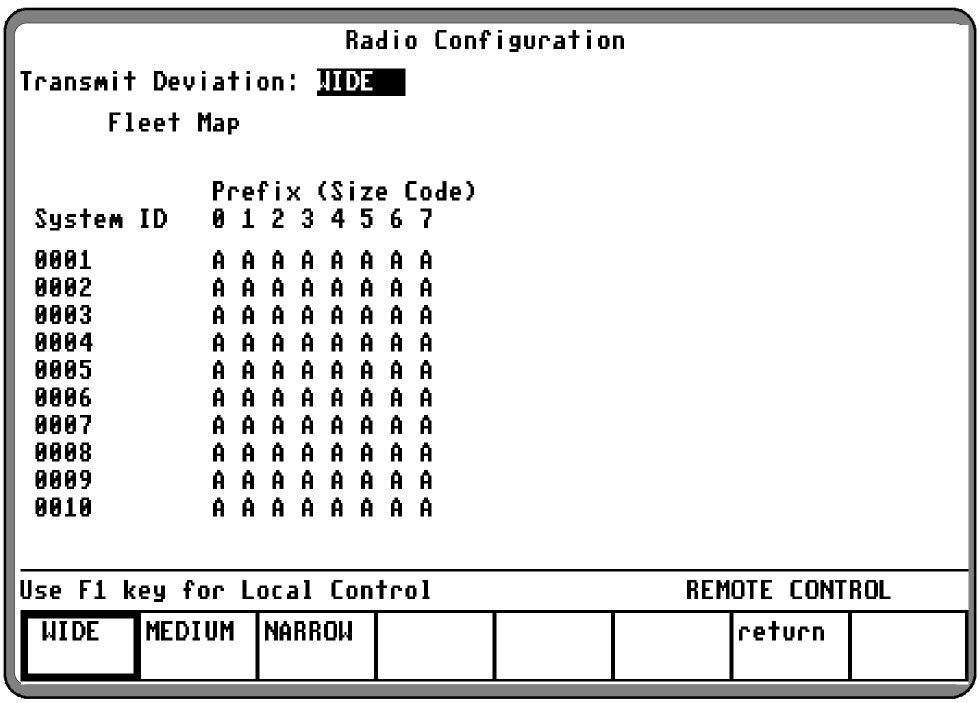

Figure 6-9. Radio Configuration Screen – Trunk I and Trunk I EP II

With the above screen displayed, use the cursor control keys to position the cursor, and the softkeys to select the following parameters:

Transmit Deviation:

The Transmit Deviation selection allows for the selection of either wide, medium, or narrow FM deviation selections per table 6-5.

Table 6-5. Transmit Deviation Selections

Selection	Range	Frequency Band	Channel Range
Wide	3.125 kHz ± 375 Hz	800 MHz (US)	0 through 599
Medium	2.4 kHz ± 300 Hz	800 MHz (US)	600 through 1022
Narrow	1.2 kHz ± 300 Hz	900 MHz	900 MHz

Fleet Map

The radio configuration screen allows for the entry and storage of ten system/fleet map configurations. The fleet map is a plan of how the radio defines the data that is passed between the radio and the central controller. The fleet map is made up of prefixes and size codes. Each fleet map can have up to eight size codes. The value of the prefix field is an index into the fleet map to the size code. A single letter designates each size code.

NOTE

Fleet Map information should be obtained from the System Manager. It also should be resident within the customer maintained data base for each system.

To enter information in the Radio Configuration screen, first obtain the system ID from the 10-digit hexadecimal number on the user label. Then, determine the size code configuration of the system from the system manager. Enter the system ID and the size code letters to the right of the system ID.

Enter the system configuration information before beginning a test to decode fleet, subfleet, and unit ID information.

The system ID and size codes of the radio being tested make up a fleet map. The fleet map must be entered accurately in order for the analyzer to decode the ISW transmitted by the radio.

Example of a Trunk I Fleet Map

The first entered item is the system ID. The radio should have a user label that contains a 10-digit hexadecimal number. The first four numbers are the system ID, the next three are the fleet ID, and the last three the radio ID, (Unit ID).

For example, suppose the user label has the following hexadecimal number:

0A09400001

This represents:

System ID	Fleet ID	Individual ID
0A09	400	001

The fleet prefix is the first number of the three digit hexadecimal fleet ID. The value of the prefix field is an index into the fleet map of a given system for looking up the size code value.

Each trunked fleet map contains a set of eight size codes that is indexed by the prefix value. A single letter designates each size code.

Determine the system configuration information from the system manager for each system. This information is usually not listed on any of the labels on the radio.

Enter the size codes to the right of the system ID on the System Configuration Screen.

If the size codes are unavailable or incorrect, some tests run, but the decoded radio ID information is not correct. The fleet map and radio programming can be verified by comparing the 10-digit hexadecimal number from the user label on the radio against the radio ID data decoded on the analyzer test screen.

Suppose the user label 10-digit hexadecimal number is:

0C08300001

Determine the system ID, fleet ID, fleet prefix, and individual ID in this number.

System ID:	0C08
Fleet ID:	300
Fleet prefix:	3
Individual ID:	001

First, enter the system ID number in the left-hand column under System ID. If the system has size codes AABBCCDD, Enter these to the right of their corresponding system ID.

	Prefix (Size Code)							
System ID	0	1	2	3	4	5	6	7
0C08	A	A	B	B	C	C	D	D

NOTE

If the system configuration contains "fill" type size codes such as Z or X, the size code A should be entered in their place for best results.

6-8.2 Radio Configuration Trunk II

The Trunk II Radio Configuration screen allows for the entry of transmit deviation, and SMARTZONE Connect Tone into the analyzer.

With the Trunk mode activated per paragraph 6-5, place the cursor in the "Sig Type:" field and press the softkey **TRUNK II** to select the desired signaling. Place the cursor in the "Meter:" field and press the softkey **RADIO CONFIG**. A screen similar to figure 6-10 appears.

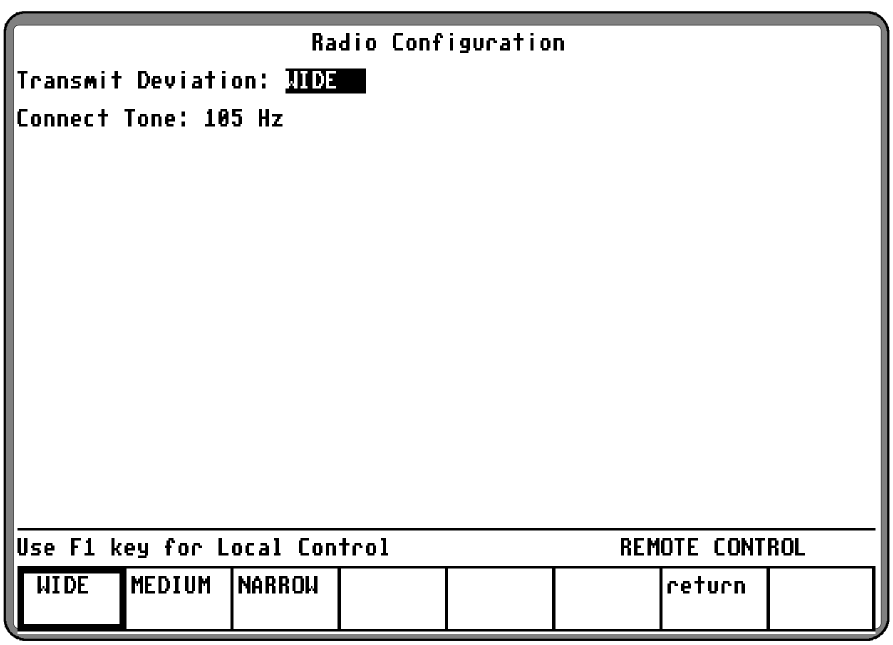

Figure 6-10. Radio Configuration Screen – Trunk II

With the above screen displayed, use the cursor control keys to position the cursor, and the softkeys to select the following parameters:

Transmit Deviation

The Transmit Deviation selection allows for the selection of either wide, medium, or narrow FM deviation selections per table 6-4.

Connect Tone

The Connect Tone selects the connect tone value that will be sent to the test radio during the SMARTZONE auto registration. The value sent is used by the radio while registered on the system. The operator can verify that the SMARTZONE radio is properly registered by comparing the connect tone sent by the radio to the connect tone selected here.

The Trunk II VHF/UHF configuration screen allows for the entry of transmit deviation, connect tone, and VHF/UHF frequency blocks into the analyzer, as described in the next subsection, paragraph 6-8.2.1.

6-8.2.1 Trunk II VHF/UHF Radio Configuration

The radio configuration screen allows for the entry and storage of VHF or UHF frequency blocks. To select the Radio Configuration screen, move the cursor to "Meter:" and select the **RADIO CONFIG** softkey with the "Sig Type:" set for **TRUNK II**, and the "Band:" set for **VHF/UHF**.

The data entered into the VHF/UHF radio configuration screen defines the frequency and channel relationships which are unique for each system in the VHF or UHF band. Calls cannot be completed without correct entry of this data. The data is obtained from the system manager. It exists within the Code Management Data Base for each individual system or the customers local assignment system. The data can also be retrieved from the individual test radios code plug.

Rx and Tx Blocks:

Operating frequencies are organized into a maximum of three blocks numbered one to three. **The number of channels in the 3 blocks must total 380.**

IMPORTANT

The transmit and receive blocks are from the radio's perspective.

1-UUT Rx lets the operator enter the start frequency of the receive block, the end frequency of the receive block, and the channel spacing of the receive block. The channel numbers for this block are calculated with the following equation:

Channel Number = (Selected Frequency – Start Frequency)/ Channel Spacing + Block Base Chan No.

To manually change the start or end frequency value, position the cursor and change the value with the keypad, or the tuning knob.

1-UUT Tx lets the operator enter the start frequency of the transmit block, the end frequency of the transmit block, and the channel spacing of the transmit block. The channel numbers for this block are calculated with the following equation:

Channel Number = (Selected Frequency – Start Frequency)/ Channel Spacing + Block Base Chan No.

The other transmit and receive blocks are entered in a similar manner as described for the first transmit and receive block.

Example:

The radio service software (RSS) for a UHF radio system is used to read the system data from a UHF radio. The following information is obtained from the radio (Refer to table 6-6):

Table 6-6 Trunking Frequency Information Example

Control Channels (MHz)		Channel Ranges			Chan Spacing (kHz)
Receive	Transmit		Start	End	25.00
1-408.00000	413.00000	1-Rx	406.02500	409.00000	25.00
2-410.00000	415.00000	Tx	406.02500	414.00000	25.00
3-415.00000	420.00000				
4-408.50000	413.50000	2-Rx	409.02500	412.02500	25.00
		Tx	414.02500	417.02500	25.00
		3-Rx	412.05000	415.50000	25.00
		Tx	417.05000	420.50000	25.00

On the Trunk II Radio Configuration Screen, the
above data should be entered as shown in figure 6-11.

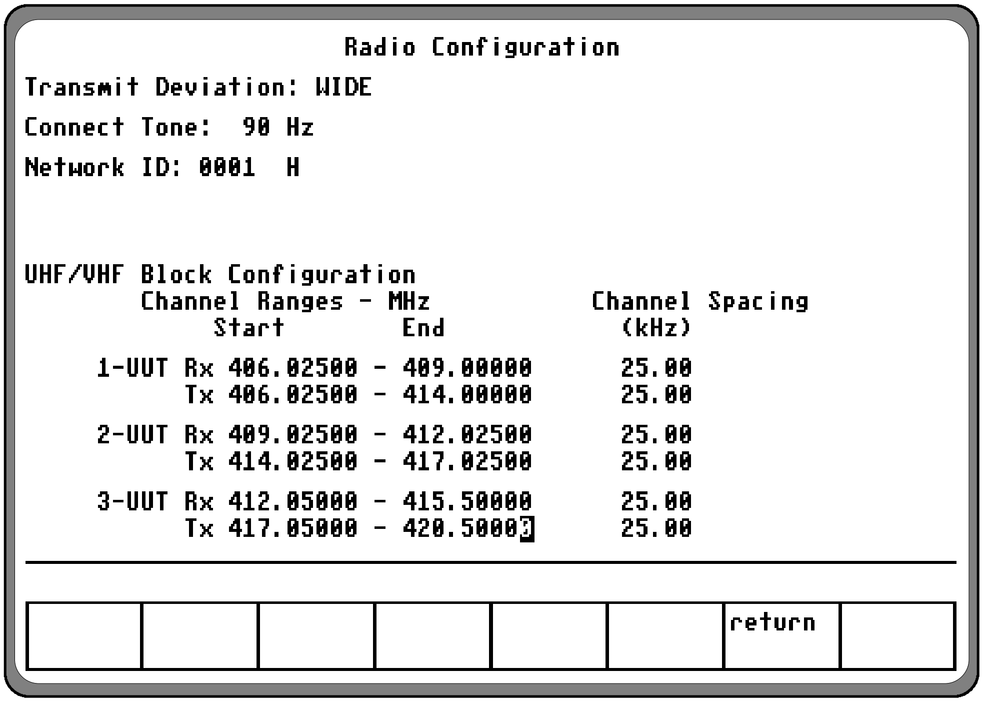

Figure 6-11. Radio Configuration Screen – Trunk II VHF/UHF Example

Rx Block 1 covers the channels from 0 through 119
(End Freq – Start Freq)/Channel Spacing + block base channel number
(409.00000 MHz – 406.02500 MHz)/25 kHz + 0

Rx Block 2 covers the channels 120 through 240
(412.02500 MHz – 409.02500 MHz)/25 kHz + 120

Rx Block 3 covers the channels 241 through 379
(415.50000 MHz – 412.05000 MHz)/25 kHz + 241

Section 7

TRUNKING APPLICATIONS

7-1 BASIC TRUNKED RADIO TESTING

This section of the manual contains information on typical test setups to perform some of the more common trunked radio tests using the R2670 Digital Communications System Analyzer with Trunking Option.

The start test softkey initiates the test sequence defined by the parameters selected on the trunking screen. If the parameters selected are not valid, the test sequence is terminated and an error message is displayed. If the parameters selected are valid when the start test softkey is pressed, the start test softkey is replaced with the stop test softkey. For a list of error and warning messages, refer to Appendix E.

7-2 DISPATCH TESTING

Configure the analyzer for trunk mode (paragraph 6-5) and Radio Initiated Testing (paragraph 6-6).

7-2.1 Radio Initiated Dispatch Test Sequence, Trunk I and Trunk I EP II Signaling

1. Enter the following parameters:

Sig Type:	Trunk I or Trunk I EP II
ID Disp:	HEX or DEC
Call Seq:	DISPATCH

NOTE

For test sequences with ID Disp set for DEC, the six-digit Unit ID decoded from the ISW is the personality ID of the radio and not the unit ID. When ID Disp is set for HEX, the unit ID is displayed in hexadecimal. The Fleet and Subfleet IDs are always displayed in hexadecimal independent of the ID Disp selection.

2. Set the System ID to match the radio system ID and one of the system IDs in the Radio Configuration screen in order to decode radio ID information.

3. Enter the CCTx or Control Channel number. Enter the VCTx or voice channel number.

NOTE

Splinter channels can only be entered by frequency. Standard channels can be entered by frequency or channel number (channel numbers only map to standard channel frequencies).

4. Set the monitor attenuation and port selection. Suggested port selection is RF I/O with 20 dB attenuation.

5. Set the generator attenuation and port selection. Suggested port selection is RF I/O with -50 dB for the level setting.

6. Press the start test softkey.

7. The status thermometer displays the major signaling events that occur during a radio initiated Dispatch test. Refer to table 7-1 (Trunk I signaling) or table 7-2 (Trunk I EP II signaling).

8. Press the stop test softkey to terminate the test sequence.

Table 7-1. Trunk I Signaling Events Radio Initiated Dispatch Testing

SIGNALING EVENT		DESCRIPTION
F	Control Channel Idle	The trunking analyzer outputs a background pattern on the control channel to lock the radio.
J	ISW Received	The radio sent an Inbound Signaling Word (ISW) on the control channel to indicate the radio has been keyed.
Q	Channel Grant OSW Sent	The trunking analyzer sends channel grant OSWs on the control channel. Channel grants direct the radio to the voice channel to use.
R	HS Data Sent On VC	At the same time as the Channel Grant, the trunking analyzer is sending high-speed data on the voice channel.
S	HS ACK Received on VC	The radio sends high-speed acknowledge tone on the voice channel indicating it received the high-speed data from the trunking analyzer.
U	LS Word Sent on VC	The trunking analyzer sends a low-speed data word on the voice channel.
V	Connect Tone Received on VC	The trunking analyzer has decoded the connect tone sent by the radio.
W	Disconnect Tone Received on VC	The radio sent a disconnect tone indicating it has de-keyed. Disconnect Tone Received on VC verifies the receipt of proper disconnect signaling.
X	Disconnect Sent	The trunking analyzer sent a disconnect word on the voice channel to end the call. The radio will return to monitor the control channel.

Table 7-2. Trunk I EP II Signaling Events Radio Initiated Dispatch Testing

SIGNALING EVENT		DESCRIPTION
F	Control Channel Idle	The trunking analyzer outputs a background pattern on the control channel to lock the radio.
J	ISW Received	The radio sent an Inbound Signaling Word (ISW) on the control channel to indicate the radio has been keyed.
Q	Channel Grant OSW Sent	The trunking analyzer sends channel grant OSWs on the control channel. Channel grants direct the radio to the voice channel to use.
U	LS Word Sent on VC	The trunking analyzer sends a low-speed data word on the voice channel.
V	Connect Tone Received on VC	The trunking analyzer decoded the connect tone sent by the radio.
W	Disconnect Tone Received on VC	The radio sent a disconnect tone indicating that it has de-keyed. Disconnect Tone Received on VC verifies the receipt of proper disconnect signaling.
X	Disconnect Sent	The trunking analyzer sent a disconnect word on the voice channel to end the call. The radio will return to monitor the control channel.

7-2.2 Radio Initiated Dispatch Test Sequence, Trunk II Signaling

Configure the analyzer for trunk mode (paragraph 6-5) and Radio Initiated Testing (paragraph 6-6).

NOTE

SMARTZONE configures the analyzer to perform a SMARTZONE affiliation sequence prior to executing the dispatch test sequence. If the radio is not capable of SMARTZONE auto affiliation, the selection should be set to DISABLED.

1. Enter the following parameters:

Sig Type:	Trunk II
ID Disp:	HEX or DEC
Call Seq:	DISPATCH

2. Set the System ID to match the radio system ID and one of the system IDs in the Radio Configuration screen in order to decode radio ID information.

NOTE

The system ID entered ***must*** *match the system ID of the radio. Otherwise the radio will not lock onto the control channel. Refer to paragraph 6-8, Radio Configuration.*

3. Enter the CCTx or Control Channel number. Enter the VCTx or voice channel number.

NOTE

Splinter channels can only be entered by frequency. Standard channels can be entered by frequency or channel number (channel numbers only map to standard channel frequencies).

4. Set the monitor attenuation and port selection. Suggested port selection is RF I/O with 20 dB attenuation.

5. Set the generator attenuation and port selection. Suggested port selection is RF I/O with -50 dB for the level setting.

6. Press the start test softkey.

NOTE

If SMARTZONE auto affiliation has been selected, the operator is prompted to apply power to the radio. Once the test radio is turned on, it begins to search for a control channel. When the radio finds the control channel, it performs an auto registration sequence with the analyzer, and the registration data is displayed.

7. The status thermometer displays the major signaling events that occur during a radio initiated Dispatch test. Refer to table 7-3 (Trunk II auto affiliation disabled), or table 7-4 (Trunk II with auto affiliation).

8. Press the stop test softkey to terminate testing.

Table 7-3. Trunk II Signaling Events Radio Initiated Dispatch Testing Without Auto Affiliation

SIGNALING EVENT		DESCRIPTION
J	ISW Received	The radio sent an Inbound Signaling Word (ISW) on the control channel to indicate the radio has been keyed.
K	Talk Group OSW Sent	The trunking analyzer sends talk group OSWs on the control channel. Talk Group OSWs tell the radio to affiliate by sending a dual word ISW that contains the talk group ID and the unit ID of the radio.
L	Dual ISW Received	The trunking analyzer received a dual word ISW from the radio.
Q	Channel Grant OSW Sent	The trunking analyzer sends channel grant OSWs on the control channel. Channel grants direct the radio to the voice channel to use.
U	LS Word Sent on VC	The trunking analyzer sends a low-speed data word on the voice channel.
V	Connect Tone Received on VC	The trunking analyzer decoded the connect tone sent by the radio.
W	Disconnect Tone Received on VC	The radio sent a disconnect tone indicating it has de-keyed. Disconnect Tone Received on VC verifies the receipt of proper disconnect signaling.
X	Disconnect Sent	The trunking analyzer sent a disconnect word on the voice channel to end the call. The radio will return to monitor the control channel.

Table 7-4. Trunk II Signaling Events Radio Initiated Dispatch Testing With Auto Affiliation

SIGNALING EVENT		DESCRIPTION
D	Affiliate ISW Received	The trunking analyzer received the Affiliate ISW from the radio.
E	Affiliate OSW Sent	The trunking analyzer sends Affiliate OSWs on the control channel. The Affiliate OSW acknowledges the radio is registered on the system and also tells the radio which connect tone to use.
F	Control Channel Idle	The trunking analyzer outputs a background pattern on the control channel to lock the radio.
J	ISW Received	The radio sent an Inbound Signaling Word (ISW) on the control channel to indicate the radio has been keyed.
K	Talk Group OSW Sent	The trunking analyzer sends talk group OSWs on the control channel. Talk Group OSWs tell the radio to affiliate by sending a dual word ISW that contains the talk group ID and the unit ID of the radio.
L	Dual ISW Received	The trunking analyzer received a dual word ISW from the radio.
Q	Channel Grant OSW Sent	The trunking analyzer sends channel grant OSWs on the control channel. Channel grants direct the radio to the voice channel to use.
V	Connect Tone Received on VC	The trunking analyzer decoded the connect tone sent by the radio.
W	Disconnect Tone Received on VC	The radio sent a disconnect tone indicating it has de-keyed. Disconnect Tone Received on VC verifies the receipt of proper disconnect signaling.
X	Disconnect Sent	The trunking analyzer sent a disconnect word on the voice channel to end the call. The radio will return to monitor the control channel.

7-2.3 System Initiated Dispatch Test Sequence, Trunk I and Trunk I EP II Signaling

Configure the analyzer for trunk mode (paragraph 6-5) and System Initiated Testing (paragraph 6-7).

NOTE

Fleet, Subfleet, and Unit ID information must be entered before the execution of a System Initiated test. If a Radio Initiated test is executed prior to the System Initiated test, these fields are automatically updated. If required, refer to paragraph 6-8.1 for information related to entry and storage of system/fleet map configurations.

1. Enter the following parameters:

Sig Type:	Trunk I or Trunk I EP II
ID Disp:	HEX or DEC
Call Seq:	DISPATCH

2. Set the System ID to match the radio system ID and one of the system IDs in the Radio Configuration screen.

NOTE

The system ID entered ***must*** *match the system ID of the radio. Otherwise the radio will not lock onto the control channel. Refer to paragraph 6-8, Radio Configuration.*

3. Enter Fleet, Subfleet, and unit ID.

4. Enter the CCTx or Control Channel number. Enter the VCTx or voice channel number.

NOTE

Splinter channels can only be entered by frequency. Standard channels can be entered by frequency or channel number (channel numbers only map to standard channel frequencies).

5. Set the monitor attenuation and port selection. Suggested port selection is RF I/O with 20 dB attenuation.

6. Set the generator attenuation and port selection. Suggested port selection is RF I/O with -50 dB for the level setting.

7. Press the start test softkey.

8. The status thermometer displays the major signaling events that occur during a system initiated Dispatch test. Refer to table 7-5 (Trunk I signaling) or table 7-6 (Trunk I EP II signaling).

9. Press the stop test softkey to terminate testing.

Table 7-5. Trunk I Signaling Events System Initiated Dispatch Testing

SIGNALING EVENT		DESCRIPTION
Q	Channel Grant OSW Sent	The trunking analyzer sends channel grant OSWs on the control channel. Channel grants direct the radio to the voice channel to use.
R	HS Data Sent On VC	At the same time as the Channel Grant the trunking analyzer is sends high-speed data on the voice channel.
U	LS Word Sent on VC	The trunking analyzer sends a low-speed data word on the voice channel.
X	Disconnect Sent	The trunking analyzer sent a disconnect word on the voice channel to end the call. The radio will return to monitor the control channel.

Table 7-6. Trunk I EP II Signaling Events System Initiated Dispatch Testing

SIGNALING EVENT		DESCRIPTION
Q	Channel Grant OSW Sent	The trunking analyzer sends channel grant OSWs on the control channel. Channel grants direct the radio to the voice channel to use.
U	LS Word Sent on VC	The trunking analyzer sends a low-speed data word on the voice channel.
X	Disconnect Sent	The trunking analyzer sent a disconnect word on the voice channel to end the call. The radio will return to monitor the control channel.

7-2.4 System Initiated Dispatch Test Sequence, Trunk II Signaling

Configure the analyzer for trunk mode (paragraph 6-5) and System Initiated Testing (paragraph 6-7).

NOTE

Fleet, Subfleet, and Unit ID information must be entered before the execution of a System Initiated test. If a Radio Initiated test is executed prior to the System Initiated test, these fields are automatically updated. If required, refer to paragraph 6-8.1 for information related to entry and storage of system/fleet map configurations.

NOTE

SMARTZONE configures the analyzer to perform a SMARTZONE affiliation sequence prior to executing the dispatch test sequence. If the radio is not capable of SMARTZONE auto affiliation, the selection should be set to DISABLED.

1. Enter the following parameters:

Sig Type:	Trunk II
ID Disp:	HEX or DEC
Call Seq:	DISPATCH

2. Set the System ID to match the radio system ID and one of the system IDs in the Radio configuration screen in order to decode radio ID information.

3. Enter Talk Group, Call Type, and Unit ID.

NOTE

If an announcement call type is selected, the operator must also set the talk group to the announcement talk group monitored by the radio.

4. Enter the CCTx or Control Channel number. Enter the VCTx or voice channel number.

NOTE

Splinter channels can only be entered by frequency. Standard channels can be entered by frequency or channel number (channel numbers only map to standard channel frequencies).

5. Set the monitor attenuation and port selection. Suggested port selection is RF I/O with 20 dB attenuation.

6. Set the generator attenuation and port selection. Suggested port selection is RF I/O with -50 dB for the level setting.

7. Press the start test softkey.

8. The status thermometer displays the major signaling events that occur during a system initiated Dispatch test. Refer to table 7-7 (Trunk II auto affiliation disabled), or table 7-8 (Trunk II with auto affiliation).

Table 7-7. Trunk II Signaling Events System Initiated Dispatch Testing Without Auto Affiliation

SIGNALING EVENT		DESCRIPTION
Q	Channel Grant OSW Sent	The trunking analyzer sends channel grant OSWs on the control channel. Channel grants direct the radio to the voice channel to use.
U	LS Word Sent on VC	The trunking analyzer sends a low-speed data word on the voice channel.
X	Disconnect Sent	The trunking analyzer sent a disconnect word on the voice channel to end the call. The radio will return to monitor the control channel.

Table 7-8. Trunk II Signaling Events System Initiated Dispatch Testing With Auto Affiliation

SIGNALING EVENT		DESCRIPTION
D	Affiliate ISW Received	The trunking analyzer received the Affiliate ISW from the radio.
E	Affiliate OSW Sent	The trunking analyzer sends Affiliate OSWs on the control channel. The Affiliate OSW acknowledges the radio is registered on the system and tells the radio which connect tone to use.
F	Control Channel Idle	The trunking analyzer outputs a background pattern on the control channel to lock the radio.
Q	Channel Grant OSW Sent	The trunking analyzer sends channel grant OSWs on the control channel. Channel grants direct the radio to the voice channel to use.
U	LS Word Sent on VC	The trunking analyzer sends a low-speed data word on the voice channel.
X	Disconnect Sent	The trunking analyzer sent a disconnect word on the voice channel to end the call. The radio will return to monitor the control channel.

7-3 PHONE INTERCONNECT TESTING

Configure the analyzer for trunk mode (paragraph 6-5) and Radio Initiated Testing (paragraph 6-6).

7-3.1 Radio Initiated Phone Interconnect Test Sequence, Trunk I and Trunk I EP II Signaling

1. Enter the following parameters:

Sig Type:	Trunk I or Trunk I EP II
ID Disp:	HEX or DEC
Call Seq:	PHONE INTERCONNECT

NOTE

For test sequences with ID Disp set for DEC, the six-digit Unit ID decoded from the ISW is the personality ID of the radio and not the unit ID. When ID Disp is set for HEX, the Unit ID is displayed in hexadecimal. The Fleet and Subfleet IDs are always displayed in hexadecimal independent of the ID Disp selection.

2. Set the System ID to match the radio system ID and one of the system IDs in the Radio Configuration screen in order to decode radio ID information.

3. Enter the CCTx or Control Channel number. Enter the VCTx or voice channel number.

NOTE

Splinter channels can only be entered by frequency. Standard channels can be entered by frequency or channel number (channel numbers only map to standard channel frequencies).

4. Set the monitor attenuation and port selection. Suggested port selection is RF I/O with 20 dB attenuation.

5. Set the generator attenuation and port selection. Suggested port selection is RF I/O with -50 dB for the level setting.

6. Press the start test softkey.

   The trunking analyzer generates an idle background pattern on the control channel and prompts the operator to key the transmitter. The operator keys the transmitter of the radio by sending a phone interconnect request. The request is received by the analyzer and the data is displayed. The radio is then directed to a voice channel where the appropriate Trunk I or Trunk I EP II signaling is accomplished.

7. The status thermometer displays the major signaling events that occur during a radio initiated phone interconnect test. Refer to table 7-9 (Trunk I), table 7-10 (Trunk I EP II), table 7-11 (Trunk II auto affiliation disabled) or table 7-12 (Trunk II with auto affiliation).

   The trunking analyzer continues to transmit data to keep the radio on the voice channel.

   When the radio is on the voice channel, the operator can test the DTMF capability of the radio by selecting the **DTMF DECODE** softkey from the "Meter:" cursor position. The DTMF decode screen is used to display DTMF tones from the radio.

   While the radio is being held on the voice channel, the operator has the option to select other display screens by moving the cursor to "Meter:" and selecting the desired metering function. For example, the operator can switch the analyzer to the RF Display screen and rekey the radio to measure frequency error, RF transmitter power, and frequency deviation.

8. From the "Meter:" cursor position, the operator completes the test sequence by pressing the **hangup** softkey.

The trunking analyzer prompts the operator to "hangup" the radio. The trunking analyzer receives the message from the radio, updates the display, and prompts the user that the test is ended.

Table 7-9. Trunk I Signaling Events Radio Initiated Phone Interconnect Testing

SIGNALING EVENT		DESCRIPTION
F	Control Channel Idle	The trunking analyzer outputs a background pattern on the control channel to lock the radio.
J	ISW Received	The radio sent an Inbound Signaling Word (ISW) on the control channel indicating the radio has been keyed.
Q	Channel Grant OSW Sent	The trunking analyzer sends channel grant OWSs on the control channel. Channel grants direct the radio to the voice channel to use.
R	HS Data Sent On VC	At the same time as the Channel Grant, the trunking analyzer sends high-speed data on the voice channel.
U	LS Word Sent On VC	The trunking analyzer sends a low-speed data word on the voice channel.
Y	Hangup Received	The trunking analyzer decoded the Hangup ISW from the radio.

Table 7-10. Trunk I EP II Signaling Events Radio Initiated Phone Interconnect Testing

SIGNALING EVENT		DESCRIPTION
F	Control Channel Idle	The trunking analyzer outputs a background pattern on the control channel to lock the radio.
J	ISW Received	The radio sent an Inbound Signaling Word (ISW) on the control channel indicating the radio has been keyed.
Q	Channel Grant OSW Sent	The trunking analyzer sends channel grant OWSs on the control channel. Channel grants direct the radio to the voice channel to use.
U	LS Word Sent On VC	The trunking analyzer sends a low-speed data word on the voice channel.
Y	Hangup Received	The trunking analyzer decoded the Hangup ISW from the radio.

7-3.2 Radio Initiated Phone Interconnect Test Sequence, Trunk II Signaling

Configure the analyzer for trunk mode (paragraph 6-5) and Radio Initiated Testing (paragraph 6-6).

NOTE

SMARTZONE configures the analyzer to perform a SMARTZONE affiliation sequence prior to executing the dispatch test sequence. If the radio is not capable of SMARTZONE auto affiliation, the selection should be set to DISABLED.

1. Enter the following parameters:

Sig Type:	Trunk II
ID Disp:	HEX or DEC
Call Seq:	PHONE INTERCONNECT

2. Set the System ID to match the radio system ID and one of the system IDs in the Radio Configuration screen in order to decode radio ID information.

NOTE

*The system ID entered **must** match the system ID of the radio. Otherwise the radio will not lock onto the control channel. Refer to paragraph 6-8, Radio Configuration.*

3. Enter the CCTx or Control Channel number. Enter the VCTx or voice channel number.

NOTE

Splinter channels can only be entered by frequency. Standard channels can be entered by frequency or channel number (channel numbers only map to standard channel frequencies).

4. Set the monitor attenuation and port selection. Suggested port selection is RF I/O with 20 dB attenuation.

5. Set the generator attenuation and port selection. Suggested port selection is RF I/O with -50 dB for the level setting.

6. Press the start test softkey.

NOTE

If SMARTZONE auto affiliation has been selected, the operator is prompted to apply power to the radio. Once the test radio is turned on, it begins to search for a control channel. When the radio finds the control channel, it performs an auto registration sequence with the analyzer, and the registration data is displayed.

7. The status thermometer displays the major signaling events that occur during a radio initiated phone interconnect test. Refer to table 7-11 (Trunk II auto affiliation disabled), or table 7-12 (Trunk II with auto affiliation).

8. Press the stop test softkey to terminate testing.

Table 7-11. Trunk II Signaling Events
Radio Initiated Phone Interconnect Testing Without Auto Affiliation

SIGNALING EVENT		DESCRIPTION
F	Control Channel Idle	The trunking analyzer outputs a background pattern on the control channel to lock the radio.
J	ISW Received	The radio sent an Inbound Signaling Word (ISW) on the control channel indicating the radio has been keyed.
Q	Channel Grant OSW Sent	The trunking analyzer sends channel grant OWSs on the control channel. Channel grants direct the radio to the voice channel to use.
U	LS Word Sent On VC	The trunking analyzer sends a low-speed data word on the voice channel.
Y	Hangup Received	The trunking analyzer decoded the Hangup ISW from the radio.

Table 7-12. Trunk II Signaling Events
Radio Initiated Phone Interconnect Testing With Auto Affiliation

SIGNALING EVENT		DESCRIPTION
A	Control Channel Idle	The trunking analyzer outputs a background pattern on the control channel for the radio to lock onto.
D	Affiliate ISW Received	The trunking analyzer received the Affiliate ISW from the radio.
E	Affiliate OSW Sent	The trunking analyzer sends Affiliate OSWs on the control channel. The Affiliate OSW acknowledges the radio is registered on the system and tells the radio which connect tone to use.
F	Control Channel Idle	The trunking analyzer outputs a background pattern on the control channel to lock the radio.
J	ISW Received	The radio sent an Inbound Signaling Word (ISW) on the control channel indicating the radio has been keyed.
Q	Channel Grant OSW Sent	The trunking analyzer sends channel grant OWSs on the control channel. Channel grants direct the radio to the voice channel to use.
U	LS Word Sent On VC	The trunking analyzer sends a low-speed data word on the voice channel.
Y	Hangup Received	The trunking analyzer decoded the Hangup ISW from the radio.

7-3.3 System Initiated Phone Interconnect Test Sequence, Trunk I and Trunk I EP II Signaling

Configure the analyzer for trunk mode (paragraph 6-5) and System Initiated Testing (paragraph 6-7).

NOTE

Fleet, Subfleet, and Unit ID information must be entered before the execution of a System Initiated test. If a Radio Initiated test is executed prior to the System Initiated test, these fields are automatically updated. If required, refer to paragraph 6-8.1 for information related to entry and storage of system/fleet map configurations.

1. Enter the following parameters:

Sig Type:	Trunk I or Trunk I EP II
ID Disp:	HEX or DEC
Call Seq:	PHONE INTERCONNECT

2. Set the System ID to match the radio system ID and one of the system IDs in the Radio Configuration screen.

NOTE

*The System ID entered **must** match the System ID of the radio. Otherwise the radio will not lock onto the control channel. Refer to paragraph 6-8, Radio Configuration.*

3. Enter Fleet, Subfleet, and Unit ID.

4. Enter the CCTx or Control Channel number. Enter the VCTx or voice channel number.

NOTE

Splinter channels can only be entered by frequency. Standard channels can be entered by frequency or channel number (channel numbers only map to standard channel frequencies).

5. Set the monitor attenuation and port selection. Suggested port selection is RF I/O with 20 dB attenuation.

6. Set the generator attenuation and port selection. Suggested port selection is RF I/O with -50 dB for the level setting.

7. Press the start test softkey.

   The trunking analyzer generates an idle OSW pattern for the radio to lock to. After a short period of time, the analyzer will send a message to the radio instructing it to ring. The radio sends a message to the analyzer when the call has been answered. At that time, the analyzer directs the radio to a voice channel and provides the appropriate Trunk I or Trunk I EP II handshake.

8. The status thermometer displays the major signaling events that occur during a system initiated phone interconnect test. Refer to table 7-13 (Trunk I signaling) or table 7-14 (Trunk I EP II signaling).

   Once on the voice channel, the operator can modulate the carrier with tones, or voice, and select other displays.

9. To complete the last step on the status thermometer and end the test sequence, the operator must return to the System Init selection. From the "Meter:" cursor position, the operator completes the test sequence by pressing the **hangup** softkey.

   The trunking analyzer prompts the user to hang up the phone. When the analyzer detects that the phone has been hung up, the status thermometer is updated, the ISW decode field is updated, and the test ended message is displayed on the screen.

Table 7-13. Trunk I Signaling Events System Initiated Phone Interconnect Testing

SIGNALING EVENT		DESCRIPTION
F	Control Channel Idle	The trunking analyzer outputs a background pattern on the control channel to lock the radio.
G	Transpond OSW Sent	The trunking analyzer sent the Transpond OSW to the radio.
H	Transpond OSW Received	The trunking analyzer detected the Transpond ISW from the radio.
I	Ring OSW Sent	The trunking analyzer sent the Ring OSW to the radio.
J	ISW Received	The radio sent an Inbound Signaling Word (ISW) on the control channel to indicate the radio has been keyed.
Q	Channel Grant OSW Sent	The trunking analyzer sends channel grant OWSs on the control channel. Channel grants direct the radio to the voice channel to use.
R	HS Data Sent On VC	At the same time as the Channel Grant, the trunking analyzer sends high-speed data on the voice channel.
U	LS Word Sent On VC	The trunking analyzer sends a low-speed data word on the voice channel.
Y	Hangup Received	The trunking analyzer decoded the Hangup ISW from the radio.

Table 7-14. Trunk I EP II Signaling Events System Initiated Phone Interconnect Testing

SIGNALING EVENT		DESCRIPTION
F	Control Channel Idle	The trunking analyzer outputs a background pattern on the control channel to lock the radio.
G	Transpond OSW Sent	The trunking analyzer sent the Transpond OSW to the radio.
H	Transpond OSW Received	The trunking analyzer detected the Transpond ISW from the radio.
I	Ring OSW Sent	The trunking analyzer sent the Ring OSW to the radio.
J	ISW Received	The radio sent an Inbound Signaling Word (ISW) on the control channel to indicate the radio has been keyed.
Q	Channel Grant OSW Sent	The trunking analyzer sends channel grant OWSs on the control channel. Channel grants direct the radio to the voice channel to use.
U	LS Word Sent On VC	The trunking analyzer sends a low-speed data word on the voice channel.
Y	Hangup Received	The trunking analyzer decoded the Hangup ISW from the radio.

7-3.4 System Initiated Phone Interconnect Test Sequence, Trunk II

Configure the analyzer for trunk mode (paragraph 6-5) and System Initiated Testing (paragraph 6-7).

NOTE

Fleet, Subfleet, and Unit ID information must be entered before the execution of a System Initiated test. If a Radio Initiated test is executed prior to the System Initiated test, these fields are automatically updated. If required, refer to paragraph 6-8.1 for information related to entry and storage of system/fleet map configurations.

NOTE

SMARTZONE configures the analyzer to perform a SMARTZONE affiliation sequence prior to executing the dispatch test sequence. If the radio is not capable of SMARTZONE auto affiliation, the selection should be set to DISABLED.

1. Enter the following parameters:

Sig Type:	Trunk II
ID Disp:	HEX or DEC
Call Seq:	PHONE INTERCONNECT

2. Set the System ID to match the radio system ID and one of the system IDs in the Radio configuration screen in order to decode radio ID information.

3. Enter talk group, call type, and unit ID.

NOTE

If an announcement call type is selected, the operator must also set the talk group to the announcement talk group monitored by the radio.

4. Enter the CCTx or Control Channel number. Enter the VCTx or voice channel number.

NOTE

Splinter channels can only be entered by frequency. Standard channels can be entered by frequency or channel number (channel numbers only map to standard channel frequencies).

5. Set the monitor attenuation and port selection. Suggested port selection is RF I/O with 20 dB attenuation.

6. Set the generator attenuation and port selection. Suggested port selection is RF I/O with -50 dB for the level setting.

7. Press the start test softkey.

8. The status thermometer displays the major signaling events that occur during a system initiated Phone Interconnect test. Refer to table 7-15 (Trunk II auto affiliation disabled), or table 7-16 (Trunk II with auto affiliation).

Table 7-15. Trunk II Signaling Events
System Initiated Phone Interconnect Testing Without Auto Affiliation

SIGNALING EVENT		DESCRIPTION
F	Control Channel Idle	The trunking analyzer outputs a background pattern on the control channel to lock the radio.
G	Transpond OSW Sent	The trunking analyzer sent the Transpond OSW to the radio.
H	Transpond OSW Received	The trunking analyzer detected the Transpond ISW from the radio.
I	Ring OSW Sent	The trunking analyzer sent the Ring OSW to the radio.
J	ISW Received	The radio sent an Inbound Signaling Word (ISW) on the control channel to indicate the radio has been keyed.
Q	Channel Grant OSW Sent	The trunking analyzer sends channel grant OWSs on the control channel. Channel grants direct the radio to the voice channel to use.
U	LS Word Sent On VC	The trunking analyzer sends a low-speed data word on the voice channel.
V	Connect Tone Received On VC	The trunking analyzer decoded the connect tone sent by the radio.
Y	Hangup Received	The trunking analyzer decoded the Hangup ISW from the radio.

Table 7-16. Trunk II Signaling Events
System Initiated Phone Interconnect Testing With Auto Affiliation

SIGNALING EVENT		DESCRIPTION
A	Control Channel Idle	The trunking analyzer outputs a background pattern on the control channel for the radio to lock onto.
D	Affiliate ISW Received	The trunking analyzer received the Affiliate ISW from the radio.
E	Affiliate OSW Sent	The trunking analyzer sends Affiliate OSWs on the control channel. The Affiliate OSW acknowledges the radio is registered on the system and tells the radio which connect tone to use.
F	Control Channel Idle	The trunking analyzer outputs a background pattern on the control channel to lock the radio.
G	Transpond OSW Sent	The trunking analyzer sent the Transpond OSW to the radio.
H	Transpond OSW Received	The trunking analyzer detected the Transpond ISW from the radio.
I	Ring OSW Sent	The trunking analyzer sent the Ring OSW to the radio.
J	ISW Received	The radio sent an Inbound Signaling Word (ISW) on the control channel indicating the radio has been keyed.
Q	Channel Grant OSW Sent	The trunking analyzer sends channel grant OWSs on the control channel. Channel grants direct the radio to the voice channel to use.
U	LS Word Sent On VC	The trunking analyzer sends a low-speed data word on the voice channel.
V	Connect Tone Received On VC	The trunking analyzer decoded the connect tone sent by the radio.
Y	Hangup Received	The trunking analyzer decoded the Hangup ISW from the radio.

7.4 CALL ALERT TESTING

7-4.1 Radio Initiated Call Alert Test Sequence, Trunk I and Trunk I EP II Signaling

Configure the analyzer for trunk mode (paragraph 6-5) and Radio Initiated Testing (paragraph 6-6).

1. Enter the following parameters:

Sig Type:	Trunk I or Trunk I EP II
ID Disp:	HEX or DEC
Call Seq:	CALL ALERT

NOTE

For test sequences with ID Disp set for DEC, the six-digit Unit ID decoded from the ISW is the personality ID of the radio and not the Unit ID. When ID Disp is set for HEX, the Unit ID is displayed in hexadecimal. The Fleet and Subfleet IDs are always displayed in hexadecimal independent of the ID Disp selection.

2. Set the System ID to match the radio system ID and one of the system IDs in the Radio Configuration screen in order to decode radio ID information.

3. Enter the CCTx or Control Channel number. Enter the VCTx or voice channel number.

NOTE

Splinter channels can only be entered by frequency. Standard channels can be entered by frequency or channel number (channel numbers only map to standard channel frequencies).

4. Set the monitor attenuation and port selection. Suggested port selection is RF I/O with 20 dB attenuation.

5. Set the generator attenuation and port selection. Suggested port selection is RF I/O with -50 dB for the level setting.

6. Press the start test softkey.

7. The status thermometer displays the major signaling events that occur during a radio initiated Call Alert test. Refer to table 7-17.

8. Press the stop test softkey to terminate the test sequence.

Table 3-17. Trunk I and Trunk I EP II Signal Events Radio Initiated Call Alert Testing

SIGNALING EVENT		DESCRIPTION
F	Control Channel Idle	The trunking analyzer outputs a background pattern on the control channel to lock the radio.
J	ISW Received	The radio sent an Inbound Signaling Word (ISW) on the control channel indicating the radio has been keyed.
P	Call Alert Ack OSW	The trunking analyzer sends a call alert acknowledge OSW to the radio simulating that the target radio received the call alert signal.

7-4.2 Radio Initiated Call Alert Test Sequence, Trunk II Signaling

Configure the analyzer for trunk mode (paragraph 6-5) and Radio Initiated Testing (paragraph 6-6).

NOTE

SMARTZONE configures the analyzer to perform a SMARTZONE affiliation sequence prior to executing the dispatch test sequence. If the radio is not capable of SMARTZONE auto affiliation, the selection should be set to DISABLED.

1. Enter the following parameters:

Sig Type:	Trunk II
ID Disp:	HEX or DEC
Call Seq:	CALL ALERT

2. Set the System ID to match the radio system ID and one of the system IDs in the Radio Configuration screen in order to decode radio ID information.

NOTE

*The system ID entered **must** match the system ID of the radio. Otherwise the radio will not lock onto the control channel. Refer to paragraph 6-8, Radio Configuration.*

3. Enter the CCTx or Control Channel number. Enter the VCTx or voice channel number.

NOTE

Splinter channels can only be entered by frequency. Standard channels can be entered by frequency or channel number (channel numbers only map to standard channel frequencies).

4. Set the monitor attenuation and port selection. Suggested port selection is RF I/O with 20 dB attenuation.

5. Set the generator attenuation and port selection. Suggested port selection is RF I/O with -50 dB for the level setting.

6. Press the start test softkey.

NOTE

If SMARTZONE auto affiliation has been selected, the operator is prompted to apply power to the radio. Once the test radio is turned on, it begins to search for a control channel. When the radio finds the control channel, it performs an auto registration sequence with the analyzer, and the registration data is displayed.

7. The status thermometer displays the major signaling events that occur during a radio initiated Call Alert test. Refer to table 7-18 (Trunk II auto affiliation disabled), or table 7-19 (Trunk II with auto affiliation).

   The trunking analyzer generates an idle pattern on the control channel and prompts the operator to key the transmitter. When the radio sends an ISW, the analyzer decodes it and displays it. If the ISW call type is a call alert, the analyzer will wait a short period of time and send an acknowledgment to the raido that the call alert has been received, and the test is termianted. During the execution of the test sequence, the status thermometer is appropriately updated.

8. Press the stop test softkey to terminate testing.

Table 7-18. Trunk II Signaling Events Radio Initiated Call Alert Testing Without Auto Affiliation

SIGNALING EVENT		DESCRIPTION
F	Control Channel Idle	The trunking analyzer outputs a background pattern on the control channel to lock the radio.
L	Dual ISW Received	The trunking analyzer received a dual word ISW from the radio.
M	Call Alert Ring OSW	The trunking analyzer sends a call alert ring OSW to the target radio.
O	Call Alert Ring Ack OSW	The trunking analyzer sends call alert ring acknowledge OSW to simulate the system sending an acknowledge to the requesting radio.

Table 7-19. Trunk II Signaling Events Radio Initiated Call Alert Testing With Auto Affiliation

SIGNALING EVENT		DESCRIPTION
A	Control Channel Idle	The trunking analyzer outputs a background pattern on the control channel for the radio to lock onto.
D	Affiliate ISW Received	The trunking analyzer received the Affiliate ISW from the radio.
E	Affiliate OSW Sent	The trunking analyzer sends Affiliate OSWs on the control channel. The Affiliate OSW acknowledges the radio is registered on the system and tells the radio which connect tone to use.
F	Control Channel Idle	The trunking analyzer outputs a background pattern on the control channel to lock the radio.
L	Dual ISW Received	The trunking analyzer received a dual word ISW from the radio.
M	Call Alert Ring OSW	The trunking analyzer sends a call alert ring OSW to the target radio.
O	Call Alert Ring Ack OSW	The trunking analyzer sends call alert ring acknowledge OSW to simulate the system sending an acknowledge to the requesting radio.

7-4.3 System Initiated Call Alert Test Sequence, Trunk I and Trunk I EP II Signaling

NOTE

A radio initiated dispatch test (refer to paragraph 7-2) should be performed prior to a system initiated call alert.

Configure the analyzer for trunk mode (paragraph 6-5) and System Initiated Testing (paragraph 6-7).

NOTE

Fleet, Subfleet, and Unit ID information must be entered before the execution of a System Initiated test. If a Radio Initiated test is executed prior to the System Initiated test, these fields are automatically updated. If required, refer to paragraph 6-8.1 for information related to entry and storage of system/fleet map configurations.

1. Enter the following parameters:

Sig Type:	Trunk I or Trunk I EP II
ID Disp:	HEX or DEC
Call Seq:	CALL ALERT

2. Set the System ID to match the radio system ID and one of the system IDs in the Radio Configuration screen.

NOTE

*The system ID entered **must** match the system ID of the radio. Otherwise the radio will not lock onto the control channel. Refer to paragraph 6-8, Radio Configuration.*

3. Enter Target Fleet, Target Subfleet, and Unit ID.

For the System Initiated Call Alert, the Target Fleet, Subfleet, and Unit are the values for the radio under test. If a radio initiated dispatch, phone interconnect, or call alert test has been executed prior to the system initiated test, the target fleet, target subfleet, and unit ID decoded from the ISW will be displayed. If the operator wants to change a target fleet, target subfleet, or unit ID, move the cursor to the appropriate position and enter the new number.

4. Enter the CCTx or Control Channel number. Enter the VCTx or voice channel number.

NOTE

Splinter channels can only be entered by frequency. Standard channels can be entered by frequency or channel number (channel numbers only map to standard channel frequencies).

5. Set the monitor attenuation and port selection. Suggested port selection is RF I/O with 20 dB attenuation.

6. Set the generator attenuation and port selection. Suggested port selection is RF I/O with -50 dB for the level setting.

7. Press the start test softkey.

8. The status thermometer displays the major signaling events that occur during a system initiated Call Alert test. Refer to table 7-20 (Trunk I and Trunk I EP II signaling).

9. Press the stop test softkey to terminate testing.

Table 7-20. Trunk I and Trunk I EP II
Signaling Events System Initiated Call Alert Testing

SIGNALING EVENT		DESCRIPTION
F	Control Channel Idle	The trunking analyzer outputs a background pattern on the control channel to lock the radio.
J	ISW Received	The radio sent an Inbound Signaling Word (ISW) on the control channel to indicate the radio has been keyed.
P	Call Alert Ack OSW	The trunking analyzer sends a call alert acknowledge OSW to the radio simulating that the target radio received the call alert signal.

7-4.4 System Initiated Call Alert Test Sequence, Trunk II Signaling

Configure the analyzer for trunk mode (paragraph 6-5) and System Initiated Testing (paragraph 6-7).

NOTE

Fleet, Subfleet, and Unit ID information must be entered before the execution of a System Initiated test. If a Radio Initiated test is executed prior to the System Initiated test, these fields are automatically updated. If required, refer to paragraph 6-8.1 for information related to entry and storage of system/fleet map configurations.

NOTE

SMARTZONE configures the analyzer to perform a SMARTZONE affiliation sequence prior to executing the dispatch test sequence. If the radio is not capable of SMARTZONE auto affiliation, the selection should be set to DISABLED.

1. Enter the following parameters:

Sig Type:	Trunk II
ID Disp:	HEX or DEC
Call Seq:	CALL ALERT

2. Set the System ID to match the radio system ID and one of the system IDs in the Radio configuration screen in order to decode radio ID information.

3. Target Unit, Calling Unit
   If a radio initiated dispatch, phone interconnect, or call alert test has been executed prior to the system initiated test, the Target Unit ID and Calling Unit ID decoded from the ISW will be displayed. If the operator wants to change the Target Unit ID or Calling Unit ID, simply move the cursor to the appropriate position and enter the new number.

   In the system initiated test sequence, the target Unit ID contains the data for the test radio while the Calling Unit ID contains the data for the "other radio" that is trying to call alert the target unit.

4. Enter the CCTx or Control Channel number. Enter the VCTx or voice channel number.

NOTE

Splinter channels can only be entered by frequency. Standard channels can be entered by frequency or channel number (channel numbers only map to standard channel frequencies).

5. Set the monitor attenuation and port selection. Suggested port selection is RF I/O with 20 dB attenuation.

6. Set the generator attenuation and port selection. Suggested port selection is RF I/O with -50 dB for the level setting.

7. Press the start test softkey.

   The trunking analyzer generates an idle pattern on the control channel. After a short period of time the analyzer sends a call alert message to the radio. When the radio receives the call alert, it issues an acknowledgment to the analyzer and an audible call alert tone is generated by the radio. The analyzer terminates the test sequence and displays the test ended message when the acknowledgment is received.

8. The status thermometer displays the major signaling events that occur during a system initiated Call Alert test. Refer to table 7-21 (Trunk II auto affiliation disabled), or table 7-22 (Trunk II with auto affiliation).

Table 7-21. Trunk II Signaling Events
System Initiated Call Alert Testing Without Auto Affiliation

SIGNALING EVENT		DESCRIPTION
F	Control Channel Idle	The trunking analyzer outputs a background pattern on the control channel to lock the radio.
M	Call Alert Ring OSW	The trunking analyzer sends a call alert ring OSW to the target radio.
N	Call Alert Ring Ack ISW	The radio sends a call alert ring ack ISW to indicate the radio received the call alert.
O	Call Alert Ring Ack OSW	The trunking analyzer sends call alert ring acknowledge OSW to simulate the system sending an acknowledge to the requesting radio.

Table 7-22. Trunk II Signaling Events
System Initiated Call Alert Testing With Auto Affiliation

SIGNALING EVENT		DESCRIPTION
A	Control Channel Idle	The trunking analyzer outputs a background pattern on the control channel for the radio to lock onto.
D	Affiliate ISW Received	The trunking analyzer received the Affiliate ISW from the radio.
E	Affiliate OSW Sent	The trunking analyzer sends Affiliate OSWs on the control channel. The Affiliate OSW acknowledges the radio is registered on the system and tells the radio which connect tone to use.
F	Control Channel Idle	The trunking analyzer outputs a background pattern on the control channel to lock the radio.
M	Call Alert Ring OSW	The trunking analyzer sends a call alert ring OSW to the target radio.
N	Call Alert Ring Ack ISW	The radio sends a call alert ring ack ISW to indicate that the radio received the call alert.
O	Call Alert Ring Ack OSW	The trunking analyzer sends call alert ring acknowledge OSW to simulate the system sending an acknowledge to the requesting radio.

7-5 FAILSOFT TESTING

7-5.1 System Initiated Failsoft Test Sequence

Configure the analyzer for trunk mode (paragraph 6-5) and System Initiated Testing (paragraph 6-7).

1. Enter the following parameters:

Sig Type:	SYSTEM INIT
ID Disp:	
Call Seq:	FAILSOFT

2. Enter the
   FSTx or channel number
   FSRx or channel number (if VHF/UHF)

3. Enter the Port selection and monitor attenuation. In most cases the port selection should be RF I/O with 20 dB attenuation.

4. Enter the generator Port selection. In most cases the port selection should be RF I/O.

5. Press the **start test** softkey. If the parameters selected are not valid, the test sequence is terminated and an error message is displayed. When the **start test** softkey is pressed, it is replaced with the **stop test** softkey. For a list of error and warning messages, refer to Appendix E.

   The trunking transmits the failsoft word on the failsoft channel, and nothing on the control channel. When the radio cannot detect a control channel, it looks at its failsoft channel. When the radio decodes the failsoft word it will unmute and conventional radio operation is possible. After the radio has locked on the failsoft channel, the operator can transmit modulation from the trunking analyzer to the radio.

6. Press the **stop test** softkey to terminate testing.

Section 8

ASTRO TRUNKING INTRODUCTION

8-1 INTRODUCTION

The General Dynamics R2670 Digital Communications System Analyzer tests the unique requirements of Motorola's Astro trunked mobile and portable radios. All R2600 Series capabilities are retained with the trunked test sequences accessed via the LCD display, numeric keypad, screen defined softkeys, cursor movement keys, and the optical tuning knob. The trunking option functions may also be accessed via the remote control interface port.

The trunking option simulates the functions of a central controller of a trunked radio system by providing control channel and voice channel signaling protocols. Testing with the trunked radio option provides dynamic call processing and direction to a voice channel. Once on the voice channel, the general purpose RF test capabilities of the analyzer can be used to measure the radio performance. Trunk option testing provides proof of basic inbound and outbound signaling and displays specification compliance data.

Throughout this manual the "system" refers to the fixed-end central controller. Thus, a system initiated call is the analyzer simulating the central controller calling the radio under test.

8-2 CAPABILITIES

The trunking option has the following capabilities:

Vocoder Capabilities

The analyzer allows the selection of either the Astro VSELP or Astro IMBE vocoder for voice channel operation. Control channel signaling is not affected by the selection, therefore Astro VSELP and Astro IMBE tests are identical. The Astro IMBE vocoder is used when testing Astro 3.0 Trunked Systems. Vocoder selection occurs in the Sig Type field as described in Section II of this manual. Throughout this manual the use of the term “Astro” solely, applies to either Astro VSELP or Astro IMBE.

Dynamic Call Processing

Test trunked mobile and portable radios under actual signaling conditions by simulating the function of the central controller. The trunking analyzer provides separate screens for inbound (radio initiated) and outbound (system initiated) calling modes.

Closed Cover Measurements

The analyzer measures and displays transmitter power, frequency error, and frequency deviation while in the dynamic calling mode. While the radio is on the voice channel, the operator can make additional measurements using other functions of the analyzer.

Radio ID Decoding

The ISW data received from the radio is decoded and displayed on the analyzer. The following data is decoded and displayed for Astro signaling trunked radios: Talkgroup, Unit, and Call Type.

Manual Mode

The trunking analyzer supports a mode in which the operator can exit from the trunking screens and access standard displays of the analyzer while the test sequence is in progress.

Radios with Message Trunking

The trunking analyzer supports the testing of message trunked radios.

Radios with Message Trunking and PTT ID Enabled

The trunking analyzer supports message trunked radios testing with PTT-ID enabled.

Transmission Trunked Radios

The trunking analyzer testing of transmission trunked radios is somewhat limited due to the nature of the radio. Test sequences can be performed on transmission trunked radios by pressing the PTT of the radio and keeping the radio keyed while switching to other display screens to make measurements and observe waveforms. Once the PTT button on the radio is released, the transmission trunked radio returns to the control channel and the test must be re-started in order to rekey the radio.

Dispatch Call

The analyzer supports dispatch call processing where the radio, or the system, initiates the call sequence. The dispatch type call is where one radio is communicating through a repeater with several other radios assigned to the same group.

Call Alert

The analyzer supports the testing of call alert service. The analyzer simulates the signaling for the radio to initiate, or to receive a call alert.

Failsoft

The analyzer simulates an inoperative central controller by not transmitting OSWs on the control channel, and sending the failsoft word on the failsoft channel.

Section 9

ASTRO TRUNKING OPERATING INSTRUCTIONS

CAUTION

When testing a radio, the analyzer generates a control channel signal. Take care to prevent this signal from unintentionally capturing other radios in the area. Observe the following precautions:

- ***Do not** use an antenna on the analyzer for over-the-air testing.*
- ***Use** double-shielded cables on the analyzer to carry signals to and from the radio.*
- ***Locate** the analyzer at least 35 feet from the antenna of a unit that is working in the same system that the analyzer is testing.*

9-1 INTRODUCTION

The R2670 Digital Communications System Analyzer includes all the features of the R2600 Series Communications System Analyzer. Refer to sections 8, 9, and 10 of the General Operation section of this manual for general installation information, a description of the control functions, and general operational information. The following sections of this manual contain information on how to connect trunked radios under test to the analyzer and how to set controls and indicators to obtain the correct screen display.

Error/Warning Messages

Refer to Appendix G for a listing and description of setup and radio error messages. Messages common to all the R2600 Series equipment are detailed in paragraph 9-4 of the General Operation section of this manual.

9-2 TEST SETUP

9-2.1 Connecting a Radio

Use a 50 ohm BNC cable and an N to BNC adapter to connect from the RF I/O port of the trunking analyzer to the antenna port of the radio as shown in figure 9-1.

CAUTION

Observe the input power ratings and warnings of the analyzer to insure that no damage occurs to the analyzer.

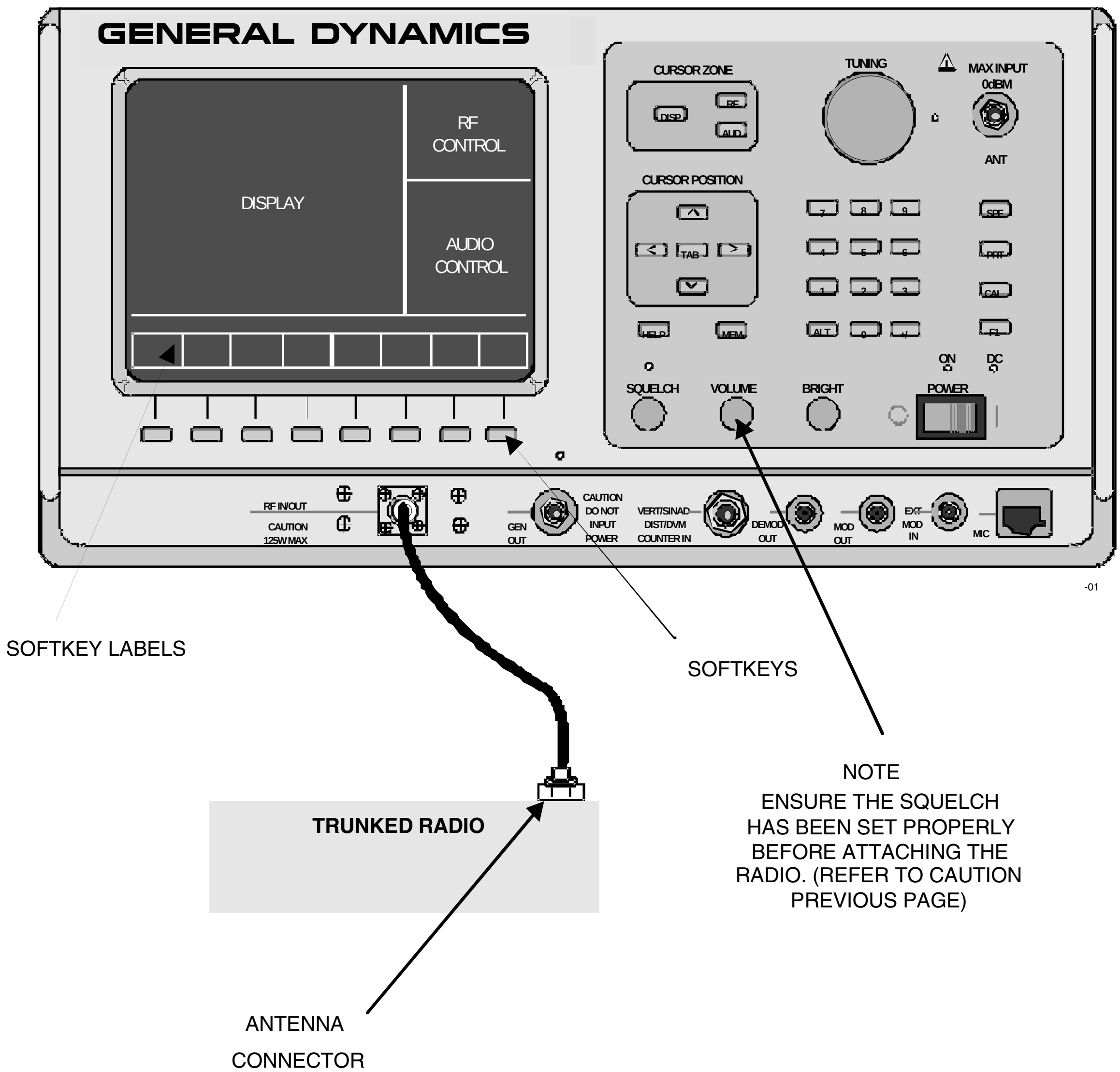

Figure 9-1. Trunked Radio Test Setup

9-3 TRUNKING ANALYZER SOFTWARE VERSION SCREEN

To confirm installation of the Astro Trunking Option, press the SPF hard key, move the cursor to "VERSION," and select the display table soft-key. This will configure the trunking analyzer to generate a screen that displays the standard and option platform screens. Move the cursor to the TRUNKING position and select the view options softkey. A screen similar to the following screen will be displayed if the analyzer contains the R2670 Astro Trunking Option.

NOTE

The Astro trunking option is only available if the Motorola Analog Trunking Option is installed.

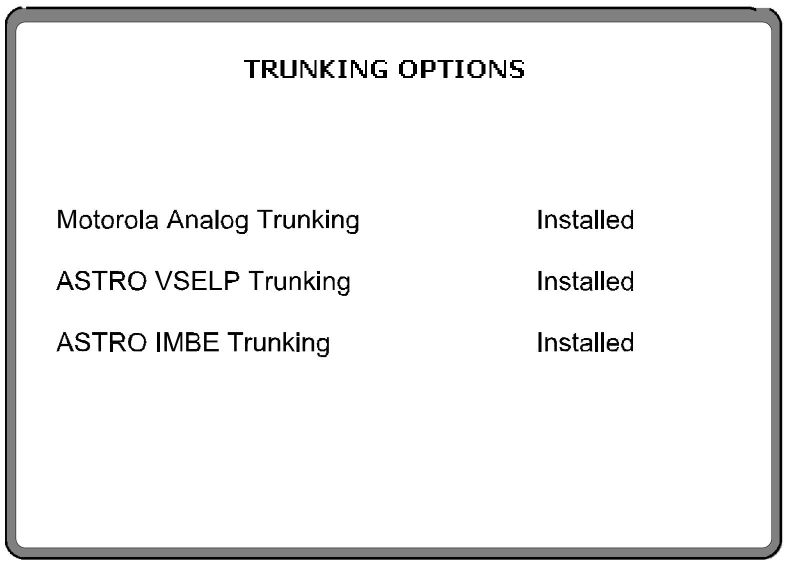

Figure 9-2. Trunking Analyzer Option Screen

9-4 GENERAL OPERATION

The display screen is divided into three major zones, The Display Zone, the RF Zone, and the Audio Zone. The top portion of display zone displays the status and selections for the current test sequence. The bottom portion of the Display Zone displays the data about the radio under test. The RF Zone is used for the selection of trunking frequency bands, for control and voice channels, and port selections. The Audio Zone is modified during Astro testing to allow setting the loudness of the radio under test, as well as the deviation settings for a fixed 1 kHz tone and/or an external (microphone or BNC) input.

A status thermometer is displayed in the Display Zone during the performance of the test. Appendix I identifies all of the signaling events identified in the status thermometer display.

9-4.1 Access to Standard System Test Screens During Trunking Testing

The analyzer must remain in the main trunking test screen during the initial call processing sequence. Once this has been completed and the radio under test is on the voice channel, other standard system screens may be entered from the "Meter:" position of the Display zone. Simply press the **more** softkey to cycle through the available menus and make the selection accordingly. To end the test, it is necessary to return to the trunking test screen from which the test was initiated.

9-4.2 Spectrum Analyzer Dispersion Limit While in Trunked Test Mode

While the trunked test mode is active, the spectrum analyzer maximum dispersion is limited to 1 MHz per division. To use the higher dispersion selections of 2, 5 and 10 MHz per division, it is necessary to set the "mode:" field of the Display zone to STANDARD.

9-4.3 Remote Operation

All R2600 Series Communications System Analyzers are equipped with a standard RS-232 interface. Optionally, the R2670 is equipped with an IEEE 488 (HP-IB / GPIB) interface. Either of these interfaces may be used to remotely control the analyzer using a set of commands, queries, and responses that are defined in the General Dynamics Communications System Analyzer Programming Reference Manual (68-P80309F55). Tabbed sections for Motorola Analog Trunking and Astro Trunking define trunking-specific commands and queries.

9-5 ACCESSING TRUNK MODE

Select the Trunk mode by placing the cursor in the "Mode:" field in the Display Zone located at the top of the screen. Use the **TRUNK** softkey to select the trunk mode. In addition, the "Meter:" field must be set to a trunking test. Use the **"more"** softkey to access the appropriate selection. A screen similar to figure 9-3 appears.

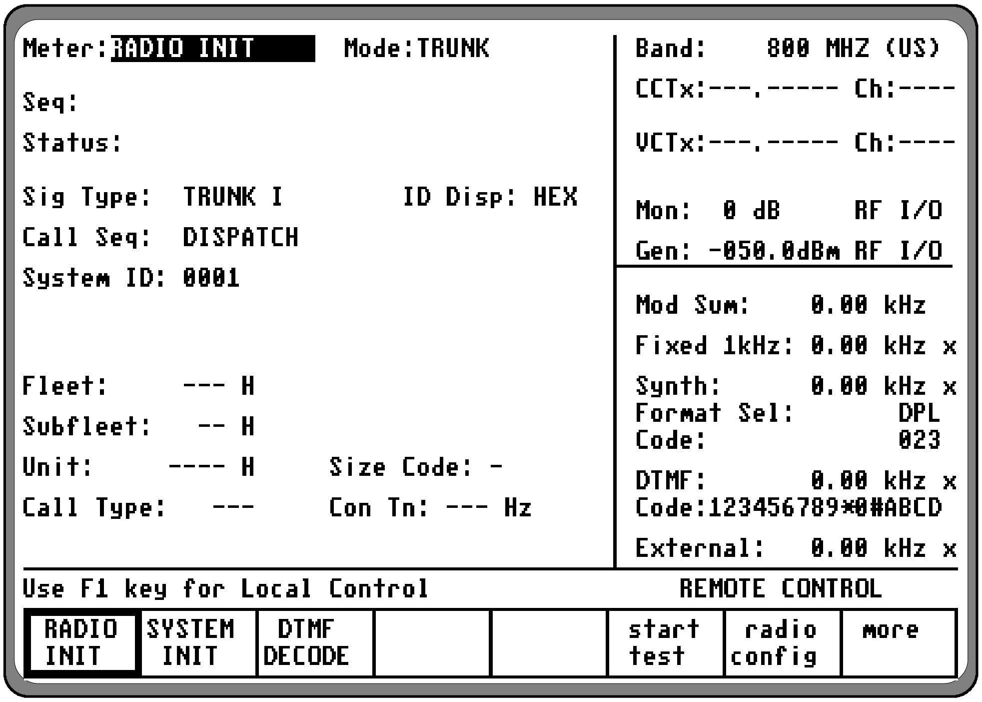

Figure 9-3. Trunk Mode Screen

9-6 RADIO INITIATED TRUNKING

The RADIO INIT softkey configures the analyzer to display the current data and test status for the radio initiated trunked test sequence. When the test is started, the analyzer will blank out decoded ISW data from the previous test sequence and generate idle channel signaling on the control channel. The analyzer will wait for the operator to initiate a transmission from the radio. When a transmission from the radio is detected, the analyzer will execute the test sequence defined by the parameters on the trunking screen.

In the following subsections, the call sequence selected is Dispatch. For details on testing Radio Initiated Call Alert and Failsoft call sequences, refer to Section 10 ASTRO Trunking Applications, in this manual.

9-6.1 Radio Initiated Dispatch Astro Testing

Display Zone

Refer to Appendix I for a description of the status thermometer signaling events for each test sequence.

To set up testing, select the Trunk mode by placing the cursor in the "Mode:" field in the Display Zone, and pressing the **TRUNK** softkey. Place the cursor in the "Meter:" field and press the **RADIO INIT** softkey to view current data and test status for a radio initiated trunked test sequence. Within the Display zone, place the cursor in the "Sig Type:" field and press either the **ASTRO VSELP** or **ASTRO IMBE** softkey. Refer to Section 8 for a description of ASTRO vocoder configurations.

In this example, the **ASTRO VSELP** softkey is pressed. A screen similar to figure 9-4 appears.

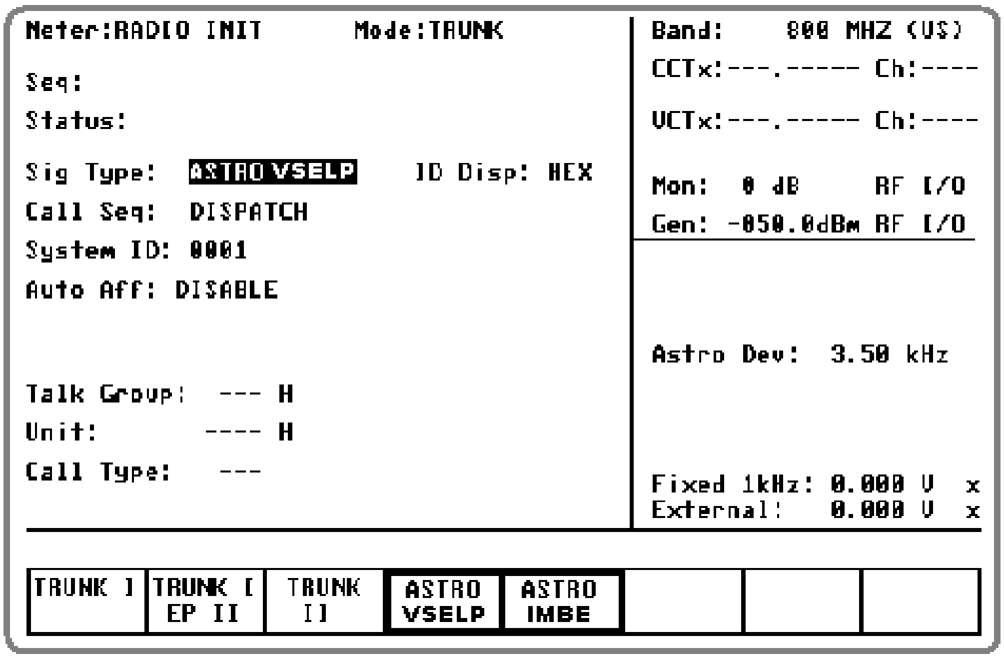

Figure 9-4. Dispatch Test Screen Radio Initiated Astro Signaling

With the screen in figure 9-4 displayed, use the cursor control keys to position the cursor and the softkeys to select the following parameters:

ID Disp:

ID Display is entered with the softkeys. ID Display selects the format of the ISW data that is decoded. The format of the decoded ISW data is either hexadecimal or decimal format.

Call Seq:

Call Sequence configures the trunking analyzer with the test sequence to be executed. Dispatch, Call Alert, and Failsoft call sequences are supported in Astro signaling.

System ID:

Enter the system ID as a four-digit hexadecimal number. Use the numeric keypad, the soft keys or tuning knob to make this entry. If the screen already displays a system ID and it requires a change, enter the new system ID over the old.

Talk Group:, Unit:, Call Type:

During a radio initiated dispatch test, the Talk Group, Unit ID, and Call Type decoded from the ISW will be displayed.

Auto Aff:

The Auto Aff: selection on the analyzer configures the analyzer to respond to the SMARTZONE registration sequence. The Auto Aff: selection only is available when

Trunk II or Astro signaling is selected. The operator has the option of disabling the auto affiliation sequence, or selecting the SMARTZONE affiliation sequence. If the radio is not capable of SMARTZONE auto affiliation, the selection should be set to DISABLED.

If auto affiliation is disabled, the analyzer transmits idle data on the control channel until the radio initiates the test sequence.

9-6.2 Testing the Auto Affiliation Feature

After setting up the test conditions with the radio turned "off," press the **start test** softkey to activate control channel signaling. Turn the radio "on" when the prompt message appears so it can lock to the control channel and register.

Successful registration will be indicated by seeing the squelch indicator LED flash briefly followed by the presence of decoded radio ID parameters The call type M1 should be displayed to indicate that an auto affiliation sequence has been received. At this time, the radio may be keyed to proceed with the radio initiated calling sequence.

The radio will remain registered as long as it remains powered up and there have been no changes in basic test configuration. Stopping and re-starting the test requires re-registration as long as SMARTZONE is selected at the "Auto Aff:" field on the screen.

NOTE

If changes to the test setup entries are made after a test has been started, even though theses changes appear on the screen, they will not be entered as part of the test until the test is ended and restarted. Similarly, if invalid entries are made for frequency or other parameters, they may be accepted until a final validity check is done by the system at the time the ***"start test"*** *softkey is pressed.*

9-6.3 RF ZONE

Band:

Band selects the frequency channel plan for the analyzer. For Astro trunked radio, the only selection is 800 MHz (US). The 800 MHz (US) band configures the analyzer for the frequency and channel plan described in table 9-1. This table shows analyzer transmit frequency ranges.

CCTx:

CCTx is the control channel transmit frequency of the analyzer. The control channel frequency can be changed by moving the cursor into the CCTx cursor field and changing the value with the keypad or with the tuning knob. When the control channel frequency is changed, the corresponding channel number is also updated. If the frequency selected is out of range of the frequency channel plan, the corresponding channel number will be dashed out.

As a convenience, the control channel can also be entered by moving the cursor to the associated channel position on the display and selecting a channel number with the keypad or tuning knob. When the channel number is changed, the corresponding frequency value is changed. If the channel number selected is out of range of the frequency channel plan, the corresponding frequency will be dashed out.

Splinter channels can only be entered by frequency. Standard channels can be entered by frequency or channel number (channel numbers only map to standard channel frequencies).

VCTx:

VCTx sets the voice channel transmit frequency of the analyzer. The voice channel frequency can be changed by moving the cursor into the VCTx cursor field and changing the value with the keypad or with the tuning knob. When the voice channel frequency is changed, the corresponding channel number is also updated. If the channel number selected is out of range of the frequency channel plan, the corresponding frequency will be dashed out.

As a convenience, the voice channel also can be entered by moving the cursor to the associated channel position on the display and selecting a channel number by the keypad or tuning knob. When the channel number is changed, the corresponding frequency value is changed. If the channel number selected is out of range of the frequency channel plan, the corresponding frequency will be dashed out.

Splinter channels can only be entered by frequency. Standard channels can be entered by frequency or channel number (channel numbers only map to standard channel frequencies).

Mon:

Enter the monitor input attenuation value with softkeys. The operator has the option of selecting 0, 20, or 40 dB attenuation.

Monitor Port

Enter the port selection with softkeys. In most cases, the operator will set the monitor port to RF I/O.

CAUTION:

Do not input RF power into the antenna port of the analyzer. Damage to the analyzer may result.

Gen:

Enter the generator output level with the keypad or the tuning knob.

Generator Port:

Enter the generator port selection with softkeys. In most cases, the operator will select the port to RF I/O.

9-6.4 AUDIO ZONE

The Audio Zone during Astro Trunking tests is modified to include only three sources. Refer to figure 9-4.

The "Astro Dev" source sets the loudness of the radio through the digital information sent to the radio. A setting of 3.50 is recommended for most tests.

The Fixed 1 kHz and External sources provide control of the amount of modulation, measured in kHz deviation, of a fixed 1 kHz tone, and an external input that includes both the BNC labeled EXT MOD IN and the microphone input.

Table 9-1. Available Transmit Frequency Ranges and Channel Plans (800 MHz Selection)

	Frequency Range (MHz)	Channel Range	Channel Spacing (KHz)	Xmit/Rcv Offset (MHz)
800 MHz (US) Standard	851.01250 - 865.98750	000 - 599	25	+ 45
800 MHz (US) Splinter	851.00000 - 865.97500	000 - 599	25	+45
800 MHz (US) Block 1	866.01250 - 868,98750	600 - 719	25	+45
800 MHz (US) Block 2	866.00000 - 866.97500	720 - 759	25	+45
800 MHz (US) Block 3	867.00000 - 867.40000	815 - 831	25	+45
800 MHz (US) Block 4	867.42500 - 868.97500	961 - 1022	25	+45
800 MHz (US) Block 5	868.97500	958	25	+45

The Trunking Analyzer performs an ISW decode sequence on the control channel that provides talkgroup and unit ID information. Once the ISW data is decoded, the trunking analyzer sends channel grant OSWs on the control channel and link control data on the voice channel. The radio detects the channel grant OSW's, switches to the voice channel, and begins transmitting. The trunking analyzer enables its modulation and unmutes its speaker. Throughout the handshaking sequence, the trunking analyzer updates the status thermometer at the appropriate time. Refer to Appendix I for a description of the status thermometer signaling events for each test sequence.

The thermometer display progresses rapidly through the signaling events.

9-7 SYSTEM INITIATED TRUNKING

Selection of the SYSTEM INIT softkey in the "Meter" field configures the analyzer to display the current data and test status for the system initiated trunked test sequence. The analyzer simulates the central controller calling the radio under test.

NOTE

Talk Group, Unit ID, and Call Type information must be entered before the execution of a System Initiated test. If a Radio Initiated test is executed prior to the System Initiated test, these fields are automatically updated. If required, refer to paragraph 9-8.1 for information related to entry and storage of system/fleet map configurations.

When the test is started, the analyzer generates an idle OSW pattern on the control channel selected for a short period of time so the radio can acquire the control channel. After the time has elapsed, the analyzer directs the radio to the voice channel and provides the voice channel handshake signaling. Throughout the signaling process, the status thermometer is updated at the appropriate time.

9-7.1 System Initiated Dispatch Astro Signaling

The trunking analyzer sends a link control data word on the voice channel frequency. The radio receives the control channel message to move to the voice channel and switches to that voice channel. When the radio detects the link control data word, the radio unmutes and stays on the voice channel until the test is terminated.

To set up testing, select the Trunk mode by placing the cursor in the "Mode:" field and pressing the TRUNK softkey. Place the cursor in the "Meter:" field and press the SYSTEM INIT softkey to view current data and test status for a system initiated trunked test sequence. Within the Display zone, place the cursor in the "Sig Type:" field and press either the ASTRO VSELP or ASTRO IMBE softkey. Refer to Section 8 for a description of ASTRO vocoder configurations. In this example, the ASTRO IMBE softkey is pressed. A screen similar to figure 9-5 appears.

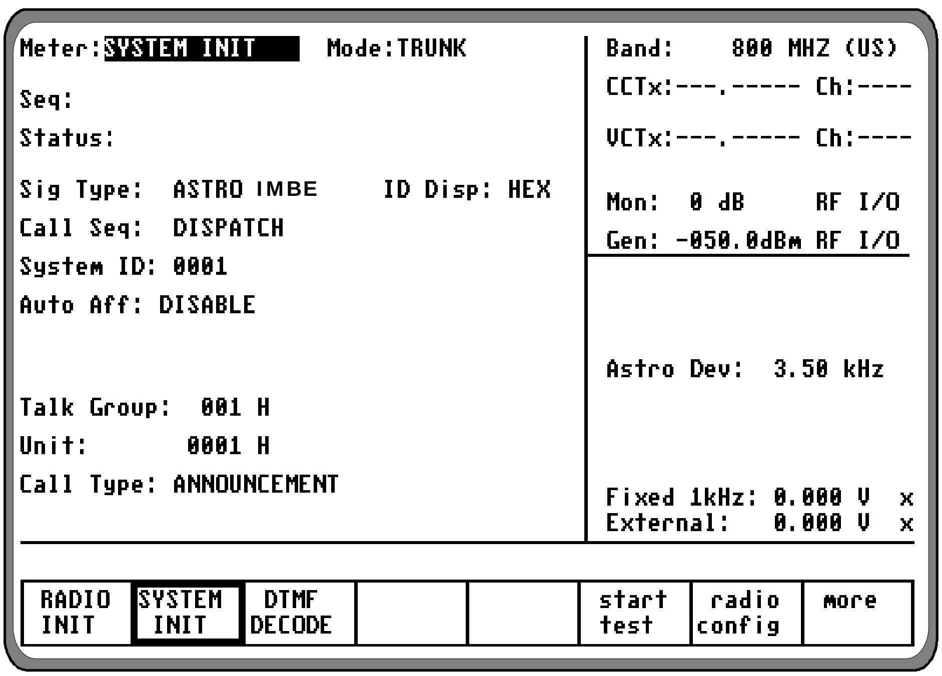

Figure 9-5. Dispatch Test Screen System Initiated Astro Signaling

9-7.2 DISPLAY ZONE, RF ZONE, AND AUDIO ZONE

Parameter selection is similar to Radio Initiated Dispatch Test described in paragraph 9-6.1.

Announcement Calls

Radios in Astro systems monitor an announcement talk group in addition to their own talk group. If the operator is making an announcement call to the radio, the announcement talk group must be entered.

NOTE

SMARTZONE Auto Affiliation may be tested in the system initiated call by selecting SMARTZONE at the "Auto Aff:" field. This will require power cycling the radio at the start of each test as described in paragraph 9-6.1.

9-8 RADIO CONFIGURATION

Data displayed on the Radio Configuration screen for Astro signaling includes only the Control Channel Transmit Deviation.

With the Trunk mode activated per paragraph 9-5, and "**ASTRO VSELP**" or "**ASTRO IMBE**" selected in the "Sig Type:" field, place the cursor in the "Meter:" field and press the **RADIO CONFIG** softkey. A screen similar to figure 9-6 appears.

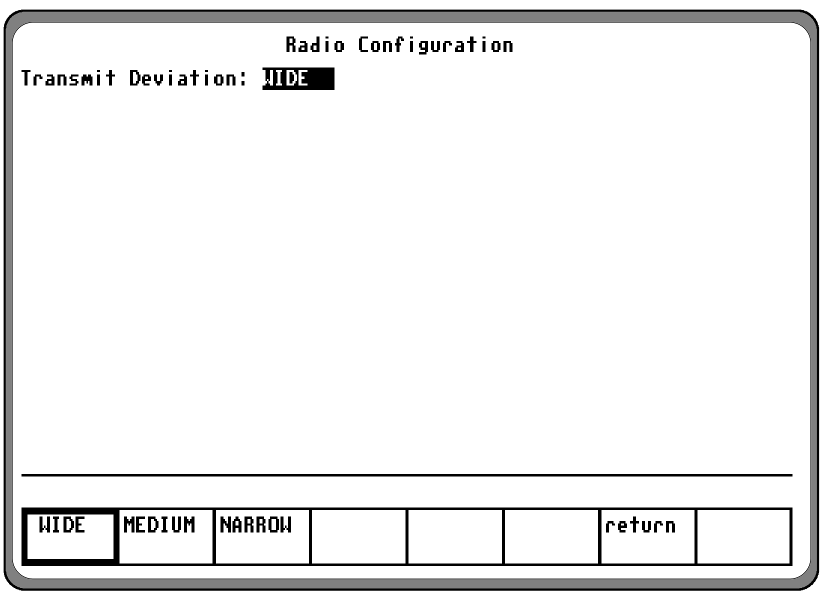

Figure 9-6. Radio Configuration Screen-Astro

With the screen displayed (figure 9-6), use the softkeys to select the following parameter:

Transmit Deviation:

The Transmit Deviation selection allows for the selection of either wide, medium, or narrow FM deviation selections per table 9-2.

Table 9-2. Transmit Deviation Selections

Selection	Range	Frequency Band	Channel Range
Wide	3.125 kHz ± 375 Hz	800 MHz (US)	0 through 599
Medium	2.4 kHz ± 300 Hz	800 MHz (US)	600 through 1022
Narrow	1.2 kHz ± 300 Hz	900 MHz	900 MHz

Section 10

ASTRO TRUNKING APPLICATIONS

10-1 BASIC TRUNKED RADIO TESTING

This section of the manual contains information on typical test setups to perform some of the more common trunked radio tests using the R2670 Digital Communications System Analyzer with Trunking Option.

The **start test** softkey initiates the test sequence defined by the parameters selected on the trunking screen. If the parameters selected are not valid, the test sequence is terminated and an error message is displayed. If the parameters selected are valid when the **start test** softkey is pressed, the **start test** softkey is replaced with the **stop test** softkey. For a list of error and warning messages, refer to Appendix G.

10-2 DISPATCH TESTING

10-2.1 Radio Initiated Dispatch Test, Astro Signaling

Configure the analyzer for trunk mode (paragraph 9-5) and Radio Initiated Testing (paragraph 9-6).

NOTE

SMARTZONE configures the analyzer to perform a SMARTZONE affiliation sequence prior to executing the dispatch test sequence. If the radio is not capable of SMARTZONE auto affiliation, the selection should be set to DISABLED.

1. Enter the following parameters:

Sig Type:	ASTRO VSELP or ASTRO IMBE
ID Disp:	HEX or DEC
Call Seq:	DISPATCH

2. Set the System ID.
3. Enter the CCTx or Control Channel number. Enter the VCTx or voice channel number.

NOTE

Splinter channels can only be entered by frequency. Standard channels can be entered by frequency or channel number (channel numbers only map to standard channel frequencies).

4. Set the monitor attenuation and port selection. Suggested port selection is be RF I/O with 20 dB attenuation.

5. Set the generator attenuation and port selection. Suggested port selection is be RF I/O with -50 dB for the level setting.

6. Press the **start test** softkey.

NOTE

If SMARTZONE auto affiliation has been selected, the operator is prompted to apply power to the radio. Once the test radio is turned on, it begins to search for a control channel. When the radio finds the control channel, it performs an auto registration sequence with the analyzer, and the registration data is displayed.

7. The status thermometer displays the major signaling events that occur during a radio initiated test. Refer to table 10-1 or table 10-2.

8. Press **stop test** softkey to terminate testing.

Table 10-1. Astro Signaling Events
Radio Initiated Dispatch Testing Without Auto Affiliation

SIGNALING EVENT		DESCRIPTION
J	ISW Received	The radio sent an Inbound Signaling Word (ISW) on the control channel to indicate the radio has been keyed.
K	Talk Group OSW Sent	The trunking analyzer sends talk group OSWs on the control channel. Talk Group OSWs tell the radio to affiliate by sending a dual word ISW that contains the talk group ID and the unit ID of the radio.
L	Dual ISW Received	The trunking analyzer received a dual word ISW from the radio.
Q	Channel Grant OSW Sent	The trunking analyzer sends channel grant OSWs on the control channel. Channel grants direct the radio to the voice channel to use.
T	LC Word Sent on VC	The trunking analyzer sends a link control data word on the voice channel.
B	LC Received on VC	The trunking analyzer received a link control data word on the voice channel.
C	Voice Channel Available	Voice Channel Available.
X	Disconnect Sent	The trunking analyzer sent a disconnect word on the voice channel to end the call. The radio will return to monitor the control channel.

Table 10-2. Astro Signaling Events
Radio Initiated Dispatch Testing With Auto Affiliation

SIGNALING EVENT		DESCRIPTION
A	Control Channel Idle	Control Channel Idle.
D	Affiliate ISW Received	The trunking analyzer received the Affiliate ISW from the radio.
E	Affiliate OSW Sent	The trunking analyzer sends Affiliate OSWs on the control channel. The Affiliate OSW acknowledges the radio is registered on the system and tells the radio which connect tone to use.
F	Control Channel Idle	The trunking analyzer outputs a background pattern on the control channel to lock the radio.
J	ISW Received	The radio sent an Inbound Signaling Word (ISW) on the control channel to indicate the radio has been keyed.
K	Talk Group OSW Sent	The trunking analyzer sends talk group OSWs on the control channel. Talk Group OSWs tell the radio to affiliate by sending a dual word ISW that contains the talk group ID and the unit ID of the radio.
L	Dual ISW Received	The trunking analyzer received a dual word ISW from the radio.
Q	Channel Grant OSW Sent	The trunking analyzer sends channel grant OSWs on the control channel. Channel grants direct the radio to the voice channel to use.
T	LC word sent on VC	The trunking analyzer sends a link control data word on the voice channel.
B	LC Received on VC	The trunking analyzer received link control on the voice channel.
C	Voice channel available	Voice channel available.
X	Disconnect Sent	The trunking analyzer sent a disconnect word on the voice channel to end the call. The radio will return to monitor the control channel.

10-2.2 System Initiated Dispatch Test Astro Signaling

Configure the analyzer for trunk mode (paragraph 9-5) and System Initiated Testing (paragraph 9-7).

NOTE

Talk Group, Unit ID, and Call Type information must be entered before the execution of a System Initiated test. If a Radio Initiated test is executed prior to the System Initiated test, these fields are automatically updated.

NOTE

SMARTZONE configures the analyzer to perform a SMARTZONE affiliation sequence prior to executing the dispatch test sequence. If the radio is not capable of SMARTZONE auto affiliation, the selection should be set to DISABLED.

1. Enter the following parameters:

Sig Type:	ASTRO VSELP or ASTRO IMBE
ID Disp:	HEX or DEC
Call Seq:	DISPATCH

2. Set the System ID to match the radio system ID and one of the system IDs in the Radio configuration screen to decode the radio's ID information.

3. Enter Talk Group, Call Type, and Unit ID.

NOTE

If an announcement call type is selected, the operator must also set the talk group to the announcement talk group monitored by the radio.

4. Enter the CCTx or Control Channel number. Enter the VCTx or voice channel number.

NOTE

Splinter channels can only be entered by frequency. Standard channels can be entered by frequency or channel number (channel numbers only map to standard channel frequencies).

5. Set the monitor attenuation and port selection. Suggested port selection is be RF I/O with 20 dB attenuation.

6. Set the generator attenuation and port selection. Suggested port selection is be RF I/O with -50 dB for the level setting.

7. Press the **start test** softkey.

8. The status thermometer displays the major signaling events that occur during a radio initiated test. Refer to table 10-3 or table 10-4.

Table 10-3. Astro Signaling Events System Initiated Dispatch Testing Without Auto Affiliation

SIGNALING EVENT		DESCRIPTION
F	Control Channel Idle	Control Channel Idle.
Q	Channel Grant OSW Sent	The trunking analyzer sends channel grant OSWs on the control channel. Channel grants direct the radio to the voice channel to use.
T	LC Word Sent on VC	The trunking analyzer sends a link control data word on the voice channel.
X	Disconnect Sent	The trunking analyzer sent a disconnect word on the voice channel to end the call. The radio will return to monitor the control channel.

Table 10-4. Astro Signaling Events System Initiated Testing With Auto Affiliation

SIGNALING EVENT		DESCRIPTION
A	Control Channel Idle	Control Channel Idle.
D	Affiliate ISW Received	The trunking analyzer received the Affiliate ISW from the radio.
E	Affiliate OSW Sent	The trunking analyzer sends Affiliate OSWs on the control channel. The Affiliate OSW acknowledges the radio is registered on the system and tells the radio which connect tone to use.
F	Control Channel Idle	The trunking analyzer outputs a background pattern on the control channel to lock the radio.
Q	Channel Grant OSW Sent	The trunking analyzer sends channel grant OSWs on the control channel. Channel grants direct the radio to the voice channel to use.
T	LC Word Sent on VC	The trunking analyzer sends a link control data word on the voice channel.
X	Disconnect Sent	The trunking analyzer sent a disconnect word on the voice channel to end the call. The radio will return to monitor the control channel.

10-3 CALL ALERT TESTING

10-3.1 Radio Initiated Call Alert Test, Astro Signaling

Configure the analyzer for trunk mode (paragraph 9-5) and Radio Initiated Testing (paragraph 9-6).

NOTE

SMARTZONE configures the analyzer to perform a SMARTZONE affiliation sequence prior to executing the dispatch test sequence. If the radio is not capable of SMARTZONE auto affiliation, the selection should be set to DISABLED.

1. Enter the following parameters:

Sig Type:	ASTRO VSELP or ASTRO IMBE
ID Disp:	HEX or DEC
Call Seq:	CALL ALERT

2. Set the System ID to match the radio system ID and one of the system IDs in the Radio Configuration screen to decode the radio's ID information.

NOTE

*The system ID entered **must** match the system ID of the radio. Otherwise the radio will not lock onto the control channel.*

3. Enter the CCTx or Control Channel number. Enter the VCTx or voice channel number.

NOTE

Splinter channels can only be entered by frequency. Standard channels can be entered by frequency or channel number (channel numbers only map to standard channel frequencies).

4. Set the monitor attenuation and port selection. Suggested port selection is RF I/O with 20 dB attenuation.

5. Set the generator attenuation and port selection. Suggested port selection is RF I/O with -50 dB for the level setting.

6. Press the **start test** softkey.

NOTE

If SMARTZONE auto affiliation has been selected, the operator is prompted to apply power to the radio. Once the test radio is turned on, it begins to search for a control channel. When the radio finds the control channel, it performs an auto registration sequence with the analyzer, and the registration data is displayed.

7. The status thermometer displays the major signaling events that occur during a radio initiated Call Alert test. Refer to table 10-5 (Astro auto affiliation disabled), or table 10-6 (Astro with auto affiliation).

The trunking analyzer generates an idle pattern on the control channel and prompts the operator to key the transmitter. When the radio sends an ISW, the analyzer decodes it and displays it.

If the ISW call type is a call alert, the analyzer waits a short period of time and sends an acknowledgment to the radio that the call alert was received, and terminates the test. During the execution of the test sequence, the status thermometer is appropriately updated.

8. Press the **stop test** softkey to terminate testing.

Table 10-5. Astro Signaling Events Radio Initiated Call Alert Testing Without Auto Affiliation

SIGNALING EVENT		DESCRIPTION
F	Control Channel Idle	The trunking analyzer outputs a background pattern on the control channel to lock the radio.
L	Dual ISW Received	The trunking analyzer received a dual word ISW from the radio.
M	Call Alert Ring OSW	The trunking analyzer sends a call alert ring OSW to the target radio.
O	Call Alert Ring Ack OSW	The trunking analyzer sends call alert ring acknowledge OSW to simulate the system sending an acknowledge to the requesting radio.

Table 10-6. Astro Signaling Events Radio Initiated Call Alert Testing With Auto Affiliation

SIGNALING EVENT		DESCRIPTION
A	Control Channel Idle	The trunking analyzer outputs a background pattern on the control channel for the radio to lock onto.
D	Affiliate ISW Received	The trunking analyzer received the Affiliate ISW from the radio.
E	Affiliate OSW Sent	The trunking analyzer sends Affiliate OSWs on the control channel. The Affiliate OSW acknowledges the radio is registered on the system and tells the radio which connect tone to use.
F	Control Channel Idle	The trunking analyzer outputs a background pattern on the control channel to lock the radio.
L	Dual ISW Received	The trunking analyzer received a dual word ISW from the radio.
M	Call Alert Ring OSW	The trunking analyzer sends a call alert ring OSW to the target radio.
O	Call Alert Ring Ack OSW	The trunking analyzer sends call alert ring acknowledge OSW to simulate the system sending an acknowledge to the requesting radio.

10-3.2 System Initiated Call Alert Test, Astro Signaling

Configure the analyzer for trunk mode (paragraph 9-5) and System Initiated Testing (paragraph 9-7).

NOTE

Fleet, Subfleet, and Unit ID information must be entered before the execution of a System Initiated test. If a Radio Initiated test is executed prior to the System Initiated test, these fields are automatically updated.

NOTE

SMARTZONE configures the analyzer to perform a SMARTZONE affiliation sequence prior to executing the dispatch test sequence. If the radio is not capable of SMARTZONE auto affiliation, the selection should be set to DISABLED.

1. Enter the following parameters:

Sig Type:	ASTRO VSELP or ASTRO IMBE
ID Disp:	HEX or DEC
Call Seq:	CALL ALERT

2. Set the System ID to match the radio system ID in order to decode the radio's ID information.

3. Target Unit, Calling Unit
   If a radio initiated dispatch or call alert test has been executed prior to the system initiated test, the Target Unit ID and Calling Unit ID decoded from the ISW will be displayed. If the operator wants to change the Target Unit ID or Calling Unit ID, simply move the cursor to the appropriate position and enter the new number.

   In the system initiated test sequence, the Target Unit ID contains the data for the test radio while the Calling Unit ID contains the data for the "other radio" that is trying to call alert the Target Unit.

4. Enter the CCTx or Control Channel number. Enter the VCTx or voice channel number.

NOTE

Splinter channels can only be entered by frequency. Standard channels can be entered by frequency or channel number (channel numbers only map to standard channel frequencies).

5. Set the monitor attenuation and port selection. Suggested port selection is RF I/O with 20 dB attenuation.

6. Set the generator attenuation and port selection. Suggested port selection is RF I/O with -50 dB for the level setting.

7. Press the **start test** softkey.

   The trunking analyzer generates an idle pattern on the control channel. After a short period of time the analyzer sends a call alert message to the radio. When the radio receives the call alert, it issues an acknowledgment to the analyzer and an audible call alert tone is generated by the radio. The analyzer terminates the test sequence and displays the test ended message when the acknowledgment is received.

8. The status thermometer displays the major signaling events that occur during a system initiated Call Alert test. Refer to table 10-7 (Astro auto affiliation disabled), or table 10-8 (Astro with auto affiliation).

9. Set the generator attenuation and port selection. Suggested port selection is be RF I/O with -50 dB for the level setting.

Table 10-7. Astro Signaling Events System Initiated Call Alert Testing Without Auto Affiliation

SIGNALING EVENT		DESCRIPTION
F	Control Channel Idle	The trunking analyzer outputs a background pattern on the control channel to lock the radio.
M	Call Alert Ring OSW	The trunking analyzer sends a call alert ring OSW to the target radio.
N	Call Alert Ring Ack ISW	The radio sends a call alert ring ack ISW to indicate the radio received the call alert.
O	Call Alert Ring Ack OSW	The trunking analyzer sends call alert ring acknowledge OSW to simulate the system sending an acknowledge to the requesting radio.

Table 10-8. Astro Signaling Events System Initiated Call Alert Testing With Auto Affiliation

SIGNALING EVENT		DESCRIPTION
A	Control Channel Idle	The trunking analyzer outputs a background pattern on the control channel for the radio to lock onto.
D	Affiliate ISW Received	The trunking analyzer received the Affiliate ISW from the radio.
E	Affiliate OSW Sent	The trunking analyzer sends Affiliate OSWs on the control channel. The Affiliate OSW acknowledges the radio is registered on the system and tells the radio which connect tone to use.
F	Control Channel Idle	The trunking analyzer outputs a background pattern on the control channel to lock the radio.
M	Call Alert Ring OSW	The trunking analyzer sends a call alert ring OSW to the target radio.
N	Call Alert Ring Ack ISW	The radio sends a call alert ring ack ISW to indicate the radio received the call alert.
O	Call Alert Ring Ack OSW	The trunking analyzer sends call alert ring acknowledge OSW to simulate the system sending an acknowledge to the requesting radio.

10-4 FAILSOFT TESTING

10-4.1 Radio or System Initiated Failsoft Test, Astro Signaling

Configure the analyzer for trunk mode (paragraph 9-5) and Radio Initiated or System Initiated Testing (paragraph 9-7).

1. Enter the following parameters:

Sig Type:	ASTRO VSELP or ASTRO IMBE
ID Disp:	HEX or DEC
Call Seq:	FAILSOFT
Systm ID:	

2. Enter the FSTx or channel number.

3. Enter the Input Port selection and monitor attenuation. In most cases, the port selection should be RF I/O with 20 dB attenuation.

4. Enter the generator Port selection. In most cases, the port selection should be RF I/O.

5. Press the **start test** softkey. If the parameters selected are not valid, the test sequence is terminated and an error message is displayed. When the **start test** softkey is pressed, it is replaced with the **stop test** softkey. For a list of error and warning messages, refer to Appendix G.

   The trunking transmits the failsoft word on the failsoft channel, and nothing on the control channel. When the radio cannot detect a control channel, it looks at its failsoft channel. When the radio decodes the failsoft word it will unmute and conventional radio operation is possible. After the radio has locked on the failsoft channel, the operator can transmit modulation from the trunking analyzer to the radio.

6. Press the **stop test** softkey to terminate testing.

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Section 11

SECURENET OPTION INTRODUCTION

11-1 INTRODUCTION

This manual contains information for using the R2670 FDMA Digital Communications System Analyzer with SECURENET Options. The SECURENET Option provides unique testing features for communications equipment using SECURENET encoding and modulation principles. Standard R2670 capabilities are retained. The additional SECURENET test sequences are accessed via the LCD display, screen-defined softkeys, numeric keypad, cursor movement keys, and optical tuning knob. The SECURENET Option functions may also be accessed via the remote control interface port.

11-2 CAPABILITIES

The SECURENET Option gives the R2670 the capability of monitoring and generating SECURENET signals. A SECURENET signal relates to a Motorola proprietary signaling scheme in which a 12 kbps serial bit stream is mapped into one of two corresponding amplitudes, filtered digitally, and then modulated onto an RF carrier. Most of the SECURENET user interface operates exactly like that of the standard R2670. Several new features were added to test the unique requirements of user SECURENET equipment.

Voice Mode System Testing

Voice mode provides SECURENET-compatible modulation and demodulation with vocoding. The SECURENET Option generate and monitor modes support actual functional voice testing in encrypted mode using either a test key or an operating key loaded from a separate compatible keyloader.

Bit Error Rate (BER) Testing

A BER test pattern can be selected to modulate the R2670 generator section. A BER test pattern can likewise be decoded by the R2670 in monitor mode. BER tests can also be conducted in duplex mode for loop testing.

Dedicated Test Screens

Dedicated test screens can be setup as a start-up default condition or as a programmable test set-up. Dedicated SECURENET test screens are zoned with RF and Audio Modulation control screens to simultaneously display test results along with their test conditions.

Baseband Audio Scope Display

The display provides a graphic image of the audio baseband signal. This baseband signal is selectable at either the vocoder input in generate mode or the vocoder output in monitor mode.

11-3 SECURENET OPTION HOUSING

11-3.1 Description

The SECURENET Option housing (figure 11-1) is an external module containing circuitry and connectors to support SECURENET functions. The SECURENET Option housing attaches to the rear of the R2670 analyzer. In some instances, the Option housing may be attached along with another option housing or in conjunction with the R2670 battery pack (optional). The battery pack, if used, mounts on the back of the final option housing.

11-3.2 Connectors

The SECURENET Option housing has two connectors as shown in figure 11-1. Both connectors are located on the side of the housing. The KVL connector provides a receptacle for loading an external encryption key or for programming a radio with a test key. The other connector is an interface port.

Key Variable Loader (Kvl) Port

The KVL port allows the analyzer to be preloaded with a user-selected encryption key from any compatible keyloader (key inserter). The port also is used with an optional cable to transfer test keys from the analyzer to a radio being tested. The R2670 with SECURENET Option is compatible with the following Motorola key inserters: T3010DX, T3011DX, T3012DX, T3013DX, T3014DX, or any KVL 3000 with the ASN option.

Serial Port (25 Pin)

The serial interface port is multiplexed to provide the future addition of an HDLC wireline serial data interface or an RS-232 interface for data communications.

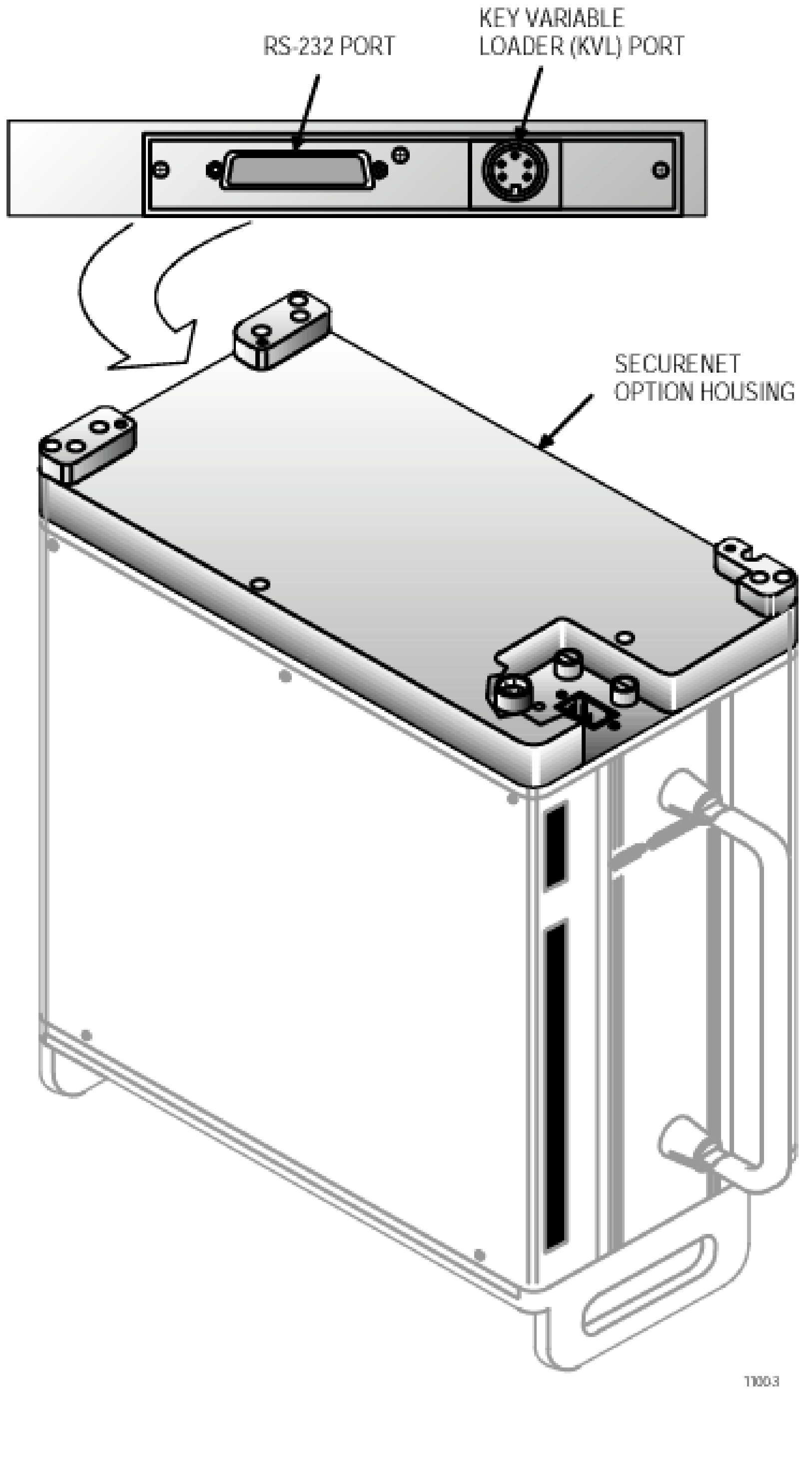

Figure 11-1. R-2670 with SECURENET Option Housing

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Section 12

SECURENET DESCRIPTION

12-1 INTRODUCTION

The SECURENET Option extends the standard functions of the R2670 to provide an all-in-one servicing instrument for communications equipment that uses SECURENET voice protection.

12-2 BASIC OPERATION

The R2670 with SECURENET Option can emulate the same digital environment used by SECURENET radios in private mode. This capability allows the analyzer to interoperate with conventional SECURENET user equipment. Standard test equipment is unable to decipher private audio transmissions from SECURENET radios because the audio signals are converted from their native analog format to a digital, ciphered representation prior to transmission.

Some radios in the SECURENET system have both clear and privacy modes available. When operated in privacy mode, the radio scrambles communications prior to their transmission. Only intended subscribers, with compatible hardware plus matching security keys, can decipher the message. In this way, users of a system can be partitioned into groups, each with their own security key. The R2670 with SECURENET Option will accept an external operating key from any compatible key loader. Alternately, the user can select one of the Option's own internal test keys to program the radio under test.

In its SECURENET mode, the R2670 provides display screens for monitoring bit error rate characteristics of a radio under test and also generates bit error rate test patterns to support this mode of operation.

The R2670 with SECURENET Option provides a clear scope display of baseband signals as either the input to the vocoder (generate mode) or the output from the vocoder (monitor mode).

12-3 TEST CONSIDERATIONS

Systems using encrypted communications have a need to maintain even higher standards on RF signal quality than normal FM radio systems. Encryption subjects the SECURENET signals to additional processing. In order to work reliably, the radios must be tuned to preserve critical factors such as operating frequency response and transmitter deviation. Individual test meters and generators compound the effects of multiple RF paths and wirelines in the test environment, resulting in degraded signals and less accurate measurements.

Operating in secure or standard mode, the R2670 with SECURENET Option bundles a wide assortment of sophisticated test features in a single instrument.

12-4 SPECIAL TERMS

The following list contains brief definitions of special terms that are used in association with SECURENET radios and test equipment:

Algorithm - In secure systems, an algorithm is a distinct method for translating clear information (input) to a secure version of the information (output). The same algorithm is used to interpret the message. SECURENET systems use the following algorithms:

- DVP and DVP-XL
- DES and DES-XL
- DVI-XL

BER Test - In generate mode, the analyzer modulates the RF carrier with Bit Error Rate test pattern to test the radio receiver. This BER test pattern consists of a free running, unframed pseudo-random bit pattern. In monitor mode, the analyzer monitors the BER test pattern input and provides a metering display of bits received, number of bits expected, and bit error rate percentage.

Cipher - to convert information to a seemingly random pattern for transmission or wireline delivery in order to protect sensitive information. Ciphered voice and data can only be understood by means of a special key.

CVSD Modulation - Continuously-Variable-Slope Delta technique used in SECURENET radios and test equipment to digitize analog signals before transmission and to reconstruct analog signals on the receiving end.

Decryption - process of converting cipher text to plain text

Encryption - process of converting plain text to cipher text

EOM Signal - A short signal burst identifying the End-Of-Message. SECURENET radios transmit (or receive) an EOM signal at the end of all private mode transmissions. The signal burst lasts for at least 140 milliseconds.

Key - a sequence of bits stored electronically in the encryption and decryption modules. Once the key has been loaded, it trains the internal encyption/decryption circuits.

Key Inserter - a device used to load an electronic encryption key into a radio or other device. Also called a keyloader.

Section 13

SECURENET OPTION OPERATING INSTRUCTIONS

CAUTION

When testing a radio, observe the following precautions:

- ***Do not** use an antenna on the analyzer for over-the-air testing.*
- ***Use** double-shielded cables on the analyzer to carry signals to and from the radio.*
- ***Locate** the analyzer at least 35 feet from the antenna of a unit that is working in the same system that the analyzer is testing.*
- ***Adjust** the squelch to where the LED indicator for squelch just turns off or is closed. When the signal from the radio is present, the squelch LED will illuminate indicating that squelch has been detected and there is a signal present.*

13-1 INTRODUCTION

The R2670 FDMA Digital Communications System Analyzer with SECURENET Option is an enhancement of the R2600 Series Communications System Analyzer. Refer to sections 11, 12, 13, and 14 of the General Operations tab in this manual for general operational information. The following sections of this manual contain information on how to connect SECURENET radios under test to the analyzer and how to set controls and indicators to obtain the correct screen display.

Error/Warning Messages

Refer to Appendix J for a listing and description of setup and radio error messages. Messages common to all the R2600 Series equipment are described in paragraph 13-4 under the General Operations tab in this manual.

13-2 SOFTWARE VERSION SCREEN

To view the software version of the R2670 Analyzer, turn power on and wait for the display to appear on the screen. Press the **SPF** hard key, and move the cursor to "VERSION." Select the **display table** softkey. This will configure the analyzer to generate a screen that displays the SECURENET software version (figure 13-1).

Move the cursor to the SECURENET position and select the **view options** softkey. A screen similar to figure 13-2 will be displayed and indicates the analyzer options installed and encryption algorithms available.

Select **return** softkey twice to return to the SECURENET mode screen.

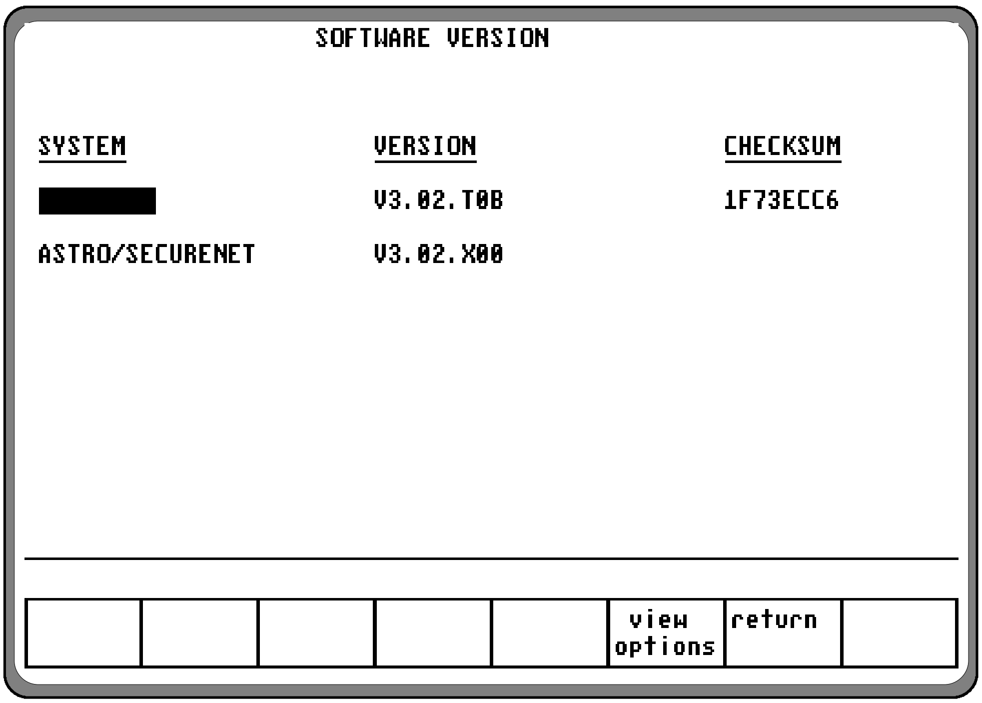


Figure 13-1. SECURENET Version Screen

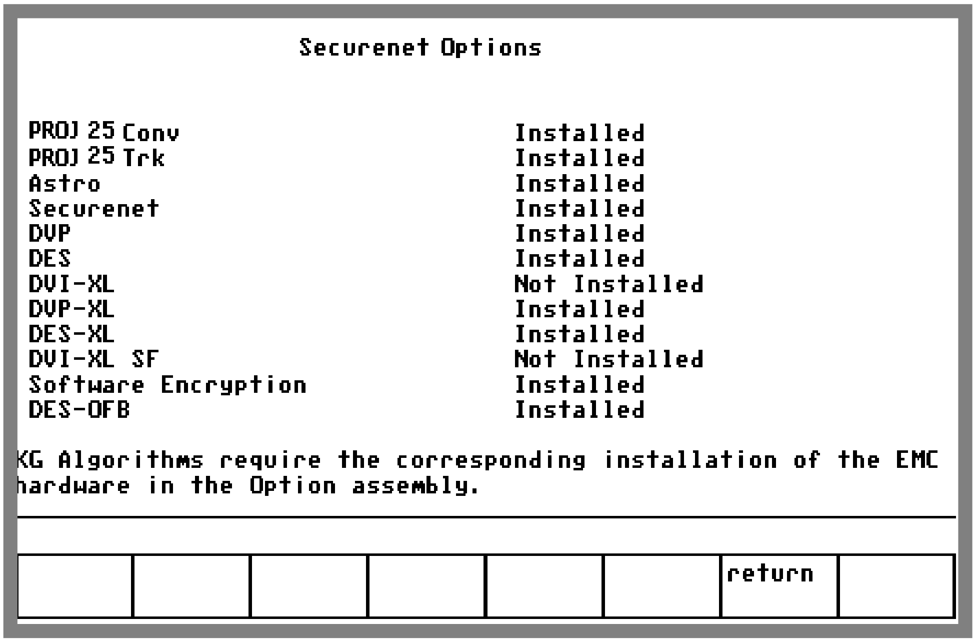


Figure 13-2. SECURENET Options Screen

13-3 BASIC OPERATION

Control of the unit and selection of data to be displayed are done through the use of three main windows which simultaneously appear on the screen: the Display Zone, the RF Zone, and the Audio Zone. These three zones are shown in figure 13-3.

The top portion of Display Zone displays the status and selections for the current test sequence. The bottom portion of the Display Zone displays the data about the radio under test.

The RF Zone is used for selection of RF mode, for selection of frequency band, for port selection and for control of RF signal level at the input/output port. The audio section is unchanged from the standard system except that, in SECURENET mode, modulation options are limited.

13-3.1 Display Screens

The three main windows, or cursor zones, are accessed through a cluster of three CURSOR ZONE keys at the top center of the unit. The location where the cursor rests within each zone is called a cursor field. To control the unit and enter data, all operator inputs are made at highlighted cursor fields (brighter-face type).

Below the screen are softkeys. These softkeys, with customized on-screen labels, interact with the screen to provide a unique menu of entry options for each cursor field. This greatly reduces the number of keys and eliminates having to search through unrelated controls to find the one that is needed.

13-3.2 Manual Operation

To control the cursor location and input information by (manual control):

- Use the CURSOR ZONE keys to move the cursor among the three zones.
- Use the CURSOR POSITION keys to move the cursor from field to field within a zone.
- Once at the desired field, use either the TUNING knob or the numeric keys to enter numeric information. Use the softkeys for other menu selections.

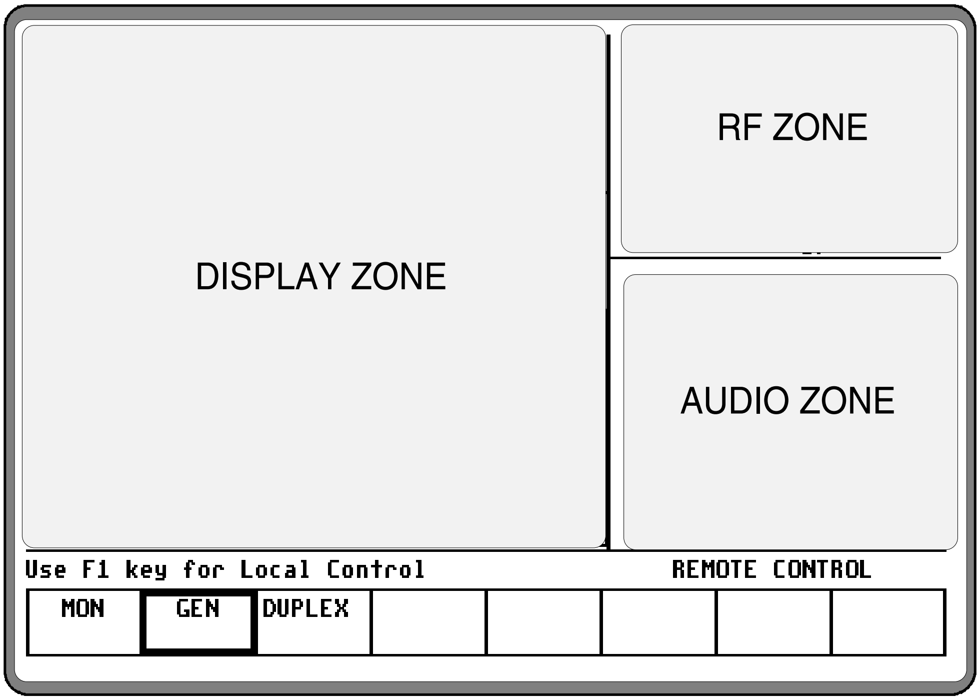


Figure 13-3. Screen Zone Arrangement

13-3.3 Expanded Display

Some fields have the ability to expand their contents and overwrite other display areas. These consist of the following:

- Spectrum analyzer, scope waveforms, bargraph displays
- Decode tables
- Encode tables
- Dedicated keys

13-3.4 Dedicated Keys

Refer to paragraph 13-8 under the General Operations tab in this manual for an explanation of expanded screens in the HELP, MEM, SPF, and CAL modes.

13-3.5 Remote Operation

All R2600 Series Communications System Analyzers are equipped with a standard RS-232 interface. Optionally, the R2670 is equipped with an IEEE 488 interface. Either of these interfaces may be used to remotely control the analyzer using a set of commands, queries, and responses that are defined in the General Dynamics R2600 Series Communications System Analyzer Programming Reference Manual (68-80309E55).

13-3.6 HELP

The analyzer provides on-screen operating instructions via the dedicated HELP key. Help screens are organized such that each display area has an associated help screen pertaining to that area of the screen. System help is available via a softkey within each help screen. Use the **return** softkey to return to the function in progress.

13-4 ENCRYPTION CAPABILITIES

Hardware encryption is always enabled when the R2670 is in SECURENET mode. SECURENET equipment converts normal speech patterns to their digital equivalent and then uses an encryption algorithm to encrypt data for transmission. A receiving radio, using the same algorithm and a matching key, automatically reverses the process so you can hear a normal audio message.

A set of either U.S. or European encryption algorithms are available with the SECURENET Option. Algorithms include Data-Encryption System (DES) - a U.S. Federal Government encryption standard, Digital Voice Protection (DVP) - a Motorola Proprietary encryption algorithm, and DVI - a Motorola Proprietary encryption algorithm for international use only. Within a set, each algorithm is individually selectable:

- *Domestic: DES, DES-XL, DVP, DVP-XL*
- *International: DVI-XL, DVP, DVP-XL*

13-5 TEST SETUP

13-5.1 Connecting a Radio

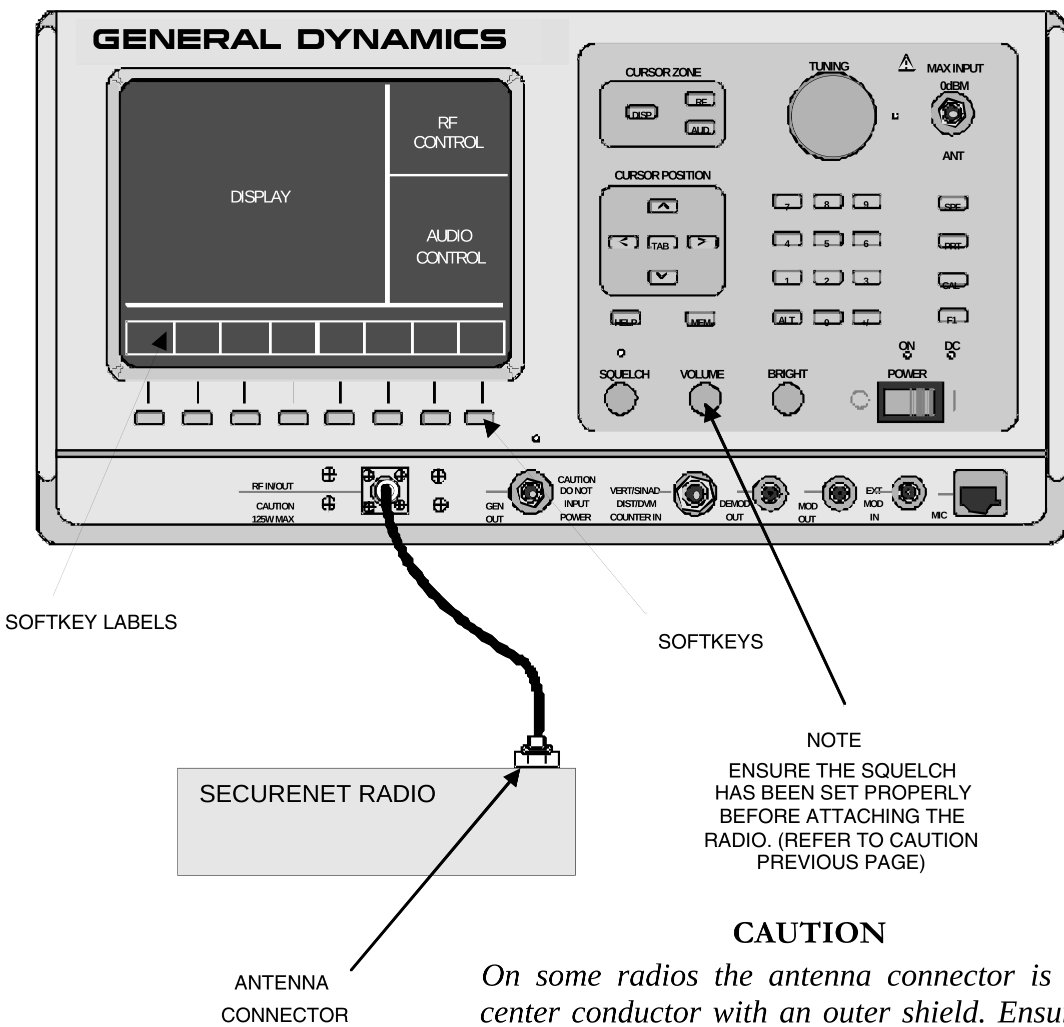
Use a 50-ohm BNC cable and an N to BNC adaptor to connect from the RF I/O port of the R2670 analyzer to the antenna port of the radio as shown in figure 13-4.

CAUTION

Adjust the squelch to where the led indicator for squelch just turns off or is closed. When the signal from the radio is present, the squelch LED will illuminate indicating that squelch has been detected and there is a signal present.

CAUTION

Observe the input power ratings and warnings of the analyzer to insure that no damage occurs to the analyzer.



CAUTION

On some radios the antenna connector is not a center conductor with an outer shield. Ensure the signal is not shorted to the shield of the BNC cable by disconnecting the shield at the radio end.

Figure 13-4. Radio to Analyzer Test Setup

13-6 ACCESSING SECURENET MODE

Select the SECURENET mode by placing the cursor in the "Mode:" field in the Display Zone located at the top of the screen. Use the **SECURE NET** softkey to select the SECURENET mode. A screen similar to figure 13-5 appears.

When the display zone "Mode:" is set to SECURENET, the R2670 will configure itself to generate and monitor SECURENET signals.

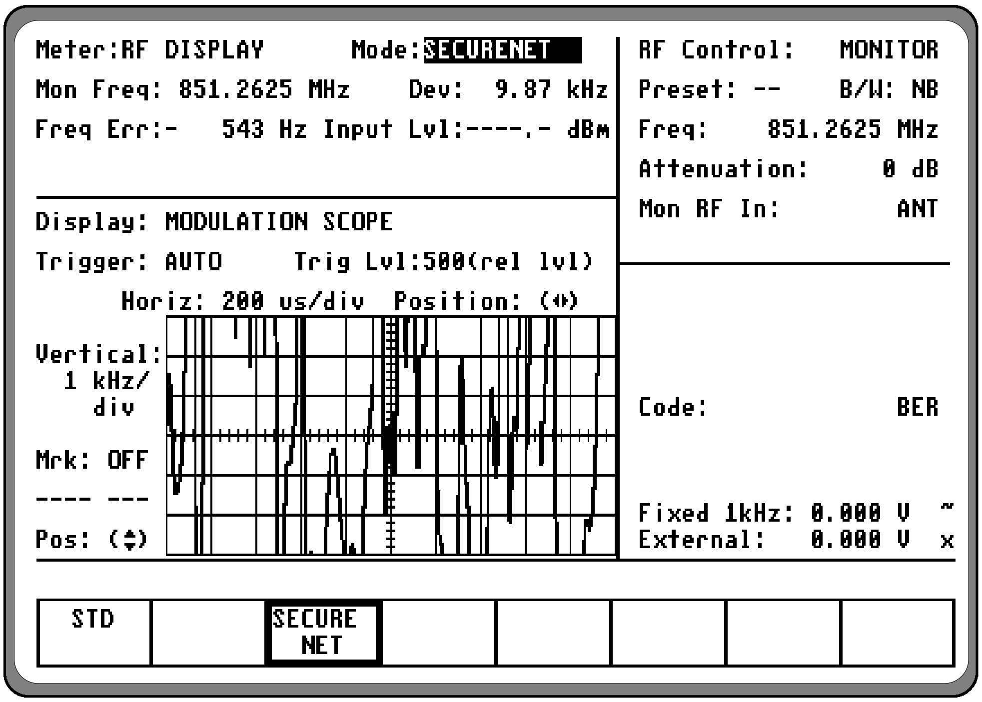


Figure 13-5. SECURENET Mode Screen

13-7 SECURENET ENCRYPTION SET UP

13-7.1 SET UP Encrypter Display

The SET UP display places the analyzer in encryption setup mode and allows the operator to select the desired algorithm. SET UP display is accessed from the Display Zone. To use SET UP display, move the cursor to the "Display:" field and select SET UP using the **SET UP** softkey. The Display Zone will show a menu of SET UP options as shown in figure 13-6.

13-7.1.1 Algorithm Select

Within the SET UP display, the first option field is Algorithm Select. Algorithm is a term that describes the method of coding data or audio so that only equipment having the same algorithm selected, and the same key, is able to exchange intelligible information. The analyzer includes several algorithms recognized by radios using SECURENET. You will need to select one of these algorithms to use for processing messages.

In the Display Zone, move the cursor to the "Algorithm Sel:" field as shown in figure 13-7. The softkeys will provide a menu of the available algorithms. Select the algorithm that corresponds to the radio being tested. Menu choices depend on which SECURENET option was purchased. Refer to paragraph 13-4 for a description of the U.S. and International encryption algorithms.

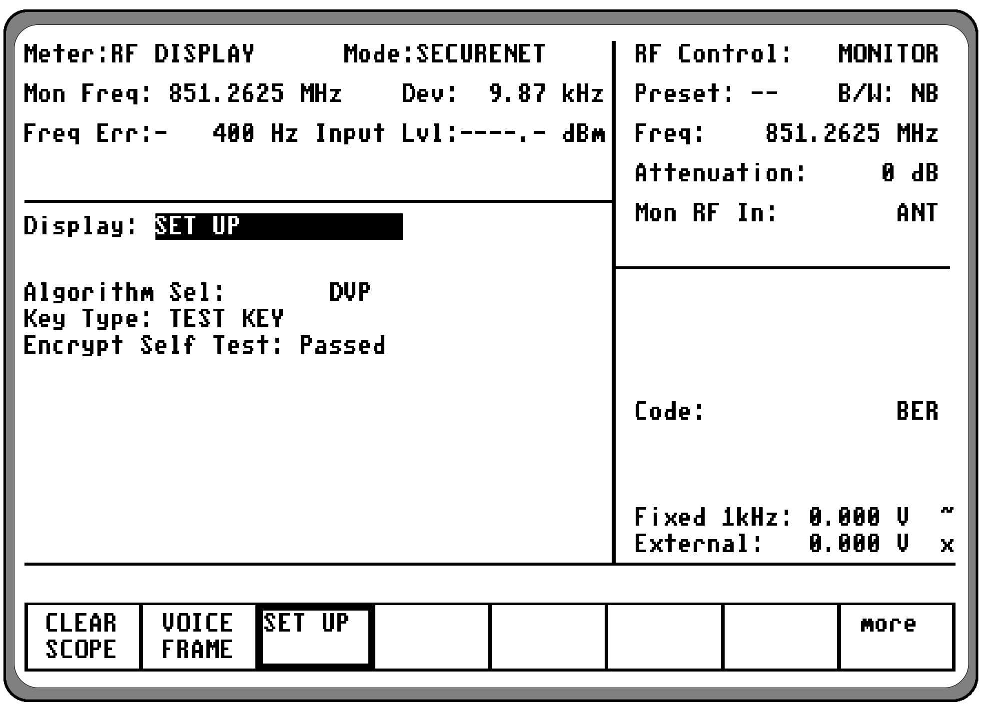


Figure 13-6. SET UP Display Screen

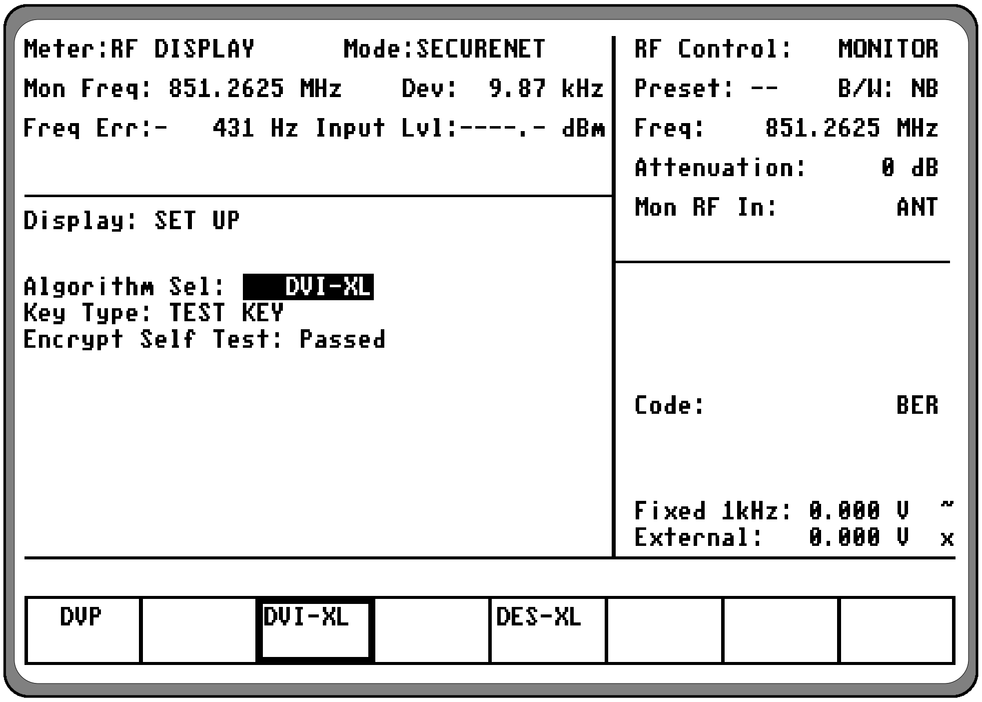


Figure 13-7. Algorithm Select Display

13-7.1.2 Key Type

Each algorithm is associated with one particular key type: either a Test Key or an External Key. Test Key is the default and is used to support most SECURENET testing. The Test Key is a dummy key which is programmed into the radio and the analyzer for maintenance purposes only. The test key should never be used for sending private radio communications. Its security is compromised (all SECURENET Option analyzers use the same test key). The analyzer provides these softkey selections:

Test Key

This softkey selects the Test Key saved in the analyzer's key storage memory. The Test Key will then be used for testing.

Ext Key

This softkey selects the External Key saved in the analyzer's key storage memory.

Erase Ext Key

This softkey erases from the analyzer's key storage memory any External Key saved for the current algorithm.

Load Ext Key

This softkey starts the sequence of programming the analyzer with an external key for the algorithm selected from a key inserter. This procedure requires a key loading cable and a key inserter (KVL).

Key Load Radio

This softkey starts the automatic sequence of programming the attached radio with a test key for the algorithm selected. This procedure requires a key loading cable.

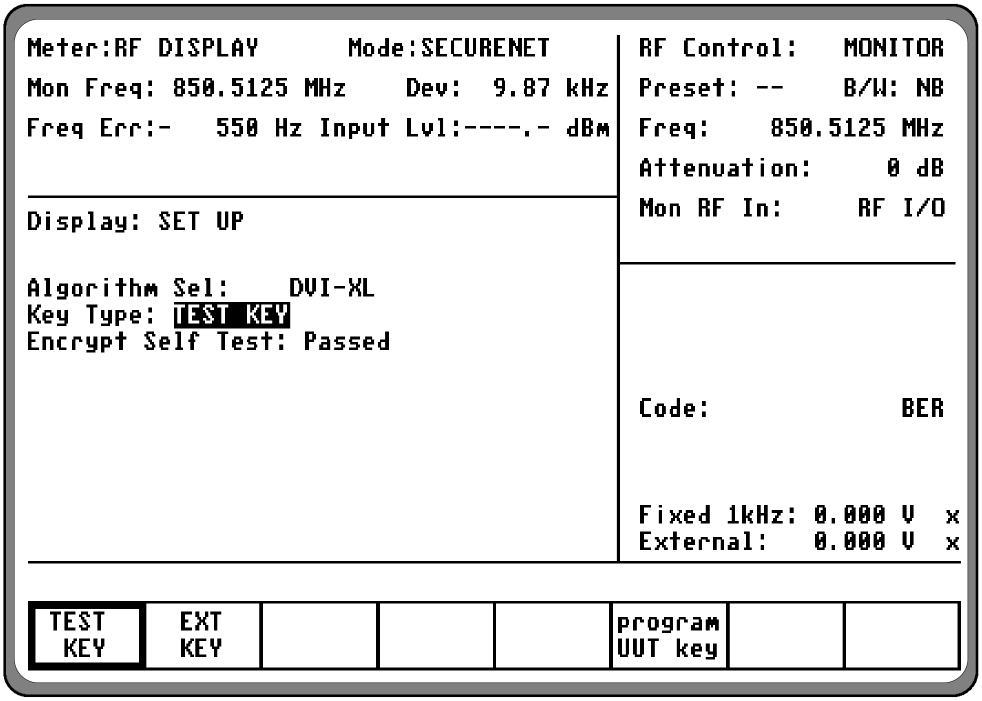


Figure 13-8. Test Key Programming Display

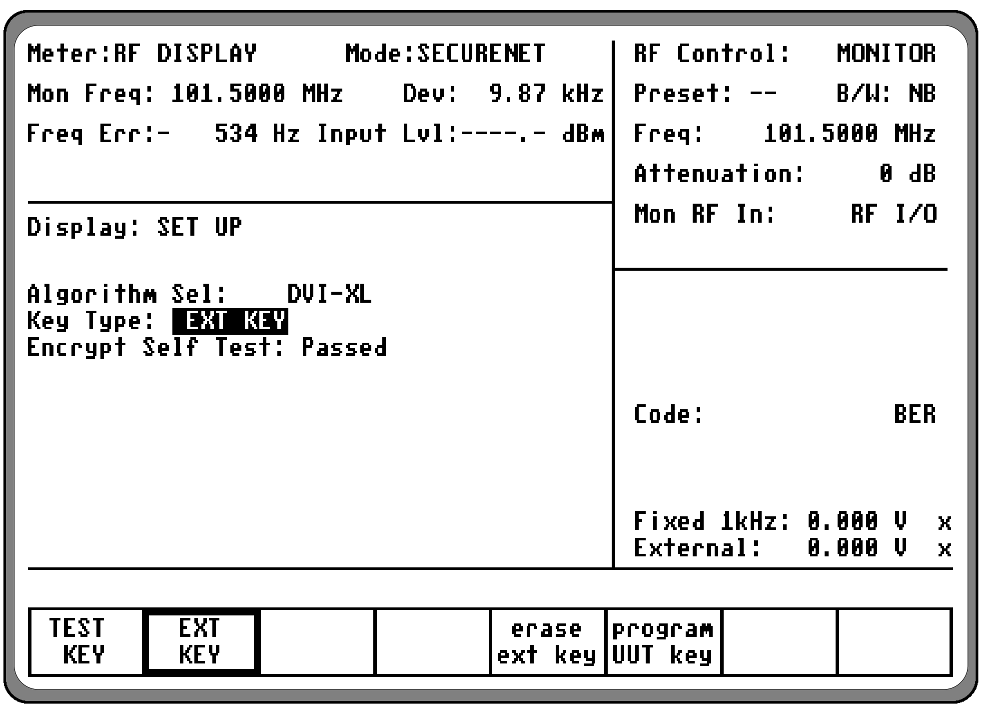


Figure 13-9. External Key Programming Display

13-7.1.3 Encrypt Self Test

A self test of the encryption functions is performed at power up. The "Encrypt Self Test:" field in the SET UP display (figure 13-6) indicates the results of the self test, passed or failed.

13-7.2 Programming with Test Key

Connect the proper key loading cable between the Key Variable Loader port of the analyzer (figure 11-1) and the programming port on the radio (refer to radio operator's manual).

To program the radio with a test key, place the cursor in "Display:" field in the Display Zone. Select SET UP using the **SET UP** softkey. This accesses the SET UP display screen (figure 13-6).

Move cursor to "Algorithm Sel:" field and select desired algorithm using softkeys (figure 13-7).

Move cursor to "Key Type:" field.

Apply power to the radio if not already on.

Select **key load radio** softkey. This will exercise the Key Variable Loader feature of the R2670 and start an automatic transfer of the test key from the analyzer to the radio. The R2670 will display "Radio key load complete."

To verify that a key has been loaded into the radio, disconnect the key loading cable, turn the radio off then back on. If the key load was unsuccessful, the radio will display key fail if it has a visual readout or will make an audio sound to indicate key fail.

CAUTION

Disconnect the key loading cable before continuing. Testing the radio with the key loading cable still connected could result in loss of the key.

To test the radio with the analyzer, be sure TEST KEY is displayed in the "Key Type:" field. This completes test key loading. It is all right to exit the SET UP screen.

13-7.3 Programming with External Key

You can use a customer key to program the analyzer and operate in private mode with a keyed radio. The customer (external) key, once loaded, is saved in memory by the analyzer until the operator erases it. The key is stored in non-volatile memory and will be retained even if power to the analyzer is turned off.

13-7.3.1 Connecting the Key Inserter

The key inserter plugs into the Key Variable Loader (KVL) port (figure 11-1) on the side of the analyzer opposite the carrying handle. Connect the key inserter to the analyzer and then use the following instructions to load the external key.

CAUTION

Use only DX, or any KVL 3000 with the ASN option, key loaders. Other types of key loaders (AX, BX or CX) may cause the encryption hardware to malfunction. To recover, press the encrypt reset softkey under the "Special Functions" (SPF) menu.

13-7.3.2 Loading External Key

To initiate loading an external key, place cursor in "Display:" field in the Display Zone and select SET UP mode display using the **SET UP** softkey.

Move cursor to "Algorithm Sel:" field and select desired algorithm using softkeys (figure 13-7).

Move cursor to "Key Type:" field.

Press the **load ext key** softkey to initiate the key load sequence.

Push the switch on the key inserter to begin loading. This activates the programming function. When programming is complete, the key inserter displays "pass" if the key load procedure was successful. The analyzer displays a message Ext key passed." If the key load procedure was unsuccessful, the key inserter displays "fail."

If key load procedure was successful, disconnect the key inserter. Be sure to press the EXT KEY softkey after loading an external key from the key inserter to transfer the external key into the analyzer's key storage memory. This completes external key loading. It is all right to exit the SET UP screen.

13-7.3.3 Erasing External Key

To erase an external key, place cursor in "Display:" field in the Display Zone and select **SET UP** softkey. This will access the SET UP display screen (figure 13-6).

Move cursor to "Algorithm Sel:" field. Using softkey, select the algorithm associated with the external key you want to erase.

Move cursor to "Key Type:" field and select External Key using softkeys.

Press **erase ext key** softkey (figure 13-9). The analyzer will erase the stored external key and display "key erased" in the message area.

13-8 SECURENET RF OPERATING MODES

Select the RF operating mode by placing the cursor in the "RF Control:" field in the RF Zone. Use the desired softkey to select MONITOR, GENERATE, or DUPLEX.

13-8.1 MONITOR Mode

The Monitor mode (figure 13-10) provides the analyzer's test receiver function which is used in the testing of radio transmitters. In SECURENET Monitor mode, the RF Zone is similar to the RF Zone in standard mode. It is capable of setting up the analyzer to monitor RF input through its antenna or a direct connection to the transmitter.

The RF Zone in Monitor mode contains fields for choosing the monitor bandwidth, frequency, attenuation, and source of the SECURENET RF signal. All of these fields operate as described under the General Operations tab in this manual except the Modulation Type field is not required.

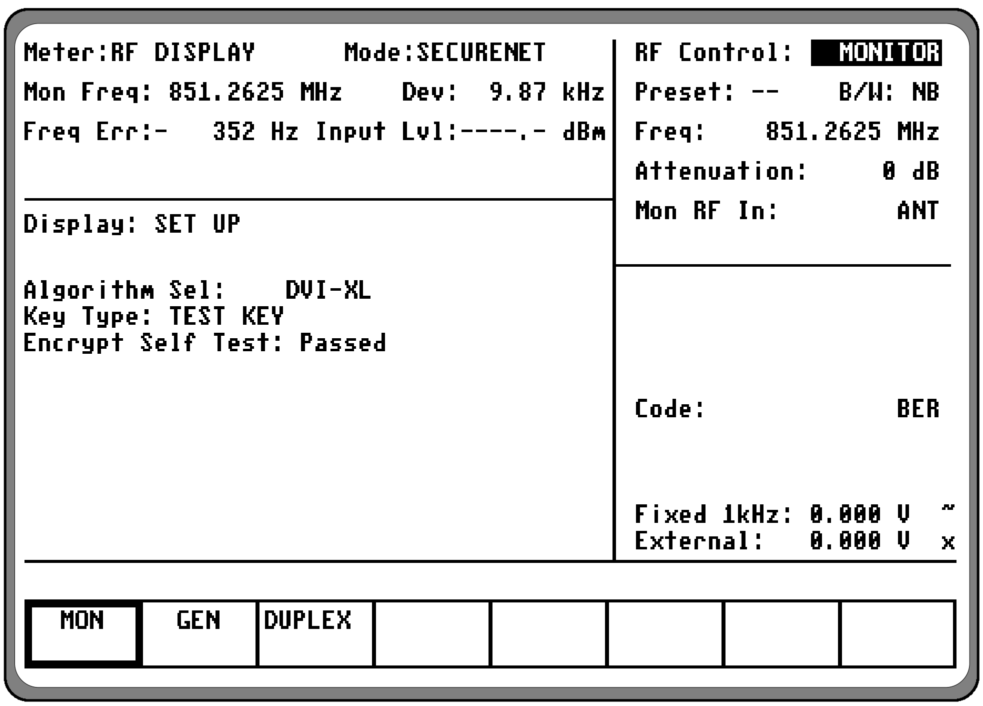


Figure 13-10. Monitor Mode - RF Zone

The specific entry fields are as follows.

Preset

The preset entry field provides a convenient way to enter a bandwidth, frequency, and other information for the unit by recalling preset data from nonvolatile memory. If a preset is not to be used, enter the desired information at each of the fields.

NOTE

If a preset had been selected and changes are made to any of the preset values, the "Preset:" field will have dashes through it, indicating the preset is no longer selected.

B/W

Selects either wide or narrow IF bandwidth of the unit via softkey selection.

Freq

Enter the desired monitor frequency using keypad or TUNING knob.

Attenuation

Selects the amount of attenuation at the RF input to the monitor receiver using softkeys. Selectable input attenuation is useful in adjusting displays for a wide range of input levels, as well as for use in high RF field environments where intermodulation may cause desensitization of the receiver.

Mon RF In

Selects the RF input port via softkeys. The RF I/O port contains an RF load and should be used for direct connection to the radio under test. The ANT port accesses the unit's sensitive receiver and should be used with an antenna for "off-the-air" reception. Selection of the ANT port is indicated by a red LED next to the ANT connector.

CAUTION

Do not apply input power to the ANT input port. In the event RF power is inadvertently applied, the port is protected by an in-line RF fuse. This fuse may be accessed by unscrewing the front of the BNC connector out of the front panel. Refer to paragraph 12-2.4.1 under the General Operations tab in this manual for additional detail.

13-8.2 GENERATE Mode

The GENERATE mode (figure 13-11) configures the Analyzer to generate an RF signal at a controlled output level. The GENERATE mode thus provides for a wide range of radio receiver testing. In SECURENET Generate mode, the RF Zone is similar to the RF Zone in standard mode. It is capable of setting up the analyzer to generate RF output through its RF I/O port or through the Generator Output (GEN OUT) port.

The RF Zone contains fields for choosing the generator bandwidth, frequency, output level, and output connector of the SECURENET RF signal. All of these fields operate as described under the General Operations tab in this manual except the Modulation Type field is not required.

Specific controls which further configure the GENERATE mode are located in RF Control Zone when GENERATE is first selected.

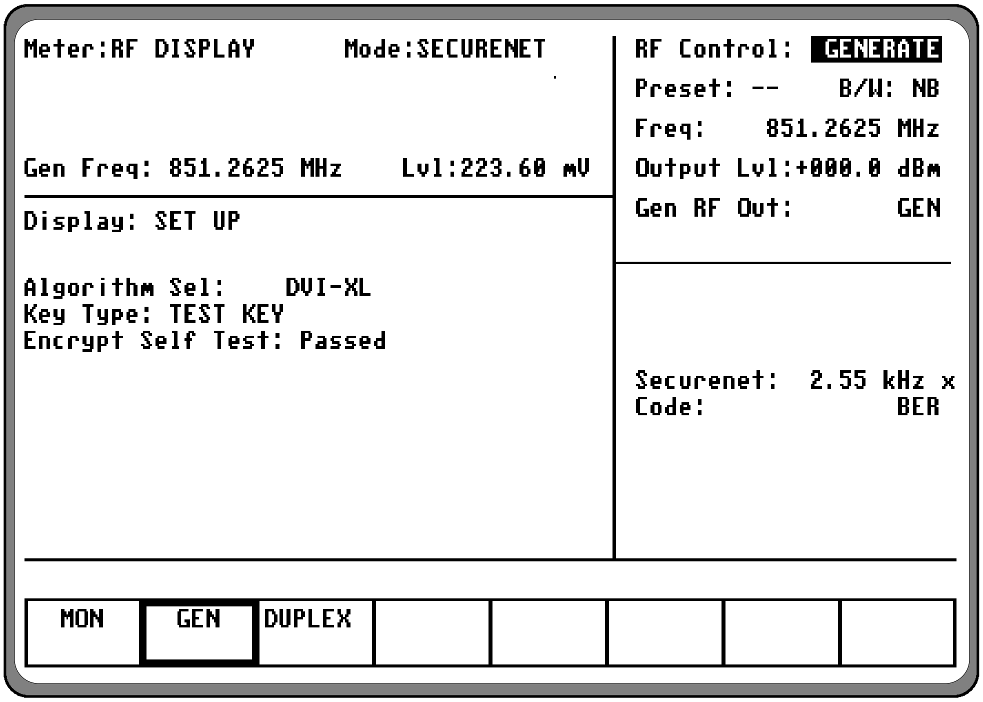


Figure 13-11. Generate Mode - RF Zone

The specific entry fields are as follows:

Preset

The preset function is the same as in the MONITOR mode.

B/W

Selects either wide or narrow bandwidth of the unit via softkey selection.

Freq

Enter the desired generate RF frequency using keypad or TUNING knob.

Output Lvl

Selects generator output level in 0.1 dBm steps over the range of -130 dBm to 0 dBm. An alternate display of generate level in microvolts is available in the "Meter:" area of the Display Zone. Output level is available in two ranges depending upon which output port is selected:

- *The range of -80 dBm to 0 dBm is available when the high level GEN OUT port is selected.*
- *The range of -130 dBm to -50 dBm is available when the RF I/O output port is selected.*

Gen RF Out

Selects the RF output port via softkeys. The RF I/O port is recommended for most applications. GEN and MON ports are combined for a single connection to the radio under test.

The GEN port is recommended where higher levels are needed. Selection of the GEN port is indicated by a red LED adjacent to the GEN OUT connector.

CAUTION

Do not apply input power to the GEN OUT port. In the event RF power is inadvertently applied, the port is protected by an in-line RF fuse. This fuse may be accessed by unscrewing the front of the BNC connector out of the front panel.

13-8.3 DUPLEX Mode

The DUPLEX Mode (figure 13-12) provides a simultaneous RF generator output that is offset in frequency from the monitor center frequency and fully adjustable in output level.

This capability provides for servicing full duplex radio equipment as well as repeaters and radios operating with offset transmit and receive frequencies. The Display zone provides softkey selections for Generated or Monitor clear baseband signal as shown in figure 13-12.

Specific controls which further configure the DUPLEX mode are located within the RF Control Zone when DUPLEX is first selected.

The specific entry fields are as follows:

Preset

The preset function is the same as in the MONITOR mode.

B/W

Selects either wide or narrow bandwidth of the unit via softkey selection.

Mon Freq

Enter the desired monitor frequency using keypad or tuning knob.

Offset

Enter the generator frequency offset relative to the monitor frequency entered. Offset frequencies of –999.99975 to +999.99975 MHz are allowed, but the final generate frequency will be constrained to 000.40000 MHz through 999.99995 MHz. The offset frequency is set in 2.5 kHz steps.

Mon

This field actually contains two separate fields, one for monitor input attenuation and one for monitor port selection. Refer to the MONITOR mode description for further details.

Gen

This field actually contains two separate fields, one for generate output level and one for generate output port selection. Refer to the GENERATE mode description for further details.

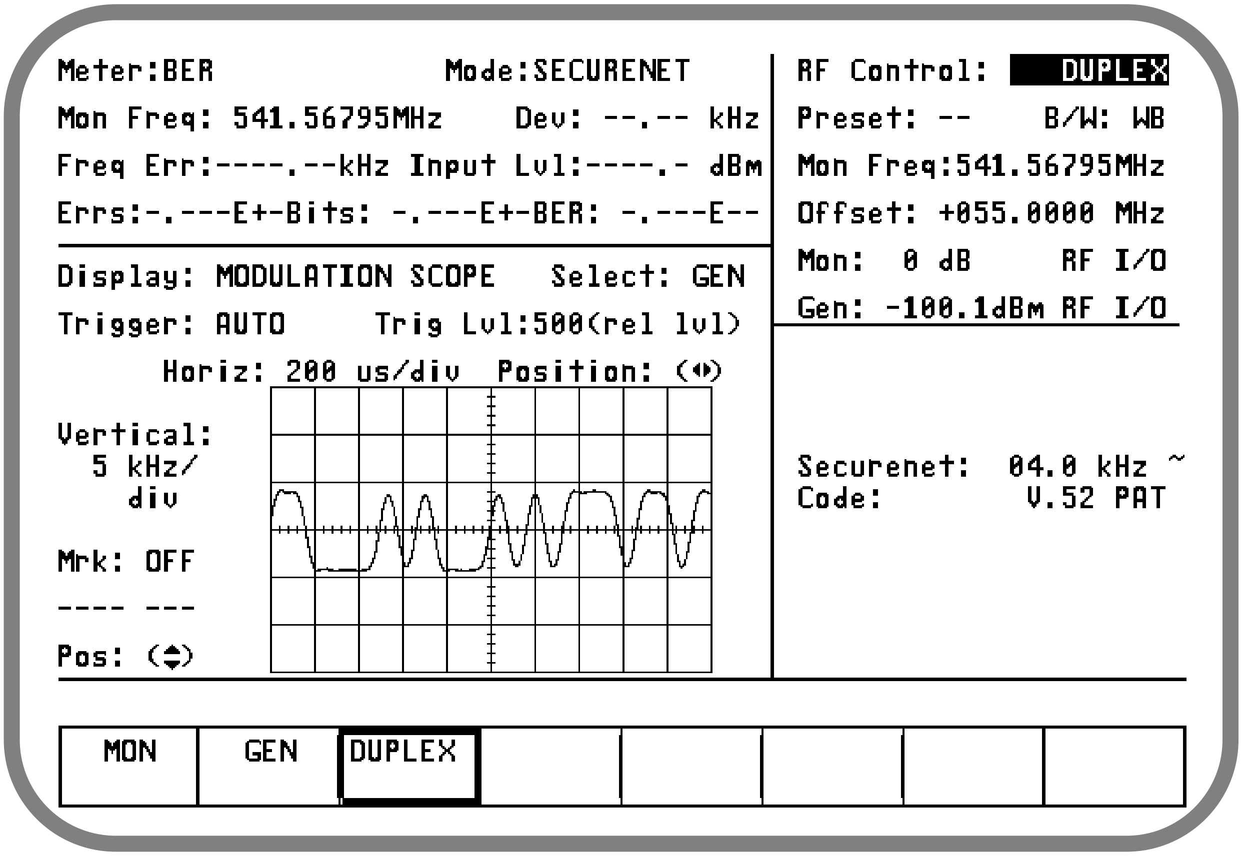


Figure 13-12. Duplex Mode - Display Zone

13-9 SECURENET AUDIO/MODULATION CONTROL

The Audio Zone located at the lower right of the screen (figure 13-13) is used to control the multi-purpose audio synthesizer section of the R2670. Signals generated by the audio synthesizer are coupled internally to the generator modulation input as well as to the MOD OUT connector on front panel. The main categories of modulation in SECURENET mode are Voice and Bit Error Rate (BER). Many of the features available in standard mode are not available in SECURENET mode. The Audio Zone has been changed accordingly to simplify testing of SECURENET radios and equipment.

Each modulation signal has a cursor field for entering its desired level. Use the keypad or TUNING knob to enter the desired level.

An additional cursor field, adjacent to each level entry, is used to switch each selection on and off using softkeys. This field is located at the extreme right side of the zone. There are three possible conditions for this softkey selection.

- CONT activates continuous ON condition, or continuous cycling if a sequence has been selected. A "~" symbol is indicated at the extreme right, adjacent to the level to indicate continuous ON.
- OFF switches off the modulation source. Off is indicated by an "X" at the extreme right, adjacent to the level.

13-9.1 Modulation Sources

There are two modulation sources selectable in the Audio Zone, Fixed 1 kHz and External.

13-9.1.1 Fixed 1 kHz

The analyzer produces a fixed 1 kHz modulation source, which can be selected independently from the other audio synthesizers. Level control and on-off selection is previously described.

13-9.1.2 External

External modulation can be applied to the external modulation input (EXT MOD IN) connector on the front panel. When external modulation source is selected, this external modulation input is summed with the microphone (voice) input. Level control and on-off selection for an external modulation source are selectable via softkey or the TUNING knob.

13-9.2 Voice Encode

The Audio Zone provides controls for both signal level and frequency deviation of Voice baseband signal that is used to modulate the SECURENET RF transmissions.

13-9.2.1 Monitor Mode

The analyzer can generate SECURENET voice patterns when placed in the Monitor mode. The SECURENET signal is encrypted with one of the hardware algorithms.

Be sure Monitor is selected in the RF Control Zone in the upper right section of display. Move cursor to the Audio Zone and place the cursor in the "Code:" field. Select Voice modulation using the **VOICE** softkey. Selection of Monitor Voice allows for the addition of the following audio sources:

- External + microphone, or
- 1 kHz tone

These inputs are selected by using the off and continuous switches and the level is adjusted using the keypad or tuning knob. The level range varies depending on whether the bandwidth (in the RF Zone) is set to narrow or wide.

BW Setting	Audio level Range
Narrow	0.000 to 0.795 volt maximum, in 0.001 volt increments
Wide	0.00 to 7.95 volt maximum, in 0.01 volt increments

13-9.2.2 Generate Mode

The analyzer can generate SECURENET voice patterns when placed in the Generate mode. The SECURENET signal is encrypted with one of the hardware algorithms.

Be sure GENERATE is selected in the RF Control Zone in the upper right section of display. Move cursor to the Audio Zone and place the cursor in the "Code:" field. Select Voice modulation using the **VOICE** softkey.

When code Voice is selected in the Audio Zone (figure 3-13), the analyzer allows audio inputs to the modulator to be selected from two sources:

- External + microphone, or
- 1 kHz tone

Controls for each modulating input consist of a switch with values of Off and Continuous. Move cursor to the appropriate switch field and turn the modulating input on "~" or off "X" using the softkeys.

The audio inputs also include a level control for precisely setting the audio input to the modulator. Use the keypad or TUNING knob to enter the desired level. The level range varies depending on whether the bandwidth (in the RF Zone) is set to narrow or wide.

BW Setting	Audio level Range
Narrow	0.00 to 9.95 kHz maximum, in 0.01 kHz increments
Wide	00.0 to 99.5 kHz maximum, in 0.1 kHz increments

In Generate mode, Deviation control is available in the Audio Zone consisting of a switch with values of Off and Continuous, and a level control. Move cursor to the switch field and turn deviation on "~" or off "X" using the softkeys.

Use the keypad or TUNING knob to enter the desired deviation. The deviation range varies depending on whether the bandwidth (in the RF Zone) is set to narrow or wide.

BW Setting	Deviation Range
Narrow	0.00 to 5.00 kHz maximum, in 0.01 kHz increments
Wide	00.0 to 50.0 kHz maximum, in 0.10 kHz increments

The baseband signal of the generated Voice pattern is available at the MOD OUT connector on the front panel.

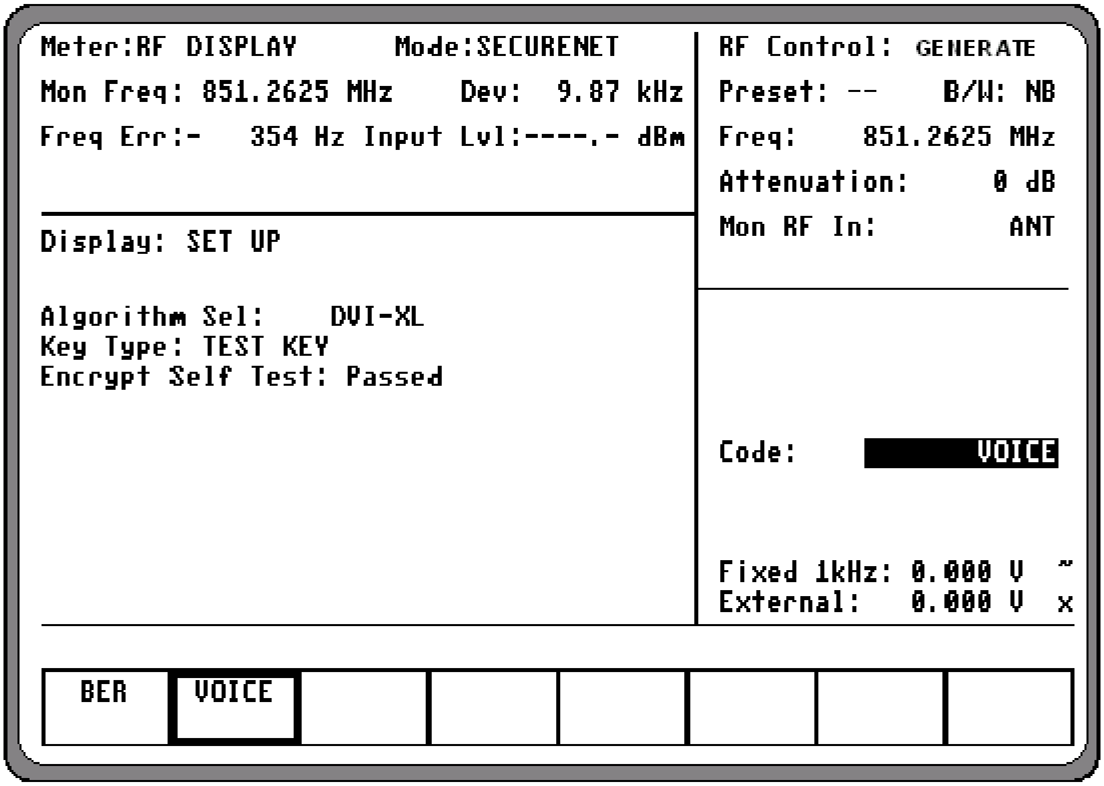


Figure 13-13. SECURENET Audio Zone - Voice Generate Mode

13-9.3 BER Encode

The Audio Zone provides controls for both *signal level* and frequency deviation of BER baseband signal that is used to modulate the SECURENET RF transmissions.

13-9.3.1 Monitor Mode

When Monitor is selected in the RF Control Zone and code BER is selected in the Audio Zone, the analyzer is configured to receive a BER pattern. The received BER pattern can be displayed in the Display tri-sector and measured in the Metering Zone.

13-9.3.2 Generate Mode

The analyzer can generate SECURENET BER patterns when placed in the Generate mode. The SECURENET signal is encrypted with one of the hardware algorithms. The Audio Zone provides the "Code:" field to select BER generation.

When code BER is selected in the Audio Zone (figure 13-14), the R2670 modulates BER on the carrier at either of two output ports:

- RF I/O port, or
- GEN OUT port

In Generate mode, modulation deviation is controlled in the Audio Zone by a switch with values of Off and Continuous, and a level control. Move cursor to the switch field and turn deviation on "~" or off "X" using the softkeys.

Use the keypad or TUNING knob to enter the desired deviation. The deviation range varies depending on whether the bandwidth (in the RF Zone) is set to narrow or wide.

BW Setting	Deviation Range
Narrow	0.50 to 5.00 kHz maximum, in 0.05 kHz increments
Wide	05.0 to 50.0 kHz maximum, in 0.50 kHz increments

The baseband signal of the generated BER pattern is available at the MOD OUT connector on the front panel.

13-9.3.3 Duplex Mode

The analyzer can generate SECURENET BER patterns when placed in the Duplex mode. The Audio Zone user interface is the same as in Generate mode.

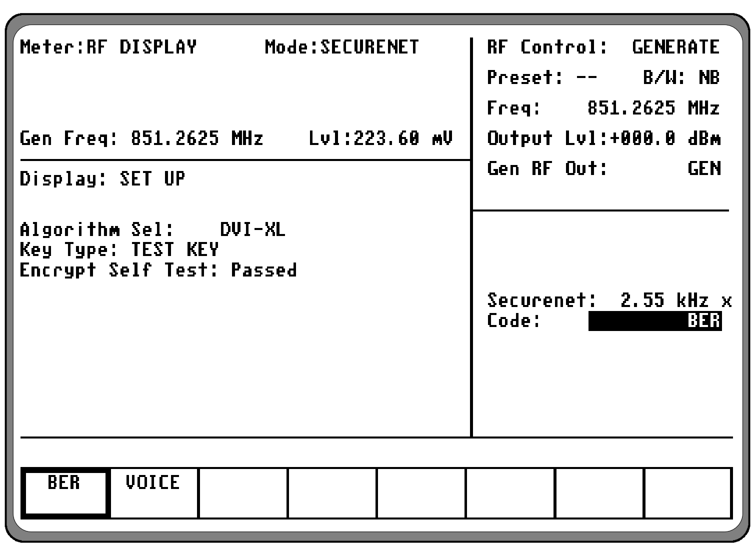


Figure 13-14. SECURENET Audio Zone – BER Generate Mode

13-10 SECURENET METER AND DISPLAY CONTROL

SECURENET meter and Display Zone is similar to the standard mode. All softkey selections are available; however, many of the selections will return a "not available in SECURENET mode" message. Refer to paragraph 13-7 under the General Operations tab of this manual for a functionality description of meter and display zone selections that are still available in SECURENET mode. The Display Zone is slightly modified to accommodate testing of SECURENET radio equipment. A BER Meter is added to the metering functions in the Display Zone. CLEAR SCOPE and SET UP display functions also have been added to the Display Zone. The VOICE FRAME display function is not applicable to Securenet mode. The message "Voice Frame Decode Disabled in the Mode:" appears on screen if the VOICE FRAME softkey is selected. Added functions are described in the following paragraphs. Description of the other displays can be found in paragraph 13-7.2 under the General Operations tab of this manual.

13-10.1 SECURENET BER Meter

The BER Meter is available only during BER Monitor or Duplex Testing. This BER monitor test verifies the integrity of test signals generated by SECURENET radios. The BER Meter provides digital readout of bit error rate, frequency error and input power level as well as monitor frequency and deviation. An example of the BER Meter is shown in figure 13-15.

Test setup for the BER Meter test is the same as figure 13-3. To activate the BER Meter test, set controls in the RF Zone as follows:

- RF Control: Monitor (or Duplex)
- Frequency: Same as radio transmit frequency
- Attenuation: 0 dB
- Mon RF In: RF I/O

The BER Meter is accessed by placing the cursor in the Display Zone's "Meter:" field and pressing the **more** softkey until the **BER** softkey is presented. Select the **BER** softkey to access the BER Meter (figure 13-15).

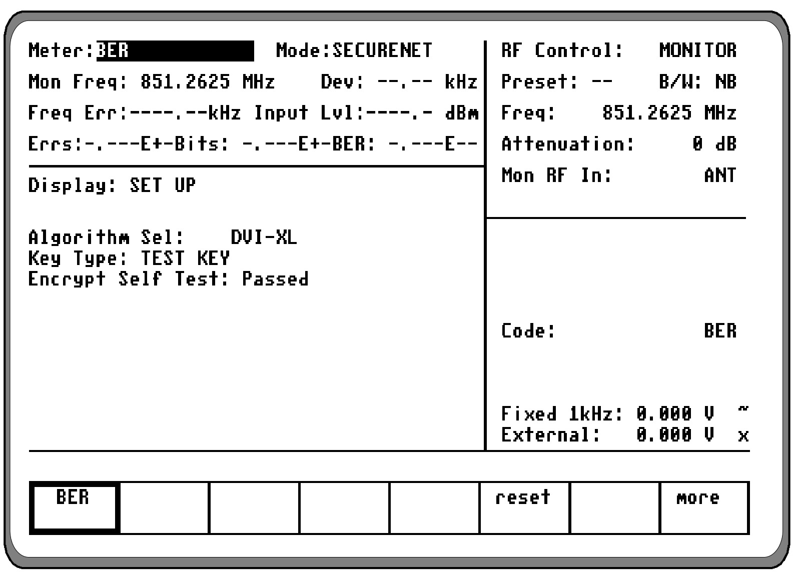


Figure 13-15. SECURENET BER Meter

Mon Freq

Display of the actual monitored frequency.

Dev

Display of the frequency deviation in kHz.

Freq Err

The acquisition frequency error range is +1500 Hz as described for the RF Display.

Input Lvl

(Recall that Input Lvl is a short term average not affected by the value selected for Slots.)

Errs

Display of the bit error count detected during the test.

Bits

Display of the bit count during the test.

BER

Display of the ratio of bit errors to total bits counted during the test. BER is displayed as a percentage. The BER for one error in one thousand bits is **00.1000%.**

NOTE

BER Meter measurement is accurate up to 20 percent bit errors.

Enabling the BER Test

The BER test begins when BER meter is selected in the Display Zone "Meter:" field.

Resetting the BER Test

To reset the BER test, move cursor to the "Meter:" field in the Display Zone and press more until reset is displayed. Press reset and the BER count is started over from zero.

13-10.2 CLEAR SCOPE Display

The CLEAR SCOPE display shows either the received audio signal after it has been converted to analog or the analog transmit signal before it is digitized. To activate the CLEAR SCOPE, place the analyzer in SECURENET mode. The selection of either Monitor or Generate in the RF Zone determines which signal will be displayed on the screen. Press the DISP hardkey, place the cursor in "Display:" field, and select the CLEAR SCOPE softkey. The Display area of the screen will indicate CLEAR SCOPE with the input signal displayed in a time-versus-amplitude graph. figure 13-16 shows the display, cursor and associated softkey used for the CLEAR SCOPE.

The operator can adjust the horizontal scale by placing the cursor in "Horiz:" field and selecting the appropriate value from the softkey selections.

To change the vertical scale, go to the "Vert:" field and select the appropriate value from the softkey selections.

13-10.2.1 Monitor Mode

In Monitor mode, the CLEAR SCOPE display shows the recovered analog audio signal. The CLEAR SCOPE operational controls are similar to the Standard version MOD SCOPE except the vertical scope is mv/div instead of kHz/div.

To change horizontal position, horizontal range, vertical position, or vertical range, use the cursor control keys to highlight the appropriate cursor fields as follows:

Horiz

Press the desired softkey to select the Horizontal Sweep rate (20 μs to 1 sec/div).

Since all ranges cannot be shown on one screen, press the **more** softkey for additional selections.

NOTE

If horizontal sweep rates of greater than 10 msec/div are selected, the update rate will slow down. A good overall setting for most applications is 200 μsec per division.

Horizontal Position

Adjust the horizontal position through the **(◀▶)** cursor field either by using the desired softkey (MOVE LEFT, MOVE RIGHT) or by using the rotary TUNING knob.

Vertical Sensitivity

Press the desired softkey to select the Vertical Sensitivity (10 mV to 10 V per division). When all ranges cannot be shown on one screen, press the **more** softkey for additional selections.

Vertical Position

Adjust the vertical position through the **(▲▼)** cursor field either by using the desired softkey (MOVE UP, MOVE DOWN) or by using the rotary TUNING knob.

Press the **expand** softkey from any field in the scope display window to enlarge the display for more detailed analysis. Use the **return** softkey to get back to the normal size display.

Marker

Select marker operation by moving the cursor to the "Mrk:" field, then pressing the desired *delta* softkey (ΔV, ΔT, or 1/ΔT). Selection provides two markers on the CLEAR SCOPE screen (refer to figure 13-17). Press the **toggle marker** softkey to alternate between markers and use TUNING knob to position markers.

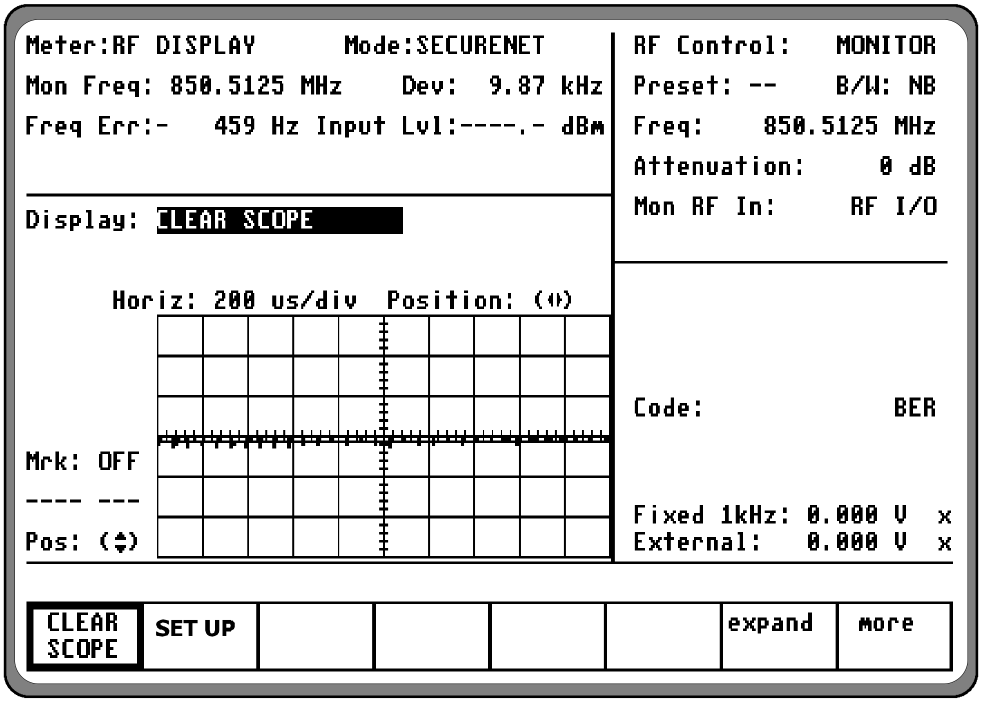


Figure 13-16. SECURENET CLEAR SCOPE Display

ΔV

This softkey selection provides markers that are *horizontally located* to permit relative readings along the scope vertical axis. The display adjacent to the "Mrk:" field shows the relative voltage difference between the two marker positions.

ΔT

This key selection provides markers that are horizontally located to permit relative readings along the scope *vertical axis*. The display adjacent to the "Mrk:" field shows the relative horizontal deflection between the two marker positions in units of time.

1/ΔT

This softkey selection provides markers that are also *vertically located* to permit relative readings along the scope horizontal axis. This selection inverts the time reading to display the relative difference in terms of frequency.

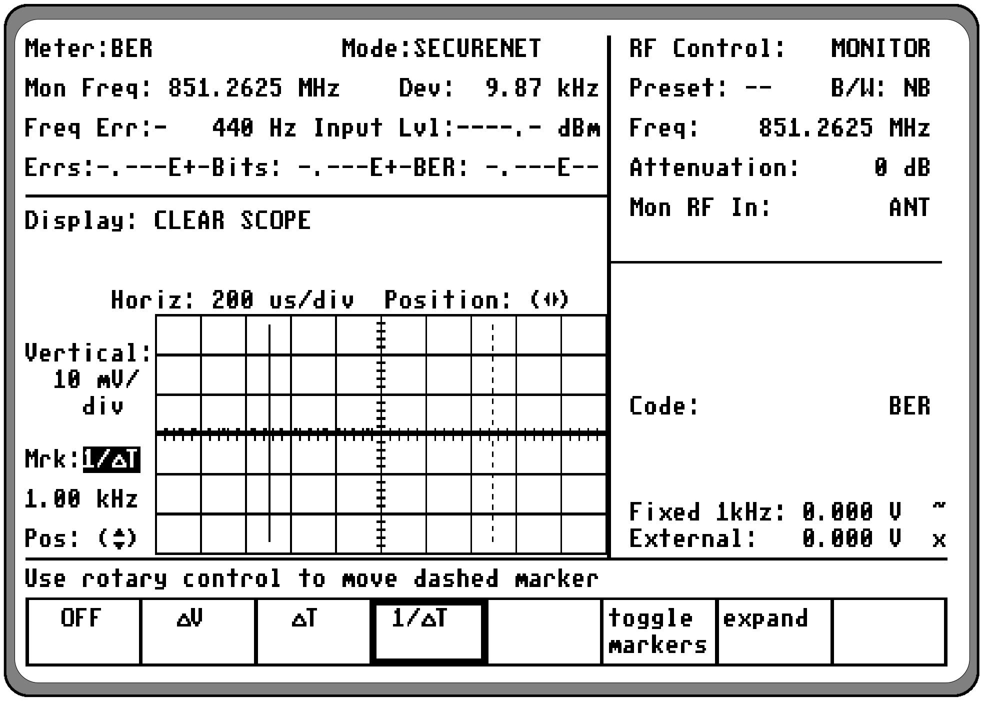
13-10.2.2. Generate Mode

In Generate mode, the CLEAR SCOPE display shows the generated analog audio signal. The CLEAR SCOPE operational controls are similar to the Standard version MOD SCOPE, however the vertical scale is different as previously listed for Monitor mode.

13-10.2.3 Duplex Mode

In Duplex mode, the softkeys provide selection of either the recovered analog audio signal or the generated analog audio signal. Otherwise, the CLEAR SCOPE display is the same as in paragraph 13-10.2.1.

In DUPLEX mode, select either generate or monitor CLEAR SCOPE display by first moving the cursor to the "Select:" field within the Display area, and then pressing the desired soft-key **GEN** or **MON**.



VOICE

Figure 13-17. CLEAR SCOPE Markers

13-10.3 EOM Signaling Tone

The SECURENET Option generates an End-of-Message (EOM) signaling tone at the end of encrypted transmissions. In Generate mode, this tests the decoding circuit in the radio being tested.

In Monitor mode, the SECURENET option detects the EOM signaling tone from the radio under test. The EOM signaling tone is a 6 kHz uncoded sine wave appended to encrypted transmissions by the transmitting unit. The range of tone frequencies detected is 6 kHz +/- 300 Hz. The EOM signaling tone tells the receiving unit that the transmitted signal is finished and squelch should be applied. An "EOM indication" is displayed on the analyzer screen (figure 13-18) as a message whenever the unit being tested furnishes proper EOM signaling as it terminates transmission. The message remains on the display screen until either the mode is switched out of SECURENET or until another SECURENET signal is detected.

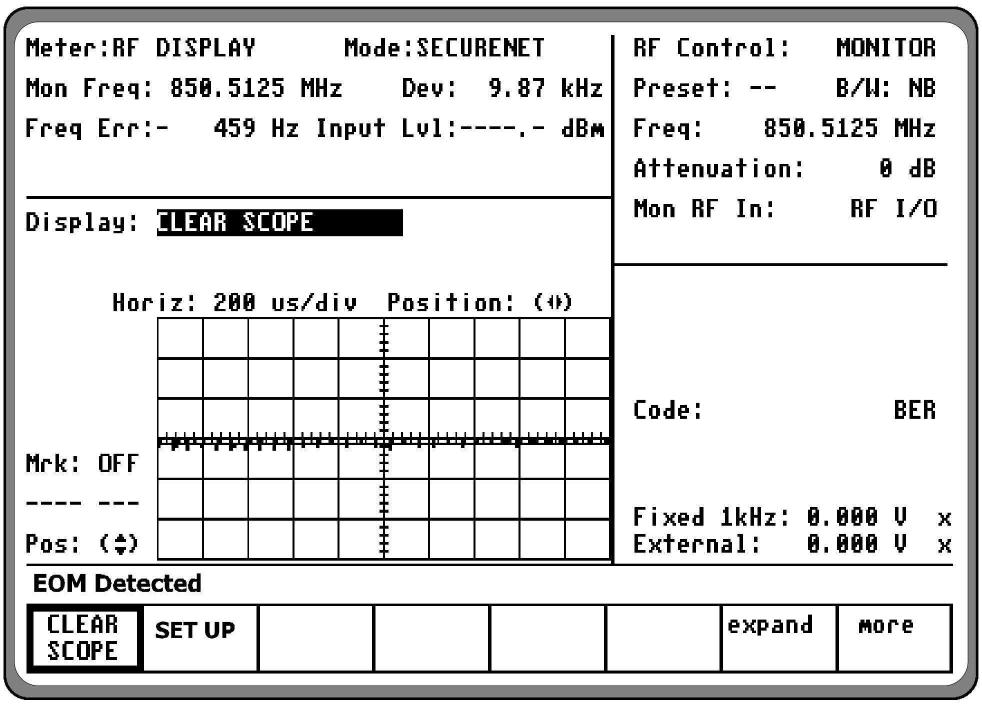


Figure 13-18. EOM Received Message

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Section 14

SECURENET OPTION APPLICATIONS

CAUTION

When testing a radio, observe the following precautions:

- ***Do not*** *use an antenna on the analyzer for over-the-air testing.*
- ***Use*** *double-shielded cables on the analyzer to carry signals to and from the radio.*
- ***Locate*** *the analyzer at least 35 feet from the antenna of a unit that is working in the same system that the analyzer is testing.*
- ***Adjust*** *the squelch to where the led indicator for squelch just turns off or is closed. When the signal from the radio is present, the squelch LED will illuminate indicating that squelch has been detected and there is a signal present.*

14.1 Basic SECURENET Radio Testing

This section of the manual contains information on how to connect equipment under test to the R2670 Analyzer. It is a supplement to sections 13 and 14 under the General Operations tab of this manual.

14-1.1 Setting the Deviation Level

The deviation of the radio can be set with greater accuracy by configuring the R2670 Analyzer in the following manner:

Display Zone

- Mode: SECURENET
- Display: BAR GRAPHS

RF ZONE

- RF Control: MONITOR
- B/W: WB

Both the digital display and the bar graph results are improved by a smoothing algorithm over many samples for accurate average peak deviation measurements. The bar graphs display both the positive and negative modulation peaks of the radio signal. Note that instantaneous deviation measurements can be obtained by changing the Mode Cursor to STD.

The deviation level of the R2670 Analyzer is calibrated during system calibration for both narrow and wide band. Internal adjustments are made during calibration for all levels including 4 kHz so no operator manual tuning is necessary.

14-1.2 Monitor Mode Testing

To setup for Monitor mode testing, put the analyzer in SECURENET mode, and in the RF zone select Monitor mode. Select the desired settings for each cursor position in the RF zone. Select the corresponding softkey for the Mon RF In cursor location. There are two choices: ANT and RF I/O port. The ANT port accesses the analyzer's sensitive receiver and should be used for strictly "off the air" measurements. If ANT is used, attach the supplied antenna to the ANT port. The RF I/O port should be used for direct connection to the radio under test. If RF I/O port is used, connect a coaxial cable from the analyzer's input port to the radio's output port.

Select the desired meter and display needed to perform the test. See the General Operations table and other sections in this manual for more details about the analyzer's Monitor functions.

NOTE

Do not directly apply excessive input power to the ANT port. In the event that excessive RF power is inadvertently applied, the port is protected by in-line RF fuse. This fuse may be accessed by unscrewing the front of the BNC connector out of the front panel. Refer to paragraph 12-2.4 under the General Operations tab of this manual.

14-1.3 Generate Mode Testing

To setup for Generate mode testing, put the analyzer in SECURENET mode, and in the RF zone select Generate mode. Select the desired settings for each cursor position in the RF zone. Also select the desired levels in the Audio zone for the summed modulating signal and SECURENET deviation. Remember to enable the switches. To transmit anything other than BER, the Generate code in the Audio zone must be set to voice frame.

In the RF zone, select the appropriate softkey for the Gen RF Out cursor location. There are two choices: GEN and RF I/O port. The RF I/O port is recommended for most applications where GEN and MON ports are combined for a single connection to the radio under test. The GEN port is recommended where higher levels of output signal are needed. Connect a coaxial cable from the selected output port to the input of the radio. See the General Operations tab and other sections in this manual for more details about the analyzer's Generate functions.

NOTE

Do not apply input power to the GEN output port. In the event RF power is inadvertently applied, the port is protected by in-line RF fuse. This fuse may be accessed by unscrewing the front of the BNC connector out of the front panel. Refer to paragraph 12-2.4 under the General Operations tab of this manual.

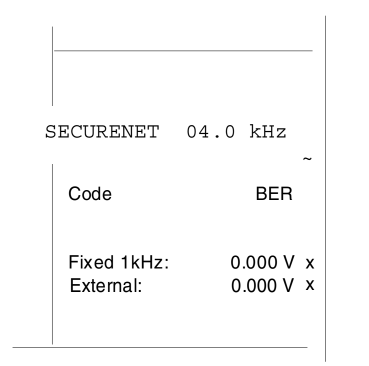
14-2 BER TESTING THE RADIO RECEIVER (Generate Mode)

14-2.1 Radio in BER Test Mode

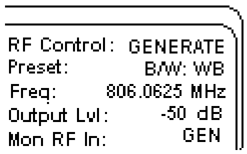
This application example describes the receiver test for radios that have BER test capability. The receiver must have the capability of receiving an unencrypted V.52 BER test pattern. Performance of this test requires the analyzer to operate in Generate BER Test mode. In this mode the analyzer generates a test signal and the radio monitors the test signal. When testing the receiver, the radio under test measures the BER of the received signal and displays the result to the operator. The output level of the analyzer is reduced until the radio BER threshold is determined. Consult the radio maintenance manual to determine the BER threshold percentage to be used in testing.

Test frequencies may be specified for BER test of your equipment. Consult the radio maintenance manual.

1. Connect the RF Input port of the radio under test to the GEN OUT port of the analyzer. Consult the radio maintenance manual to determine the appropriate test port.
2. Select the SECURENET BER Test mode by placing the cursor in the “Code:” field in the Audio Zone (figure 14-1). With the cursor in the “Code:” field, select the BER softkey.
3. Set controls in the Audio zone as follows.



4. Place the cursor within the RF zone and configure the analyzer as follows:



5. Configure the radio under test to BER Test mode. Consult your radio maintenance manual for specific instructions. Reset the analyzer frequency to the BER Test frequency of the radio.
6. Monitor the radio's received BER. Reduce the analyzer's output level until the radio measures a BER corresponding to sensitivity threshold. Consult your radio's maintenance manual for the receiver sensitivity specification.

14-3 BER TESTING THE RADIO TRANSMITTER (Monitor mode)

14-3.1 Radio in BER Test Mode

This application example describes the transmitter test for radios that have BER test capability. The transmitter must have the capability of transmitting an unencrypted V.52 BER test pattern. Performance of this test requires the analyzer to operate in monitor or duplex mode, and monitoring a test signal transmitted by the radio under test.

When testing the transmitter, the radio generates a test signal. The analyzer measures the transmitted BER, frequency error, and power level of the signal transmitted by the radio under test.

Consult the radio maintenance manual, as specific test frequencies may be specified for BER test of your equipment.

1. Connect the RF input/output of the radio under test to the RF I/O port of the analyzer as shown in figure 13-4. Consult the radio maintenance manual to determine the appropriate test port.

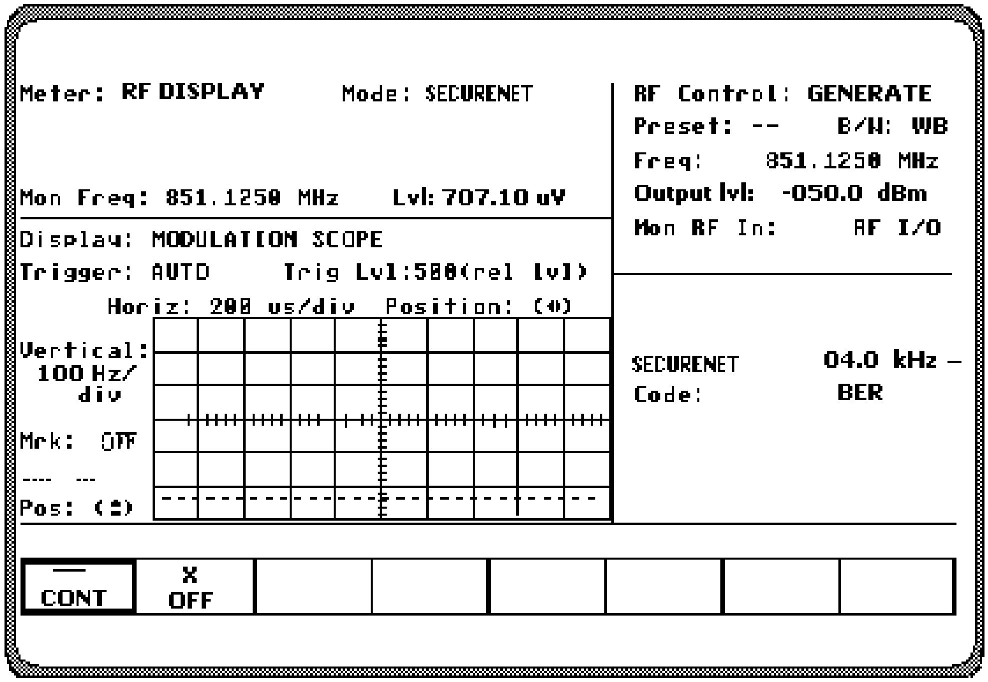


Figure 14-1. Radio (BER Test Mode) Audio Zone

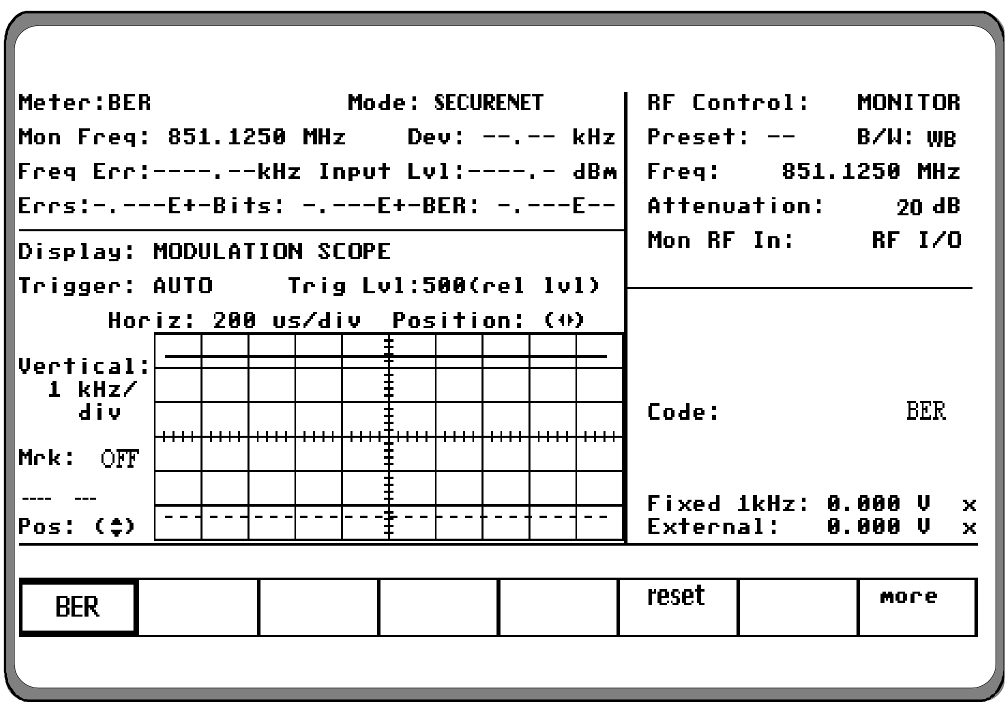
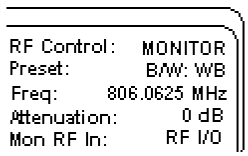


Figure 14-2. Radio (BER Test Mode) BER Meter Sample

2. Place the cursor within the RF Control zone and configure the analyzer as follows:



3. Configure the radio under test to BER Test mode. Consult your radio maintenance manual for specific instructions. Reset the frequency of the analyzer to appropriate BER test frequency.
4. Turn on the transmitter of the radio. Consult your radio maintenance manual for instructions.
5. Access the BER Meter by placing the cursor in the Display zone's "Meter:" field and pressing the more softkey until the BER softkey is presented. Select BER via the softkey to display the BER Meter. A screen similar to figure14-2 appears.
6. BER measurements will be terminated at end of transmission or when switching out of BER Monitor Mode.

14-4. BER TESTING USING DUPLEX MODE

The analyzer can perform BER testing using RF or Baseband. The analyzer generates a CCITT V.52 standard BER pattern.

Figures 14-3 and 14-4 show where the analyzer BER test pattern is inserted and sampled in the transmit and receive paths.

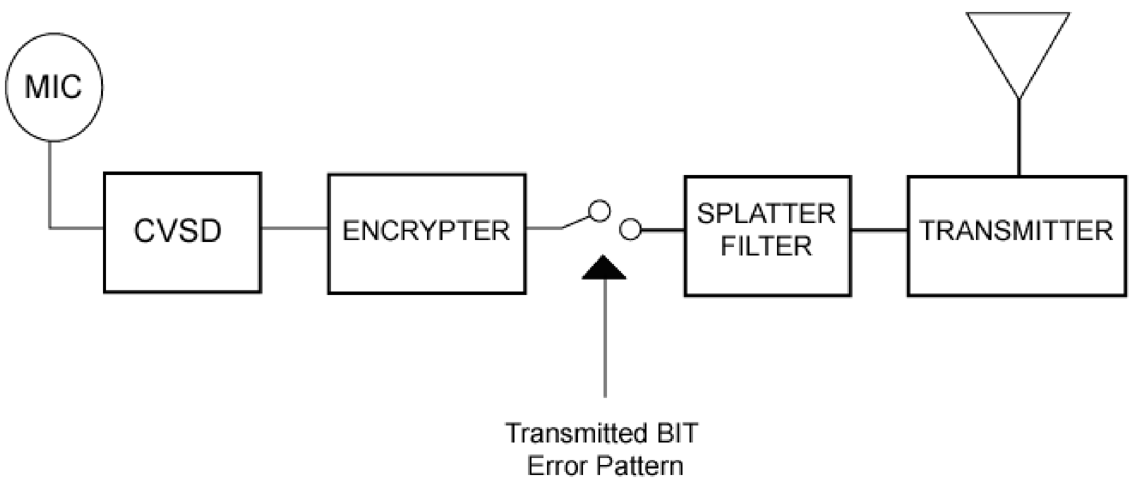


Figure 14-3. Transmit BER

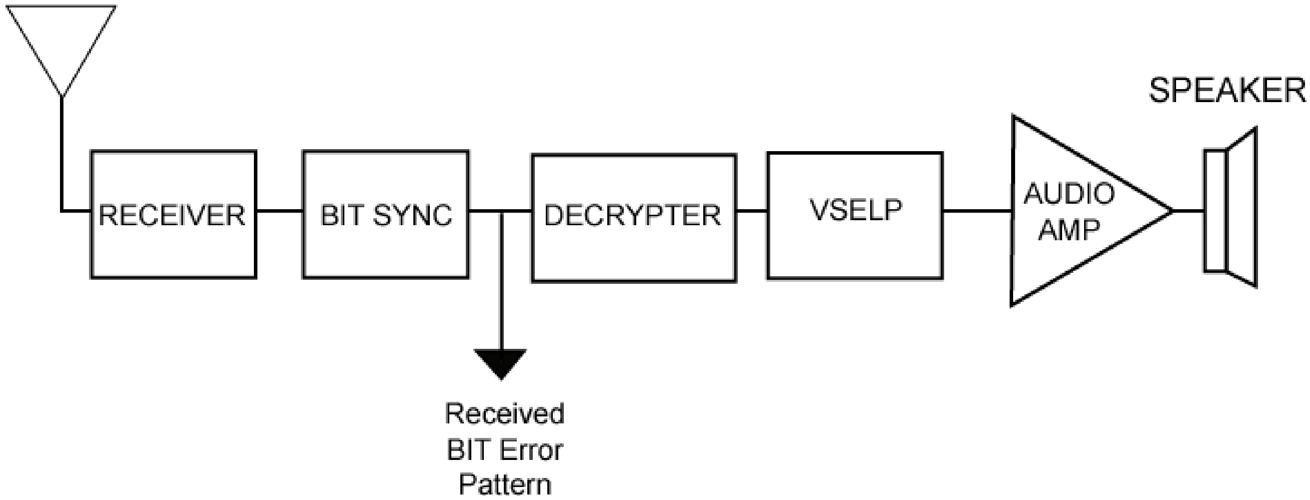


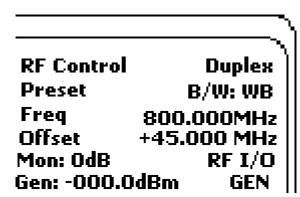
Figure 14-4. Receive BER

14-4.1 Radios Without BER Test Capability

Radio receivers can be tested using the analyzer in the duplex mode. The test is performed by outputting an RF test pattern from the analyzer and feeding back the received baseband digital test pattern from the radio. The received digital bit stream can be monitored for errors. This test requires that the receiving radio be opened to provide access to the digital data at a point before it enters the decrypter. (Consult the radio maintenance manual to determine this point.)

To set up the analyzer for the Duplex BER test, perform the following sequence:

1. Connect the RF input port of the radio under test the GEN OUT port of the analyzer.
2. Place the cursor in the RF Zone and configure the analyzer as shown below. Set the monitor frequency of the radio to be tested. The default offset frequency is +45 MHz, but is unimportant because the signal being returned from the radio is baseband.
3. Set the controls in the Audio Zone as follows:
   - *Securenet: 4.0 kHz*
   - *Code: BER*
4. Press the SPF hardkey to access the special functions screen and select External Input under "Decoding." Press the return softkey to return to the main screen.



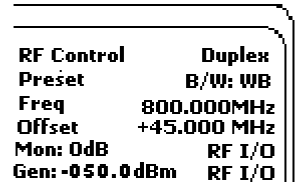
5. With the cursor on RF Display, press the more softkey and select BER. The BER metering will appear in the top left corner of the screen.
6. Place the cursor on Display and select Ext Scope.
7. Turn on the radio. Connect a probe to the VERT input on the analyzer and sample the digital data at the point indicated above.

The BER metering screen will indicate the BER. The digital bit pattern is also viewable on the analyzer Ext Scope. Due to the features of digital scopes, the generated eye pattern may be seen more clearly by connecting the MOD OUT on the analyzer front panel to a conventional oscilloscope. The monitored eye pattern can be seen at the DEMOD OUT port.

14-4.2 Radios With BER Test Capability and Repeaters

Radios with BER capability and repeaters can be tested by the analyzer using the V.52 BER test pattern. In RF mode, the operation of both the radio receiver and transmitter can be evaluated. To set up the analyzer for the BER test, use the following sequence:

1. Connect the RF IN/OUT port of the analyzer to the RF port of the radio under test.
2. Place the cursor in the RF Zone and configure the analyzer as shown below. Set the monitor frequency of the analyzer at the generate frequency of the radio to be tested, and set the analyzer offset frequency to correspond to that of the radio.
3. Set the controls in the Audio Zone as follows:
   - *Securenet 4.0 kHz*
   - *Code: BER*
4. With the cursor on RF Display, press the more softkey and select BER. The BER metering will appear in the top left corner of the screen.



5. Press the reset softkey to reset the BER measurements.

The monitored or generated BIT pattern can be observed by selecting MODULATION SCOPE in the Display Zone.

Remote repeaters, modems or other devices using a 600-ohm balance line can be tested by the analyzer using baseband mode. To set up the analyzer for baseband operation, refer to paragraphs 14-10 and 14-11.

14.5 VOICE PATTERN TESTING IN GENERATE MODE

This section contains the basic test setup for FM receivers. Testing procedures are contained in section 14 under the General Operations tab in this manual.

The analyzer's DVM input is unbalanced (ground referenced). Use an appropriate interface to measure balanced circuits, such as certain receiver audio outputs or telephone lines.

Refer to figure 14-3. Connect the analyzer's RF I/O port to the radio antenna connector. Connect the radio audio output to VERT/SINAD port of the analyzer. Use

CAUTION

With some radios, grounding the speaker leads will damage the audio circuitry. Use isolation techniques on these radios.

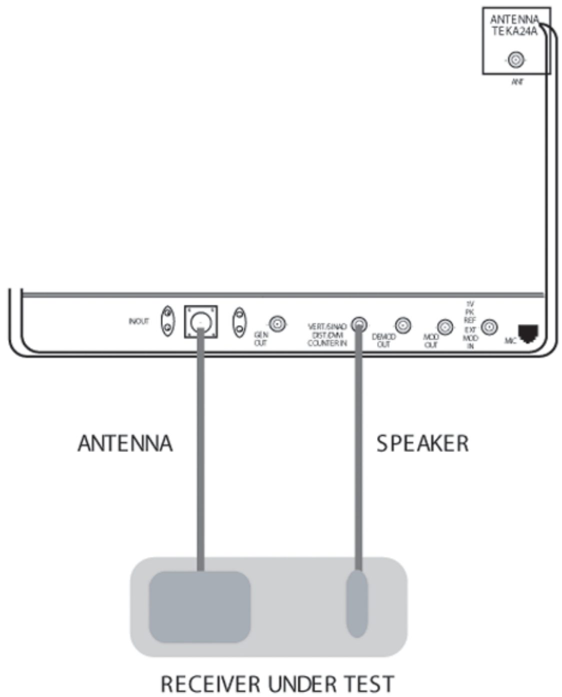


Figure 14-5. Basic FM Receiver Testing Setup

14.6 VOICE PATTERN TESTING IN MONITOR MODE

This section contains basic test setup for FM transmitters. Testing procedures are contained in Section 4 of the General Operations tab of this manual.

CAUTION

For transmit power output measurements, connect the transmitter under test only to the analyzer's RF I/O port. ***Do not*** *connect it to the ANT port. The ANT Port is used with an antenna for over-the air testing.*

The built-in RF load dissipates up to 50 W for three minutes and up to 125 W for one minute. If a high-power transmitter is keyed into the analyzer long enough to threaten overheating the power measuring circuitry, the analyzer's audible alarm sounds and the display changes to the ***RF LOAD OVERTEMPERATURE*** *warning, signaling the operator to unkey.*

Refer to Figure 14-6. Connect the analyzer's RF I/O port to the RF output of the transmitter under test. Connect the analyzer's MOD OUT jack to the mic audio input of the transmitter under test.

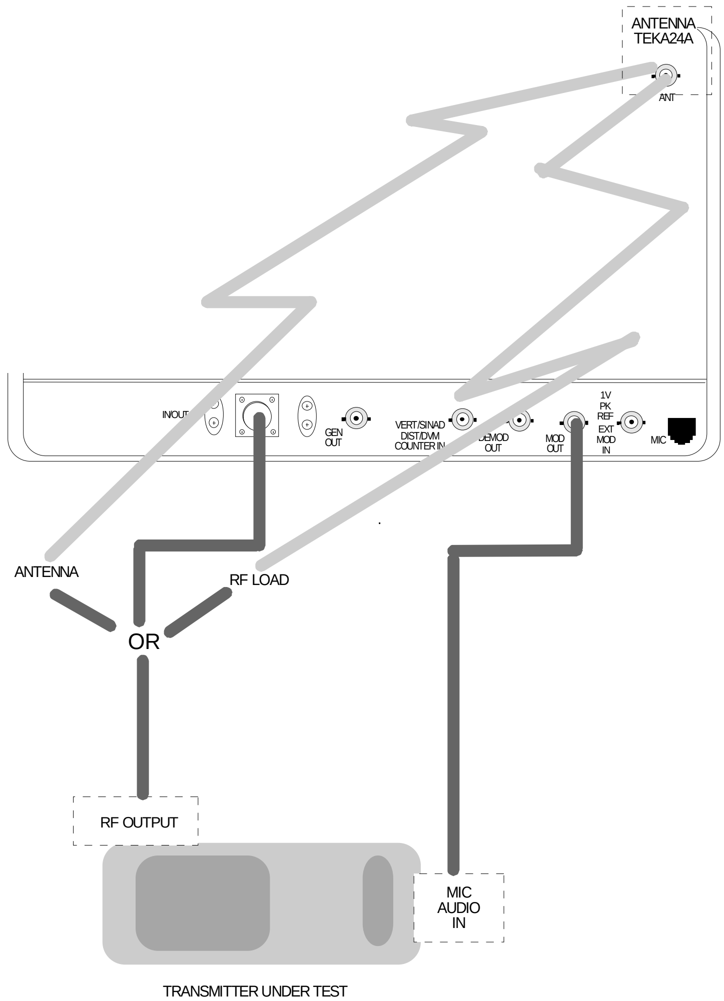


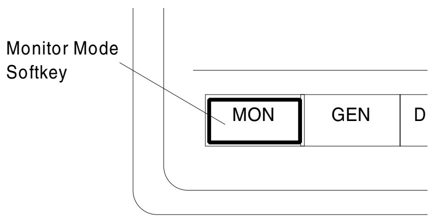
Figure 14-6. Basic FM Transmitter Testing Setup

14-7 MEASURING RECEIVED AUDIO WITH CLEAR SCOPE

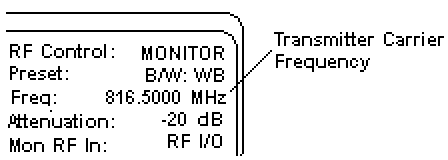
This section of the manual contains information on using the Clear Scope function to monitor an audio signal that has been transmitted by SECURENET radio and then recovered by the analyzer.

Connect the analyzer's RF I/O port to the RF output of the transmitter under test.

1. Place the analyzer in Securenet mode. Place the cursor within the RF Zone in "RF Control:" field. Press the MON softkey to place the analyzer into its Monitor mode of operation.

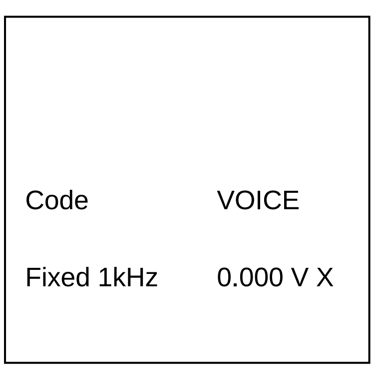


2. Within the RF Zone, set as follows:



3. Set the SQUELCH control on analyzer to threshold.

4. Press AUD hardkey.and select voice.



5. Press DISP hardkey to move the cursor to the Display zone.

6. Place cursor in the "Display:" field and press CLEAR SCOPE softkey. The CLEAR SCOPE screen should appear similar to figure 14-7. No waveform is present until the transmitter is turned on.

7. Key up the transmitter in Secure mode.

CAUTION

*The analyzer's built-in RF load dissipates up to 50 W for three minutes and up to 125 W for one minute. If a high-power transmitter is keyed into the analyzer for a time long enough to threaten overheating the power measuring circuitry, the analyzer's audible alarm sounds and the display changes to the **RF LOAD OVERTEMPERATURE** warning, signaling the operator to unkey.*

8. Move the cursor to Horiz: field and select the appropriate scale.

9. Move the cursor to Vert: field and select the appropriate scale.

10. Move the cursor to Vert Position: field. Use move up/move down softkeys or rotary control to position the recovered audio waveform on a convenient graticule.

11. Move the cursor to Horiz Position: field. Use move left/move right softkeys or rotary control to position the recovered audio waveform on a convenient graticule.

12. Move the cursor to Mrk: field.

- *Press **ΔV** softkey to display movable markers that measure voltage differential (Vp-p).*
- *Press **ΔT** softkey to display movable markers that measure time differential (sec).*
- *Press **Δ1/T** softkey to display movable markers that measure reciprocal time differential (in Hz).*

13. Position the markers as desired using TUNING knob (press toggle marker softkey to select marker). The movable marker is indicated by a dashed line. Observe digital readout of marked values below Mrk: field.

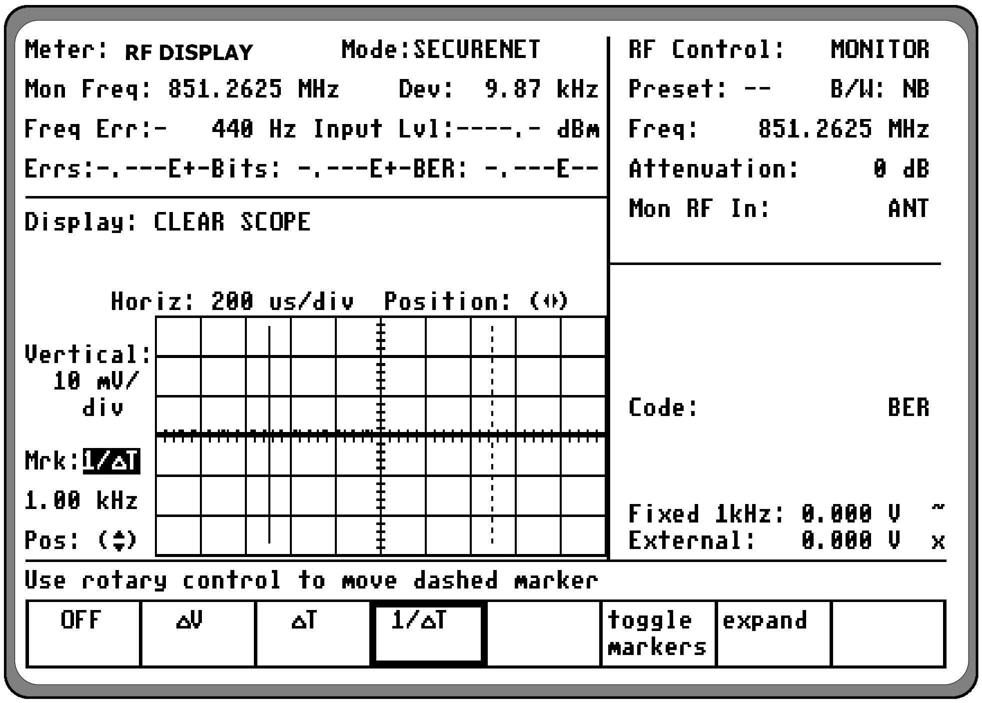


Figure 14-7. SECURENET CLEAR SCOPE Display of Recovered Audio

14-8 MEASURING TRANSMITTED AUDIO WITH CLEAR SCOPE

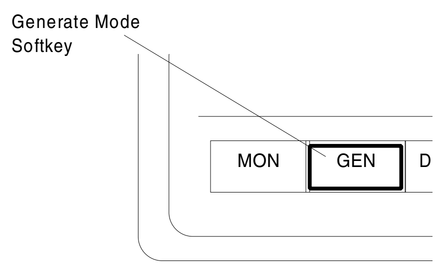
This section of the manual contains information on using the Clear Scope function to analyze the R2670's raw modulation signal (1 kHz) in SECURENET generate mode. This analog signal is viewed prior to being digitized and encrypted.

Refer to Figure 14-3. Connect the analyzer's RF I/O port to the radio's antenna connector.

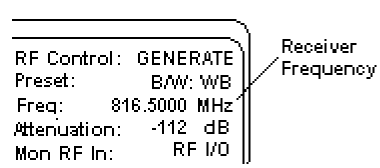
NOTE

It is not necessary to connect the analyzer's DVM port for this application.

1. Place the analyzer in Securenet mode. Place the cursor within the RF Control zone in "RF Control:" field. Press the **GEN** softkey to place the analyzer into its Generate mode of operation.



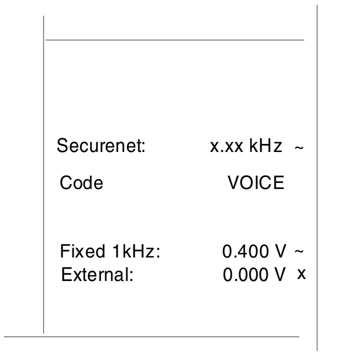
2. Within the RF Control zone, set as follows:



NOTE

For setup and distortion measurements, set output level to at least 30 dB above sensitivity threshold (-80 dBm recommended).

3. Use the CURSOR ZONE keys to move the cursor to the Audio zone. Within the Audio zone, move the cursor to Fixed 1 kHz controls field. Select 1 kHz audio source as the modulating signal (also available from the MOD OUT connector on the front panel) by turning 1 kHz on "~". Set 1 kHz voltage level to 0.4 volt.



4. Turn on the SECURENET receiver and tune receiver and analyzer to the same frequency. Verify receiver locks onto test signal and transitions to Private mode.

5. Use the CURSOR ZONE keys on analyzer front panel and move the cursor to the Display zone.

6. Place cursor in the "Display:" field and press CLEAR SCOPE softkey. The CLEAR SCOPE screen should appear similar to figure 14-8.

7. Move the cursor to Horiz: field and press 200 us softkey.

8. Move the cursor to Vert: field and press 200 mv softkey.

9. Move the cursor to Vert Position: field. Use move up/move down softkeys or rotary control to position the modulating 1 kHz waveform on a convenient graticule.

10. Move the cursor to Horiz Position: field. Use move left/move right softkeys or rotary control to position the modulating 1 kHz waveform on a convenient graticule.

11. Move the cursor to Mrk: field.
    - *Press ΔV softkey to display movable markers that measure voltage differential (Vp-p).*
    - *Press ΔT softkey to display movable markers that measure time differential (sec).*
    - *Press Δ1/T softkey to display movable markers that measure reciprocal time differential (in Hz).*

12. Position the markers as desired using TUNING knob (press toggle marker softkey to select marker). The movable marker is indicated by a dashed line. Observe digital readout of marked values below Mrk: field.

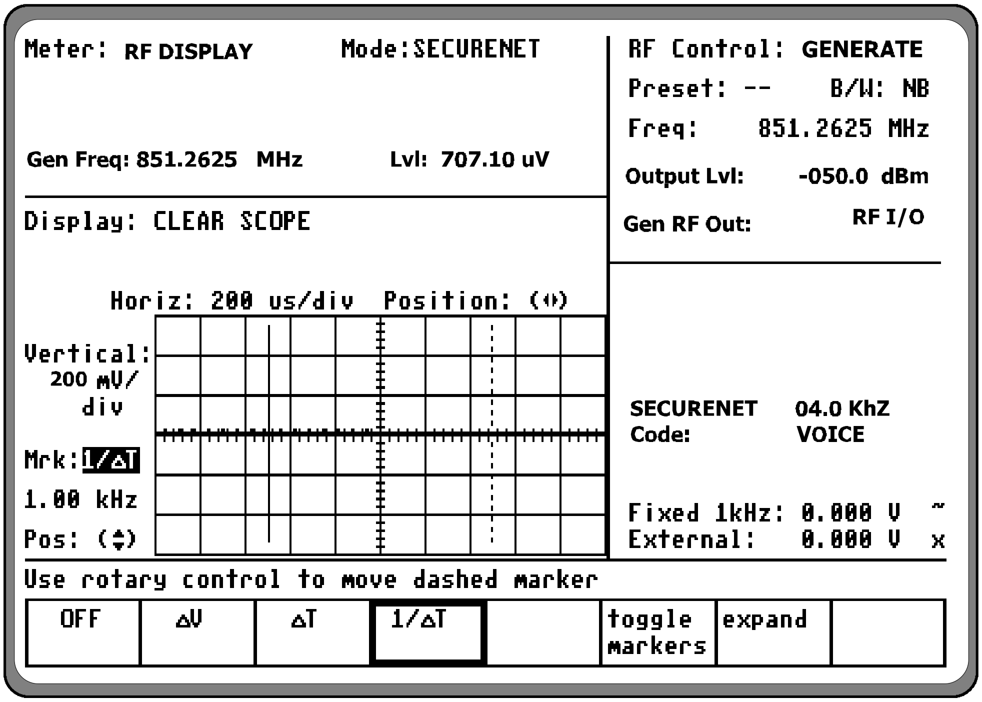


Figure 14-8. SECURENET CLEAR SCOPE Display of Output Modulation

14-9 AUDIO/BER BASEBAND INPUT MONITORING

The analyzer is capable of monitoring SECURENET baseband signals which are transmitted over a 600-ohm balanced line. Connect the baseband input signal to the analyzer as shown in figure 14-9 using isolation transformer part number 01-80302E83.

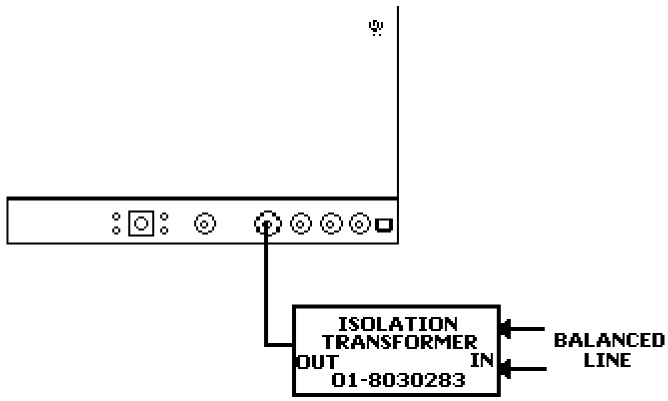


Figure 14-9. Audio/BER Baseband Input Monitoring

1. To configure the analyzer to receive a baseband signal, go to the special functions screen by pressing the SPF hardkey.

2. Move the cursor to "Decoding" and select EXT. Input.

3. Return to the main screen and select Monitor in the "RF Control:" zone.

4. Set the appropriate frequency and observe the baseband signal by selecting ":Ext Scope" in the Display Zone.

14-10 AUDIO/BER BASEBAND OUTPUT GENERATION

The baseband output is available at the MOD OUT connector during normal SECURENET Audio transmission. Use isolation transformer 01-80302E82 to connect from the MOD OUT connector to a 600-ohm balanced line. Make the connection as shown in figure 14-10.

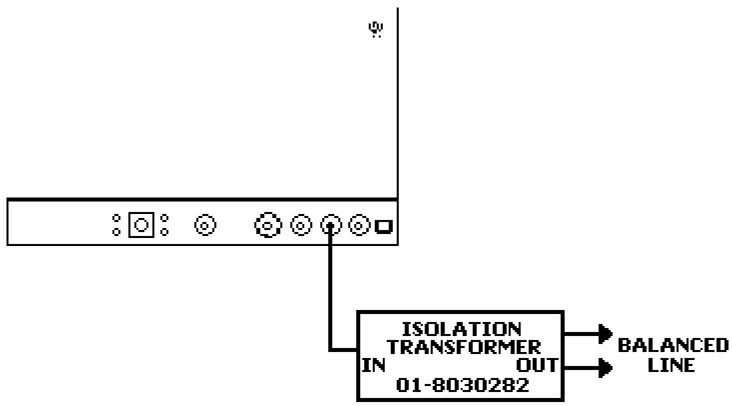


Figure 14-10. Audio/BER Baseband Output Generation

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Section 15

ASTRO OPTION INTRODUCTION

15-1 INTRODUCTION

This manual contains information for using the R2670 FDMA Digital Communications System Analyzer with ASTRO Options. The ASTRO Option provides unique testing features for communications equipment using ASTRO encoding and modulation principles. Standard R2670 capabilities are retained. The additional ASTRO test sequences are accessed via the LCD display, screen-defined softkeys, numeric keypad, cursor movement keys, and optical tuning knob. The ASTRO Option functions may also be accessed via the remote control interface port.

15-2 CAPABILITIES

The ASTRO Option gives the R2670 the capability of monitoring and generating ASTRO signals. An ASTRO signal relates to a Motorola proprietary signaling scheme in which a 12 kbps serial bit stream is mapped into one of two corresponding amplitudes, filtered digitally, and then modulated onto an RF carrier. Most of the ASTRO user interface operates exactly like that of the standard R2670. Several new features were added to test the unique requirements of user ASTRO equipment.

Voice Mode System Testing

Voice mode provides ASTRO-compatible modulation and demodulation with vocoding. The ASTRO Option generate and monitor modes support actual functional voice testing in encrypted mode using either a test key or an operating key loaded from a separate compatible keyloader.

Bit Error Rate (BER) Testing

A BER test pattern can be selected to modulate the R2670 generator section. A BER test pattern, likewise, can be decoded by the R2670 in monitor mode. BER tests can also be conducted in duplex mode for loop testing.

Dedicated Test Screens

Dedicated test screens can be setup as a start-up default condition or as a programmable test set-up. Dedicated ASTRO test screens are zoned with RF and Audio Modulation control screens to simultaneously display test results along with their test conditions.

Baseband Audio Scope Display

The display provides a graphic image of the audio baseband signal. This baseband signal is selectable at either the vocoder input in generate mode or the vocoder output in monitor mode.

15-3 ASTRO OPTION HOUSING

15-3.1 Description

The ASTRO Option housing (figure 15-1) is an external module containing circuitry and connectors to support ASTRO functions. The ASTRO Option housing attaches to the rear of the R2670 analyzer. In some instances the Option housing may be attached along with another option housing or in conjunction with the R2670 battery pack (optional). The battery pack, if used, mounts on the back of the final option housing.

15-3.2 Connectors

The ASTRO Option housing has two connectors as shown in Figure 1-1. Both connectors are located on the side of the housing. The KVL connector provides a receptacle for loading an external encryption key or for programming a radio with a test key. The other connector is an interface port.

Key Variable Loader (KVL) Port

The KVL port allows the analyzer to be preloaded with a user-selected encryption key from any compatible keyloader (key inserter). The port is also used with an optional cable to transfer test keys from the analyzer to a radio being tested. The R2670 with ASTRO Option is compatible with the following Motorola key inserters: T3010DX, T3011DX, T3012DX, T3013DX, T3014DX, or any KVL 3000 with the ASN option.

Serial Port (25 PIN)

The serial interface port is multiplexed to provide the future addition of an HDLC wireline serial data interface or an RS-232 interface for data communications.

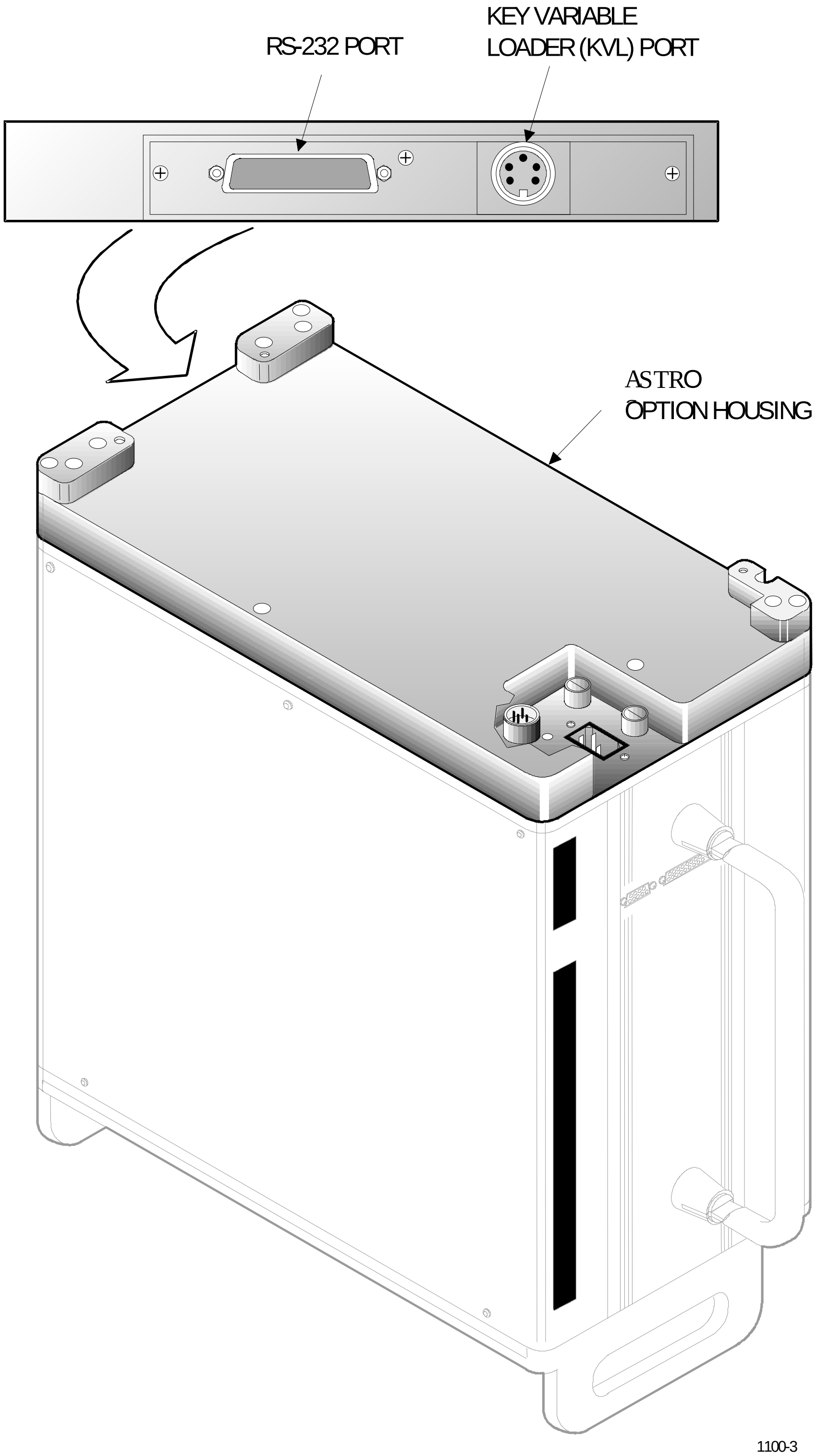

Figure 15-1. ASTRO Option Housing

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Section 16

ASTRO OPTION DESCRIPTION

16-1 INTRODUCTION

The ASTRO Option extends the standard functions of the R2670 to provide an all-in-one servicing instrument for ASTRO digital radio systems.

16-2 BASIC OPERATION

The R2670 with ASTRO Option can emulate the same digital environment used by ASTRO radios in private mode. This capability allows the analyzer to interoperate with conventional ASTRO radios. Standard test equipment is unable to decipher private audio transmissions from ASTRO radios because the audio signals are converted from their native analog format to a digital, ciphered representation prior to transmission.

An ASTRO digital radio provides for both clear and privacy voice and data. When operated in privacy mode, the radio scrambles communications prior to their transmission. Only intended subscribers, with compatible hardware plus matching security keys, can decipher the message. In this way, users of a system can be partitioned into groups, each with their own security key. The R2670 with ASTRO Option will accept an external operating key from any compatible key loader.

In its ASTRO mode, the R2670 provides display screens for monitoring bit error rate characteristics of a radio under test and also generates bit error rate test patterns to support this mode of operation.

The R2670 with ASTRO Option, provides a clear scope display of baseband signals, either the input to the vocoder (generate mode) or the output from the vocoder (monitor mode).

16-3 TEST CONSIDERATIONS

ASTRO digital radio systems encrypted communications have a need to maintain even higher standards on RF signal quality than normal FM radio systems. Encryption subjects the ASTRO signals to additional processing. In order to work reliably, the radios must be tuned to preserve critical factors such as operating frequency response and transmitter deviation. Individual test meters and generators compound the effects of multiple RF paths and wirelines in the test environment, resulting in degraded signals and less accurate measurements.

Operating in secure or standard mode, the R2670 with ASTRO Option bundles a wide assortment of sophisticated test features in a single instrument.

16-4 SPECIAL TERMS

The following list contains brief definitions of special terms that are used in association with ASTRO radios and test equipment:

Algorithm - In secure systems, an algorithm is a distinct method for translating clear information (input) to a secure version of the information (output). The same algorithm is used to interpret the message. ASTRO systems use the following algorithms:

- DVP-XL
- DES-XL
- DVI-XL

BER Test - In generate mode, the analyzer modulates the RF carrier with Bit Error Rate test pattern to test the radio receiver. This BER test pattern consists of a free running, unframed pseudo-random bit pattern. In monitor mode, the analyzer monitors the BER test pattern input and provides a metering display of bits received, number of bits expected, and bit error rate percentage.

Cipher - to convert information to a seemingly random pattern for transmission or wireline delivery in order to protect sensitive information. Ciphered voice and data can only be understood by means of a special key.

VSELP Modulation – Vector Sum Excited Linear Predictive technique used in ASTRO radios and test equipment to digitize analog signals before transmission and to reconstruct analog signals on the receiving end.

Decryption - process of converting cipher text to plain text

Encryption - process of converting plain text to cipher text

Key - a sequence of bits stored electronically in the encryption and decryption modules. Once the key has been loaded, it trains the internal encryption/decryption circuits.

Key Inserter - a device used to load an electronic encryption key into a radio or other device. Also called a keyloader.

Section 17

ASTRO OPTION OPERATING INSTRUCTIONS

CAUTION

When testing a radio, observe the following precautions:

- ***Do not*** *use an antenna on the analyzer for over-the-air testing.*
- ***Use*** *double-shielded cables on the analyzer to carry signals to and from the radio.*
- ***Locate*** *the analyzer at least 35 feet from the antenna of a unit that is working in the same system that the analyzer is testing.*
- ***Adjust*** *the squelch to where the LED indicator for squelch just turns off or is closed. When the signal from the radio is present, the squelch LED will illuminate indicating that squelch has been detected and there is a signal present.*

17-1 INTRODUCTION

The R2670 FDMA Digital Communications System Analyzer with ASTRO Option is an enhancement of the R2600 Series Communications System Analyzer. Refer to sections 16, 17 and 18 of the General Operations tab in this manual for general operational information. The following sections of this manual contain information on how to connect ASTRO radios under test to the analyzer and how to set controls and indicators to obtain the correct screen display.

Error/Warning Messages

Refer to Appendix K for a listing and description of setup and radio error messages. Messages common to all the R2600 Series equipment are described in paragraph 17-4 under the General Operations tab in this manual.

17-2 SOFTWARE VERSION SCREEN

To view the software version of the R2670 Analyzer, turn power on and wait for the display to appear on the screen. Press the **SPF** hard key, and move the cursor to "VERSION." Select the **display table** softkey. This will configure the analyzer to generate a screen that displays the ASTRO software version (figure 17-1).

Move the cursor to the ASTRO position and select the **view options** softkey. A screen similar to figure 17-2 will be displayed and indicates the analyzer options installed and encryption algorithms available.

Select **return** softkey twice to return to the ASTRO mode screen.

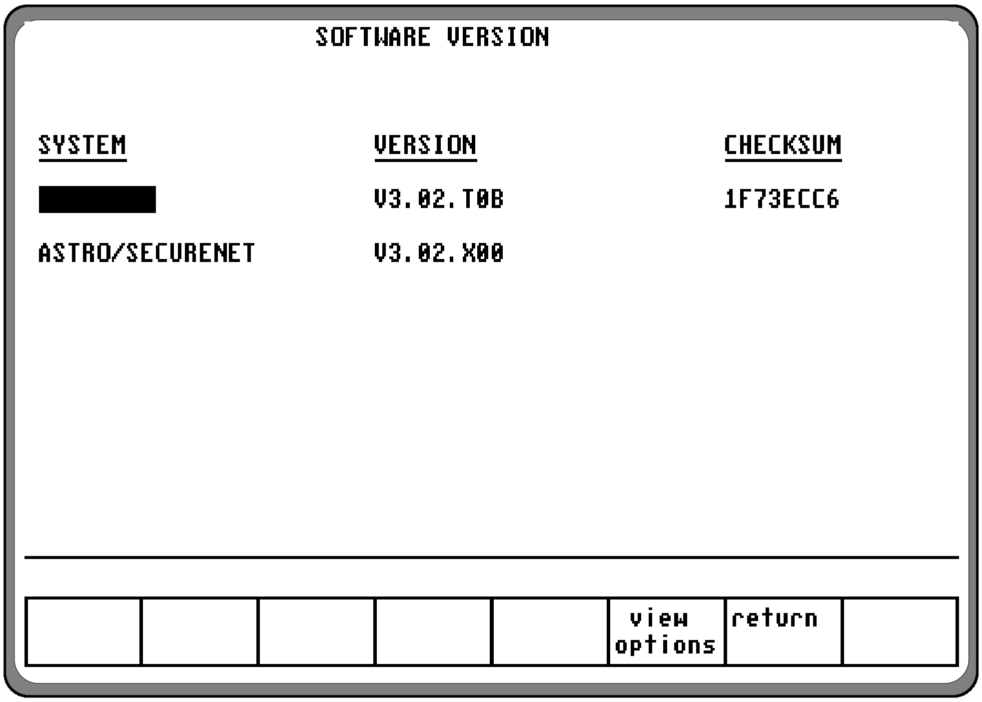

Figure 17-1. ASTRO Version Screen

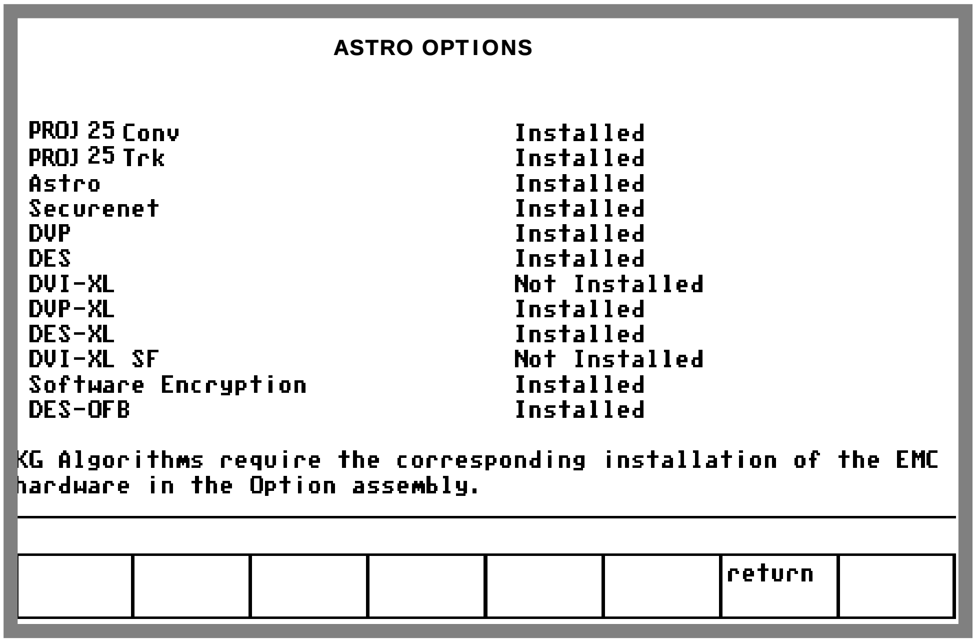

Figure 17-2. ASTRO Options Screen

17-3 BASIC OPERATION

Control of the unit and selection of data to be displayed are done through the use of three main windows which simultaneously appear on the screen: the Display Zone, the RF Zone, and the Audio Zone. These three zones are shown in figure 17-3.

The top portion of Display Zone displays the status and selections for the current test sequence. The bottom portion of the Display Zone displays the data about the radio under test. The RF Zone is used for selection of RF mode, for selection of frequency band, for port selection and for control of RF signal level at the input/output port. The Audio section is unchanged from the standard system except that, in ASTRO mode, modulation options are limited.

17-3.1 Display Screens

The three main windows, or cursor zones, are accessed through a cluster of three CURSOR ZONE keys at the top center of the unit. The location where the cursor rests within each zone is called a cursor field. To control the unit and enter data, all operator inputs are made at highlighted cursor fields (brighter-face type).

Below the screen are softkeys. These softkeys, with customized on-screen labels, interact with the screen to provide a unique menu of entry options for each cursor field. This greatly reduces the number of keys and eliminates having to search through unrelated controls to find the one that is needed.

17-3.2 Manual Operation

To control the cursor location and input information by (manual control):

- Use the CURSOR ZONE keys to move the cursor among the three zones.
- Use the CURSOR POSITION keys to move the cursor from field to field within a zone.
- Once at the desired field, use the TUNING knob or the numeric keys to enter numeric information. Use the softkeys for other menu selections.

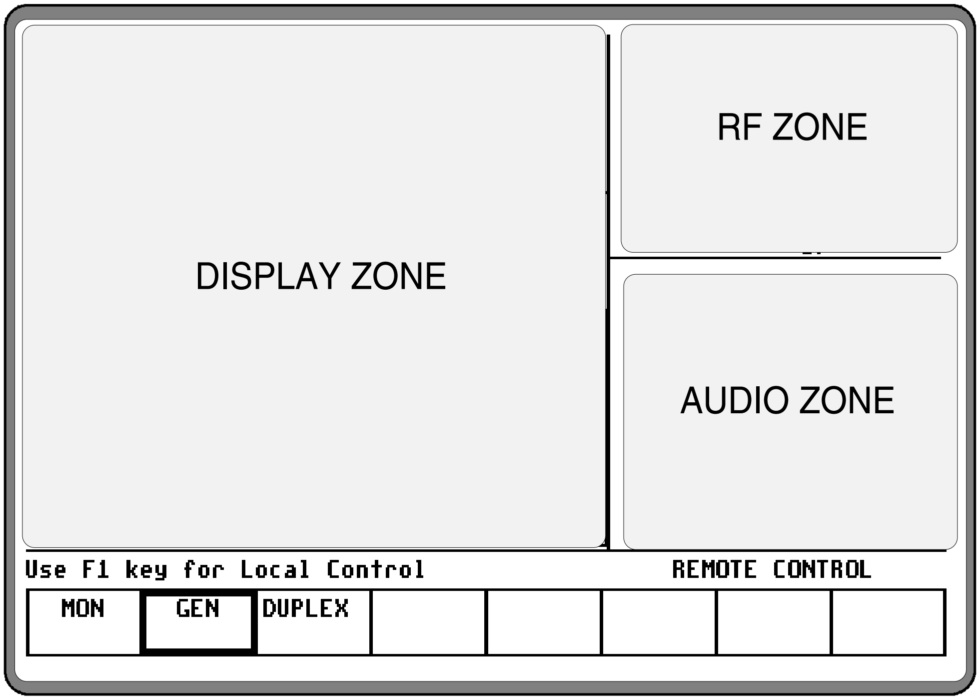

Figure 17-3. Screen Zone Arrangement

17-3.3 Expanded Display

Some fields have the ability to expand their contents and overwrite other display areas. These consist of the following:

- Spectrum analyzer, scope waveforms, bargraph displays
- Decode tables
- Encode tables
- Dedicated keys

17-3.4 Dedicated Keys

Refer paragraph 17-8 under the General Operations tab of this manual for an explanation of expanded screens in the HELP, MEM, SPF, and CAL modes.

17-3.5 Remote Operation

All R2600 Series Communications System Analyzers are equipped with a standard RS-232 interface. Optionally, the R2670 is equipped with an IEEE 488 (HP-IB / GPIB) interface. Either of these interfaces may be used to remotely control the analyzer using a set of commands, queries, and responses that are defined in the General Dynamics R2600 Series Communications System Analyzer Programming Reference Manual (68-80309E55).

17-3.6 HELP Key

The analyzer provides on-screen operating instructions via the dedicated HELP key. Help screens are organized such that each display area has an associated help screen pertaining to that area of the screen. System help is available via a softkey within each help screen. Use the **return** softkey to return to the function in progress.

17-4 ENCRYPTION CAPABILITIES

When in ASTRO mode, the R2670 can operate in clear, hardware encrypted or software encrypted modes. ASTRO equipment converts normal speech patterns to their digital equivalent and then uses an encryption algorithm to encrypt data for transmission. A receiving radio, using the same algorithm and a matching key, automatically reverses the process so you can hear a normal audio message.

A set of either U.S. or International encryption algorithms is available with the ASTRO Option. Algorithms include Data-Encryption System (DES) - a U.S. Federal Government encryption standard, Digital Voice Protection (DVP) - a Motorola Proprietary encryption algorithm, and DVI - a Motorola Proprietary encryption algorithm for international use only. Within a set, each algorithm is individually selectable:

- Domestic: DES-XL, DVP-XL
- International: DVI-XL, DVP-XL

17-5 TEST SETUP

17-5.1 Connecting a Radio

Use a 50 ohm BNC cable and an N to BNC adapter to connect from the RF I/O port of the R2670 analyzer to the antenna port of the radio as shown in figure 17-4.

CAUTION

When in Monitor mode, adjust the squelch to where the LED indicator for squelch just turns off or is closed. When the signal from the radio is present, the squelch LED will illuminate indicating that squelch has been detected and there is a signal present.

CAUTION

Observe the input power ratings and warnings of the analyzer to insure that no damage occurs to the analyzer.

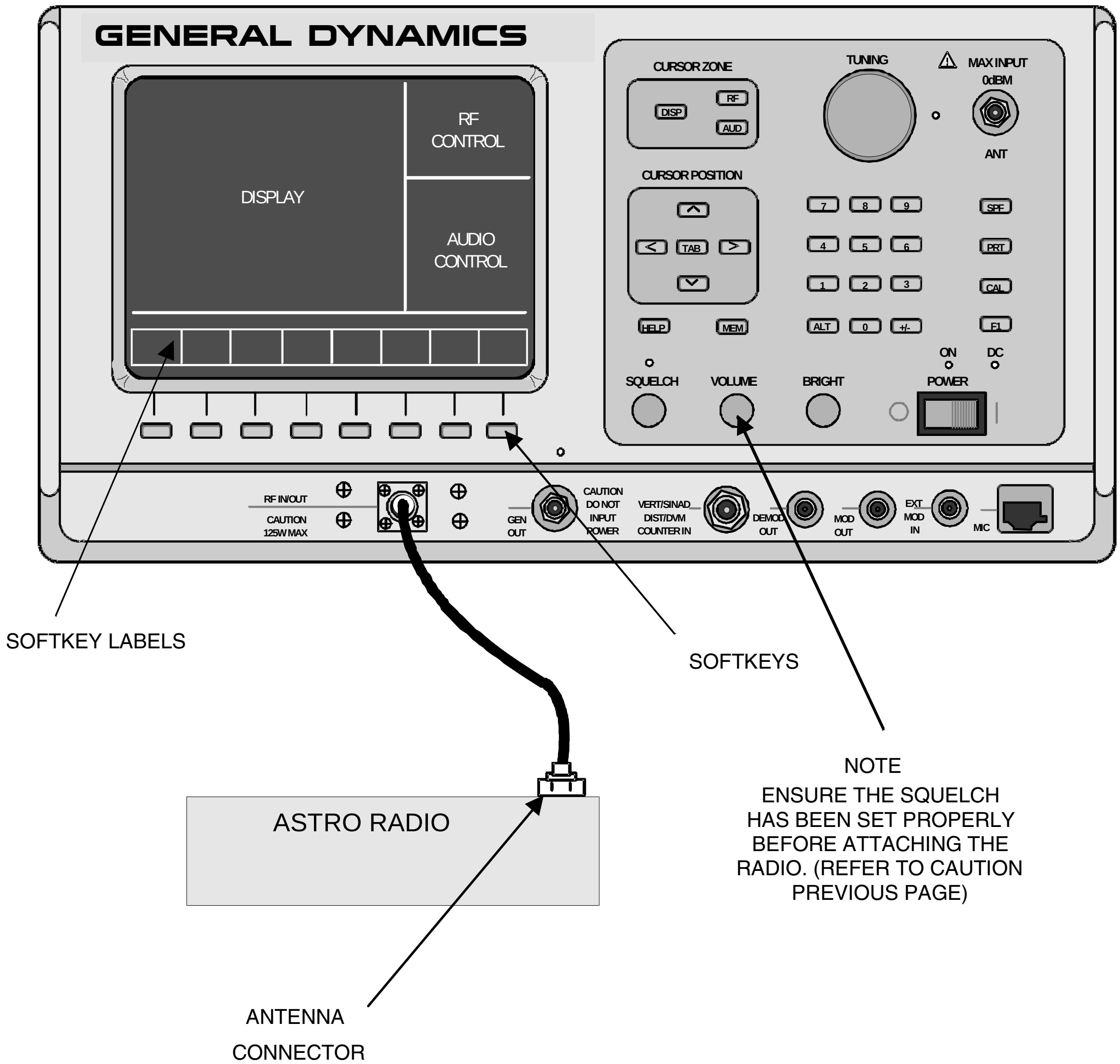

Figure 17-4. Radio to Analyzer Test Setup

17-6 ACCESSING ASTRO MODE

Select the ASTRO mode by placing the cursor in the "Mode:" field in the Display Zone located at the top of the screen. Use the **ASTRO** softkey to select the ASTRO mode. A screen similar to figure 17-5 appears.

When the display zone "Mode:" is set to ASTRO, the R2670 will configure itself to generate and monitor ASTRO signals.

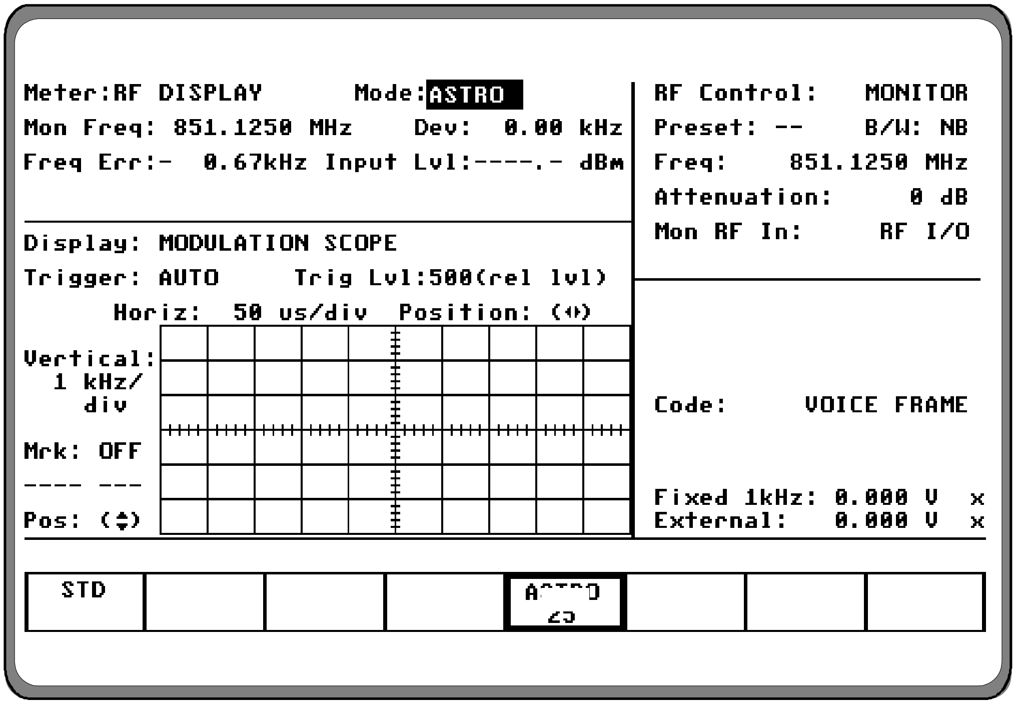

Figure 17-5. ASTRO Mode Screen

17-7 ASTRO ENCRYPTION SET UP

17-7.1 SET UP Encryption Display

The SET UP display places the analyzer in encryption setup mode and allows the operator to select the desired algorithm. The SET UP display is accessed from the Display Zone. To use SET UP display, move the cursor to the "Display:" field and select SET UP using the **SET UP** softkey. The Display Zone will show a menu of SET UP options as shown in figure 17-6.

17-7.1.1 Encrypt

The analyzer operates in either clear or encrypted modes. In the Display Zone, scroll the cursor to the "Encrypt:" field and select ON as shown in figure 17-7 for encrypted ASTRO or OFF for clear ASTRO operation

17-7.1.2 Algorithm Select

Within the SET UP display, the first option field is Algorithm Select. Algorithm is a term that describes the method of coding data or audio so that only equipment having the same algorithm selected, and the same key, are able to exchange intelligible information. The analyzer includes several algorithms recognized by radios using ASTRO. You will need to select one of these algorithms to use for processing messages.

In the Display Zone, move the cursor to the "Algorithm Sel:" field as shown in figure 17-8. The softkeys will provide a menu of the available algorithms. Select the appropriate algorithm. Refer to section 17-4 for a description of the U.S. and International encryption algorithms.

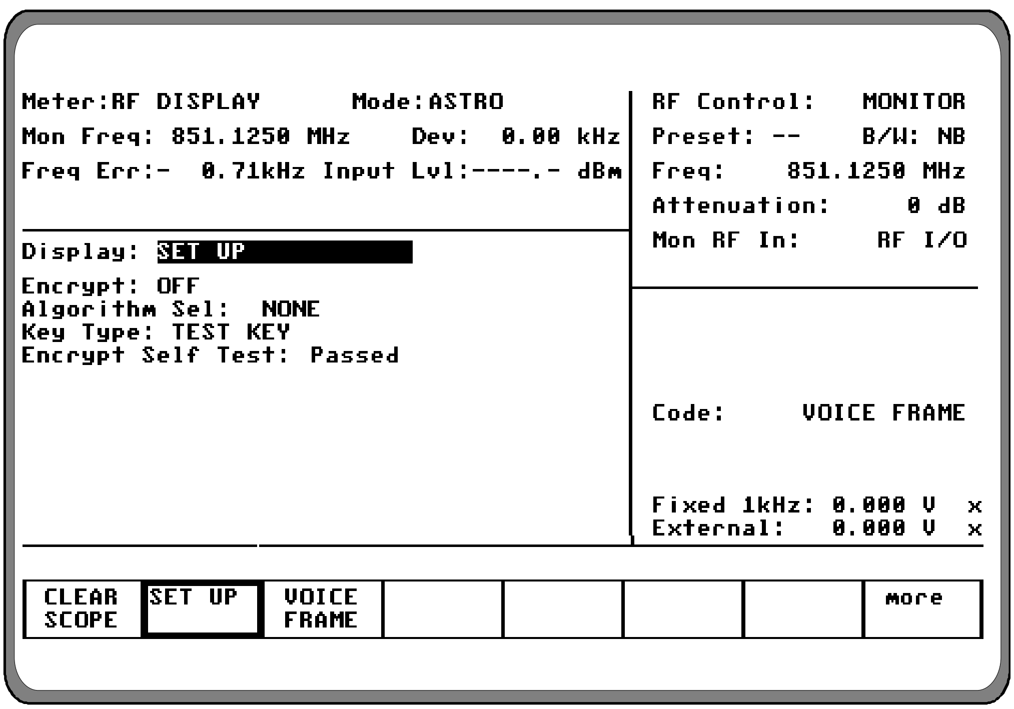

Figure 17-6. SET UP Display Screen

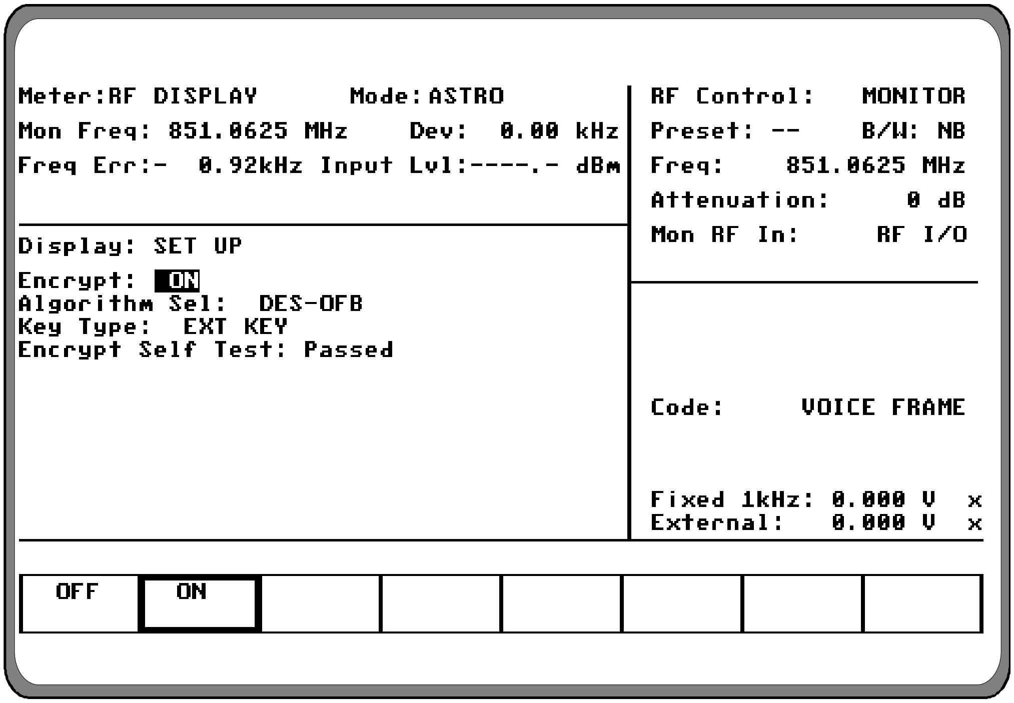

Figure 17-7. Encryption Select Display

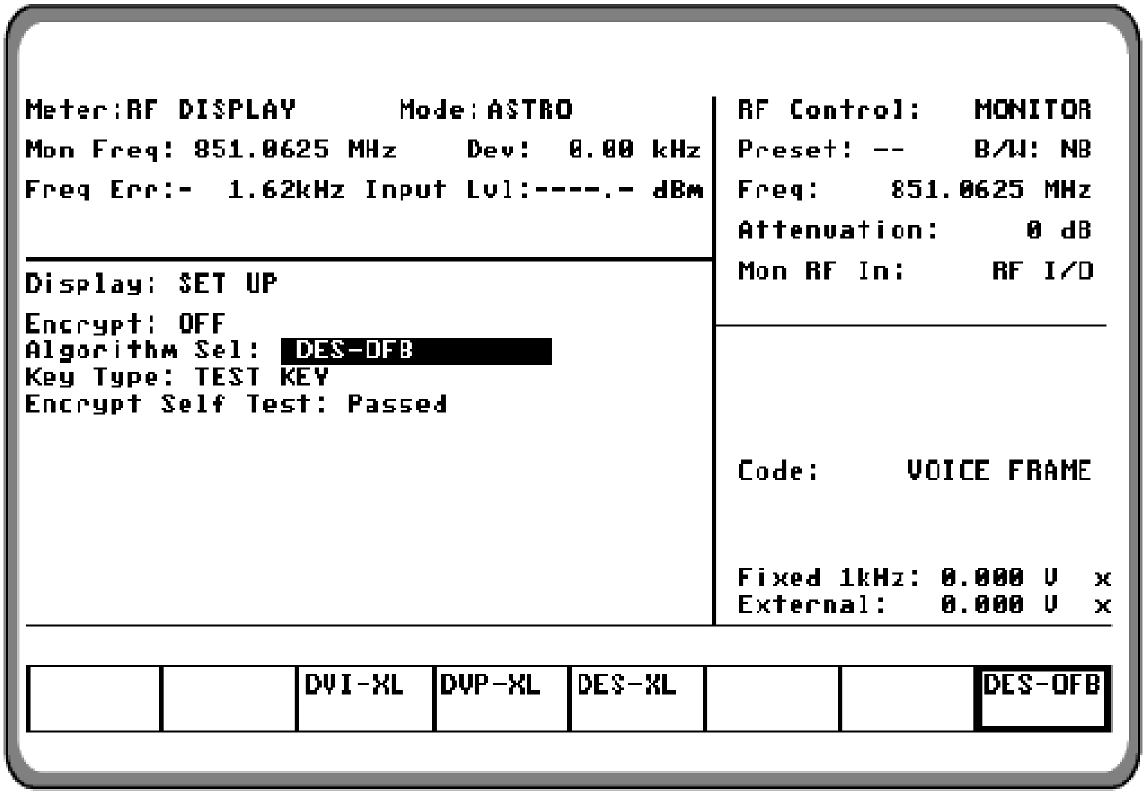

Figure 17-8. Algorithm Select Display

17-7.1.3 Key Type

Each algorithm is associated with one particular key type: either a Test Key or an External Key. Test Key is the default and is used to support most ASTRO testing.

The Test Key is a dummy key which is programmed into the radio and the analyzer for maintenance purposes only. The Test Key should never be used for sending private radio communications. Its security is compromised (all ASTRO Option analyzers use the same Test Key). The analyzer provides other softkey selections:

Test Key

This softkey selects the Test Key saved in the analyzer's key storage memory. The Test Key will then be used for testing.

EXT Key

This softkey selects the External Key saved in the analyzer's key storage memory.

Erase EXT Key

This softkey erases from the analyzer's key storage memory any External Key saved for the current algorithm.

Load Ext Key

This softkey starts the sequence of programming the analyzer with an External Key for the algorithm selected from a Key Variable Loader (KVL). This procedure requires a key loading cable and a KVL. If the software encryption algorithm had been selected (section 17-7.1.2), then selecting **load ext key** softkey puts a “Key” field on the display. The key is entered using the softkeys or numeric keypad. Press **STORE KEY** softkey to load.

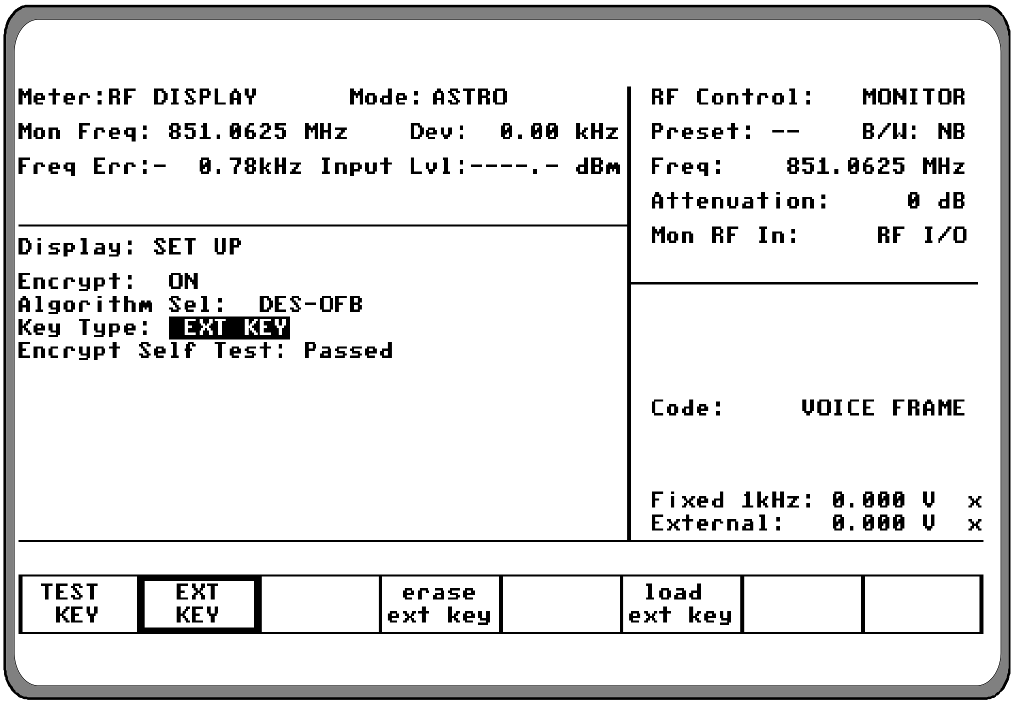

Figure 17-9. Test Key Programming Display

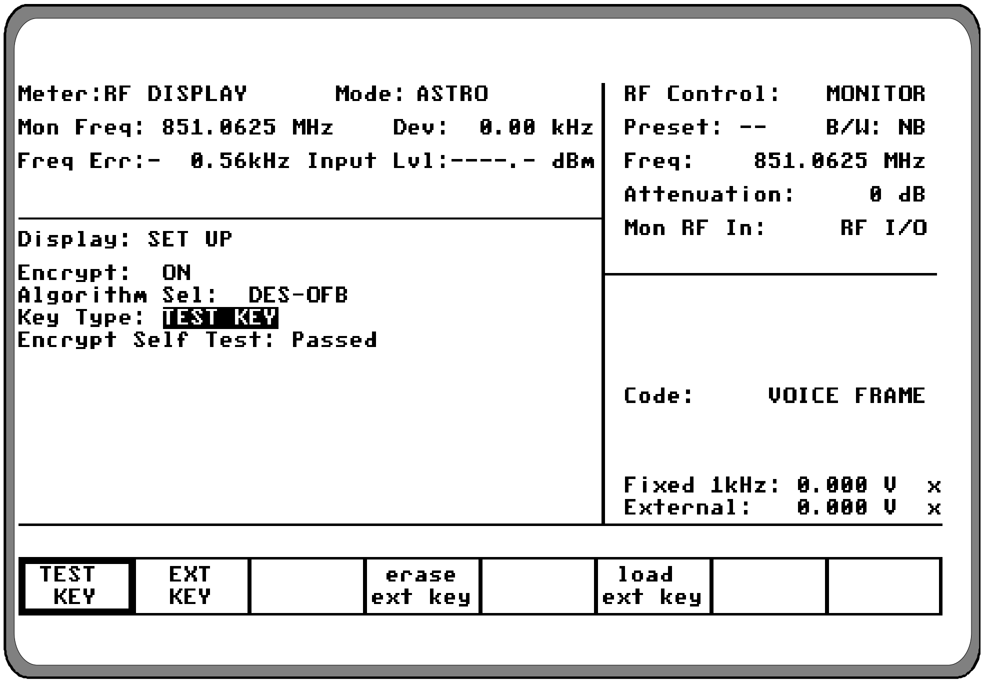

Figure 17-10. External Key Programming Display

17-7.1.4 Encrypt Self Test

A self test of the encryption functions is performed at power up. The "Encrypt Self Test:" field in the SET UP display (figure 17-6) indicates the results of the self test, passed or failed.

17-7.2 Using the Test Key

The analyzer can be used to test radios using the internal Test Key (707070…..hex). To select the Test Key, place the cursor in the "Display:" field in the Display Zone. Select SET UP using the **SET UP** softkey. This will access the SET UP display screen (figure 17-6)

Move the cursor to the "Encrypt:" field and select the **ON** softkey (figure 17-7). Move the cursor to the "Algorithm Sel:" field and select the desired algorithm using softkeys (figure 17-8). Move cursor to the "Key Type:" field and select the **TEST KEY** softkey (figure 17-9). The analyzer is now programmed with the Test Key.

ASTRO radios also have an internal Test Key which is the same as the analyzer's. Refer to the radio service manual to determine if this key can be activated in your particular radio. If the internal Test Key cannot be activated, it must be loaded from a KVL.

Follow the procedure in the KVL instruction manual to load the 707070…..hex key into the radio. The radio encrypter is now keyed to match the analyzer.

17-7.3 Programming with External Key

You can use a customer key to program the analyzer and operate in private mode with a keyed radio. The customer (external) key, once loaded, is saved in memory by the analyzer until the operator erases it. The key is stored in non-volatile memory and will be retained even if power to the analyzer is turned off.

When software encryption is selected, the External Key is not saved when the analyzer is turned off. For all algorithms except software encryption, a KVL is required to load an External Key.

17-7.3.1 Connecting the KVL

The KVL plugs into the KVL port (figure 15-1) on the side of the analyzer opposite the carrying handle. Connect the key inserter to the analyzer and then use the following instructions to load the external key.

CAUTION

Use only DX key loaders, or any KVL 3000 with the ASN option. Other types of key loaders (AX, BX or CX) may cause the encryption hardware to malfunction. To recover, press the ***encrypt reset*** *softkey under the "Special Functions" (SPF) menu.*

17-7.3.2 Loading External Key

To initiate loading an external key, place cursor in "Display:" field in Display Zone and select SET UP mode display using **SET UP** softkey.

Move cursor to "Algorithm Sel:" field and select desired algorithm using softkeys (figure 17-8).

Move cursor to "Key Type:" field.

Press the **load ext key** softkey to initiate the key load sequence.

If the Software Algorithm was selected, the "Key:" field will be displayed and a key can be entered using the softkeys for alpha characters and the keypad for numerics. Press the **STORE KEY** softkey to load. For the other algorithms (DES-XL, DVP-XL, or DVI-XL), the External Key must be loaded from a KVL.

Push the switch on the KVL to begin loading. This activates the programming function. When programming is complete, the KVL displays "pass" if the key load procedure was successful. The analyzer displays a message "Ext key passed." If the key load procedure was unsuccessful, the KVL displays "fail."

If key load procedure was successful, disconnect the KVL. Be sure to press the EXT KEY softkey after loading an External Key from the KVL to transfer the External Key into the analyzer's key storage memory. This completes external key loading. You can exit the SET UP screen at this time.

17-7.3.3 Erasing External Key

To erase an external key, place cursor in "Display:" field in the Display Zone and select **SET UP** softkey. This will access the SET UP display screen (figure17-6).

Move cursor to "Algorithm Sel:" field. Using softkey, select the algorithm associated with the external key you want to erase.

Move cursor to "Key Type:" field and select External Key using softkeys. Press **erase ext key** softkey (figure 17-10). The analyzer will erase the stored external key and display "key erased" in the message area.

17-8 ASTRO RF OPERATING MODES

Select the RF operating mode by placing the cursor in the "RF Control:" field in the RF Zone. Use the desired softkey to select MONITOR, GENERATE, or DUPLEX.

17-8.1 MONITOR Mode

The Monitor mode (figure 17-11) provides the analyzer test receiver function which is used in the testing of radio transmitters. In ASTRO Monitor mode, the RF Zone is similar to the RF Zone in standard mode. It is capable of setting up the analyzer to monitor RF input through its antenna or direct connection to the transmitter.

The RF Zone in Monitor mode contains fields for choosing the monitor bandwidth, frequency, attenuation, and source of the ASTRO RF signal. All of these fields operate as described under the General Operations tab of this manual except the Modulation Type field is not required.

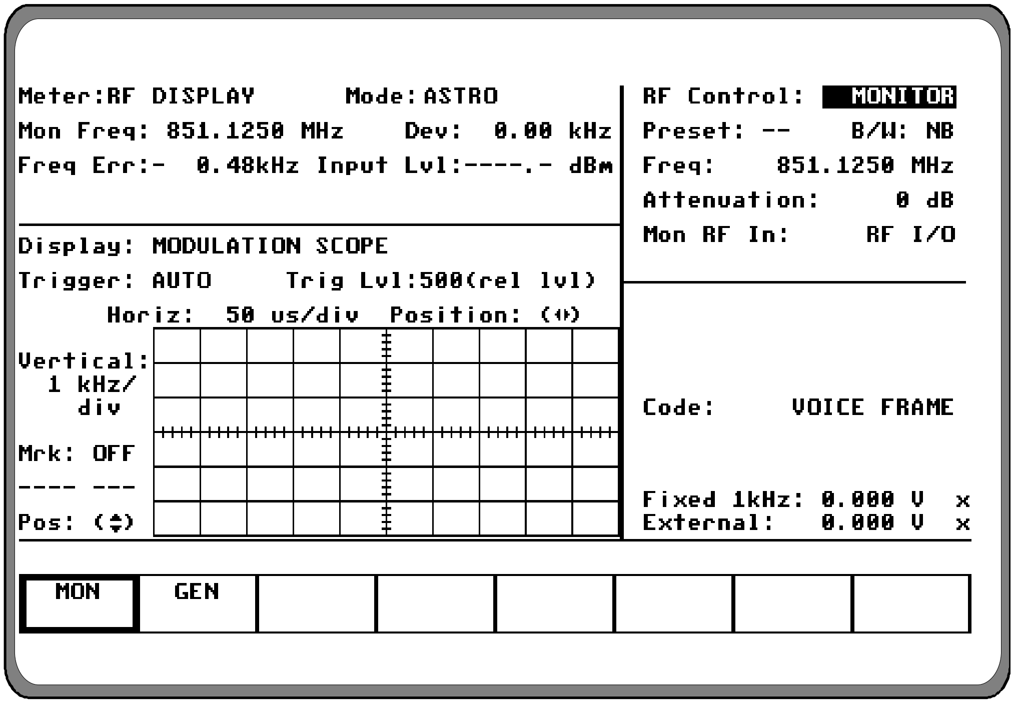

Figure 17-11. Monitor Mode - RF Zone

The specific entry fields are as follows.

Preset

The preset entry field provides a convenient way to enter a bandwidth, frequency, and other information for the unit by recalling preset data from nonvolatile memory. If a preset is not to be used, enter the desired information at each of the fields.

NOTE

If a preset had been selected and changes are made to any of the preset values, the "Preset:" field will have dashes through it, indicating the preset is no longer selected.

B/W

Selects either wide or narrow IF bandwidth of the unit via softkey selection.

Freq

Enter the desired monitor frequency using keypad or TUNING knob.

Attenuation

Selects the amount of attenuation at the RF input to the monitor receiver using softkeys. Selectable input attenuation is useful in adjusting displays for a wide range of input levels, as well as for use in high RF field environments where intermodulation may cause desensitization of the receiver.

Mon RF In

Selects the RF input port via softkeys. The RF I/O port contains an RF load and should be used for direct connection to the radio under test. The ANT port accesses the unit's sensitive receiver and should be used with an antenna for "off-the-air" reception. Selection of the ANT port is indicated by a red LED next to the ANT connector.

CAUTION

Do not apply input power to the ANT input port. In the event RF power is inadvertently applied, the port is protected by an in-line RF fuse. This fuse may be accessed by unscrewing the front of the BNC connector out of the front panel. Refer to paragraph 16-2.4.1 under the General Operations tab of this manual for additional detail.

17-8.2 GENERATE Mode

The GENERATE mode (figure 17-12) configures the Analyzer to generate an RF signal at a controlled output level. The GENERATE mode thus provides for ASTRO radio receiver testing. In ASTRO Generate mode, the RF Zone is similar to the RF Zone in standard mode. It is capable of setting up the analyzer to generate RF output through its RF I/O port or through the Generator Output (GEN OUT) port.

The RF Zone contains fields for choosing the generator bandwidth, frequency, output level, and output connector of the ASTRO RF signal. All of these fields operate as described under the General Operations tab in this manual except the Modulation Type field is not required.

Specific controls that further configure GENERATE mode are located in RF Control Zone when GENERATE is first selected.

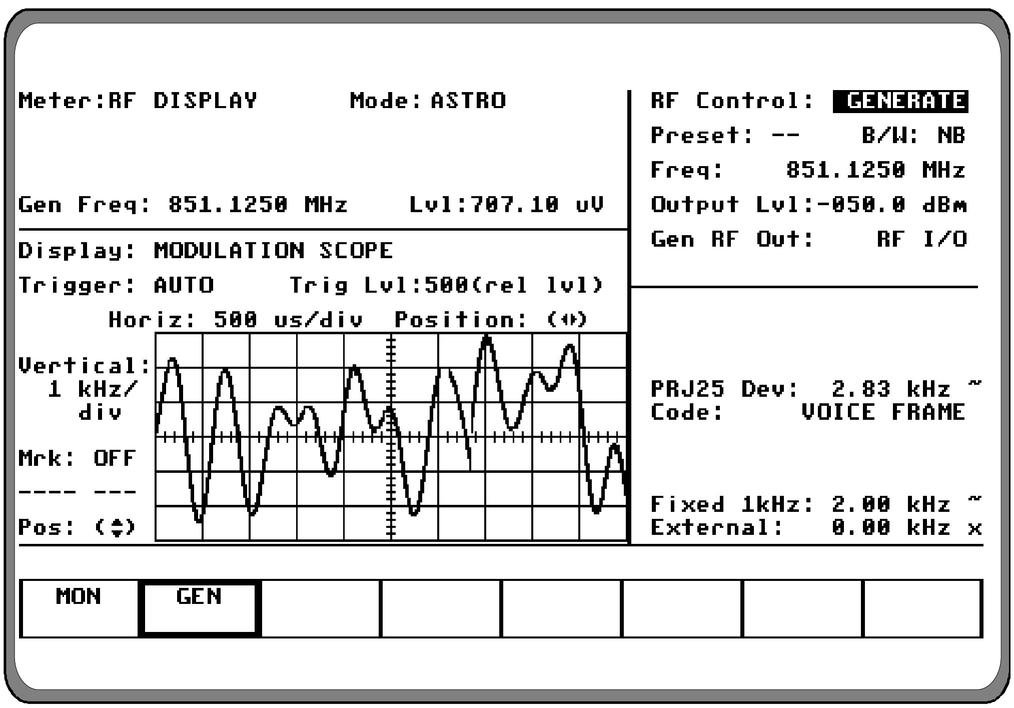

Figure 17-12. Generate Mode - RF Zone

The specific entry fields are as follows:

Preset

The preset function is the same as in the Monitor mode.

B/W

Selects either wide or narrow bandwidth of the unit via softkey selection.

Freq

Enter the desired generate RF frequency using keypad or TUNING knob.

Output Lvl

Selects generator output level in 0.1 dBm steps over the range of -130 dBm to 0 dBm. An alternate display of generate level in microvolts is available in the "Meter:" area of the Display Zone. Output level is available in two ranges depending upon which output port is selected:

- The range of -80 dBm to 0 dBm is available when the high level GEN OUT port is selected.
- The range of -130 dBm to -50 dBm is available when the RF I/O output port is selected.

Gen RF Out

Selects the RF output port via softkeys. The RF I/O port is recommended for most applications. GEN and MON ports are combined for a single connection to the radio under test. The GEN port is recommended where higher levels are needed. Selection of the GEN port is indicated by a red LED adjacent to the GEN OUT connector.

CAUTION

Do not apply input power to the GEN OUT port. In the event RF power is inadvertently applied, the port is protected by an in-line RF fuse. This fuse may be accessed by unscrewing the front of the BNC connector out of the front panel.

17-8.3 DUPLEX Mode

The Duplex Mode (figure 17-13) provides a simultaneous RF generator BER pattern output that is offset in frequency from the monitor center frequency and fully adjustable in output level.

This capability provides for servicing full duplex radio equipment as well as repeaters and radios operating with offset transmit and receive frequencies. The Display zone provides softkey selections for generated or monitored clear baseband signal as shown in figure 3-12.

Specific controls which further configure the Duplex mode are located within the RF Control Zone when DUPLEX is first selected.

The specific entry fields are as follows:

Preset

The preset function is the same as in the Monitor mode.

B/W

Selects either wide or narrow bandwidth of the unit via softkey selection.

Mon Freq

Enter the desired monitor frequency using keypad or tuning knob.

Offset

Enter the generator frequency offset relative to the monitor frequency entered. Offset frequencies of –999.99975 to +999.99975 MHz are allowed, but the final generate frequency will be constrained to 000.40000 MHz through 999.99995 MHz. The offset frequency is set in 2.5 kHz steps.

Mon

This field actually contains two separate fields, one for monitor input attenuation and one for monitor port selection. Refer to the Monitor mode description for further details.

Gen

This field actually contains two separate fields, one for generate output level and one for generate output port selection. Refer to the Generate mode description for further details.

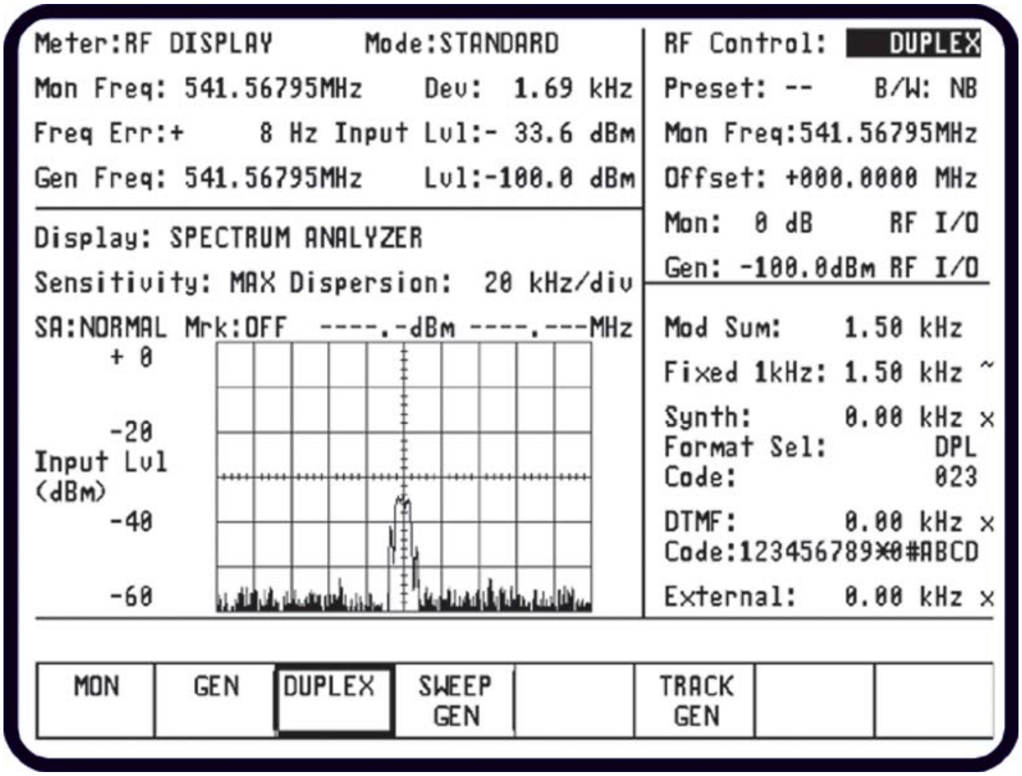

Figure 17-13. Duplex Mode - Display Zone

17-9 ASTRO AUDIO/MODULATION CONTROL

The Audio Zone located at the lower right of the screen (figure 17-14) is used to control the multi-purpose audio synthesizer section of the unit. Signals generated by the audio synthesizer are coupled internally to the generator modulation input as well as to the MOD OUT connector on front panel. The main categories of modulation in ASTRO mode are Voice Frame and Bit Error Rate (BER). Many of the features available in standard mode are not available in ASTRO mode. The Audio Zone has been changed accordingly to simplify testing of ASTRO radios and equipment.

Each modulation signal has a cursor field for entering its desired level. Use the keypad or TUNING knob to enter the desired level.

An additional cursor field, adjacent to each level entry, is used to switch each selection on and off using softkeys. This field is located at the extreme right side of the zone. There are two possible conditions for this softkey selection.

- CONT activates continuous ON condition, or continuous cycling if a sequence has been selected. A "~" symbol is indicated at the extreme right, adjacent to the level to indicate continuous ON.
- OFF switches off the modulation source. Off is indicated by an "X" at the extreme right, adjacent to the level.

17-9.1 Modulation Sources

In addition to Voice Frame and BER, there are two other modulation sources selectable in the Audio Zone, Fixed 1 kHz and External.

17-9.1.1 Fixed 1 kHz

The analyzer produces a fixed 1 kHz modulation source, which can be selected independently from the other audio synthesizers. Level control and on-off selection is described above.

17-9.1.2 External

External modulation is applied to the external modulation input (EXT MOD IN) connector on the front panel. When external modulation source is selected, this external modulation input is summed with the microphone input. Level control and on-off selection for an external modulation source are selectable via softkey or the TUNING knob.

17-9.2 Voice Encode

The Audio Zone provides for selection of Voice Frame or BER pattern. In generate mode, controls are provided for both signal level and frequency deviation settings of the voice baseband signal that is used to modulate the ASTRO RF transmissions.

17-9.2.1 Monitor Mode

Voice Frame decode is not selectable in the Audio Zone in Monitor mode. To display Voice Frame decoded data, refer to section 17-10.3. Be sure Monitor is selected in the RF Control Zone in the upper right section of display. Move cursor to the Audio Zone and place the cursor in the “Code:” field. Select Voice modulation using the **VOICE FRAME** softkey. Selection of Monitor Voice allows for the addition of the following audio sources:

- External + microphone, or
- 1 kHz tone
- These inputs are selected by using the off and continuous switches and the level is adjusted using the keypad or tuning knob. The level range varies depending on whether the bandwidth (in the RF Zone) is set to narrow or wide.

BW Setting	Audio Level Range
Narrow	0.000 to 0.795 volt maximum, in 0.001 volt increments
Wide	0.00 to 7.95 volt maximum, in 0.01 volt increments

17-9.2.2 Generate Mode

The analyzer can generate ASTRO voice patterns when placed in the Generate mode. The ASTRO signal can be clear or encrypted with one of the hardware or software algorithms.

Be sure GENERATE is selected in the RF Control Zone in the upper right section of display. Move cursor to the Audio Zone and place the cursor in the "Code:" field. Select Voice modulation using the **VOICE FRAME** softkey.

When code Voice Frame is selected in the Audio Zone (figure 17-14), the analyzer allows audio inputs to the modulator to be selected from two sources:

- External + microphone, or
- 1 kHz tone.

Controls for each modulating input consist of a switch with values of Off and Continuous. Move cursor to the appropriate switch field and turn the modulating input on "~" or off "X" using the softkeys.

The audio inputs also include a level control for precisely setting the audio input to the modulator. Use the keypad or TUNING knob to enter the desired level. The level range varies depending on whether the bandwidth (in the RF Zone) is set to narrow or wide.

BW Setting	Audio Level Range
Narrow	0.00 to 9.95 kHz maximum, in 0.01 kHz increments
Wide	00.0 to 99.5 kHz maximum, in 0.1 kHz increments

In Generate mode, Deviation control is available in the Audio Zone consisting of a switch with values of Off and Continuous, and a level control. Move cursor to the switch field and turn deviation on "~" or off "X" using the softkeys.

Use the keypad or TUNING knob to enter the desired deviation. The deviation range varies depending on whether the bandwidth (in the RF Zone) is set to narrow or wide.

BW Setting	Deviation Range
Narrow	0.00 to 5.00 kHz maximum, in 0.01 kHz increments
Wide	00.0 to 50.0 kHz maximum, in 0.10 kHz increments

The default deviation setting for ASTRO is 2.55 kHz.

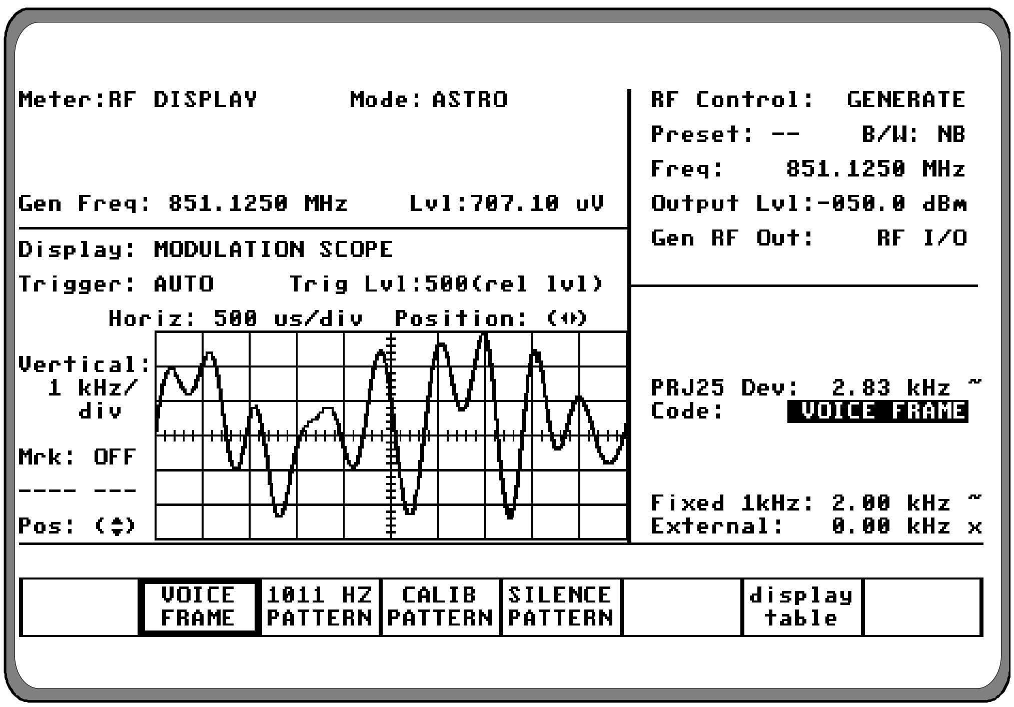

Figure 17-14. ASTRO Audio Zone - Voice Generate Mode

17.9.3 Voice Frame Embedded Signaling (Generate)

When the audio source is selected to Voice Frame, a **display table** user selection is available which provides access to the embedded signaling information contained in voice frames. The display table presentation is shown in figure 17-15. The following information is encoded by the ASTRO option:

Embedded Information	Size (bits)
Link Control Field (LCF)	60
Presentation Address (PA)	56
Key ID	16
Network ID	12
Busy Bits	2

Mnemonic	Default Value
Link Control Field	0
Selective Call Variable Octet	N/A
Talkgroup ID	0
Channel	0
Source ID	0
Destination ID	0
Emergency	0
Acknowledge	0
Power Level	0
Bit Error Rate	0
RF Level	0

The LCF information is further decomposed to allow entry of specific LCF data units. Encoding of the following LCFs is supported from the user interface:

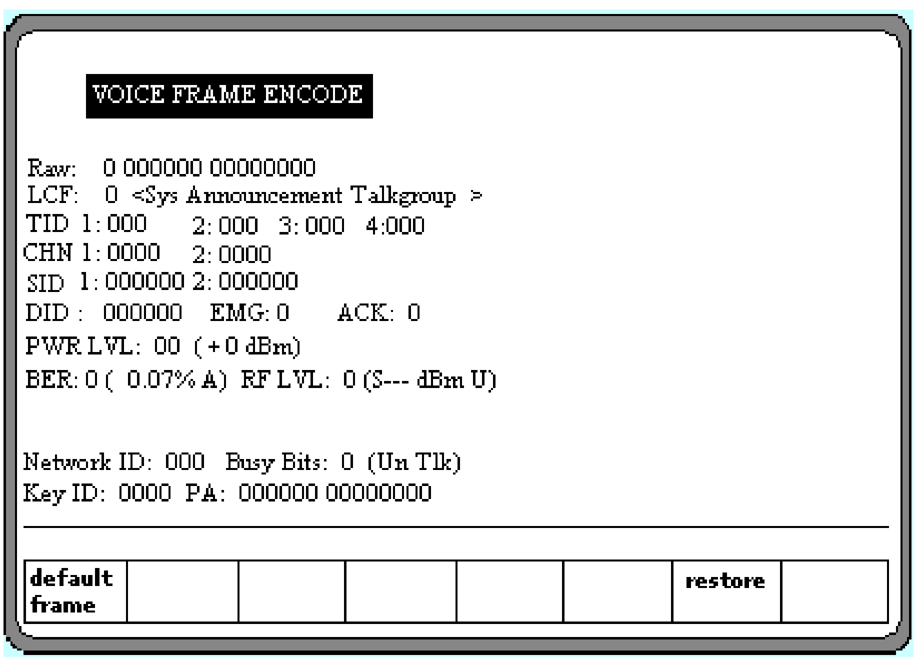

Figure 17-15. Voice Frame Encode - Generate

The embedded information associated with a particular Link Control Format Identifier is available for encoding from the user interface: The user interface provides entry of the embedded signaling information as hexadecimal numbers. A softkey that sets the encoded embedded signaling information to a default frame is provided. Default values are shown in table 17-1.

Table 17-1. Encoded Embedded Signal Default Values

Link Control Format Indentifier	Value (binary)
System/ Announcement/ Talkgroup	%0000
System Talkgroup Activity Update with Channel Numbers	%0001
System Talkgroup Activity Update	%0010
Selective Call	%0011
System Individual Activity Update with Channel Numbers	%0100
System Individual Activity Update	%0101
System Status	%0110
Encrypted PTT ID	%1110
Expansion, includes Received Signal Quality Indicator	%1111

Selection of the default embedded signaling values causes an information message to verify the network ID to be displayed.

17.10 BER

The Audio Zone provides for selection of Voice Frame or BER pattern. In generate mode, controls are provided for both signal level and frequency deviation settings of the voice baseband signal that is used to modulate the ASTRO RF transmissions.

17.10.1 Monitor Mode

When MONITOR is selected in the RF Zone and code BER is selected in the Audio Zone, the analyzer is configured to receive a BER pattern. The received BER pattern can be displayed and measured in the Display Zone,

17.10.2 Generate Mode

The analyzer can generate ASTRO BER patterns when placed in the Generate mode. The Audio Zone provides the "Code:" field to select BER generation.

When code BER is selected in the Audio Zone (figure 17-16), the analyzer modulates BER on the carrier at either of two output ports:

- RF I/O port, or
- GEN OUT port

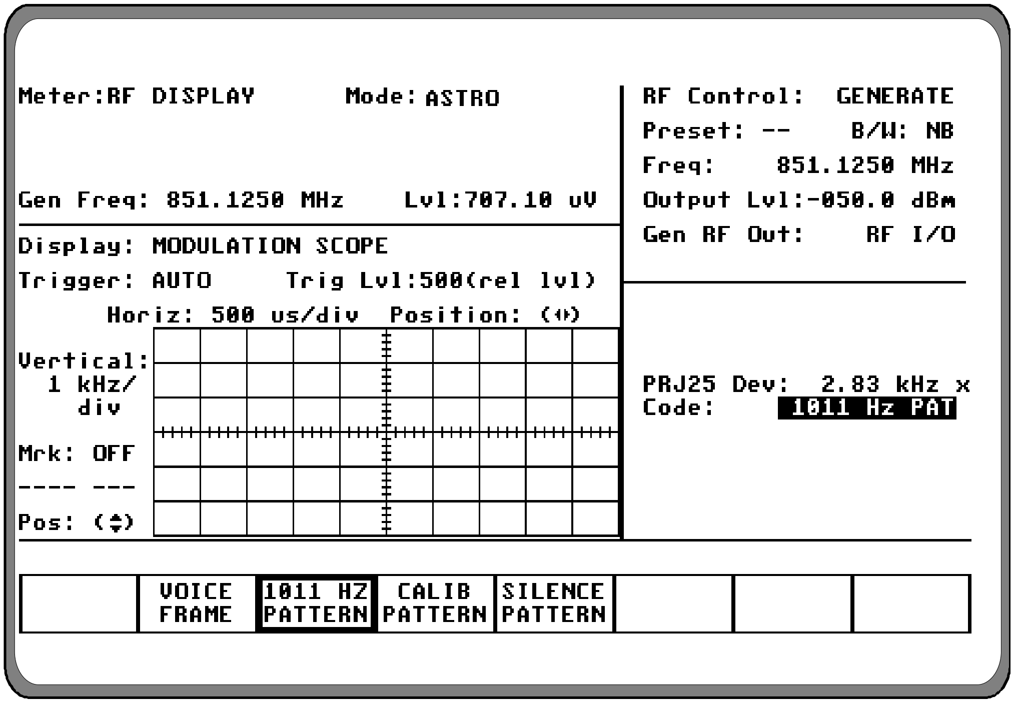

Figure 17-16. ASTRO Audio Zone - BER Generate Mode

In Generate mode, Deviation control is available consisting of a switch with values of Off and Continuous, and a level control in the Audio Zone. Move cursor to the switch field and turn deviation on "~" or off "X" using the softkeys.

Use the keypad or TUNING knob to enter the desired deviation. The deviation range varies depending on whether the bandwidth (in the RF Zone) is set to narrow or wide.

BW Setting	Deviation Range
Narrow	0.50 to 5.00 kHz maximum, in 0.05 kHz increments
Wide	05.0 to 50.0 kHz maximum, in 0.50 kHz increments

17-10.3 Duplex Mode

The analyzer can generate ASTRO BER patterns when placed in the Duplex mode. The Audio Zone user interface is the same as in Generate mode.

17-11 ASTRO METER AND DISPLAY CONTROL

ASTRO meter and display zone is similar to the standard mode. Many of the softkey selections are available, however, many of the selections will return a "not available in ASTRO mode" message. Refer to paragraph 17-7.1 in the General Operation tab of this manual for a description of the functionality of meter and display zone selections that are still available in ASTRO mode.

The Display Zone is slightly modified to accommodate testing of ASTRO radio equipment. A BER Meter is added to the metering functions in the Display Zone. VOICE FRAME, CLEAR SCOPE and SET UP display functions also have been added to the Display Zone. Functions that have been added are described in the following paragraphs. Description of the other displays can be found in paragraph 17-7.2 of the General Operations tab of this manual.

The BER Meter is available only during BER Monitor or Duplex Testing. This BER meter is used to verify the performance of test signals generated by ASTRO radios. The BER Meter provides display of bit error rate, frequency error and input power level as well as monitor frequency and deviation. An example of the BER Meter is shown in figure 17-17.

To activate the BER test, set controls in the RF Zone as follows:

- RF Control: Monitor (or Duplex)
- Frequency: Same as radio transmit frequency
- Attenuation: 0 dB
- Mon RF In: RF I/O

The BER Meter is accessed by placing the cursor in the Display Zone's "Meter:" field and pressing the **more** softkey until the **BER** softkey is presented. Select the **BER** softkey to access the BER Meter (figure 17-17).

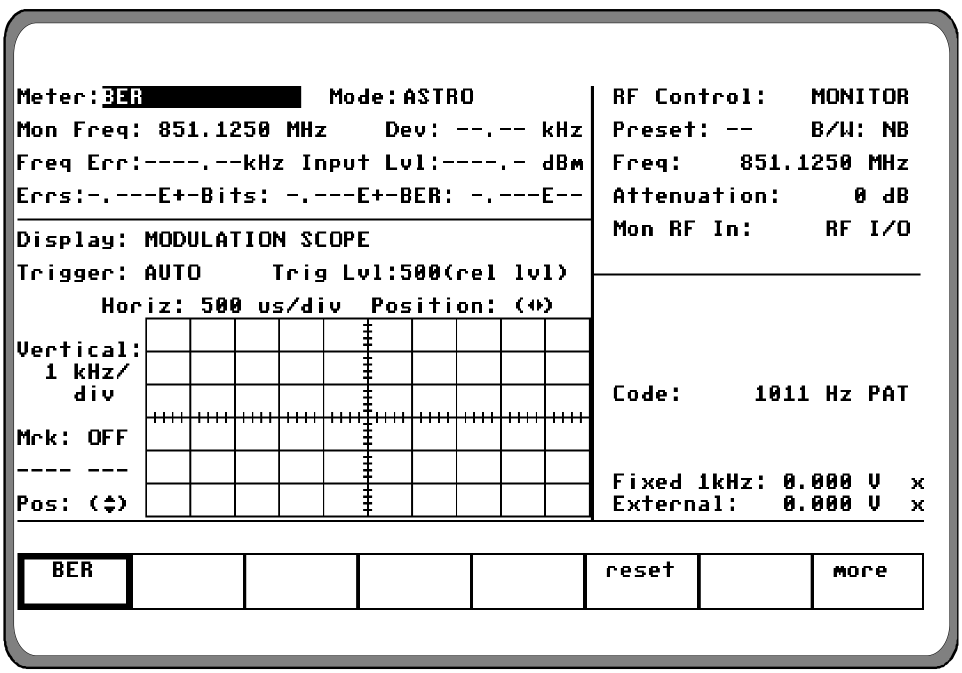

Figure 17-17. ASTRO BER Meter

17-11.1 ASTRO BER Meter

Mon Freq

Display of the actual monitored frequency.

Dev

Display of the frequency deviation in kHz.

Freq Err

The acquisition frequency error range is ±1500 Hz as described for the RF Display.

Input Lvl

Displays the signal level received at the selected front panel connector. A single cursor field at this location allows selection by softkey of either microvolts/watt or dBm units of display.

Errs

Display of the bit error count detected during the test.

Bits

Display of the bit count during the test.

BER

Display of the ratio of bit errors to bit count determined during the test. BER is displayed as an exponent. The BER for one error in one thousand bits is 0.001E01.

NOTE

BER Meter measurement is accurate up to 20 percent bit errors.

17-11.1.1 Enabling the BER Test

The BER test begins when BER meter is selected in the Display Zone "Meter:" field.

17-11.1.2 Resetting the BER Test

To reset the BER test, move cursor to the "Meter:" field in the Display Zone and press more until reset is displayed. Press reset and the BER count is started over from zero.

17-11.2 CLEAR SCOPE Display

The CLEAR SCOPE display shows either the received audio signal after it has been converted to analog or the analog transmit signal before it is digitized. To activate the CLEAR SCOPE, place the analyzer in ASTRO mode.

The selection of either MONITOR or GENERATE in the RF Zone determines which signal will be displayed on the screen. Press the DISP hardkey, place the cursor on "Display:" field, and select the **CLEAR SCOPE** softkey. The Display area of the screen will indicate CLEAR SCOPE with the input signal displayed in a time-versus-amplitude graph.

The operator can adjust the horizontal scale by placing the cursor on "Horiz:" field and selecting the appropriate value from the softkey selections. To change the vertical scale, go to the "Vert:" field and select the appropriate value for the softkey selections. Figure 17-18 shows the display, cursor and associated softkey used for the CLEAR SCOPE

17-11.2.1 Monitor Mode

In Monitor mode, the CLEAR SCOPE display shows the recovered analog audio signal. The CLEAR SCOPE operational controls are similar to the Standard version MOD SCOPE with the following differences in vertical scale.

- 10 mV/div
- 20 mV/div
- 50 mV/div
- 100 mV/div
- 200 mV/div
- 500 mV/div
- 1 V/div
- 2 V/div
- 5 V/div
- 10 V/div

To change horizontal position, horizontal range, vertical position, or vertical range, use the cursor control keys to highlight the appropriate cursor fields as follows:

Horizon

Press the desired softkey to select the Horizontal Sweep rate (20 µs to 1 sec/div). Since all ranges cannot be shown on one screen, press the **more** softkey for additional selections.

NOTE

If horizontal sweep rates of greater than 10 msec/div are selected, the update rate will slow down. A good overall setting for most applications is 200 µsec per division.

Horizontal Position

Adjust the horizontal position through the **(◀▶)** cursor field either by using the desired softkey (MOVE LEFT, MOVE RIGHT) or by using the rotary TUNING knob.

Vertical Sensitivity

Press the desired softkey to select the Vertical Sensitivity (10 mV to 10 V per division). When all ranges cannot be shown on one screen, press the **more** softkey for additional selections.

Vertical Position

Adjust the vertical position through the **(▲▼)** cursor field either by using the desired softkey (MOVE UP, MOVE DOWN) or by using the rotary TUNING knob.

Press the **expand** softkey from any field in the scope display window to enlarge the display for more detailed analysis. Use the **return** softkey to get back to the normal size display.

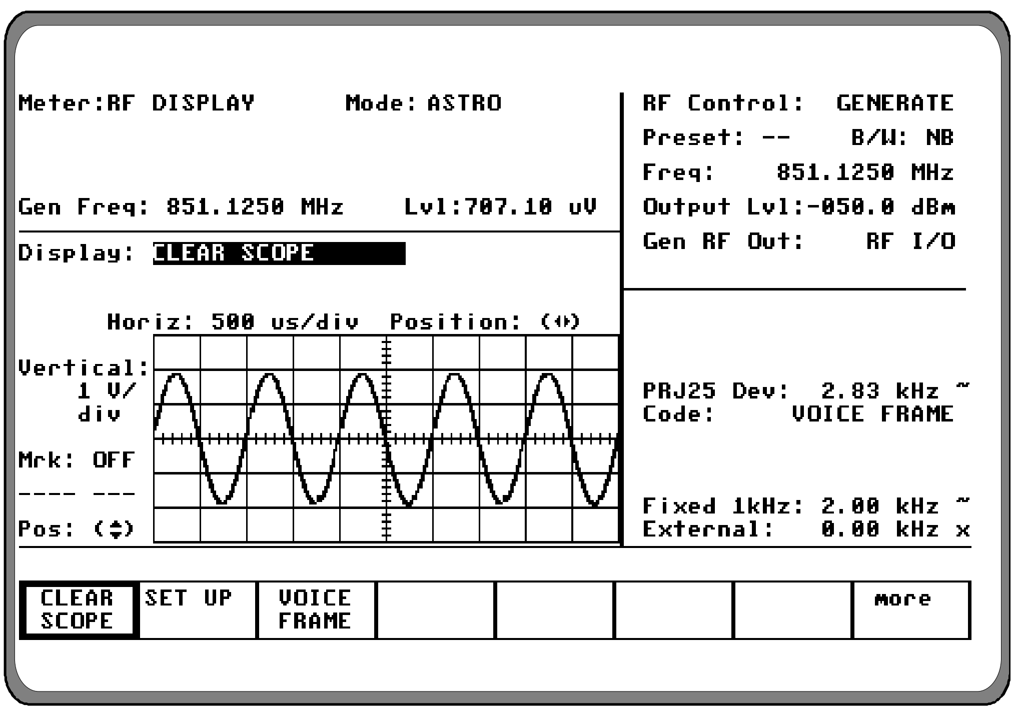

Figure 17-18. ASTRO CLEAR SCOPE Display

17-11.2.2 Marker (if equipped)

Select marker operation by moving the cursor to the "Mrk:" field, then pressing the desired *delta* softkey (ΔV, ΔT, or 1/ΔT). Selection provides two markers on the CLEAR SCOPE screen (refer to figure 17-19). Press the **toggle marker** softkey to alternate between markers and use TUNING knob to position markers.

ΔV

This softkey selection provides markers that are horizontally located to permit relative readings along the scope vertical axis. The display adjacent to the "Mrk:" field shows the relative voltage difference between the two marker positions.

ΔT

This key selection provides markers that are horizontally located to permit relative readings along the scope horizontal axis. The display adjacent to the "Mrk:" field shows the relative horizontal deflection between the two marker positions in units of time.

1/ΔT

This softkey selection provides markers that are also vertically located to permit relative readings along the scope horizontal axis. This selection inverts the time reading to display the relative difference in terms of frequency.

17-10.2.3 Generate Mode

In Generate mode, the CLEAR SCOPE display shows the generated analog audio signal. The CLEAR SCOPE operational controls are similar to the Standard version MOD SCOPE, however the vertical scale is different as listed above for Monitor mode.

17-10.2.4 Duplex Mode

In Duplex mode, the softkeys provide selection of either the recovered analog audio signal or the generated analog audio signal. Otherwise, the CLEAR SCOPE display is the same as previously described in paragraph 17-10.2.1.

In DUPLEX mode, select either generate or monitor CLEAR SCOPE display by first moving the cursor to the "Select:" field within the Display area, then pressing the desired softkey **GEN** or **MON**.

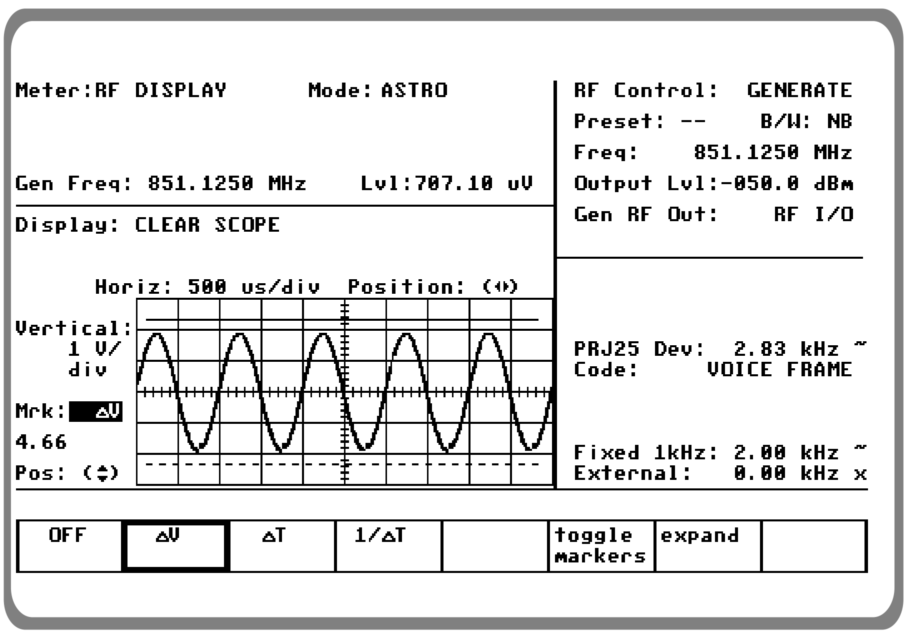

Figure 17-19. CLEAR SCOPE Markers

17-11.3 Voice Frame Decode

The Voice Frame display is used to decode and view the received embedded data in the link control frame of ASTRO transmissions.

17-11.3.1 Embedded Signaling

The ASTRO Option provides a user display of decoded embedded signaling (figure 17-20). The ASTRO option saves the last 30 frames of information on a first-in, first-out (FIFO) basis. User controls are provided to start and stop the data decoding process and to select a specific frame for display.

To monitor the received embedded voice frame data, move cursor to the RF Control zone. Set the fields as follows:

- RF Control: Monitor
- Freq: (same as transmitting unit)
- B/W: NB
- Attenuation: 0dB

Move cursor to the Display Zone. Place cursor in the “Display:” field and press **VOICE FRAME** softkey. Press **the decode start** softkey to select continuous decoding of embedded data. As the analyzer decodes embedded signaling data, the “Frame Counter” counts from 0 to 9999. The last 30 frames of data are stored and can be individually recalled.

To recall a frame, press the **decode stop** softkey and place the cursor on the “Frame:” field. Enter a number from 0 to 29 to recall a frame of data (29 being the most recent). To reset the “Frame Counter” or “Frame Number,” press the **frame reset** softkey.

The “Voice Frame” decode fields are shown in figure 17-19. The decode fields are the same as described for the encode fields in section 17-9.2.2.2 except for the “Raw:” field.

Raw

Field that contains the raw I.C. data prior to decoding. Data is displayed in hex format.

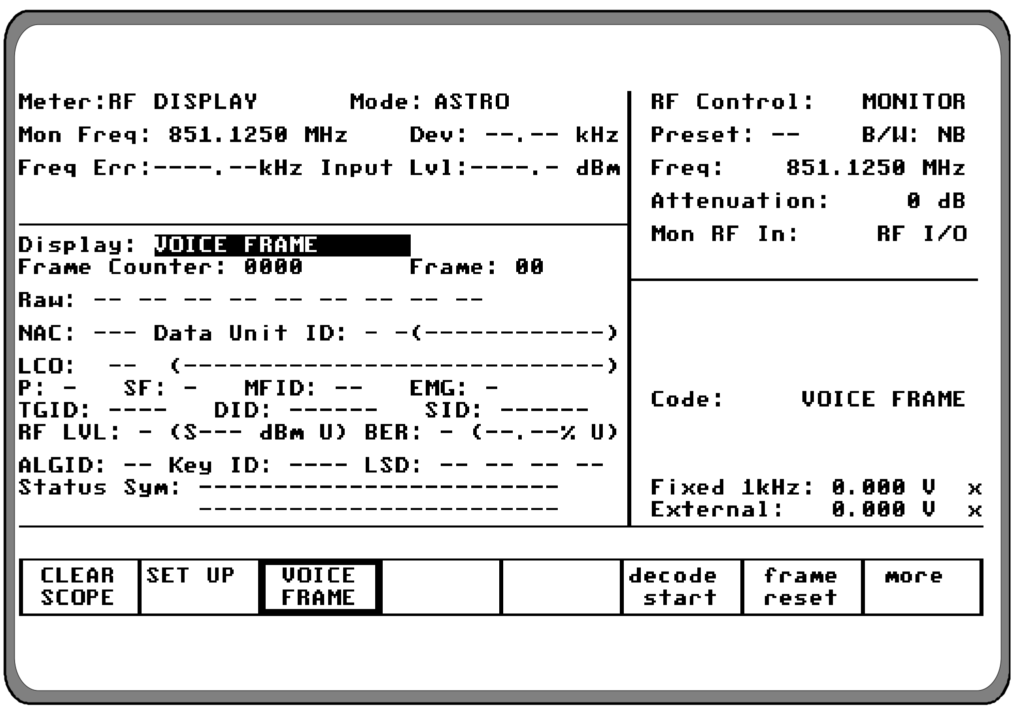

Figure 17-20-. Voice Frame Decode Display

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Section 18

ASTRO APPLICATIONS

CAUTION

When testing a radio, observe the following precautions:

- ***Do not*** *use an antenna on the analyzer for over-the-air testing.*
- ***Use*** *double-shielded cables on the analyzer to carry signals to and from the radio.*
- ***Locate*** *the analyzer at least 35 feet from the antenna of a unit that is working in the same system that the analyzer is testing.*
- ***Adjust*** *the squelch to where the LED indicator for squelch just turns off or is closed. When the signal from the radio is present, the squelch LED will illuminate indicating that squelch has been detected and there is a signal present.*

18.1 Basic ASTRO Radio Testing

This section of the manual contains information on how to connect equipment under test to the R2670 Analyzer. It is a supplement to sections 3 and 4 of the General Operations section of this manual.

18-1.1 Monitor Mode Testing

To setup for Monitor mode testing, put the analyzer in ASTRO mode, and in the RF zone select Monitor mode. Select the desired settings for each cursor position in the RF zone. Select the corresponding softkey for the Mon RF In cursor location. There are two choices: ANT and RF I/O port. The ANT port accesses the analyzer's sensitive receiver and should be used for strictly "off the air" measurements. If ANT is used, attach the supplied antenna to the ANT port. The RF I/O port should be used for direct connection to the radio under test. If RF I/O port is used, connect a coaxial cable from the analyzer's input port to the radio's output port.

Select the desired meter and display needed to perform the test. See the General Operations section and other sections in this manual for more details about the analyzer's Monitor functions.

NOTE

Do not directly apply input power to the ANT port. In the event RF power is inadvertently applied, the port is protected by in-line RF fuse. This fuse may be accessed by unscrewing the front of the BNC connector out of the front panel. Refer to section 16-2.4 in the General Operations section of this Manual for more details.

18-1.2 Generate Mode Testing

To setup for Generate mode testing, put the analyzer in ASTRO mode, and in the RF zone select Generate mode. Select the desired settings for each cursor position in the RF zone. Also select the desired levels in the Audio zone for the summed modulating signal and ASTRO deviation. Remember to enable the switches. To transmit anything other than BER, the Generate code in the Audio zone must be set to VOICE FRAME.

In the RF zone, select the appropriate softkey for the Gen RF Out cursor location. There are two choices: GEN and RF I/O port. The RF I/O port is recommended for most applications where GEN and MON ports are combined for a single connection to the radio under test. The GEN port is recommended where higher levels of output signal are needed.

Connect a coaxial cable from the selected output port to the input of the radio. Refer to the General Operations section and other sections in this manual for more details about the analyzer's Generate functions.

NOTE

Do not apply input power to the GEN output port. In the event RF power is inadvertently applied, the port is protected by in-line RF fuse. This fuse may be accessed by unscrewing the front of the BNC connector out of the front panel. Refer to section 16-2.4 in the the General Operations section of this manual for more details.

18-2 ASTRO RADIO TRANSMIT TESTS

This section describes the basic test setup for testing ASTRO radio transmitted voice and embedded data. If the selected radio channel is encrypted, select the analyzer encryption algorithm and key as described in section 17-7. Place the analyzer in Monitor mode as shown in the example below: Select the appropriate frequency that matches the radio under test; 806.0625 MHz is used in this example.

1. Place the cursor in the RF Zone and configure each field as follows:

RF Control:	MONITOR
Preset:	B/W:NB
Freq:	806.0625 MHz
Attenuation:	0 dB
Mon RF In	RF I/O

2. Connect the RF input/output of the radio under test to the RF I/O port of the analyzer as shown in figure 17-4.
3. Press the AUD hardkey to place the cursor in the Audio Zone and select VOICE FRAME.

Code:	VOICE FRAME	
Fixed 1kHz:	0.000 V	×
External:	0.000 V	×

4. Press the DISP hardkey to place the cursor in the Display Zone. If the radio transmit frequency is unknown, it can be determined by turning on the radio, pressing the radio PTT and placing the analyzer in RF Scan mode. Refer to section 17-7.1.2 for a description of the RF Scan function. After the frequency is captured, place the cursor in the "Meter:" field and select RF DISPLAY. The scanned frequency, deviation, frequency error and input power level are all displayed in the Display Zone.

18-2.1 ASTRO Voice

Move the cursor to the "Display:" field and select **MOD SCOPE**. Note that when the radio PTT is pressed, the ASTRO modulated waveform appears on the scope in the Display Zone. Turn up the volume on the analyzer and with the radio PTT pressed, speak into the radio microphone. If the radio is operating, the transmitted voice will be heard from the speaker of the analyzer.

18-2.2 ASTRO Embedded Data

Move the cursor to the "Display:" field and select **VOICE FRAME**. The Voice Frame decode table will be displayed as shown in figure 17-20. Press the **decode start** softkey then press the PTT on the radio to display the embedded data. As each frame is captured, the number displayed in the "Frame Counter:" field will be incremented. Press the **decode stop** softkey to discontinue capturing frames.

The last 30 frames of data from the radio are stored and can be recalled for further analysis. To recall a frame, enter a number from 0 to 29 in the "Frame:"

field (29 being the most recent), and the selected frame will be displayed.

To reset the "Frame:" and "Frame Counter:" fields, press the **frame reset** softkey.

The "Raw:" field displays the captured link control format data for a single frame in hex format.

18-3 ASTRO RADIO RECEIVE TESTS

This section describes the basic test setup for testing ASTRO radio received voice and embedded data. If the selected radio channel is encrypted, select the analyzer encryption algorithm and key as described in section 17-7. Place the analyzer in Generate mode as shown in the example below: Select the appropriate frequency that matches the radio under test; 806.0625 MHz is used in this example.

1. Place the cursor in the RF Zone and configure each filed as follows:

RF Control:	GENERATE
Preset:	B/W:NB
Freq:	806.0625 MHz
Output Level	-50.0 dBm
Gen RF Out	RF I/O

2. Connect the RF input/output of the radio under test to the RF I/O port of the analyzer as shown in figure 17-4.
3. Press the **AUD** hardkey to place the cursor in the Audio Zone and make the selections shown below. External must be set to a value and turned on with ~ to enable the input from the microphone of the analyzer.

ASTRO Dev:	2.55 kHz -
Code:	VOICE FRAME
Fixed 1kHz:	0.00kHz x
External:	9.95kHz -

4. Place the cursor on VOICE FRAME in the Audio Zone, and press the **display table** softkey. The VOICE FRAME ENCODE screen shown in figure 17-14 will be displayed.
5. Insert the desired values into each field of the VOICE FRAME ENCODE table or press the **default frame** softkey to enter pre-programmed values. It is essential to enter the correct Network ID code that matches the radio. This can be determined from the VOICE FRAME DECODE table when monitoring the transmitted voice frames from the radio (refer to section 18-2).
6. Press the **return** softkey from the VOICE FRAME ENCODE screen.
7. Press the **DISP** hardkey then move the cursor to the "Display:" field and select the **CLEAR SCOPE** softkey.
8. Connect a microphone to the analyzer and press the PTT. Note, when the microphone PTT is pressed, the ASTRO modulated waveform appears on the scope in the Display Zone. Turn on the radio and talk into the microphone of the analyzer. If the radio is operating, the received voice will be heard from the speaker of the radio.

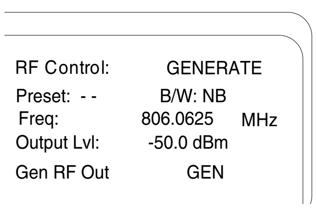
18-4 BER TESTING THE RADIO RECEIVER (Generate Mode)

This application example describes the receiver test for radios that have BER test capability. The receiver must have the capability of receiving an unencrypted V.52 BER test pattern. Performance of this test requires the analyzer to operate in Generate BER Test mode. In this mode the analyzer generates a test signal and the radio monitors the test signal. When testing the receiver, the radio under test measures the BER of the received signal and displays the result to the operator. The output level of the analyzer is reduced until the mobile radio BER threshold is determined. Consult the mobile radio maintenance manual to determine the BER threshold percentage to be used in testing.

Test frequencies may be specified for the BER test of your equipment. Consult the radio maintenance manual.

1. Connect the RF Input port of the radio under test to the analyzer GEN OUT port. Consult the radio maintenance manual to determine the appropriate test port.
2. Select the ASTRO BER Test mode by placing the cursor in the “Code:” field in the Audio Zone (Figure 4-1). With the cursor in the “Code:” field, select the **BER** softkey.
3. Set controls in the Audio zone as follows.

4. Place the cursor within the RF Control zone and configure the analyzer as follows:



5. Configure the radio under test to BER Test mode. Consult your radio maintenance manual for specific instructions. Reset the analyzer frequency to the BER Test frequency of the radio.
6. Monitor the radio's received BER. Reduce the analyzer's output level until the radio measures a BER corresponding to sensitivity threshold. Consult your radio maintenance manual for the receiver sensitivity specification.

18-5 BER TESTING THE RADIO TRANSMITTER (Monitor mode)

This application example describes the transmitter test for radios that have BER test capability. The transmitter must have the capability of transmitting an unencrypted V.52 BER test pattern. Performance of this test requires the analyzer to operate in monitor or duplex mode, while monitoring a test signal transmitted by the radio under test.

When testing the transmitter, the radio generates a test signal. The analyzer measures the transmitted BER, frequency error, and power level of the signal transmitted by the radio.

Consult the radio maintenance manual, as specific test frequencies may be specified for BER test of your equipment.

1. Connect the RF input/output of the mobile radio under test to the RF I/O port of the analyzer as shown in figure 17-3. Consult the radio maintenance manual to determine the appropriate test port.

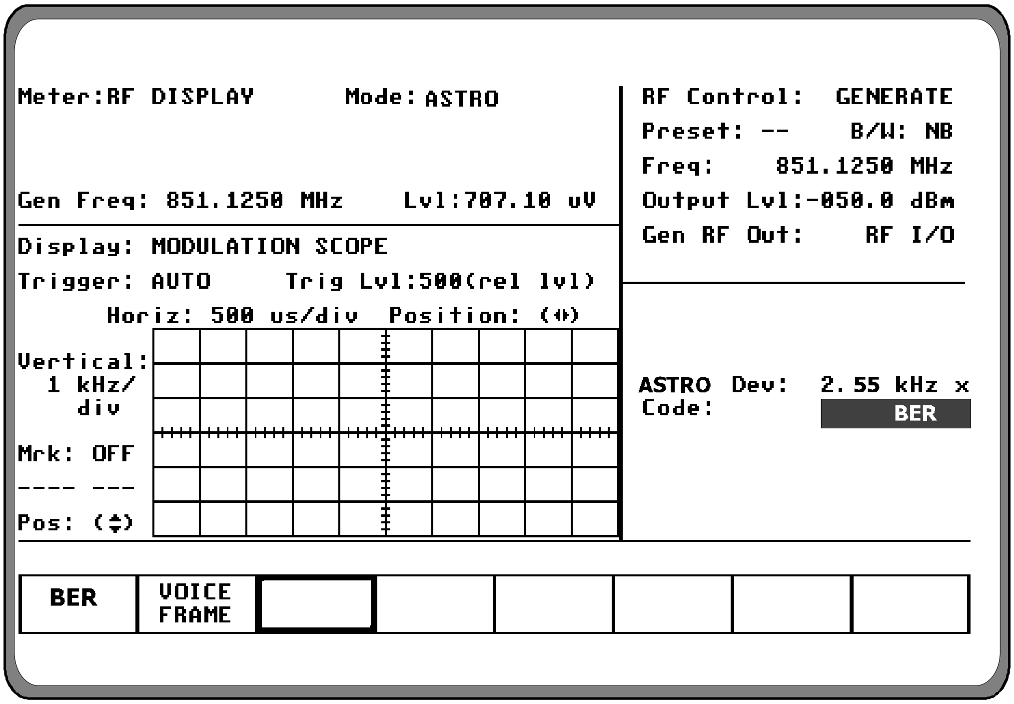


Figure 18-1. Radio (BER Test Mode) Audio Zone

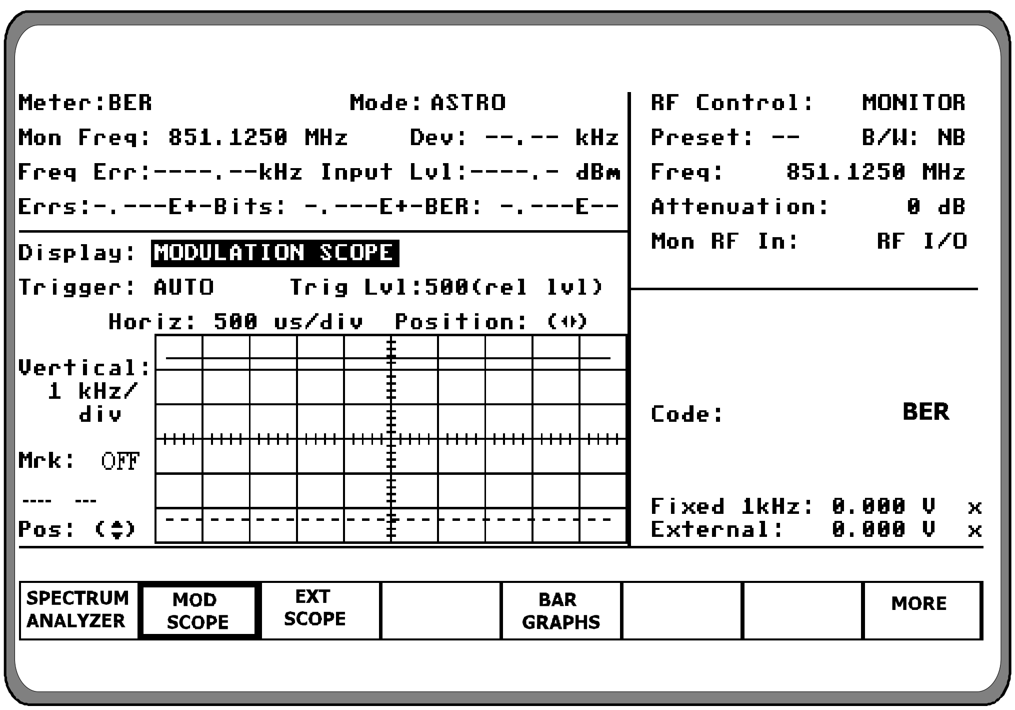
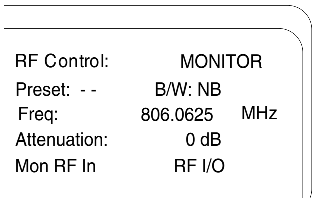


Figure 18-2. Radio (BER Test Mode) BER Meter

2. Place the cursor within the RF Control zone and configure the analyzer as follows:



3. Configure the radio under test to BER Test mode. Consult your radio maintenance manual for specific instructions. Reset the frequency of the analyzer to appropriate BER test frequency.
4. Turn on the transmitter of the radio. Consult your radio maintenance manual for instructions.
5. Access the BER Meter by placing the cursor in the Display zone's "Meter:" field and pressing the **more** softkey until the **BER** softkey is presented. Select BER via the softkey to display the BER Meter. A screen similar to figure 18-2 appears.
6. BER measurements sill be terminated at end of transmission or when switching out of BER Monitor Mode.

18-6 BER TESTING USING DUPLEX MODE

The analyzer can perform BER testing using RF or Baseband. The analyzer generates a CCITT V.52 standard BER pattern.

Figures 18-3 and 18-4 show where the analyzer BER test pattern is inserted and sampled in the transmit and receive paths.

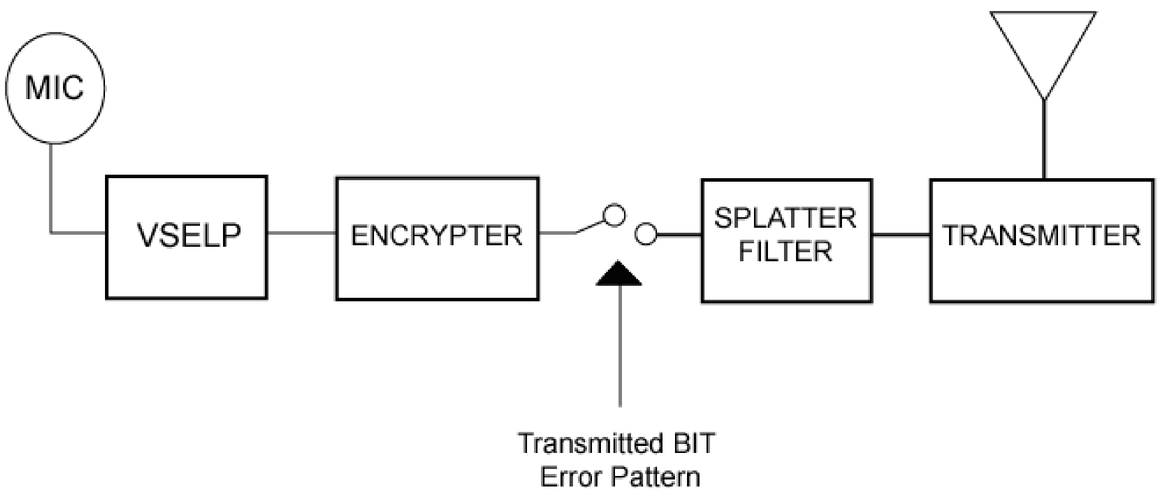


Figure 18-3. Transmit BER

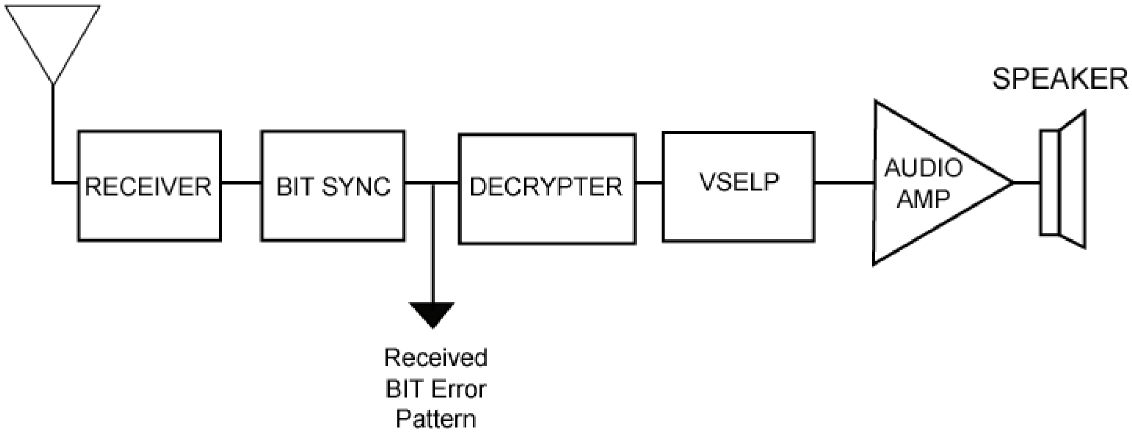


Figure 18-4. Receive BER

18.7 RADIOS WITH BER TEST CAPABILITY AND REPEATERS

Radios with BER capability and repeaters can be tested by the analyzer using the V.52 BER test pattern. In RF mode, the operation of both the radio receiver and transmitter can be evaluated. To set up the analyzer for the BER test, use the following sequence:

1. Connect the RF IN/OUT port of the analyzer to the RF port of the radio under test.
2. Place the cursor in the RF Zone and configure the analyzer as shown below. Set the monitor frequency of the analyzer at the generate frequency of the radio to be tested, and set the analyzer offset frequency to correspond to the radio.
3. Set the controls in the Audio Zone as follows:
   - ASTRO: 2.55 kHz
   - Code: BER
4. With the cursor on RF Display, press the **more** softkey and select BER. The BER metering will appear in the top left corner of the screen.
5. Press the **reset** softkey to reset the BER measurements.

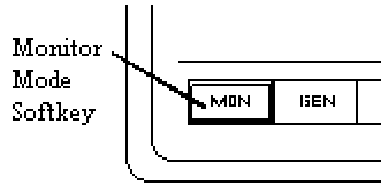
The monitored or generated BIT pattern can be observed by selecting MODULATION SCOPE in the Display Zone.

18-8 MONITORING RECEIVED AUDIO WITH CLEAR SCOPE

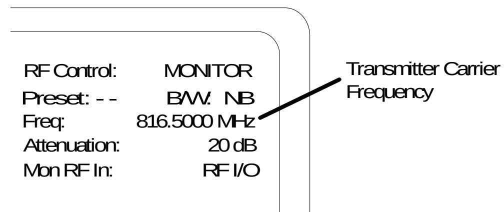
This section of the manual contains information on using the Clear Scope function to monitor an audio signal that was transmitted by an ASTRO radio and then recovered by the analyzer.

Connect the analyzer's RF I/O port to the RF output of the transmitter under test.

1. Place the analyzer in ASTRO mode. Place the cursor within the RF Zone in "RF Control:" field. Press the **MON** softkey to place the analyzer into its Monitor mode of operation.

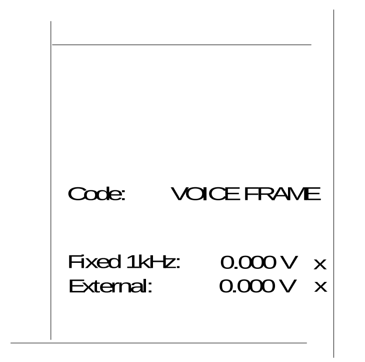


2. Within the RF Zone, set as follows:



3. Set the SQUELCH control on analyzer to threshold.

4. Press AUD hardkey and select VOICE FRAME.

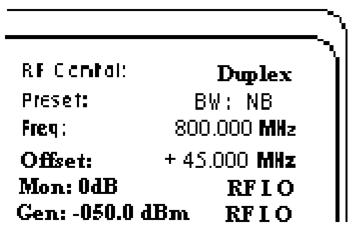


5. Press **DISP** hardkey to move the cursor to the Display Zone.

6. Place cursor in the "Display:" field and press **CLEAR SCOPE** softkey. The CLEAR SCOPE screen should appear similar to figure 18-5.

   No waveform is present until the transmitter is turned on.

7. Turn on the ASTRO radio and press PTT.



CAUTION

The analyzer's built-in RF load dissipates up to 50 W for three minutes and up to 125 W for one minute. If a high-power transmitter is keyed into the analyzer for a time long enough to threaten overheating the power measuring circuitry, the analyzer's audible alarm sounds and the display changes to the RF LOAD OVERTEMPERATURE warning, signaling the operator to unkey.

8. Move the cursor to "Horiz:" field and select the desired scale.

9. Move the cursor to "Vert:" field and select the desired scale.

10. Move the cursor to "Vert Position:" field. Use **move up/move down** softkeys or rotary control to position the recovered audio waveform on a convenient graticule.

11. Move the cursor to "Horiz Position:" field. Use **move left/move right** softkeys or rotary control to position the recovered audio waveform on a convenient graticule.

12. Move the cursor to "Mrk:" field.

13. Press **ΔV** softkey to display movable markers that measure voltage differential (Vp-p).

14. Press ΔT softkey to display movable markers that measure time differential (sec).

15. Press Δ1/T softkey to display movable markers that measure reciprocal time differential (in Hz).

16. Position the markers as desired using TUNING knob (press toggle marker softkey to select marker). The movable marker is indicated by a dashed line. Observe digital readout of marked values below "Mrk:" field.

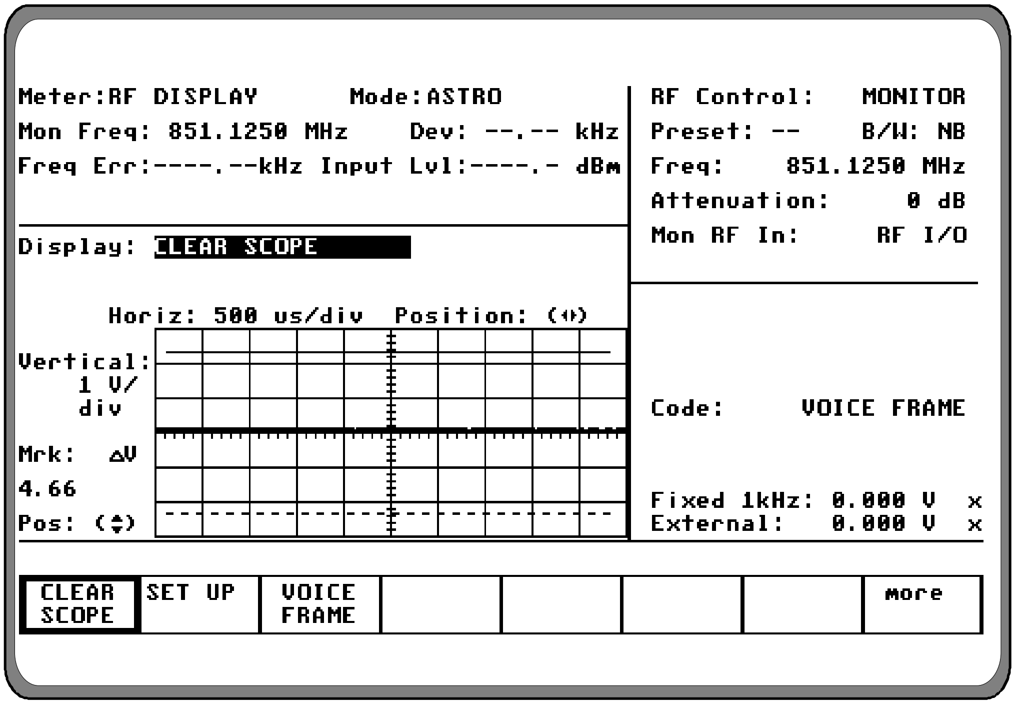


Figure 18-5. ASTRO CLEAR SCOPE Display of Recovered Audio

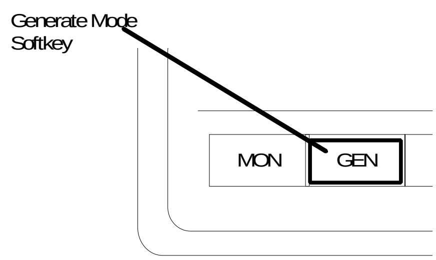
18-9 MONITORING TRANSMITTED AUDIO WITH CLEAR SCOPE

This section of the manual contains information on using the Clear Scope function to analyze the R2670's raw modulation signal (1 kHz) in ASTRO Generate mode. This analog signal is viewed prior to being digitized and encrypted.

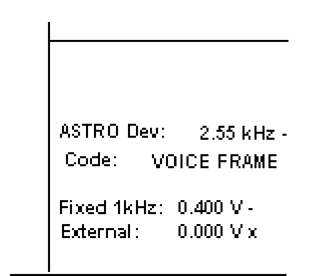
NOTE

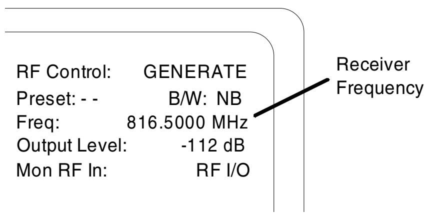
It is not necessary to connect the analyzer's DVM port for this application.

1. Place the analyzer in ASTRO mode. Place the cursor within the RF Zone in "RF Control:" field. Press the **GEN** softkey to place the analyzer into its Generate mode of operation.



2. Within the RF Zone, set as follows:





NOTE

For setup and distortion measurements, set the output level to at least 30 dB above the sensitivity threshold (-80 dBm recommended).

3. Use the CURSOR ZONE keys to move the cursor to the Audio Zone. Within the Audio Zone, move the cursor to Fixed 1 kHz controls field. Select 1 kHz audio source as the modulating signal (also available from the MOD OUT connector on the front panel) by turning 1 kHz on "~". Set 1 kHz voltage level to 0.4 volt.

4. Turn on the ASTRO receiver and tune receiver and analyzer to the same frequency. Verify receiver locks onto test signal.

5. Use the CURSOR ZONE keys on analyzer front panel and move the cursor to the Display Zone.

6. Place cursor in the "Display:" field and press **CLEAR SCOPE** softkey. The CLEAR SCOPE screen should appear similar to figure 18-4.

7. Move the cursor to "Horiz:" field and press **200 us** softkey.

8. Move the cursor to "Vert:" field and press **200 mv** softkey.

9. Move the cursor to "Vert Position:" field. Use **move up/move down** softkeys or rotary control to position the modulating 1 kHz waveform on a convenient graticule.

10. Move the cursor to "Horiz Position:" field. Use **move left/move right** softkeys or rotary control to position the modulating 1 kHz waveform on a convenient graticule.

11. Move the cursor to "Mrk:" field.
    - Press **ΔV** softkey to display movable markers that measure voltage differential (Vp-p).
    - Press **ΔT** softkey to display movable markers that measure time differential (sec).
    - Press **Δ1/T** softkey to display movable markers that measure reciprocal time differential (in Hz).

12. Position the markers as desired using TUNING knob (press **toggle marker** softkey to select marker). The movable marker is indicated by a dashed line. Observe digital readout of marked values below "Mrk:" field.

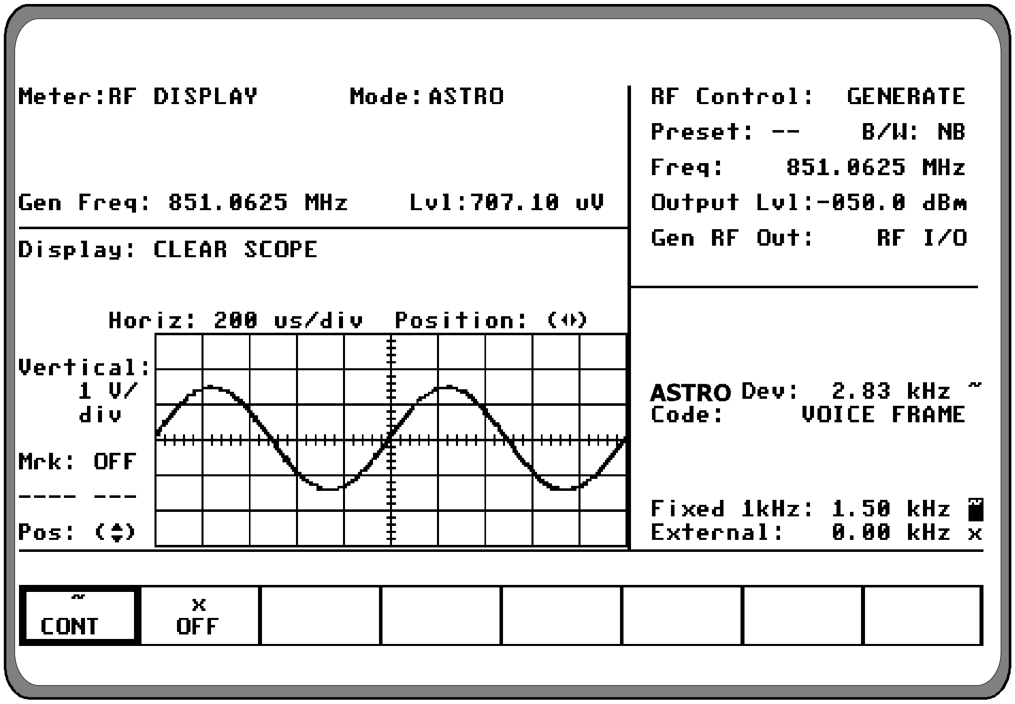


Figure 18-6. ASTRO CLEAR SCOPE Display of Output Modulation

Section 19

PROJECT 25 INTRODUCTION

19-1 INTRODUCTION

This manual contains information regarding the R2670 Project 25 features. Project 25 provides unique testing features for communications equipment using Project 25 encoding and modulation principles. The additional Project 25 test capabilities are accessed via the LCD display, screen-defined softkeys, numeric keypad, cursor movement keys, and optical tuning knob. Some of the Project 25 functions may also be accessed via the remote control interface port.

19-2 CAPABILITIES

The Project 25 feature set gives the R2670 the capability of monitoring and generating Project 25 signals. A Project 25 signal relates to the Association of Public-Safety Communications Officials International (APCO) Project 25 digital standard Common Air Interface (CAI) signaling scheme in which a serial bit stream is encoded, mapped into one of four corresponding amplitudes, filtered digitally, and then modulated onto an RF carrier.

NOTE

Trunking operation is described in section 23.

Voice Mode System Testing

Voice mode provides Project 25-compatible modulation and demodulation with Improved Multi-Band Excitation (IMBE) vocoding. The Project 25 Option generate and monitor modes support actual functional voice testing in both the unencrypted and encrypted modes. In the encrypted mode, either a test key or an operator key loaded from a separate compatible keyloader can be used.

Bit Error Rate (BER) Testing

A BER test pattern can be selected to modulate the R2670 generator for BER testing. A 1011 Hz Tone Test pattern can likewise be decoded by the R2670 in monitor mode and a BER computed from a comparison with a stored version of the expected pattern.

Dedicated Test Screens

Dedicated Project 25 test screens are zoned with RF and Modulation control screens to simultaneously display test results along with their test conditions. Dedicated test screens can be set up as a start-up default condition or as a programmable test set-up.

Clear Scope Display

The display provides a graphic image of the audio clear signal. This clear signal is selectable at either the vocoder input in generate mode or the vocoder output in monitor mode.

19-3 PROJECT 25 CONNECTORS

The R2670 has two connectors as shown in Figure 19-1. Both connectors are located on the side of the housing. The KVL connector provides a receptacle for loading an external encryption key. The other connector is an interface port.

KEY VARIABLE LOADER (KVL) PORT

The KVL port allows the analyzer to be preloaded with a user-selected encryption key from any compatible KVL keyloader. Project 25 is compatible with DX compatible key loaders or any KVL 3000 with the ASN option.

INTERFACE PORT (25 pin)

The interface port is provided for future capability.

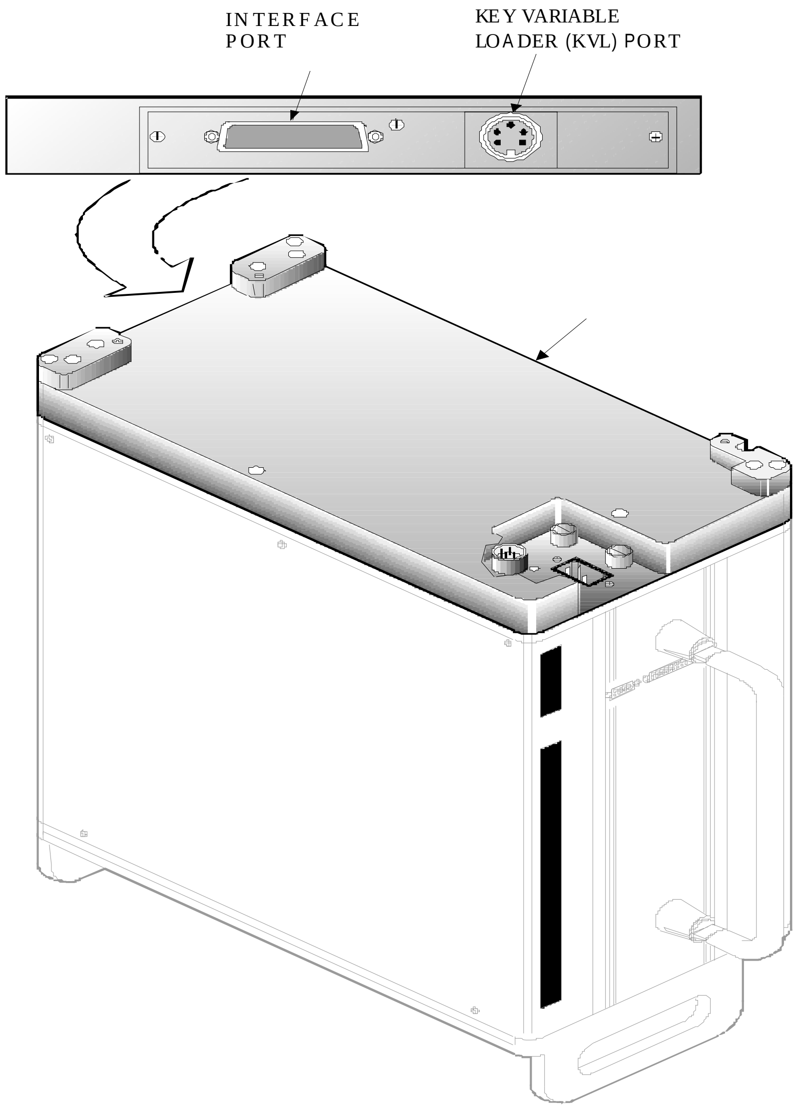


Figure 19-1. Bottom of R2670

Section 20

DESCRIPTION

20-1 INTRODUCTION

The Project 25 features extend the standard functions of the R2670 to provide an all-in-one servicing instrument for Project 25 digital radio systems.

20-2 BASIC OPERATION

The R2670 can emulate the same digital environment used by Project 25 radios in clear and secure mode. This capability allows the analyzer to interoperate with conventional Project 25 radios. Standard test equipment is unable to decrypt secure audio transmissions from Project 25 radios because the audio signals are converted from their native analog format to a digital, ciphered representation prior to transmission.

A Project 25 digital radio provides for both clear and secure voice and data. When operated in secure mode, the radio encrypts communications prior to their transmission. Only intended subscribers, with compatible hardware plus matching security keys, can decrypt the message. In this way, users of a system can be partitioned into groups, each with their own security key. The R2670 will accept an external operating key from any compatible keyloader.

In its Project 25 mode, the R2670 provides display screens for monitoring bit error rate characteristics of a radio under test and also generates bit error rate test patterns to support this mode of operation.

The R2670 provides a clear scope display of audio signals, either the input to the vocoder (generate mode) or the output from the vocoder (monitor mode).

20-3 TEST CONSIDERATIONS

Project 25 digital radio systems encrypted communications have a need to maintain even higher standards of RF signal quality than normal FM radio systems. Encryption subjects the Project 25 signals to additional processing. In order to work reliably, the radios must be tuned to preserve critical factors such as operating frequency response and transmitter deviation.

Operating in secure or standard mode, the R2670 bundles a wide assortment of sophisticated test features in a single instrument.

20-4 SPECIAL TERMS

The following list contains brief definitions of special terms that are used in association with Project 25 radios and test equipment:

algorithm - In secure systems, an algorithm is a distinct method for translating clear information (input) to a secure version of the information (output). The same algorithm is used to interpret the message. Project 25 systems use the following algorithm:

- *DES-OFB*
- *DES-XL*
- *DVP-XL*
- *DVI-XL*

BER test - In generate mode, the analyzer modulates the RF carrier with Bit Error Rate test pattern to test the Unit Under Test receiver. The test pattern received by the Unit Under Test will be compared in the unit under test with a stored version of the test pattern to compute a BER. This will only be possible if the Unit Under Test has this test mode capability.

In monitor mode, the analyzer monitors the received 1011 Hz tone test pattern, compares it with a stored version, and provides a metering display of bits received, number of bits expected, and bit error rate percentage.

cipher - to convert information to a seemingly random pattern for transmission or wireline delivery in order to protect sensitive information. Ciphered voice and data can only be understood by means of a special key.

IMBE vocoding – Improved Multi-Band Excitation technique used in Project 25 radios and test equipment to code digitized analog voice signals before transmission and the reconstruct analog voice signals on the receiving end.

decryption - process of converting cipher text to plain text

encryption - process of converting plain text to cipher text

key - a sequence of bits stored electronically in the encryption and decryption modules.

key loader (KVL)- a device used to load an electronic encryption key into a radio or other device.

Section 21

OPERATING INSTRUCTIONS

CAUTION

When testing a radio, observe the following precautions:

- ***Do not** use an antenna on the analyzer for over-the-air testing.*
- ***Use** double-shielded cables on the analyzer to carry signals to and from the radio.*
- ***Locate** the analyzer at least 35 feet from the antenna of a unit that is working in the same system that the analyzer is testing.*
- ***Adjust** the squelch to where the LED indicator for squelch just turns off or is closed. When the signal from the radio is present, the squelch LED will illuminate indicating that squelch has been detected and there is a signal present.*

21-1 INTRODUCTION

The Project 25 features are an enhancement to the R2670 Communications System Analyzer. The following sections of this manual contain information on how to connect Project 25 radios under test to the analyzer and how to set controls and indicators to obtain the correct screen display.

Error/Warning Messages

Refer to Appendix L for a listing and description of error and warning messages related to the Project 25 test mode.

21-2 SOFTWARE VERSION SCREEN

To view the software version of the R2670 Analyzer, turn power on and wait for the display to appear on the screen. Press the **SPF** hard key, and move the cursor to "VERSION." Select the **display table** softkey. This will configure the analyzer to generate a screen that displays the PROJ 25 software version (Figure 21-1).

Move the cursor to the PROJ 25 position and select the **view options** softkey. A screen similar to Figure 21-2 will be displayed and indicates the analyzer options installed and encryption algorithms available.

Select **return** softkey twice to return to the PROJ 25 CONV mode screen.

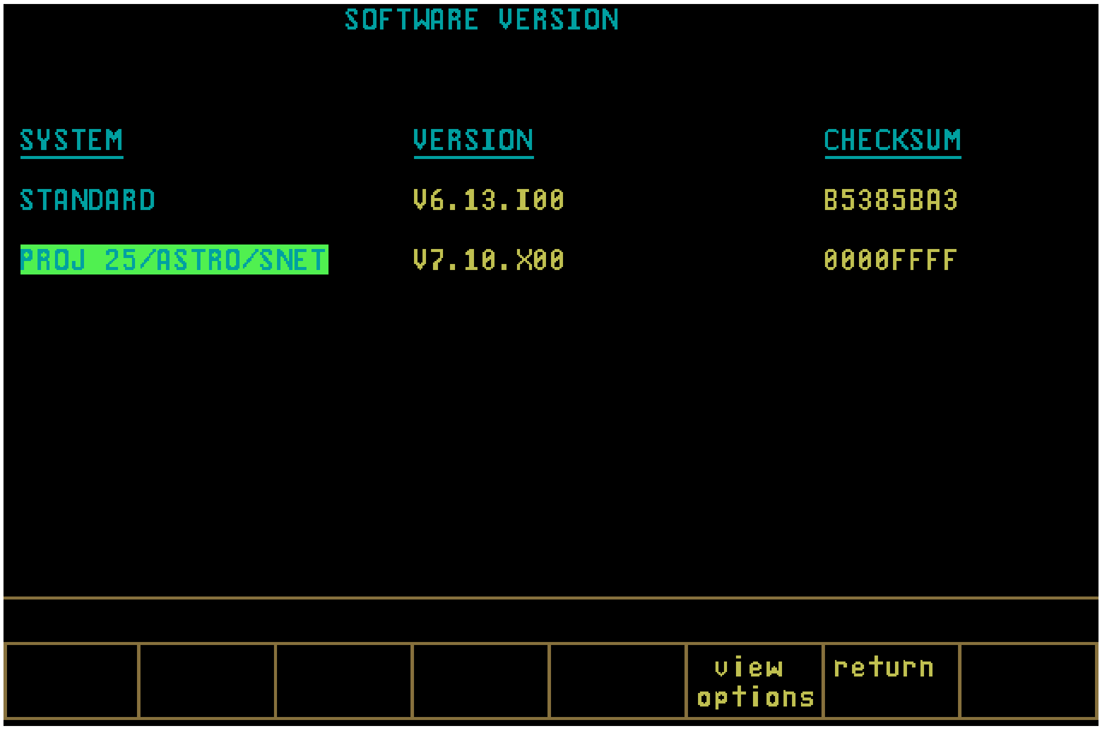


Figure 21-1. PROJ 25 Version Screen

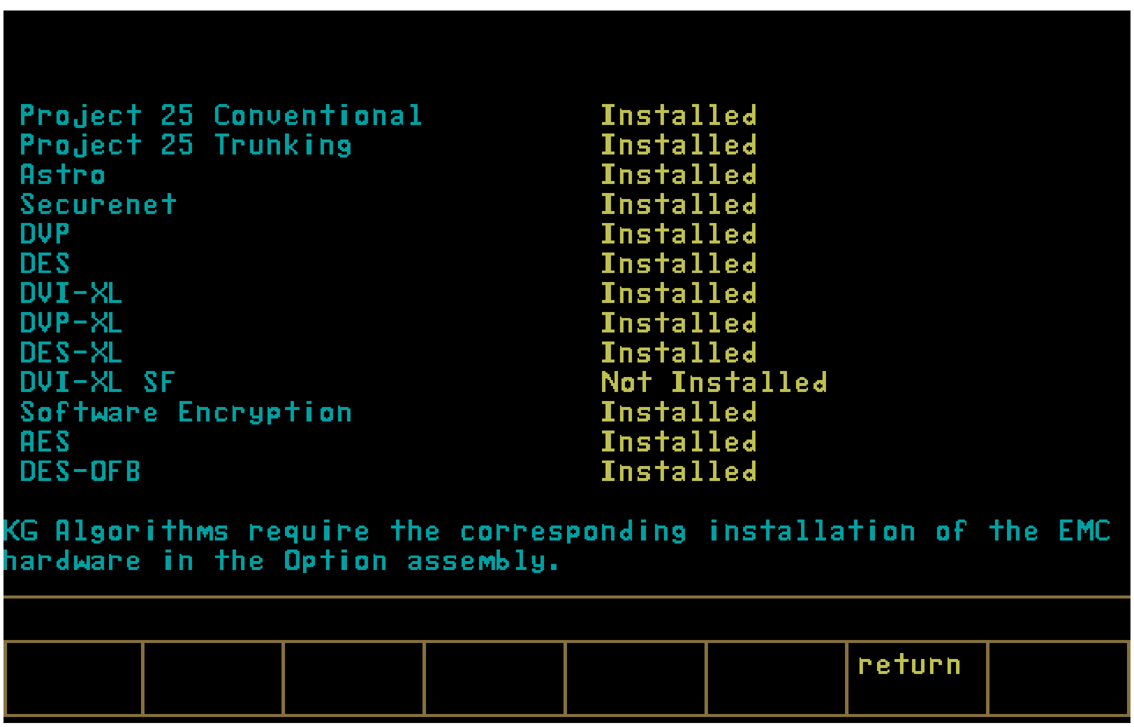


Figure 21-2. PROJ 25 Options Screen

21-3 BASIC OPERATION

Control of the unit and selection of data to be displayed are done through the use of three main windows which simultaneously appear on the screen: the Display Zone, the RF Zone, and the Audio Zone. These three zones are shown in Figure 21-3. The Display Zone displays data related to the radio under test. The RF Zone is used for selection of RF mode, selection of frequency band, I/O port selection and for control of RF signal level at the input/output port. The Audio Zone is used to select the modulation format, and the signal source and deviation level when generate mode has been selected.

21-3.1 Display Screens

The three main windows, or cursor zones, are accessed through a cluster of three CURSOR ZONE keys at the top center of the unit. The location where the cursor rests within each zone is called a cursor field. To control the unit and enter data, all operator inputs are made at highlighted cursor fields (brighter-face type).

Below the screen are softkeys. These softkeys, with customized on-screen labels, interact with the screen to provide a unique menu of entry options for each cursor field. This greatly reduces the number of keys and eliminates having to search through unrelated controls to find the one that is needed.

21-3.2 Manual Operation

To control the cursor location and input information by (manual control):

- Use the CURSOR ZONE keys to move the cursor among the three zones.
- Use the CURSOR POSITION keys to move the cursor from field to field within a zone.
- Once at the desired field, use either the TUNING knob or the numeric keys to enter numeric information. Use the softkeys for other menu selections.

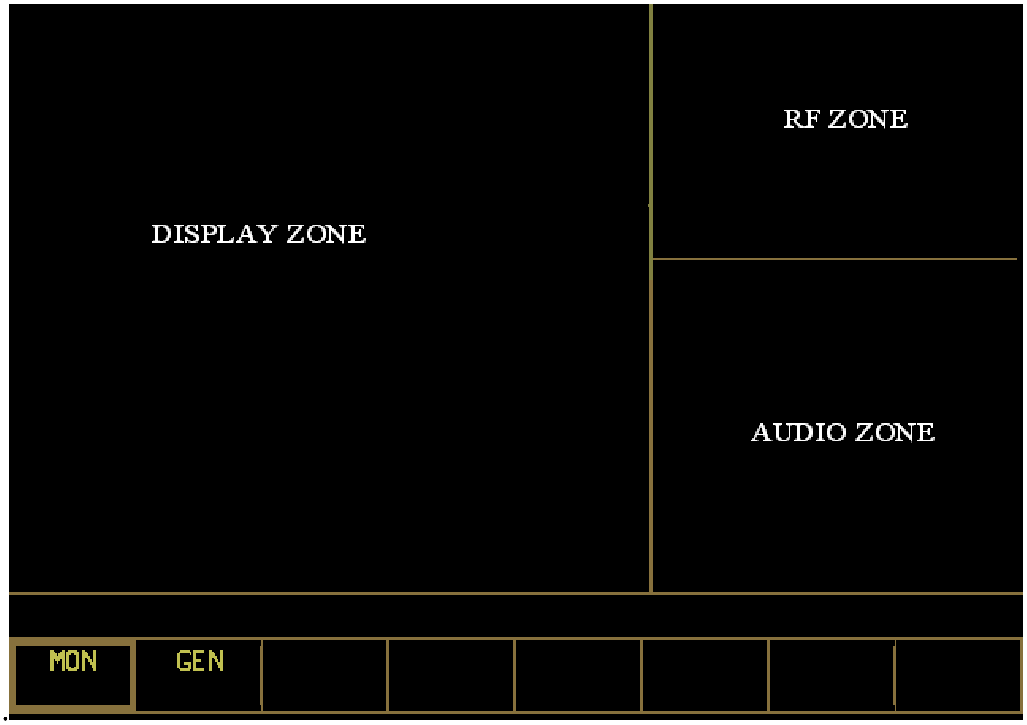


Figure 21-3. Screen Zone Arrangement

21-3.3 Expanded Display

Some fields have the ability to expand their contents to fill the entire screen. These fields consist of the following:

- Spectrum analyzer, clear scope, mod scope, ext scope, bar graph displays
- Encode tables
- Dedicated keys

21-3.4 Dedicated Keys

Refer to Section 2-2.1 in this manual for an explanation of the HELP, MEM, SPF, and CAL keys.

21-3.5 Remote Operation

The R2670 Communications System Analyzer is equipped with a standard RS-232 interface. This interface may be used to remotely control the analyzer using a set of commands, queries, and responses that are defined in the General Dynamics R2600 Series Communications System Analyzer Programming Reference Manual (68-80309E55).

21-3.6 HELP

The analyzer provides on-screen operating instructions via the dedicated HELP key. Help screens are organized such that each display area has an associated help screen pertaining to that area of the screen. System help is available via a softkey within each help screen. Use the **return** softkey to return to the function in progress.

21-4 ENCRYPTION CAPABILITIES

When in PROJ 25 CONV mode, the R2670 can operate in clear or hardware encrypted modes. Project 25 equipment converts normal speech patterns to their digital equivalent and then uses an encryption algorithm to encrypt data for transmission. A receiving radio, using the same algorithm and a matching key, automatically reverses the process so you can hear a normal audio message.

A set of either U.S. or International encryption algorithms is available with the Project 25. Algorithms include Data-Encryption System (DES) - a U.S. Federal Government encryption standard, and Digital Voice Protection (DVP) - a Motorola Proprietary encryption algorithm, and DVI - a Motorola Proprietary encryption algorithm for international use. Within a set, each algorithm is individually selectable:

Domestic: DES-OFB, DES-XL, DVP-XL

International: DVI-XL, DVP-XL

21-5 TEST SETUP

Connecting a Radio

Use a 50 ohm BNC cable and an N to BNC adapter to connect from the RF I/O port of the R2670 analyzer to the antenna port of the radio as shown in Figure 21-4.

CAUTION

When in Monitor mode, adjust the squelch to where the LED indicator for squelch just turns off or is closed. When the signal from the radio is present, the squelch LED will illuminate indicating that squelch has been detected and there is a signal present.

CAUTION

Observe the input power ratings and warnings of the analyzer to insure that no damage occurs to the analyzer.

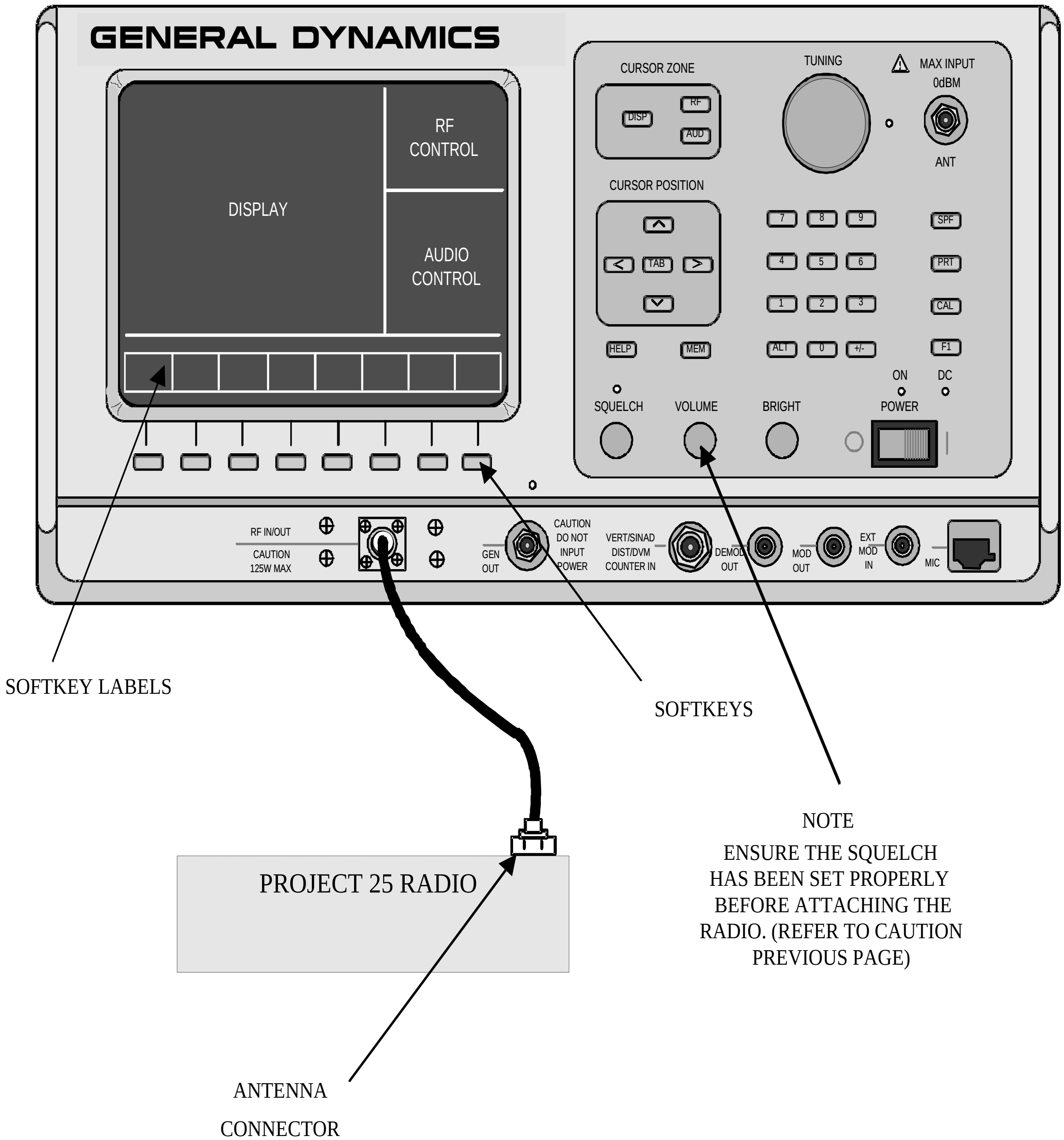


Figure 21-4. Radio to Analyzer Test Setup

21-6 ACCESSING PROJ 25 CONV MODE

Select the PROJ 25 CONV mode by placing the cursor in the "Mode:" field in the Display Zone located at the top of the screen. Use the **PROJECT 25 CONV** softkey to select the PROJ 25 CONV mode. A screen similar to Figure 21-5 appears.

When the display zone "Mode:" is set to PROJ 25 CONV, the R2670 will configure itself to generate and monitor conventional Project 25 signals.

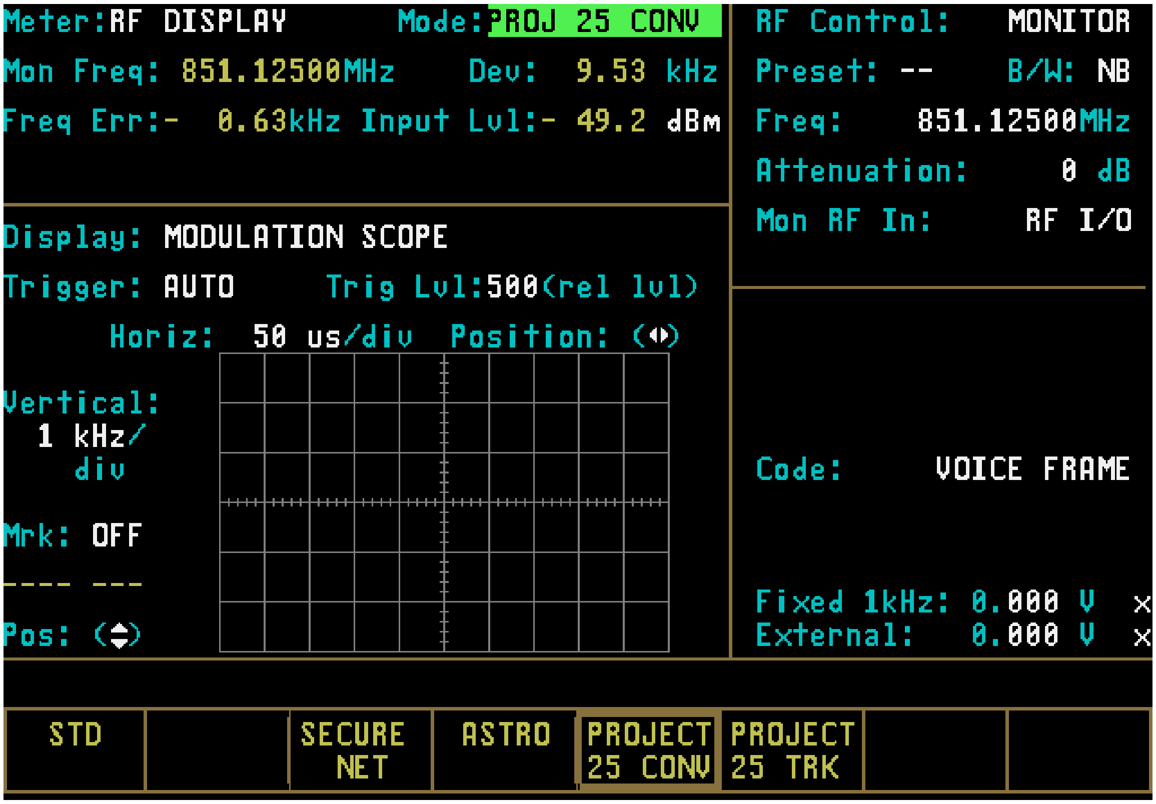


Figure 21-5. PROJ 25 CONV Mode Screen

21-7 PROJ 25 CONV ENCRYPTION SET UP

21-7.1 SET UP Encryption Display

The SET UP display places the analyzer in encryption setup mode and allows the operator to select the desired algorithm. The SET UP display is accessed from the Display Zone. To use SET UP display, move the cursor to the "Display:" field and select SET UP using the **SET UP** softkey. The Display Zone will show a menu of SET UP options as shown in Figure 21-6.

21-7.1.1 Encrypt

The analyzer operates in either clear or encrypted modes. In the Display Zone, scroll the cursor to the "Encrypt:" field and select ON as shown in Figure 21-7 for encrypted PROJ 25 CONV, or OFF for clear PROJ 25 CONV operation.

21-7.1.2 Algorithm Select

Within the SET UP display, the type of algorithm can be selected. Algorithm is a term that describes the method of coding data or audio so that only equipment having the same algorithm selected and the same key are able to exchange voice and data information. The analyzer includes several algorithms recognized by radios using Project 25. You will need to select these algorithms to use for processing messages.

In the Display Zone, move the cursor to the "Algorithm Sel:" field as shown in Figure 21-8. Softkeys will provide for selection of the available algorithms. Select the appropriate algorithm. Refer to 21-4 for a description of the U.S. and International encryption algorithms.

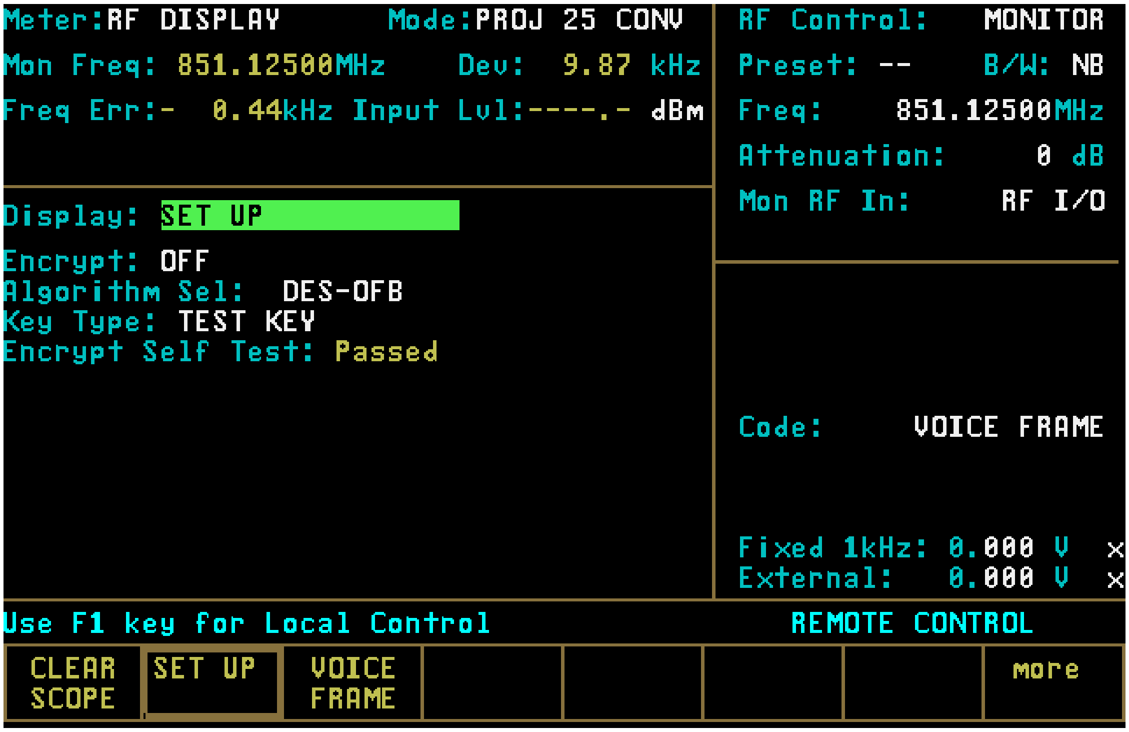


Figure 21-6. SET UP Display Screen

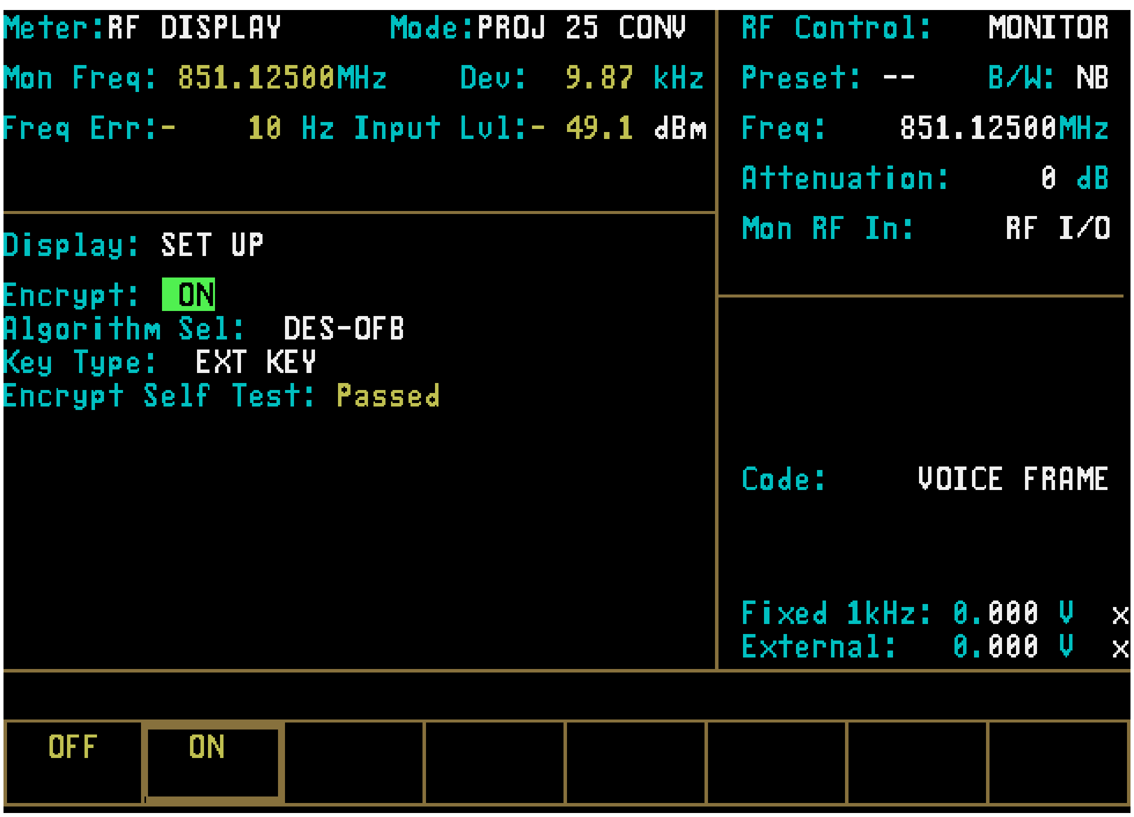


Figure 21-7. Encryption Select Display

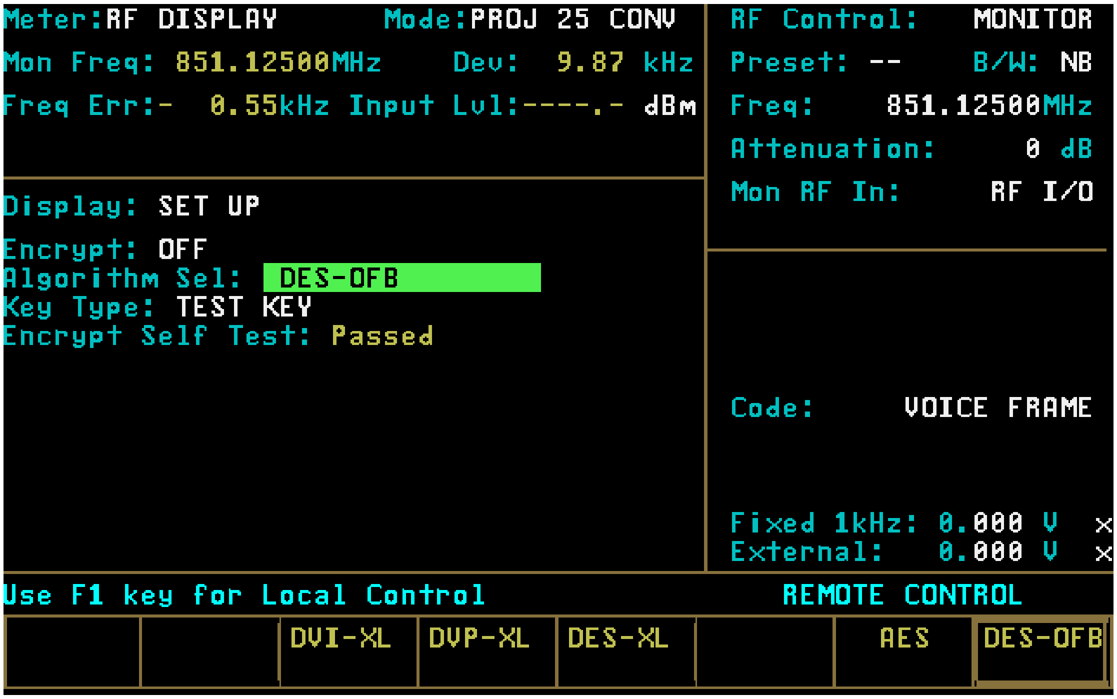


Figure 21-8. Algorithm Select Display

21-7.1.3 Key Type

An encryption key is needed when testing in the encryption mode. There are two encryption key types that can be selected, either a Test Key or an External Key. The Test Key is the default and is used to support most Project 25 testing. The Test Key is a predefined key that is programmed into the analyzer for testing purposes only. In order to prevent compromised security, the Test Key should never be used for sending secure radio communications (all Project 25 analyzers use the same Test Key). The External Key is a key that has been loaded from a KVL. In order to test secure communications the keys in both the Unit Under Test and the analyzer must be the same. The analyzer provides these softkey selections:

TEST KEY

This softkey selects the Test Key saved in the analyzer's key storage memory.

EXT KEY

This softkey selects the External Key saved in the analyzer's storage memory for the selected algorithm. This key is defined by the customer and must first be loaded into the analyzer by a KVL.

erase ext key

This softkey erases from the analyzer's key storage memory any External Key saved for the current algorithm.

load ext key

This softkey starts the sequence of programming the analyzer with an External Key for the algorithm selected from a Key Variable Loader (KVL). This procedure requires a key loading cable and KVL.

21-7.1.4 Encrypt Self Test

A self test of the encryption functions is performed at power up. The "Encrypt Self Test:" field in the SET UP display (Figure 21-6) indicates the results of the self test, passed or failed.

21-7.2 Using the Test Key

The analyzer can be used to test radios using the internal Test Key (707070….hex). To select the Test Key, place the cursor in the

"Display:" field in the Display Zone. Select SET UP using the **SET UP** softkey. This will

access the SET UP display screen (Figure 21-6).

Move the cursor to the "Encrypt:" field and select the **ON** softkey (Figure 21-7). Move the cursor to the "Algorithm Sel:" field and select the desired algorithm using softkeys (Figure 21-8). Move cursor to the "Key Type:" field and select the **TEST KEY** softkey (Figure 21-9). The analyzer is now programmed with the Test Key.

Project 25 radios also have an internal Test Key which is the same as the analyzer's. Refer to the radio service manual to determine if this key can be activated in your particular radio. If the internal Test Key cannot be activated, it must be loaded from a KVL.

Follow the procedure in the KVL instruction manual to load the 707070…..hex key into the radio. The radio encrypter is now keyed to match the analyzer.21-7.3

You can use a customer key to program the analyzer and operate in private mode with a keyed radio. The customer (external) key, once loaded, is saved in memory by the analyzer until the operator erases it. The key is stored in non-volatile memory and will be retained even if power to the analyzer is turned off.

21-7.3.1 Connecting the KVL

The KVL plugs into the KVL port (Figure 21-1) on the side of the analyzer opposite the carrying handle. Connect the KVL to the analyzer and then use the following instructions to load the External Key.

CAUTION

*Use only DX key loaders, or any KVL 3000 with the ASN option. Other types of key loaders (AX, BX or CX) may cause the encryption hardware to malfunction. To recover, press the **encrypt reset** softkey under the "Special Functions" (SPF) menu.*

Programming with External Key

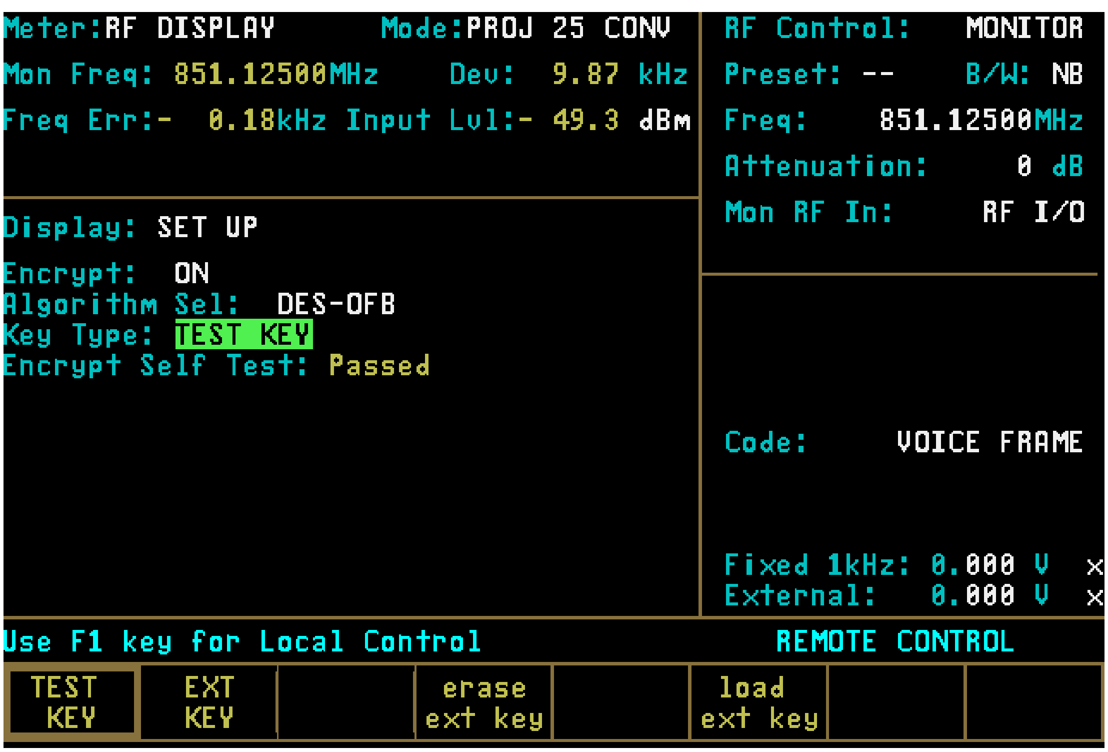


Figure 21-9. Test Key Programming Display

21-7.3.2 Loading External Key

To initiate loading an external key, place cursor in "Display:" field in Display Zone and select SET UP mode display using **SET UP** softkey.

Move cursor to "Algorithm Sel:" field and select desired algorithm using softkeys (Figure 21-8).

Move cursor to "Key Type:" field.

Press the **load ext key** softkey to initiate the key load sequence.

Push the switch on the KVL to begin loading. This activates the programming function. When programming is complete, the KVL displays "pass" if the key load procedure was successful. The analyzer displays a message “Ext key passed." If the key load procedure was unsuccessful, the KVL displays "fail."

If key load procedure was successful, disconnect the KVL. Be sure to press the **EXT KEY** softkey after loading an External Key from the KVL in order to use the key. This completes External Key loading. You can exit the SET UP screen at this time.

21-7.3.3 Erasing External Key

To erase an External Key, place cursor in "Display:" field in the Display Zone and select **SET UP** softkey. This will access the SET UP display screen (Figure 21-6).

Move cursor to "Algorithm Sel:" field. Using softkey, select the algorithm associated with the external key you want to erase.

Move cursor to "Key Type:" field and press **erase ext key** softkey (Figure 21-10). The analyzer will erase the stored External Key and display "key erased" in the message area.

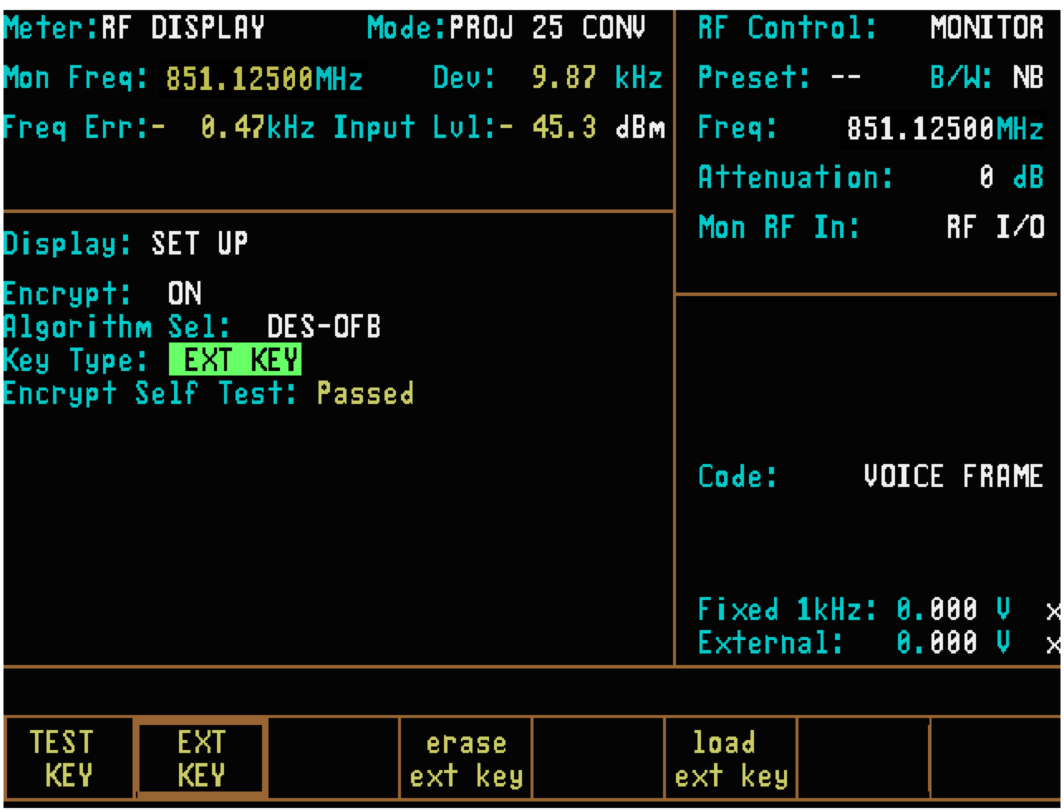


Figure 21-10. External Key Programming Display

21-8 PROJ 25 CONV RF OPERATING MODES

Select the RF operating mode by placing the cursor in the "RF Control:" field in the RF Zone. Use the desired softkey to select MONITOR or GENERATE.

21-8.1 Monitor Mode

The Monitor mode (Figure 21-11) provides the analyzer's test receiver function which is used in the testing of radio transmitters. In PROJ 25 CONV Monitor mode, the RF Zone is similar to the RF Zone in standard mode. It is capable of setting up the analyzer to monitor RF input through its antenna or direct connection to the transmitter.

The RF Zone in Monitor mode contains fields for choosing the monitor bandwidth, frequency, attenuation, and source of the Project 25 RF signal.

The specific entry fields are as follows.

Preset

Refer to Section 21-8.5 Memory Screens under the General Operation tab in this manual for information on this field.

B/W

Selects either wide or narrow IF bandwidth of the unit via softkey selection. Narrow bandwidth is typically used for Project 25.

Freq

Enter the desired monitor frequency using keypad or TUNING knob.

Attenuation

Selects the amount of attenuation at the RF input to the monitor receiver using softkeys. Selectable input attenuation is useful in adjusting displays for a wide range of input levels, as well as for use in high RF field environments where intermodulation may cause desensitization of the receiver.

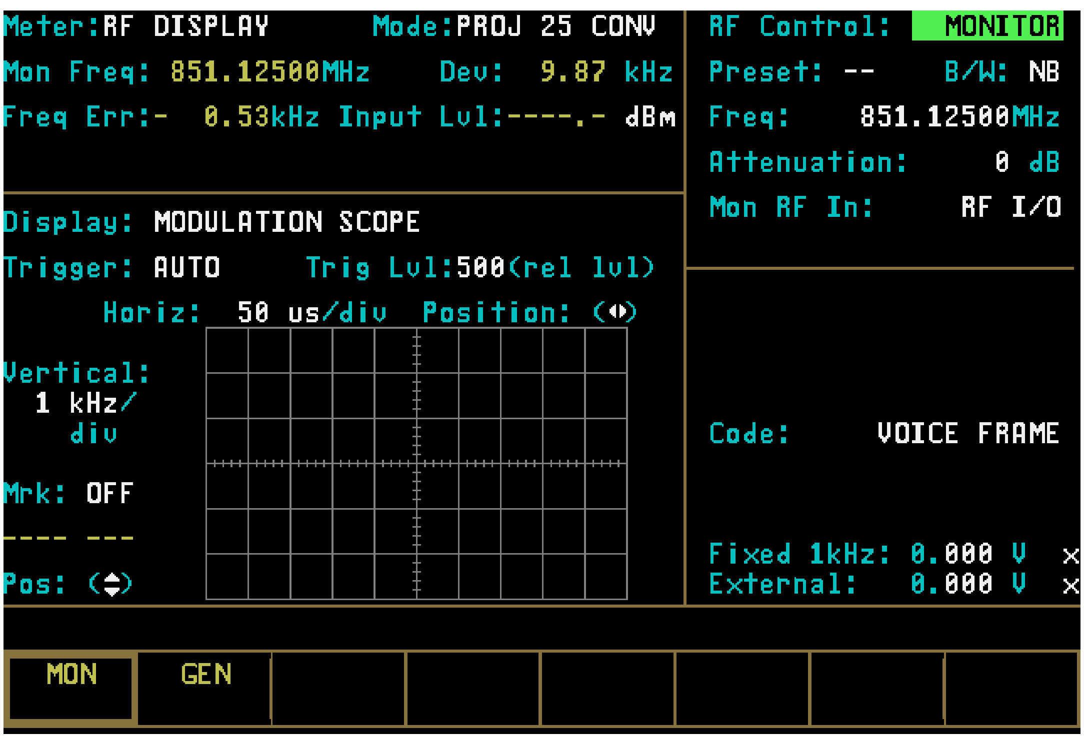


Figure 21-11. Monitor Mode - RF Zone

Mon RF In

Selects the RF input port via softkeys. The RF I/O port contains an RF load and should be used for direct connection to the radio under test. The ANT port accesses the unit's sensitive receiver and should be used with an antenna for "off-the-air" reception. Selection of the ANT port is indicated by a red LED next to the ANT connector.

CAUTION

Do not apply input power to the ANT input port. In the event RF power is inadvertently applied, the port is protected by an in-line RF fuse. This fuse may be accessed by unscrewing the front of the BNC connector out of the front panel.

21-8.2 GENERATE Mode

The GENERATE mode (Figure 21-12) configures the Analyzer to generate an RF signal at a controlled output level. The GENERATE mode thus provides for Project 25 radio receiver testing. In PROJ 25 CONV Generate mode, the RF Zone is similar to the RF Zone in standard mode. It is capable of setting up the analyzer to generate RF output through its RF I/O port or through the Generator Output (GEN OUT) port. The RF Zone contains fields for choosing the generator bandwidth, frequency, output level, and output connector of the Project 25 RF signal. All of these fields operate as described under the General Operations tab in this manual except the “Modulation Type:” field is not required.

Specific controls that further configure the GENERATE mode are located in RF Zone when GENERATE is first selected.

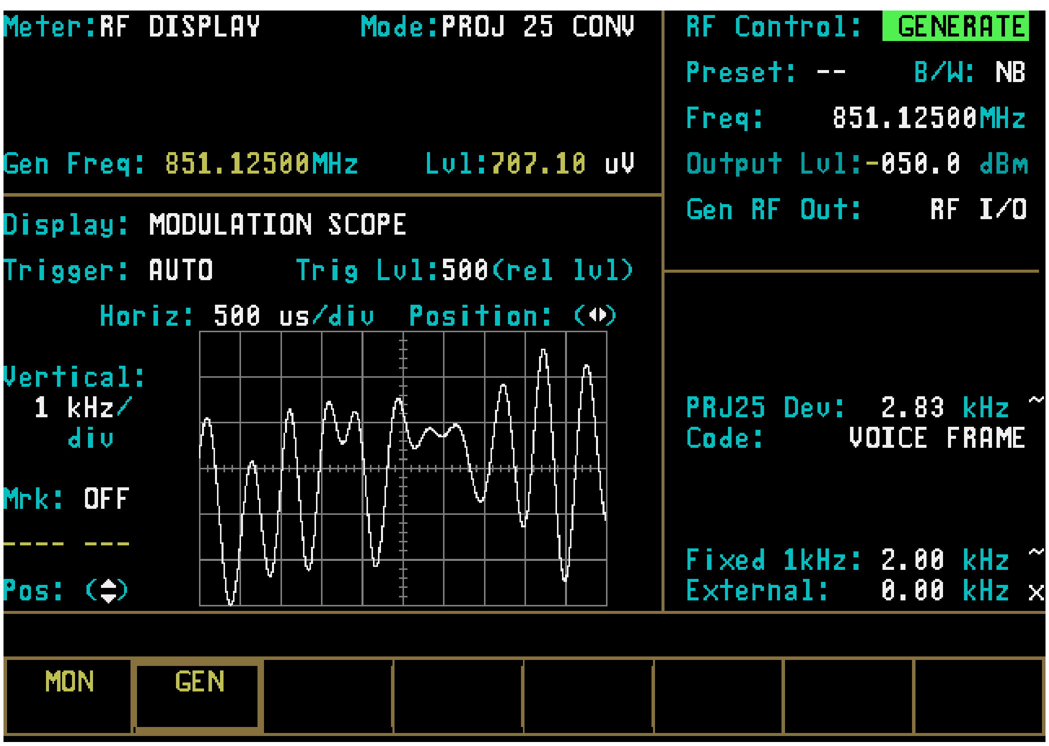


Figure 21-12. Generate Mode - RF Zone

The specific entry fields are as follows:

Preset

The preset function is the same as in the Monitor mode.

B/W

Selects either wide or narrow bandwidth of the unit via softkey selection. Narrow bandwidth is typically used for Project 25.

Freq

Enter the desired generate RF frequency using keypad or TUNING knob.

Output Lvl

Selects generator output level in 0.1 dBm steps over the range of -130 dBm to 0 dBm. An alternate display of generate level in microvolts is available in two ranges depending upon which output port is selected:

- The range of -80 dBm to 0 dBm is available when the high level GEN OUT port is selected.
- The range of -130 dBm to -50 dBm is available when the RF I/O output port is selected.

Gen RF Out

Selects the RF output port via softkeys. The RF I/O port is recommended for most applications. GEN and MON ports are combined for a single connection to the radio under test. The GEN port is recommended where higher levels are needed. Selection of the GEN port is indicated by a red LED adjacent to the GEN OUT connector.

CAUTION

Do not apply input power to the GEN OUT port. In the event RF power is inadvertently applied, the port is protected by an in-line RF fuse. This fuse may be accessed by unscrewing the front of the BNC connector out of the front panel.

21-9 PROJ 25 CONV AUDIO/ MODULATION CONTROL

The Audio Zone, located at the lower right of the screen (Figure 21-13), is used to control the multipurpose audio synthesizer section of the unit. Signals generated by the audio synthesizer are coupled internally to the generator modulation input as well as to the MOD OUT connector on the front panel. The primary categories of modulation in PROJ 25 CONV mode are Voice Frame, 1011 Hz tone test pattern, calibration test pattern, and silence pattern. Many of the features available in standard mode are not available in PROJ 25 CONV mode. The Audio Zone has been changed to accommodate testing of Project 25 radios and equipment.

Each modulation signal has a cursor field for entering its desired level. Use the keypad or TUNING knob to enter the desired level. An additional cursor field, adjacent to each level entry, is used to enable or switch each selection on and off using softkeys. This field is located at the extreme right side of the zone. There are two possible conditions for this softkey selection.

- CONT activates continuous ON condition, or continuous cycling if a sequence has been selected. A “~” symbol is indicated at the extreme right, adjacent to the level to indicate continuous ON.
- OFF switches off the modulation source. Off is indicated by an “X” at the extreme right, adjacent to the level.

21-9.1 Modulation Sources

In addition to Voice Frame, 1011 Hz tone test pattern, calibration test pattern, and silence pattern, there are two other modulation sources selectable in the Audio Zone, a Fixed 1 kHz tone and an External signal.

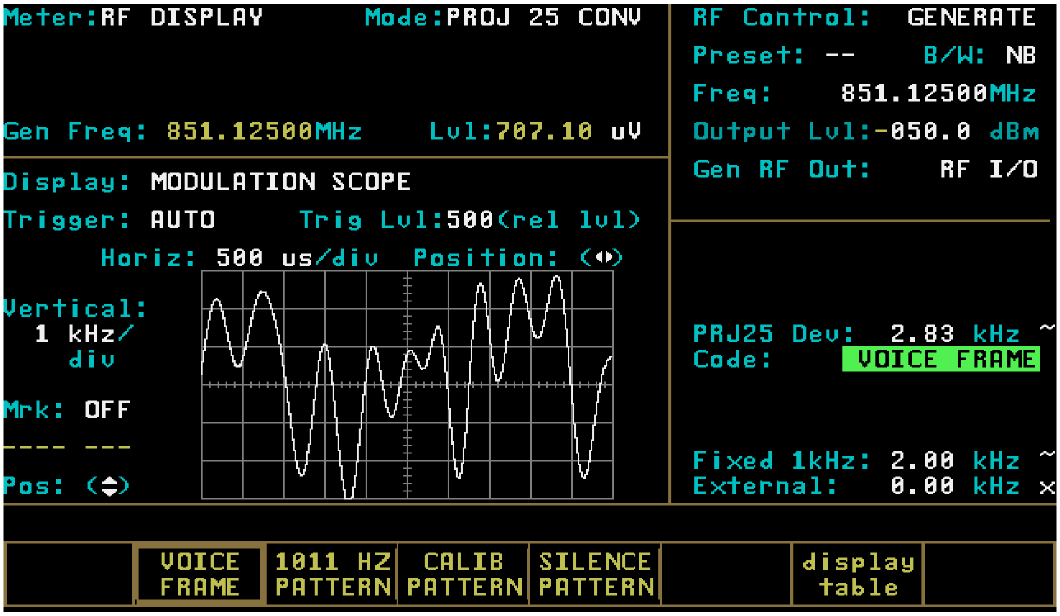


Figure 21-13. PROJ 25 CONV Audio Zone - Voice Generate Mode

21-9.1.1 Fixed 1 kHz

The analyzer contains a fixed 1 kHz modulation source, which can be selected independently from the other audio synthesizers. Level control and on-off selection is described above.

21-9.1.2 External

External modulation is applied to the external modulation input (EXT MOD IN) connector on the front panel. When external modulation source is selected, the modulation input is summed with the microphone input. Level control and on-off selection for an external modulation source are selectable via softkey or the TUNING knob.

21-9.2 Voice Frame

The Audio Zone provides for audio source selection. In generate mode, controls are provided for both signal level and frequency deviation settings of the voice baseband signal that is used to modulate the Project 25 RF transmissions.

21-9.2.1 Monitor Mode

Voice Frame decode is selectable from the Display Zone. To display Voice Frame decoded data, refer to Section 21-10.3. Be sure Monitor is selected in the RF Control Zone in the upper right section of display. Move cursor to the Audio Zone and place the cursor in the “Code:” field. Select Voice modulation using the **VOICE FRAME** softkey. Selection of Monitor Voice allows for the addition of the following audio sources:

- External + microphone, or
- 1 kHz tone

These inputs are selected by using the off and continuous switches and the level is adjusted using the keypad or tuning knob. The level range varies depending on whether the bandwidth (in the RF Zone) is set to narrow or wide.

BW Setting	Audio Level Range
Narrow	0.000 to 0.795 volt maximum, in 0.001 volt increments
Wide	0.00 to 7.95 volt maximum, in 0.01 volt increments

21-9.2.2 Generate Mode

The analyzer generates Project 25 voice patterns when placed in the Generate mode. The Project 25 signal can be clear or encrypted with one of the hardware algorithms.

Be sure GENERATE is selected in the RF Zone in the upper right section of display. Move cursor to the Audio Zone and place the cursor in the "Code:" field. Select Voice modulation using the **VOICE FRAME** softkey.

When code VOICE FRAME is selected in the Audio Zone (Figure 21-14), the analyzer allows audio inputs to the modulator to be selected from two sources:

- External + microphone, or
- 1 kHz tone.

Controls for each modulating input consist of a switch with values of Off and Continuous. Move cursor to the appropriate switch field and turn the modulating input on "~" or off "X" using the softkeys.

The audio inputs also include a level control for precisely setting the audio input to the modulator. Use the keypad or TUNING knob to enter the desired level. The level range varies depending on whether the bandwidth (in the RF Zone) is set to narrow or wide.

BW Setting	Audio Level Range
Narrow	0.00 to 9.95 kHz maximum, in 0.01 kHz increments
Wide	00.0 to 99.5 kHz maximum, in 0.1 kHz increments

In Generate mode, deviation control is available in the Audio Zone consisting of a switch with values of Off and Continuous, and a level control. Move cursor to the switch field and turn deviation on "~" or off "X" using the softkeys.

Use the keypad or TUNING knob to enter the desired deviation. The deviation range varies depending on whether the bandwidth (in the RF Zone) is set to narrow or wide.

BW Setting	Deviation Range
Narrow	0.00 to 5.00 kHz maximum, in 0.01 kHz increments
Wide	00.0 to 50.0 kHz maximum, in 0.10 kHz increments

The default deviation setting for Project 25 is 2.83 kHz.

21-9.2.3 Voice Frame Embedded Signaling (Generate)

When the audio source is selected to Voice Frame, a **display table** user selection is available which provides access to the embedded signaling information contained in voice frames. The display table presentation is shown in Figure 21-14. The following information is encoded by the Project 25:

Embedded Information	Size (bits)
Link Control Field (LCF)	72
Network Access Code (NAC)	12
Low Speed Data(LSD)	96
Status Symbol	2

The LCF information is further decomposed to allow entry of specific LCF data units. Encoding of the following LCFs is supported from the user interface:

Link Control Opcode Identifier	Value (binary)
Group Voice Chan User	%000000
Unit to Unit Voice Chan User	%000011
Adaptive Power Control	%001111

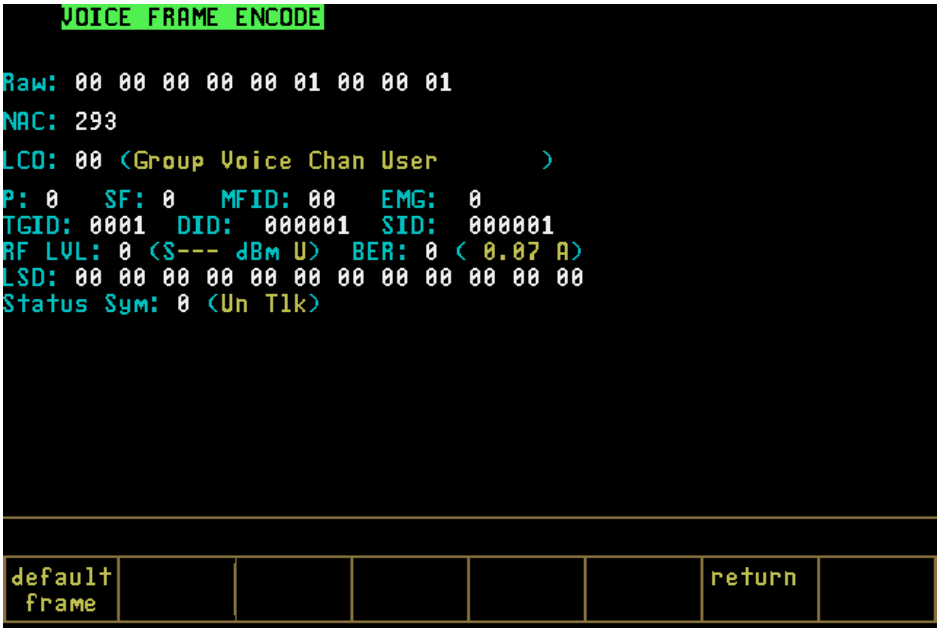


Figure 21-14. Voice Frame Encode - Generate

The embedded information associated with a particular Link Control Opcode Identifier is available for encoding from the user interface:

Mnemonic	Default Value
Link Control Opcode (LCO)	0
Priority (P)	0
Standard Format (SF)	0
Manufacture ID (MFID)	0
Emergency Bit (EMG)	0
Talkgroup ID	1
Destination ID (DID)	1
Source ID (SID)	1
RF Lvl	0
Bit Error Rate(BER)	0

The user interface provides entry of the embedded signaling information as hexadecimal numbers. A softkey that sets the encoded embedded signaling information to a default frame is provided. Default values are shown in the table above.

Selection of the default embedded signaling values causes an information message to verify the network ID to be displayed.

21-9.3 1011 Hz Tone Test Pattern

The Audio Zone provides for selection of a 1011 Hz Tone Test pattern. In generate mode, control is provided for setting the frequency deviation of the 1011 Hz Tone Test Pattern baseband signal that is used to modulate the Project 25 RF transmissions.

21-9.3.1 Monitor Mode

When MONITOR is selected in the RF Zone and the 1011 Hz Tone Test pattern is selected for the Audio Zone "Code:" field, the analyzer is configured to receive a 1011 Hz Tone Test pattern. The received 1011 Hz Tone Test pattern will be compared with a stored version of the pattern and a BER will be computed. The computed BER can be displayed in the Display Zone when BER is selected for the "Meter:" field in the Display Zone.

NOTE

The Monitor mode must be selected to compute BER.

21-9.3.2 Generate Mode

The analyzer generates a 1011 Hz Tone Test pattern when Generate mode is selected in the RF Zone and the 1011 Hz Tone Test pattern is selected for the "Code:" field in the Audio Zone.

When code 1011 Hz Tone Test pattern is selected in the Audio Zone (Figure 21-16), the analyzer modulates the 1011 Hz Tone Test pattern on the carrier at either of two output ports:

- RF I/O port, or
- GEN OUT port

Both deviation level control and a deviation switch are provided in the Audio Zone for deviation control of the generated signal.

The deviation level "PRJ25 Dev:" can be set by either the keypad or the TUNING knob to enter the desired deviation. The deviation range varies depending on whether the bandwidth (in the RF Zone) is set to narrow or wide.

BW Setting	Deviation Range
Narrow	0.50 to 5.00 kHz maximum, in 0.05 kHz increments
Wide	05.0 to 50.0 kHz maximum, in 0.50 kHz increments

The deviation switch with values of Off and Continuous is located to the right of the deviation level control field. Move the cursor to the switch field and turn deviation on "~" or off "X" using the softkeys.

The generated 1011 Hz Tone Test pattern can be used to measure the received BER of the radio under test. If the 1011 Hz Tone Test pattern is received without error, the BER detected by the unit under test will be zero. These measurements will only be possible for radios that are capable of computing a BER when the received signal is compared with a stored 1011 Hz Tone Test pattern and having the necessary radio test mode software.

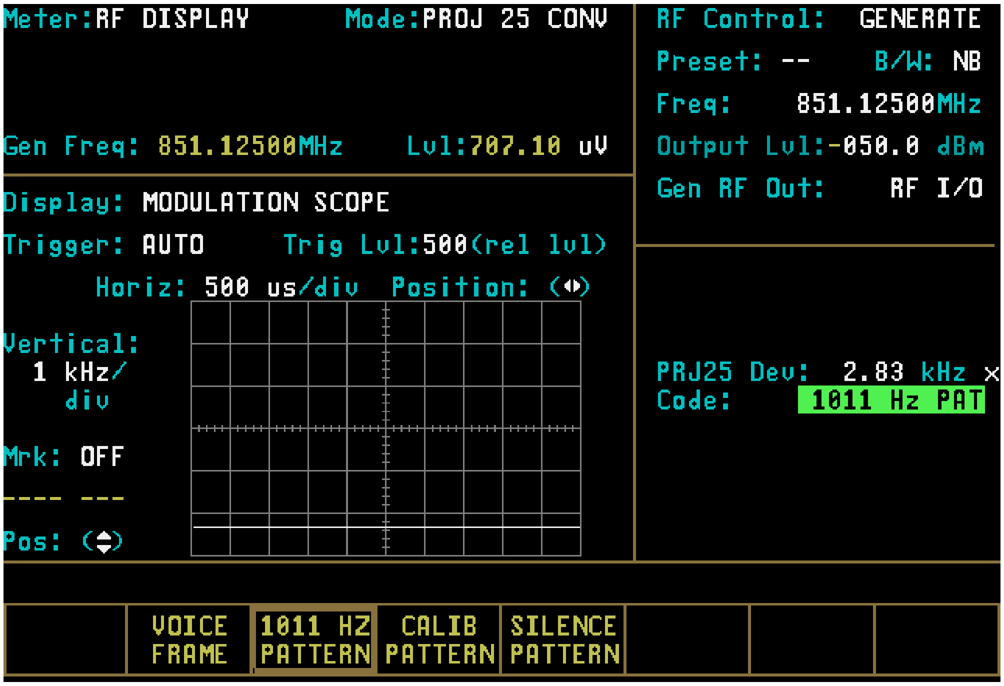


Figure 21-15. PROJ 25 CONV Audio Zone - BER Generate Mode

21-9.4 Calibration Test Pattern

The Audio Zone provides for selection of a Calibration Test Pattern when the GENERATE mode is selected in the RF Zone. This pattern is the same as the 1011 Hz Tone Test pattern with every 20^{th} bit inverted, to yield 172 errors out of 3456 bits. When this pattern is compared with a 1011 Hz tone test pattern, a 4.977% BER will result. This pattern conforms to the calibration test pattern specified in the Digital C4FM/CQPSK Transceiver Measurement Methods Document TIA/EIA IS-102.CAAA for the Project 25 system.

21-9.4.1 Generate Mode

The analyzer generates a Calibration Test Pattern when Generate mode is selected in the RF Zone and the Calibration Test Pattern is selected for the "Code:" field in the Audio Zone.

When code Calibration Test Pattern is selected in the Audio Zone (Figure 21-16), the analyzer modulates the Calibration Test Pattern on the carrier at either of two output ports:

- RF I/O port, or
- GEN OUT port.

Both deviation level control and a deviation switch are provided in the Audio Zone for deviation control of the generated signal.

The deviation level "PRJ25 Dev:" can be set by either the keypad or the TUNING knob to enter the desired deviation. The deviation range varies depending on whether the bandwidth (in the RF Zone) is set to narrow or wide.

BW Setting	Deviation Range
Narrow	0.50 to 5.00 kHz maximum, in 0.05 kHz increments
Wide	05.0 to 50.0 kHz maximum, in 0.50 kHz increments

The deviation switch with values of Off and Continuous is located to the right of the deviation level control field. Move the cursor to the switch field and turn deviation on "~" or off "X" using the softkeys.

The generated Calibration Test Pattern can be used to determine if the unit under test receiver is operating correctly. This is done by computing the BER for the received calibration test pattern when compared against a 1011 Hz tone test pattern in the unit under test. If the Calibration Test Pattern is received correctly, the measured BER will be 4.977%. These measurements will only be possible for radios that are capable of computing a BER when the received signal is compared with a stored 1011 Hz Tone Test pattern and having the necessary radio test mode software.

21-9.5 Silence Pattern

The Audio Zone provides for selection of a Silence Pattern when the GENERATE mode is selected in the RF Zone. This pattern will produce silence in the radio under test.

21-9.5.1 Generate Mode

The analyzer generates a Silence Pattern when Generate mode is selected in the RF Zone and the Silence Pattern is selected for the "Code:" field in the Audio Zone.

When code Silence Pattern is selected in the Audio Zone (Figure 21-15), the analyzer modulates to Silence Pattern on the carrier at either of two output ports:

- RF I/O port, or
- GEN OUT port.

Both deviation level control and a deviation switch are provided in the Audio Zone for deviation control of the generated signal.

The deviation level "PRJ25 Dev:" can be set by either the keypad or the TUNING knob to enter the desired deviation. The deviation range varies depending on whether the bandwidth (in the RF Zone) is set to narrow or wide.

BW Setting	Deviation Range
Narrow	0.50 to 5.00 kHz maximum, in 0.05 kHz increments
Wide	05.0 to 50.0 kHz maximum, in 0.50 kHz increments

The deviation switch with values of Off and Continuous is located to the right of the deviation level control field. Move the cursor to the switch field and turn deviation on "~" or off "X" using the softkeys.

21-10 PROJ 25 CONV METER AND DISPLAY CONTROL

PROJ 25 CONV "Meter:" and "Display:" fields in the Display Zone are similar to the standard mode. Refer to Section 21-7 under the General Operation tab in this manual for a general description of the functionality of "Meter:" and "Display:" field selections. To accommodate testing of Project 25 radio equipment, several additional selections have been added for these fields. A BER meter is added to the metering functions in the Display Zone. VOICE FRAME, CLEAR SCOPE and SET UP selections have been added to the display functions in the Display Zone. The selections that have been added are described in the following paragraphs.

21-10.1 PROJ 25 CONV BER Meter

The BER Meter is used to verify the performance of test signals, generated by Project 25 radios. The BER Meter provides display of bit error rate, frequency error and input power level as well as monitor frequency and deviation. An example of a BER Meter is available only when Monitor "RF Control:" mode has been selected.

To activate the BER test, set controls in the RF Zone as follows:

RF Control: Monitor

Frequency: Same as radio transmit frequency

Attenuation: 0 dB

Mon RF In: RF I/O

The BER Meter is accessed by placing the cursor in the Display Zone's "Meter:" Field and pressing the **more** softkey until the **BER** softkey is presented. Selected the **BER** softkey to access the BER Meter (Figure 21-16).

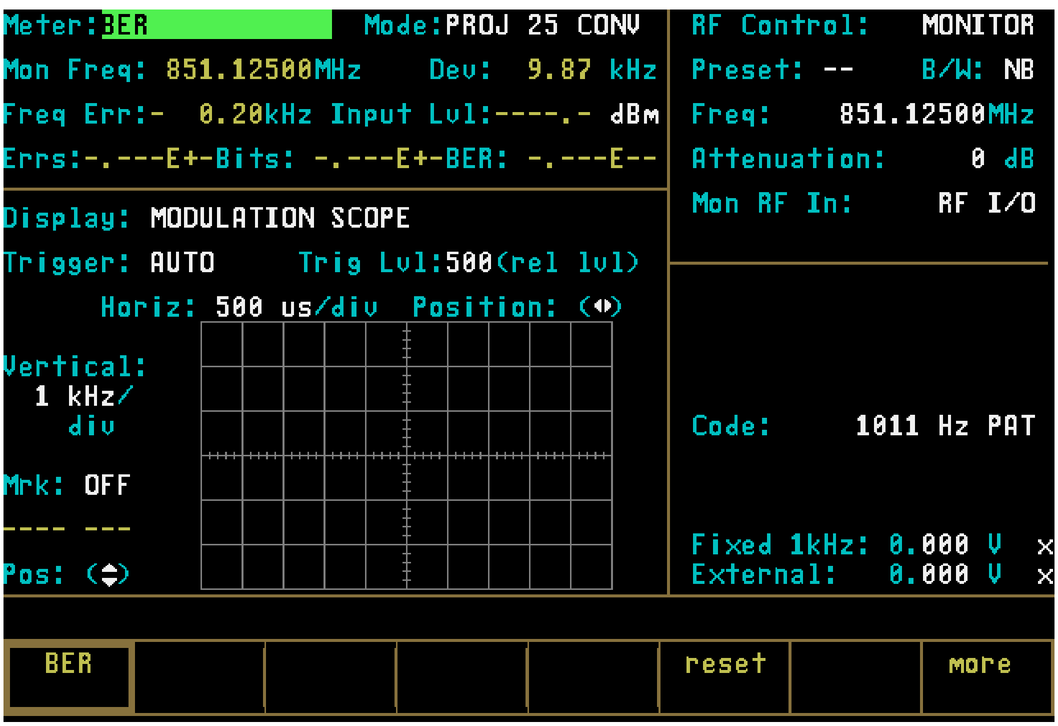


Figure 21-16. PROJ 25 CONV BER Meter

Mon Freq

Monitor frequency for the radio under test as entered in the RF Zone.

Dev

Display of the frequency deviation in kHz.

Freq Err

The error in frequency between the received frequency and the frequency entered in the RF Zone.

Input Lvl

Displays the signal level received at the selected front panel connector. A single cursor field at this location allows selection by softkey of either microvolts/watt or dBm units of display.

Errs

Display of the bit error count during the test. This display is in exponential notation.

Bits

Display of the bit count during the test. This display is in exponential notation.

BER

Display of the ratio of bit errors to bits sampled during the test. BER is displayed in exponential notation. The BER for one error in one thousand bits or 0.1% will be displayed as 1.000E-3.

NOTE

BER Meter measurement is accurate up to 20 percent bit errors.

21-10.1.1 Enabling the BER Test

The BER test begins when BER meter is selected in the Display Zone “Meter:” field.

21-10.1.2 Resetting the BER Test

To reset the BER test, move cursor to the “Meter:” field in the Display Zone and press **more** until **reset** is displayed. Press **reset** and the BER count is started over from zero.

21-10.2 CLEAR SCOPE Display

The CLEAR SCOPE display shows either the received audio signal after it has been converted to analog or the analog transmit signal before it is digitized. To activate the CLEAR SCOPE, place the analyzer in PROJ 25 CONV mode. The selection of either MONITOR or GENERATE in the RF Zone determines which signal will be displayed on the screen. Press the **DISP** hardkey, place the cursor on “Display:” field and select the **CLEAR SCOPE** softkey. The “Display:” field in the Display Zone of the screen will indicate CLEAR SCOPE with the input signal displayed in a time-versus amplitude graph. The operator can adjust the horizontal scale by placing the cursor on “Horiz:” field and selecting the appropriate value from the softkey selections. To change the vertical scale, go to the “Vert:” field and select the appropriate value for the softkey selections. Figure 21-17 shows the display, cursor and associated softkey used for the CLEAR SCOPE.

21-10.2.1 Monitor Mode

In Monitor mode, the CLEAR SCOPE display shows the recovered analog audio signal. The CLEAR SCOPE operational controls are similar to the Standard version MOD SCOPE.

NOTE

The waveform amplitude of this signal is an internal voltage only and does not reflect the deviation of the RF signal.

To change horizontal position, horizontal range, vertical position, or vertical range, use the cursor control keys to highlight the appropriate cursor fields as follows:

Horiz

Press the desired softkey to select the Horizontal Sweep rate (20 us to 1 sec/div). Since all ranges cannot be shown on one screen, press the **more** softkey for additional selections.

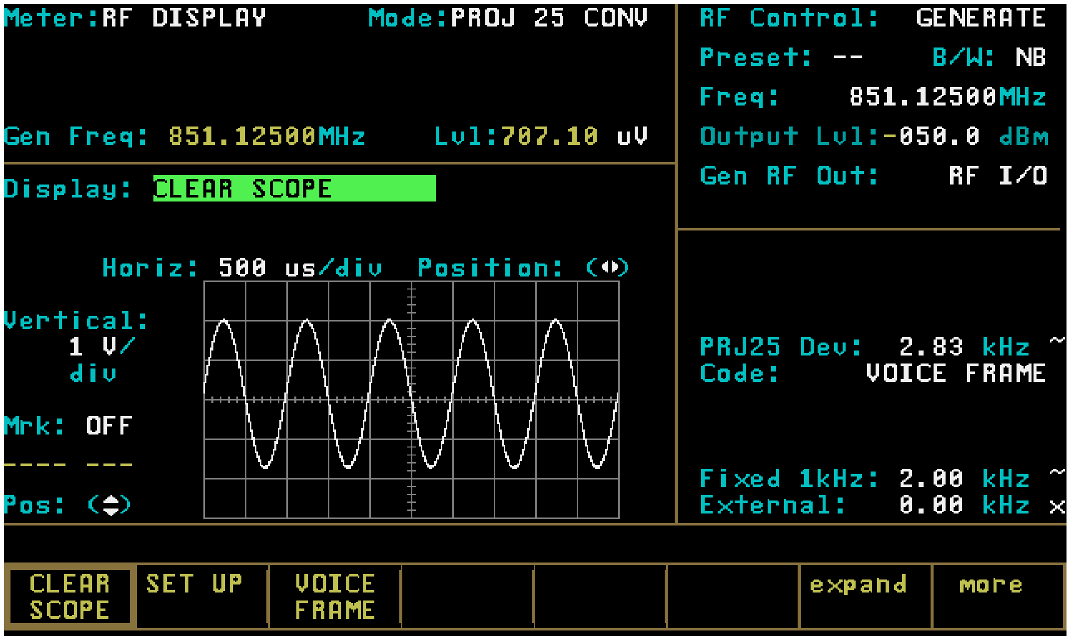


Figure 21-17. PROJ 25 CONV Clear Scope Display

NOTE

If horizontal sweep rates of greater than 10 msec/div are selected, the update rate will slow down. A good overall setting for most applications is 200 usec per division.

Horizontal Position

Adjust the horizontal position through the (◄►) cursor field either by using the desired softkey (MOVE LEFT, MOVE RIGHT) or by using the rotary TUNING knob.

Vertical Sensitivity

Press the desired softkey to select the Vertical Sensitivity (10 mV to 10 V per division). When all ranges cannot be shown on one screen, press the **more** softkey for additional selections.

Vertical Position

Adjust the vertical position through the (▲▼) cursor field either by using the desired softkey (MOVE UP, MOVE DOWN) or by using the rotary TUNING knob.

Press the **expand** softkey from any field in the scope display window to enlarge the display for more detailed analysis. Use the **return** softkey to get back to the normal size display.

Marker

Select marker operation by moving the cursor to the "Mrk:" field, then pressing the desired "delta" softkey (**ΔV**, **ΔT**, or **1/ΔT**). Selection provides two markers on the CLEAR SCOPE screen (refer to Figure 21-18). Press the **toggle marker** softkey to alternate between markers and use TUNING knob to position markers.

ΔV

This softkey selection provides markers that are horizontally located to permit relative readings along the scope vertical axis. The display adjacent to the "Mrk:" field shows the relative voltage difference between the two marker positions.

ΔT

This key selection provides markers that are vertically located to permit relative readings along the scope horizontal axis. The display adjacent to the "Mrk:" field shows the relative horizontal deflection between the two marker positions in units of time.

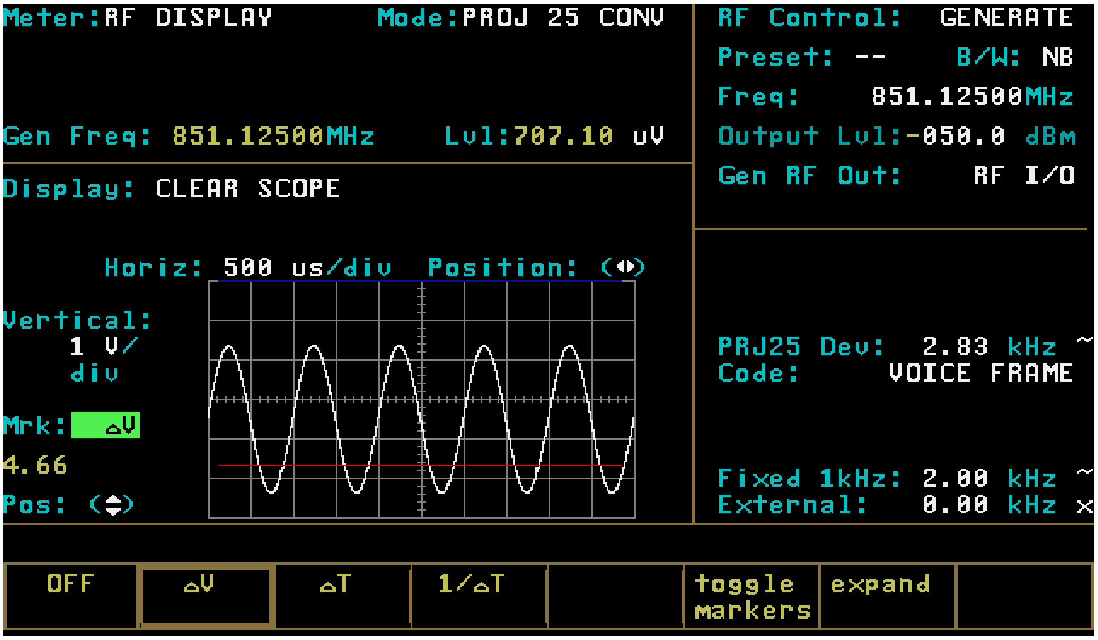


Figure 21-18. Clear Scope Markers

1/ΔT

This softkey selection provides markers that are also vertically located to permit relative readings along the scope horizontal axis. This selection, however, inverts the time reading and displays the relative difference in terms of frequency.

21-10.2.2 Generate Mode

In Generate mode, the CLEAR SCOPE display shows the generated analog audio signal. The CLEAR SCOPE operational controls are the same as those described for the CLEAR SCOPE in Monitor mode.

21-10.3 Voice Frame Decode

The Voice Frame display is used to decode and view the received embedded data in the link control frame of Project 25 transmissions.

21-10.3.1 Embedded Signaling

The Project 25 provides a user display of decoded embedded signaling (Figure 21-19). It saves the last 30 frames of information on a first-in, first-out (FIFO) basis. User controls are provided to start and stop the data decoding process and to select a specific frame for display.

To monitor the received embedded, voice frame data, move cursor to the RF Control zone. Set the fields as follows:

RF Control:	Monitor
Freq:	(same as transmitting unit)
B/W:	NB
Attenuation:	0 db

Move the cursor to the Display Zone. Place cursor in the "Display:" field and press **VOICE FRAME** softkey. Press the **decode start** softkey to select continuous decoding of embedded data. As the analyzer decodes embedded signaling data, the “Frame Counter” counts from 0 to 9999. The last 30 frames of data are stored and can be individually recalled.

To recall a frame, press the **decode stop** softkey and place the cursor on the “Frame:” field. Enter a number from 1 to 29 to recall a frame of data (29 being the most recent). To reset the “Frame Counter” or “Frame Number”, press the **frame** softkey.

The “Voice Frame” decode fields are shown in Figure 21-19. The decode fields are the same as described for the encode fields in Section 21-9.2.3 except for the “Raw:” field.

Raw

Field that contains the raw LC data prior to decoding. The data is displayed in hex format.

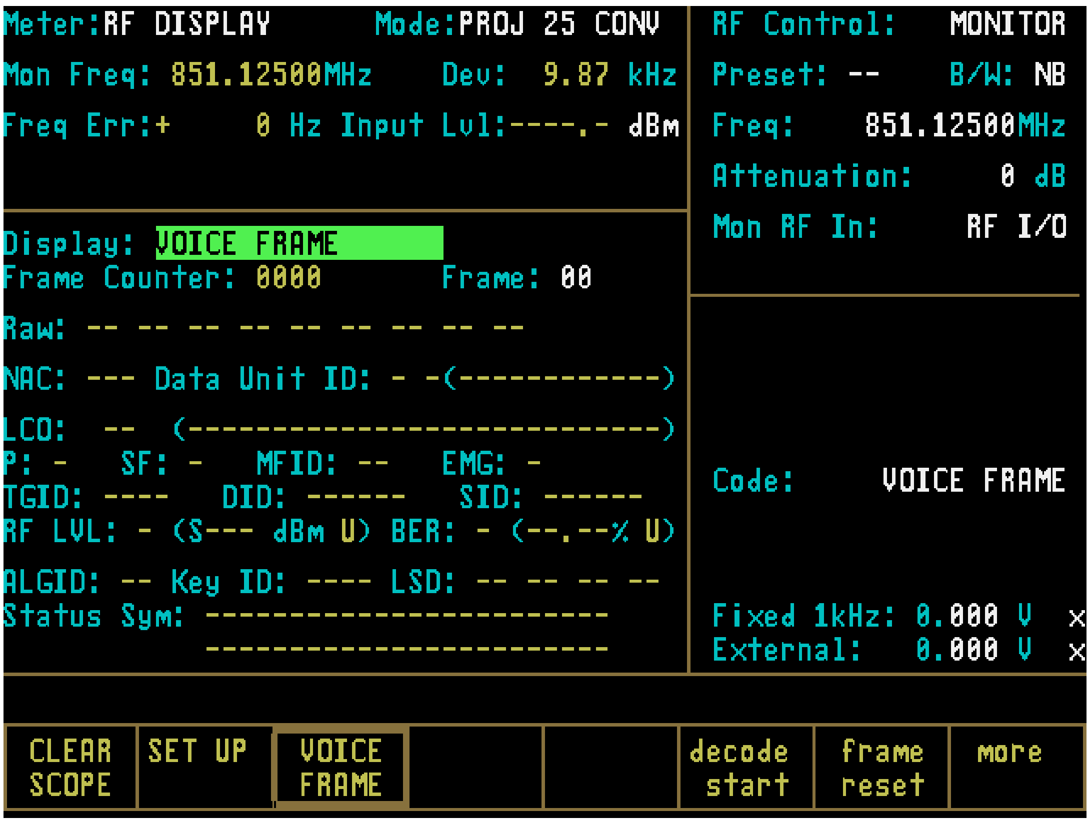


Figure 21-19. Voice Frame Decode Display

Section 22

APPLICATIONS

CAUTION

When testing a radio, observe the following precautions:

- ***Use** double-shielded cables on the analyzer to carry signals to and from the radio.*
- ***Locate** the analyzer at least thirty five feet from the antenna of a unit that is working in the same system that the analyzer is testing.*
- ***Adjust** the squelch to where the LED indicator for squelch just turns off or is closed. When the signal from the radio is present, the squelch LED will illuminate indicating that squelch has been detected and there is a signal present.*

22-1 General Information

This section contains operational testing examples for testing Project 25 radios.

22-1.1 Configuration for Monitor Mode Testing

To configure the analyzer for Monitor mode testing, first select PROJ 25 CONV for the “Mode:” field in the Display Zone. Next select Monitor mode for the “RF Control:” field and the appropriate settings for “B/W:”, “Freq:”, and “Attenuation:” fields in the RF Zone.

The “Mon RF In:” field in the RF Zone has two softkey selections: **ANT** and **RF IN/OUT**. The ANT port accesses the analyzer’s sensitive receiver and should be used for “off the air” or low power measurements. If an antenna is used with the ANT port, attach the supplied antenna to the ANT port. The RF I/O port should be used for direct connection to the radio under test. If RF I/O port is used, connect a coaxial cable from the analyzer’s input port to the radio’s output port.

NOTE

Do not directly apply excessive input power to the ANT port. In the event that excessive RF power is inadvertently applied, the port is protected by in-line RF fuse. The fuse may be accessed by unscrewing the front of the BNC connector out of the front panel.

22-1.2 Configuration for Generate Mode Testing

To configure the analyzer for Generate mode testing, first select PROJ 25 CONV for the “Mode:” field in the Display Zone. Next select Generate mode for the “RF Control:” field and the appropriate settings for “B/W:”, “Freq:”, and “Output Lvl:” fields in the RF Zone.

Place the cursor in the Audio Zone and select the desired levels for the summed modulating signal and Project 25 deviation. Remember to enable the switches to the right of the level entry. To transmit anything other than 1011 Hz Tone Test pattern, Calibration Test pattern or silence pattern, the Generate code in the Audio Zone must be set to VOICE FRAME.

Place the cursor on the “Gen RF Out:” field in the RF Zone. This field has two softkey selections: GEN and RF IN/OUT port. The RF I/O port is recommended for most applications where the generate (GEN) and monitor (MON) ports are combined for a single connection to the radio under test. The GEN port is recommended where higher levels of output signal are needed. Connect a coaxial cable from the selected output port to the input of the radio.

NOTE

Do not apply input power to the GEN output port. In the event RF power is inadvertently applied, the port is protected by in-line RF fuse. This fuse may be accessed by unscrewing the front of the BNC connector out of the front panel.

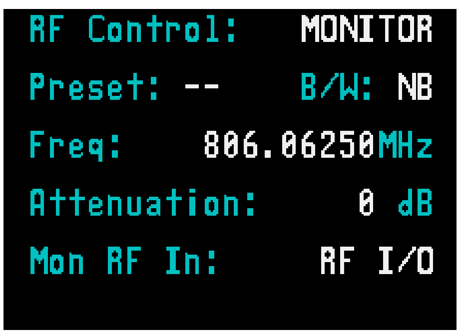
22-2 PROJ 25 CONV RADIO TRANSMIT TESTS (Monitor Mode)

This section describes the basic test setup for testing Project 25 radio transmitted voice and embedded data.

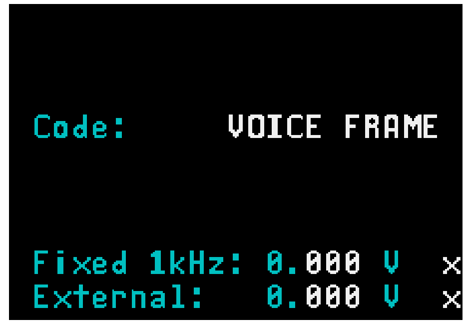
NOTE

If the selected radio channel is encrypted, select the analyzer encryption algorithm and key as described in Section 21-7.

1. Place the cursor in the RF Zone and configure the analyzer in Monitor mode as shown in the example below:



2. Select the desired frequency that matches the radio under test; 806.0625 MHz is used in this example.
3. Connect the RF input/output of the radio under test to the RF I/O port of the analyzer as shown in Figure 21-4.
4. Press the **AUD** hardkey to place the cursor in the Audio Zone and select **VOICE FRAME**.



5. Press the **DISP** hardkey to place the cursor in the Display Zone.

NOTE

If the radio transmit frequency is unknown, it can be determined by turning on the radio, pressing the radio PTT and placing the analyzer in RF Scan mode. Refer to Section 21-7.1.2 under the General Operation tab for a description of the RF Scan function.

Place the cursor in the "Meter:" Field and select **RF DISPLAY**. The monitored frequency, deviation, frequency error and input power level are all displayed in the Display Zone.

22-2.1 PROJ 25 CONV Voice

To display the voice analog waveform move the cursor to the "Display:" field in the Display Zone and select **CLEAR SCOPE**. Press the radio PTT, speak into the radio microphone, and turn up the volume on the analyzer. If the radio is operating, the transmitted voice will be heard from the speaker of the analyzer.

22-2.2 PROJ 25 CONV Voice Frame Embedded Data

To display the voice frame embedded data, move the cursor to the "Display:" field in the Display Zone and select **VOICE FRAME**. The Voice Frame decode table will be displayed as shown in Figure 21-19. Press the **decode start** softkey then press the PTT on the radio to display the embedded data. As each frame is captured, the number displayed in the "Frame Counter:" field will be incremented. Press the **decode stop** softkey to discontinue capturing frames.

The last 30 frames of data from the radio are stored and can be recalled for further analysis. To recall a frame, enter a number from 0 to 29 in the "Frame:" field (29 being the most recent), and the selected frame will be displayed. To reset the "Frame:" and "Frame Counter:" fields, press the **frame reset** softkey.

The "Raw:" field displays the captured link control format data for a single frame in hex format.

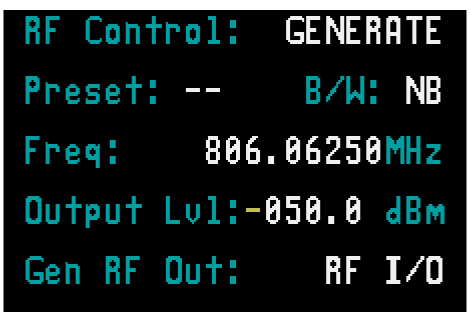
22-3 PROJ 25 CONV RADIO RECEIVE TESTS (Generate Mode)

This section describes the basic test setup for testing Project 25 radio received voice and embedded data.

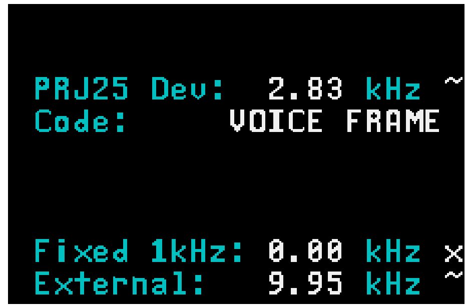
NOTE

If the selected radio channel is encrypted, select the analyzer encryption algorithm and key as described in Section 21-7.

1. Place the cursor in the RF Zone and configure the analyzer in Generate mode as shown in the example below:



2. Select the desired frequency that matches the radio under test; 806.0625 MHz is used in this example.
3. Connect the RF input/output of the radio under test to the RF I/O port of the analyzer as shown in Figure 21-4.
4. Press the **AUD** hardkey to place the cursor in the Audio Zone and make the selections shown below. External must be set to a value and turned on with ~ to enable the input from the microphone of the analyzer.



5. Place the cursor on VOICE FRAME in the Audio Zone, and press the **display table** softkey. The VOICE FRAME ENCODE screen shown in Figure 21-14 will be displayed.
6. Insert the appropriate values into each of the fields of the VOICE FRAME ENCODE table or press the **default frame** softkey to enter pre-programmed values. It is essential to enter the correct Network ID code that matches the radio. This can be determined from the VOICE FRAME DECODE table when monitoring the transmitted voice frames from the radio (refer to Section 22-2).
7. Press the **return** softkey from the VOICE FRAME ENCODE screen.
8. Press the **DISP** hardkey then move the cursor to the "Display:" field and select the **CLEAR SCOPE** softkey.
9. Connect a microphone to the analyzer and press the PTT. Note that when the microphone PTT is pressed, the Project 25 analog voice can be observed on the CLEAR SCOPE in the Display Zone. Turn on the radio and talk into the microphone of the analyzer. If the radio is operating, the received voice will be heard from the speaker of the radio.

22-4 BER TESTING THE RADIO RECEIVER (Generate Mode)

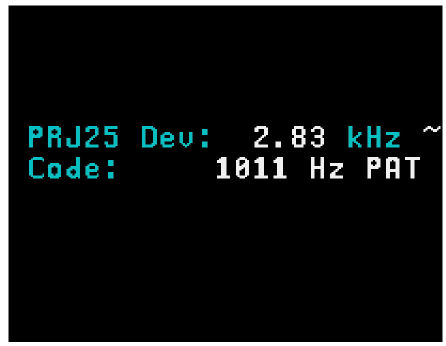
This application example describes the receiver test for radios that have BER test capability. The receiver must have the capability of comparing an unencrypted received signal with a stored 1011 Hz Tone Test Pattern. Performance of this test requires the analyzer to operate in Generate mode with either 1011 Hz Tone Test Pattern or Calibration

Test Pattern selected for the “Code:” field in the Audio Zone. In this mode the analyzer generates a test signal and the radio monitors the signal. When testing the receiver, the radio under test measures the BER of the received signal and displays the result to the operator. When a 1011 Hz Tone Test Pattern has been selected for the output signal, the output level of the analyzer is reduced until the radio BER threshold is determined. Consult the radio maintenance manual to determine the BER threshold percentage to be used in testing. When a Calibration Test Pattern has been selected for the output signal, the measured BER should be 4.977%

NOTE

Test frequencies may be specified for BER test of your equipment. Consult the radio maintenance manual.

1. Connect the RF Input port of the radio under test to the GEN OUT port of the analyzer. Consult the radio maintenance manual to determine the appropriate test port.
2. Place the cursor on the “Code:” field in the Audio Zone (Figure 22-1) and select the **1011 Hz PAT** softkey. This will generate a 1011 Hz tone test pattern. If this pattern is received correctly by the unit under test, the BER measured by the unit under test should be zero.
3. Set deviation in the Audio Zone as below:



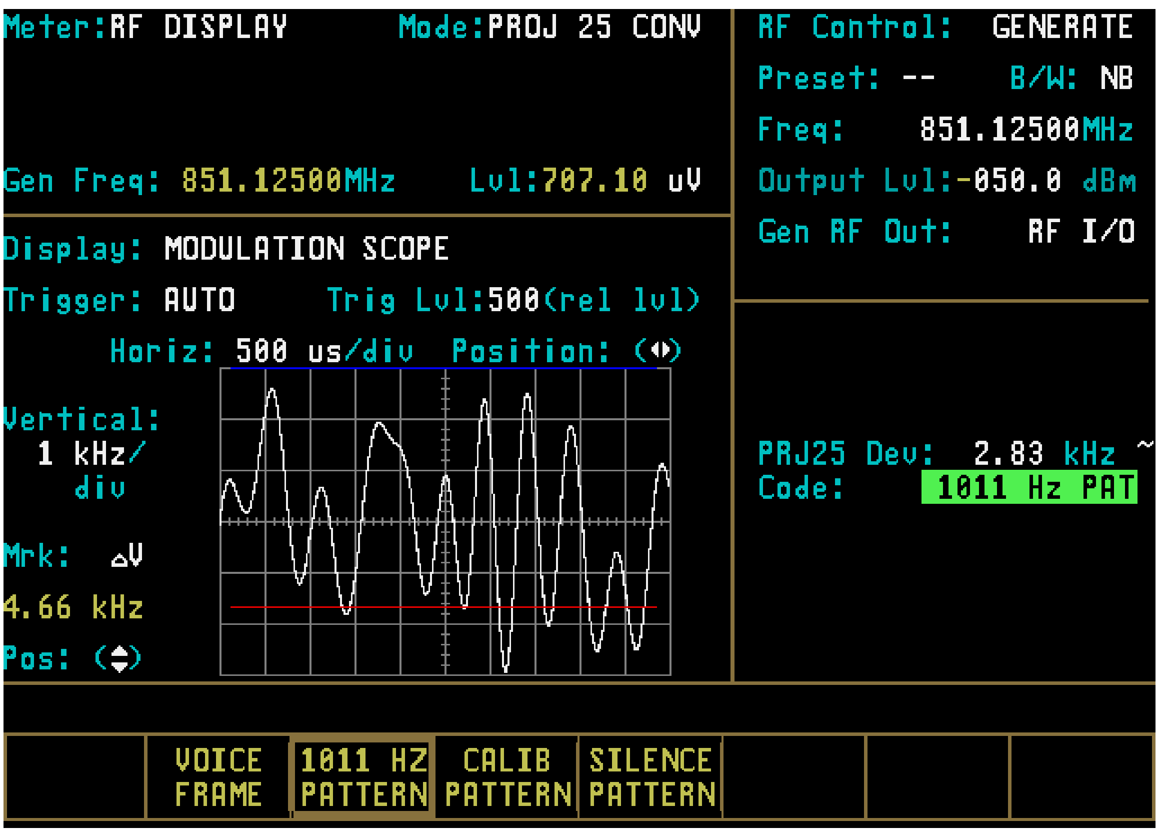
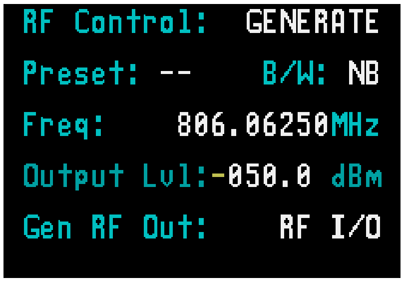


Figure 22-1. Radio (BER Test Mode) Audio Zone

4. Place the cursor in the RF Zone and configure the analyzer in Generate mode as shown in the example below:



5. Select the desired frequency that matches the radio under test; 806.0625 MHz is used in this example.
6. Configure the radio under test to the BER Test mode. Consult your radio maintenance manual for specific instructions.
7. Monitor the radio's received BER. Reduce the analyzer's output level until the radio measures a BER corresponding to the sensitivity threshold. Consult your radio maintenance manual for the receiver sensitivity specification.

22-5 BER TESTING THE RADIO TRANSMITTER (Monitor Mode)

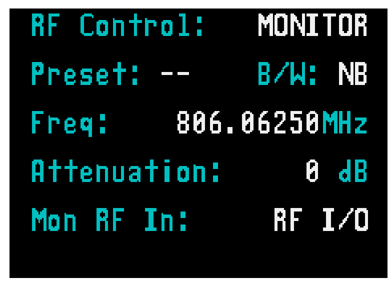
This application example describes the transmitter test for radios that have BER test capability. The transmitter must have the capability of transmitting an unencrypted 1011 Hz Tone Test Pattern. Performance of this test requires the analyzer to operate in monitor mode, while monitoring a test signal transmitted by the radio under test.

When testing the transmitter, the radio generates a test signal. The analyzer measures the transmitted BER, frequency error, and power level of the signal transmitted by the radio.

NOTE

Consult the radio maintenance manual, as specific test frequencies may be specified for BER test of your equipment.

1. Connect the RF input/output of the radio under test to the RF I/O port of the analyzer as shown in Figure 21-4. Consult the radio maintenance manual to determine the appropriate test port.
2. Place the cursor within the Audio Zone and place the cursor on the "Code:" field; select the **1011 HZ PATTERN** softkey.
3. Place the cursor in the RF Zone and configure the analyzer in Monitor mode as shown in the example below:



4. Select the desired frequency that matches the radio under test; 806.0625 MHz is used in this example.
5. Configure the radio under test to transmit a 1011 Hz Tone Test Pattern. Consult your radio maintenance manual for specific instructions.
6. Turn on the transmitter of the radio. Consult your radio maintenance manual for instructions.
7. Access the BER Meter by placing the cursor in the Display Zone's "Meter:" field and pressing the **more** softkey until the **BER** softkey is presented. Select **BER** via the softkey to display the BER Meter. A screen similar to Figure 22-2 appears.
8. BER measurements will be terminated at the end of transmission or when switching out of Monitor Mode.

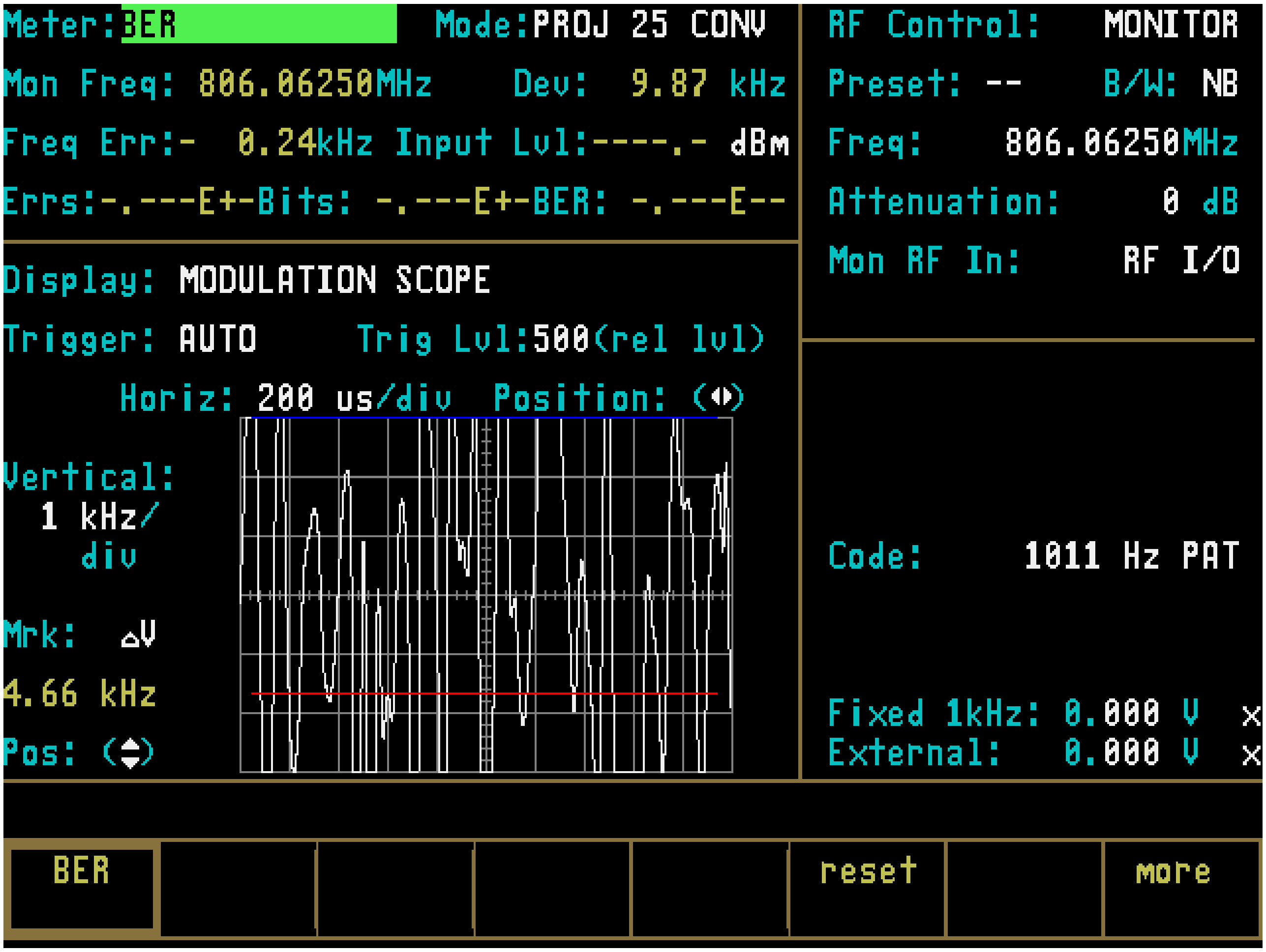
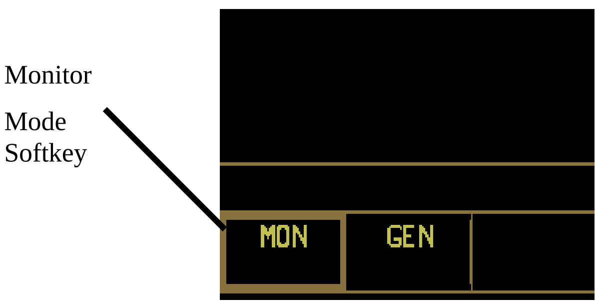


Figure 22-2. Radio (BER Test Mode) BER Meter

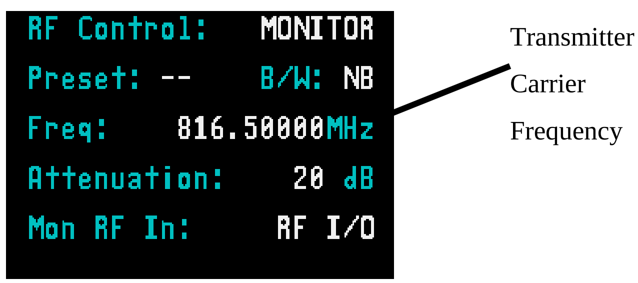
22-6 MONITORING RECEIVED AUDIO WITH CLEAR SCOPE

This section of the manual contains information on using the Clear Scope function to monitor an audio signal that has been transmitted by a Project 25 radio and then recovered by the analyzer.

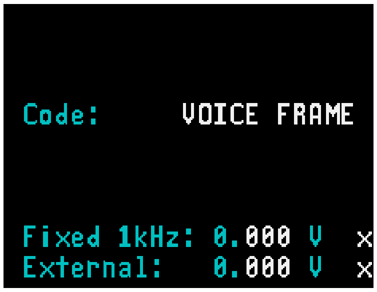


1. Place the cursor within the RF Zone in "RF Control:" field. Press the **MON** softkey to place the analyzer into its Monitor mode of operation.

2. Within the RF Zone, set as follows:



3. Connect the analyzer's RF I/O port to the RF output of the transmitter under test.
4. Set the SQUELCH control on analyzer to threshold.
5. Press **AUD** hardkey and select **VOICE FRAME**.



6. Press **DISP** hardkey to move the cursor to the Display Zone.
7. Place cursor in the "Display:" field and press **CLEAR SCOPE** softkey. The CLEAR SCOPE screen should appear similar to Figure 22-3. No waveform is present until the transmitter is turned on.
8. Turn on the Project 25 radio and press PTT.

CAUTION

The analyzer's built-in RF load dissipates up to 50 W for three minutes and up to 125 W for one minute. If a high-power transmitter is keyed into the analyzer for a time long enough to threaten overheating the power measuring circuitry, the analyzer's audible alarm sounds and the display changes to the ***RF LOAD OVERTEMPERATURE*** *warning, signaling the operator to unkey.*

9. Move the cursor to "Horiz:" field and select the desired scale.
10. Move the cursor to "Vert:" field and select the desired scale.
11. Move the cursor to "Vert Position:" field. Use **move up/move down** softkeys or rotary control to position the recovered audio waveform on a convenient graticule.
12. Move the cursor to "Horiz Position:" field. Use **move left/move right** softkeys or rotary control to position the recovered audio waveform on a convenient graticule.
13. Move the cursor to "Mrk:" field.
    - Press **ΔV** softkey to display movable markers that measure voltage differential (Vp-p).
    - Press **ΔT** softkey to display movable markers that measure time differential (sec).
    - Press **Δ1/T** softkey to display movable markers that measure reciprocal time differential (in Hz).
14. Position the markers as desired using TUNING knob (press **toggle marker** softkey to select marker). The movable marker is indicated by a red line. Observe digital readout of marked values below "Mrk:" field.

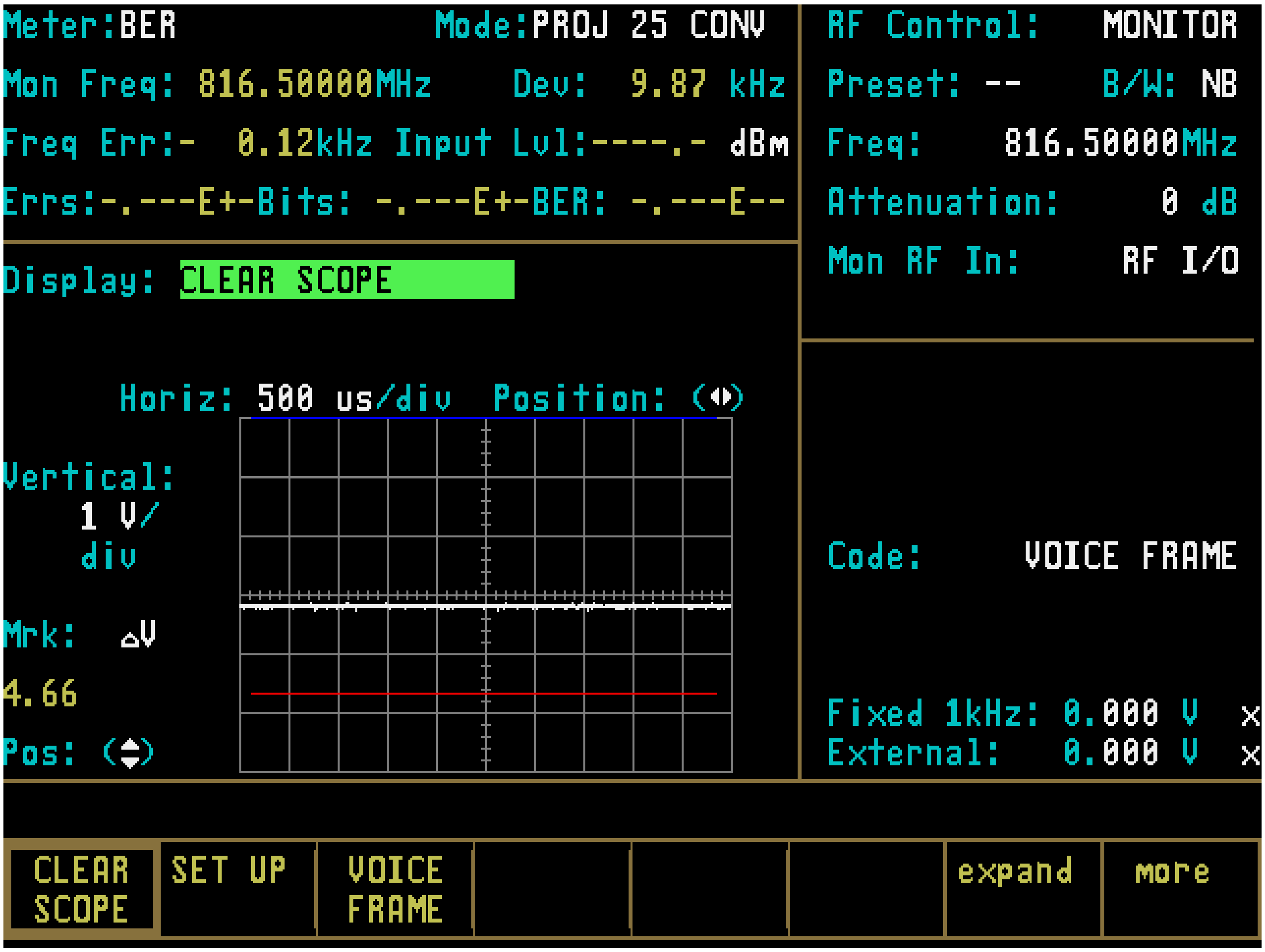


Figure 22-3. PROJ 25 CONV CLEAR SCOPE Display of Recovered Audio

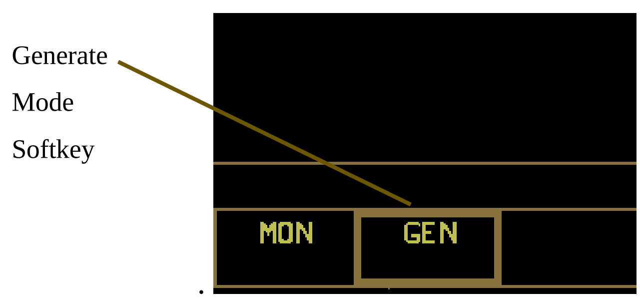
22-7 MONITORING TRANSMITTED AUDIO WITH CLEAR SCOPE

This section of the manual contains information on using the Clear Scope function to analyze the R2670's raw modulation signal (1 kHz) in PROJ 25 CONV Generate mode. This analog signal is viewed prior to being digitized and encrypted.

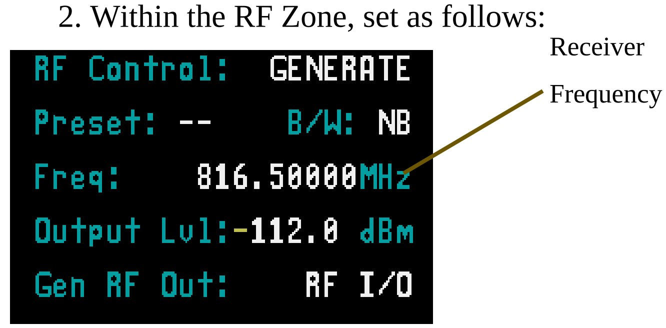
NOTE

It is not necessary to connect the analyzer's DVM port for this application.

1. Place the cursor within the RF Zone in "RF Control:" field. Press the **GEN** softkey to place the analyzer into its Generate mode of operation



2. Within the RF Zone, set as follows:

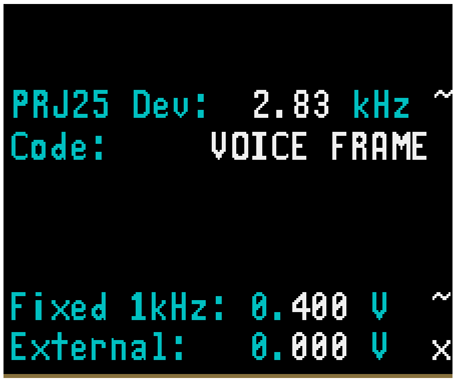


NOTE

For setup and distortion measurements, set output level to at least 30 dB above sensitivity threshold (-80 dBm recommended).

3. Connect the analyzer's RF I/O port to the radio's antenna connector.

4. Use the CURSOR ZONE keys to move the cursor to the Audio Zone. Within the Audio Zone, move the cursor to "Fixed 1 kHz:" field. Select 1 kHz audio source as the modulating signal (also available from the MOD OUT connector on the front panel) by turning 1 kHz on "~". Set 1 kHz voltage level to 0.4 volt.



5. Turn on the PROJ 25 CONV receiver and tune receiver and analyzer to the same frequency. Verify receiver locks onto test signal.

6. Use the CURSOR ZONE keys on analyzer front panel and move the cursor to the Display Zone.

7. Place cursor in the "Display:" field and press **CLEAR SCOPE** screen should appear similar to Figure 22-4.

8. Move the cursor to "Horiz:" field and press **200 us** softkey.

9. Move the cursor to "Vert:" field and press **200 mv** softkey.

10. Move the cursor to "Vert Position:" field. Use **move up/move down** softkeys or rotary control to position the modulating 1 kHz waveform on a convenient graticule.

11. Move the cursor to "Horiz Position:" field. **Use move left/move right** softkeys or rotary control to position the modulating 1 kHz waveform on a convenient graticule.

12. Move the cursor to "Mrk:" field.
    - Press **ΔV** softkey to display movable markers that measure voltage differential (Vp-p).
    - Press **ΔT** softkey to display movable markers that measure time differential (sec).
    - Press **Δ1/T** softkey to display movable markers that measure reciprocal time.

13. Position the markers as desired using TUNING knob (press **toggle marker** softkey to select marker). The movable marker is indicated by a red line. Observe digital readout of marked values below "Mrk:" field.

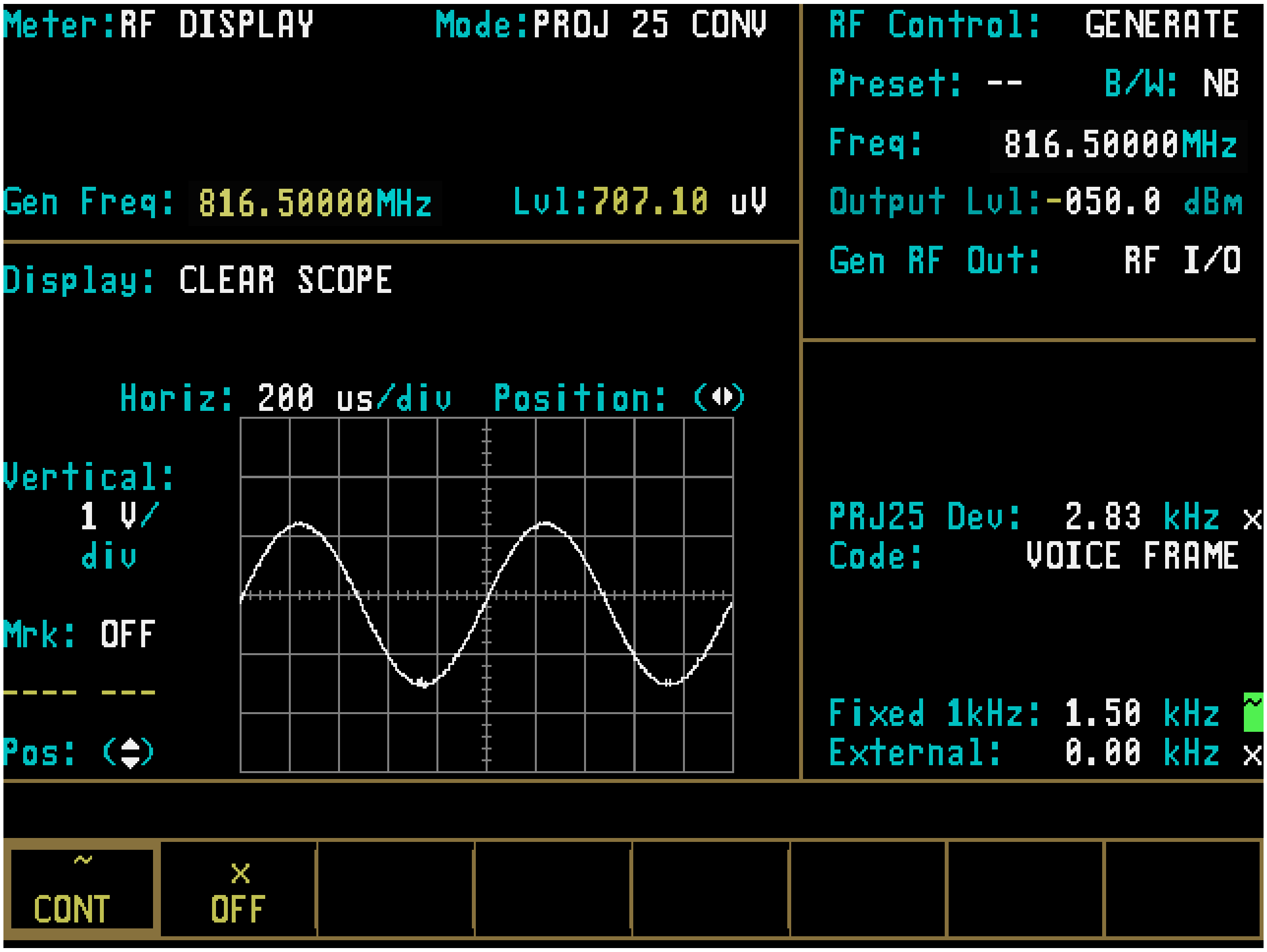


Figure 22-4. PROJ 25 CONV CLEAR SCOPE Display of Output Modulation

Section 23

PROJECT 25 TRUNKING INTRODUCTION

23-1 INTRODUCTION

This manual contains information for using the R2670 and R2625 Digital Communications System Analyzers with the Project 25 Trunking Option. The analyzer provides unique testing features for Project 25 Trunking based communications equipment. All R2600 series capabilities are retained with the Project 25 Trunking tests accessed via the LCD display, numeric keypad, screened defined softkeys, cursor movement keys and the optical tuning knob.

23-2 CAPABILITIES

The Project 25 Trunking Option is capable of generating and receiving a Project 25 signal. A Project 25 signal relates to the Association of Public-Safety Communications Officials International (APCO) Project 25 digital standard Common Air Interface (CAI) signaling scheme in which a serial bit stream is encoded, mapped into one of four corresponding amplitudes, filtered digitally, and then modulated onto an RF carrier.

The Project 25 Trunking Option simulates the functions of a Project 25 central controller by providing control channel and voice channel protocols to perform various tests. Call sequence status is displayed in the form of a thermometer with numbers 1 through N (see Appendix M) representing the various call states. A textual message also is displayed below the thermometer to give an indication of call status. Features incorporated in this option include:

Registration/Call Alert

Registration/Call Alert tests the radio's ability to acquire and interpret the control channel being transmitted by the analyzer. ID parameters are entered in the R2670 or R2625 to match the radio's configuration. Successful registration verifies the radio's receiver as well as the configuration.

Dispatch Voice

Dispatch voice capability allows the user to verify the radio's transition from the control channel to the voice channel. In addition, receive and transmit voice capability can be verified.

BASE

Provides a duplex function to transmit a C4FM 1011 Hz test pattern and receive a 1011 Hz test pattern in either C4FM or LSM modulation. It also provides an averaging wattmeter capability

BER

Provides receive only V.52 test pattern functionality. Can receive either a C4FM or LSM modulation. Displays the received BER values.

23-3 PROJECT 25 CONNECTORS

The R2670 has two connectors as shown in Figure 23-1. Both connectors are located on the side of the housing. The KVL connector provides a receptacle for loading an external encryption key. The other connector is an interface port.

KEY VARIABLE LOADER (KVL) PORT

The KVL port allows the analyzer to be preloaded with a user-selected encryption key from any compatible KVL keyloader. Project 25 is compatible with DX compatible key loaders or any KVL 3000 with the ASN option.

INTERFACE PORT (25 pin)

The interface port is provided for future capability.

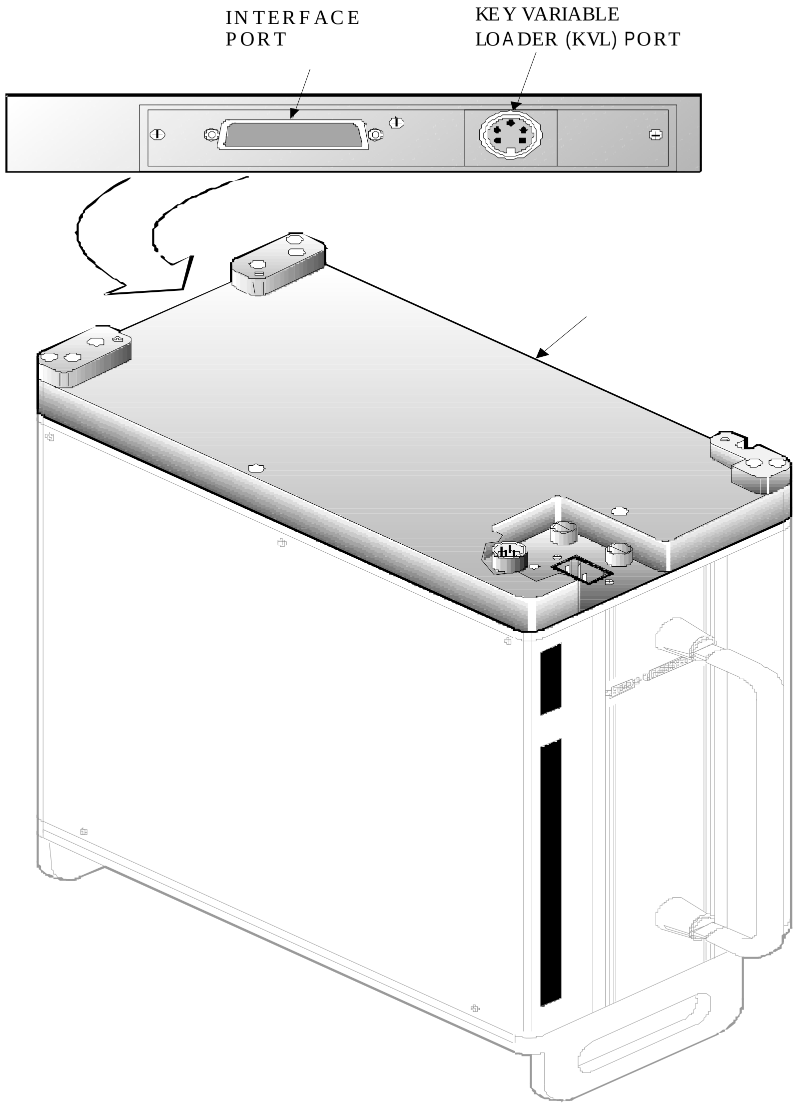


Figure 23-1. Bottom of R2670

Section 24

PROJECT 25 TRUNKING OPERATING INSTRUCTIONS

CAUTION

When testing a radio, the analyzer generates a control channel signal. Take care to prevent this signal from unintentionally capturing other radios in the area. Observe the following precautions:

- • *Do not* ***use an antenna on the analyzer for over-the-air testing.***
- • *Use* ***double-shielded cables on the analyzer to carry signals to and from the radio.***
- • *Locate* ***the analyzer at least 35 feet from the antenna of a unit that is working in the same system that the analyzer is testing.***
- • *Adjust* ***the squelch to where the LED indicator for squelch just turns off or is closed. When the signal from the radio is present, the squelch LED will illuminate indicating that squelch has been detected and there is a signal present.***

24-1 INTRODUCTION

The Project 25 Trunking Option is an enhancement to the R2670 and R2625 Digital Communications System Analyzers. Refer to sections 1, 2, and 3 under the General Operation tab in this manual for general installation information, a description of the control functions, and general operational information. The following sections of this manual contain information on screen field definitions and test setup.

Error/Warning Messages

Refer to Appendix M-3 for a listing and description of error and warning messages related to the Project 25 trunking test mode. Messages common to all test modes are described in paragraph 2-4 under the General Operation tab of this manual.

24-2 SOFTARE VERSION SCREEN

To view the software version of the R2670 or R2625 Analyzer:

1. Turn power on and wait for the display to appear on the screen.
2. Press the SPF hard key, and move the cursor to “VERSION”.
3. Select the display table softkey. This will configure the analyzer to generate a screen that displays the Project 25 software version (figure 24-1).
4. Move the cursor to the Project 25 (PRJ25) position and select the view options softkey. A screen similar to figure 24-2 will be displayed. This screen indicates the analyzer options installed.
5. Select the return softkey to return to the power up screen.

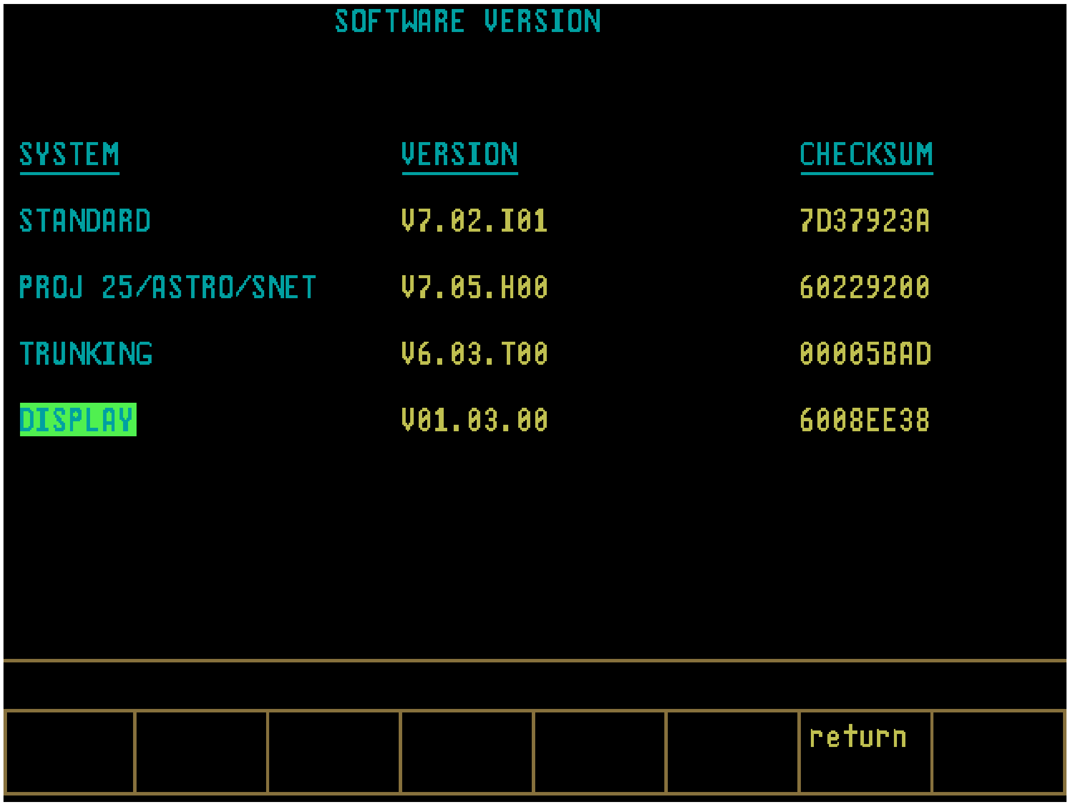


Figure 24-1. PROJ 25 Version Screen

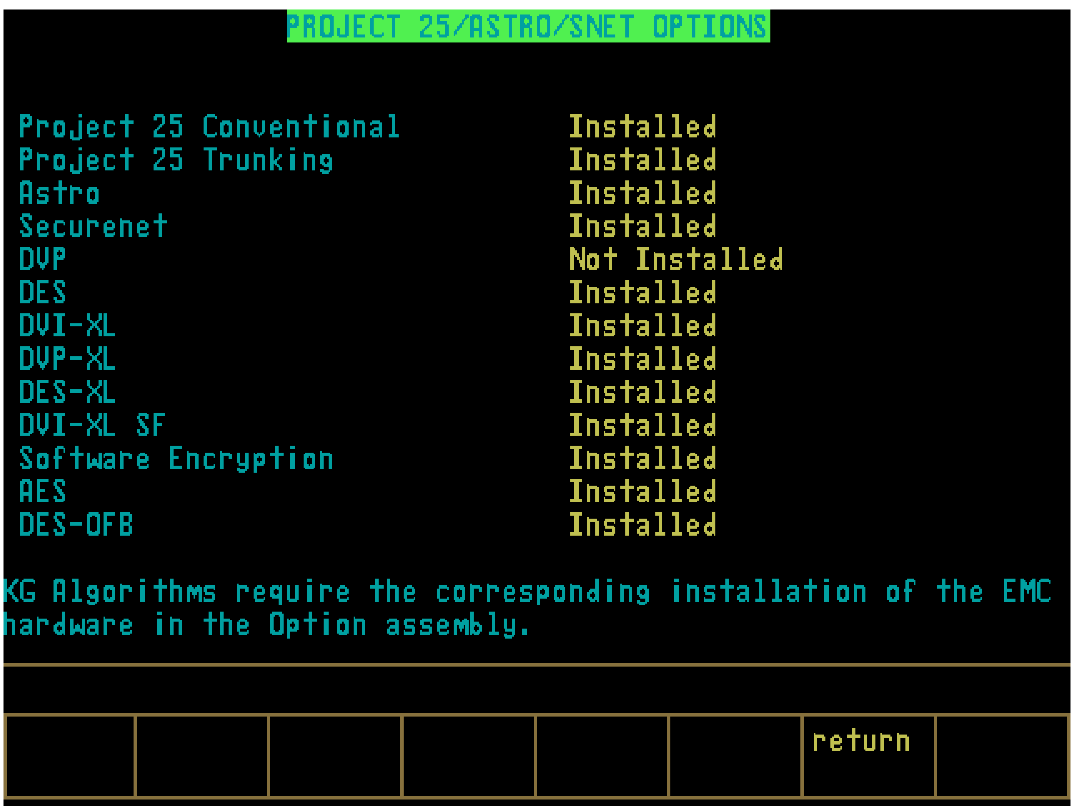


Figure 24-2. PROJ 25 Options Screen

24-3 BASIC OPERATION

Control of the unit and selection of data to be displayed are performed through the use of three main windows that simultaneously appear on the screen: 1) the Display Zone, 2) the RF Zone, and 3) the Audio Zone. These three zones are shown in figure 24-3. The Display Zone displays data related to the radio under test.

The RF Zone is used for selection of RF mode, selection of frequency band, I/O port selection and for control of RF signal level at the input/output port. The Audio Zone is used to select the modulation format, and the signal source and deviation level when generate mode has been selected.

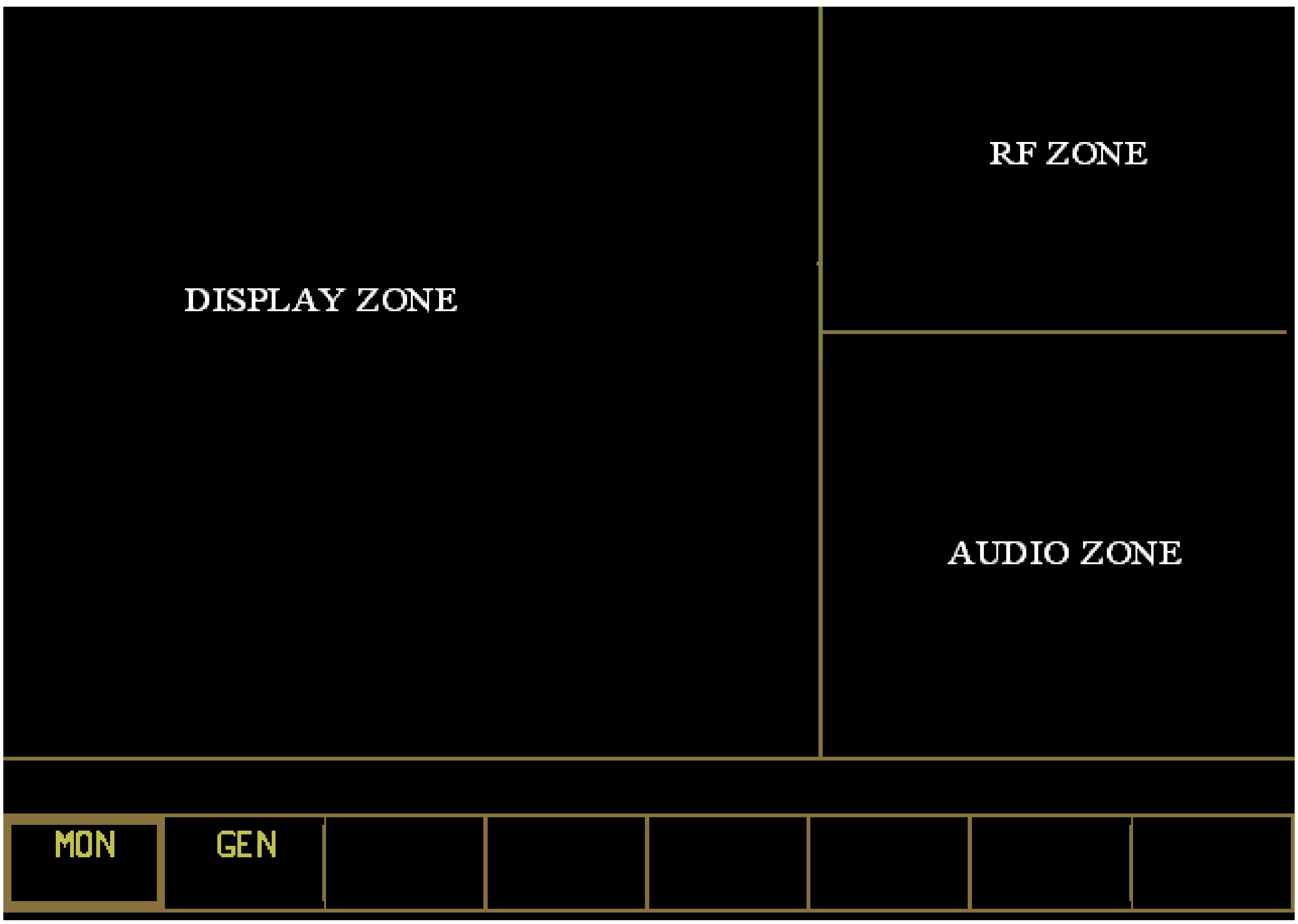


Figure 24-3. Screen Zone Arrangement

24-3.1 Display Screens

The three main windows, or cursor zones, are accessed through a cluster of three CURSOR ZONE keys at the top center of the unit. The location where the cursor rests within each zone is called a cursor field. To control the unit and enter data, all operator inputs are made at highlighted cursor fields (brighter-face type).

Below the screen are softkeys. These softkeys, with customized on-screen labels, interact with the screen to provide a unique menu of entry options for each cursor field. This greatly reduces the number of keys and eliminates having to search through unrelated controls to find the one that is needed.

24-3.2 Manual Operation

To control the cursor location and input information by (manual control):

- Use the CURSOR ZONE keys to move the cursor among the three zones.
- Use the CURSOR POSITION keys to move the cursor from field to field within a zone.
- Once at the desired field, use either the TUNING knob or the numeric keys to enter numeric information. Use the softkeys for other menu selections.

24-3.3 Expanded Display

Some fields have the ability to expand their contents to fill the entire screen. These fields consist of the following:

- Spectrum analyzer, clear scope, mod scope, ext scope, and bar graph displays
- Encode tables
- Dedicated keys

24-3.4 Dedicated Keys

Refer to paragraph 3-8 under the General Operation tab in this manual for an explanation of the HELP, MEM, SPF, and CAL keys.

24-3.5 Remote Operation

The R2670 and R2625 analyzers are equipped with a standard RS-232 interface. This interface may be used to remotely control the analyzer using a set of commands, queries, and responses that are defined in the General Dynamics *R2600 Series Communications System Analyzer Programming Reference Manual (68-80309E55).*

24-3.6 Help

The analyzer provides on-screen operating instructions via the dedicated HELP key. Help screens are organized such that each display area has an associated help screen pertaining to that area of the screen. System help is available via a softkey within each help screen. Use the **return** softkey to return to the function in progress.

24-4 PROJ 25 TRUNK MODE

Select the **PROJ 25 TRUNK** mode by placing the cursor in the “Mode:” field in the Display Zone located at the top of the screen. Use the **PROJ 25 TRK** softkey to select the **PROJ** 25 mode. A screen similar to figure 24-4 appears.

When the Display Zone “Mode:” is set to **PROJ** 25 TRK, the R2670 or R2625 will configure itself to generate and monitor Project 25 trunking signals.

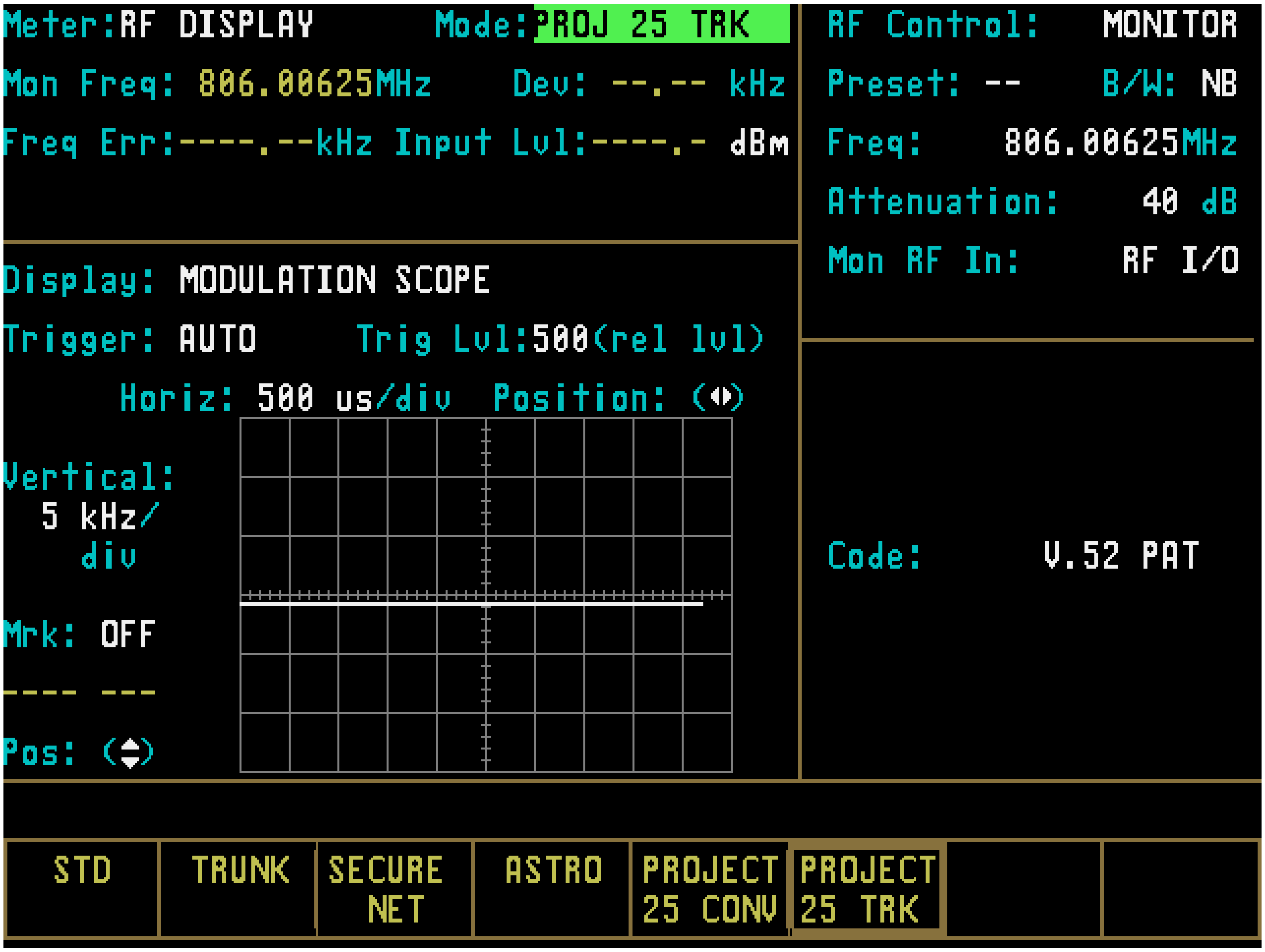


Figure 24-4 PROJ 25 TRK Mode Screen

Upon selection of the PROJ 25 Trunk mode, access specific tests by pressing the **more** softkey in the “Meter” field.

The following softkey selections are available for this field: **REG/CAL ALERT** (registration call alert, refer to figure 24-5), **DISPTCH VOICE** (dispatch voice), **BASE TEST**, and **BER TEST**. A description of each test, as well as the screens associated with the tests, is included in the following sections.

24-4.1 Registration Call Alert

This test verifies the radio under test is capable of registering and receiving a call alert from the analyzer that is simulating fixed site base station.

24-4.2 Dispatch Voice

This test verifies control channel to voice channel transitions as well as transmit and receive voice capabilities.

Softkey selection of the test is available once the PROJ 25 Trunk mode has been entered. Refer to figure 24-5. To execute a test, various parameters specific to the radio under test must be entered. A screen description, including parameter definitions is contained in section 24-4.

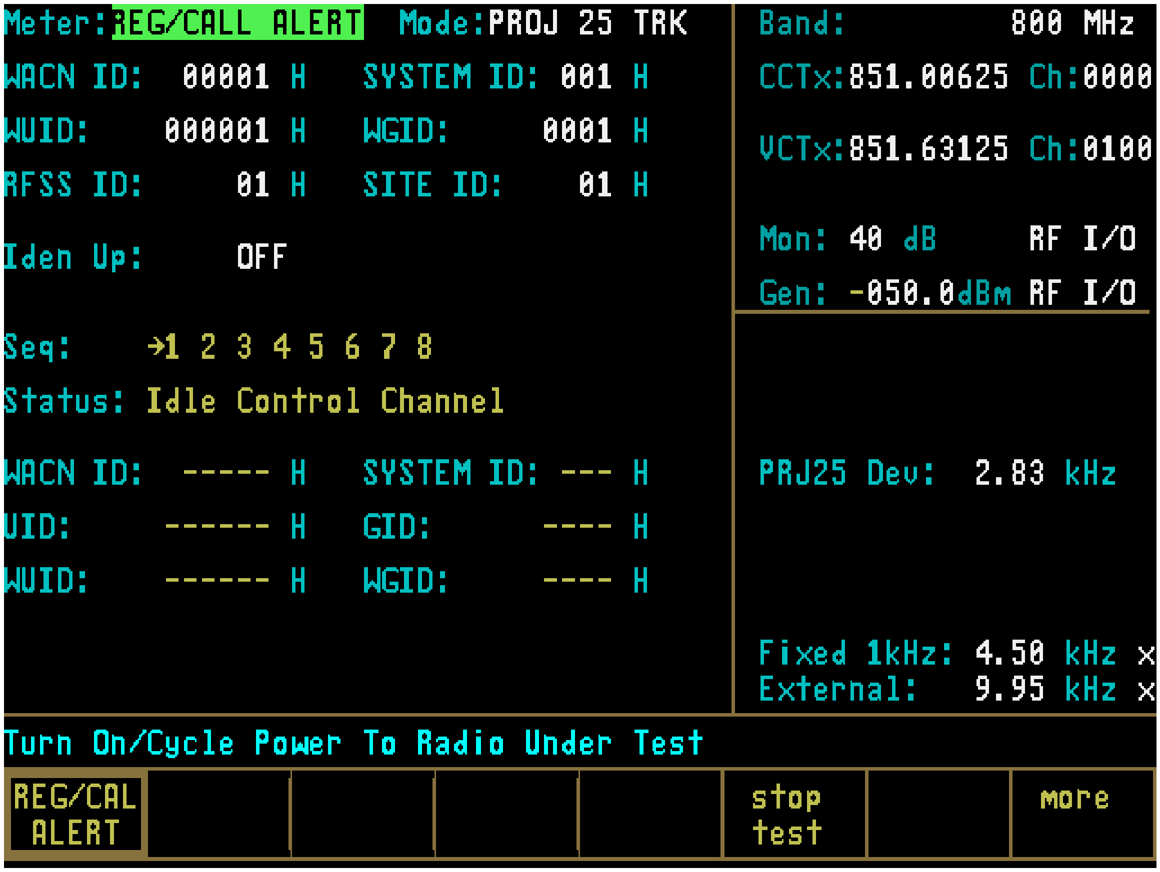


Figure 24-5 Registration Call Alert meter Selection

24-4.3 PROJ 25 Trunking Screens

Upon selection of REG/CAL ALERT, DISPATCH VOICE, BASE, or BER the screen zones defined in section 24-3 will display parameters associated with Project 25 Trunking. Parameters associated with REG/CAL ALERT and DISPTCH VOICE are identical, therefore the screens look identical until the start test softkey is pressed.

Upon test initiation, the screens differ for each test only in the call sequence diagram and message prompts. The following sections define the Project 25 parameters associated with each Display Zone. The BASE and BER screens each require their own set of parameters. These selections also will modify the parameters that are available in the RF Zone and Audio Zone.

24-4.3.1 Display Zone

The Display Zone consists of two main sections User Input Parameter Section and the Result Section. The User Input Section consists of various IDs that must be entered by the user. These IDs match the IDs contained within the radio so that a communication link can be established between the analyzer and the radio. The result section consists of parameters received from the radio under test. Some of the parameter definitions are identical to those in the Input Parameter Section.

The User Input section of the display zone consists of various parameters that must be entered by the user. These parameters must match the configuration set in radio codeplug. The radio codeplug is read using Radio Service Software (RSS). The parameters definitions are as follows.

WACN ID

Wide Area Communication Network IDentity

SYSTEM ID

System IDentity

WUID

Working Unit IDentity

WGID

Working Group IDentity

RFSS

RF Sub-System IDentity

SITE ID

Site IDentity

IDEN-UP

This selects which IDEN_UP TSBK format will be transmitted the control channel.

None

No IDEN_UP TSBK is transmitted on the control channel.

800 MHz

The 8/700 MHz format IDEN_UP TSBK is transmitted. It defines the following band:

Field	Value	IDEN_UP TSBK Value
Identifier	1	%0001
Bandwidth	12.5 kHz	0x64
Transmit Offset	-45 MHz	0xB4
Channel Spacing	6.25 kHz	0x32
Base Frequency	851.00625	0xA2510A2

700 MHz

The 8/700 MHz format IDEN_UP TSBK is transmitted. It defines the following band:

Field	Value	IDEN_UP TSBK Value
Identifier	2	%0010
Bandwidth	12.5 kHz	0x64
Transmit Offset	+30 MHz	0x178
Channel Spacing	6.25 kHz	0x32
Base Frequency	762.00625	0x9157562

UHF/VHF

The UHF/VHF MHz format IDEN_UP TSBK is transmitted. The UHF/VHF Config screen is used to define the IDEN_UP parameters.

The middle of the Display Zone contains a field named SEQ. This area of the display, also known as a thermometer will update the user as to the state of the call sequence. Refer to Appendix M for a description of the status thermometer signaling events for each test sequence.

The bottom portion of the Display Zone contains those parameters received from the radio under test. The parameters received from the radio are defined as follows.

WACN ID

Wide Area Communication Network IDentity

SYSTEM ID –

System IDentity

WUID

Working Unit IDentity

WGID

Working Group IDentity

UID

Unit IDentity

GID

Group IDentity

24-4.3.2 RF Zone

This zone contains general RF information specifically related to the Project 25 Trunking mode of operation. Channel selection for both the control channel and the voice channel is made in this zone. The RF zone provides for user selection of the channels and frequencies. A description of each field contained within the RF Zone is as follows.

Band

This entry allows the user to select the RF Band for a particular test. These include the following bands:

800 MHz

851.00625 MHz – 876.59375 MHz with a -45 MHz offset. Channel plan #1.

700 MHz

762.00625 MHz – 787.59375 MHz with a +30 MHz offset. Channel plan #2.

UHF/VHF

User defined channel plan. The channel plan range is 1 thru 16. This can also be used to define non-standard 700 MHz channel plans.

CCTx

Control Channel Generate Frequency

This parameter allows the user to enter the control channel frequency in MHz.

Ch Control Channel Number

This parameter allows the user to enter the control channel number. The 800 MHz band allows for channel numbers 0 to 4094 which correspond to a frequency range of 851.00625 to 876.59375 MHz respectively.

VCTx

Voice Channel Generate Frequency

This parameter allows the user to enter the voice channel generate frequency in MHz.

Ch Voice Channel Number

This parameter allows the user to enter the voice channel number. The 800 MHz band allows for channels 0 to 4094 which correspond to a frequency range of 851.00625 to 876.59375 respectively.

Mon

This field allows the user to select the attenuation and port for the received signal. Attenuation is softkey selectable and can be set to 0, 20, or 40dB. The port is softkey selectable to RF I/O or ANT.

Gen

This field allows output, level setting and generate port selection. The output level can be entered using the keypad or the tuning knob. The port is softkey selectable to Gen Out or ANT. The output level varies based on the generate port selection as follows:

Gen out 0 - -80dB

RF/IO -50 – 130dB

24-4.3.2.1 UHF/VHF Config

The UHF/VHF allows the user to define a channel plan that is different than the predefined channel plans (i.e., 800/700 MHz). This definition is used to determine channel number mappings. A description of each field in the UHF/VHF Config is as follows:

Band Identifier

This value is used as part of the channel definition in the voice channel grant message.

Transmit Offset

This is the offset from the radio's receive frequency used to compute the transmit frequency.

TX frequency = RX frequency + TX Offset

Channel Spacing

This is the spacing between consecutive channels and is used in the computation of frequencies based on a channel number.

Base Frequency

The radio receives frequency for channel number 0.

NOTE

Use the Project 25 Trunking radio RSS/CPS software to read system values from UHF, VHF, or non-standard 8/700 MHz radio to fill in the above fields (UHF/VHF Config screen) for a band plan. Utilize the following equation to compute/verify the Tx Freq or the Chan No:

(CCTx or VCTx – Base Frequency) / (Channel Spacing) = 0 to 4094

24-4.3.3 Audio Zone

This zone contains baseband audio controls and level setting.

PRJ25 Dev

This field allows the user to set the PROJ 25 generate signal deviation. The deviation range is 0 – 5kHz.

Fixed 1kHz

This field allows a fixed 1kHz to be enabled and the amount of modulation, measured in kHz deviation, to be adjusted.

External

This field allows an external input to be enabled, and the amount of modulation measured in kHz deviation to be adjusted. The external input selection includes both the BNC labeled: EXT MOD IN and the MIC (microphone input).

24-4.4 PROJ 25 Trunking BASE Screen

Upon selection of the PROJ 25 Trunking BASE test the screen zones defined in section 24-3 will display parameters associated with Project 25 Trunking BASE testing.

The BASE test performs a duplex operation were the analyzer will transmit a C4FM (only) 1011 Hz test pattern, and will receive either C4FM or LSM 1011 Hz test pattern. It also provides an averaging wattmeter function on the received RF signal.

24-4.4.1 Display Zone

The display zone consists of a single section with several fields that relate to BASE testing. A description of each field is as follows.

Meter

The meter provides the standard PROJ 25 Trunking meter selections and a start test/stop test softkey. This softkey allows the user to initiate the duplex test operation. When the test has been started the analyzer will begin transmitting a 1011 Hz test pattern on the generate frequency from the RF zone. Once the test has been started the start test/stop test softkey displays:

Stop Test

When a test is not in progress the start test/stop test softkey displays:

Start Test

RX Signal Type

There are two options available for this field: LSM (Linear Simulcast Modulation) and C4FM (4 level FM-C). These define what modulation format is going to be received on the monitor frequency.

Averaging Wattmeter

This field will turn on or turn off the averaging wattmeter function. This function computes the average RF input power of a time period (specified in the Measurement Period field). When the averaging wattmeter is on any keypress or received remote command will halt the measurement (will turn off the average wattmeter) and the keypress will be ignored.

Measurement Period

This defines the time period (in seconds) that the input power is averaged over. This allows values of 0.09 seconds to 4.32 seconds.

Input Lvl

This field displays the results of the power measurement when the average wattmeter is on. The user can select how the results are displayed as either dBm or as micro volts or watts (uV or W).

24-4.4.2 RF Zone

The BASE test will configure the RF zone for duplex operation. The fields available will be similar to the RF Zone fields when in standard mode. A description of the RF zone fields is as follows:

RF Control

This provides DUPLEX as the only selection. Duplex is required when in BASE test mode.

Preset

This field allows the user to select predefined memory presets. This is the same function that is available when in standard mode (refer to GENERAL OPERATIONS).

B/W

This is the bandwidth selection field and has the same functionality as the B/W in standard mode (refer to GENERAL OPERATIONS). The user can select either NB (Narrow Band) or WB (Wide Band). For BASE testing only the NB should be used.

Mon Freq

This field allows the user to specify the frequency that the analyzer will receive the 1011 Hz test pattern from the base station being tested. This is the frequency that the base station being tested is transmitting.

Offset

This is the relative offset from the Mon Freq that defines the analyzer's generator frequency. This can range in values of: -999.99975 to +999.99975. The generator frequency is computed by:

Gen freq = Mon freq + Offset

The generator frequency is the analyzer's transmit frequency for the C4FM 1011 Hz test pattern. This should be the receive frequency for the base station being tested.

Mon

Allows the user to select the amount of attenuation to apply to the received RF signal. This can be 0, 20, or 40 dB. It also allows the selection of the receive port, either ANT or RF I/O.

Gen

Allows the user to select the RF power level of the analyzer's transmit signal. The allowed ranges very depending on the output port selected:

GEN port+000.0 to –080.0 dBm

RF I/O -050.0 to –130 dBm

The output port is also selectable as either GEN or RF I/O.

24-4.4.3 Audio Zone

The audio zone allows the user to enter parameters relating to the transmitted signal modulation. A description of the audio zone fields follows:

PRJ25 Dev

Defines the deviation level of the analyzer's transmitted C4FM signal. This ranges in value of 0.00 kHz to 5.00 kHz.

Code

This defines the test pattern to be transmitted. The only option available is 1011 Hz PAT (the 1011 Hz test pattern).

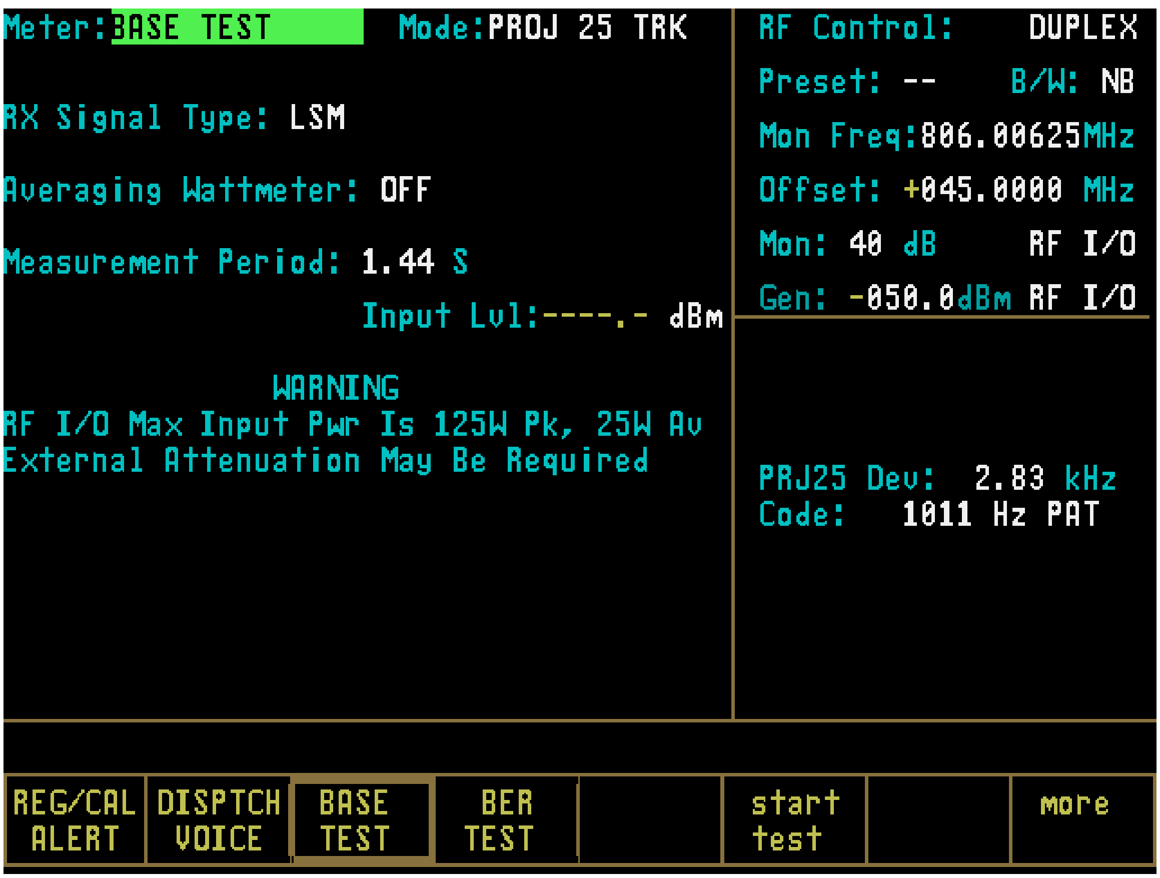


Figure 24-6. PROJ 25 Trunk BASE Test Meter Selection

24-4.5 PROJ 25 Trunking BER Screen

Upon selection of the PROJ 25 Trunking BER (Bit Error Rate) test the screen zones defined in section 24-3 will display parameters associated with Project 25 Trunking BER testing. The BER test performs a monitor operation where the analyzer will receive either C4FM or LSM V.52 test pattern. The results of the BER are displayed in the Display Zone. Refer to paragraph 24-4.5.1 Display Zone.

The Display Zone consists of a single section with several fields that relate to BER testing. A description of each field is included below.

Meter

The meter provides the standard PROJ 25 Trunking meter selections and a reset softkey. This softkey allows the user to clear the accumulated BER values and restart the BER computation.

24-4.5.1 RF Zone

The BASE test will configure the RF zone for monitor operation. The fields available will be similar to the RF Zone fields when in standard mode. A description of the RF zone fields is as follows:

RF Control

This provides MONITOR as the only selection. MONITOR is required when in BER test mode.

Preset

This field allows the user to select predefined memory presets. This is the same function that is available when in standard mode (refer to GENERAL OPERATIONS).

B/W

This is the bandwidth selection field and has the same functionality as the B/W in standard mode (refer to GENERAL OPERATIONS). The user can select either NB (Narrow Band) or WB (Wide Band). The NB should be used for BASE testing only.

Mon Freq

This field allows the user to specify the frequency that the analyzer will receive the V.52 test pattern from the base station being tested. This is the frequency that the base station being tested is transmitting.

Mon

Allows the user to select the amount of attenuation to apply to the received RF signal. This can be 0, 20, or 40 dB. It also allows the selection of the receive port, either ANT or RF I/O.

24-4.5.2 Audio Zone

The audio zone allows the user to enter parameters relating to the received signal. A description of the audio zone fields is as follows:

Code

This defines the test pattern to be received. The only option available is V.52 BER.

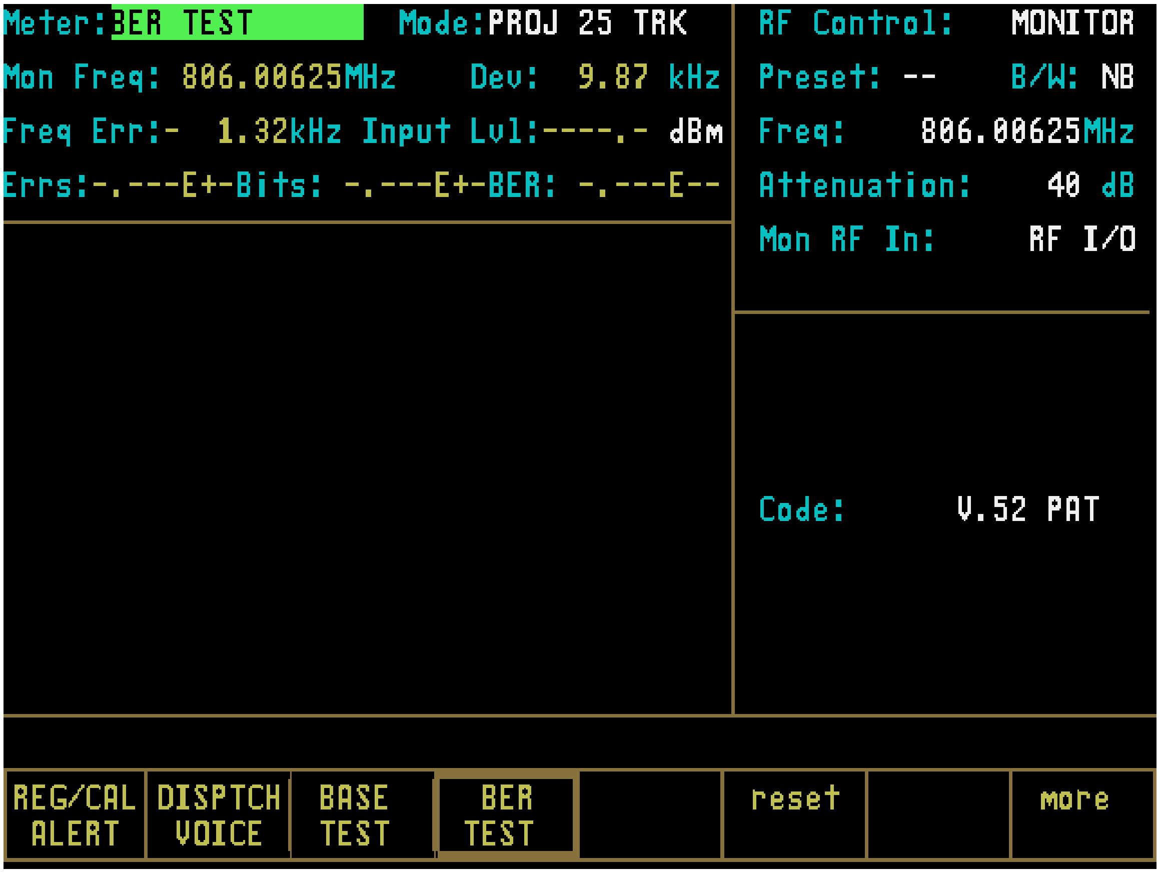


Figure 24-7. PROJ 25 Trunk BER test Meter Selection

24-5 TEST SETUP

24-5.1 Connecting a Radio

Use a 50-ohm BNC cable and an N to BNC adapter to connect from the RF I/O port of the R2670 or R2625 analyzer to the antenna port of the radio as shown in figure 24-8.

CAUTION

When in Monitor mode, adjust the squelch to where the LED indicator for squelch turns off or is closed. When the signal from the radio is present, the squelch LED will illuminate, indicating that squelch has been detected and there is a signal present

CAUTION.

Observe the input power ratings and warnings of the analyzer to insure that no damage occurs to the analyzer

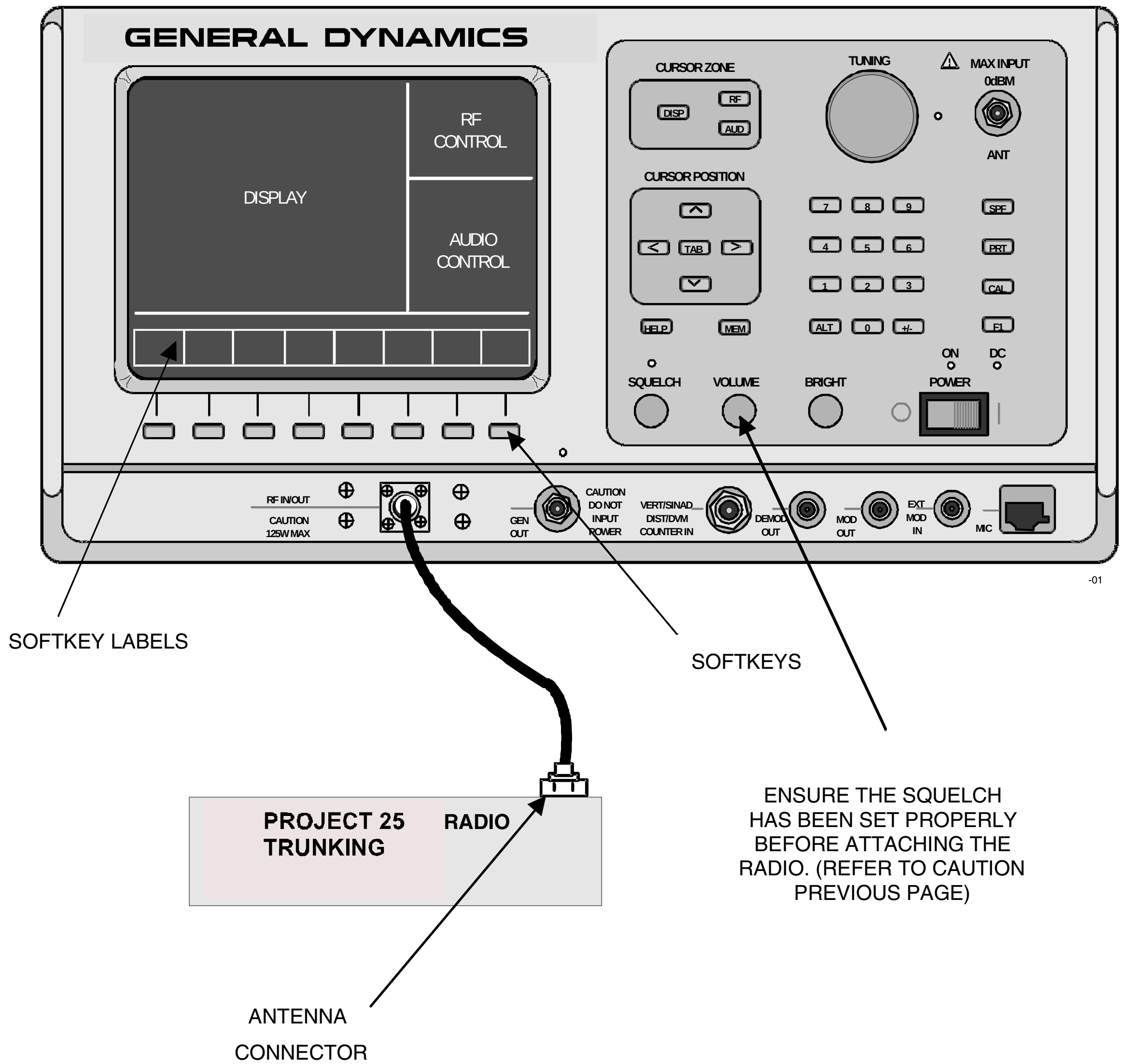


Figure 24-8. Test Setup

PROJECT 25 TRUNKING APPLICATIONS

25-1 PROJECT 25 TRUNK RADIO TESTING

This section of the manual contains information on testing Project 25 trunked radios using the R2670 or R2625 Digital Communications System Analyzer with the Project 25 Trunking Option. Two types of subscriber tests are defined: Registration/Call Alert and Dispatch Voice; and two types of base station/repeater test are defined: BASE and BER

25-2 ACCESSING PROJ 25 TRK MODE

Select the PROJ 25 TRK mode by placing the cursor in the "Mode:" field in the Display Zone located at the top of the screen. Use the **PROJECT 25 TRK** softkey to select the PROJ 25 TRK mode. A screen similar to Figure 25-1 appears.

When the display zone "Mode:" is set to PROJ 25 TRK, the R2670 will configure itself to emulate a Project 25 basestation.

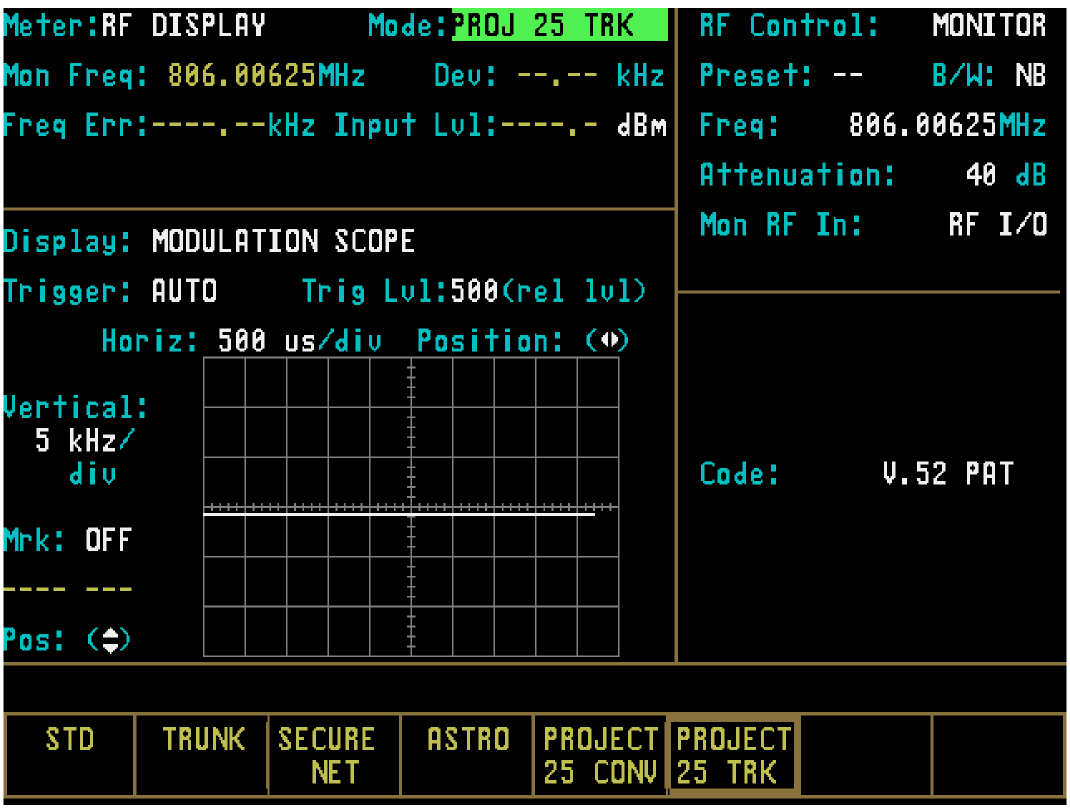


Figure 25-1. PROJ 25 CONV Mode Screen

25-3 PROJ 25 TRK ENCRYPTION SET UP

For systems that utilize encryption on voice channels, the R2670 provides encryption support to properly encrypt and decrypt voice traffic. This section describes how to enable voice channel encryption and how to setup encryption keys.

25-3.1 SET UP Encryption Display

The SET UP display places the analyzer in encryption setup mode and allows the operator to select the desired algorithm. The SET UP display is accessed from the Display Zone. To use SET UP display, move the cursor to the “Display:” field and select SET UP using the SET UP softkey. The Display Zone will show a menu of SET UP options as shown in Figure 25-2.

25-3.1.1 Encrypt

The analyzer operates in either clear or encrypted modes. In the Display Zone, scroll the cursor to the “Encrypt:” field and select ON as shown in Figure 25-3 for encrypted PROJ 25 TRK, or OFF for clear PROJ 25 TRK operation.

25-3.1.2 Algorithm Select

Within the SET UP display, the type of algorithm can be selected. Algorithm is a term that describes the method of coding data or audio so that only equipment having the same algorithm selected and the same key are able to exchange voice and data information. The analyzer includes several algorithms recognized by radios using Project 25. You will need to select these algorithms to use for processing messages.

In the Display Zone, move the cursor to the “Algorithm Sel:” field as shown in Figure 25-4. Softkeys will provide for selection of the available algorithms. Select the appropriate algorithm.

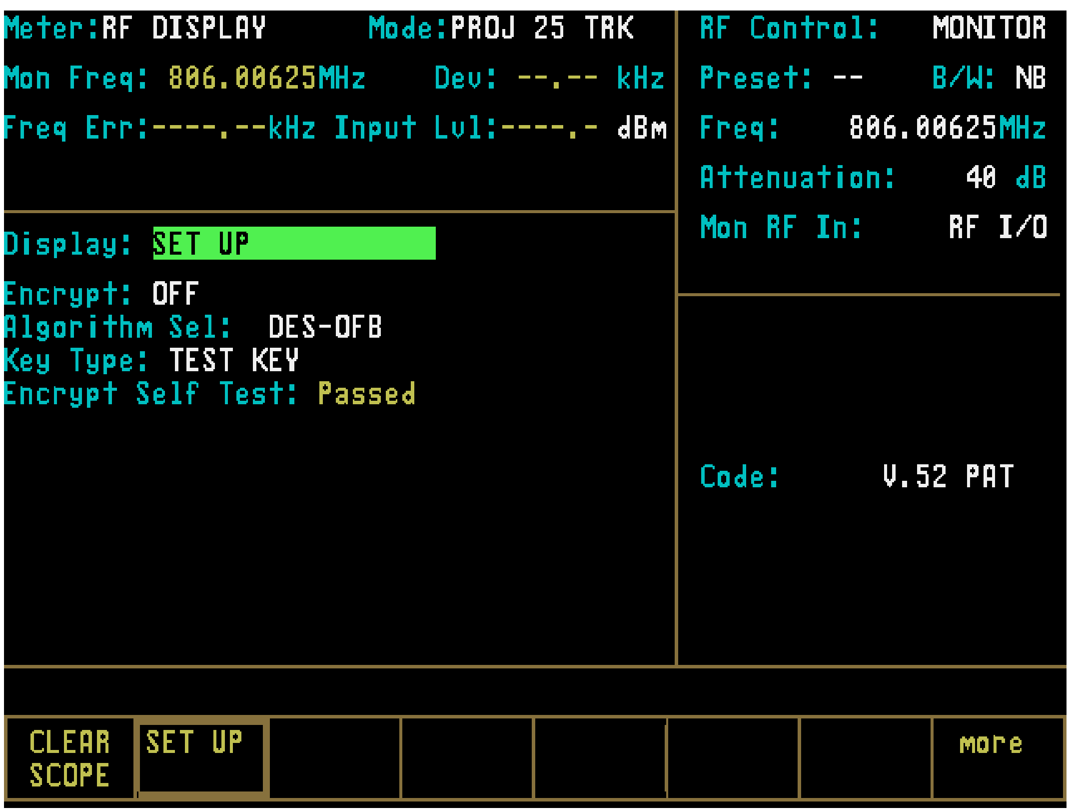


Figure 25-2. SET UP Display Screen

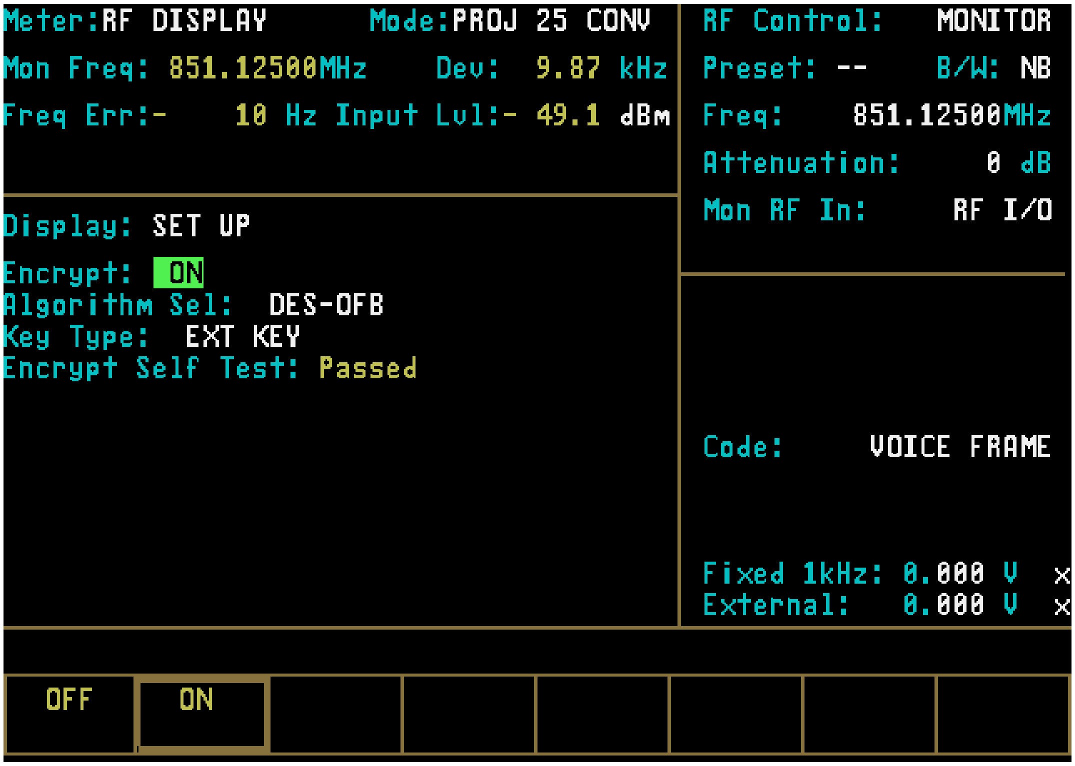


Figure 25-3. Encryption Select Display

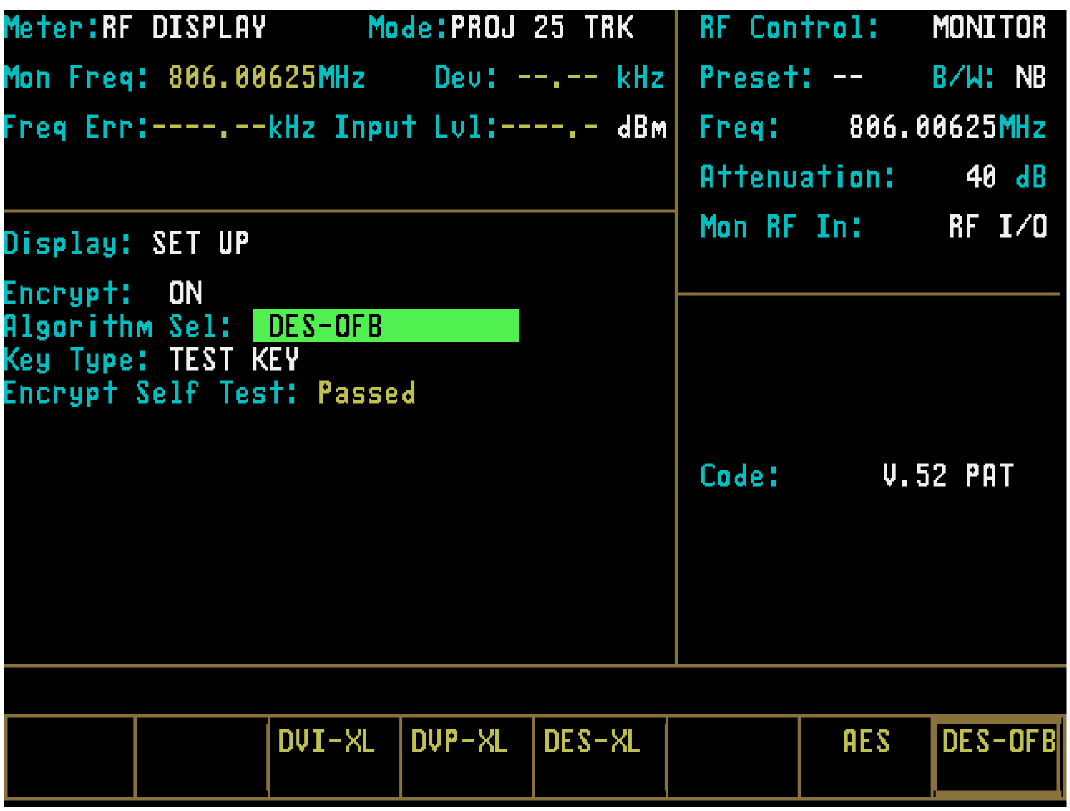


Figure 25-4. Algorithm Select Display

25-3.1.3 Key Type

An encryption key is needed when testing in the encryption mode. There are two encryption key types that can be selected, either a Test Key or an External Key. The Test Key is the default and is used to support most Project 25 testing. The Test Key is a predefined key that is programmed into the analyzer for testing purposes only. In order to prevent compromised security, the Test Key should never be used for sending secure radio communications (all Project 25 analyzers use the same Test Key). The External Key is a key that has been loaded from a KVL. In order to test secure communications the keys in both the Unit Under Test and the analyzer must be the same. The analyzer provides these softkey selections:

TEST KEY

This softkey selects the Test Key saved in the analyzer's key storage memory.

EXT KEY

This softkey selects the External Key saved in the analyzer’s storage memory for the selected algorithm. This key is defined by the customer and must first be loaded into the analyzer by a KVL.

erase ext key

This softkey erases from the analyzer’s key storage memory any External Key saved for the current algorithm.

load ext key

This softkey starts the sequence of programming the analyzer with an External Key for the algorithm selected from a Key Variable Loader (KVL). This procedure requires a key loading cable and KVL.

25-3.1.4 Encrypt Self Test

A self test of the encryption functions is performed at power up. The “Encrypt Self Test:” field in the SET UP display (Figure 25-2) indicates the results of the self test, passed or failed.

25-3.2 Using the Test Key

The analyzer can be used to test radios using the internal Test Key (707070….hex). To select the Test Key, place the cursor in the “Display:” field in the Display Zone. Select SET UP using the **SET UP** softkey. This will access the SET UP display screen (Figure 25-2).

Move the cursor to the “Encrypt:” field and select the **ON** softkey (Figure 25-3). Move the cursor to the "Algorithm Sel:" field and select the desired algorithm using softkeys (Figure 25-4). Move cursor to the "Key Type:" field and select the **TEST KEY** softkey (Figure 25-5). The analyzer is now programmed with the Test Key.

Project 25 radios also have an internal Test Key which is the same as the analyzer’s. Refer to the radio service manual to determine if this key can be activated in your particular radio. If the internal Test Key cannot be activated, it must be loaded from a KVL.

Follow the procedure in the KVL instruction manual to load the 707070…..hex key into the radio. The radio encrypter is now keyed to match the analyzer.

25-3.3 Programming with External Key

You can use a customer key to program the analyzer and operate in private mode with a keyed radio. The customer (external) key, once loaded, is saved in memory by the analyzer until the operator erases it. The key is stored in non-volatile memory and will be retained even if power to the analyzer is turned off.

25-3.3.1 Connecting the KVL

The KVL plugs into the KVL port (Figure 23-1) on the side of the analyzer opposite the carrying handle. Connect the KVL to the analyzer and then use the following instructions to load the External Key.

CAUTION

Use only DX key loaders, or any KVL 3000 with the ASN option. Other types of key loaders (AX, BX or CX) may cause the encryption hardware to malfunction. To recover, press the ***encrypt reset*** *softkey under the "Special Functions" (SPF) menu.*

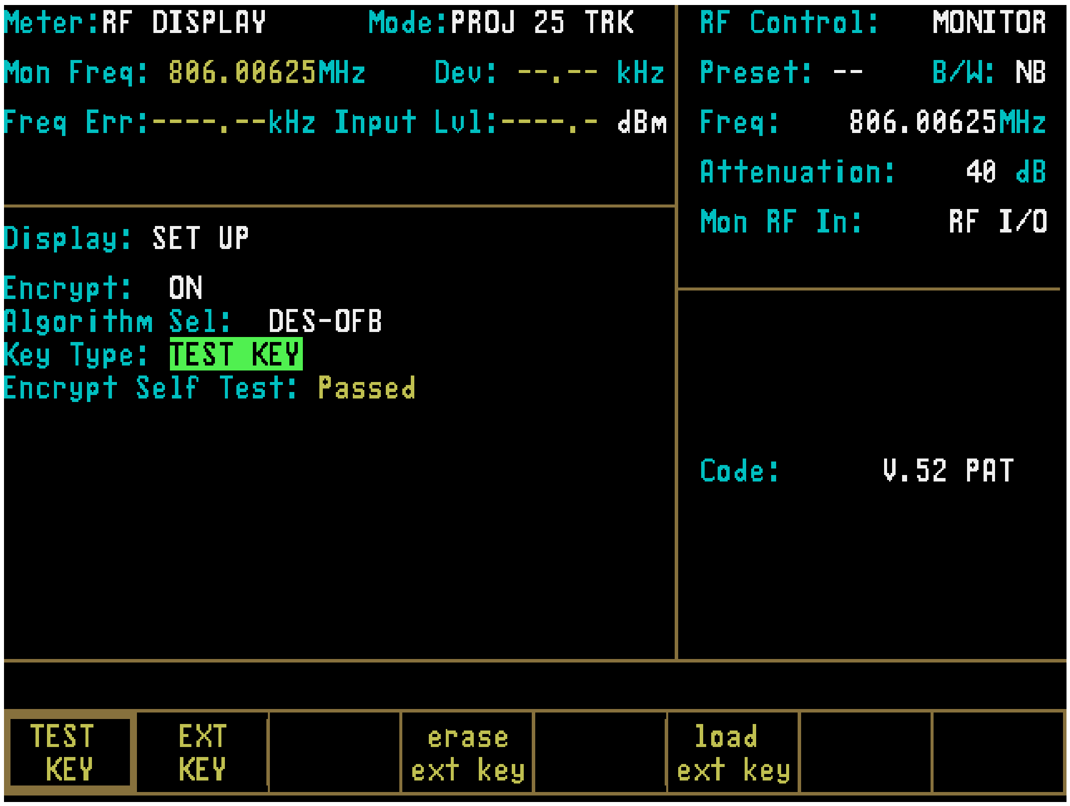


Figure 25-5. Test Key Programming Display

25-3.3.2 Loading External Key

To initiate loading an external key, place cursor in "Display:" field in Display Zone and select SET UP mode display using **SET UP** softkey.

Move cursor to "Algorithm Sel:" field and select desired algorithm using softkeys (Figure 25-4).

Move cursor to "Key Type:" field.

Press the **load ext key** softkey to initiate the key load sequence.

Push the switch on the KVL to begin loading. This activates the programming function. When programming is complete, the KVL displays "pass" if the key load procedure was successful. The analyzer displays a message "Ext key passed." If the key load procedure was unsuccessful, the KVL displays "fail."

If key load procedure was successful, disconnect the KVL. Be sure to press the **EXT KEY** softkey after loading an External Key from the KVL in order to use the key. This completes External Key loading. You can exit the SET UP screen at this time.

25-3.3.3 Erasing External Key

To erase an External Key, place cursor in "Display:" field in the Display Zone and select **SET UP** softkey. This will access the SET UP display screen (Figure 25-2).

Move cursor to "Algorithm Sel:" field. Using softkey, select the algorithm associated with the external key you want to erase.

Move cursor to "Key Type:" field and press **erase ext key** softkey (Figure 25-5). The analyzer will erase the stored External Key and display "key erased" in the message area.

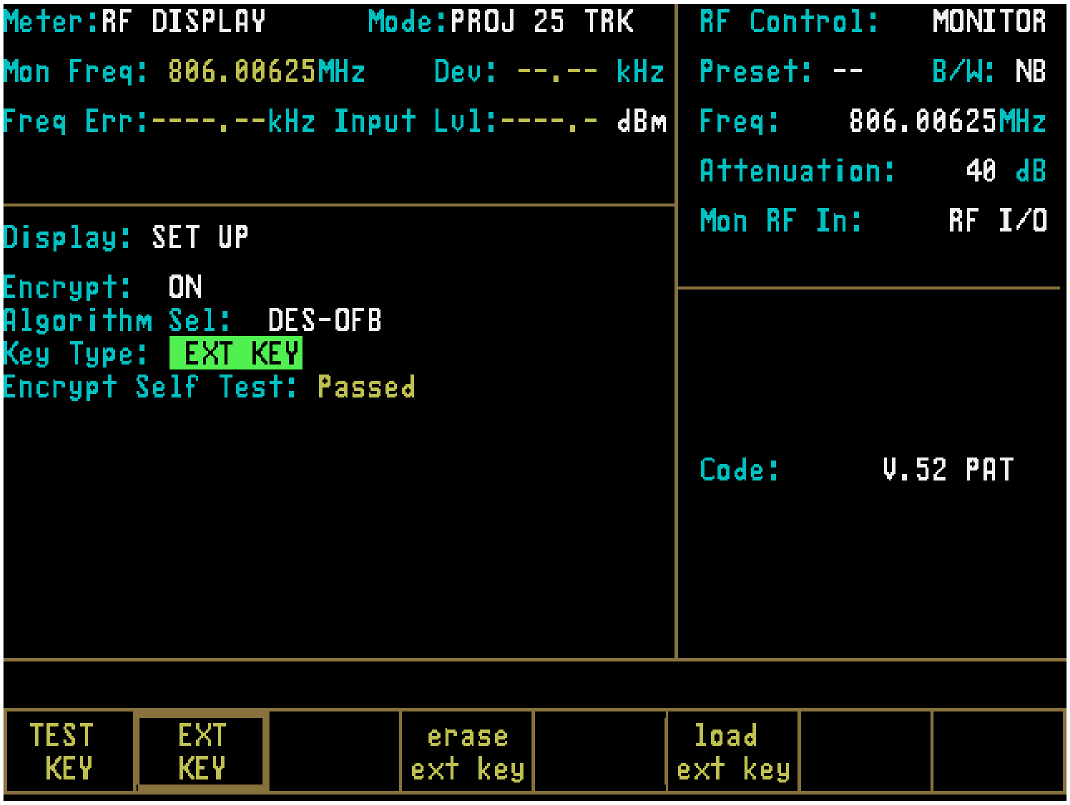


Figure 25-6. External Key Programming Display

25-4 PROJECT 25 TRUNK TESTS

25-4.1 Registration/Call Alert

Select the PROJ 25 TRUNK mode by placing the cursor in the "Mode" field in the Display Zone located at the top of the screen. Use the **PROJ 25 TRK** softkey to select the mode.

1. Move the cursor to the "Meter" field by pressing the **TAB** key.

2. Press the **REG/CAL ALERT** softkey to select the Registration Call Alert test.

3. Enter the parameters listed below. If the parameters are not known, the radio codeplug must be read using Radio Service Software (RSS).

NOTE

WACN ID and SYSTEM ID are required for communication with the radio under test. The remaining parameters are optional unless the radio was configured for specific modes of operation.

- ***WACN ID***
- ***SYSTEM ID***

- ***WUID***
- ***WGID***
- ***RFSS ID***
- ***SITE ID***

4. Press the **RF** Cursor Zone hardkey to move to the RF zone.

5. Press the **800 MHz** softkey to select the 800 MHz band. Move the cursor to the "CCTx field and enter either the control channel transmit frequency or the channel number.

6. Set the monitor attenuation and port selection. Suggested port selection is RF I/O with 20 dB attenuation.

7. Set the generator attenuation and port selection. Suggested port selection is RF I/O with –50 dB for the level setting.

8. Press the **AUD** Cursor Zone hardkey to move the Audio zone.

9. Set the PROJ 25 deviation. The default and suggested deviation is 2.83 kHz.

10. Connect the radio under test to the RF I/O port as shown in figure 24-8.

11. Press the **DISP** Cursor Zone hardkey to move to the Display zone.

12. Move the cursor to the "Meter" field and press the **start test** softkey to begin the test.

13. Observe the user prompts displayed above the row of softkeys. Turn radio on as directed by the prompt.

14. Follow the call sequence by looking at the sequence thermometer in the middle of the screen.

    The status below the sequence thermometer gives a textual description of the Call State. For a description of all call states, refer to Appendix M.

If the call is successful, the thermometer will reach 8 and the test is completed. The bottom portion of the Display Zone will exhibit those parameters received from the radio.

25-4.2 Dispatch Voice

Select the PROJ 25 TRUNK mode by placing the cursor in the "Mode" field in the Display Zone located at the top of the screen.

1. Press the **PROJ 25 TRK** softkey to select the mode.

2. Move the cursor to the "Meter" field by pressing the **TAB** key.

3. Press the DISPTCH VOICE softkey to select the Dispatch Voice test.

4. Enter the parameters listed below. If the parameters are not known, the radio codeplug must be read using Radio Service Software (RSS).

NOTE

WACN ID and SYSTEM ID are required for communication with the radio under test. The remaining parameters are optional unless the radio has been configured for specific modes of operation.

- ***WACN ID***
- ***SYSTEM ID***
- ***WUID***
- ***WGID***
- ***RFSS ID***
- ***SITE ID***

5. Press the **RF** Cursor Zone hardkey to move to the RF zone.

6. Press the **800 MHz** softkey to select the 800 MHz band.
7. Move the cursor to the "CCTx" field and enter either the control channel transmit frequency or the channel number.
8. Move the cursor to the "VCTx" field and enter either the voice channel transmit frequency or the channel number
9. Set the monitor attenuation and port selection. Suggested port selection is RF I/O with 20 dB attenuation.
10. Set the generator attenuation and port selection. Suggested port selection is RF I/O with –50 dB for the level setting.
11. Connect the radio under test to the RF I/O port as shown in Figure 24-8.
12. Press the **AUD** Cursor Zone hardkey to move the Audio zone.
13. Set the PROJ 25 deviation. The default and suggested deviation is 2.83 kHz.
14. Move the cursor to the "external" field. Set the deviation. Press the **TAB** key to move to the switch selection. Press the **CONT** softkey to turn on the external port (microphone).
15. Press the **DISP** Cursor Zone hardkey to move to the Display Zone.
16. Move the cursor to the "Meter" field and press the **start test** softkey to begin the test.
17. Observe the user prompts displayed above the row of softkeys. Turn radio on as directed by the prompt. Perform actions specified by user prompts throughout the remainder of the test.
18. Follow the call sequence by looking at the sequence thermometer in the middle of the screen.

    The status below the sequence thermometer gives a textual description of the Call State. For a description of all call states, refer to Appendix M.

Upon completion of the test, the sequence thermometer will reach 11. Press the **stop test** softkey to complete the test (state 12). The bottom portion of the Display Zone will exhibit those parameters received from the radio.

25-4.3 BASE

Connect a 10dB pad to the RF I/O port and connect the unit under test to the 10dB pad.

1. Place the cursor on the "Mode" field in the Display Zone located at the top of the screen. Use the **PROJ25 TRK** softkey to select the mode.
2. Move the cursor to the "Meter" field by pressing the TAB key. Select the **more** softkey and the **BASE** softkey to select the BASE TEST.

   The RF Zone display will switch to the Duplex format, displaying "Mon Freq:" and "Offset:" fields.

4. Press the RF Cursor Zone hardkey to move to the RF zone.
5. Move the cursor to the "Mon Freq:" field and enter the frequency to be monitored by the analyzer.
6. Move the cursor to the "Offset:" field and enter the desired duplex offset for the analyzer's transmit frequency.
7. Set the monitor attenuation and port selection. Suggested port selection is RF I/O with 20dB attenuation.

8. Set the generator output level and port selection. Suggested port selection is RF I/O with -50dB for the level setting.

9. Press the AUD Cursor Zone hardkey to move the Audio zone. Set the deviation level. Default is 2.83 kHz.

10. Connect the base station to the RF I/O port and start base station rx/tx.

11. Press the DISP Cursor Zone hardkey to move to the Display Zone. Move the cursor to the "Rx Signal Type:" field and select LSM or C4FM receiver.

12. Move the cursor back to the "Meter:" field and press the **start test** softkey. This will start transmit of the 1011Hz test pattern and receive of voice.

13. Verify transmit of the 1011 Hz pattern by selecting the **more** softkey and the **RF DISPLAY** softkey. Move the cursor to the “Display:” field and select the **MOD SCOPE** softkey. Then move the cursor to the “Select:” field and select the **GEN** softkey.

    A PROJ 25 modulation waveform should be observed on the Mod Scope.

14. Verify receipt of the 1011 Hz pattern from the base station by selecting the **MON** softkey.

    A PROJ 25 modulation waveform should be observed on the Mod scope.

15. Turn the volume knob and verify the 1011 Hz tone is being decoded and routed to the speaker of the analyzer.

16. Move the cursor to the “Display:” field and select the MORE softkey and the BASE TEST softkey.

17. Move the cursor to the “Measurement Period:” field and enter the desired averaging interval. An interval of 90ms to 4.32 seconds can be entered using the numeric keys or the rotary knob.

18. Move the cursor to the “Averaging Wattmeter:” field and select the **ON** softkey. The average power measured will be displayed in the “Input Level:” field.

NOTE

The input level displayed on the screen will be 10dB less than the actual input power because of the 10dB pad on the RF I/O port.

The power measurement is stopped by pressing the **OFF** softkey or by any button push. Button pushes will be ignored until the current measurement completes.

19. Move the cursor to the “Meter:” field and press the **stop test** softkey to stop transmit and receive of the 1011 Hz tone.

    The power measurement and the 1011 Hz rx/tx are independent of each other, I.E., the full duplex rx/tx can be performed without using the averaging wattmeter and the averaging wattmeter can be used without turning on the 1011 Hz rx/tx.

25-4.4 BER

Connect a 10dB pad to the RF I/O port and the unit under test to the 10dB pad.

1. Place the cursor on the “Mode” field in the Display Zone located at the top of the screen. Use the **PROJ25 TRK** softkey to select the mode.

2. Move the cursor to the “Meter” field by pressing the TAB key.

3. Select the **more** softkey and the **BER** softkey to select the BER TEST.

   The RF Zone display will switch to the Monitor format, displaying “Freq:” field.

4. Press the RF Cursor Zone hardkey to move to the RF Zone.

5. Move the cursor to the “Freq:” field and enter the frequency to be monitored by the analyzer.

6. Set the monitor attenuation and port selection. Suggested port selection is RF I/O with 20dB attenuation.

The selected BER measurement type, shown in the AUD Zone, defaults to a V.52 measurement using the C4FM receiver algorithm.

1. Start the BER measurement by selecting the reset softkey.

   This will clear any previous BER results and start the BER measurement. The BER measurement can be cleared and restarted at any time by selecting the reset softkey.

Appendix A

LIST OF ABBREVIATIONS

A	Ampere
AC	Alternating Current
AM	Amplitude Modulation
ATTEN	Attenuation
AUTO	Automatic
BATT	Battery
BNC	Coaxial RF Connector
BW	Bandwidth
C	Celsius
CAL	Calibrate
CCIR	International Radio Consultative Committee
Cm	Centimeters
CMOS	Complementary Metal Oxide Semiconductor
Cntr	Counter
CRLF	Carriage-return-line feed
CW	Continuous Wave
dB	Decibel
dBc	Decibel (referred to carrier)
dBm	Decibel (referred to 1mW into 50 ohms)
DC	Direct Current
Demod	Demodulation
DEV	Deviation
Disp	Dispersion
DIST	Distortion
Div	Division
DPL	Digital Private Line, a Motorola registered trademark
DTMF	Dual-tone multi-frequency
Dur	Duration
DVM	Digital Voltmeter
EEA	Electronic Engineering Association
EIA	Electronics Industry Association
Ext'l	External
FM	Frequency Modulation
FREQ	Frequency
GEN	Generate
GHz	Gigahertz
Horiz	Horizontal
HPF	High Pass Filter
Hz	Hertz
IC	Integrated Circuit
IDC	Instantaneous Deviation Control
IEEE	Institute of Electrical and Electronics Engineers
IF	Intermediate Frequency
IMTS	Improved MobileTelephone System
I/O	Input/Output
Kohm	Kiloohm
kHz	Kilohertz
LCD	Liquid Crystal Display
LED	Light-Emitting Diode
LPF	Low Pass Filter
Lvl	Level
MHz	Megahertz
MIC	Microphone
MIN	Minimum
MOD	Modulation
MON	Monitor
us	Microsecond
ms	Millisecond

LIST OF ABBREVIATIONS-CONTINUED

MSEC	Millisecond
Mtr	Metering
MTS	Mobile Telephone System
MV	Millivolts
uV	Microvolts
mW	Milliwatt
n	Number
N/A	Not Applicable
NB	Narrow Bandwidth
NVM	Non-volatile memory
ORIG	Originated
PCT	Percent
PL	Private Line, a Motorola registered trademark
+/-	Plus or minus
PRT	Print
RF	Radio Frequency
RMS	Root-Mean-Square
Rng	Range
RS	Receiver Specification
SEC	Second
SEQ	Sequence
SINAD	Ratio of (Signal + Noise + Distortion)/(Noise + Distortion)
SPF	Special Function
SSB	Single Sideband
STD	Standard
SW	Switch
SWP	Sweep
Synth	Synthesizer
TN	Tone
Trig	Trigger
TX	Transmitter
UHF	Ultra High Frequency
V	Volts
VAC	Volts Alternating Current
VDC	Volts Direct Current
Vert	Vertical
VRMS	Volts (root-mean-square)
W	Watts
WB	Wide Bandwidth
XCVR	Transceiver
XX	(Select Any Valid Number)
ZVEI	Zentral-Verband der Elektro-Industrie (a German Electronics Industry Association)

Appendix B

TONE AND CODE SPECIFICATIONS

Table B-1. Standard DTMF Tones

Tone Group	Standard Dtmf (Hz)
LOW	697
LOW	770
LOW	852
LOW	941
HIGH	1209
HIGH	1336
HIGH	1477
HIGH	1633

Table B-2. DTMF Frequency Coding*

Key	Low Group Tone (Hz)				High Group Tone (Hz)			
	697	770	852	941	1209	1336	1447	1633
1	•				•			
2	•					•		
3	•						•	
A	•							•
4		•			•			
5		•				•		
6		•					•	
B		•						•
7			•		•			
8			•			•		
9			•				•	
C			•					•
*				•	•			
O				•		•		
#				•			•	
D				•				•

*The analyzer has provisions for encoding and decoding 16 different keys. Each key is assigned two frequencies: one from a low-tone group and one from a high-tone group. Four tones are available from each group, with 16 different combinations of low and high group tones. This table shows the tone assignments of each key.

Table B-3. Private-Line (PL) Codes

Code	Frequency (Hz)
XZ	67.0
WZ	69.3
XA	71.9
WA	74.4
XB	77.0
WB	79.7
YZ	82.5
YA	85.4
YB	88.5
ZZ	91.5
ZA	94.8
ZB	97.0
1Z	100.0
1A	103.5
1B	107.2
2Z	110.9
2A	114.8
2B	118.8
3Z	123.0
3A	127.3
3B	131.8
4Z	136.5
4A	141.3
4B	146.2
5Z	151.4
5A	156.7
5B	162.2
6Z	167.9
6A	173.8
6B	179.9
7Z	186.2
7A	192.8
M1	203.5

Table B-3. Private-Line (PL) Codes (cont)

Code	Frequency (Hz)
8Z	206.5
M2	210.7
M3	218.1
M4	225.7
9Z	229.1
M5	233.6
M6	241.8
M7	250.3

Table B-4. 5/6 Tone Paging Tones

Digit	Frequency
0	600
1	741
2	882
3	1023
4	1164
5	1305
6	1446
7	1587
8	1728
9	1869
R	459
X	2010

Table B-5. DPL Standard Codes

023	174	445
025	205	464
026	223	465
031	226	466
032	243	503
043	244	506
047	245	516
051	251	532
054	261	546
065	263	565
071	265	606
072	271	612
073	306	624
114	311	627
115	315	631
116	331	632
125	343	654
131	351	662
132	364	664
134	365	703
143	371	712
152	411	723
155	412	731
156	413	732
162	423	734
165	431	743
172	432	

Table B-6. Select V Frequencies

Character	ZVEI Std (Hz)	ZVEI Mod (Hz)	ZVEI French (Hz)	CCIR Std (Hz)	CCIR 70ms (Hz)	EEAA (Hz)
0	2400	2200	2400	1981	1981	1981
1	1060	970	1060	1124	1124	1124
2	1160	1060	1160	1197	1197	1197
3	1270	1160	1270	1275	1275	1275
4	1400	1270	1400	1358	1358	1358
5	1530	1400	1530	1446	1446	1446
6	1670	1530	1670	1540	1540	1540
7	1830	1670	1830	1640	1640	1640
8	2000	1830	2000	1747	1747	1747
9	2200	2000	2200	1860	1860	1860
G	2800	885	885	2400	2400	1055
B	810	810	810	930	930	930
C	970	2600	2600	2247	2247	2247
D	885	2800	2800	991	991	991
F	930	930	930	873	873	873
R	2600	2400	970	2110	2110	2110
N_T Tone	0	0	0	0	0	0
Length (msec)	70	70	70	100	70	40

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Appendix C

SAFE HANDLING OF CMOS INTEGRATED CIRCUIT DEVICES

Many of the integrated circuit devices used in communications equipment are of the CMOS (Complementary Metal Oxide Semiconductor) type. Because of their high open circuit impedance, CMOS ICs are vulnerable to damage from static charges. Care must be taken in handling, shipping, and servicing them and the assemblies in which they are used.

Even though protection devices are provided in CMOS IC inputs, the protection is effective only against overvoltage in the hundreds of volts range such as are encountered in an operating system. In a system, circuit elements distribute static charges and load the CMOS circuits, decreasing the chance of damage. However, CMOS circuits can be damaged by improper handling of the modules even in a system.

To avoid damage to circuits, observe the following handling, shipping, and servicing precautions.

1. Prior to and while servicing a circuit module, particularly after moving within the service area, momentarily touch both hands to a bare metal earth grounded surface. This will discharge any static charge which may have accumulated on the person doing the servicing.

NOTE

Wearing Conductive Wrist Strap will minimize static buildup during servicing.

WARNING

When wearing Conductive Wrist Strap, be careful near sources of high voltage. The good ground provided by the wrist strap will also increase the danger of lethal shock from accidentally touching high voltage sources.

2. Whenever possible, avoid touching any electrically conductive parts of the circuit module with your hands.
3. Normally, circuit modules can be inserted or removed with power applied to the unit. However, check the INSTALLATION and MAINTENANCE sections of the manual as well as the module schematic diagram to insure there are no objections to this practice.
4. When servicing a circuit module, avoid carpeted areas, dry environments, and certain types of clothing (silk, nylon, etc.) because they contribute to static buildup.
5. All electrically powered test equipment should be grounded. Apply the ground lead from the test equipment to the circuit module before connecting the test probe. Similarly, disconnect the test probe prior to removing the ground lead.
6. If a circuit module is removed from the system, it is desirable to lay it on a conductive surface (such as a sheet of aluminum foil) which is connected to ground through 100k of resistance.

WARNING

If the aluminum foil is connected directly to ground, be cautious of possible electrical shock from contacting the foil at the same time as other electrical circuits.

7. When soldering, be sure the soldering iron is grounded.

1. Prior to connecting jumpers, replacing circuit components, or touching CMOS pins (if this becomes necessary in the replacement of an integrated circuit device), be sure to discharge any static buildup as described in procedure 1. Since voltage differences can exist across the human body, it is recommended that only one hand be used if it is necessary to touch pins on the CMOS device and associated board wiring.

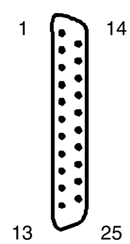
Appendix D

EXTERNAL PORT PIN ASSIGNMENTS

RS-232 PORT

This is a full bidirectional RS-232 port with the capability to respond to a serial input. The port serves a dual purpose in that if an RS-232 is not desired, the port can be used as a printer output. Software determines if the port functions as an RS-232 bidirectional port or as an output-only printer port. 25 pin female "D" connector on Processor Module for RS-232 interface at the side panel. Drawing shows pins as seen from a side view of the Analyzer.

PIN	
1	GND
2	TXD (transmit data)
3	RXD (receive data)
4	RTS (request to send)
5	CTS (clear to send)
6	DSR (data set ready)
7	SIG GND (signal ground)
8	DCD* (data carrier detect)
9-19	not used
20	DTR* (data terminal ready)
21	not used
22	RI (Ring Indicator)
23-25	not used



NOTE

For printer use, pins 5 and 20 of this port should be tied together inside the cable to the printer. 30-80387B58 printer cable provides the required interface.

DCD* (Data Carrier Detect) input is not used in this application.

DSR* (Data Set Ready) is a general purpose input that is used for modem control. This line is not used when a printer is connected.

DTR* (Data Terminal Ready) is a general purpose output to indicate the Analyzer is ready to receive more data on the RXD line.

RTS* and CTS* (Request-To-Send, Clear-To-Send) are handshaking signals used in RS232 communications.

RXD (Receive Data) input signal is the data received. If this connector is used as a printer output, the RXD pin is not used.

TXD (Transmit Data) output signal is the data being transmitted.

REAR PANEL DC INPUT PORT

Drawing shows pins as seen from a rear view of the Analyzer.

Positive DC voltage must be between +11 and +18VDC.

Either "+" pin may be used for the positive DC voltage since these two pins are tied together internally.

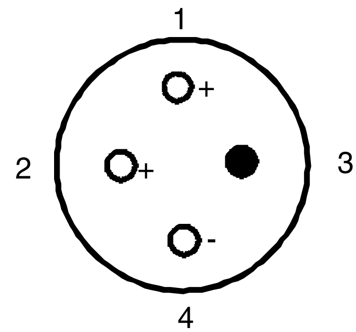


Figure D-1. Rear Panel DC Input Port

Appendix E

MOTOROLA ANALOG TRUNKING OPTION
ERROR AND WARNING MESSAGES

E-1 ERRORS

If an error occurs during a test, the test ends. To run the test again, correct the mistake and restart the test. Errors fall into three categories: setup errors, radio errors and trunking analyzer test set errors. A summary of setup and radio error messages follows.

E-1.1 Setup Error Messages

The following errors occur when data entered by the user is incorrect. Note, these errors are detected after the Start Test softkey is pressed, and prevent the test from starting. The user must enter the correct data and press the start button again.

- Invalid System ID Entered
- CC Tx Frequency Out of Range
- CC Rx Frequency Out of Range
- VC Tx Frequency Out of Range
- VC Rx Frequency Out of Range
- CC Tx Channel Number Out of Range
- CC Rx Channel Number Out of Range
- VC TxChannel Number Out of Range
- VC RxChannel Number Out of Range
- CC Tx to VC Rx Offset Out of Range
- CC Tx to CC Rx Offset Out of Range
- Prefix Out of Range
- Fleet ID Out of Range
- Subfleet ID Out of Range
- Unit ID Out of Range

E-1.2 Radio Error Messages

ISW Timeout

The trunking analyzer did not receive a response from the radio in the time allowed. This could indicate a radio problem or an incorrect test type entered by the user.

Connect Tone Timeout

The trunking analyzer did not receive the connect tone in the time allowed. This could indicate a radio problem or an incorrect test type entered by the user.

Test Terminated by User

The user has halted the test prior to completion by pressing the Stop Test softkey, or by changing the mode of the trunking analyzer (e.g., entering calibration or standard mode).

Invalid ISW Call Type Received

The trunking analyzer did not receive the ISW call type expected for the selected test sequence. This could indicate a radio problem or incorrect input from the user such as test type, Fleet ID, etc.

High-Speed ACK Timeout

The trunking analyzer did not receive the High-Speed Acknowledge tone in the time allowed (Trunk I signaling only.) This could indicate a radio problem or an incorrect test type entered by the user.

E-1.3 Trunking Analyzer Error Messages

The following errors are internal to the trunking analyzer, and require servicing by a trained field representative.

- Invalid Opcode
- Current Function Not Implemented
- Unexpected ISW Type Received
- Invalid Test Type

Appendix F

MOTOROLA ANALOG TRUNKING OPTION
ISW CALL TYPE DESCRIPTION

F-1 TRUNK I SIGNALING TYPES

Table F-1. Trunk I Signaling Types

Code	Description
G1	5 Channel Subfleet Call Request
I1	20 Channel Level 1 Private Call Request
G2	20 Channel Subfleet Call Request
P2	Consolette Interconnect Request for Subfleet Call
P3	Centralized Phone Interconnect Request for Subfleet Call
Z1	Reserved for Data Channel Request
Z2	Reserved for SECURENET Channel request
E2	20 Channel Emergency Call Request
X	1st word code for Dual ISW Format
I2	Private Call Level II Request: 2nd word of Dual ISW
Y1	Dynamic Reqrouping Request Command: 2nd word of Dual ISW
Y2	Reserved for additional messages: 2nd word of Dual ISW
P1	Individual Interconnect Request or Response
S	System Wide Request
Z3	Res. - Sys. Definable Call Type
R	Interconnect Reject Request
M0	Status or Message 0
M1	Status or Message 1
M2	Status or Message 2
M3	Status or Message 3
M4	Status or Message 4
M5	Status or Message 5
M6	Status or Message 6
M7	Status or Message 7
A	Individual Call Alert Command or Acknowledge
E1	Emergency Alarm Message or Acknowledge
M10	Status or Message 10
M11	Status or Message 11
M12	Status or Message 12
M13	Status or Message 13
M14	Status or Message 14
M15	Status or Message 15

F-2 TRUNK II SIGNALING CALL TYPES

Table F-2. Trunk II Signaling Call Types

Code	Description
G1	Steered Call Request (Reserved)
P1	Individual Interconnect Request
G2	20 Channel (affiliated) Group Call Request
P2	Centralized Interconnect Request For: Group_To_Land Call (reserved)
P3	Centralized Interconnect Request for: Subfleet Call
P4	Individual Interconnect; Mobile_Transpond Response
R	Interconnect Reject Request
Z7	2nd FIRST WORD CODE FOR DUAL ISWS Will be used to Multiplex Existing $08 Dual Words
X1	First Word Code for Dual ISW Format
I2	Private Call II Channel Request: 2nd word of Dual ISW
Y1	Dynamic Reqrouping Command: 2nd word of Dual ISW
X2	Extended Function Command: 2nd word of Dual ISW
G3	Un-affiliated Group Call Request: 2nd word of Dual ISW
X3	Talk Group Association for Emergency Alarm
S1	DVP Enhanced PCII: 2nd word of Dual ISW
P5	Mobile_To_Land Subfleet Interconnect: 2nd word of Dual ISW
M1	Automatic Unit Affiliation; 2nd word of Dual ISW
Z2	Type II Messages
S2	DVP Individual Interconnect
S3	DVP (SBLT) Land-to-Mobile Interconnect (ICU comm.) (reserved)
S4	DVP Secure (SBLT) (affiliated): single word request
S5	DVP PC-II Enhanced Ring: 2nd word of Dual ISW
S6	Not Assigned
I1	PC II Enhanced Ring: 2nd word of Dual ISW
I3	PC II Enhanced Ring Acknowledge: 2nd word of Dual ISW
A1	Call Alert II - Enhanced Ring: 2nd word of Dual ISW
A2	Call Alert II - Enhanced Ring Acknowledge: 2nd word of Dual ISW
Z4	LINKNET Radio Registration: 2nd word of Dual ISW
Z5	Dispatcher Interrupt Ring: 2nd word of Dual ISW
Z6	Not Assigned
Z1	Super Word Identifier (used for variable id info): 2nd word of Dual ISW
Z3	Variable ID Registration: 2nd word of Dual ISW

Table F-2. Trunk II Signaling Call Types (cont.)

Code	Description
TS1	Status 1
TS2	Status 2
TS3	Status 3
TS4	Status 4
TS5	Status 5
TS6	Status 6
TS7	Status 7
TS8	Status 8
TE1	Emergency Alarm
TDR	Dynamic reprogram request
TDI	ACK Dynamic ID assignment
X2	ACK Announcement talkgroup assignment.
CE	Clear-Voice Emergency Talkgroup
CP1	Clear-Voice Patched Talkgroups
CD	Unused, (Use to be Clear Data Talk Groups)
CEA	Clear-Voice Emergency Announcement Group
CP2	Clear-Voice Paging or AVL group
CVM	Clear-Voice MSEL group
SM	Coded Message Trunked Talkgroups
SA	Coded Announcement Talkgroups
SE	Coded Emergency
SP1	Coded Patched Talkgroups
SD	Unused (Use to be Secure-Voice Data)
SEA	Coded Emergency Announcement Group
SP2	Reserved for Coded Paging or AVL group
SVM	Coded MSEL group

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Appendix G

ASTRO TRUNKING ERROR AND WARNING MESSAGES

G-1 ERRORS

If an error occurs during a test, the test ends. To run the test again, correct the mistake and restart the test. Errors fall into three categories: setup errors, radio errors and trunking analyzer test set errors. A summary of setup and radio error messages follows.

G-1.1 Setup Error Messages

The following errors occur when data entered by the user is incorrect. Note that these errors are detected after the **Start Test** softkey is pressed, and prevent the test from starting. The user must enter the correct data and press the start button again.

- Invalid System ID Entered
- CC Tx Frequency Out of Range
- CC Rx Frequency Out of Range
- VC Tx Frequency Out of Range
- VC Rx Frequency Out of Range
- CC Tx Channel Number Out of Range
- CC Rx Channel Number Out of Range
- VC TxChannel Number Out of Range
- VC RxChannel Number Out of Range
- CC Tx to VC Rx Offset Out of Range
- CC Tx to CC Rx Offset Out of Range
- Prefix Out of Range
- Fleet ID Out of Range
- Subfleet ID Out of Range
- Unit ID Out of Range

G-1.2 Radio Error Messages

ISW Timeout

The trunking analyzer did not receive a response from the radio in the time allowed. This could indicate a radio problem or an incorrect test type entered by the user.

Connect Tone Timeout

The trunking analyzer did not receive the connect tone in the time allowed (Motorola Analog Trunking only). This could indicate a radio problem or an incorrect test type entered by the user.

Test Terminated by User

The user has halted the test prior to completion by pressing the **Stop Test** softkey, or by changing the mode of the trunking analyzer (e.g., entering calibration or standard mode).

Invalid ISW Call Type Received

The trunking analyzer did not receive the ISW call type expected for the selected test sequence. This could indicate a radio problem or incorrect input from the user (e.g., test type or Fleet ID).

High-Speed ACK Timeout

The trunking analyzer did not receive the high-speed acknowledge tone in the time allowed (Trunk I signaling only.) This could indicate a radio problem or an incorrect test type entered by the user.

G-1.3 Trunking Analyzer Error Messages

The following errors are internal to the trunking analyzer, and require servicing by a trained field representative.

- Invalid Opcode
- Current Function Not Implemented
- Unexpected ISW Type Received
- Invalid Test Type

Appendix H

ASTRO TRUNKING TEST SEQUENCE CODE DESCRIPTION

H-1. Test Sequence Code Description for ASTRO Trunking

Table H-1. Test Sequence Code Description for ASTRO Trunking

Code	Description
A	Control Channel Idle
B	LC Received on VC
C	Voice Channel Available
D	Affiliate ISW Received
E	Affiliate OSW Sent
F	Control Channel Idle
J	ISW Received
K	Talkgroup OSW Sent
L	Dual ISW Received
M	Call Alert Ring OSW
N	Call Alert Ring ACK ISW
O	Call Alert Ring ACK OSW
Q	Channel Grant OSW Sent
T	LC Word Sent on VC
X	Disconnect Sent

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Appendix I

ISW CALL TYPE DESCRIPTION

I-1 ASTRO Signaling ISW Call Types

Table I-1. ASTRO Signaling ISW Call Types

Code	Description
G1	Steered Call Request (Reserved)
P1	Individual Interconnect Request
G2	20 Channel (affiliated) Group Call Request
P2	Centralized Interconnect Request For: Group_To_Land Call (reserved)
P3	Centralized Interconnect Request for: Subfleet Call
P4	Individual Interconnect; Mobile_Transpond Response
R	Interconnect Reject Request
Z7	2nd First Word Code For Dual ISWS Will be used to Multiplex Existing $08 Dual Words
X1	First Word Code for Dual ISW Format
I2	Private Call II Channel Request: 2nd word of Dual ISW
Y1	Dynamic Reqrouping Command: 2nd word of Dual ISW
X2	Extended Function Command: 2nd word of Dual ISW
G3	Un-affiliated Group Call Request: 2nd word of Dual ISW
X3	Talk Group Association for Emergency Alarm
S1	DVP Enhanced PCII: 2nd word of Dual ISW
P5	Mobile_To_Land Subfleet Interconnect: 2nd word of Dual ISW
M1	Automatic Unit Affiliation; 2nd word of Dual ISW
Z2	Type II Messages
S2	DVP Individual Interconnect
S3	DVP (SBLT) Land-to-Mobile Interconnect (ICU comm.) (reserved)
S4	DVP Secure (SBLT) (affiliated): single word request
S5	DVP PC-II Enhanced Ring: 2nd word of Dual ISW
S6	Not Assigned
I1	PC II Enhanced Ring: 2nd word of Dual ISW
I3	PC II Enhanced Ring Acknowledge: 2nd word of Dual ISW
A1	Call Alert II - Enhanced Ring: 2nd word of Dual ISW
A2	Call Alert II - Enhanced Ring Acknowledge: 2nd word of Dual ISW
Z4	LINKNET Radio Registration: 2nd word of Dual ISW
Z5	Dispatcher Interrupt Ring: 2nd word of Dual ISW

Table I-1. ASTRO Signaling ISW Call Types (cont.)

Code	Description
Z6	Not Assigned
Z1	Super Word Identifier (used for variable id info): 2nd word of Dual ISW
Z3	Variable ID Registration: 2nd word of Dual ISW
TS1	Status 1
TS2	Status 2
TS3	Status 3
TS4	Status 4
TS5	Status 5
TS6	Status 6
TS7	Status 7
TS8	Status 8
TE1	Emergency Alarm
TDR	Dynamic reprogram request
TDI	ACK Dynamic ID assignment
X2	ACK Announcement talkgroup assignment.
CE	Clear-Voice Emergency Talkgroup
CP1	Clear-Voice Patched Talkgroups
CD	Unused, (Use to be Clear Data Talk Groups)
CEA	Clear-Voice Emergency Announcement Group
CP2	Clear-Voice Paging or AVL group
CVM	Clear-Voice MSEL group
SM	Coded Message Trunked Talkgroups
SA	Coded Announcement Talkgroups
SE	Coded Emergency
SP1	Coded Patched Talkgroups
SD	Unused (Use to be Secure-Voice Data)
SEA	Coded Emergency Announcement Group
SP2	Reserved for Coded Paging or AVL group
SVM	Coded MSEL group

APPENDIX J

SECURENET OPTION
ERROR AND WARNING MESSAGES

J-1 ERRORS

SECURENET errors fall into two categories: EMC/Encryption Key Errors and SECURENET Option Errors. Error messages are defined as: "Messages displayed to alert the user to failures which affect system or test functionality." A summary of EMC/Encryption Key and SECURENET Option Errors follows.

J-1.1 EMC/Encryption Error Messages

The following errors occur when there has been an error or failure that prevents encryption decode or encode from operating correctly. The probable cause for the error, along with a recommended solution is presented.

(qwdId: quick, what do I do ?)

KG Hardware Not Installed

KG EMC module not installed on High Tier board.

qwdId:

Verify that the Encryption Option has been purchased. If so, contact sales representative.

Encryption Hardware Failure

This message means that one of the following failures has occurred:

- EMC Temperature Violation
- EMC Voltage Violation
- SPI Failure
- SCI Failure
- EMC Internal Critical Failure
- Irrecoverable Password Failure
- ASTRO Transmit Security Test Failure
- SECURENET CFB Transmit Security Test Failure
- SECURENET XL Transmit Security Test Failure

qwdId:

Perform **encrypt reset** from the Special Function window then perform action again. If the problem persists, contact the Service Representative.

Warning - External Key Lost

This message is displayed when an EMC Powerup Configuration Failure has occurred. This is most likely due to a Password Validation Failure and the EMC has erased any previously stored keys and passwords as part of the recovery.

qwdId:

If an External Key is required, it must be reloaded

UUT Test Key Load Failed

An attempt to load a UUT Test Key has failed.

qwdId:

Make sure radio is attached, correct algorithm is selected, then retry keyload. If keyload still fails, perform encrypt reset from the Special Functions page and retry.

External Key Load Failed

An attempt to load an External Key has failed.

qwdId:

Make sure KVL key loader is attached, correct algorithm is selected, retry keyload. If keyload still fails, perform encrypt reset from the Special Functions page and retry.

J-1.2 SECURENET Option Error Messages

The following messages are very similar. They are all related to a severe failure of the SECURENET Option. A general discussion of the cause follows with a general recommended solution; basically to reset the R2670 and restart the powerup sequence.

- SECURENET Failed, Notify Local Service Rep
- SECURENET Option Timed Out
- SECURENET Option - Illegal CP Request
- SECURENET Option - Bad CP opcode
- SECURENET Option Error

The Option Software is not responding to the R2670.

qwdId:

Verify that SECURENET is installed, and at least one encryption algorithm type is installed. This can be done by inspecting the Installed Options window from the Special Functions page.

If the options are installed, press the encrypt reset key from the system functions line on the Special Functions window. This will reset the R2670. Retry the test or procedure. If the message is redisplayed, perform an nvm clear from the system functions line (note: this will erase all parameters previously input). Retry the test. If the message is redisplayed, contact your local service representative.

J-2 WARNINGS

SECURENET Warnings also fall into two categories: Informational Warnings and User Prompt Warnings. Informational Warnings provide feedback to the user, informing the user of results of actions. User Prompt Warnings prompt the user to perform some action to continue.

J-2.1 SECURENET Informational Warnings

The following SECURENET Informational Messages occur as the result of some user or system action.

EOM Detected

End Of Message detected. This message appears after the release of PTT, confirming the release.

qwdId:

Nothing, informational only.

Internal Key Loaded

This message means that an internal key selected has been successfully loaded. This message will remain displayed until another message is loaded or erased. This message continues to be displayed to remind the user what type of key is loaded while other Display Screens are selected (i.e. Modulation Scope displayed).

qwdId:

Nothing, informational only.

Warning – SECURENET Mode Error

This message is displayed when the EMC failed to enter SECURENET Mode. This is typically caused by No key or a bad key internally loaded.

qwdId:

Select TEST KEY or EXT KEY from the SET UP display select cursor to reload the desired key type.

External Key Load Passed

An External Key has been successfully loaded into the EMC.

qwdId:

Nothing, informational only

Keyload In Progress

A keyload has been initiated and is on progress.

qwdId:

Nothing, informational only

J-2.2 SECURENET User Prompt Warnings

Radio Keyload Complete – Press PTT

Radio keyload has been successfully done and the use may start the radio test by pressing the PTT on the radio.

qwdId:

Press PTT to start test.

Select RF Display to Decode B-Band Voice

Baseband Voice Decode is input through the DVM/IN, VERT/SINAD port on the front panel when RF Display is selected as the Metering function. Other Metering selections use this port for different inputs and may change the attenuation on the input signal.

qwdId:

When decoding Baseband Voice select RF Display as the metering function.

Press KVL PTT to Start Keyload

The EMC is prepared to load an external key via a KVL key loader. The keyload is initiated via PTT.

qwdId:

Attach a KVL loader and load an external key, or press the cancel keyload softkey.

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Appendix K

ASTRO ERROR AND WARNING MESSAGES

K-1 ERRORS

ASTRO errors fall into two categories: EMC/Encryption Key Errors and ASTRO Errors. Error messages are defined as: "Messages displayed to alert the user to failures which affect system or test functionality." A summary of EMC/ Encryption Key and ASTRO Errors follows.

K-1.1 EMC/Encryption Error Messages

The following errors occur when there has been an error or failure that prevents encryption decode or encode from operating correctly. The probable cause for the error, along with a recommended solution is presented.

(qwdId: quick, what do I do ?)

Hardware Failure - Perform Encrypt Reset

This message indicates that the Hardware Encryption Modules have failed. The system has either been unable to communicate with one or both of the modules or the module has indicated that it has experienced a startup error.

qwdId:

Perform **encrypt reset** from the Special Function window. If the problem persists, contact the Service Representative.

Warning - External Key Lost

This message is displayed when a Powerup Configuration Failure has occurred. This is most likely due to a Password Validation Failure. In this case, all previously stored keys and passwords have been erased as part of the hardware recovery process.

qwdId:

If an External Key is required, it must be reloaded using a DX type KVL, or any KVL 3000 with the ASN option.

Key Invalid - Verify Key Loaded

The user has attempted to use an External Key which is not available for the selected algorithm or encryption type.

qwdId:

This error can be cleared in one of two ways. You can either test using the TEST KEY or you can load an External Key using a DX type key loader, or any KVL 3000 with the ASN option.

To continue testing using the TEST KEY, select the correct algorithm from the SET UP menu. Select the **TEST KEY** softkey.

To test using the External Key in the SET UP menu, select the correct algorithm and then select the **load ext key** softkey. Connect a DX, or a KVL 3000 with an ASN option, key loader which matches the selected algorithm to the R2670. Enter the desired key into the key loader. When the key is loaded in the key loader, press the PTT on the key loader.

The R2670 should respond with the "External Key Loaded" message. If the key does not load, follow instructions in this manual under "External Key Load Failed" message. If the key loads successfully, reselect the **EXT KEY** softkey in the SET UP menu.

External Key Load Failed

An attempt to load an External Key with a key loader has failed.

qwdId:

Observe the SET UP menu in the Display Zone. Verify the selected algorithm matches the key loader type. For example, if the key loader is a DVP-XL type, verify the SET UP menu displays "Algorithm Sel: DVP-XL." Also, verify that the selected key type is EXT KEY.

On the back of the key loader, verify that the key loader type is DX, or a KVL 3000 with an ASN option.

Check the connection from the key loader to the R2670 then retry the key load. If the key load continues to fail, perform an **encrypt reset** from the Special Functions (SPF) menu. After the reset, retry the key load. If the key load still fails, contact the Service Representative.

Entry Field Must Be Made with Mod OFF

An attempt to change the embedded data fields has been made while the R2670 is generating ASTRO VOICE.

qwdId:

In the Audio Zone, turn off the ASTRO signal by changing CONT to OFF before attempting to change the embedded data fields.

K-1.2 ASTRO Error Messages

The following messages are very similar. They are all related to a severe failure of the ASTRO Option. A general discussion of the cause follows, along with a general recommended solution.

This solution is basically to reset the R2670 and restart the powerup sequence.

1. ASTRO Failed, Notify Local Service Rep
2. ASTRO Option - Illegal CP Request

ASTRO Option - Bad CP Opcode

While in the ASTRO mode, the system experiences difficulty when communicating with the ASTRO.

qwdId:

First try **encrypt reset**, and if that fails, notify the Service Representative.

No Response From Option

The R2670 has attempted to communicate with the ASTRO Option but has not received a response.

qwdId:

Verify that the ASTRO Option is installed. This can be done by inspecting the Installed Options window from the Special Functions (SPF) page.

If the option is installed, press the **encrypt reset** softkey from the system functions line on the SPF window. This will reset the R2670. Retry the test. If the message is redisplayed, perform the **nvm clear** from the SPF menu. (This function will clear all settings previously input.) Retry the test. If the message is redisplayed, contact the Service Representative.

Option Not Responding To Calibration Msg

A command to start the modulation calibration for the ASTRO Option has been generated but the option is not responding.

qwdId:

Perform an **nvm clear** from the Special Functions (SPF) menu to restart calibration. If the option fails to respond, notify the Service Representative

K-2 WARNINGS

ASTRO Warnings also fall into two categories Informational Warnings and User Prompt Warnings. Informational Warnings provide feedback to the user, informing the user of results of actions. User Prompt Warnings prompt the user to perform some action to continue.

K-2.1 ASTRO Informational Warnings

The following ASTRO Informational Messages occur as the result of some user or system action. All of these messages are informational only and do not require any user action.

External Key Load Passed

An External Key has been successfully loaded into the EMC.

Keyload In Progress

The operator has selected the **load ext key** softkey and then pressed PTT on the KVL.

External Key Erased

The user has erased a previously loaded External Key.

External Keyload Canceled

The user has chosen to cancel a key load operation. The system has been restored from key load mode back to normal operating mode.

K-2.2 ASTRO User Prompt Warnings

Verify Correct Network ID

When generating ASTRO VOICE, this message indicates that the user has not entered a valid Network ID.

qwdId:

In the Audio Zone, cursor down to VOICE FRAME. Select **display table**. Change the Network ID to a nonzero value.

Press KVL PTT to Start Keyload

The user has selected **load ext key**. The R2670 is now in key load mode and is awaiting the start of the key loading function from the KVL.

qwdId:

Press the KVL PTT to start the key load or press the **cancel** softkey to terminate the key load.

NOTE

*Software encryption is different. Either cancel or set the desired key and then press the **STORE KEY** softkey.*

Secure Mode Failure

User is attempting to run a secure voice scenario but is unable to load an algorithm or key into the Encryption Module.

qwdId:

Press the **encrypt reset** softkey.

Warning - Encryption Hardware Failure

One or more algorithms is installed in the R2670 via the Monitor Service Software (MSS) but were not detected on either Encryption Module.

qwdId:

Notify the Service Representative.

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Appendix L
PROJECT 25 ERROR AND WARNING MESSAGES

L-1 ERRORS

Project 25 errors fall into two categories: EMC/Encryption Key Errors and Project 25 Errors. Error messages are defined as: "Messages displayed to alert the user to failures which affect system or test functionality." A summary of EMC/Encryption Key and PROJ 25 Errors follows.

L-1.1 EMC/Encryption Error Messages

The following errors occur when there has been an error or failure that prevents encryption decode or encode from operating correctly. The probable cause for the error, along with a recommended solution is presented.

(qwdId: quick, what do I do?)

Hardware Failure- Perform Encrypt Reset

This message indicates that the Hardware Encryption Modules have failed. The system has either been unable to communicate with one or both of the modules or the module has indicated that is has experienced a startup error.

qwdId:

Perform **encrypt reset** from the Special Function window. If the problem persists, contact the Service Representative.

Warning-External Key Lost

This message is displayed when a Powerup Configuration Failure has occurred. This is most likely due to a Password Validation Failure. In this case, all previously stored keys and passwords have been erased as part of the hardware recovery process.

qwdId:

If an External Key is required, it must be reloaded using a DX type KVL or any KVL 3000 with the ASN option.

Key Invalid-Verify Key Loaded

The user has attempted to use an External Key which is not available for the selected algorithm or encryption type.

qwdId:

This error can be cleared in one of two ways. You can either test using the TEST KEY or you can load an External Key using a DX type key loader, or any KVL 3000 with the ASN option. To continue testing using the TEST KEY, select the correct algorithm from the SET UP menu. Select the **TEST KEY** softkey. To test using the External Key in the SET UP menu, select the correct algorithm and then select the **load ext key** softkey. Connect a DX key loader, or any KVL 3000 with the ASN option, which matches the selected algorithm to the R625. Enter the desired key into the key loader. When the key is loaded in the key loader, press the PTT on the key loader. The R2670 should respond with the "External Key Loaded" message. IF the key does not load, follow instructions in this manual under "External Key Load Failed" message. If the key loads successfully, reselect the **EXT KEY** softkey in the SET UP menu.

External Key Load Failed

An attempt to load an External Key with a key loader has failed.

qwdId:

Observe the SET UP menu in the Display Zone. Verify that the selected algorithm matches the key loader type. For example, if the key loader is a DVP-XL type, verify that the SET UP menu displays "Algorithm Sel: DVP-XL." Also, verify that the selected key type is EXT KEY.

On the back of the key loader, verify that the key loader type is DX or any KVL 3000 with the ASN option. Check the connection from the key loader to the R2670 then retry the key load. IF the key load continues to fail, perform an **encrypt reset** from the Special Functions (SPF) menu. After the reset, retry the key load. If the key load still fails, contact the Service Representative.

Entry Field Must Be Made with Mod OFF

An attempt to change the embedded data fields has been made while the R2670 is generating Project 25 VOICE.

qwdId:

In the Audio Zone, turn off the Project 25 signal by changing CONT to OFF before attempting to change the embedded data fields.

Encryption Algorithm Mismatch

An attempt has been made to receive voice in an encryption mode that is different from the encryption mode used for transmitting the voice. (This error only occurs when the analyzer is in monitor mode.)

qwdId:

If the message is displayed and clear voice is heard, then the encryption needs to be turned off on the setup page. If the message is displayed and garbled voice is heard, then the encryption type selected on the setup screen needs to be changed to the same encryption type used for transmitting the voice.

L-1.2 Project 25 Error Messages

The following three messages are very similar. They are all related to a severe failure of the Project 25. A general discussion of the cause follows, along with a general recommended solution. This solution is basically to reset the R2670 and restart the powerup sequence.

<u>PROJ 25 Failed, Notify Local Service Rep</u>
<u>PROJ 25 Option-Illegal CP Request</u>
<u>PROJ 25 Option-Bad CP opcode</u>

While in the Project 25 mode, the system experiences difficulty when communicating with the Project 25.

qwdId:

First try **encrypt reset**, and if that fails, notify the Service Representative.

No Response From Option

The R2670 has attempted to communicate with the Project 25 Option but has not received a response.

qwdId:

Verify that the Project 25 Option is installed. This can be done by inspecting the Installed Options window from the Special Functions (SPF) page.

If the option is installed, press the **encrypt reset** softkey from the system functions line on the SPF window. This will reset the R2670. Retry the test. If the message is redisplayed, perform the **nvm clear** from the SPF menu. (This function will clear all settings previously input.) Retry the test. If the message is redisplayed, contact the Service Representative.

Option Not Responding To Calibration Msg

A command to start the modulation calibration for the Project 25 Option has been generated but the option is not responding.

qwdId:

Perform an **nvm clear** from the Special Functions (SPF) menu to restart calibration. If the option fails to respond, notify the Service Representative.

Astro Option-Failed DSP SRAM Test

Indicates failure of the DSP powerup test of the three DSP static RAM chips on the option card.

Astro Option-Failed DSP ROM Test

Indicates failure of the DSP powerup test of the DSP program ROM on the option card.

Astro Option-Failed DSP Startup

Indicates failure of the DSP powerup sequence has been detected by the HC11 when the required DSP startup message is not correctly received from the DSP.

ASTRO Option Timed Out

Indicates failure of the option has been detected by the 68k during powerup when the required diagnostic response has not been received from the HC11.

qwdId:

For the above four messages, first try to reset the analyzer. If this fails notify the Service Representative.

L-2 WARNINGS

Project 25 Warnings also fall into two categories: Informational Warnings and User Prompt Warnings. Informational Warnings provide feedback to the user, informing the user of results of actions. User Prompt Warnings prompt the user to perform some action to continue.

L-2.1 Project 25 Informational Warnings

The following Project 25 Informational Messages occur as the result of some user or system action. All of these messages are informational only and do not require any user action.

External Key Load Passed

An External Key has been successfully loaded into the EMC.

Keyload in Progress

The operator has selected the **load ext key** softkey and then pressed PTT on the KVL.

External Key Erased

The user has erased a previously loaded External Key.

External Keyload Canceled

The user has chosen to cancel a key load operation. The system has been restored from key load mode back to normal operating mode.

E-2.2 **Project 25 User Prompt Warnings**

Verify Correct Network ID

When generating Project 25 VOICE, this message indicates that the user has not entered a valid Network ID.

qwdId:

In the Audio Zone, cursor down to VOICE FRAME. Select **display table**. Change the Network ID to a nonzero value.

Press KVL PTT to Start Keyload

The user has selected **load ext key**. The R2670 is now in key load mode and is awaiting the start of the key loading function from the KVL.

qwdId:

Press the KVL PTT to start the key load or press the **cancel** softkey to terminate the key load.

Secure Mode Failure

User is attempting to run a secure voice scenario but is unable to load an algorithm or key into the Encryption Module.

qwdId:

Press the **encrypt reset** softkey.

Warning-Encryption Hardware Failure

One or more algorithms is installed in the R2670 via the Monitor Service Software (MSS) but were not detected on either Encryption Module.

qwdId:

Notify the Service Representative.

Appendix M

PROJECT 25 TRUNKING SEQUENCE DESCRIPTIONS

Table M-1. Test Sequence Code Description for Registration/Call Alert Test

Code	Call Status
1	Idle Control Channel
2	Registration Request Received
3	Registration Response Sent
4	Grp. Affiliation. Request Received
5	Grp. Affiliation. Response Transmitted
6	Call Alert Request Transmitted
7	Call Alert Response Received
8	Test Complete

Table M-2. Test Sequence Code Description for Dispatch Voice Test

Code	Call Status
1	Idle Control Channel
2	Registration Request Received
3	Registration Response Sent
4	Grp. Aff. Request Received
5	Grp. Aff. Response Transmitted
6	Group Voice Request Received
7	Group Voice Channel Grant Sent
8	Receive Voice Data
9	Transmit Voice Mic Off
10	Transmit Voice Mic On
11	Transmit Voice Mic Off (On)
12	Test Complete

Table M-3. Registration Call Alert/Dispatch Voice Error Messages

Error
Test Terminated by User
Timeout – Test Halted

Appendix N

PROJECT 25 TRUNKING BAND DETAILS

Table N-1. 800 MHZ Band Details

Channel Type	Frequency Range	Channel Number	Frequency Offset
Control Channel/Voice Channel	851.00625 – 876.59375	0 - 4094	-45 MHz

Table N-2. 700 MHZ Band Details

Channel Type	Frequency Range	Channel Number	Frequency Offset
Control Channel/Voice Channel	762.00625 – 787.59375	0 - 4094	+30 MHz

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Revision History

Original – Rev. A (supersedes 68-P30715C001 Rev. E)	B. Tanner	11/4/09	M. Humphries	11/4/09	9326
Rev. No/change	Revised By	Date	Approved By	Date	ECO#