DANIELS™
ELECTRONICS LTD.

TN910
Daniels MT-3 and IFR COM-120 by Aeroflex Test Procedures

Technical Note for Tuning, Testing Maintaining and Servicing MT-3 Analog Radio Systems with the IFR COM-120 (B or C) by Aeroflex

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TN910 Daniels MT-3 and IFR COM-120 Test Procedures

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Important Information

This Technical Note is intended as an aid to configuring and testing Daniels radios using an IFR COM-120 (B or C) Service Monitor by Aeroflex. Neither Daniels Electronics Ltd. or Aeroflex Inc. assume responsibility for damaged caused to either unit as a result of misinterpretation or misuse of this procedure. Daniels manufactured Products are warranted against defective materials and workmanship. This warranty does not extend to damage due to misuse, neglect, accident, improper configuration or installation. Daniels and Aeroflex shall be released from all obligations under its respective warranty in the event the Products are subject to misuse, neglect, alteration, accident, improper installation or testing, or if un-authorized repairs are performed by the Customer or others. These procedures can be modified, changed and altered at any time to better suit your specific needs and requirements.

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General Set-Up and Connections

Frequencies and Bandwidths:
The receiver and transmitter modules are individually programmed with RF frequencies and are also designed for wide or narrow band operation. Familiarize yourself with all of the transmitter and receiver settings before testing or tuning the Daniels radio system.

Typical Specifications:
This document refers to some TYPICAL receiver and transmitter specifications. Refer to the Instruction Manuals for complete radio system specifications.

Adapters, Cables and Extender Cards:
Various adapters, cables and extender cards are required for the different radio tests. Extender cards and adapters are available from Daniels Electronics. The receiver front end filter tuning requires an SMB - BNC adapter (5192-WJ01BJ01) that is available from Daniels.

Control Cards:
Most Daniels MT-3 radio systems have an AC-3E or AC-3L-96 Audio Control Card for use in the radio system. The Control Cards connect to the receiver and transmitter balanced audio lines with an unbalanced load, which could cause some measurements to be in error. If the radio system includes an Audio Control Card, remove the control card from the rack for the individual receiver and transmitter tests unless otherwise noted.

Audio Connections:
The Receiver, Transmitter and Auxiliary Balanced audio lines are available for connection on Daniels extender cards or by connecting to the back panel A-PNL-AUX96-3 screw terminal option. The extender cards have solder points available on each signal line that can have a small wire loop soldered to them for easy connection with clip-on type clips.

Audio Control Card Extender Card pins (EC-96D1):
Auxiliary 1 Audio output = B11 & A11
Auxiliary 1 Audio input = C19 & C20
Auxiliary 2 Audio output = C1 & C3
Auxiliary 2 Audio input = B14 & A14

Receiver and Transmitter Extender Card pins (EC-48RD):
Rx Balanced Audio output = B26 & Z26
Tx Balanced audio input = B18 & Z18
Tx Subtone Input 1 = B22 & Ground (B32)

Optionally the Receiver audio output can also be connected to by the Meter Jacks on the front panel of the System Monitor (this is the de-emphasis audio line out of the receiver). If connecting to the System Monitor, ensure the A/B switch is in the proper position and the 12-position rotary switch is in position 8. Do NOT use the System Monitor connection for the Receiver Audio Level Test.

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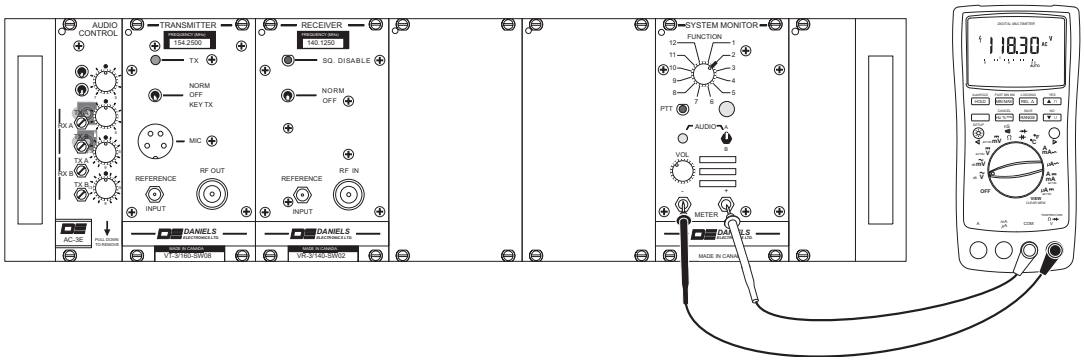
System Monitor Testing

System Voltage Testing:

The first stage of testing a Daniels radio system is to perform a basic system check on the supply and regulated voltages. The System Monitor module is designed with a convenient and easy test point built in to the front panel. This test point allows a technician access to the DC supply and regulated voltages, as well as other test points in the Daniels radio system. Simply connect a standard Digital Volt Meter (DVM) to the METER jacks on the front panel of the System Monitor. See the diagram below:



The FUNCTION rotary switch on the front panel of the System Monitor will allow you to test various points in the radio system. Following is a list of System Monitor rotary switch positions, the functions they measure and the parameters measured (please note that switch positions 4, 5, 11 and 12 require a carrier injected into the receiver and position 8 requires an audio tone as well):

1	No Connection	Not Used
2	Supply Voltage	+10 Vdc to +17 Vdc (+13.8 Vdc nominal)
3	+9.5 Volts Regulated	+9.5 Vdc (± 0.1 Vdc)
4	Rx A Carrier Strength	+1 Vdc to +5 Vdc based on received signal strength (+1 Vdc is a low RF signal level, +5 Vdc is high)
5	Rx B Carrier Strength	+1 Vdc to +5 Vdc based on received signal strength (+1 Vdc is a low RF signal level, +5 Vdc is high)
6	Rx A +6.0 Volts	+6.0 Vdc (± 0.1 Vdc)
7	Rx B +6.0 Volts	+6.0 Vdc (± 0.1 Vdc)
8	Rx A / B Audio	Receiver Audio (NOT Rx Balanced Output)
9	Spare	Not Used
10	Spare	Not Used
11	Rx A Priority COR	Open Collector Output; Measure with an Ohm meter. Ground for Active; Open for Inactive
12	Rx B Priority COR	Open Collector Output; Measure with an Ohm meter. Ground for Active; Open for Inactive

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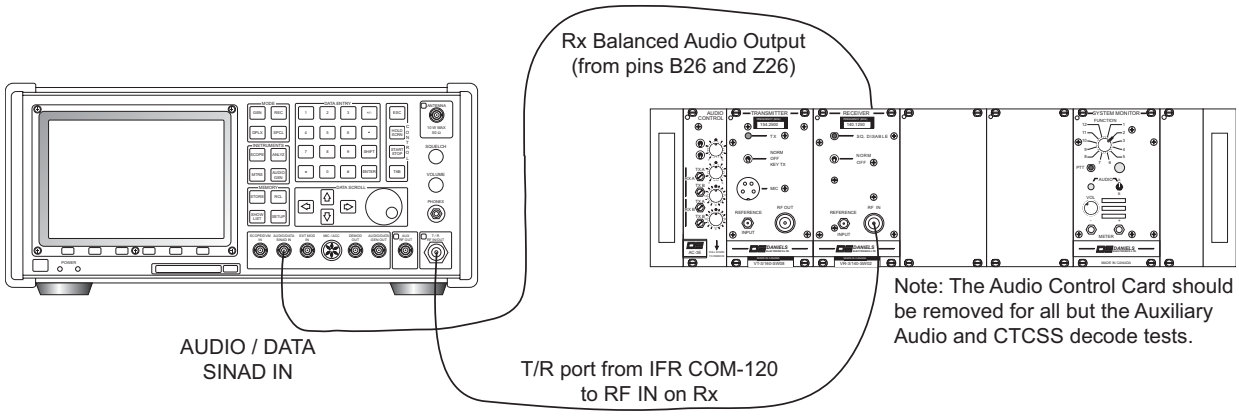
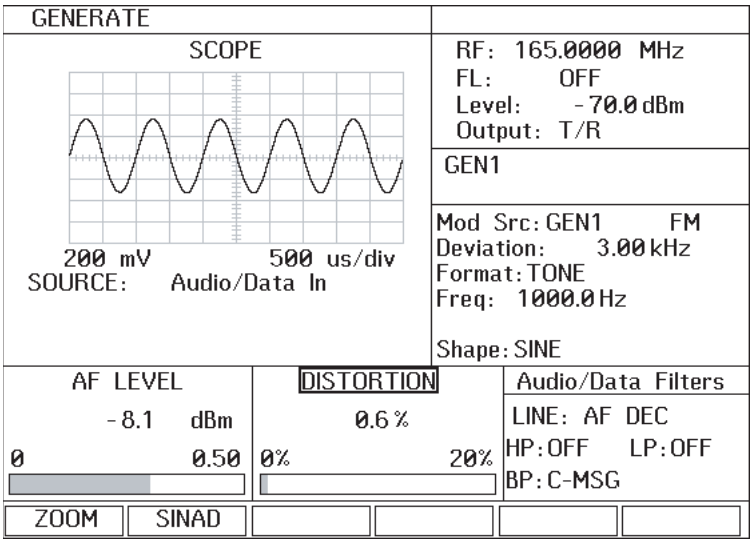
Receiver Testing

Connect the IFR COM-120 and Daniels radio as follows:



Select the GEN MODE button and set up the IFR COM-120 as follows:



The AF LEVEL and SCOPE may not read as shown, these levels are set with an external 600 ohm matching load. Audio levels will read higher without the matching load. See the Receiver and Auxiliary Output Audio Level section for more information. Enter the correct RF frequency, and ensure that the deviation level is set at +/- 60% maximum deviation (+/-3.0 KHz wide / +/-1.5 KHz narrow). On the Daniels Radio system, ensure the receiver is turned on and turn the System Monitor Speaker switch to A or B (depending on the receiver being tested), then turn the volume up until the 1 KHz tone is audible.

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Receiver Testing

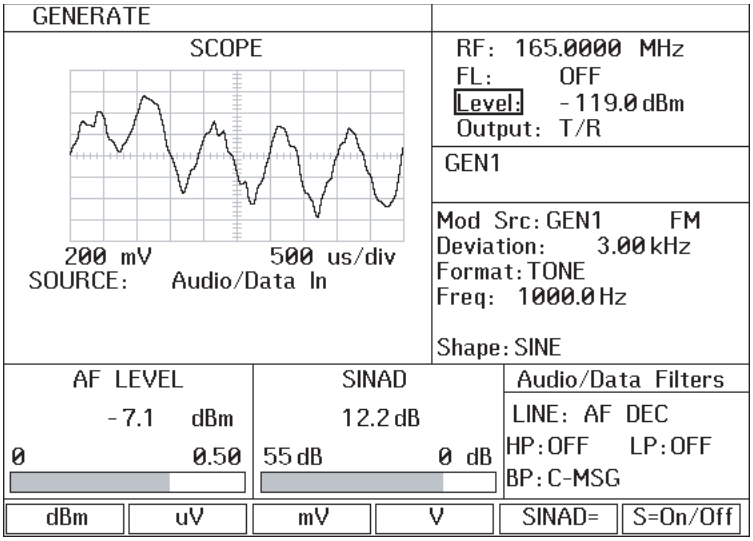
Distortion:

Receiver audio distortion is typically less than 3.0 %.

Sensitivity (12 dB SINAD):

Highlight DISTORTION and select SINAD. Highlight LEVEL and push enter on the keypad, then slowly turn the DATA SCROLL spinner down to lower RF generator levels while monitoring the SINAD meter. The receiver sensitivity point is where the RF generator level is for a 12 dB SINAD reading (The SINAD meter tends to jump around, look for the closest RF level for an average of 12 dB SINAD). Receiver sensitivity is typically -116 dBm to -118 dBm depending on the receiver model.

The IFR COM-120 setup as shown below shows a receiver with -119.0 dBm senstivity:



If the Distortion or SINAD measurements are not within Daniels published specifications, the Front End may need re-alignment. Refer to the Receiver Front End Alignment and Tuning section.

Squelch:

To check the receiver squelch points, adjust the RF carrier level up and down with the DATA SCROLL spinner until the receiver squelches and unsquelches. There should be approximately 6 dBm of hysteresis (centered around the sensitivity point) on MT-3 receivers. The squelch and unsquelch point can be adjusted on the receiver main board (R88 & R115). Refer to the Instruction Manual or Technical Note for squelch setting procedures.

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Receiver Testing

Receiver and Auxiliary (AC-3E) Output Audio Levels:

The audio level adjustment can be done on both the Rx Balanced Audio Output and the Auxiliary Balanced Output (1 and 2). The Auxiliary Balanced Output is only available on the AC-3E Control Card. The Receiver and Auxiliary Balanced Audio Outputs are 600 ohm balanced audio outputs and will require an external 600 ohm matching load before an accurate measurement of the audio level can be performed by the IFR COM-120.

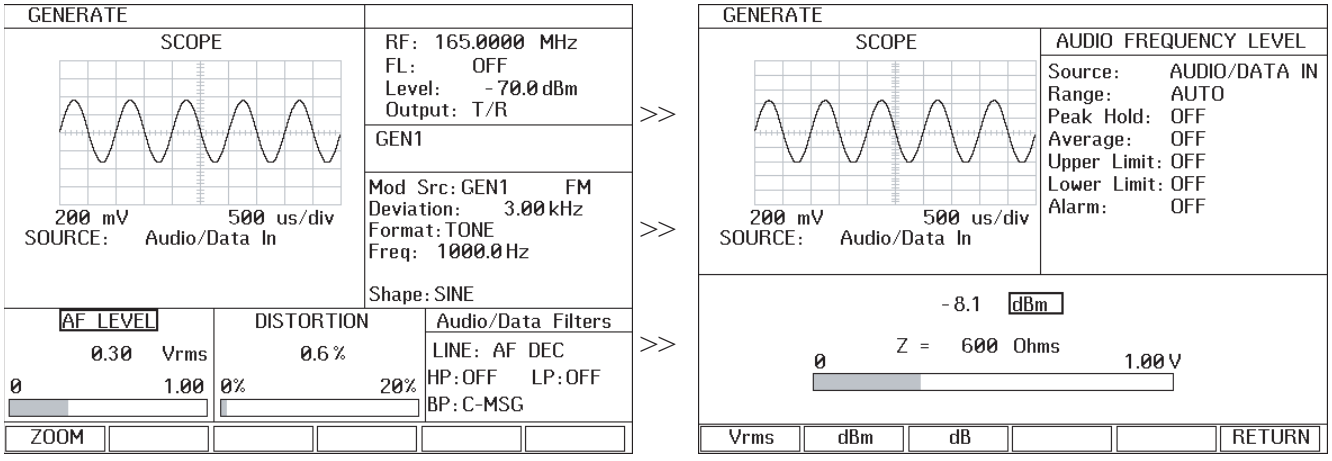
Rx Balanced Output:

1. Ensure the receiver is turned on and the Audio Control Card is NOT plugged into the subrack.
2. Adjust the Rx Balanced Audio level adjustment (R64 the High Level Drive Adjust) for -8.0 dBm audio level (308 mVrms @ 600 ohms). If no external 600 ohm load is available, the audio level could be adjusted for approximately 585 mVrms in the IFR COM-120.

Auxiliary Balanced Output (1 & 2):

1. Ensure the receiver is turned on and the Audio Control Card IS plugged into the subrack.
2. Connect the Auxiliary Balanced Audio Output (1 or 2) from the AC-3E to the AUDIO/DATA SINAD IN input on the IFR COM-120.
3. Adjust the Auxiliary Balanced Audio level adjustment (R13 for Aux Out 1, R56 for Aux Out 2) for 0.0 dBm audio level (775 mVrms @ 600 ohms). If no external 600 ohm load is available, the audio level could be adjusted for approximately 2.50 Vrms in the IFR COM-120.

To select between dBm and Vrms highlight AF LEVEL and select ZOOM . Highlight the measurement units and select Vrms or dBm (ensure that the impedance is set to 600 Ohms when selecting dBm). Hit RETURN to return to the GENERATE window.



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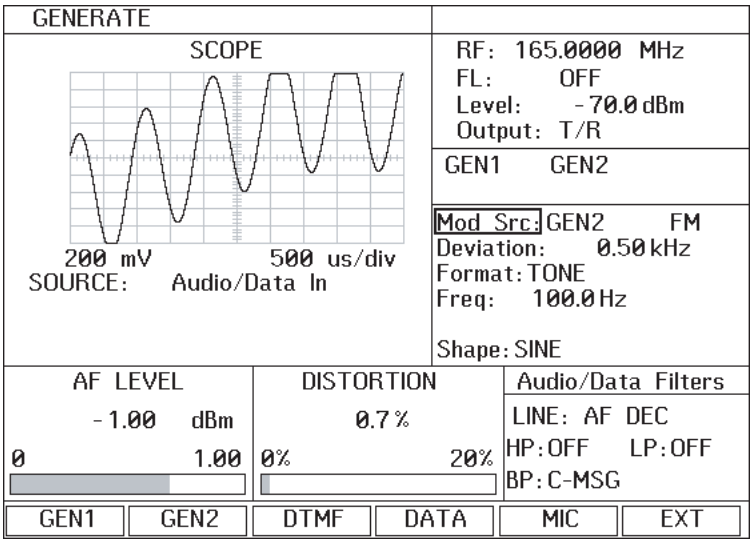
Receiver Testing

CTCSS Decode:

To check the CTCSS decode of the receiver, plug the Audio Control Card into the subrack and ensure that the CTCSS decode switch is turned ON (if applicable). When the decoder is turned ON the receiver will mute and audio will no longer be audible at the System Monitor speaker.

If the Auxiliary Balanced Output test was last performed, re-connect the Receiver Balanced Audio Output to the AUDIO/DATA SINAD IN input on the IFR COM-120. Ensure the 1.0 KHz audio tone is still injected into the receiver (with GEN1) and that the deviation level is set at +/- 60% maximum deviation (+/-3.0 KHz wide / +/-1.5 KHz narrow).

To inject the CTCSS tone into the receiver, highlight Mod Src and select GEN2, then highlight OFF and select FM. Highlight Freq and enter the CTCSS decode tone, then highlight Deviation and enter a deviation of +/-0.50 KHz wide / +/-0.35 KHz narrow.



The receiver will now un-mute and the 1 KHz tone (and possibly the CTCSS tone) will be audible on the System Monitor speaker. If the receiver does not un-mute, check that the correct CTCSS tone frequency is entered in the IFR COM-120.

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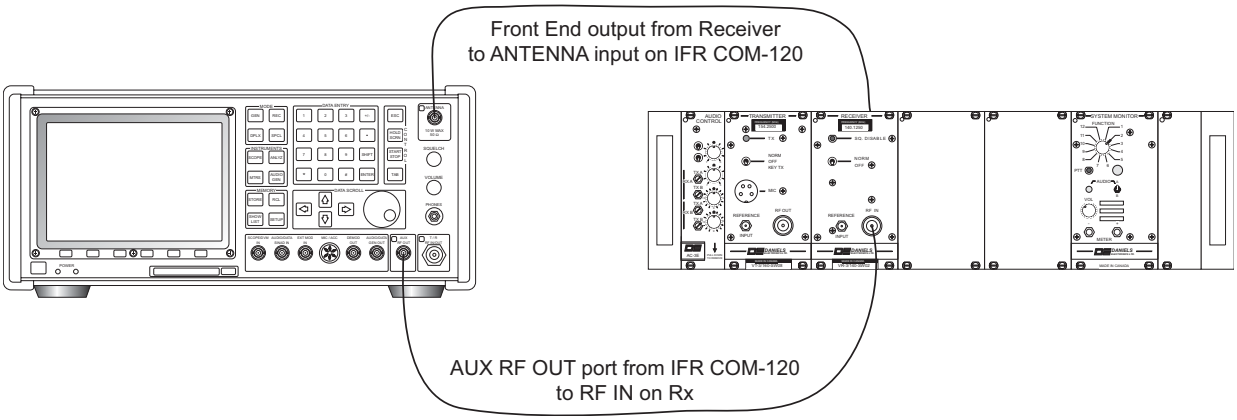
Receiver Testing

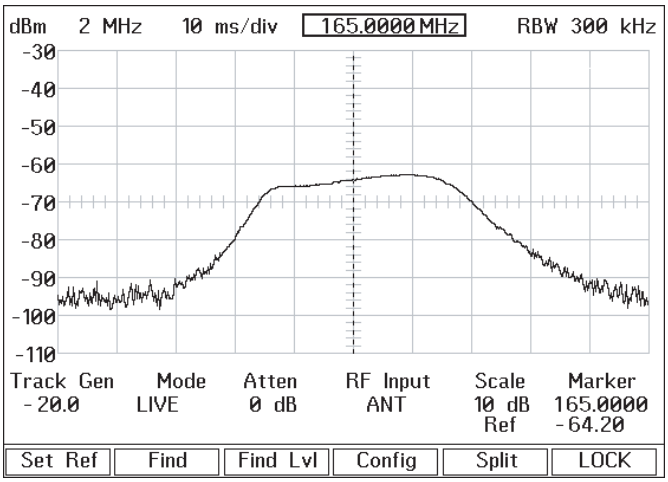
Receiver Front End Alignment and Tuning:

Tuning of the Front End filter is typically only required when the Sensitivity or Distortion does not meet published specifications, or when the receiver RF frequency is changed beyond the band pass of the filter (typically 5 - 7 MHz). Connect the IFR COM-120 and Daniels radio as follows:



The internal cable in the receiver from the output of the front end terminates in an SMB connector. The SMB plugs directly into the Receiver 21.4 MHz IF / Audio Main Board. Disconnect the SMB cable from the Main Board connector and use the SMB-BNC adapter to connect this point to the ANT input on the IFR COM-120.

Select the ANLYZ INSTRUMENTS button and set up the IFR COM-120 as follows:



Enter the correct RF frequency and ensure the receiver is turned on. The filter waveform will appear on the scope display. To tune the Front End filter, remove the dust caps on the variable capacitors and, starting from the capacitor closest to the front panel and moving back, tune the filter to its new frequency.

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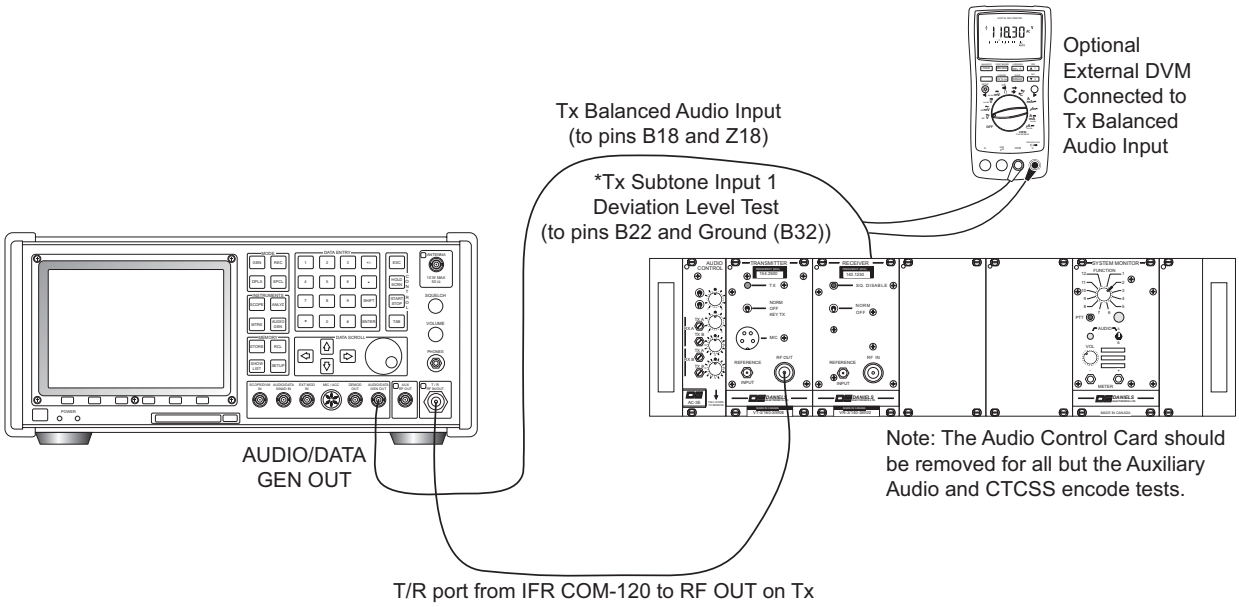
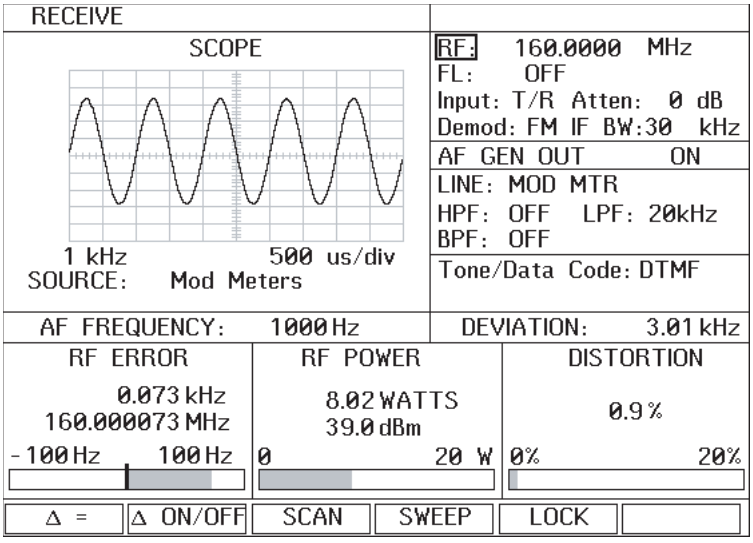
Transmitter Testing

Connect the IFR COM-120 and Daniels radio as follows:



Select the REC MODE button and set up the IFR COM-120 as follows:



Enter the correct RF frequency, and ensure that the transmitter is set to KEY TX and the Audio Control Card is NOT plugged into the subrack. Set the receive audio filters and AF Generator frequency and level as shown on the next page.

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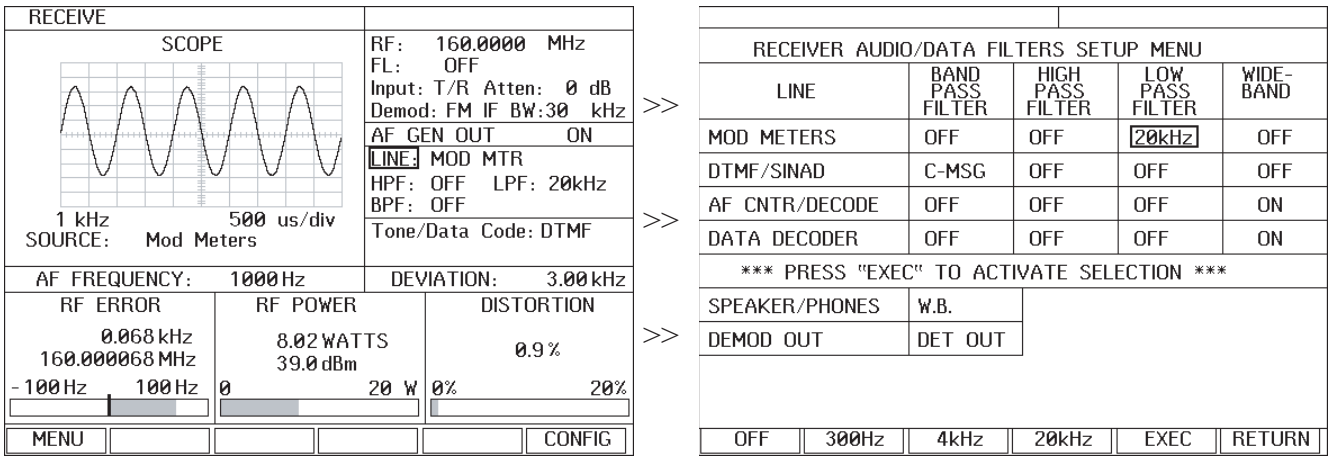
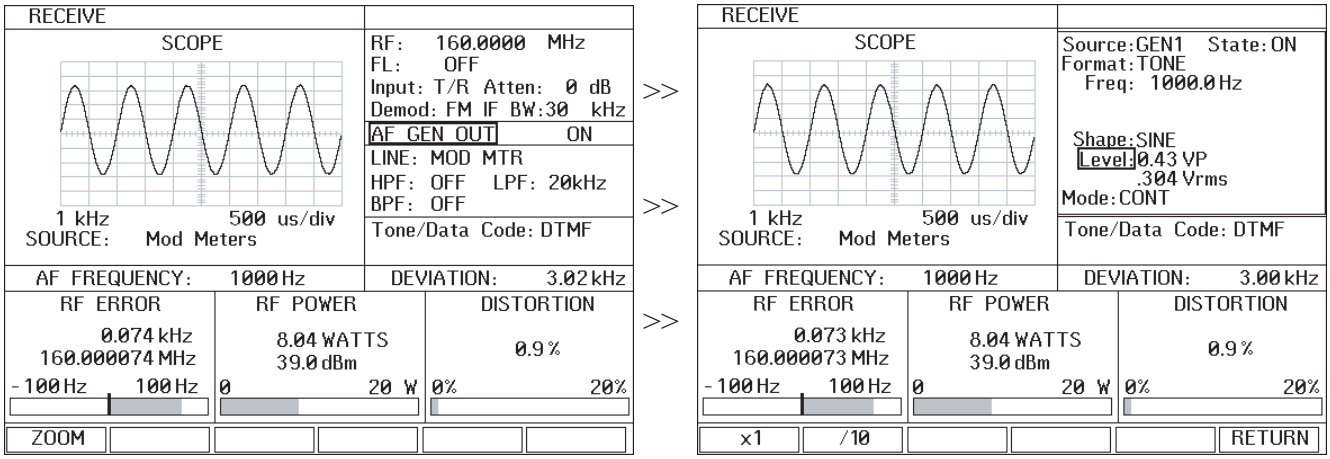
Transmitter Testing

To set the IFR COM-120 receive audio filters, highlight LINE and select CONFIG. Set up the filters as shown below. Hit RETURN to return to the RECEIVE window.



To set the IFR COM-120 AF Generator frequency and level, highlight AF GEN OUT and select ZOOM. Set up the GEN1 as shown below. The Audio level of 0.43 Vp is 0.304 Vrms or -8.0 dBm. Hit RETURN to return to the normal RECEIVE window.



This will set the proper filters and audio levels for distortion and deviation measurements.

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Transmitter Testing

Distortion:

Transmitter audio distortion is typically less than 2.0 %. If transmitter distortion is greater than 2.0%, the transmitter Audio Processor may need re-tuning. Refer to the Instruction Manual or Technical Note for audio processor tuning procedures.

Power:

RF power output should typically be between 2.0 to 8.0 Watts. Adjust R7 in the Transmitter Amplifier section to change the RF output power. High Power Amplifiers can also be checked by setting the METER switch to 150 WATTS AVG. Transmitter RF power output will vary slightly with the 10 - 17 Vdc input.

RF Frequency Stability:

Transmitter frequency stability is typically +/- 1 ppm.

Transmitter Deviation Levels:

Transmitter deviation is typically +/- 60% maximum deviation (+/-3.0 KHz wide / +/-1.5 KHz narrow) for an audio frequency of 1.0 KHz at -8.0 dBm audio level input.

To check the transmitter maximum deviation level highlight AF GEN OUT and select ZOOM. Enter an audio level of 2.50 Vp (1.767 Vrms or +7.2 dBm). Ideally the audio level should be set at +10.0 dBm, but the IFR COM-120 is not capable of higher than 2.50 Vp audio level (the difference between the ideal +10.0 dBm and +7.2 dBm is neglible for this test). Enter an audio frequency of 300.0 Hz and increase the 300.0 Hz sine wave up to 3400.0 Hz in increments of 100.0 Hz. Monitor the analog meter in the top right corner and check that the transmitter deviation does not rise above +/- 5.0 KHz wide or +/- 2.5 KHz narrow at any time.

To check the transmitter subtone input level highlight AF GEN OUT and select ZOOM. Disconnect the AUDIO/DATA GEN OUT from the Tx Balanced Audio Input connector and connect it to the Tx Subtone Input 1 connector. Enter an audio level of 0.14 Vp (0.098 Vrms or -18.0 dBm). Enter an audio frequency of 100.0 Hz. Hit RETURN to return to the RECEIVE window then set the IF BW at 15 KHz. Highlight LINE and select CONFIG then set the MOD METERS LOW PASS FILTER for 300 Hz. Transmitter subtone deviation is typically +/-0.50 KHz wide / +/-0.35 KHz narrow for -18.0 dBm audio level input.

If transmitter deviation is off by more than +/- 0.15 KHz deviation, the transmitter over-deviates, or the subtone deviation is off by more than +/- 0.10 KHz, the transmitter Audio Processor may need re-tuning. Refer to the Instruction Manual or Technical Note for audio processor tuning procedures.

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Transmitter Testing

Auxiliary (AC-3E) Input Audio Levels:

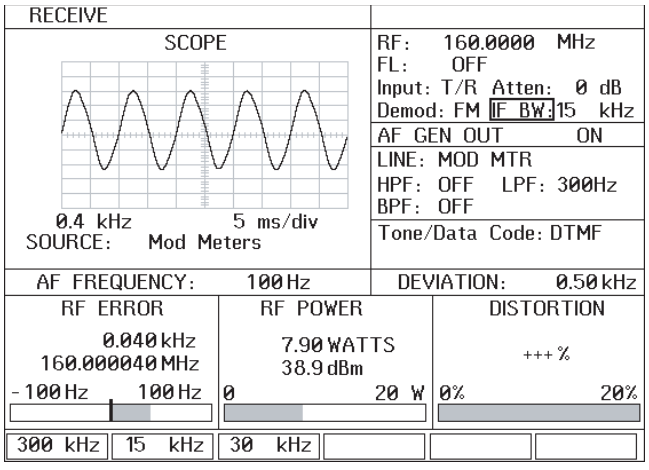
The auxiliary audio input level is set while measuring the transmitter deviation. Ensure that the IF BW is set at 30 KHz and the MOD METERS LOW PASS FILTER is set at for 20 KHz.

1. Ensure the transmitter is set to KEY TX and the Audio Control Card IS plugged into the subrack.
2. Connect AUDIO/DATA GEN OUT on the IFR COM-120 to the Auxiliary Balanced Audio Input (1 or 2).
3. Highlight AF GEN OUT and select ZOOM. Enter an audio level of 1.10 Vp (0.777 Vrms or 0.0 dBm).
4. Adjust the Auxiliary Balanced Audio level adjustment (R120 for Aux In 1, R123 for Aux In 2) for a transmitter deviation of +/- 60% maximum deviation (+/-3.0 KHz wide / +/-1.5 KHz narrow)

CTCSS Encode:

The CTCSS encode tone can be supplied from a CTCSS decoder (encode is same tone as decode), a separate CTCSS encoder, or some base stations may be configured for the tone remote adapter to supply the CTCSS encode tone. These procedures are for use when the audio control card supplies the CTCSS encode tone (with a decoder or encoder).

1. Ensure the transmitter is set to KEY TX and the Audio Control Card IS plugged into the subrack.
2. Ensure that the CTCSS encode switch is turned ON (if applicable).
3. Disconnect the Tx Balanced Audio Input from the AUDIO/DATA GEN OUT connector on the IFR COM-120.
4. In the RECEIVE window set the IF BW at 15 KHz.
5. Highlight LINE and select CONFIG then set the MOD METERS LOW PASS FILTER for 300 Hz.



Adjust the Transmitter CTCSS deviation for +/-0.50 KHz wide / +/-0.35 KHz narrow (the adjustment pot is located directly on the CTCSS module in the audio control card). The CTCSS encode tone is the AF Frequency.

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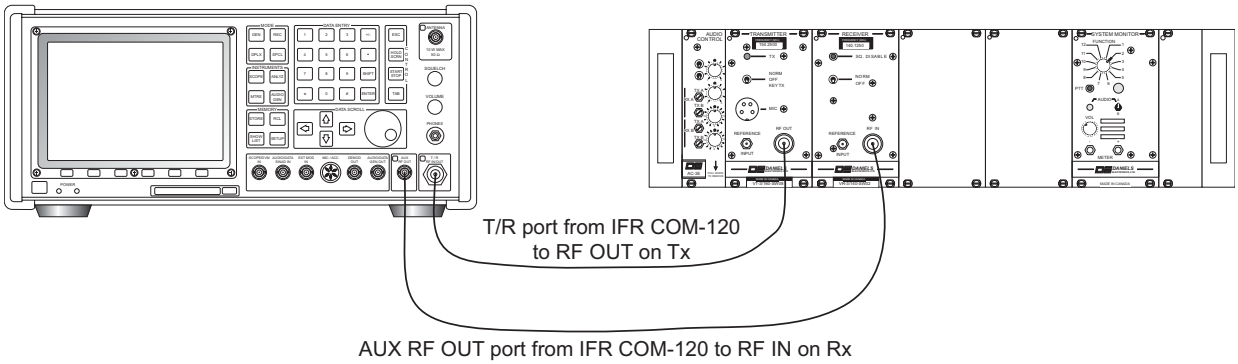
Audio Control Card Testing (Repeater)

Connect the IFR COM-120 and Daniels radio as follows:



Select the DPLX MODE button and set up the IFR COM-120 as follows:

DUPLEX RECEIVE AND GENERATE	
RECEIVE	GENERATE
RF: 160.0000 MHz	RF: 165.0000 MHz
FL: OFF	Offset: 5.0000 MHz
Input: T/R Atten: 0 dB	Level: -70.0 dBm
Demod: FM IF BW: 30 kHz	Output: AUX
Tone/Data Code: DTMF	GEN1
Deviation: 3.00 kHz AF Frequency: 1000 Hz Distortion: 1.9 % RF Power: 8.00 WATTS RF Error Freq: 0.023 kHz	Mod Src: GEN1 FM Deviation: 3.00 kHz Format: TONE Freq: 1000.0 Hz Shape: SINE
Δ = | Δ ON/OFF | | | PAIR |	

Enter the correct RF frequency for both the transmitter and receiver, and ensure that the transmitter and receiver are set to NORM. Ensure the Audio Control Card IS plugged into the subrack and the CTCSS decode and encode are turned OFF.

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Audio Control Card Testing (Repeater)

Distortion:

Complete radio system audio distortion is typically less than 5.0 %. If the radio system distortion is greater than 5.0%, the transmitter or receiver may need re-tuning. Refer to the Instruction Manual or Technical Note for tuning procedures.

Repeater Deviation Levels:

Ensure the deviation into the receiver is set at +/- 60% maximum deviation (+/-3.0 KHz wide / +/-1.5 KHz narrow). The transmitter deviation into the IFR COM-120 should read within +/- 0.15 KHz of the input deviation.

AC-3E Audio Control Cards:
If transmitter deviation is off by more than +/- 0.15 KHz deviation from the input deviation of +/- 60%, adjust the audio level matching pot on the front panel (RXA to TXA, RXA to TXB, RXB to TXA or RXB to TXB) of the Audio Control Card until the deviation levels match.

AC-3L-96 Audio Control Cards:
If transmitter deviation is off by more than +/- 0.15 KHz deviation from the input deviation of +/- 60%, check the receiver audio level and transmitter deviation level individually in the Rx and Tx modules.

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