MAINTENANCE MANUAL

FSK MODEM MODULE
19D902521G1

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SPECIFICATION

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- Table 4 outlines the various digital clocks and data specifications.
- Table 5 outlines the jumper definition and default configurations.
- Tables 1 through 5 depict the specifications as it relates to the actual operation as part of the **16PLUS** Digital Simulcast System.

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TABLE 1 - GENERAL SPECIFICATIONS

ITEM	SPECIFICATION
INPUT VOLTAGE	+5 Vdc ± 10%
TEMPERATURE	-30 TO +60 DEGREES C
DIMENSION	8.0 (L) BY 4.0 (W) IN
WEIGHT	10 OUNCES
DATA INPUT	RS-232C
ALARM OUTPUT	TTL
ANALOG INPUT/OUTPUT	VOICE GRADE AUDIO CIRCUITS

TABLE 2 - POWER SPECIFICATION

VOLTAGE	CONNECTOR POINT	TOLERANCE ± %	CURRENT DRAIN TYPICAL mA	CURRENT DRAIN MAXIMUM mA
GND	P1-A2 P1-C2 P1-A31 P1-C31	NA	NA	NA
+5	P1-A1 P1-C1 P1-A32 P1-C32	10	100	150

TABLE 3 - P1 CONNECTOR DEFINITION

CONNECTOR PIN	SIGNAL NAME	INPUT/ OUTPUT	ANALOG/ DIGITAL	LEVEL DIGITAL DC-VOLT AC-VRMS	CONTROL/ TX SITE
P1-A1	5V	I/O	D	+5 V	C/T
P1-C1	5V	I/O	D	+5 V	C/T
P1-A2	GND	I/O	D	0 V	C/T
P1-C2	GND	I/O	D	0 V	C/T
P1-A6	TXDIN	I	D	RS-232C	C
P1-A8	OUT 1	O	D	RS-232C	T
P1-C8	OUT 2	O	D	RS-232C	T
P1-A9	OUT 3	O	D	RS-232C	T
P1-C9	OUT 4	O	D	RS-232C	T
P1-A10	OUT 5	O	D	RS-232C	T
P1-C10	OUT 6	O	D	RS-232C	T
P1-A11	OUT 7	O	D	RS-232C	T
P1-C11	OUT 8	O	D	RS-232C	T
P1-A12	OUT 9	O	D	RS-232C	T
P1-C12	OUT 10	O	D	RS-232C	T
P1-A13	OUT 11	O	D	RS-232C	T
P1-C13	OUT 12	O	D	RS-232C	T
P1-A14	OUT 13	O	D	RS-232C	T
P1-C14	OUT 14	O	D	RS-232C	T
P1-A15	OUT 15	O	D	RS-232C	T
P1-C15	OUT 16	O	D	RS-232C	T
P1-A16	OUT 17	O	D	RS-232C	T
P1-C16	OUT 18	O	D	RS-232C	T
P1-A17	OUT 19	O	D	RS-232C	T
P1-C17	OUT 20	O	D	RS-232C	T
P1-A18	OUT 21	O	D	RS-232C	T
P1-C18	OUT 22	O	D	RS-232C	T
P1-A19	OUT 23	O	D	RS-232C	T
P1-C19	OUT 24	O	D	RS-232C	T
P1-A20	OUT 25	O	D	RS-232C	T
P1-A23	MODEM RX TIP	I	A	-10 dBm	T
P1-C23	MODEM RX RING	I	A	-10 dBm	T
P1-A26	MODEM TX TIP	O	A	- 0 dBm	C
P1-C26	MODEM TX RING	O	A	- 0 dBm	C
P1-A30	ALARM-FSK	O	D	TTL	C/T
P1-A31	n/c	I/O	D	0 V	C/T
P1-C31	n/c	I/O	D	0 V	C/T
P1-A32	n/c	I/O	D	+5 V	C/T
P1-C32	n/c	I/O	D	+5 V	C/T

TABLE 4 - DIGITAL CLOCKS AND DATA SPECIFICATIONS

CONNECTOR PIN	SIGNAL NAME	CLOCK/DATA AND LEVEL	RATE HZ (C)/BPS(D)
P1-A6	TXDIN	D	150 BPS
P1-A8	OUT1	D	150 BPS
P1-C8	OUT2	D	150 BPS
P1-A9	OUT3	D	150 BPS
P1-C9	OUT4	D	150 BPS
P1-A10	OUT5	D	150 BPS
P1-C10	OUT6	D	150 BPS
P1-A11	OUT7	D	150 BPS
P1-C11	OUT8	D	150 BPS
P1-A12	OUT9	D	150 BPS
P1-C12	OUT10	D	150 BPS
P1-A13	OUT11	D	150 BPS
P1-C13	OUT12	D	150 BPS
P1-C14	OUT13	D	150 BPS
P1-C14	OUT14	D	150 BPS
P1-A15	OUT15	D	150 BPS
P1-C15	OUT16	D	150 BPS
P1-A16	OUT17	D	150 BPS
P1-C16	OUT18	D	150 BPS
P1-A17	OUT19	D	150 BPS
P1-C17	OUT20	D	150 BPS
P1-A18	OUT21	D	150 BPS
P1-C18	OUT22	D	150 BPS
P1-A19	OUT23	D	150 BPS
P1-C19	OUT24	D	150 BPS
P1-A20	OUT25	D	150 BPS
P1-A23	RXTIP	A	1200/2200 HZ
P1-C23	RXRING	A	1200/2200 HZ
P1-A26	TXTIP	A	1200/2200 HZ
P1-C26	TXRING	A	1200/2200 HZ

TABLE 5 - JUMPER DEFINITION AND CONFIGURATION

JUMPER	SHORTING PLUG	POSITION	DESCRIPTION	CONTROL/ TX SITE
J2	P2	1 & 2 2 & 3	NORMAL OPERATION LOOPBACK TEST MODE	C/T
J3	P3	1 & 2 2 & 3	NORMAL OPERATION LOOPBACK TEST MODE	C/T

GENERAL DESCRIPTION

The FSK Modem Module is used in the **16PLUS** Simulcast System to provide low speed data (150 bits per second) detection and transmission by means of a phase coherent **Bell 202** frequency shift keyed signaling and corresponding TTL conversion.

It is physically located in the sync unit assembly at the control point or transmit site. The **FSK** Modem Module plugs into the sync unit assembly (slot 4).

The **FSK** Modem Module is used at the control point to encode the selected 150 baud low speed data and send it to the transmitter sites. It is used at the transmit site(s) to decode the selected 150 baud data from the control point.

The **FSK** Modem Module employs a **Bell 202** signaling operating at speeds up to 1200 bits per second. Each data bit of the 150 baud low speed data is transmitted and received using a phase coherent frequency shift keyed signaling. A mark (logic one) is encoded/decoded as a 1200 Hz tone and a space (logic zero) is encoded/decoded as a 2200 Hz tone. The transmitting and receiving section of the **FSK** Modem Module are independent and allow for a full duplex mode of operation.

The **FSK** Modem Module obtains the TTL compatible 150 baud transmit data from the Data Selector 1 (150 baud) Module at the control point only. It decodes the 150 baud receive data from the mux audio lines and sends the RS-232C compatible data to GETC Interface Module at the transmit site only.

Four potentiometers are used on the module to adjust the receive audio gain, the transmit audio gain, the receive bias adjust, and the carrier level detect. A test connector, P4, is provided to allow monitoring of these voltages.

Two jumpers, P2 and P3 are provided to allow for a local loopback test mode of operation at the site.

An LED on the front of the module, diode D1, is used to provide a visual indication of the loss of receive carrier and subsequently the generation of the FSK alarm.

CIRCUIT AND FUNCTIONAL DESCRIPTION

The **FSK** Modem Module provides generation and detection of the 150 baud **FSK** low speed data (up to 1200 baud for other applications) per **Bell 202** specification for the simulcast system.

The modem converts the RS-232C compatible 150 baud data selected by the Data Selector 1 module of the sync assembly (at the control point) to TTL and sends it to the **FSK** modem (U1). The **FSK** modem U1 generates the 1200 (mark or logic one) and 2200 (space or logic zero) frequency shift keying signal, operational amplifier U3 amplifies and transformer coupled the signal to P1 A-26 and P1 C-26.

The **FSK** Modem Module receives the 1200 (mark or logic one) and 2200 (space or logic zero) frequency shift keying signal where it is transformer coupled to an operational amplifier. The operational amplifier U2 amplifies the received signal and sends it to the **FSK** modem IC. A bank of 5 TTL to RS-232C converters are used to drive the decoded 150 baud data to the GETC Interface Module (via the cross connect panel) and to the **16PLUS** station at the transmit site.

The **FSK** modem IC performs the 150 data to **Bell 202** conversion and **Bell 202** to 150 baud data conversion using switched capacitor technology. The **FSK** modem IC is configured for 1200 baud operation (8 times the low speed data rate) with a mark frequency of 1200 Hz and a space frequency of 2200 Hz.

Four potentiometers are used on the **FSK** Modem Module. A carrier level detect adjustment is used to set the minimum input level necessary for acceptable input audio. A receive bias adjustment is used to set the bias point and compensate for internal offsets. A receive gain adjustment is used to amplify the received audio to the **FSK** modem IC prior to decoding. A transmit level adjustment is used to amplify the encoded signal from the **FSK** modem.

The **FSK** modem IC outputs a loss of carrier alarm based on the level of the incoming received audio and compared against the level as set by the carrier detect level adjustment. This loss of carrier is the basis of the **FSK** alarm output sent to the Subsystem Alarm Module of the Sync Unit.

A general block diagram of the **FSK** Modem Module is shown in Figure 1

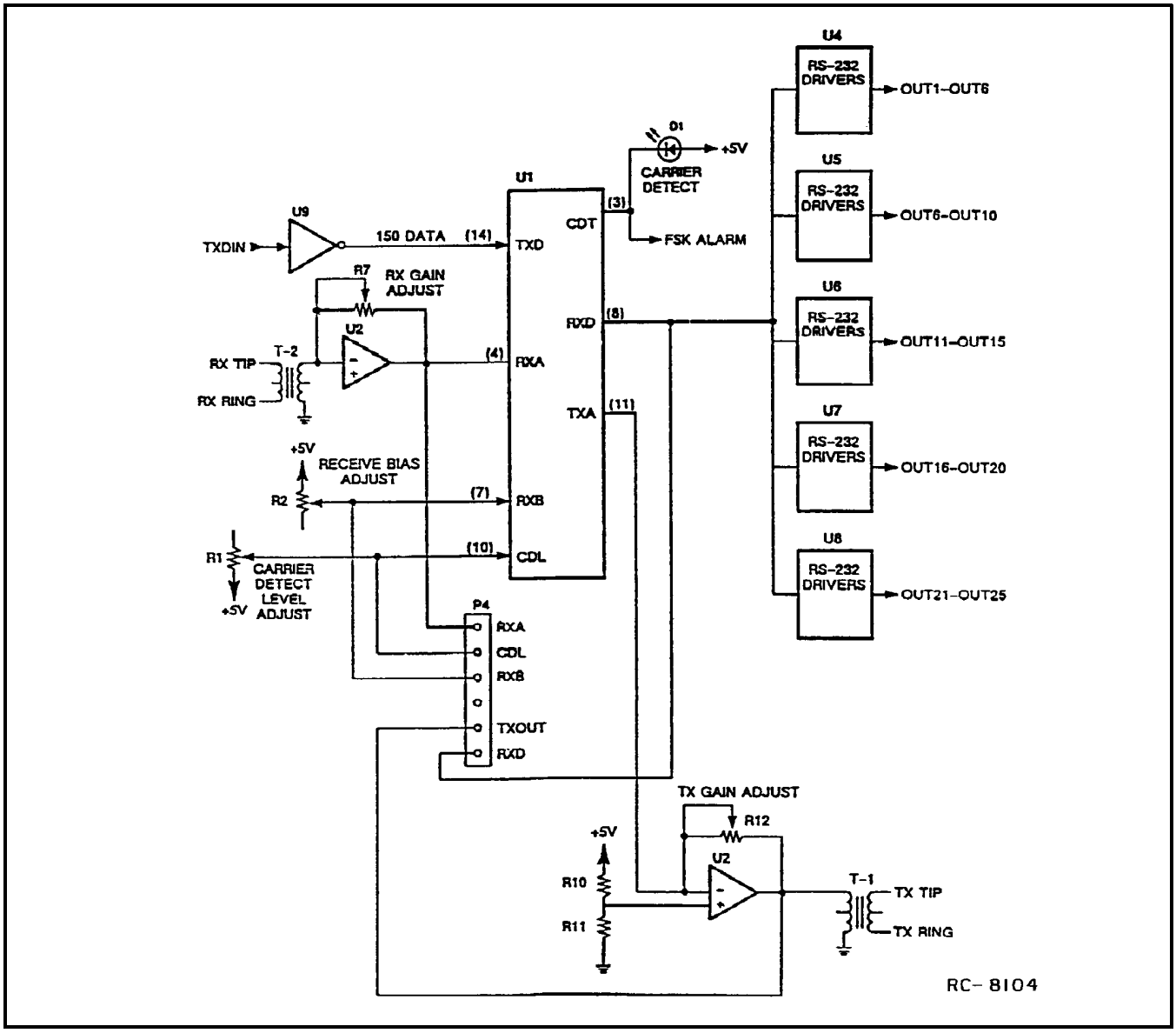


Figure 1 - FSK Block Diagram

CONNECTORS AND SYSTEM INTERFACE

There are two connectors on the **FSK** Modem Module, P1 and P4. Connector P1 is used to interface the **FSK** Modem Module to the Universal Sync Unit Assembly. The **FSK** Modem Module plugs into slot 4 (J4) of the Sync Unit. A description of the various signals, data, and clocks used between the **FSK** Modem Module and the Sync Unit is summarized in Table 3.

Connector P4 serves as a test jack and is used to aid in the monitoring of test points during potentiometer adjustments. The signals to the connector, P4, include the carrier detect dc level to the FSK modem IC, the receive bias dc level to the **FSK** modem IC, the received audio to the FSK modem IC, and ground, the TTL version of the received data, and the transformer data on the primary side.

FSK MODEM MODULE AND CROSS CONNECT PANEL SIGNAL FLOW

TXDIN

TXDIN is an RS-232C compatible input derived from the Data Selector 1 module of the Universal Sync Unit assembly.

OUT1 - OUT 25

OUT 1-OUT 25 are identical RS-232C outputs from the **FSK** Modem Module. These outputs are derived from the received data output of the **FSK** modem IC and are sent to the GETC logic modules (through the cross connect panel and GETC Interface Module) and to the **16PLUS** stations at a transmit simulcast site.

MODEM RX TIP - MODEM RX RING

MODEM RX TIP and **MODEM RX RING** are the received tip and ring signals of the 4-wire audio derived from the channel bank. These two lines are transformer coupled to the circuitry of the **FSK** Modem Module. **RXTIP** and **RXRING** are only used at a transmit simulcast site.

MODEM TX TIP - MODEM TX RING

MODEM TX TIP and **MODEM TX RING** are the transmitted tip and ring signals of the 4-wire audio sent to the channel bank. These two lines are transformer coupled out of the circuitry of the **FSK** Modem Module. **TXTIP** and **TXRING** are used only at a control point site.

ALARM - FSK

ALARM - FSK is a TTL output from the **FSK** Modem Module and is sent to the Subsystem Alarm Module of the Sync Unit. This signal indicates the loss of a carrier level on the received audio input. **ALARM - FSK** is monitored at a transmit simulcast site only. It always indicates an **FSK** failure (alarm) at a control point due to the absence of received audio.

JUMPER DEFINITION AND CONFIGURATION

Table 5 summarizes the jumper configuration and definition at the control point and transmit sites as well as the default position. The normal configuration of the jumpers is on pins 1 and 2 for both J3 and J4.

The loopback test mode of operation is enabled when jumpers P3 and P4 are installed on pins 2 and 3 of J3 and J4, respectively. In this mode, transmit low speed data on **TXDIN** will be encoded by the **FSK** modem IC, be output as a frequency shift keying signal on the **TXTIP** and **TXRING** outputs, looped back onto **RXTIP** and **RXRING**, respectively, sent to the **FSK** modem IC for decoding, and finally output on **OUT1** through **OUT25**.

POWER DISTRIBUTION AND FILTERING

The +5 volt power supply used by the **FSK** Modem Module is derived from the simulcast power supplies (+5 Vdc). The +5 Vdc power input (**5V**) is used to power all active components on the **FSK** Modem Module. The active components include the **FSK** modem IC, the five (5) TTL to RS-232C converters, the operational amplifier and the TTL inverter.

The +5 Vdc power is also used to supply power to the LED and pullup resistors and potentiometers necessary for fixed level bias adjustment.

There are power bypass capacitors on the **FSK** Modem Module to filter any power noise transients or spikes from affecting circuit operation and module performance. Some capacitors are 0.1 μF in value and are numbered C29 through C36. Another capacitor, C37, provides a bulk power supply filter on the +5 Vdc. Additional capacitors bypass the fixed bias points. They are numbered C4 and C28.

FSK MODEM RECEIVER

The received audio from the four-wire interface is derived from the channel bank and enters the **FSK** Modem Module on **MODEM RX TIP** and **MODEM RX RING**. Transformer T2 couples the two wire balance line to the single ended audio input. Resistor R3 sets the input impedance to 600 ohm.

The audio on pin 6 of transformer T2 is AC coupled (capacitor C3) into the receive amplifier (U2). Potentiometer R7 is used to adjust the gain of the amplifier, (**MODEM RX TIP** and **MODEM RX RING**). Resistors R5 and R6, and capacitor C4 set up a fixed and stable dc bias operating point of 2.5 Vdc dc. Resistor R8 is the operational amplifier load resistor used to eliminate crossover distortion. The output of the operational amplifier, Pin 7, is AC coupled (capacitor C5) into the receive input of the **FSK** modem IC, (U1).

The received audio input to **FSK** modem IC U1 is connected to connector P4, Pin 3 for monitoring purposes during receive gain adjustment.

The receive section of **FSK** modem U1 demodulates the analog signal appearing on the **RXA** input, Pin 4. The receive section contains a frequency to voltage converter, group delay equalizer (to correct phase distortion), automatic gain control, carrier detect level adjustment, and bias level adjustment. The switched capacitor technology used in the receiver section to perform these functions optimize performance and achieve the lowest possible bit error rate. A carrier detect output is also generated if the received in-band energy falls below the DC voltage set on the **CDL** (R2).

A block diagram of the complete receive section in the FSK modem in shown in Figure 2.

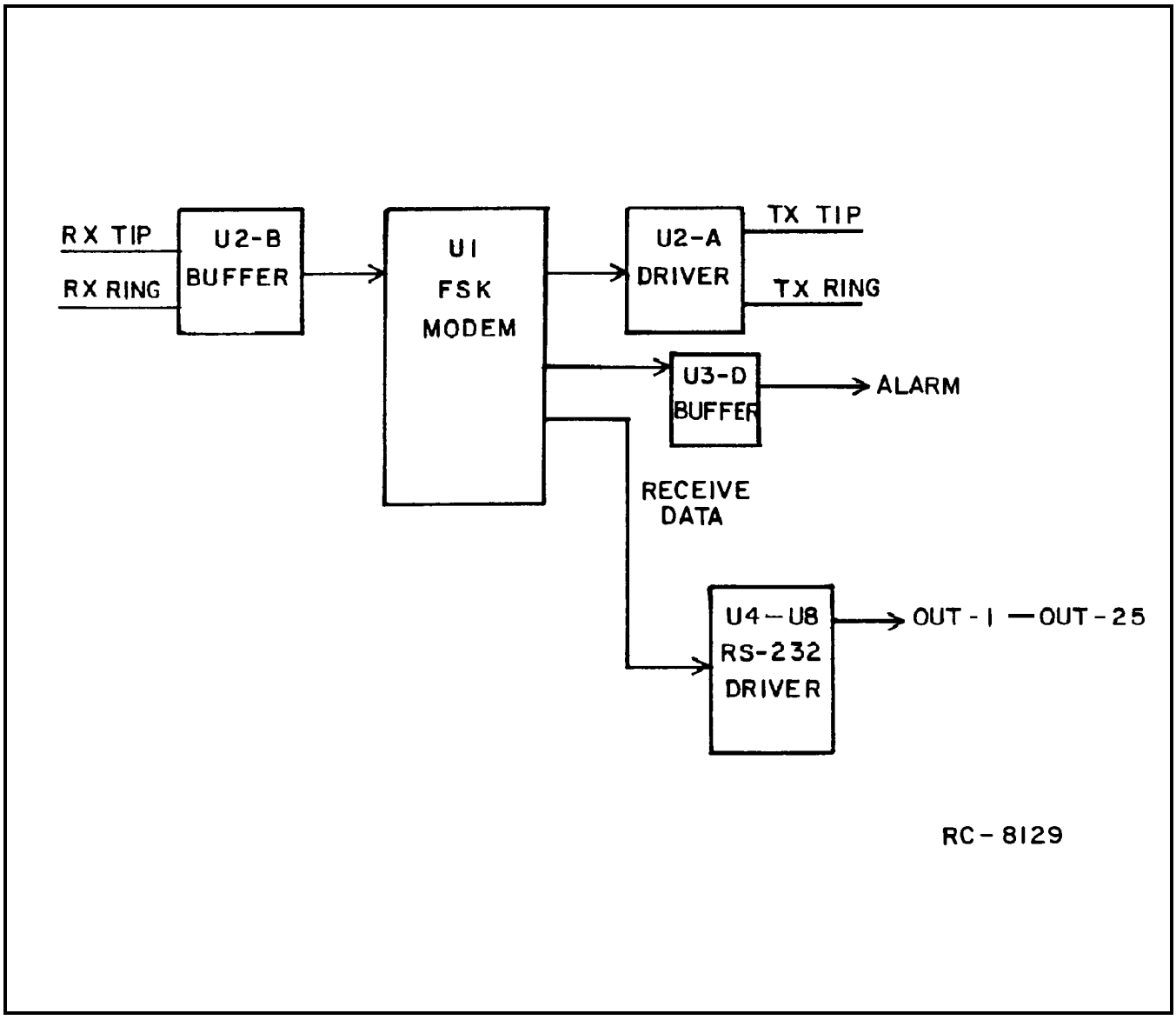


Figure 2 - Block Diagram Of The Receiver Section

The following describes the operation of the **FSK** modem IC (U1) in the receiver mode.

A continuous low-pass anti-aliasing filter is followed by the receive amplifier, which automatically controls the gain to give a constant output level from the receive filter. The receive filter limits the bandwidth of the signal presented to the demodulator, reducing out-of-band interference, and has very high rejection of the transmit channel frequency that is part of the same IC package.

The group delay equalizer is a switched capacitor network that compensates the delay introduced by the receive filter and the rest of the network. The output of the equalizer is then limited to give an **FSK** modulated squarewave that is presented to the demodulator.

The demodulator is an edge triggered multivibrator that triggers off positive and negative going edges. The output of the demodulator is a stream of constant length pulses at a frequency twice that of the analog input signal. The DC component of this stream is proportional to the received frequency and is extracted by the switched capacitor, low-pass, post demodulator filter.

The variation of the dc level with the received frequency is presented to a comparator that slices at a level externally set by the **RXB** (pin 7) bias adjustment input. This voltage is dependent upon the received bit rate and internal offsets. The comparator output is sent to the **RXD** (pin 8) output.

The **RXB** input is sent to the connector, P4, to be monitored during the receive bias adjustment.

The internal timing and control chain consists of an oscillator that runs from the external 4.4336 MHz crystal, X1, connected between the OSC1 (pin 15) and OSC2 (pin 16) points. The internal timing and control chain generates the clock to the switched capacitor filters for both the receive and the transmit sections.

The **FSK** modem IC, U1, is configured for a maximum 1200 baud operation at tone frequencies of 1200 Hz (mark or logic one) and 2200 Hz (space or logic zero). This configuration is performed by strapping the **TXR1** (pin 13) and **TXR2** (pin 12) inputs to ground along with inputting the inversion of the **CLK** (pin 2) output to the **TRS** (pin 5) input.

The **RXD** data output from the **FSK** modem IC is double buffered and sent to the twenty five inputs of the TTL to RS-232C converters. The converters consist of U4 through U8 and capacitors C6 through C25. The converters are powered from the +5 Vdc power supply (5V). Capacitors at the C1+ (pin 8), C1- (pin 10), C2+ (pin 11), and C2- (pin 12) of devices U4, U5, U6, U7, and U8, provide the converter capacity for the internal 15 kHz oscillator used to step up the +5V to +10 Vdc (capacitors on the C1+ and C1- inputs) and to -10 Vdc (capacitors on the C2+ and C2- inputs). Capacitors at the V+ output (pin 9) and the V- output (pin 13) of the devices provide the storage capacity for the internal +10 Vdc (V+ output) and the -10 Vdc (V- output). The +10 and -10 Vdc are used to supply the internal power to the TTL to RS-232C converters. The typical output voltage swing produced for the RS-232C level is ± 9 Vdc. The outputs of the converters exit the **FSK** Modem Module on **150 IN 232 CH 1 - 150 IN 232 CH 25**.

FSK MODEM TRANSMITTER

The transmitter low speed (150 baud) data stream is derived from the Data Selector 1 module of the Sync Unit assembly and enters the **FSK** Modem Module on the RS-232C compatible signal, **TXDIN** (P1 - A6)

Converter U9 translates the RS-232C signal to a TTL output to be sent directly to the FSK modem IC, U1, on the **TXD** (pin 14) input.

The **FSK** modem transmitter consists of a frequency synthesizer that provides two output frequencies on **TXA** (pin 11) representing the marks and spaces of the digital signal present on the **TXD** (pin 14) input.

A block diagram of the complete transmit section in the FSK modem is shown in Figure 3.

The following describes the operation of the FSK modem IC (U1) in the transmitter mode.

The transmitter comprises a phase coherent **FSK** modulator, a transmit filter, and a transmit amplifier. The modulator is a programmable frequency synthesizer that is configured for 1200 baud operation (as described in section **FSK MODEM RECEIVER**) that drives the output frequencies by variable division of the oscillator frequency (4.4336 MHz). The division ratio is set by the states of **TRS** (pin 5), **TXR1** (pin 13), and **TXR2** (pin 12), under control of the timing and control chain, and the digital data input **TXD** (pin 14).

A switched capacitor low-pass filter limits the harmonics and noise outside the transmit band and the characteristics of this filter are set by frequency select inputs previously mentioned. The harmonics introduced by the transmit filter are removed by a continuous low-pass filter.

The transmit output of the **FSK** modem IC (pin 11) is AC coupled (through capacitor C27) and into the amplifier consisting of U2, R12,and R9. Resistors R10 and R11, and capacitor C28 set up a fixed and stable dc bias operating point of 2.5 V. Resistor R13 is the operational amplifier load resistor used to eliminate crossover distortion. The single ended output of the operational amplifier, pin 1, is AC coupled (through capacitor C38) into the load resistor R15 and finally to the transmit transformer T1.

The transmitted audio from the operational amplifier output is coupled through transformer T1 and onto the two-wire T1 line, **TXTIP** and **TXRING**, and finally to the channel bank. Resistor R15 is the effective 600 ohm resistor on the transmitted audio.

The **FSK** modem IC, U1, is configured for 1200 baud operation at tone frequencies of 1200 Hz (mark or logic one) and 2200 Hz (space or logic zero).

FSK CARRIER DETECT AND ALARM GENERATION

The carrier detect circuit of the **FSK** modem IC, U1, comprise an energy detector and a digital delay. The energy detector compares the signal level at the output of the internal (U1) receive filter to an externally set threshold on the **CDL** (pin 10) input. The comparator has a 2.5 dB hysteresis and a delay to allow for momentary signal loss and to prevent oscillation. The output of the detector is available on the **CDT** (pin 3) output where a high level indicates the presence of a carrier.

The carrier detect threshold is adjusted by potentiometer R1 as specified by the maintenance and service procedures. This level is also sent to the connector P4 for monitoring purposes.

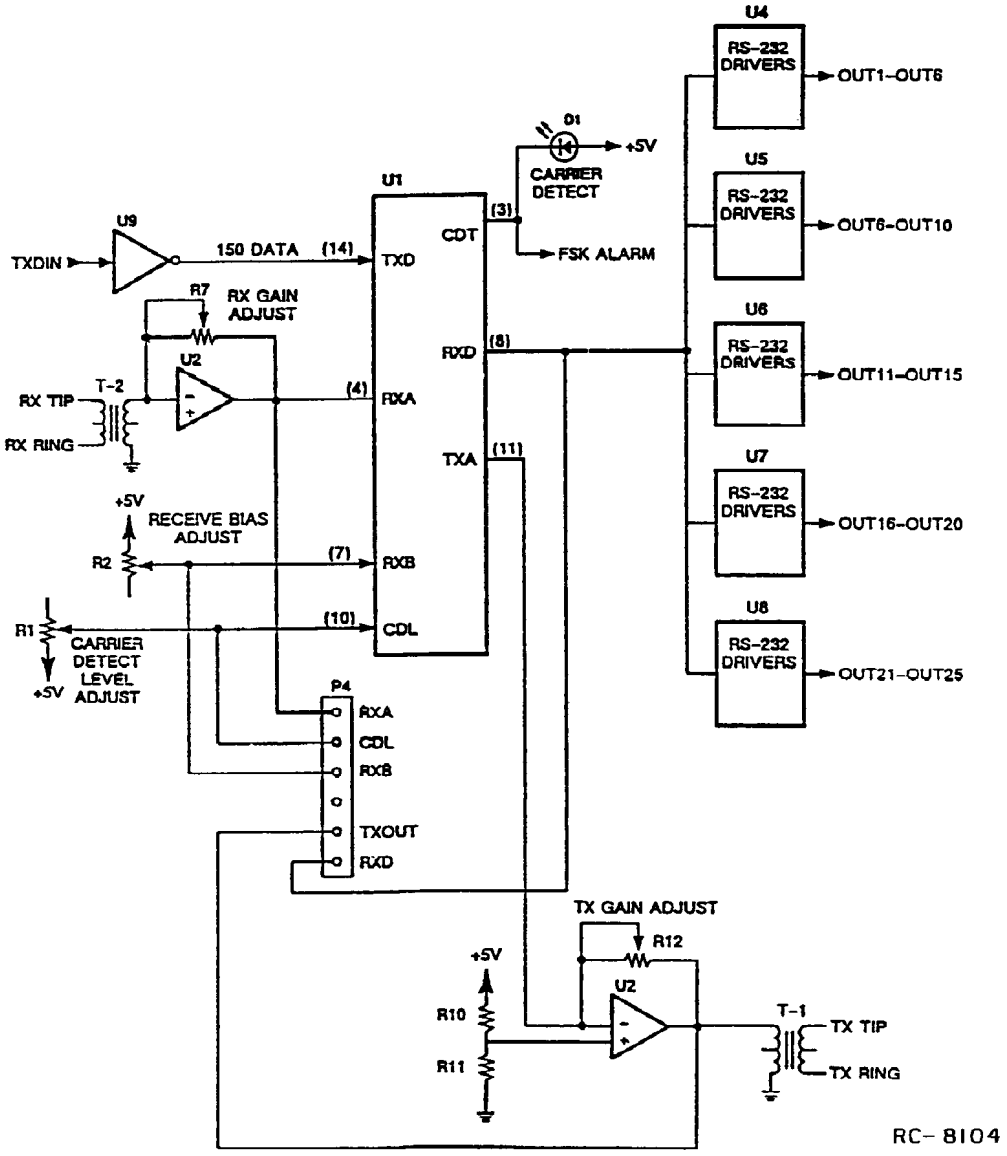


Figure 3 - Block Diagram Of The Transmitter Section

The **CDT** output (pin 3) of the **FSK** modem IC, U1, is double buffered by diver U3 and used to drive the carrier detect indicator/LED, D1. The **CDT** output is also inverted by U3 and sent to the P1 connector as **FSKALARM** to indicate a carrier loss. The **FSK** alarm signal, **ALARM - FSK**, is sent to the Subsystem Alarm Module of the Sync Unit to indicate the loss of carrier.

MAINTENANCE/TEST

The **FSK** Modem Module has jumpers that must be configured for the normal mode of operation. The standard jumper positions are shown as follows:

Jumper	Shorting Plug	Standard Position
J3	P3	Pins 1 and 2
J4	P4	Pins 2 and 2

The following equipment is necessary to maintain the modem module as part of the Simulcast System:

1. Extender Card
2. Tektronix R5223 Digital Storage Scope or equivalent
3. Triplett Model 630-PL Type 5 or equivalent
4. Test Cables as required
5. HP 8116 Pulse/Function Generator or equivalent

The **FSK MODEM** has four potentiometer adjustments that must be made when first placed in actual operation and anytime thereafter during test and service. The adjustments are outlined as follows:

1. **Transmit Gain Adjust**
   - At a transmit site, no adjustment is necessary.
   - At a control site, adjust R12 for the specified level on **TXTIP** and **TXRING** (typically 0 dBm).
2. **Receive Gain Adjust**
   - At a control site, no adjustment is necessary.
   - At a transmit site, adjust R7 for 0.5 Volts rms on **RXA** (P4-3).
3. **Receive Bias Adjust**
   - At a control site, no adjustment is necessary.
   - At a transmit site, adjust R2 for a bit time (high or low level) of 6.67 milliseconds on **150 IN 232 CH1 - 150 IN 232 CH25**.
4. **Carrier Detect Level Adjust**
   - At a control site, no adjustment is necessary.
   - At a transmit site, interrupt the **RXTIP** and **RXRING** audio and inject a -44 dBm, 1200 Hz tone. Adjust R1 until the carrier detect LED just goes out. Remove the interruption on **RXTIP** and **RXRING**.

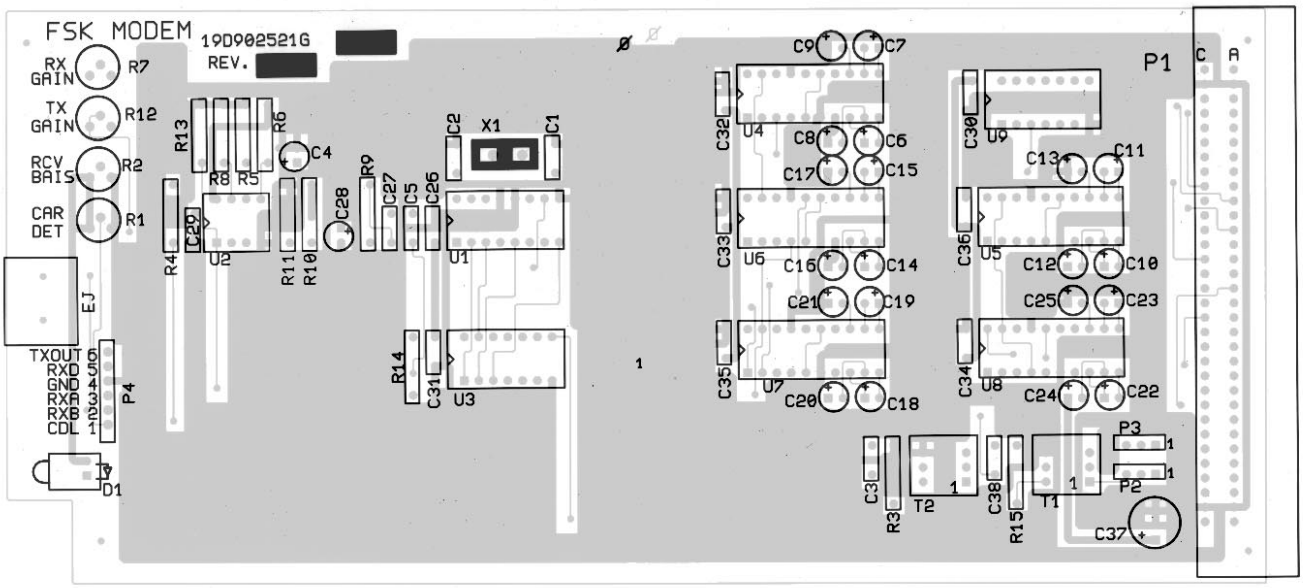
TEST AND SERVICE

The following equipment is necessary to test the **FSK** Modem Module as part of the Simulcast System.

1. Extender Card
2. Tektronix R5223 Digital Storage Scope or equivalent
3. Triplett Model 630-PL Type 5 or equivalent
4. Test Cables as required
5. HP 8116 Pulse/Function Generator or equivalent

The following steps are necessary to test the **FSK MODEM** as part of the Simulcast System.

1. Configure the jumpers for the normal mode of operation.
2. Install the **FSK** Modem Module as part of the operational simulcast system.
3. Verify the presence of +5 Vdc power (5V).
4. Control Site
   - Verify 150 baud data on **TXDIN**.
   - Verify the specified level on **TXTIP** and **TXRING**.
5. Transmit Site
   - Verify the specified level on **RXTIP** and **RXRING**.
   - Verify 0.5 volt rms at **RXA**.
   - Verify a 6.67 millisecond bit time on **RXD** (J4-5).
   - Verify data output on **OUT1** through **OUT25**.



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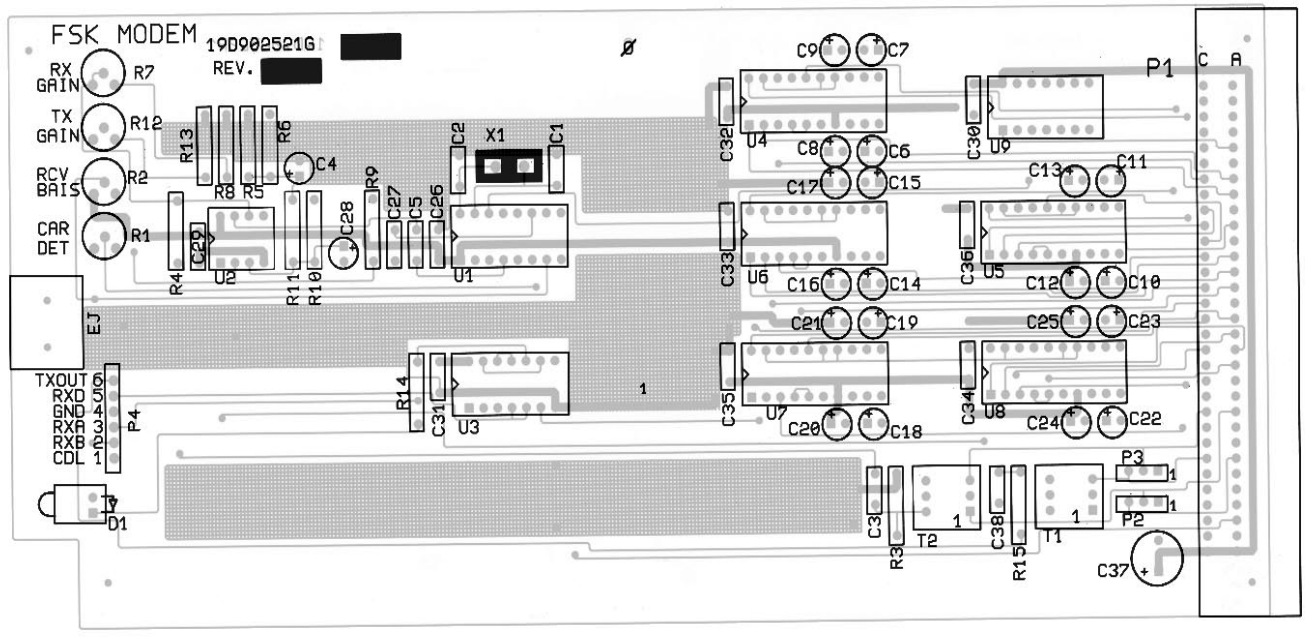
(19D902520P1, Component Side, Rev 0)



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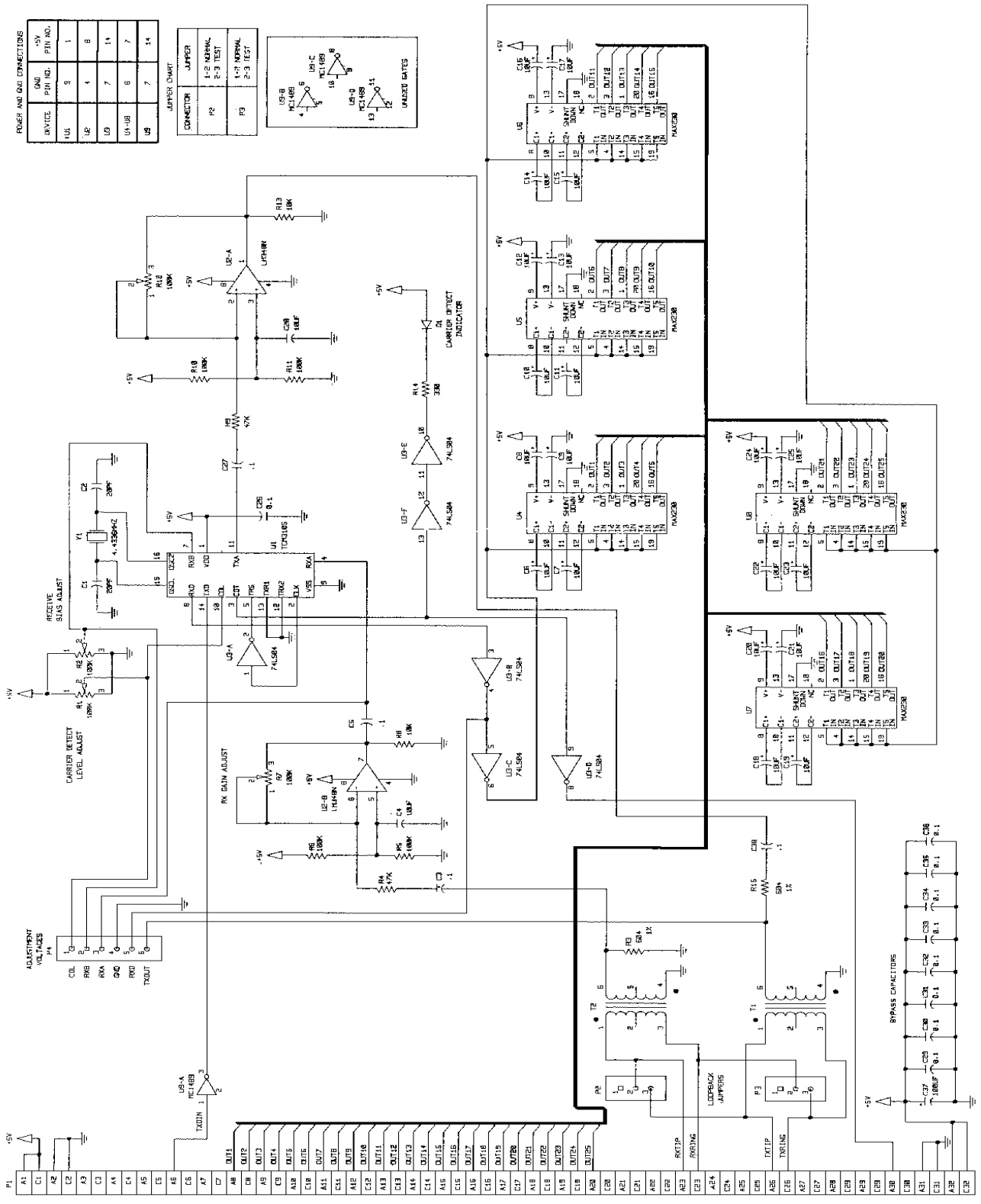
(19D902520P1, Solder Side, Rev 0)



FSK MODEM
19D902521G1

PARTS LIST

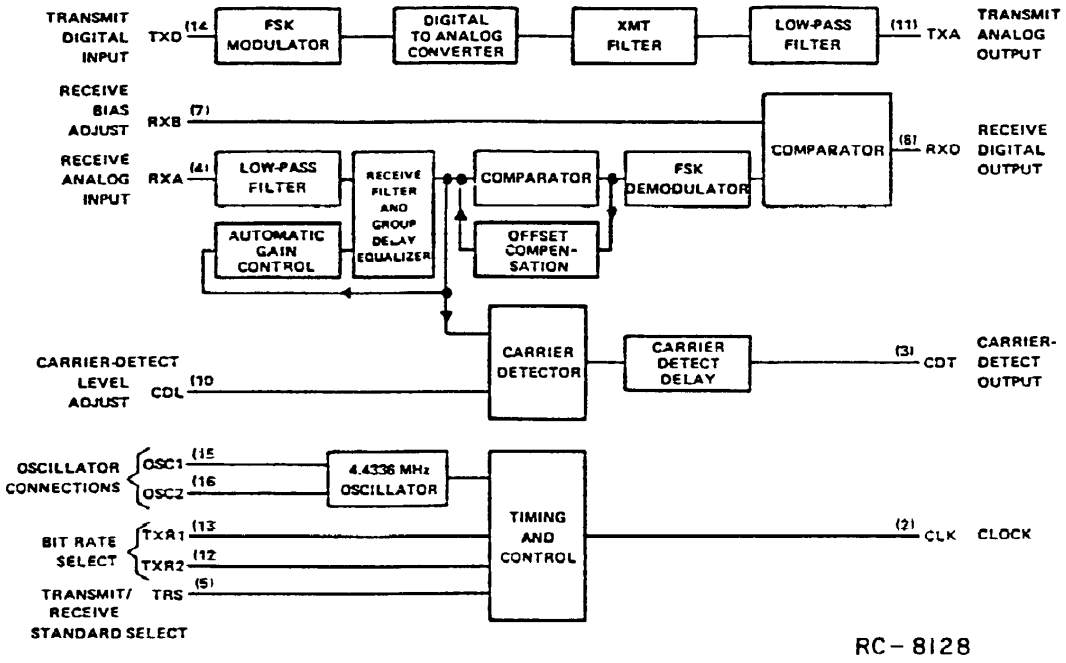
FSK MODEM
19D902521G1
ISSUE 1

SYMBOL	GE PART NO.	DESCRIPTION
		- - - - - - - - - - CAPACITORS - - - - - - - - - -
C1 and C2	19A700235P17	Ceramic: .22 pF ±5%, 100 V.
C3	T644ACP410K	Ceramic: .1 uF ±10%, 50 V.
C4	19A701534P7	Tantalum: 10 uF ±10%, 16 V.
C5	T644ACP410K	Ceramic: .1 uF ±10%, 50 V.
C6 thru C25	19A701534P7	Tantalum: 10 uF ±10%, 16 V.
C26 and C27	T644ACP410K	Ceramic: .1 uF ±10%, 50 V.
C28	19A701534P7	Tantalum: 10 uF ±10%, 16 V.
C29 thru C36	T644ACP410K	Ceramic: .1 uF ±10%, 50 V.
C37		Aluminum: 100 uF ±20%, 100 V; sim to Sprag 500D107M025CC2.
C38	T644ACP410K	Ceramic: .1 uF ±10%, 50 V.
		- - - - - - - - - - DIODES - - - - - - - - - -
D1		Led, red; sim to Dialight 550-2406.
		- - - - - - - - - - PLUGS - - - - - - - - - -
P1		Connector: male, 64 pins, right angle; sim to Panduit 100-964-023.
P2 and P3		Connector: male, 3 pins, head; sim to Molex 22-54-1403.
P4		Connector: male, 6 pins, head; sim to Molex 22-54-1406.
JP2 and JP3		Connector: female, 2 pins jump; sim to Molex 15-29-1024.
		- - - - - - - - - RESISTORS - - - - - - - - - -
R1 and R2		Potentiometer: 100K; sim to Bourn 3296X-104.
R3	19A701250P176	Metal Film: 604 ohms ±1%, 1/4 w.
R4	H212CRP347C	Carbon Film: 47K ohms ±5%, 1/4 w.
R5 and R6	H212CRP410C	Carbon Film: 100K ohms ±5%, 1/4 w.
R7		Potentiometer: 100K; sim to Bourn 3296X-104.
R8	H212CRP310C	Carbon Film: 10K ohms ±5%, 1/4 w.
R9	H212CRP347C	Carbon Film: 47K ohms ±5%, 1/4 w.
R10 and R11	H212CRP410C	Carbon Film: 100K ohms ±5%, 1/4 w.
R12		Potentiometer: 100K; sim to Bourn 3296X-104.
R13	H212CRP310C	Carbon Film: 10K ohms ±5%, 1/4 w.
R14	H212CRP133C	Carbon Film: 330 ohms ±5%, 1/4 w.
R15	19A701250P176	Metal Film: 604 ohms ±1%, 1/4 w.
		- - - - - - - - - TRANSFORMERS - - - - - - - - -
T1 and T2		Transformer, mini, 600 CT; sim to Microtran PM34-M.
		- - - - - - - - - INTEGRATED CIRCUIT - - - - - - - - -
U1		Integrated Circuit; sim to Texas Instruments TCM3105JL.
U2		Linear, Op Amp, 8 pins; sim to Motorola LM358N.
U3		LSTTL, Hex Invert, 14 pins; sim to Texas Instruments SN74LS04N.
U4 thru U8		RS 232 Transmit, 20 pins; sim to Maxim MAX230CPP.
U9		Linear, Receiver, 14 pins; sim to Motorola MC1489APD.
		- - - - - - - - - CRYSTALS - - - - - - - - -
X1		Crystal: 4.4336 MHz, HC18; sim to ESC-4.4336MHz.
		- - - - - - - - - MISCELLANEOUS - - - - - - - - -
		Card handle; sim to VERO 2-0243G.

*COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES

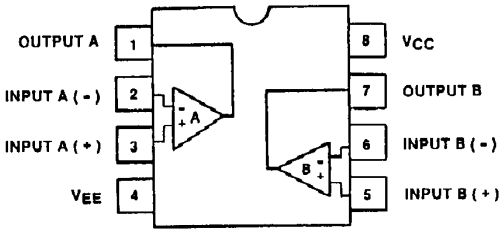
U1

functional block diagram



OPERATIONAL AMPLIFIER

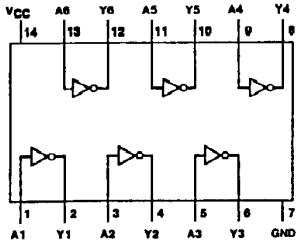
U2



RC-5750

INVERTER

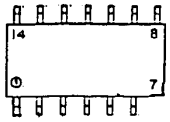
U3

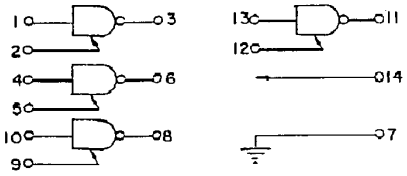


RC-7812

QUAD DTL LINE RECEIVER

U9

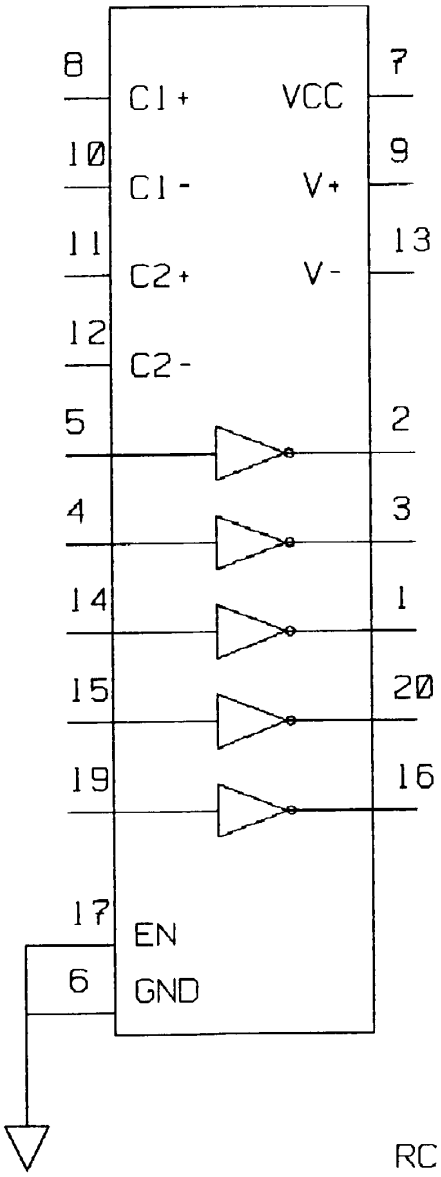




RC-7905

MAX230CCP

U4 - U8



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