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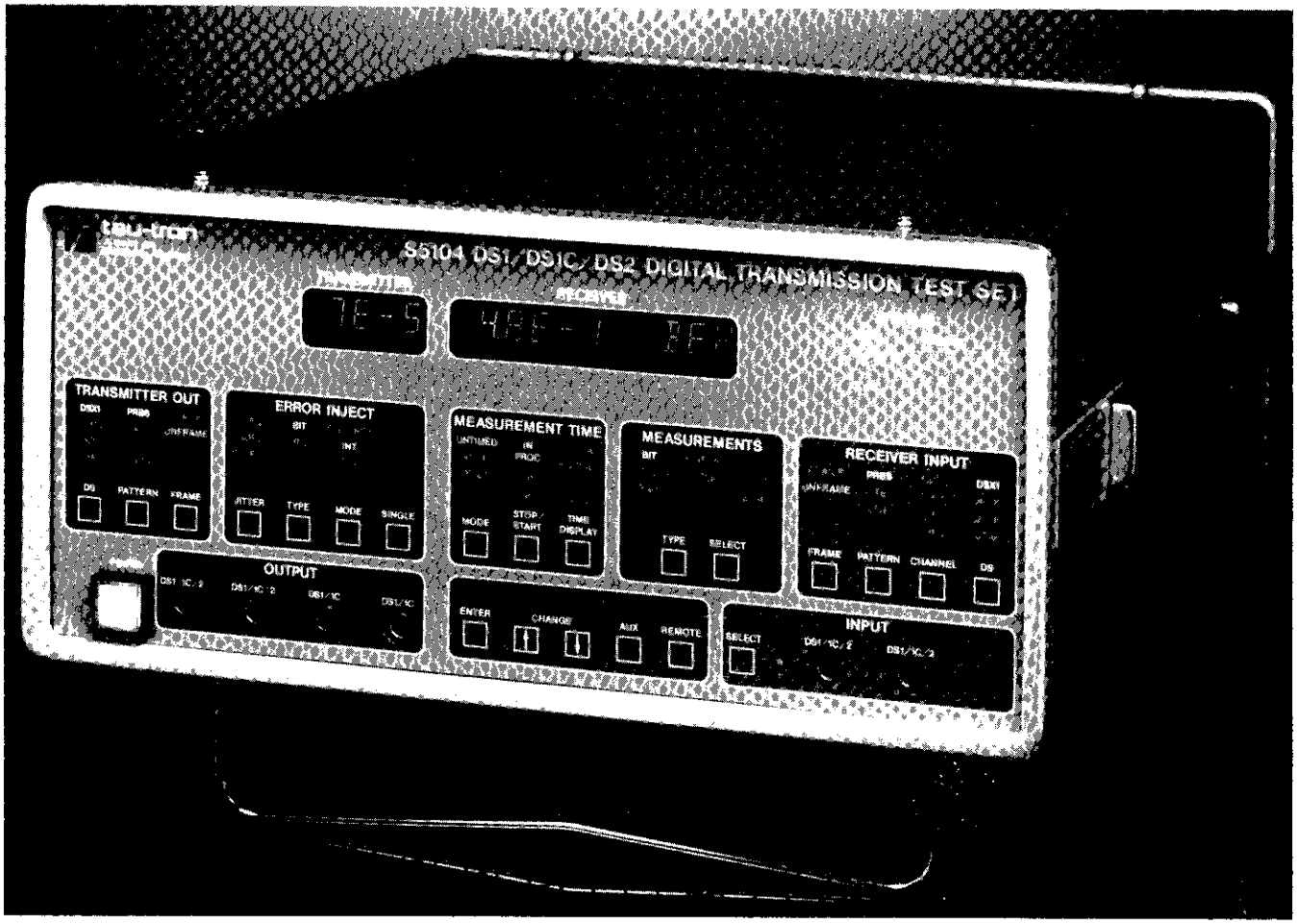

S5104 DS1/DS1C/DS2

DIGITAL TRANSMISSION TEST SET

OPERATION MANUAL

FORM 0309-0884B

Phone (617)692-5100 Telex 750245 1-800-TAU-TRON (Outside MA)

SAFETY INFORMATION

Caution: This instrument is designed to operate from a single phase power source, with one of the current carrying conductors at ground. Operation from power sources where both current carrying conductors are live with respect to ground is not recommended.

Warning: To avoid dangerous electrical shock, do not perform electrical tasks when there are signs of shipping damage to any part of the instrument case.

Warning: Before the instrument is switched on, all protective ground terminals, extension cords, autotransformers and devices connected to it should be connected to a protective grounded socket. Any interruption of the protective grounding will cause a potential shock hazard that could result in personal injury.

WARRANTY

All Tau-tron products are warranted against any defects in material and workmanship. This warranty applies for one year from the date of delivery for all Tau-tron manufactured products. The warranty period for OEM products sold by Tau-tron will depend on the original OEM warranty (consult factory for specific products). We will repair or replace products which, upon our examination, prove to be defective during the warranty period.

NO OTHER WARRANTY, EXPRESSED OR IMPLIED, INCLUDING FITNESS FOR PURPOSE, MERCHANTABILITY, OR OTHERWISE, IS GIVEN.

For any assistance, contact the factory and be prepared to provide instrument model and serial numbers and all details regarding the malfunction.

S5104

DIGITAL TRANSMISSION TEST SET

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SECTION 1

INTRODUCTION

1. INTRODUCTION

A. General

1.01 This manual provides the user with all information required for the installation, operation, and maintenance of the Tau-tron S5104 Digital Transmission Test Set.

B. Scope

1.02 The following information is provided:

- Equipment description.
- Specifications.
- Installation instructions and site requirements.
- Operation instructions.
- Theory of Operation.
- Maintenance.

C. Errors, Omissions, and Recommendations

1.03 Errors or omissions discovered in this manual should be reported immediately. When reporting errors or omissions, please be specific and indicate the section number, title, and page number; also, indicate the paragraph number, figure number or table designation.

1.04 Your recommendations for improving the quality, contents, and usability of this document are requested and solicited. Please address all correspondence to:

Tau-tron Inc.
ATTN: PUBLICATIONS MANAGER
10 Lyberty Way
Westford, MA 01886

SECTION 2

DESCRIPTION

2. DESCRIPTION

A. General

2.01 The Tau-tron S5104 Digital Transmission Test Set is a comprehensive instrument providing complete characterization of digital transmission systems operating at DS1, DS1C and DS2 signal levels. It is ideal for the testing of digital radio, fiber-optic, satellite and T-carrier systems including multiplexers, switches and lines.

2.02 The S5104 incorporates many unique features and abilities which make it a very versatile and cost-effective test set. It can provide framed and unframed pattern generation, and error measurements at all three transmission rates and generate test patterns at one rate while performing measurements at another. The ability of the S5104 to measure framing errors and Bipolar Violations (BPV's) also permits performance measurements of systems carrying live traffic. In addition to Alternate Mark Inversion (AMI) at DS1, the S5104 has the ability to encode/decode B8ZS signals making it ideal for the development and testing of equipment designed for clear channel operation.

2.03 With the Jitter Injection/Measurement Option, the S5104 can inject jitter into all transmitter modes using either its own internal sinusoidal oscillator or an external source. This capability permits peak-to-peak jitter, jitter threshold seconds, maximum jitter and weighted jitter (WJIT) to be measured simultaneously. Simultaneous measurements can also be made of jitter, status event seconds, BPV's and either bit errors or frame bit errors. Furthermore, a "THRU" mode permits jitter, BPV's or bit errors to be added to live traffic or user generated signals for performance testing of protection switches, channel banks, and other equipment under controlled conditions.

B. Features

2.04 The S5104 has the following features:

- Advanced microprocessor controls.
- Transmitter and Receiver combined into one highly portable, stand-alone unit.
- Large, easy-to-read, alphanumeric display.
- Self-prompting keyboard design.
- Choice of framed or unframed patterns at all transmission rates.
- Programmable length (16-24 bits) and content short patterns.
- Programmable bit and bipolar error rates.
- Multiple outputs at all rates: DS1 (four), DS1C (four) and DS2 (two).
- Thru mode provides Automatic Protection Switch (APS) and live traffic test and ability to add controlled perturbations to user supplied signals.
- Optional Jitter Injection/Measurement feature for Mux/Spanline tolerance testing.
- Real-time clock provides time/date display and elapsed time measurements and printer output time/date stamp (has internal battery backup).
- B8ZS encoding and decoding for clear channel test.

- NRZ Data and Clock Input and Output connectors.
- Two optional interfaces available for printer output and/or full remote control: RS-232C or IEEE-488 (GPIB).

C. Functional Control Areas

2.05 Front and rear panel controls, indicators, and connectors are used to operate the S5104. The front and rear panels are illustrated in Fig. 1. The S5104 contains four functional sections: power, transmitter, receiver, and interface.

Power

2.06 The power section is composed of:

- POWER switch/indicator (#12).
- AC input power/fuse block (#15).

Transmitter

2.07 The transmitter section is composed of:

- TRANSMITTER OUT pushbuttons and indicators (#1).
- ERROR INJECT pushbuttons and indicators (#2).
- TRANSMITTER alphanumeric display (#3).
- OUTPUT signal jacks (#4).
- Control pushbuttons (#5).
- TRANSMITTER rear panel control section (#14).

Receiver

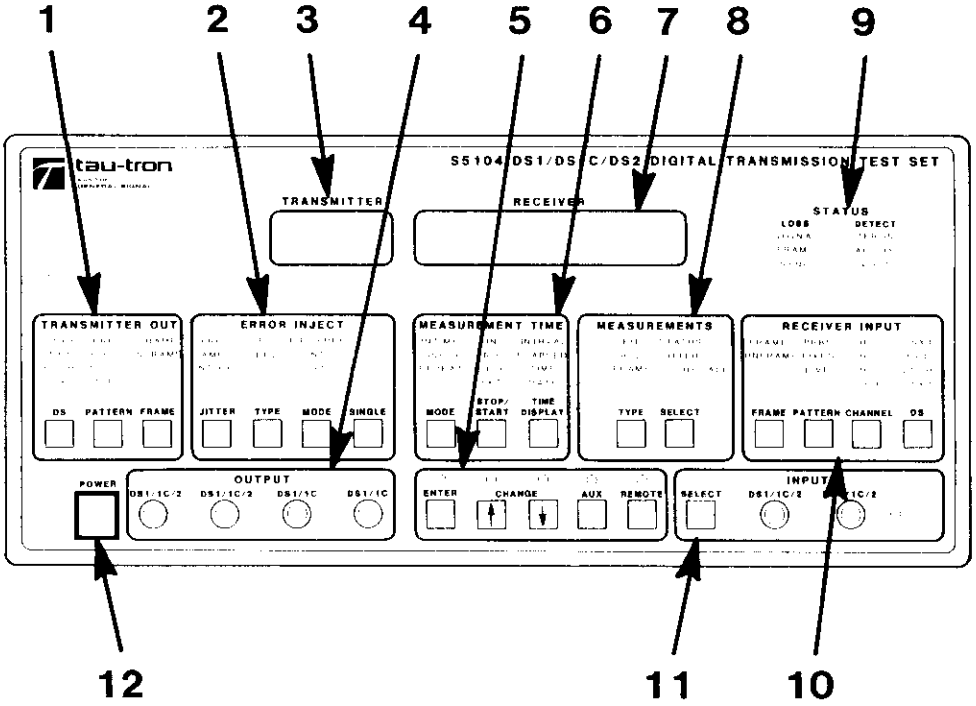
2.08 The receiver section is composed of:

- Control pushbuttons (#5).
- MEASUREMENT TIME pushbuttons and indicators (#6).
- RECEIVER alphanumeric display (#7).
- MEASUREMENTS pushbuttons and indicators (#8).
- STATUS test indicators (#9).
- RECEIVER INPUT pushbuttons and indicators (#10).
- INPUT signal jacks (#11).
- RECEIVER rear panel connectors (#13).

Interfaces

2.09 The interface section is composed of:

- GPIB (IEEE 488) interface connector and ADDRESS DIP switch (#16).
- RS-232C interface connector and configuration DIP switch (#17).



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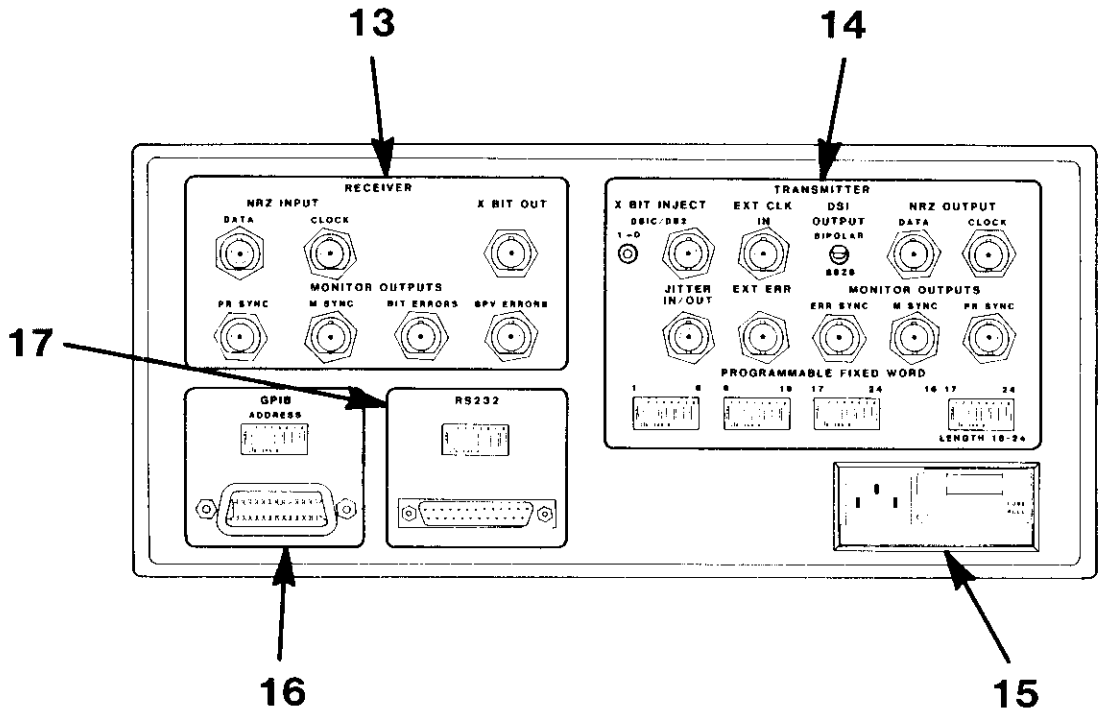
(FRONT PANEL)



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(REAR PANEL)

Fig. 1-S5104 Functional Control Areas

SECTION 3

SPECIFICATIONS

3. SPECIFICATIONS

A. General

3.01 This section describes all the transmitter, receiver, mechanical, and environmental specifications of the S5104 Digital Transmission Test Set. A list of all options and accessories are also included in this section. Specifications are subject to change without notice.

B. Transmitter

3.02 The transmitter specifications are listed and defined in Table A.

TABLE A

S5104 TRANSMITTER SPECIFICATIONS

ITEM	DESCRIPTION
CLOCK (Internal)	
Frequency: DS1 DS1C DS2	 1.544 MHz ±15ppm 3.152 MHz ±15ppm 6.312 MHz ±15ppm
Stability	± 10 ppm at 32° to 122°F (0° to 50°C), ±1 ppm aging rate per month.
CLOCK (External)	
Frequency	1 MHz to 8.5 MHz
Impedance	75 ohms
Level	Amplitude of 2.5 to 5V. Baseline of zero volts.
Interface	Rear panel BNC connector.
Selection	Automatically selected when external frequency is connected to the rear panel BNC connector.
OUTPUT (Bipolar)	
Code: DS1 DS1C DS2	 AMI or B8ZS (selectable) AMI B6ZS

TABLE A (CON'T)

S5104 TRANSMITTER SPECIFICATIONS

ITEM	DESCRIPTION
OUTPUT (Bipolar)	
Level	
DS1	± 3.0V ± 0.3V
DS1C	± 3.0V ± 0.3V
DS2HI	± 2.1V ± 0.25V
DSX2	High output in series with 1,000 ft. (300m) ABAM cable simulator.
Impedance	110 ohms, balanced
Return Loss	>26 dB for frequency range 0.3 to 6.3 MHz
OUTPUT (Binary)	
Data/Clock Level	2.5 V ± .05V, 0V baseline
Impedance	75 ohms
Interface	Rear Panel BNC connector
Phasing	Positive clock center of data. Internally strappable (see Appendix C) to negative clock in center of data.
DATA PATTERNS	
PRBS Framed.	
DS1	2^{23}-1, with 14 zero constraint (before framing), at 1.536 Mb/s rate with 8 KHz DS1 frame information inserted.
DS1C	Two unframed DS1 signals multiplexed into a 3.152 Mb/s DS1C signal with DS1C frame and bit stuff control information.
DS2	Four unframed DS1 signals multiplexed into a 6.312 Mb/s DS2 Signal with DS2 frame and bit stuff control information.
PRBS Unframed:	
DS1	2^{23}-1 PRBS with 14 zero constraint
DS1C	2^{23}-1 PRBS at the DS1C rate.

TABLE A (CON'T)

S5104 TRANSMITTER SPECIFICATIONS

ITEM	DESCRIPTION
DATA PATTERNS	
DS2	2^{20}-1 PRBS at the DS2 rate.
All Ones	Framed or unframed
Fixed Short Pattern	Framed or unframed programmable repeating sequence. Both pattern content and pattern length (16-24 bits) programmable by rear panel DIP switches.
Thru Data	Internal connection of received data to transmitter output with error and/or jitter injection capability provided.
X-Bit	For DS1C or DS2 level signals. Normal logic "1" with rear panel pushbutton for logic "0". Rear panel BNC connector for external control.
FRAMING	
Unframed	No framing bits
Framed:	
DS1	193 bits/frame
DS1C	1272 bits/master frame with 24 control bits
DS2	1176 bits/master frame with 24 control bits.
ERROR MODES	
General	Error modes are valid for all patterns and rates.
Error Free	No errors generated.
Internal Error Inject:	
Bit/BPV	Inject rate $1x10^{-8}$ to $9x10^{-3}$ with mantissa and exponent units selectable. Errors inserted aperiodically.
BPV	BPVs inserted without generating bit errors and without violating the B6ZS code in the DS2 mode or the B8ZS code in the DS1 mode.

TABLE A (CON'T)

S5104 TRANSMITTER SPECIFICATIONS

ITEM	DESCRIPTION
Bit	Bit errors inserted in all bits (framing and information bits).
ERROR MODES	
Single Error Inject:	
Method	Front panel pushbutton.
BPV	Single BPV error without bit errors and without violation of B6ZS or B8ZS codes.
Logic (Bit)	Single bit errors without BPV errors or without violation of 14-zero constraint. Valid in error-free mode. Errors in information (data) bits only.
External:	
Signal	Sinewave = 100 Hz to 2 MHz frequency, 0.5 V pk-pk minimum/2V pk-pk maximum amplitude. Pulse = 0.5V pk-pk minimum/4.0V pk-pk maximum amplitude, 1 error/rising edge of input signal, .25 µS minimum pulse width.
Interface	Rear panel BNC connector.
Impedance	600 ohms, ac coupled.
MONITORS	
General	BNC connectors with a minimum of 2.5 Vdc into 75 ohms driving 10 ft. (3m) of cable.
Error Sync	Pulse synched to error insertion location.
M Sync Out	M frame sync in the DS1C or DS2 framed mode.
PR Sync Out	Pattern start sync. Indicates start of PRBS sequence.
JITTER	
General	Timing jitter added to NRZ clock and data and to bipolar DS1, DS1C, or DS2 output (frequency and amplitude).

TABLE A (CON'T)

S5104 TRANSMITTER SPECIFICATIONS

ITEM	DESCRIPTION
Range	Jitter generation (Fig. 2) from internal or external source meets or exceeds CCITT recommendations O.171.
JITTER	
Internal Jitter:	
Source	Sinusoidal jitter frequency and amplitude settable from front panel.
Jitter Amplitude Resolution	.05 unit intervals peak-to-peak.
Frequency Resolution	5% of mantissa selected
External Jitter:	
Interface	Rear panel BNC connector that accepts 600 ohm (nominal) input impedance.
Calibration	0.5V nominal per unit interval of peak-to-peak jitter with ±3V max. Calibrated for sine wave.
Range	As shown in the curve (Fig. 2). Meets or exceeds CCITT recommendations O.171.

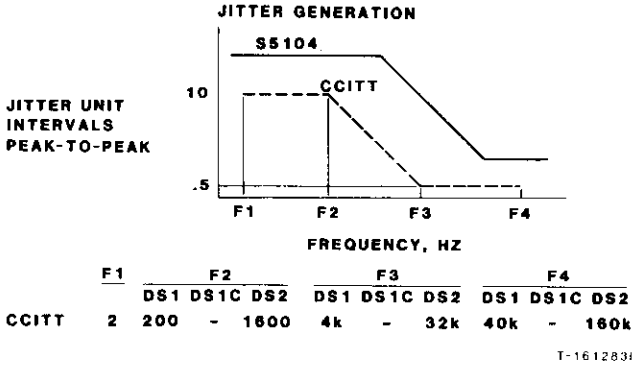


Fig. 2-Jitter Generation

C. Receiver

3.03 The receiver specifications are listed and defined in Table B.

TABLE B

S5104 RECEIVER SPECIFICATIONS

ITEM	DESCRIPTION
INPUT	
Frequency	Clock recovered from input signal
Code	AMI for DS1 and DS1C. B6ZS for DS2. DS1 B8ZS Selectable.
Level:	
DS1	± 3.0V plus up to 750ft. (22m) ABAM cable, + 6dB to -26dB.
DS1C	± 3.0V plus up to 655ft. (195m) ABAM cable, + 6dB to -26dB.
DS2	DSX2 = +2.1V plus up to 1000ft. (300m) ABAM cable, + 6 dB to -43dB. DS2H = ±2.1V, + 6dB to -26dB.
Interface	Two front panel connectors (WECo 310 plug-compatible) which are selectable by a front panel pushbutton or through remote control.
Impedance	110 ohms, balanced.
Noise Immunity	Common mode noise attenuation >60 dB for WECo 310 connectors.
BINARY SIGNAL INPUTS	
Data and Clock	Amplitude = 2.5V to 5.0V, 0V baseline. Positive clock edge in center of data bit, internally strappable to negative clock edge (see Appendix C). Rear panel BNC connectors accept 75-ohm impedance and bypass bipolar decoding and timing recovery. Timing Recovery = Phase lock loop with response tailored to communication test set requirements for DS1, DS1C, and DS2 signals.

TABLE B (CON'T)

S5104 RECEIVER SPECIFICATIONS

ITEM	DESCRIPTION
BINARY SIGNAL INPUTS	
Clock Frequency Range	1 MHz to 8.5 MHz.
DATA PATTERNS	
PRBS:	
Framed	2^{20}-1 sequence with 14 zero constraint. Demuxed to DS1 in DS1C/DS2 mode.
Unframed	2^{20}-1 sequence at data rate.
Programmed	Short patterns (16-24 bit) framed and unframed.
X Bit	X Bit output for DS1C and DS2 levels. Minimum of 2.5 Vdc into 75 ohms driving 10 ft. (3m) of cable.
FRAMING:	
Unframed	No framing bits. Valid for all rates and patterns.
Framed	DS1, DS1C, DS2 frame synchronization. DS1C descrambling and DS1C/DS2 demultiplexing. Proprietary algorithm provides fast acquisition and high error tolerance.
CHANNEL SELECT	
General	In framed PRBS mode, data is demultiplexed into Channels 1 through 4 for DS2 and channels 1 and 2 for DS1C. Only the appropriate channel may be selected.
MONITORS	
General	BNC connectors with a minimum 2.5 Vdc into 75 ohms capable of driving 10 ft. (3m) of cable.
Bit Errors	Bit error output.
BPV Errors	Bipolar violation error output.

TABLE B (CON'T)

S5104 RECEIVER SPECIFICATIONS

ITEM	DESCRIPTION
MONITORS	
M Sync Out	M frame sync for DS1C and DS2 levels in the framed mode.
PR Sync Out	PRBS sync.
DISPLAY	
Alphanumeric	10-character vacuum-flourescent Display which displays all bit, BPV, frame, status, and time measurements.
Status	Present and history status of signal loss, frame loss, data sync loss, excess zeros, all ones, and X bit.
MEASUREMENTS	
General	Simultaneously measures errors, status, and jitter depending on the Receiver input settings.

MEASUREMENT	UNFRAMED	FRAMED	LIVE
Bit Error	X	X	
Frame Error		X	X
BPV	X	X	X
Status	X	X	X
Jitter	X	X	X

Errors:	
Total Errors	Total errors over elapsed time of test.
Average Error Rate	Average error rate over time of test.
Current Error Rate	Current error rate over 10^7 bits. Not measured for frame errors.
Err-Secs	Synchronous error seconds, internally strappable to asynchronous error seconds (see Appendix C).

TABLE B (CON'T)

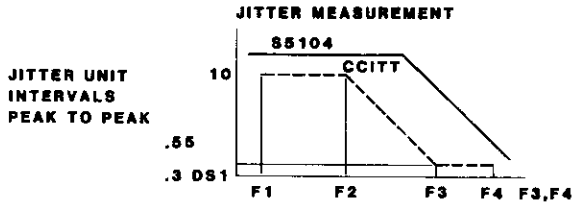
S5104 RECEIVER SPECIFICATIONS

ITEM	DESCRIPTION
Threshold Err-Secs	Synchronous threshold error seconds 10^{-5}, 10^{-4} and 10^{-3} error rate, error second in which error rate exceeds the threshold. Not measured for frame errors.
Dribbling Total	Dribbling total errors, accumulation of all errors where the error rate is $< 10^{-6}$ in an error second. Not measured for frame errors.
Status Event Seconds	Individual accumulation of number of seconds in which the following occurred: signal loss, frame loss, data sync loss, excess zeros, all ones, X bit.
JITTER	
General	Simultaneous measurement of peak-to-peak jitter, jitter threshold seconds, maximum jitter, and weighted jitter (WJIT).
Range	Meets or exceeds CCITT recommendations O.171, as shown in Fig. 3. Input bit rate tolerance for jitter measurement per Fig. 3.
Jitter Peak-to-Peak	On going real-time measurements of peak-to-peak jitter. Shows the maximum in a 1- second window.
Jitter Threshold Seconds	Seconds are counted in which the peak-to-peak jitter exceeds a user defined threshold. Settable on the front panel.
Maximum Jitter	Maximum peak-to-peak jitter during measurement interval.
Weighted Jitter	Peak-to-peak jitter weighted by high pass filter (Fig. 4).
Interface	Rear panel BNC connector. 75-ohm impedance output DC coupled. Provides demodulated jitter output. Selected as output except when in the external jitter mode.
Calibration	0.5V nominal per unit interval of peak-to-peak jitter.

TABLE B (CON'T)

S5104 RECEIVER SPECIFICATIONS

ITEM	DESCRIPTION
TIMED MODES	
Untimed	Continuous accumulation of all measurements and elapsed time.
Single	Accumulation of all measurements for duration of test. Test time programmable from 1 second to 1 second less than 100 days. If a printer is connected to the RS-232C or GPIB interface, all test results are automatically printed at the conclusion of a test.
Repeat	Accumulation of all measurements for programmable interval from 1 second to 1 second less than 100 days. At the end of the interval, test results are reset and the test is started again. Results of last completed test interval are stored for recall. If a printer is connected to the RS-232C or GPIB interface, all test results are automatically printed at the conclusion of a test.



	F1			F2			F3			F4		
	DS1	DS1C	DS2	DS1	DS1C	DS2	DS1	DS1C	DS2	DS1	DS1C	DS2
CCITT	10	-	10	200	-	1600	7k	-	32k	40k	-	160k

INPUT BIT RATE TOLERANCE FOR JITTER MEASUREMENT

RATE	FREQ
DS1	1.544±75 PPM
DS1C	3.152±30 PPM
DS2	6.312±32 PPM

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Fig. 3-Jitter Measurement

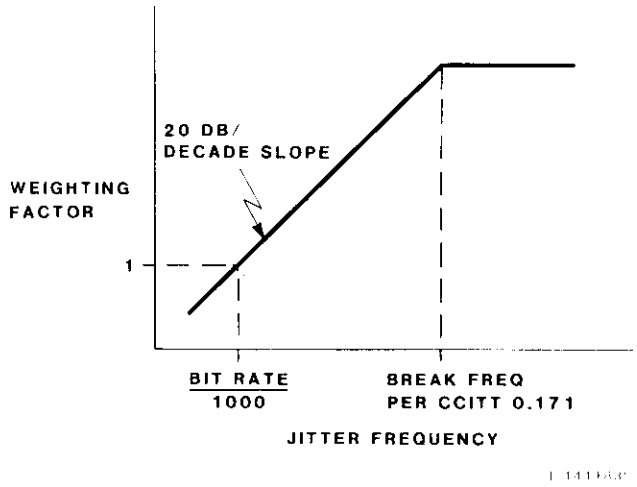

Fig. 4-WJIT Measurement Weighting Factor

D. Mechanical

3.04 The mechanical specifications of the S5104 are:

DIMENSIONS

Height:	6-5/8 in. (16.5cm)
Width:	13-5/8 in. (34.0cm)
Depth:	17-1/16 in. (43.0cm)

WEIGHT 16 lbs. (7.2 kg)

FEATURES Carrying handle on side.
Rubber feet on bottom.

E. Environmental

3.05 The environmental requirements of the S5104 are:

POWER 115 or 230Vac ±10%, 40 to 66 Hz.

TEMPERATURE 32°F to 122°F (0°C to 50°C).

F. Accessories

3.06 The accessories supplied with the S5104 are:

- 6-Ft. (1.7-m) AC power cord.
- Replacement AC power fuse.

G. Options

3.07 The options available for the S5104 are:

- OP-02 IEEE-488 (GPIB) Interface
- OP-03 RS-232C Interface
- OP-05 Jitter Inject/Measurement
- OP-06 Rackmount Kit
- OP-07 40-Column Printer (RS-232C)
- OP-08 5910 Power Converter, -20 to -60 Vdc
- OP-09 Hard Shell Shipping Case, 11 in. (28 cm) high X 18 in. (45 cm) wide X 23.5 in. (59 cm) long.
- OP-10 Soft Shell Carrying Case, 16 in. (40 cm) high X 8.5 in. (21.5 cm) wide X 22 in. (55 cm) long.

SECTION 4

INSTALLATION

4. INSTALLATION

A. General

4.01 Before installing the S5104, specific site requirements must be met and preliminary checks must be made. This section supplies the site requirements and power conditions for the installation of the S5104.

B. Site Requirements

4.02 The basic requirements for the installation and operation of the S5140 are as follows:

AC POWER	115V or 230V±10%, 40 to 66 Hz, 2A (for 115V) or 1A (for 230V).
TEMPERATURE	32°F to 120°F (0°C to 50°C).
HUMIDITY	0 to 95% RH max. at 68°F (20°C), non-condensing.
CLEARANCE	3 in. (7.5 cm) behind, and 1 in. (2.5 cm) above and below.

C. AC Power

Caution: Be sure the line-voltage selector on the rear panel AC input connector is set for the correct voltage (115V or 230V) before connecting to an AC power line. If the incorrect range is selected, the unit could be damaged. Use only a Tau-tron 115-230 VAC conversion PCB. It is also necessary to use a 3-wire ground circuit.

4.03 The line-voltage selector check is as follows:

STEP	PROCEDURE
1	Before the 3-wire, 6-foot power cord is connected to the S5104, check that the correct voltage (115V or 230V) range (voltage designation is face-up) is selected on the power PC card shown in Fig 5.
2	If not set for the correct voltage range, go to step 3.
3	Slide the cover to the left to get access to the fuse and PC card.
4	Slide the FUSE PULL lever to the left and remove the fuse, it should be rated for 2A(115V) or 1A (230V). If not, replace it. Reinsert the fuse.
5	Remove the PC card and reinsert with the correct value. The PC card must be inserted with the desired range face up and the metal contacts toward the fuse housing.
6	Slide the FUSE PULL lever and cover to the right, the normal operating position.

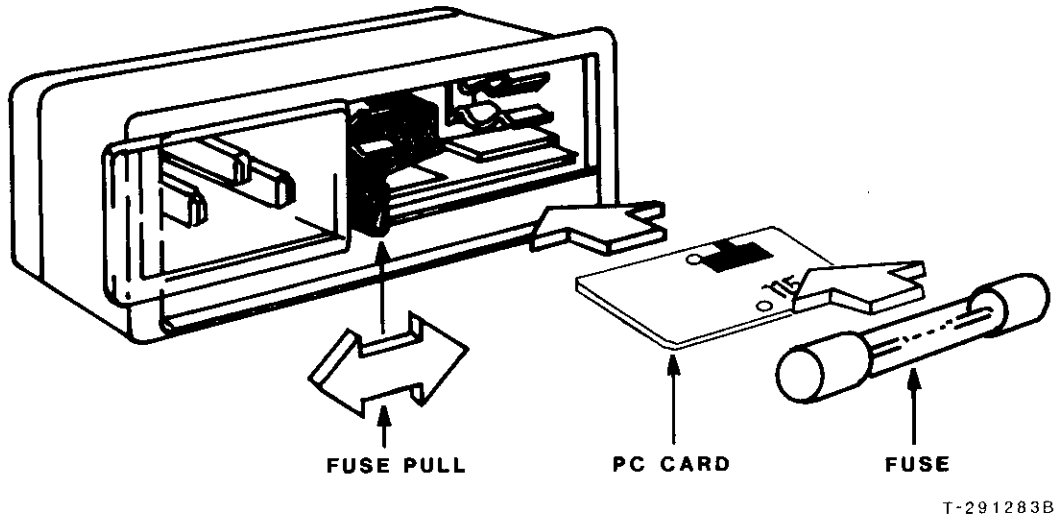

Fig. 5-AC Voltage Check

D. Rackmount Option

4.04 The Rackmount Option is designed to secure the S5104 in a vertical rackmount installation. It will fit the standard 19-inch (48 cm) rack and requires only 8.8 inches (22 cm) in height. The depth behind the front panel is 18.5 inches (47 cm). For cooling, allow 3 inches (7.5 cm) at the rear and 1 inch (2.5 cm) on each side. To install the rackmount in the field, follow the installation procedure below and Fig. 6.

STEP	PROCEDURE
1	Remove the AC power cord from the S5104.
2	Remove the existing two front top and two front bottom screws from the S5104.
3	Slide the rack front panel over the front of the unit and secure with screws removed in step 2.
4	Reconnect AC power cord removed in step 1.
5	Mount the rack mounting bracket to the desired level on the rack, and secure with four rack mounting screws.
6	Install the S5104, with the rack front panel, into the rack mounting bracket, and secure the front with four front panel mounting screws.

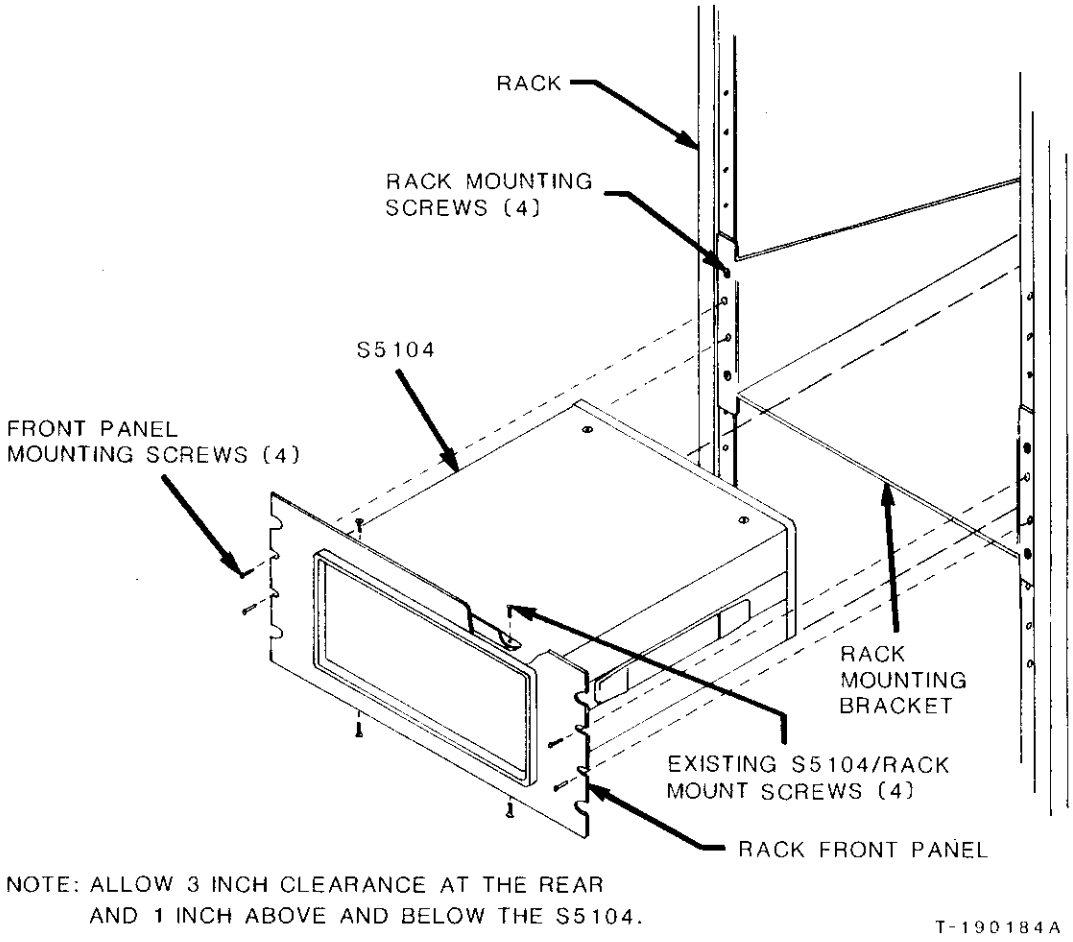

Fig. 6-Rackmount Installation

SECTION 5

OPERATION

5. OPERATION

INDEX OF S5104 CONTROLS AND CONNECTORS

A. General

5.01 This section describes the use of all controls, connectors, and indicators of the S5104 Digital Transmission Test Set. A performance verification procedure, to check that the S5104 is functioning properly, is located at the end of this manual in Appendix B.

B. Front Panel Controls, Indicators, and Displays

5.02 The transmitter section of the S5104 provides the ability to select the desired rate, level, pattern, error rate (logic or BPV), and jitter parameter.

5.03 The receiver section performs bit-by-bit measurements of bit errors and bipolar violations (BPV's) on the incoming data. Simultaneous measurements of total errors, current error-rate, average error-rate, errorseconds, percent error-free seconds, threshold error-seconds and total dribbling errors for either data bit or frame bit errors, and BPV's can be made. Other measurements include status event seconds for signal loss, frame loss, data sync, all ones, excess zeros and X-bit. With the Jitter Inject/Measurement Option, peak-to-peak jitter, threshold seconds,

maximum jitter and weighted jitter can all be measured simultaneously.

5.04 The front panel of the S5104 contains the transmitter and receiver displays and indicators. Pushbuttons are used to select settings and control tests.

5.05 Table C explains the function of all front panel controls, indicators, and displays (Fig. 7) of the S5104.

Note: A flashing indicator is an operator prompt or edit condition.

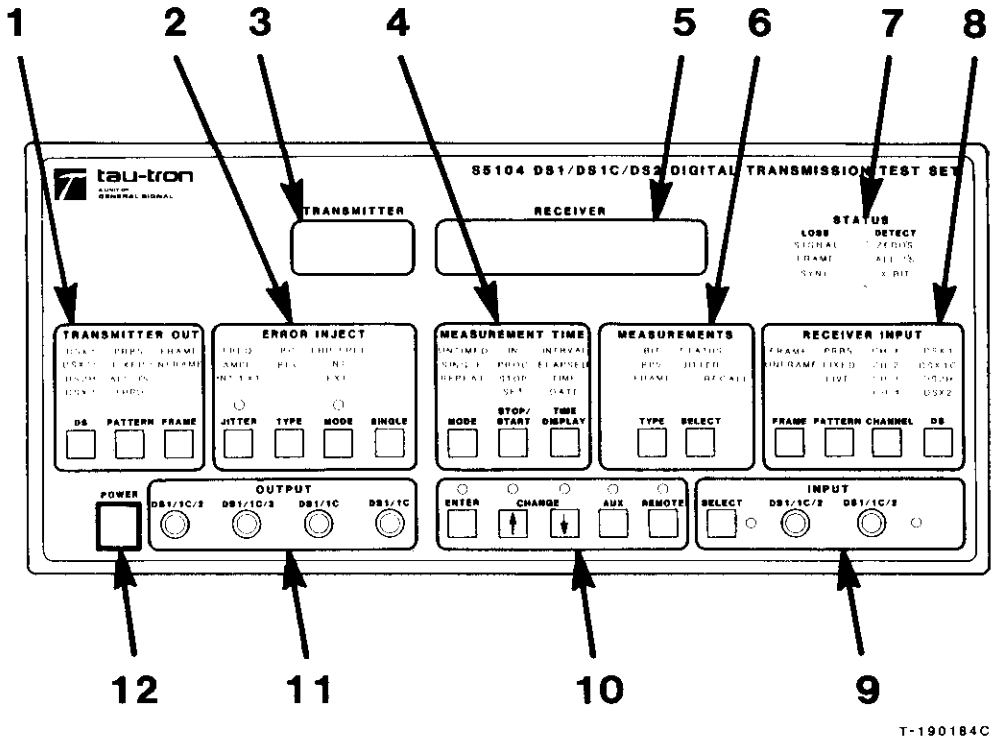

Fig. 7-S5104 Front Panel Controls, Indicators, and Displays

TABLE C

S5104 FRONT PANEL CONTROLS AND INDICATORS

NO.	DESIGNATION	DESCRIPTION
1	TRANSMITTER OUT	This section is used to select the desired signal output properties. It contains the DS, PATTERN, and FRAME selection control pushbuttons and their corresponding selection indicators.
	DS (pushbutton)	Selects one of four DS output signal rates (DSX1, DSX1C, DS2H, and DSX2). Each time the pushbutton is pressed it steps to the next selection lighting that selection's indicator.

TABLE C (CON'T)

S5104 FRONT PANEL CONTROLS AND INDICATORS

NO.	DESIGNATION	DESCRIPTION
1	DSX1 (indicator)	Lights when the DSX1 output signal is selected. The DSX1 signal rate is 1.544 Mb/s.
	DSX1C (indicator)	Lights when the DSX1C output signal is selected. The DSX1C signal rate is 3.152 Mb/s.
	DS2H (indicator)	Lights when the DS2H output signal is selected. The DS2H signal rate is 6.312 Mb/s.
	DSX2 (indicator)	Lights when the DSX2 output signal is selected. The DSX2 signal rate is 6.312 Mb/s.
	PATTERN (pushbutton)	Selects one of four output signal patterns: PRBS, FIXED, ALL 1'S, and THRU. Each time the pushbutton is pressed it steps to the next selection lighting that selection's indicator.
	PRBS (indicator)	Lights when the PRBS (pseudorandom bit sequence) output pattern is selected. The PRBS is generated in a 2^{23}-1 sequence.
	FIXED (indicator)	Lights when the FIXED (programmable short pattern) output pattern is selected. Rear panel DIP switches are used to set the programmable short pattern sequence.
	ALL 1'S (indicator)	Lights when the ALL 1'S (1111) output pattern is selected.
	THRU (indicator)	Lights when the THRU mode is selected. This mode is used for channel bank testing, particularly of Automatic Protection Switching (APS) circuitry. In this mode, incoming live traffic is input to the receiver. The recovered clock and received data are automatically routed internally to the Transmitter where errors and/or jitter may be injected into the signal. The transmitter outputs go to the APS circuitry under test. Transmitter FRAME and DS level settings are slaved to the Receiver FRAME and DS level settings. There-

TABLE C (CON'T)

S5104 FRONT PANEL CONTROLS AND INDICATORS

NO.	DESIGNATION	DESCRIPTION
1		fore, whatever Receiver FRAME and DS levels are selected will also automatically be selected at the Transmitter. The S5104 ignores Transmitter FRAME and DS pushbuttons in this mode.
	FRAME (pushbutton)	Selects either the FRAMED or the UNFRAMED signal mode. Pressing the pushbutton switches the mode, lighting the appropriate indicator.
	FRAME (indicator)	Lights when framing bits are inserted into the output data.
	UNFRAME (indicator)	Lights when an unframed sequence of signals is selected.
2	ERROR INJECT	This section is used to select the desired properties of errors and jitter to be injected into the Transmitter output signal. It contains four pushbuttons (JITTER, TYPE, MODE, and SINGLE) which, along with their corresponding indicators, are used to select and control the desired error properties.
	JITTER (pushbutton)	Selects one of four jitter parameters: FREQ, AMPL, INT, or EXT. If the S5104 does not have the Jitter Option installed, then the JITTER display control indicator will light and the TRANSMITTER Display will show N/A, when the pushbutton is pressed. Further pressing of the pushbutton will be ignored.
	FREQ (indicator)	Lights when jitter frequency is selected for programming or display.
	AMPL (indicator)	Lights when jitter amplitude is selected for programming or display.
	INT (indicator)	Lights when internal jitter is selected.
	EXT (indicator)	Lights when external jitter is selected.

TABLE C (CON'T)

S5104 FRONT PANEL CONTROLS AND INDICATORS

NO.	DESIGNATION	DESCRIPTION
2	JITTER (display control indicator)	Lights when jitter data is being shown on the TRANSMITTER Display.
	TYPE (pushbutton)	Selects either BIT or BPV (bipolar violation) error type for error injection. Pressing the pushbutton switches the error type lighting the appropriate indicator.
	BIT (indicator)	Lights when bit error injection is selected. When a framed signal is transmitted, bit errors are inserted in both data bits and framing bits.
	BPV (indicator)	Lights when BPV error injection is selected.
	MODE (pushbutton)	Selects one of three error modes: ERR FREE, INT, or EXT. The corresponding error mode indicator lights when selected. The MODE pushbutton also controls the 4-segment TRANSMITTER Display. The MODE indicator, when lit, shows that an error MODE rate is displayed on the 4-segment TRANSMITTER Display. If Jitter data is displayed and the MODE pushbutton is pressed, then the Display will switch to the selected error mode. If switched to ERR FREE, the Display will show '----'; for INT or EXT the error rate is displayed. Subsequent pressing of the MODE pushbutton switches the error mode to the next selection, lighting it's indicator. When in the ERR FREE mode, pressing the MODE pushbutton puts the Transmitter in the Rate Set mode causing the INT indicator to flash. The TRANSMITTER Display then shows the current INT (Internal) Rate in the form nE-x with the mantissa (n) flashing. The Transmitter is still sending Error-Free data at this time. The mantissa may be increased (↑) or decreased (↓) with the ↑ or ↓ Control pushbuttons. When the desired mantissa is displayed, press the ENTER pushbutton to set the mantissa and it then stops flashing. At this time the exponent (x) starts flashing. The exponent is modified

TABLE C (CON'T)

S5104 FRONT PANEL CONTROLS AND INDICATORS

NO.	DESIGNATION	DESCRIPTION
2		and set in the same manner as the mantissa. After the ENTER pushbutton is pressed, the exponent stops flashing and the Transmitter goes into the INT (Internal) Rate Inject mode. The INT indicator then stops flashing. Pressing the MODE pushbutton, when the Transmitter is injecting errors at the displayed INT error rate, puts the Transmitter back in the Rate Set mode. The Transmitter continues injecting errors at the previously selected rate until the mantissa and exponent are entered (ENTER) or the MODE pushbutton is pressed again. The Transmitter then goes to the EXT (external) error rate mode. An external error rate can be injected into the transmitted data by selecting the EXT (external) error rate mode. The EXT Rate is measured over 10^7 transmitted bits and displayed in the form n.n-x where n.n is the two-digit mantissa and x is the exponent. Error rates below $1.0x10^{-7}$ are displayed as 0.0-7 and error rates may not exceed $1.0x10^{-2}$.
	ERR FREE (indicator)	Lights when error-free signals are selected.
	INT (indicator)	Lights when internal errors are selected and flashes when internal error rate may be modified.
	EXT (indicator)	Lights when external errors are selected.
	MODE (display control indicator)	Lights when an Error Mode Rate is displayed on the 4-segment TRANSMITTER Display.
	SINGLE (pushbutton)	Injects single BIT or BPV (bipolar violation) errors. The type of error, BIT or BPV, is selected by the TYPE pushbutton. The SINGLE pushbutton injects a single error each time it is pressed. Single errors can only be injected in the ERR FREE mode.

TABLE C (CON'T)

S5104 FRONT PANEL CONTROLS AND INDICATORS

NO.	DESIGNATION	DESCRIPTION
3	TRANSMITTER (4-Character Display)	Alphanumeric display used to program internal bit and BPV error rate, jitter amplitude and frequency, and indicate error rate from external source.
4	MEASUREMENT TIME	This section is used to select, modify, and set Receiver test times. Time intervals can be programmed to set test duration.
	MODE (pushbutton)	Selects one of three time modes (UNTIMED, SINGLE, and REPEAT). Each time the pushbutton is pressed, it steps to the next selection lighting its indicator. However, if a test is in progress, pressing the MODE pushbutton stops the test. At this time, the IN PROC (In Process) indicator extinguishes and the STOP indicator lights. Further pressing the MODE pushbutton steps the selections as before. SINGLE or REPEAT modes will show the currently selected time interval on the 10-segment RECEIVER Display.
	UNTIMED (indicator)	Lights when the UNTIMED time mode is selected. In this mode, measurements and elapsed time accumulate until the test is stopped or reset.
	SINGLE (indicator)	Lights when the SINGLE time mode is selected. In this mode, test measurements accumulate until a programmed time interval elapses (1 second to 1 second less than 100 days) or until the test is stopped or reset. The time interval of the SINGLE mode is set by the TIME DISPLAY pushbutton. The measurements at the end of the time interval are held until another timed measurement is started or selected.
	REPEAT (indicator)	Lights when the REPEAT time mode is selected. In this mode, test measurements accumulate until the programmed REPEAT time interval elapses (1 second to 1 second less than 100 days) or until the test is stopped or reset. The test measurements at the end of each time interval are held while the next

TABLE C (CON'T)

S5104 FRONT PANEL CONTROLS AND INDICATORS

NO.	DESIGNATION	DESCRIPTION
4		REPEAT interval begins. The results of the most recently completed time interval are available for display on the RECEIVER Display by using the AUX pushbutton and the RECALL mode. Displayed measurements are from the IN PROC (in process) timed measurement if the RECALL indicator is not lit.
	STOP/START (pushbutton)	When pressed the STOP/START pushbutton will either stop a test in process or restart a stopped test. A stopped test cannot be continued, only started over, as pressing the pushbutton will reset the test. When a test is stopped by using the STOP/START pushbutton, it is displayed on the RECEIVER Display and the results are stored for recall.
	IN PROC (indicator)	Lights when a test is in process.
	STOP/SET (indicator)	Flashes when a test is stopped.
	TIME DISPLAY (pushbutton)	Selects one of four time categories: programmed test interval (INTRVAL), elapsed time (ELAPSED), time-of-day (TIME), or DATE. Each time the pushbutton is pressed, it steps to the next category lighting its indicator.
	INTRVAL (indicator)	Lights when the INTRVAL time category is selected. This category sets the test time interval for the SINGLE and REPEAT modes. It is displayed, on the RECEIVER Display, in the form DD-HHMM:SS where DD is days (0-99), HH is hours (0-23), MM is minutes (0-59), and SS is seconds (0-59). If the STOP/START pushbutton is stopped, the TIME DISPLAY pushbutton can be pushed once to cause the INTRVAL indicator to flash. The leftmost digit of the Interval Time on the Display will flash indicating that digit is in the edit mode. If a change is desired, the ↑,↓, and ENTER control pushbuttons are used to increase, decrease and ENTER the desired integer. Pressing the ENTER pushbutton

TABLE C (CON'T)

S5104 FRONT PANEL CONTROLS AND INDICATORS

NO.	DESIGNATION	DESCRIPTION
4		saves the flashing digit and causes the next digit to flash. This procedure continues until the rightmost digit (seconds units) is entered, and the Display stops flashing. A new test can be started by pressing the STOP-START pushbutton.
	ELAPSED (indicator)	Lights when the ELAPSED time category is selected. ELAPSED time is the total time accumulated since the start of a test. It is displayed in the form DD-HHMM:SS where DD is days (0-99), HH is hours (0-23), MM is minutes (0-59), and SS is seconds (0-59). ELAPSED time cannot be set.
	TIME (indicator)	Lights when the TIME category is selected. When TIME is selected, the RECEIVER Display shows the time-of-day in the form HHMM:SS when HH is hours (0-23), MM is minutes (0-59), and SS is seconds (0-59). TIME is maintained in a battery-backed CMOS clock which preserves the time-of-day during periods that the S5104 is not powered on. The battery will preserve the time for several months when fully charged. When TIME is displayed on the RECEIVER Display, after testing has stopped, the leftmost digit (hours tens digit) will flash if the TIME DISPLAY pushbutton is pressed. It can be changed at this time by using the ↑, ↓, and ENTER Control pushbuttons to increase, decrease and ENTER the new integer respectively. Pressing the Enter pushbutton saves the digit displayed and causes the next digit to the right to flash, which may be modified in the same manner. This progresses until the last digit that can be set (ones digit of minutes) is entered. Seconds cannot be set and are always set to 00 when a new TIME is entered.
	DATE (indicator)	Lights when the DATE category is selected. When DATE is selected, the RECEIVER Display shows the date in the form DD-MMM-YY where DD is the day of month (1-31), MMM is the three-letter month abbreviation, and YY

TABLE C (CON'T)

S5104 FRONT PANEL CONTROLS AND INDICATORS

NO.	DESIGNATION	DESCRIPTION
4		is the last two digits of the year. DATE, like TIME, is kept in the battery-backed CMOS clock. After testing has stopped and DATE is displayed, the leftmost digit will be flashing. It can be modified with the ↑, ↓, and ENTER Control pushbuttons to increase, decrease, and ENTER the digit respectively. After pressing the ENTER pushbutton the selected digit is saved and the digit to the right flashes and can be modified in the same manner. The months field, MMM, will flash changing to the next months abbreviation when the ↑ and ↓ Control pushbuttons are pressed. The year is changed in a similar manner.
5	RECEIVER (10-Character Display)	Ten-character LED alphanumeric display which displays all Receiver parameters (measurements, time, and error status)
6	MEASUREMENTS	This section is used to select the desired type of measurement to be displayed. It contains two pushbuttons, TYPE and SELECT, which together with their indicators and the RECEIVER Display enable the desired measurement type to be selected.
	TYPE (pushbutton)	Selects one of five measurement types: BIT, BPV, FRAME, STATUS, or JITTER. Each time the type pushbutton is pressed, it steps to the next measurement type, lighting its indicator. All measurements are continually updated when any test is in process (IN PROC indicator is lit), although only one is displayed at a time. However, BIT and FRAME measurements are not simultaneously maintained as they share common hardware and software. When the RECEIVER INPUT PATTERN is set for PRBS or FIXED patterns, FRAME measurements are invalid and if FRAME is selected the RECEIVER Display will show an error message. If the RECEIVER INPUT

TABLE C (CON'T)

S5104 FRONT PANEL CONTROLS AND INDICATORS

NO.	DESIGNATION	DESCRIPTION
6		PATTERN is set for LIVE, then BIT measurements are invalid resulting in an error message on the RECEIVER Display. Selecting JITTER on an S5104 not equipped with the Jitter option, will result in an error message being displayed. If a function other than measurements (i.e. TIME or AUX) is being displayed, then pressing the TYPE pushbutton returns the Display to the most recently selected measurement type. Further pressing the TYPE pushbutton changes measurement type.
	BIT (indicator)	Lights when BIT measurement is selected for display. This is an invalid setting when the RECEIVER INPUT PATTERN is set for LIVE.
	BPV (indicator)	Lights when BPV (bipolar violation) measurement is selected for display.
	FRAME (indicator)	Lights when FRAME measurement is selected for display. This is an Invalid setting when the RECEIVER INPUT PATTERN is set for PRBS or FIXED.
	STATUS (indicator)	Lights when STATUS event seconds measurement is selected for display.
	JITTER (indicator)	Lights when JITTER measurement is selected for display. This is an invalid setting if the jitter option is not installed.
	SELECT (pushbutton)	Selects available measurements of the displayed measurement TYPE. Each time the SELECT pushbutton is pressed, it advances the Display to show the next measurement of the selected measurement TYPE. The following table lists all measurements and their corresponding Display format for each measurement TYPE.

TABLE C (CON'T)

S5104 FRONT PANEL CONTROLS AND INDICATORS

NO.	DESIGNATION	DESCRIPTION	
6	MEASURMENT-TYPE	DISPLAY SELECTION	DISPLAY FORMAT
	BIT, BPV	Total ERRS since test start	nnnnnnnTOT
		Current ERR rate over 10^7 bits	n.nE-x BER
		Average ERR rate since test start	n.nE-xx AVG
		Total ERR secs since test start	nnnnnnESEC
		E-5 threshold secs since test start	nnnnnn E-5
		E-4 threshold secs since test start	nnnnnn E-4
		E-3 threshold secs since test start	nnnnnn E-3
		Dribbling ERRS since test start	nnnnnnnDRB
		% ERR FREE secs since test start	nn.nnnn %EF
	FRAME	Total ERRS since test start	nnnnnnnTOT
		Average ERR rate since test start	n.nE-xx AVG
		Total ERR secs since test start	nnnnnnESEC
		% ERR FREE secs since test start	nn.nnnn %EF
	STATUS	Signal loss secs since test start	nnnnnnSGLS
		Frame loss secs since test start	nnnnnnFRAM
		Data Sync loss secs since test start	nnnnnnSYNC
		Excess zeroes secs since test start	nnnnnnZERO
		All ones detected secs since test start	nnnnnnONES
		X-bit detected secs since test start	nnnnnnXBIT
	JITTER	Current Jitter Amplitude	nn.nn UICUR
		Maximum Jitter Amp Since Test Start	nn.nn UIMAX
		Current Weighted Jitter	nn.nn WJCUR
		Maximum Weighted Jitter	nn.nn WJMAX
		Jitter Threshold (Amplitude)	nn.nn UITHR
		(Weighted)	nn.nn WJTHR
		Jitter Threshold Hit Seconds	nnnnnnHSEC
	RECALL (indicator)	Lights when the Receiver is in the recall mode. The RECEIVER Display shows measurements from the previously completed test.	
7	STATUS LOSS/DETECT	Six STATUS indicators show current (real-time) and historical test status. A continuously lit indicator indicates a current test status. Flashing indicators indicate a history status during the test interval. History status is cleared at the start of a new test interval.	

TABLE C (CON'T)

S5104 FRONT PANEL CONTROLS AND INDICATORS

NO.	DESIGNATION	DESCRIPTION
7	SIGNAL (indicator)	Lights when the DS1, DS1C, or DS2 signal is lost. If no bipolar pulses are detected for 25 ms±10%, the SIGNAL (LOSS) indicator lights continuously, indicating a current signal loss. If bipolar pulses are then detected (signal regained) during the test interval, the SIGNAL indicator will flash, indicating a history of signal loss and that currently a signal is detected.
	FRAME (indicator)	Lights when frame is lost. For the DS1 signal, when three F_T bits out of six are in error, the FRAME (LOSS) indicator lights continuously, indicating current frame loss. When ten consecutive correct F_T bits are then detected (frame regained) the FRAME indicator flashes, indicating a history of frame loss and that framing is currently detected. For DS1C and DS2 signals, when three or more F bits are in error in one Master Frame the FRAME (LOSS) indicator lights continuously indicating current frame loss. If eight consecutive correct F bits with no errors in the next marker word are then detected, the FRAME indicator flashes indicating a history of frame loss and that framing is currently detected. A DS1C Master Frame contains 1272 bits and a DS2 Master Frame contains 1176 bits.
	SYNC (indicator)	Lights when data sync is lost. A signal is considered in sync when 40 consecutive bits feed forward without errors. If 12 bit errors are detected in a 40-bit block, then the SYNC (LOSS) indicator lights continuously, indicating sync loss. If sync is regained, the SYNC indicator will flash, indicating a history of sync loss during the current test time interval.
	ZERO'S (indicator)	Lights when excess zeros are detected. When a certain number of consecutive zeros are detected in the bipolar bit stream, the

TABLE C (CON'T)

S5104 FRONT PANEL CONTROLS AND INDICATORS

NO.	DESIGNATION	DESCRIPTION
7		ZEROS (DETECT) indicator lights continuously indicating excess zeros. The number of consecutive zeros required to turn on the ZERO'S indicator is as follows: • DS1 AMI = 16 or more zeros • DS1 B8ZS = 8 or more zeros • DS1C = 34 or more zeros • DS2 = 6 or more zeros. When zeros have been detected the zero flag will remain on for 100ms±10%.
	ALL 1'S (indicator)	Lights when excess ones are detected. The ALL 1'S monitor checks the Pattern Generator Data. The DS1, DS1C, and DS2 signals, while in the framed mode, have pattern data that is always 1.544 Mb/s. When a certain number of consecutive ones are detected, the ALL 1'S indicator lights. The number of consecutive ones required to light the ALL 1'S indicator is as follows: • DS1 framed/unframed = 1,000 ± 200 ones • DS1C framed = 1,000 ± 200 ones • DS1C unframed = 2,000 ± 400 ones • DS2 framed = 1,000 ± 200 ones • DS2 unframed = 4,000 ± 800 ones
	X BIT (indicator)	Lights when X bits are detected.
8	RECEIVER INPUT	This section is used to select and set the parameters of signals to be input to the Receiver. It contains four pushbuttons (FRAME, PATTERN, CHANNEL, and DS) with corresponding indicators.
	FRAME (pushbutton)	Selects either FRAME or UNFRAME measurements. Each time the FRAME pushbutton is pressed it switches to FRAME or UNFRAME measurement, lighting the appropriate indicator. Only framed measurements may be made on LIVE data. Selecting UNFRAME measurement while the Receiver is set

TABLE C (CON'T)

S5104 FRONT PANEL CONTROLS AND INDICATORS

NO.	DESIGNATION	DESCRIPTION
8		for LIVE PATTERN results in an error message being displayed on the RECEIVER Display. Pressing the pushbutton restarts tests in process.
	FRAME (indicator)	Lights when FRAME input is selected.
	UNFRAME (indicator)	Lights when UNFRAME input is selected. May not be used with LIVE PATTERN input.
	PATTERN (pushbutton)	Selects one of three input patterns: PRBS, FIXED, or LIVE. Each time the PATTERN pushbutton is pressed it steps to the next selection lighting its indicator. Pressing the pushbutton restarts tests in process.
	PRBS (indicator)	Lights when PRBS pattern input is selected. PRBS is a $2^{23}-1$ pseudorandom bit sequence.
	FIXED (indicator)	Lights when FIXED pattern input is selected. The FIXED pattern is programmed by the S5104 rear panel DIP switches in the TRANSMITTER section.
	LIVE (indicator)	Lights when LIVE pattern input is selected. Selecting LIVE turns off all CHANNEL input indicators. The UNFRAME input is invalid when LIVE pattern is selected and an error message will show on the RECEIVER Display.
	CHANNEL (pushbutton)	Selects one of four channels: CH1, CH2, CH3, or CH4. When FRAME measurements are made on PRBS or FIXED test data, the CHANNEL pushbutton may be used to select which DS1 channel to monitor. DS1 input contains only CH1. DS1C input contains only CH1 and CH2. An error message appears on the RECEIVER Display if an invalid channel is selected. If UNFRAME measurements or the LIVE input pattern are selected, no channel indicators will light. CHANNEL selection has no effect on BPV error measurements because BPV measurements are made on all received bits. An in-process test will restart when the CHANNEL pushbutton is pressed.

TABLE C (CON'T)

S5104 FRONT PANEL CONTROLS AND INDICATORS

NO.	DESIGNATION	DESCRIPTION
8	CH1 (indicator)	Lights when channel 1 is selected for DS1, DS1C, or DS2.
	CH2 (indicator)	Lights when channel 2 is selected for DS1C or DS2.
	CH3 (indicator)	Lights when channel 3 is selected for DS2.
	CH4 (indicator)	Lights when channel 4 is selected for DS2.
	DS (pushbutton)	Selects one of four DS level inputs: DSX1, DSX1C, DS2H, and DSX2. Pressing the pushbutton switches the DS selection, lighting that selection's indicator. An in-process test will restart when the DS pushbutton is pressed.
	DSX1 (indicator)	Lights when the DSX1 level input is selected. The DSX1 signal rate is 1.544 Mb/s.
	DSX1C (indicator)	Lights when the DSX1C level input is selected. The DSX1C signal rate is 3.152 Mb/s.
	DS2H (indicator)	Lights when DS2H level input is selected. The DS2H signal rate is 6.312 Mb/s.
	DSX2 (indicator)	Lights when DSX2 level input is selected. The DSX2 signal rate is 6.312 Mb/s.
9	INPUT	This section accepts two standard WECo 310 plugs. A SELECT pushbutton is used to select between one of two Receiver input jacks.
	SELECT (pushbutton)	Selects either the left or right DS1/1C/2 Receiver INPUT jacks. Pressing the pushbutton selects either jack lighting its indicator. An in-process test will restart if the pushbutton is pressed.
	DS1/1C/2 (jacks)	Accept WECo 310 plugs inputting a DS1, DS1C, DS2H, or DSX2 level signal to the Receiver. Only one of these jacks can be used at a time. The jack in use is indicated by an adjacent indicator.

TABLE C (CON'T)

S5104 FRONT PANEL CONTROLS AND INDICATORS

NO.	DESIGNATION	DESCRIPTION
10	CONTROL	This section is used to change and enter time, error inject, jitter, and auxiliary settings and parameters. Also, the REMOTE pushbutton can select remote control of the S5104.
	ENTER (pushbutton)	Enters the selected or modified function setting that is currently selected and displayed.
	ENTER (indicator)	Flashes when the ENTER pushbutton is active and may be used.
	CHANGE ↑ (pushbutton)	Increases the value of Transmitter or Receiver data displayed and ready for change, when pressed.
	↑ (indicator)	Flashes when the ↑ pushbutton is active and can be used.
	CHANGE ↓ (pushbutton)	Decreases the value of Transmitter or Receiver data displayed and ready for change, when pressed.
	↓ (indicator)	Flashes when the ↓ indicator is active and can be used.
	AUX (pushbutton)	Selects one of three auxiliary categories: PRINTER, SNAPSHOT, or RECALL. These selections appear on the RECEIVER Display. Pressing the AUX pushbutton causes the AUX indicator to flash showing that AUX functions are active. At the same time, the RECEIVER Display flashes PRINTER? SNAPSHOT?, or RECALL? prompting the operater to select a category. Continued pressing of the AUX pushbutton switches the Display categories. Each will appear flashing on the RECEIVER Display prompting the operater to choose the category, if desired. To select a category, press the ENTER pushbutton. Once selected, the ↑, ↓ and ENTER pushbuttons are used to select and modify functions in the category selected.

TABLE C (CON'T)

S5104 FRONT PANEL CONTROLS AND INDICATORS

NO.	DESIGNATION	DESCRIPTION
10	PRINTER? (flashing display)	When PRINTER? is flashing on the RECEIVER Display and the ENTER pushbutton is pressed, the Display will change to show PRINT AAA, where AAA is flashing the current printer status (OFF, BIT, or BPV). Summary printouts can be made when BIT or BPV is shown. The ↑ or ↓ pushbuttons are the printer in the selected mode. If the used to select printer mode (OFF, BIT or BPV). Pressing the ENTER pushbutton puts PRINT BIT or PRINT BPV mode is entered, the Display will show the error-second printout status. Entering PRINTER OFF returns the Display to the last selected measurement category. The error-second printout status is shown on the RECEIVER Display in the form ERRSEC AAA where AAA is flashing either ON or OFF. The ↑ or ↓ pushbuttons select either ERRSEC ON or OFF. Error-second printouts can be made in the ERRSEC ON mode. Pressing the ENTER pushbutton to enter ERRSEC ON will display the error-second squelch status on the RECEIVER Display. Entering ERRSEC OFF returns the Display to the last selected measurement category. When error-second squelch status is shown on the RECEIVER Display, it will be shown either in the form SQUELCH OFF, with OFF flashing, or SQU ON AAA, with AAA flashing. AAA represents the current selected squelch condition. The values of AAA are as follows: AAA — MEANING ANY — Squelch on 10 consecutive error secs of ANY type error. E-5 — Squelch on 10 consecutive error secs of 10^{-5} or higher error rate.

TABLE C (CON'T)

S5104 FRONT PANEL CONTROLS AND INDICATORS

NO.	DESIGNATION	DESCRIPTION
10		E-4 Squelch on 10 consecutive error secs of 10^{-4} or higher error rate. E-3 Squelch on 10 consecutive error secs of 10^{-3} or higher error rate. The ↑ or ↓ pushbuttons are used to show the squelch conditions available for selection. Pressing the ENTER pushbutton selects the displayed squelch condition and returns the Display to show the most recently selected measurement category.
	SNAPSHOT? (flashing display)	When SNAPSHOT? is flashing on the RECEIVER Display and the ENTER pushbutton is pressed, measurements are saved for display or immediate summary printout. An Immediate Summary will be printed for BIT and BPV error measurements only if printer output is currently enabled. Selecting SNAPSHOT? saves all current BIT, BPV, STATUS, and JITTER measurements. They may be displayed by using the AUX RECALL function.
	RECALL? (flashing display)	If RECALL? is flashing on the RECEIVER Display and the ENTER pushbutton is pressed, the Display will change to show RECALL AAA where AAA is either flashing ON or OFF. RECALL ON indicates that summary measurements are displayed and RECALL OFF indicates current measurements are displayed. The flashing ON or OFF status can be changed or selected using the ↑, ↓ or ENTER pushbuttons. Only the most recent summary is available for RECALL.
	REMOTE (pushbutton)	Pressing the REMOTE pushbutton disconnects the S5104 from GPIB remote control if the GPIB LLO (Local Lockout) command is not active.

TABLE C (CON'T)

S5104 FRONT PANEL CONTROLS AND INDICATORS

NO.	DESIGNATION	DESCRIPTION
10	REMOTE (indicator)	Lights when the S5104 has been placed under remote control via GPIB or RS-232C.
11	OUTPUT	Four Transmit OUTPUT signal jacks that accept WECo 310 plugs. They may be used simultaneously.
	DS1/1C/2 (jacks)	These jacks can output all DS signal levels output by the S5104.
	DS1/1C (jacks)	These jacks can only output DS1 or DS1C Signals.
12	POWER (switch/indicator)	Main AC power switch. When pressed in, power is ON and the indicator lights.

C. Rear Panel Controls and Connectors

5.06 The rear panel contains transmitter, receiver, and interface controls and connectors. All rear panel controls and indicators are illustrated in Fig. 8 and explained in Table D.

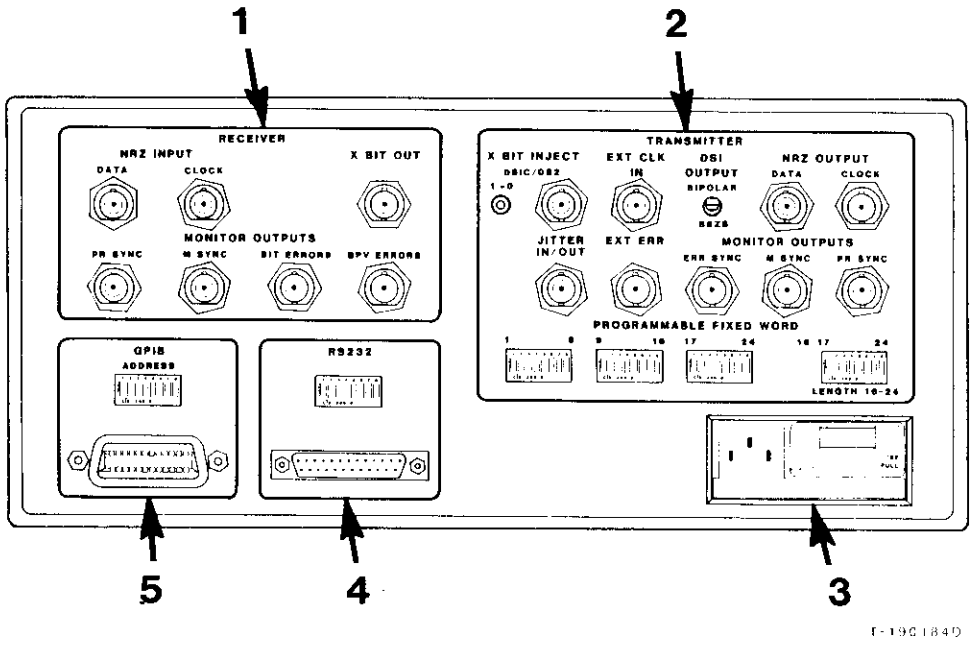

Fig. 8-S5104 Rear Panel Controls and Connectors

TABLE D

S5104 REAR PANEL CONTROLS AND INDICATORS

NO.	DESIGNATION	DESCRIPTION
1	RECEIVER	This section contains seven BNC connector jacks for Receiver Input/Output connections.
	NRZ INPUT	Non-return to zero (binary signal) DATA and CLOCK inputs.
	DATA (connector)	BNC connector that accepts TTL (logic 0 = .2 to .4V, logic 1 = 2.4 to 5V) compatible data input signals. Bypasses bipolar decoding and timing recovery. Accepts 75-ohm impedance. The pulse width is one-half the clock period.
	CLOCK (connector)	BNC connector that accepts TTL (logic 0 = .2 to .4V, logic 1 = 2.4 to 5V) compatible clock input signals. The positive clock edge in center of data bit is internally strappable to change 180° (see Appendix C). Bypasses bipolar decoding and timing recovery. Range is 1 to 8.2 Mhz. Accepts 75-ohm impedance. The pulse width is one-half the clock period.
	X BIT OUT (connector)	BNC connector that sends TTL compatible signals. Capable of driving 75 ohms and 10 ft. of cable. X-bit output occurs if X-bit = 0, DS1C/2.
	MONITOR OUTPUTS	Four TTL compatible BNC connectors.
	PR SYNC (connector)	TTL-compatible. BNC connector capable of driving 75 ohms and 10 ft. of cable. Pulse width is one-half the clock period. Occurs once per 2^{20}-1 pseudorandom sequence.
	M SYNC (connector)	TTL-compatible. BNC connector capable of driving 75 ohms and 10 ft. of cable. Occurs once per Master Frame in DS1C/2 mode.
	BIT ERRORS (connector)	TTL-compatible. BNC connector capable of driving 75 ohms and 10 ft. of cable. Bit error output. Pulse width is one-half the clock period.
	BPV ERRORS (connector)	TTL-compatible. BNC connector capable of driving 75 ohms and 10 ft. of cable. Bipolar violation error output. Pulse with is one-half the clock period.

TABLE D (CON'T)

S5104 REAR PANEL CONTROLS AND INDICATORS

NO.	DESIGNATION	DESCRIPTION
2	TRANSMITTER	This section contains BNC connectors and switches used for Transmitter Input/Output connections.
	X BIT INJECT DS1C/DS2 (connector)	TTL-compatible. BNC connector capable of driving 75 ohms and 10 ft. of cable. Injects X bits into DS1C or DS2 level signals. X bit is normally logic 1.
	X BIT INJECT DS1C/DS2 (pushbutton)	This pushbutton changes an X bit logic 1 to a logic 0 each time it is pressed.
	EXT CLK IN (connector)	TTL-compatible. BNC connector with 75 ohm input impedance. Accepts a range of 1 to 8.2 MHz.
	DS1 OUTPUT (toggle switch)	Selects either BIPOLAR or B8ZS coding for the DS1 level signal. BIPOLAR is an Alternate Mark Inversion (AMI) bipolar coding while B8ZS is a Bipolar 8 Zero Substitution coding.
	NRZ OUTPUT	Non-return to zero (binary signal) DATA and CLOCK outputs.
	DATA (connector)	TTL level (logic 0 = .2 to .4V, logic 1 = 2.4 to 5V) compatible. BNC connector capable of driving 75 ohms and 10 ft. of cable. The positive clock edge in center of data bit is internally strappable to change 180° (see Appendix C). The pulse width is one-half the clock period.
	CLOCK (connector)	TTL-level (logic 0 = .2 to .4V, logic 1 = 2.4 to 5V) compatible. BNC connector capable of driving 75 ohms and 10 ft. of cable. The positive clock edge in the center of the data bit is internally strappable to change 180° (see Appensix C). The pulse width is one-half the clock period.
	JITTER IN/OUT (connector)	BNC connector capable of driving 75 ohms and accepts 600-ohm nominal input. Used for both input and output of Jitter. In the external mode, applying external modulating input adds Timing Jitter to Transmitter

TABLE D (CON'T)

S5104 REAR PANEL CONTROLS AND INDICATORS

NO.	DESIGNATION	DESCRIPTION
2		CLOCK/DATA and bipolar DS1, DS1C, and DS2 signals. Provides demodulated Receiver Jitter output in all modes except for external jitter generation. Jitter output amplitude is 11 bits peak-to-peak max. Frequency range is 5 Hz to 300 KHz.
	EXT ERR (connector)	BNC connector accepts either bit errors or BPV errors. The error type, bit or BPV, is selected by the front panel ERROR INJECT TYPE pushbutton. The ERROR INJECT MODE pushbutton, on the front panel, is used to select for external (EXT indicator) error injection. Accepts an AC coupled 600 ohm nominal input. Level is 1V-5V peak-to-peak. Acceptable error rates are 10^{-2} to 10^{-8}.
	MONITOR OUTPUTS	Three TTL-compatible BNC connectors.
	ERR SYNC (connector)	TTL-compatible. BNC connector capable of driving 75 ohms and 10 ft. of cable. Pulse synced to error insertion location. Pulse width is one-half the clock period.
	M SYNC (connector)	TTL-compatible. BNC connector capable of driving 75 ohms and 10 ft. of cable. Occurs once per Master Frame in DS1C/DS2 level mode.
	PR SYNC (connector)	TTL-compatible BNC connector capable of driving 75 ohms and 10 ft. of cable. Pulse width is one-half the clock period. Occurs once per 2^{20}-1 sequence.
	PROGRAMMABLE FIXED WORD (DIP Switches)	These DIP switches are used to set the word (bit) pattern for use when the S5104 is set for FIXED pattern transmission or reception. This series of bits is referred to as a word. A bit is either a one or a zero and is determined by that bit's DIP switch setting (ON=1, off =0). A word must consist of a minimum of 16 bits. Therefore, the S5104 will always read the first 16 bits (DIP switches 1-8 and 9-16) of a word automatically. Words with lengths greater than 16 bits (up to 24 bits) can be created by using the 17-24 DIP

TABLE D (CON'T)

S5104 REAR PANEL CONTROLS AND INDICATORS

NO.	DESIGNATION	DESCRIPTION
2		switches in conjunction with the LENGTH 16-24 DIP switches. To accomplish this, first set the desired bit-word length by switching ON the DIP switch (on the LENGTH 16-24 DIP switches) that corresponds to the desired number of bits (i.e. switching ON the first switch, sets the bit-word length to 17 bits, switching ON the second switch (2) sets the bit-word length to 18 bits, etc.). Set ON only one switch, if no switches are set ON the S5104 will only read 16 bits. Once the length of the bit-word has been determined, the 17-24 DIP switches are used to set the bits (ON = 1, off = 0), as was done for first 16 bits. Figure 9 shows DIP switch setting examples.
3	AC Power/Fuse Block	AC power connector accepts a 3-wire cord delivering 115 or 230 Vac (depending on the S5104 configuration) and contains a fuse housing with a 2A (115V) or 1A (230V) fuse. Also, contained in this block is a PC card that must be set for the correct voltage rating (see Section 4C).
4	RS-232 (interface) (If equipped)	RS-232C interface used for interfacing with peripheral equipment, data recording, and remote control. Section 5F describes the RS-232C interface in detail.
	DIP Switch	Used to configure baud rate, bits per character, parity, and number of stop bits for the RS-232C interface. Read only on Power Up.
	Connector	A DB-25 female RS-232C 25-pin interface connector.
5	GPIB (interface) (If equipped)	IEEE-488 (GPIB) interface used for remote control and data recording. It communicates as a talker/listener. Section 5G describes the GPIB in detail.

TABLE D (CON'T)

S5104 REAR PANEL CONTROLS AND INDICATORS

NO.	DESIGNATION	DESCRIPTION
5	ADDRESS (DIP switch)	Used to configure the GPIB talk/listen address and option selection. Read only on Power Up.
	Connector	A female 24-pin GPIB interface whose dimensions and pinouts correspond to IEEE specifications.

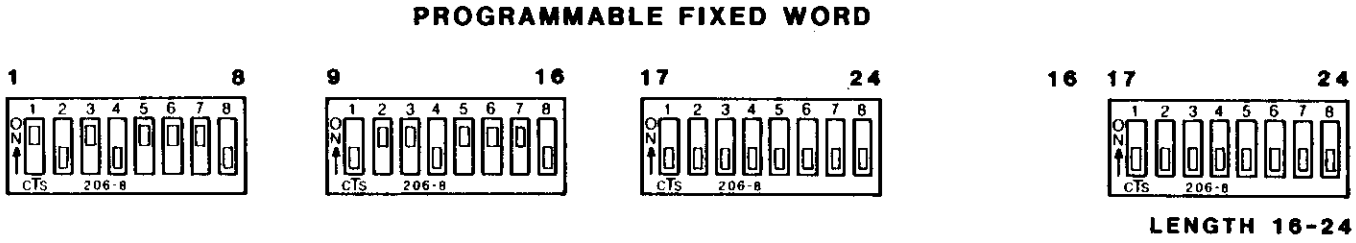

Fig. 9-Programmable Fixed Word Setting Examples

D. Printer Outputs

5.07 The S5104 is provided with user selectable automatic Printer Outputs. When selected, these outputs are routed simultaneously to both GPIB (IEEE-488) and RS-232C Interfaces (if so equipped). The RS-232C is only opperative when the AUX pushbutton is activated. Printouts are limited to 40 characters per line.

End-of-Interval Summary

5.08 All Bit (or Frame) and BPV Measurements are summarized when a Single or Repeat Interval has elapsed. If previously selected, either a Bit (Frame) or BPV End-of-Interval summary is formatted and automatically output to the Printer interfaces. (see Figs. 10 and 11). The summary printout (activated by the AUX pushbutton)

contains the following information:

- Time-of-Day and Date
- Indication of Summary Type (END-OF-INTERVAL, IMMEDIATE, or POWER LOSS)
- Indication of Error Type (BIT, FRAME, or BPV)
- Elapsed Test Time
- Receiver Input Setup
  - Framed or Unframed
  - Pattern
  - Channel
  - DS (Data Rate and Level)
  - DS1/1C/2 (A/B) Input
- Total Errors of Selected Error Type
- Total Error Seconds
- Average Error Rate
- % Error Free Seconds
- Total Dribbling Errors (BIT and BPV Only)
- Dribbling Error Rate (BIT and BPV Only)
- Threshold Error Seconds for 10^{-5}, 10^{-4}, 10^{-3} (BIT and BPV Only)
- Status Seconds for Signal Loss, Frame Loss, Sync Loss, Excess Zeroes, X-Bit, and All One's
- Jitter Measurements (if Jitter Option installed).

Immediate Summary

5.09 If summary printouts are selected by the user and the SNAPSHOT function is selected, an Immediate Summary will output to the Printer interfaces (see Fig. 12). The format of the Immediate Summary is similar to End-of-Interval summaries.

```
1230 0935:11 END OF INTERVAL BIT SUMMARY
Elapsed Time=00-0001:00    (      60 Secs)
FRAME, PRBS meas on CH1 of DSX1C input A

Bit Errs=401186          AvgErrRate =5.2E-03
Err Secs=7               %ErrFreeSec=88.3333
DribErrs=2               DribErrRate=2.2E-08
THRESHOLD ERROR SECOND SUMMARY:
  E-5=2          E-4=2          E-3=2
STATUS SECOND SUMMARY:
SigLs=2          Frame=4          Sync=4
Zeros=2          X-Bit=4          Ones=2
```

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Fig. 10-End-of-Interval BPV Summary

```
1230 0937:37 BPV=4
1230 0937:46 BPV=1
1230 0938:00 BPV=1
1230 0938:16 BPV=4
1230 0938:29 BPV=1



1230 0938:38 END OF INTERVAL BPV SUMMARY
Elapsed Time=00-0001:00    (      60 Secs)
FRAME, PRBS meas on CH1 of DSX1   input A

BPV Errs=11              AvgErrRate =1.2E-07
Err Secs=5               %ErrFreeSec=91.6667
DribErrs=3               DribErrRate=3.2E-08
THRESHOLD ERROR SECOND SUMMARY:
  E-5=0          E-4=0          E-3=0
STATUS SECOND SUMMARY:
SigLs=0          Frame=0          Sync=0
Zeros=0          X-Bit=0          Ones=0
```

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Fig. 11-End-of-Interval Bit Summary

```
1230 0942:12        IMMEDIATE BIT SUMMARY
Elapsed Time=00-0001:37    (      97 Secs)
FRAME,FIXED meas on CH2 of DS2X   input A

Bit Errs=20249           AvgErrRate =1.3E-04
Err Secs=21              %ErrFreeSec=78.3505
DribErrs=5               DribErrRate=3.3E-08
THRESHOLD ERROR SECOND SUMMARY:
  E-5=1          E-4=1          E-3=1
STATUS SECOND SUMMARY:
SigLs=1          Frame=1          Sync=2
Zeros=2          X-Bit=2          Ones=0
```

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Fig. 12-Immediate Bit Summary

Error-Second Printouts

5.10 When selected, printouts may be generated at the end of Bit, BPV, or Frame error seconds. These printouts (see Fig. 13) will contain the following information:

- Time-of-Day/Date at End of Error Second
- Error Type (BIT, BPV, or FRAME)
- Total Errors in Error Second
- Indication of Status Ocurring During Error Second (SIGNAL LOSS, FRAME LOSS, SYNC LOSS, excess ZEROES, X-BIT, ALL 1'S)
- Current Jitter Measurement (if equipped).

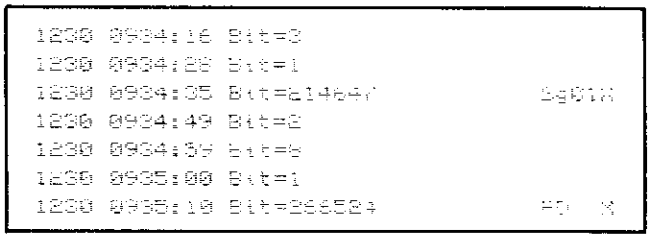
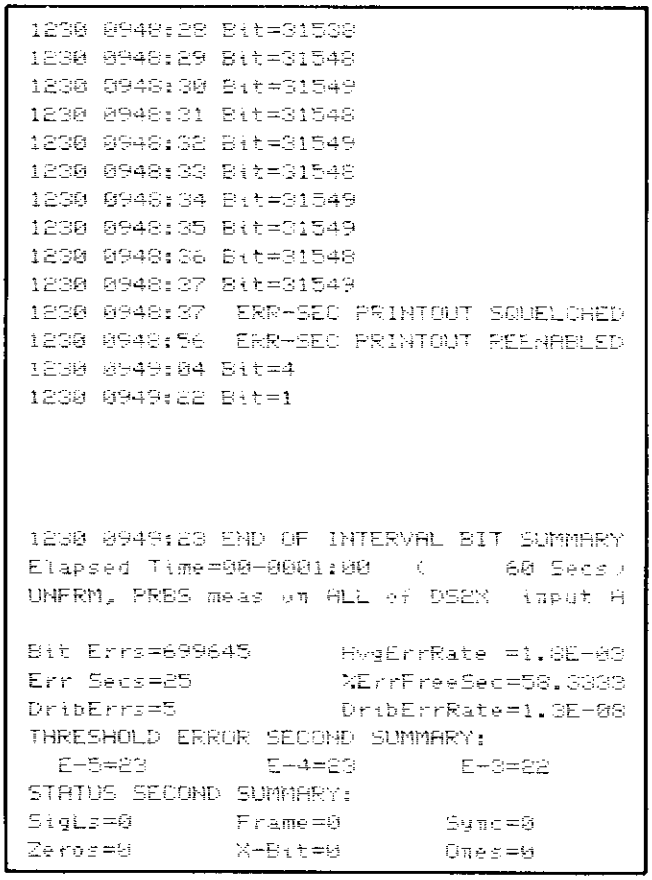


Fig. 13-Error Second Printout

Error-Second Squelching

5.11 Squelching may be enabled or disabled by the user. When selected, error-second printouts are squelched when 10 consecutive error seconds of the error condition are received. Error-second printouts are re-enabled when 5 consecutive error seconds of nonerror condition is received. A one line message is output to the Printer interfaces when printouts are squelched or re-enabled. This message contains the Time-of-Day/Date and a clear indication that error-second printouts are squelched or re-enabled (see Fig. 14). The squelch condition can be selected to be error seconds in which ANY errors are received or in which the error rate exceeds or 10^{-5}, 10^{-4}, or 10^{-3}.



T-291283G

Fig. 14-Error Second Squelching

Power-Fail Recovery Summary

5.12 If summary printouts are selected, upon recovery from power loss a summary of test results at the time of power loss and an indication of the time power was lost and recovered will be generated. The time tag in the Power Loss summary indicates the time at which power was lost (see Fig. 15). The format is identical to other summaries.

E. Power Up/Power Loss

Power Loss Protection

5.13 The S5104 hardware includes battery-backed CMOS RAM and time-of-day clock to provide for setup and measurement retention and time-

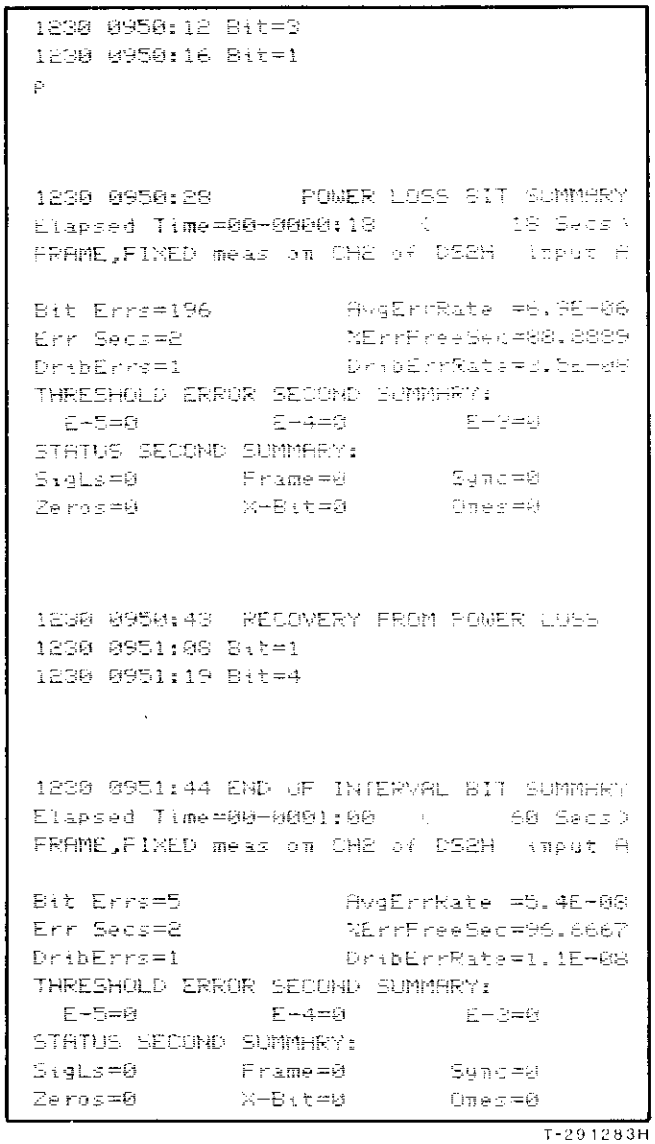


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Fig. 15-Power-Fail Recover Summary

keeping during a power loss. Setup state and measurements are not retained when the POWER is turned OFF from the front panel. The clock does continue to keep time, however.

Note: The S5104 is not equipped with enough battery backup power to continue taking measurements when the external power is lost.

Recovery From Power Loss

5.14 When power is restored following power loss, the S5104 will reinitialize operation to the state it was in when power was lost. Testing will be restarted, not continued, in the time mode selected prior to power loss. Measurements at the time of power loss are available for RECALL when power is recovered. These measurments will remain available until the next Time Measurement (SINGLE or REPEAT) completes or SNAPSHOT is used.

5.15 When power is restored, the RECEIVER Display will flash POWER LOSS. This message will continue to be displayed until any front panel key is pressed. The instrument is not inhibited from testing while the POWER LOSS message is being displayed.

F. RS-232C Interface

5.16 The RS-232C Interface provides the S5104 with a standard two-way serial interface. The interface may be used to output measurements to a Tau-tron 40-Column (5901) Printer or to any other device with an RS-232C Interface. It may also be used to remotely control and access data from the S5104 using a terminal or computer.

This section describes in detail the RS-232C Interface, serial data format, and how to connect the S5104 to RS232C devices.

Interface Connections

5.17 A 25-pin D-connector labeled RS-232 is provided on the rear panel of the S5104 for use with external equipment. The signals that are used are wired in accordance with EIA RS-232C standards for Data Terminal Equipment (DTE).

PIN	NAME	FUNCTION
1	GND	Protective Ground.
2	TxD	Transmitted Data Output: Bit-serial data stream. Format is selected by rear panel DIP switch.

3 RxD Received Data Input: Bit-serial data stream. Commands to the S5104 are received on this input. Format selected by rear panel DIP switch.

4 RTS Request To Send Output: Hi-level when S5104 has data for output.

5 CTS Clear To Send Input: Hi-level indicates external device, such as printer, is ready to accept data. This line must be high to enable the S5104 to output data. A low-level indicates the output device is busy or its buffer is full.

6 DSR Data Set Ready Input: Unused.

7 GND Signal Ground.

8 DCD Received Line Signal Detect Input: (Carrier detect) High-level (>3V) indicates external device, such as CRT terminal, wants to send commands to S5104. This line must be high to enable the S5104 to accept input commands on line 3. When this signal is absent or low, inputs on line 3 are ignored.

20 DTR Data Terminal Ready Output: Set to on (>+3V) by S5104.

All others no connection.

5.18 The S5104 may be configured for full-duplex or half-duplex operation. In full duplex mode, all characters received without error on the received data line (pin 3) are echoed back to the source on the transmit data line. No echoing is done in half duplex mode. During full duplex operation, commands and data may be received and transmitted simultaneously. In half-duplex operation, only one function, transmit or receive, may take place at a time. The Request To Send (RTS), Clear To Send (CTS), and Data Carrier Detect (DCD) signals control which function is active on a half-duplex channel. The RS-232C standard defines when transitions on the RTS, CTS, DSR, DTR, and DCD lines may take place.

Serial Data Format

5.19 Data is output from the S5104 in an asynchronous bit-serial fashion at one of eight selectable baud rates. The format of the bit-serial data stream is shown in Fig. 16.

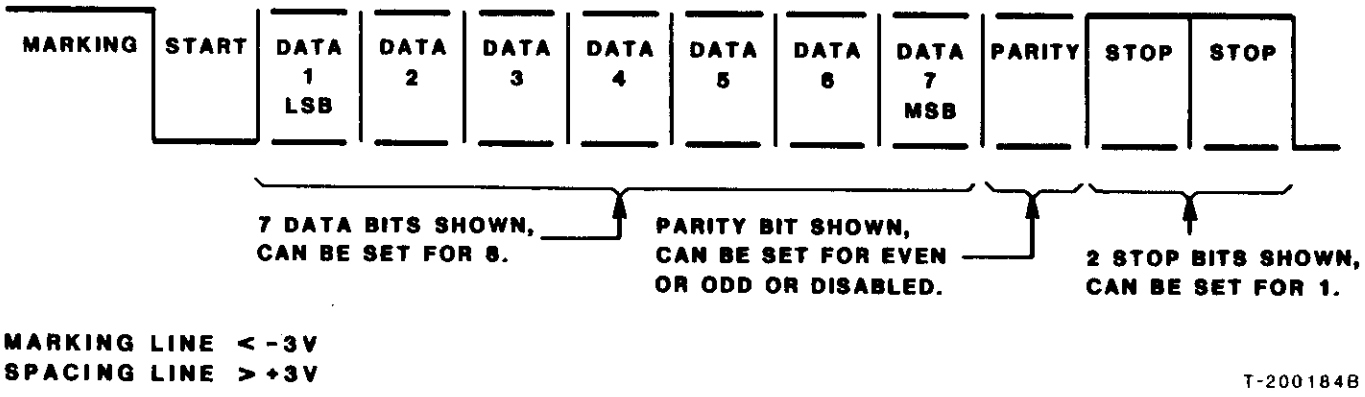

Fig. 16-Bit-Serial Data Stream Format

Baud Rate and Option Selection

5.20 The data baud rate, number of bits per character, parity selection, and number of stop bits are selected by the rear panel DIP switch. Switch assignments are as follows:

DIP SW	BAUD RATE	SW SEC. (1=ON) 1	2	3
1 (L)	110	0	0	0
2	150	1	0	0
3	300	0	1	0
	600	1	1	0
	1200	0	0	1
	2400	1	0	1
	4800	0	1	1
	9600	1	1	1
4	Bits/Char	0=7, 1=8		
5	Parity Disable	0		
	Parity Enable	1		
6	Odd Parity	0		
	Even Parity	1		
7	1 Stop Bit	0		
	2 Stop Bits	1		
8 (R)	Half Duplex	0		
	Full Duplex	1		

Note: The Dip Switch is Read on Power-Up Only. To change the S5104's baud rate or other characteristics, the unit must be turned off, then back on.

5.21 When using the RS-232C compatible Tau-tron 40-Column (5901) Printer, the DIP switch should be set as follows:

SWITCH SETTING	1	2	3	4	5	6	7	8
	OFF	OFF	ON	OFF	OFF	OFF	ON	OFF

S5104 Remote Control Commands

5.22 All S5104 capabilities controllable from the front panel may be controlled remotely. Programming the S5140 via the RS-232C interface is as simple as programming it by the front panel controls. Most commands correspond to front panel pushbuttons. These commands must be issued in the same sequence as front panel commands. Additional commands are provided to acquire measurements, status, or to reinitialize the S5104 to its power-up state.

Remote Command Sequences

5.23 All commands must be issued in the following format:

CMD 1 (delimiter CMD2) (delimiter CMD3) ... CR

CMD 1, 2, 3, etc., are any of the commands shown in Table G of subsection 5G. Command mnemonics are read from the RS-232C receive data line (pin 3). Command sequences may contain one or more commands and must be terminated by a carriage return and line feed. A command sequence must not exceed 128 characters in length. Multiple commands in a command sequence must be separated by any of the following valid delimiters:

DELIMITER	ASCII CODE (HEX)
SP (blank).....	20
NULL (null byte)....	00
, (comma).....	2C
; (semicolon).....	3B
HT (tab).....	Ø9

5.24 The S5104 will backspace and delete received characters when the ASCII backspace (HEX 08) or rubout (HEX 7F) character is received. In full duplex mode, the received backspace or rubout character will be echoed to the remote controller. In

addition, the unit will echo a carriage return and line feed when a carriage return is received. Commands are not accepted and responded to until the carriage return is received.

Response to Commands and Command Errors

5.25 When the carriage return terminating a command sequence is received, the S5104 decodes and responds to the command sequence. Multiple commands in a sequence are responded to one at a time. If any of the commands are improper, the S5104 outputs "WHAT?" to the RS-232C interface, but responds to all valid commands in the sequence. If all commands in the sequence are valid, the S5104 outputs "OK" to the RS-232C interface. "WHAT?" or "OK" is output in both full and half-duplex modes. If the S5104 is in the middle of sending printer outputs or requested data, the command acknowledgements may be interspersed with the data.

5.26 Two types of errors may occur. If parity detection is enabled, each received character is checked for proper parity. Characters with improper parity are ignored. In full duplex operation, only characters with the correct parity are echoed to the remote controller, indicating their acceptance.

5.27 Invalid commands are ignored by the S5104. If a multiple command sequence contains an invalid command, valid commands in the sequence will still be interpreted and responded to. Since many S5104 remote commands depend on previous commands, sequences containing an invalid command may be misinterpreted. Valid command mnemonics may be treated as invalid commands if they have no meaning in the S5104's current mode. When editing transmitter error rate, only the ENTER (ENT), CHANGE (INC and DEC), and transmitter error MODE (XMO) commands have meaning. Any other command, such as transmitter PATTERN (XPA), will be ignored and the S5104 will respond with "WHAT?".

Interface to Tau-tron's 40-Column (5901) Printer

5.28 Tau-tron's 40-Column (5901) Printer Option has been specifically selected for S5104 applications. Interfacing requires a null modem and 9-wire RS-232C cable which are supplied with the 5910 printer.

5.29 RS-232C specifies equipment as either Data-Terminal or Data-Communications Equipment (DTE or DCE). When similarly configured equipment try to talk to each other, a null modem is required. Since both the S5104 and the printer are configured as DTE, a null modem allows each device to see the other as DCE. The following diagram lists RS-232C pin connections on both sides and shows the null modem wiring:

S5104 PINOUT		PRINTER PINOUT
Protective Ground	1 —— 1	Protective Ground
Transmitted Data Out	2 ⟍ 2	Transmitted Data Out - Unused
Received Data In	3 ⟋ 3	Received Data In - Data to be printed
Request To Send Out	4 ⟍ 4	Request To Send Out - Unused
Clear To Send In	5 ⟋ 5	Clear To Send In - Unused
Data Set Ready In	6 ⟍ 6	Data Set Ready In - Unused
Signal Ground	7 —— 7	Signal Ground
Received Line Signal Detect In	8 —— 8	Received Line Signal Detect In - Unused
Data Terminal Ready Out	20 ⟋ 20	Data Terminal Ready Out - Printer ready to accept data

5.30 All other wires in the 25-wire interface are not connected. A null modem with this configuration is shipped with the 40-Column (5901) Printer Option.

5.31 The RS-232C cable shipped with the printer is a 9-wire, 10-foot cable. The pinout is straight-through (no cross-connection) on pins 1-8 and 20. All other pins are not connected.

5.32 The printer is shipped from Tau-tron in the following configuration:

- 1200 baud
- 7-bit word length
- 1 stop bit
- no parity.

5.33 The S5104 should be configured, as follows, by the rear panel DIP switches to talk to the printer:

- 1200 baud
- 7-bit word length
- 2 stop bits
- no parity.

Note: Configuring the S5104 to transmit 2 stop bits ensures the printer will detect the next start bit and resync on it.

Interface to Other RS-232C Devices

5.34 Interfacing the S5104 to other RS-232C devices is simple if you know the pinout and configuration of the other device. All DTE transmit on line 2 and receive on line 3. All DCE transmit on line 3 and receive on line 2. Different printers typically provide their clear-to-send (printer ready for data) handshake on different lines. A null modem may be necessary to cross-connect the printer handshake to the S5104's clear-to-send input (see paragraph 5.30 for proper pinout and null modem connection) .The S5104 must see clear-to-send active before it will transmit data. It will continue to transmit data at the specified baud rate until the clear-to-send line goes inactive or there is no more data to be output. The S5104 must be set (by rear panel DIP switches) to transmit at the same baud rate, parity selection, and data word length as the receiving

device. Generally, the S5104 should be set to transmit 2 stop bits. This gives the receiving device a better chance to resync on the next start bit.

5.35 The S5104 must see Receive Line Signal Detect (pin 8) active before it will accept data on its Receive Data Line (pin 3). A modem provides this signal on pin 8 whenever it has detected a carrier (i.e., phone link completed to another modem). If the S5104 is connected directly to a terminal, it may be necessary to cross-connect the terminal's power-on signal (often pin 20, Data Terminal Ready) to the S5104's pin 8 input.

Interfacing an RS-232C Terminal to the S5104

5.36 The RS-232C Interface specification allows many different configurations. Data rate, format, and content are not strictly specified. Therefore, getting a device's RS-232C Interface to talk to another often requires some initial configuration.

5.37 Once familiar with RS-232C interface standards, the following procedure will ease interface setup:

STEP	PROCEDURE
1.	Determine the terminal's (or printer, modem, computer, or other RS-232C device) RS-232C pinout. Consult user manual for terminal to determine its pinout. Make proper connection as described in subsections 5.17, 5.34, and 5.38. A null modem may be required to cross-connect transmit, receive, and handshake signals.
2.	Determine terminal's serial data format. Select S5104 format to match, as described in subsections 5.19 and 5.20.
3.	Turn on terminal and S5104. Using the AUX pushbutton, enable bit printouts, select SNAPSHOT, verify output at terminal. If no output or garbled output, use subsection 5.38 as a guide to determine and correct the problem.
4.	When the previous step is completed successfully, press the (RETURN) key on the terminal. Verify "OK" or "WHAT?" response output to terminal. If no response, consult subsection 5.38.
5.	After successfully completing the last step, type in a sequence of commands (see subsection 5.23) corresponding to a valid sequence of key depressions. Verify that the S5104 responds to the commands and sends back "OK" response.

RS-232C Interface Troubleshooting

5.38 The EIA RS-232C Interface specification allows many different configurations. Data rates, format, and content are not strictly specified. Getting one device's RS-232C Interface to talk to another one often requires some initial configuration. Rear panel DIP switches on the S5104 permit the user to configure the instrument's RS-232C interface to match the characteristics of many RS-232C peripherals. This section describes commonly encountered problems and their solutions when trying to make the S5104 communicate via an RS-232C interface.

5.39 The RS-232C specification defines separate transmit and receive data lines. The S5104 outputs bit-serial information over the transmit data line (pin 2 of the connector). Many printers, including Tau-tron's 40-Column (5901) Printer, expect data on the receive data line (pin 3). If this is the case, the S5104's transmit data line must be connected to the printer's

receive data line. The printer is supplied with a null modem to accomplish this cross-connection.

5.40 In order for the S5104 to transmit data, its clear-to-send input (pin 5) must be active (>3V). The printer supplies this signal on its data-terminal-ready line (pin 20). Again, the null modem makes the required cross-connection. If the printer is off-line or busy (not ready to accept data), it will drive this line inactive, signalling the S5104 to stop sending data to the printer.

5.41 The S5104 expects to receive remote commands in bit-serial form on its receive data line (pin 3). In order for the S5104 to accept commands on its receive data line, its received line signal detect input (pin 8, sometimes called data carrier detect) must be active (>3V).

5.42 The serial data stream consists of a start bit, 7 or 8 data bits, possibly a parity bit, and 1 or 2 stop bits. The baud rate, number of data bits per character, and parity bit selection must match the format expected by the printer. The S5104 should generally transmit two stop bits, while the printer should look for one. The configuration of these interface characteristics is controlled by DIP switches on the rear panel of the S5104. Subsection 5.18 describes DIP switch settings and meanings.

Note: DIP Switches are read only on power-up. If a configuration change must be made, the S5104 must be turned off, the appropriate DIP switches set and the S5104 turned back on.

5.43 When the rate at which printer output is generated exceeds the printer capability to store and print it, some data will be lost. The RS-232C clear-to-send handshake line will be enabled for the S5104 to output the data to the printer. When the printer is busy, off-line, or out of paper, it may disable this line, signaling the S5104 to discontinue output. As more error-seconds occur, print messages will continue to be generated in the S5104. 1024 bytes of queue storage are provided for backing up data. When this queue space is filled, the S5104 will keep track of the number of buffers lost. Each print buffer corresponds to a 40-character print line. When the printer is again ready for data, the number of lost buffers will be reported.

Note: The lost buffer count is reported in hexadecimal form.

5.44 The source of nearly all interface problems is improper connections and/or mismatches in the transmitted and expected data rate or format. Table E lists several commonly encountered symptoms, their likely causes, and solutions.

TABLE E

PRINTER/INTERFACE TROUBLESHOOTING

PROBLEM SYMPTOM	POSSIBLE CAUSE	SOLUTION
Front panel displays "GPIB or RS-232C required for printer GPIB output."	Neither RS-232C nor GPIB Option has been purchased	Consult Tau-tron sales representative if you wish to purchase one or both of these options.
	Internal DIP switches improperly set	Consult Tau-tron Customer Service personnel.
Printer fails to Print any data	Printer off	Plug in printer and turn it on.
	Printer off-line	Some printers, including the Tau-tron 5901, have an on-line/OFF-LINE switch. Make sure the printer is on-line (up position).
	Cable not connected	Connect RS-232C cable.
	Improper connection	Make sure pin 2 from S5104 is wired to printer's input data line. Make sure pin 5 input at S5104 is receiving clear-to-send indication from printer.
Printout is garbled	Data rate or format mismatch	Set the S5104 to off and set the rear panel DIP switches to select proper baud rate, parity, and number of data bits/character to match printer setup. Set the S5104 to on.

TABLE E (CON'T)

PRINTER/INTERFACE TROUBLESHOOTING

PROBLEM SYMPTOM	POSSIBLE CAUSE	SOLUTION
Character occasionally lost in printout	Sync loss	Set the S5104 to off and rear panel DIP switch for 2 stop bits. Set printer for 1 stop bit. Set the S5104 to on.
Multiple characters occasionally lost printout	Data overrun	Printer is not toggling the S5104 clear-to-send line when it is busy and unable to accept data. S5104 keeps transmitting and data is lost. Provide signal from printer to pin 5 of S5140 interface. Signal must be active (>3V) when printer is ready to accept data and inactive (<-3V) when printer is busy.
S5104 outputs print functions to terminal but does not accept remote commands	Improper connection	Make sure the S5104 data line (pin 3) is connected to the remote controller's transmit data line. Make sure the S5104 Receive Line Signal Detect (pin 8) is active (connected to modem Carrier Detect or remote controller power-on or ready line).
	Data format mismatch	Set the S5104 to off and set rear panel DIP switches to select parity and number of data bits per character to match remote controller setup. Set the S5104 to on.

TABLE E (CON'T)

PRINTER/INTERFACE TROUBLESHOOTING

PROBLEM SYMPTOM	POSSIBLE CAUSE	SOLUTION
Characters typed at remote control terminal do not appear on screen, but are accepted by the S5104	Terminal in full duplex; S5104 in half duplex	Set the S5104 to off. Set the S5104 switch 8 to ON. Set the S5104 to on, S5104 will echo all received characters to verify their reception.

G. IEEE-488 (GPIB) Interface

5.45 When IEEE-488 (GPIB) Interface is installed, the S5104 may communicate with other GPIB-compatible devices as a talker/listener. This section provides an introduction to GPIB and details of S5104 GPIB Capabilities.

IEEE-488 Description

5.46 The GPIB (General Purpose Interface Bus) transfers data and commands on a parallel type bus structure. The interface functions for each instrument on the bus is performed within the unit. Therefore, only passive cabling is necessary to connect the system. The cables connect all instruments, controllers, and other units of the system in parallel across the signal lines.

5.47 Eight of the lines (DI01 thru DI08) are reserved for the transfer of data and other messages in a byte serial, bit-parallel manner. Data and message transfer is asynchronous and coordinated by the three handshake lines: DAV (Data Valid), NRFD (Not Ready For Data), and NDAC (Not Data Accepted). The other five lines are for control of bus activity.

5.48 Devices connected to the bus may be talkers, listeners, or controllers. The controller dictates the roll of each of the other units by setting the ATN (Attention) line true and sending talk or listen addresses on the data lines (DI01 thru DI08). Addresses are set into each device at the time of system configuration either by switches built into the unit or by jumpers on a printed circuit board. While the ATN line is true, all units must listen to the data lines. When the ATN line is false, only devices that have been addressed will actively send or receive data. All others ignore the data lines.

5.49 Several listeners can be active simultaneously, but only one talker can be active at a time. Whenever a talk address is put on the data lines (while ATN is true), all other talkers should be automatically unaddressed.

5.50 Information is transmitted on the data lines under sequential control of the three handshake lines. No step in the sequence can be initiated until the previous step is completed. Information transfer can proceed as fast as units can respond, but no faster than allowed by the slowest device being addressed as active. This permits several devices to receive the same message byte concurrently.

5.51 The ATN line is one of five control lines. When ATN is true,

addresses and universal commands are transmitted on only seven of the data lines using ASCII code. When ATN is false, any code of eight bits or less understood by both the talker and listener(s) can be used.

5.52 The other control lines are IFC, REN, SRQ, and EOI. IFC (Interface Clear) places the interface system in a quiescent state. REN (Remote Enable) is used with other coded messages to select either local or remote control of each unit.

5.53 Any active unit can set the SRQ (Service Request) line to true. This indicates to the controller that some unit on the bus wants attention; for example, a counter on a bus may want attention because it has just completed a time-interval measurement and wants to transmit the reading to a printer.

5.54 EOI (End Or Identify) is used by a unit to indicate the end of a multiple-byte transfer sequence. When a controller sets both ATN and EOI lines to true, each unit capable of a parallel poll indicates its current status on the data line (DI01 thru DI08) assigned to it.

5.55 It is not necessary that every unit be capable of responding to all of the lines. Each unit can be designed to respond only to those lines that are pertinent to its functions on the bus.

S5104 Tx/Rx GPIB Capabilities

5.56 The S5104 may be interfaced as a talker/listener or a talker only. No controller functions are implemented. As described in the IEEE-488 (GPIB) standard, the following GPIB capabilities are implemented:

- SH1 Complete source handshake.
- AH1 Complete accepter handshake.
- T5 Basic talker, serial poll, talk only, unaddress if addressed to listen.
- TEO No extended talker (secondary talk address) capability.
- L4 Basic listener, no listen only, unaddress if addressed to talk.
- LEO No extended listener (secondary listen address) capability.
- SR1 Complete service request capability.
- RL1 Complete remote/local capability including local lockout.
- PPO No parallel poll capability.
- DC1 Complete device clear capability.
- DT1 Complete device trigger capability.
- CO No control capability.
- E2 Tri-state drivers are used on DIO lines to achieve maximum data transfers rates.

GPIB Interface Connections

5.57 A 24-pin GPIB connector is provided on the rear panel of the S5104. Connector dimensions and pinouts correspond to IEEE specifications. Tri-state drivers are used on the DI0 lines in the talk mode to achieve higher data transfer rates.

GPIB Address and Option Selection

5.58 When the IEEE-488 Interface (GPIB) Option is installed, the 8-section DIP switch on the rear panel is used for GPIB talk/listen address and option selection as follows in Table F.

TABLE F

GPIB TALK/LISTEN ADDRESS DIP SWITCH SETTINGS

SWITCH	FUNCTION (1=ON=UP)	DESCRIPTION
1 (left)	SRQ Enable	With this switch on, the S5104 is allowed to generate service requests (assert the GPIB SRQ line). In systems with many GPIB units, this may not be desirable. Service requests can be inhibited by setting this switch down to its off position. The S5104 maintains status and will respond to serial polls regardless of the SRQ Enable setting.
2	Talk Only	With this switch on, the S5104 may be used in a system with a listen-only printer and no controller. In this mode, print functions can be selected from the front panel and the printer output sent to a GPIB printer. The S5104 will ignore all GPIB commands when in a talk-only mode (switch 2 up). Switch 2 should be down (OFF) for normal talker/Listener operation.
3	Listen Only	This setting is ignored by the S5104 since it does not have a listen-only mode of operation.
4	Address A5	A1 thru A5 plus two additional bits, independent of the switch settings, form a 7-bit talk and listen address. A1 is the least-significant bit, A2 is the next most significant, etc. The two additional bits are the most-significant bits and are fixed as 1-0 for a talk address, and as 0-1 for a listen address. Once the five address bits A1 thru A5 are selected, both talk and listen addresses are specified for the S5104.
5	Address A4	
6	Address A3	
7	Address A2	
8	Address A1	

Note: The DIP Switch is read on power-up only. To change the S5104 GPIB address or other characteristics, the S5104 must be turned off then back on.

Response To GPIB Commands

5.59 The following GPIB commands and events are responded to by the S5104:

- Addressed to listen
- Universal unlisten command
- Addressed to talk
- Universal untalk command
- Data byte received
- Remote/local command
- Local lockout command
- Device clear command
- Device trigger command

- Serial poll enable/disable commanded.

5.60 Several GPIB capabilities are not supported by the S5104 test set. These commands and undefined GPIB commands are ignored. The following commands are ignored by the S5104:

- Identify (parallel poll trigger)
- Secondary addresses
- Parallel poll configure/unconfigure
- Parallel poll enable/disable
- Take control.

5.61 The following paragraphs detail the GPIB commands and events to which the S5104 will respond.

S5104 Test Set Addressed to Listen

CODE	DATA BUS DIO 8 7 6 5 4 3 2 1	INTERFACE MANAGEMENT ATN EOI SRQ IFC REN
MLA	Y 0 1 L L L L L (5 4 3 2 1)	1 x x x x

L1-L5 specify the device dependent bits of the device's listen address as set by the rear-panel DIP switch.

5.62 When MLA (My Listen Address) is present on the GPIB bus, the S5104 will be addressed to listen. If previously addressed to talk, the S5104 will automatically untalk. The S5104 cannot be configured to talk and listen at the same time in order to prevent its talk data from being interpreted as commands.

Universal Unlisten Command

CODE	DATA BUS DIO 8 7 6 5 4 3 2 1	INTERFACE MANAGEMENT ATN EOI SRQ IFC REN
UNL	Y 0 1 1 1 1 1 1 1	1 x x x x

5.63 When UNL (Unlisten) is present on the GPIB bus, the S5104 will cease to listen and addressed commands (GET, GTL, and SDC) and data will be ignored. Universal commands (IFC, REN, DCL, SPE, SPD, MLA, and MTA) will continue to be recognized and responded to.

S5104 Test Set Addressed to Talk

CODE	DATA BUS DIO 8 7 6 5 4 3 2 1	INTERFACE MANAGEMENT ATN EOI SRQ IFC REN
MTA	Y 1 0 T T T T T (5 4 3 2 1)	1 x x x x

T1-T5 on the DIO lines specify the device dependent bits of the device's talk address as set by the rear-panel DIP switch.

5.64 When MTA (My Talk Address) is present on the GPIB bus, the S5104 will be addressed to talk. If previously addressed to listen, the S5104 will automatically unlisten to prevent output data from being interpreted as commands. Since a GPIB system can have only one talker, unique talk addresses must be selected for each device in the system. All other devices must untalk when the S5104 is addressed to talk. If addressed to talk after SPE (Serial Poll Enable) and before SPD (Serial Poll Disable), the S5104 will respond by putting its status byte on the DIO lines (described later under Service Request and Serial Poll paragraph 5.84). Otherwise, S5104 output data (i.e., measurements) will be placed on the DIO lines. If the S5104 has nothing to say, it will output one or two null bytes along with the EOI signal.

Universal Untalk Command

CODE	DATA BUS DIO 8 7 6 5 4 3 2 1	INTERFACE MANAGEMENT ATN EOI SRQ IFC REN
UNT	Y 1 0 1 1 1 1 1	1 x x x x
OTA	OTA = SCA ∧ $\overline{\text{MTA}}$	

The UNT code is provided for system use.

5.65 The presence of UNT (Untalk) command or a talk address other than the S5104, OTA (Other Talk Address) causes the S5104 to become unaddressed to talk. If service requests are not inhibited and the S5104 still has data it wishes to output, a service request indicating request-to-talk will be generated.

Data Byte Received

CODE	DATA BUS DIO 8 7 6 5 4 3 2 1	INTERFACE MANAGEMENT ATN EOI SRQ IFC REN
ATN	x x x x x x x x	1 x x x x
DAB	D D D D D D D D 8 7 6 5 4 3 2 1	0 x x x x

D1-D8 specify the device dependent data bits.
The source of the message on the ATN line is always the C function, whereas the messages on the DIO and EIO lines are enabled by the T function.

5.66 When the GPIB ATN (Attention) line is inactive and the S5104 is addressed to listen, bytes received on the eight DIO lines will be interpreted as device dependent commands.

Interface Clear Command

CODE	DATA BUS DIO 8 7 6 5 4 3 2 1	INTERFACE MANAGEMENT ATN EOI SRQ IFC REN
IFC	x x x x x x x x	x x x 1 x

5.67 When the IFC (Interface Clear) line is asserted on the GPIB bus, the S5104 reinitializes its interface functions as described by IEEE-488-1978 state diagrams. A pending service request will be cleared. The status byte in the S5104 is not cleared, however. It may be polled to determine if bus errors, indicated in the status byte, may have caused bus problems prior to the interface clear command. If previously in remote mode, IFC will not return the test set to local control.

Remote/Local Command

CODE	DATA BUS DIO 8 7 6 5 4 3 2 1	INTERFACE MANAGEMENT ATN EOI SRQ IFC REN
GTL	Y 0 0 0 0 0 0 1	1 x x x x
LLO	Y 0 0 1 0 0 0 1	1 x x x x
REN	x x x x x x x x	x x x x 1

5.68 When the REN (Remote Enable) line is asserted on the bus and the S5104 is addressed to listen, the test set is put in remote mode and the front panel REMOTE indicator is illuminated. While in remote mode all local control (front panel pushbuttons) is disabled except the return-to-local key (REMOTE). If the LLO (Local Lockout) command is issued, the front panel return-to-local key is also disabled.

5.69 The S5104 may be placed under remote control only by first asserting the REN line, then being addressed to listen. When in remote mode, REN going inactive will return it to local control. If addressed to listen and in remote, the presence of the GTL (Go To Local) message returns the S5104 to local control.

Device Clear Command

CODE	DATA BUS DIO 8 7 6 5 4 3 2 1	INTERFACE MANAGEMENT ATN EOI SRQ IFC REN
DCL	Y 0 0 1 0 1 0 0	1 x x x x
SDC	Y 0 0 0 0 1 0 0	1 x x x x

5.70 The S5104 may be cleared by DCL (Universal Device Clear) or SDC (Selective Device Clear). SDC is accepted by the S5104 only if it has been addressed to listen. DCL is responded to in any mode. In response to a device clear command, the test set re-executes its power-up initialization sequence, including reinitializing its GPIB interface function. If previously

addressed to talk or listen, the S5104 will return to its unaddressed state.

Note: At least a few seconds should be allowed before issuing any further commands in order to give the S5104 time to complete its power-up reinitialization sequence.

5.71 This command provides a simple way of returning the S5104 to a known state, the power-up state. S5104 transmitter and test set functions are initialized to the following states on power-up or in response to the device clear command:

S5104 POWER-UP STATE:

TRANSMITTER:

DS (RATE & LEVEL) = DSX1
PATTERN = PRBS
FRAMING = UNFRAMED
JITTER = DISABLED (INT OFF, EXT OFF)
ERROR TYPE = BIT
ERROR MODE = ERR FREE
TX DISPLAY = ERROR MODE (----)
INT ERR RATE = 1 E-5.

RECEIVER:

DS (RATE & LEVEL) = DSX1
CHANNEL = CH1
PATTERN = PRBS
FRAMING = UNFRAMED
INPUT SELECT = LEFT (A)
MEASUREMENT TYPE = BIT

BIT MEAS SELECT = TOTAL ERRORS
BPV MEAS SELECT = TOTAL ERRORS
FRAME MEAS SELECT = TOTAL ERRORS
RX DISPLAY = MEASUREMENTS (CURRENT)
STATUS SECONDS MEAS SELECT = SIGNAL LOSS
JITTER MEAS SELECT = CURRENT AMPLITUDE
AUX FUNCTION = PRINTER
SUMMARY PRINT = OFF
ERROR SECOND PRINT = OFF
ERROR SECOND SQUELCH = OFF
TIME MODE = UNTIMED
TIME DISPLAY = TIME-OF-DAY
TESTING = IN-PROCESS.

COMMON FUNCTIONS:

REMOTE/LOCAL = LOCAL
LOCAL LOCKOUT = RETURN TO LOCAL ALLOWED.

Device Trigger Command

CODE	DATA BUS DIO 8 7 6 5 4 3 2 1	INTERFACE MANAGEMENT ATN EOI SRQ IFC REN
GET	Y 0 0 0 1 0 0 0	1 x x x x

5.72 When GET (Group Execute Trigger) command is present on the GPIB bus and the S5104 has been addressed to listen, it will execute its stop/start function. This action is identical to stopping or starting receiver measurements using the STOP START pushbutton.

Serial Poll Enable/Disable Command

CODE	DATA BUS DIO 8 7 6 5 4 3 2 1	INTERFACE MANAGEMENT ATN EOI SRQ IFC REN
SPD	Y 0 0 1 1 0 0 1	1 x x x x
SPE	Y 0 0 1 1 0 0 0	1 x x x x

5.73 The SPE (Serial Poll Enable) and SPD (Serial Poll Disable) commands are recognized by the S5104 when they are present on the bus. In response to a serial poll, the S5104 will put its GPIB status byte on the DI0 lines. The serial poll command sequence and status byte interpretation are described later under Service Request and Serial Poll.

Device-Dependent Commands

5.74 All S5104 capabilities controllable from the front panel may be remotely controlled. A set of device-dependent commands issued on the GPIB bus selects S5104 commands. When the S5104 is addressed to listen, data accepted on the DIO lines are interpreted as test set commands.

5.75 Programming the S5104 in remote control is as simple as programming it by frontpanel entry. Commands correspond to front panel pushbutton selects. These commands must be issued in the same sequence as front panel pushbuttons to select test set functions. Additional commands are provided to return test set status or SNAPSHOT the Tx and Rx displays. Device dependent commands are summarized in Table G.

Command Sequence Formats

5.76 All device-dependent command sequences must be issued in the following format:

Command 1 (delimiter command 2) (delimiter, command 3) ....CR

5.77 Commands are read as 7-bit ASCII codes off the DIO lines. Multiple commands in a command sequence must be delimited by any of the following valid delimiters. Every command sequence must be terminated by a Carriage Return (CR).

DELIMITER	ASCII CODE (HEX)
SP (blank).....	20
NUll (null byte)....	00
, (comma).....	2C
; (semicolon)....	3B
HT (tab).....	09

Command Errors

5.78 Valid commands may be treated as invalid if they have no meaning in the S5104's current mode. For example, when editing transmitter internal error rate, only the Enter (ENT), Increment (INC), Decrement (DEC), and Transmitter Error Mode (XMO) commands have meaning. Unrecognized commands or commands invalid due to context cause the command error bit to be set in the S5104's serial poll status word. If service requests are enabled, command errors also generate a service request.

5.79 Table G provides a list of S5104 remote control commands. All S5104 transmitter and receiver functions can be remotely controlled, and all status returned to the remote controller with these commands. Control commands duplicate front panel key functions. Setup status commands return the current state of the S5104. Additional status and display SNAPSHOT commands may be used to access displayed measurements and signal status. Commands are arranged in three groups: 1) Transmitter commands, 2) Receiver commands, and 3) Common commands.

TABLE G

REMOTE CONTROL COMMANDS

FUNCTION	CONTROL COMMAND	PUSH-BUTTON	STATUS COMMAND	INDICATOR STATE	ASCII STATUS
Tx Format & Level	XDS	DS	XDS?	DSX1 DSX1C DS2H DSX2	0 1 2 3
Tx Pattern	XPA	PATTERN	XPA?	PRBS FIXED ALL 1'S THRU	0 1 2 3
Tx Frame	XFR	FRAME	XFR?	FRAMED UNFRAME	0 1
Tx Error Type	XTY	TYPE	XTY?	BIT BPV	0 1
Tx Error Mode	XMO	MODE	XMO?	ERR FREE INT INT EXT	0 1 (Edit) 3 (Inject) 2
Single Error Inject	XSI	SINGLE	None	None	None
Tx Jitter Inject	XJI	JITTER	XJI?	DISABLE INT EXT	0 1 2
Tx Jitter Display	XJD	JITTER	XJD?	FREQ AMPL INT EXT	0 1 2 3
Snapshot Tx Display	XDP	None	XDP?	ERROR JITTER	0 (Note 1) 1
Rx Format & Level	RDS	DS	RDS?	DSX1 DSX1C DS2H DSX2	0 1 2 3
Rx Channel	RCH	CHANNEL	RCH?	CH 1 CH 2	0 1

TABLE G (CON'T)

REMOTE CONTROL COMMANDS

FUNCTION	CONTROL COMMAND	PUSH-BUTTON	STATUS COMMAND	INDICATOR STATE	ASCII STATUS
				CH 3 CH 4	2 3
Rx Pattern	RPA	PATTERN	RPA?	PRBS FIXED LIVE	0 1 2
Rx Frame	RFR	FRAME	RFR?	FRAMED UNFRAMED	0 1
Rx A/B Input Selection	RIN	SELECT	RIN?	Left/A Right/B	0 1
Rx Measurement Type	RTY	TYPE	RTY?	BIT BPV FRAME STATUS JITTER	0 1 2 3 4
Rx Measurement Select	RSE	SELECT	RSE?	None	(Note 2)
Rx Time Mode	RMO	MODE	RMO?	UNTIMED SINGLE REPEAT	0 1 2
Stop/Start Test	RST	STOP/ START	RST?	IN PROC STOP/SET	0 1
Time Display	RTI	TIME DISPLAY	RTI?	INTRVAL ELAPSED TIME DATE	0 1 2 3
Snapshot Signal Status	None	None	RCS?	STATUS	(Note 3)
Snapshot History Status	None	None	RHS?	STATUS	(Note 3)
Snapshot Rx Display (Note 4)	RDP	None	RDP?	MEASURE TIME AUX	0 1 2

TABLE G (CON'T)

REMOTE CONTROL COMMANDS

FUNCTION	CONTROL COMMAND	PUSH-BUTTON	STATUS COMMAND	INDICATOR STATE	ASCII STATUS
Enter	ENT	ENTER	None	None	None
Change Increment	INC	CHANGE ↑	None	None	None
Change Decrement	DEC	CHANGE ↓	None	None	None
Auxiliary Functions	AUX	AUX	None	None	None
Return to Local Control	RTL	REMOTE	RTL?	REMOTE Local	1 0
Init to Power-Up State	DCL	None	None	None	None
Go to Remote Mode	REM	None	RTL?	REMOTE Local	1 0
Lockout Return-to-Local	LLO	None	LLO?	Locked Unlocked	1 0
Unlock Local Lockout	LLU	None	LLO?	Locked Unlocked	1 0

Note: 1. The command XDP "snapshots" the current transmitter display and outputs the 4-6 character ASCII result to the remote interfaces. Display formats are summarized in the following:

DISPLAY TYPE	FORMAT
Error Injection Displays:	
Error Free	'----'
Internal Error Rate/Rate Set	'nE-x'
External Error Rate	'n.n-x'
Jitter Injection Displays:	
Internal Generated Jitter Frequency	'n.nn,x'
Internal Generated/External Applied Amplitude	'nn.nn'
Internal/External Jitter Disabled	' OFF'
Internal/External Jitter Enabled	' ON'

TABLE G (CON'T)

REMOTE CONTROL COMMANDS

Note: 2. The ASCII status code returned in response to the RSE? command depends on the current measurement type selected for display (BIT, BPV, FRAME, STATUS, or JITTER). If measurements are not currently being displayed, this command returns the status code of the last displayed measurement (i.e. the measurement which would be displayed the next time measurements are selected). The following lists ASCII status by measurement type:

MEASUREMENT	STATUS
BIT and BPV Measurements:	
Total Errors Since Start of Test	0
Current Error Rate Over 10**7 Bits	1
Average Error Rate Since Start of Test	2
Total Error Seconds Since Start of Test	3
E-5 Threshold Error Seconds Since Start of Test	4
E-4 Threshold Error Seconds Since Start of Test	5
E-3 Threshold Error Seconds Since Start of Test	6
Total Dribbling Errors Since Start of Test	7
% Error Free Seconds Since Start of Test	8
Frame Error Measurements:	
Total Frame Errors Since Start of Test	0
Average Error Rate	1
Total Frame Error Seconds	2
% Frame Error Free Seconds Since Start of Test	3
Status Second Measurements:	
Signal Loss Seconds	0
Frame Loss Seconds	1
Data Sync Loss Seconds	2
Excess Zeroes Seconds	3
All Ones Detected Seconds	4
X-Bit Detected Seconds	5
Jitter Measurements:	
Current Jitter Amplitude	0
Maximum Jitter Amplitude Since Test Start	1
Current Weighted Jitter Amplitude	2
Maximum Weighted Jitter Amplitude Since Test Start	3
Jitter Threshold	4
Jitter Threshold Hit Seconds	5

TABLE G (CON'T)

REMOTE CONTROL COMMANDS

Note: 3. Signal status (either current or history) is reported back as a 6-digit ASCII representation of the binary state of each status indicator. When current status is requested (RCS?), 0's indicate that the corresponding status is not currently active; 1's indicate that the associated status condition is currently detected. When history status is requested (RHS?), 0's indicate that the corresponding status has not been detected since the start of test; 1's indicate that status was or is detected. The 6-digit word is formatted as SFDZOX where:

S = 1 if Signal loss detected; 0 if not.
F = 1 if Frame loss detected; 0 if not.
D = 1 if Data sync loss detected; 0 if not.
Z = 1 if Excess Zeroes detected; 0 if not.
O = 1 if All ones detected; 0 if not.
X = 1 if X-bit detected; 0 if not.

Note: 4. The RDP command "snapshots" the current receiver display and outputs the 10-11 character ASCII result to the remote interfaces. The following illustrates display formats:

DISPLAY FUNCTION	FORMAT
Measurements:	
Error Measurements:	
Total Errors Since Start of Test	'nnnnnnnTOT'
Current Error Rate Over 10**7 Bits	'n.nE-x BER'
Average Error Rate Since Test Start	'n.nE-xx AVG'
Total Error Seconds Since Test Start	'nnnnnnESEC'
E-5 Threshold Error Seconds Since Test Start	'nnnnnn E-5'
E-4 Threshold Error Seconds Since Test Start	'nnnnnn E-4'
E-3 Threshold Error Seconds Since Test Start	'nnnnnn E-3'
Total Dribbling Errors Since Test Start	'nnnnnnnDRB'
% Error Free Seconds Since Start of Test	'nn.nnnn %EF'
Status Second Measurements:	
Signal Loss Seconds	'nnnnnnSGLS'
Frame Loss Seconds	'nnnnnnFRAM'
Data Sync Loss Seconds	'nnnnnnSYNC'
Excess Zeroes Seconds	'nnnnnnZERO'
All Ones Detected Seconds	'nnnnnnONES'
X-Bit Detected Seconds	'nnnnnnXBIT'
Jitter Measurements:	
Current Jitter Amplitude	'nn.nn UICUR'
Maximum Jitter Amplitude Since Test Start	'nn.nn UIMAX'

TABLE G (CON'T)

REMOTE CONTROL COMMANDS

DISPLAY FUNCTION	FORMAT
Current Weighted Jitter	'nn.nn WJCUR'
Maximum Weighted Jitter Since Test Start	'nn.nn WJMAX'
Jitter Threshold (Amplitude)	'nn.nn UITHR'
Jitter Threshold (Weighted)	'nn.nn WJTHR'
Jitter Threshold Hit Seconds	'nnnnnnHSEC'
Time:	
Time Interval	'dd-hhmm:ss'
Elapsed Time	'dd-hhmm:ss'
Time-of-Day	' hhmm:ss'
Date	' dd-mmm-yy'
Auxiliary Functions:	
Printer:	
Printer Function Select Prompt	'PRINTER? '
Printer Off/Bit/BPV Select	'PRINT xxx'
Error Second Printout Off/On Select	'ERRSEC xxx'
Error Second Printout Squelch Select	
No Squelching (All Err Secs Printed)	'SQELCH OFF'
Squelch On E-5/E-4/E-3 Error Rate	'SQU ON E-x'
Squelch On Any Errors	'SQU ON ANY'
Snapshot Measurements for Summary and/or Recall	'SNAPSHOT?'
Recall Measurement Display Off/On	'RECALL xxx'

5.80 In general, control commands are of the form 'FAA' where 'F' is an 'X' or an 'R' for transmitter or receiver function, respectively, and 'AA' is the first two characters of the associated key's front-panel label. For example, XFR is the command for the transmitter key labeled FRAME. Exceptions occur when this convention would create duplicate commands (there are two RX 'SELECT' keys). Status commands are formed by simply adding a '?' to the end of the corresponding control command; i.e., XFR? returns current transmitter framing mode.

S5104 Output to GPIB

5.81 As shown in Table G, the S5104 provides commands to access every front panel control. Status information can also be returned as needed. In addition, several other commands are provided to SNAPSHOT transmitter and receiver displays, and receiver signal status (current and history). These commands and the corresponding output format are included in Table G.

Status Output Commands

5.82 All S5104 status outputs are formatted as ASCII messages terminated by a carriage return. If multiple status commands are sent in a single command line, each output message will be separated by a carriage return. For example, the command sequence "RFR?, RPA?" would result in

Ø <CR> Ø <CR> being queued for output if the current receiver framing and pattern were FRAMED and PRBS.

Display Output Commands

5.83 Two commands, XDP and RDP, are provided to SNAPSHOT the current transmitter and receiver displays, respectively. After receipt of one of these commands, the S5104 will output the ASCII-formatted display message when addressed to talk. The message will be terminated by a carriage return. Since all S5104 measurements can be displayed on the receiver display, all measurement capabilities are available for output to a remote controller.

5.84 Displays are described in detail in preceding sections covering transmitter and receiver front-panel operation. Table G shows the format for all display functions.

Automatic Print Functions

5.85 Error-second and summary measurements may be obtained by selecting test set printer outputs and configuring the instrument to talk. These outputs are particularly useful when the test set is in the talk-only mode, outputing to a listen-only printer.

Service Request and Serial Poll Response

5.86 Several conditions detected in the S5104 will cause it to request service of the GPIB controller. The ability of the S5104 to request service may be inhibited by the rear panel DIP switch as described in subsection 5.57, GPIB Option Selection.

5.87 When the controller detects a service request, it should serial poll the S5104 to determine if it is requesting service and why. In response to a Serial Poll Addressed to the S5104, the S5104 will place its 8-bit GPIB status byte on the DIO lines. The S5104 clears its status byte when it receives a Serial Poll Disable (SPD) command. The GPIB status byte is also cleared on power-up and in response to device clear. Only the service request bit in the status byte is reset by an interface clear.

Service Request, GPIB Status Byte

5.88 The following conditions will cause the S5104 to request service, if SRQ is enabled:

MOST-SIGNIF. HEX DIGIT				LEAST-SIGNIF. HEX DIGIT			
7	6	5	4	3	2	1	BIT Ø
Ø	RQS	Ø	Ø	POWER LOSS	CMD ERR	BUS ERR	TALK REQ

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- Bus Error (BIT 1) - Bus error occurs when the S5104 is addressed to talk with no listeners active on the bus. Since a source handshake may have been started by the talking S5104 with no acceptor to complete the handshake, this error may hang up the bus. This condition can be cleared and detected by the controller issuing an interface clear followed by a serial poll. The ON condition for the bit is 1.

- Cmd Error (BIT 2) - Command error occurs when the S5104 detects an invalid device-dependent command as described earlier under Device-Dependent Commands, subsection 5.73. The command error bit is set in the GPIB status byte. The ON condition for the bit is 1.

- Talk Request (BIT 0) - When the S5104 has data to output, but is not addressed to talk, it will generate a service request with the talk request bit set in the GPIB status byte. The ON condition for the bit is 1. If configured to talk before serial

polled, this bit will be cleared in the status byte. If no other bits are set, the service request will be deasserted.

- Power Loss (BIT 3) - If power to the S5104 is lost and recovered, the POWER LOSS bit will be set in the GPIB status byte. Commands issued while power was lost are not accepted by the S5104. On recovery from power failure, the S5104 may not be in the mode commanded by the controller. Subsection 5E describes S5104 response to power failure and subsequent recovery. The ON condition for the bit is 1.

5.89 The SRQ bit is on (1) whenever one or more of the other bits (power loss, cmd error, bus error, or talk request) is on and service request has been enabled by DIP switch 1.

5.90 Multiple bits may be set in the status byte when it is polled. All bits are cleared following a serial poll.

5.91 Status displayed by front panel indicators is not available through the GPIB status byte acquired by serial polling. S5104 status may be obtained as described earlier under Output Status Commands.

5.92 The S5104 will not respond to parallel polling commands.

Serial Polling

5.93 The GPIB status byte may be accessed from the S5104 by serial polling as follows:

1. Issue 'UNT' universal untalk command.
2. Issue 'SPE' serial poll enable command.
3. Issue controller listen address.
4. Issue 'MTA' S5104 S5104 talk address.
5. Receive 'STB' S5104 S5104 status byte.
6. Issue 'UNT' or 'OTA' S5104 test set untalk command.
7. Issue 'SPD' serial poll disable command.

Note: A random loss of the SRQ bit may occur after the S5104 has generated a service request and has been polled. It is recommended that the user check for any bits set in the serial poll status word to determine if the S5104 may have requested service.

H. Jitter Selection and Measurement

5.94 If the Jitter Option is installed, jitter may be applied to the transmitter clock and data and may be measured. This section describes all jitter option functions.

Transmitter Jitter Injection

5.95 There are three transmitter jitter modes: Internal, External, and No Jitter. The following paragraphs describe transmitter jitter injection modes.

Internal Jitter Generation

5.96 The jitter option provides an internal jitter generator to sine-wave modulate transmitter clock and data. The user may program jitter frequency and amplitude. The 4-character transmitter display may show either error rate or jitter parameters. The display control indicator above the JITTER and Error MODE pushbuttons indicate which function is currently being displayed. When the TRANSMITTER Display is currently showing error rate, pressing the JITTER pushbutton will cause the most recently

selected jitter parameter to be displayed. Jitter frequency is the power-up default jitter display.

5.97 When jitter frequency is first selected, the current jitter frequency is displayed non-flashing. A JITTER keyhit (pushbutton pressing) will place the frequency in edit causing the FREQ indicator and the left-most frequency display digit to flash. A second JITTER keyhit will cause the "in edit" frequency to be saved and the jitter amplitude to be displayed non-flashing. Jitter amplitude is displayed in unit-intervals (bits peak-to-peak). The next JITTER keyhit will place the amplitude "in edit", causing the AMPL indicator and left-most amplitude display digit to flash. Another JITTER keyhit will save the "in edit" amplitude and cause the current jitter enable status to be placed "in-edit". If neither internal nor external jitter injection is enabled, the INT indicator will flash and OFF will flash in the display. Internal jitter may be enabled by selecting the enable state with either CHANGE (↓ ↑) pushbutton. With INT jitter flashing ON, another jitter keyhit will cause INT to be displayed non-flashing, and cycle the TRANSMITTER Display to the previously selected jitter frequency. With INT jitter flashing OFF, another JITTER keyhit will cause the INT indicator to extinguish and the EXT indicator to begin flashing. External jitter may be enabled as described in paragraph 5.106.

Internal Jitter Frequency Selection

5.98 Jitter frequency is displayed in units of Hertz. Display format will be a.bc,x where a.bc is the 3-digit mantissa (1.00-9.95) a=1-9, b=0-9, c=0,5 and x is the power of ten exponent (0-5). Jitter can range from 1 Hz (1.00,Ø) to 200 kHz (2.00,5).

5.99 When jitter frequency is placed "in edit" as previously described, the leftmost display digit will flash and may be incremented or decremented using the CHANGE pushbuttons. When ENTERed, the leftmost digit will stop flashing and the first digit to the right of the decimal point will begin flashing. The flashing digit may be selected or modified using the ENTER or CHANGE pushbuttons. When ENTERed, this digit will stop flashing and the right-most mantissa digit will begin to flash. This digit may be toggled between Ø and 5 using either CHANGE pushbutton. When ENTERed, this digit will stop flashing and the exponent digit will begin to flash. The exponent may be incremented or decremented using the CHANGE pushbuttons. When ENTERed, the FREQ indicator and display will stop flashing and the selected jitter frequency will be saved. If internal jitter is currently enabled, as indicated by the INT indicator, the transmitter output will be jittered at the new frequency. Partially edited jitter frequency is also saved when the user exits frequency edit by hitting the JITTER pushbutton. The user is not allowed to exit edit if the jitter frequency is not in the allowable range.

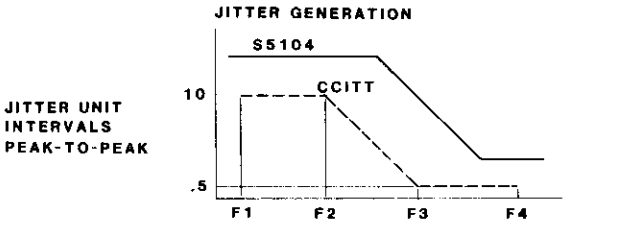
5.100 If the user tries to save a frequency that is not in the allowable range, the display will flash HIGH. The next JITTER, ENTER, or CHANGE pushbutton pressed will place the left-most frequency digit back in edit.

Internal Jitter Amplitude Selection

5.101 Jitter amplitude will be displayed in unit-intervals (bits peak-to-peak). Display format will be nn.nn where nn.nn is the 4-digit amplitude (00.05-12.00).

5.102 When jitter amplitude is placed "in edit" as previously described, the leftmost display digit will flash and may be incremented or decremented using the CHANGE pushbuttons. When ENTERed, this digit will stop flashing and the next digit to the right will begin flashing and may be selected or modified using the ENTER or CHANGE pushbuttons. Jitter amplitude range

varies according to data rate and selected jitter frequency. The following illustration (Fig. 17) identifies amplitude ranges for different data rates over their full jitter frequency ranges. The fourth (rightmost) digit may only be selected between 0 and 5. When the last digit has been ENTERed, the new jitter amplitude will be saved and the AMPL indicator and Display will stop flashing. If jitter is currently enabled, as indicated by the INT indicator, jitter will be injected at the new jitter amplitude.



	F1	F2			F3			F4		
		DS1	DS1C	DS2	DS1	DS1C	DS2	DS1	DS1C	DS2
CCITT	2	200	-	1600	4k	-	32k	40k	-	160k

Fig. 17-S5104 Jitter Generation

5.103 Incompletely edited jitter amplitude will be saved when the user exits edit by hitting the JITTER pushbutton. The user is not allowed to exit edit if the jitter amplitude is not in the allowable range.

5.104 If the user tries to save an amplitude that is not in the allowable range, the Display will flash HIGH. The next JITTER, ENTER, or CHANGE pushbutton pressed will place the leftmost amplitude digit back in edit.

Enabling/Disabling Internal Jitter

5.105 When the internal jitter enable state is "in edit", the INT indicator and the TRANSMITTER Display will flash. The flashing state (ON or OFF) may be selected using the ENTER or CHANGE pushbuttons. When selected, the new state immediately takes effect. When ENTERed, the INT indicator remains on if internal jitter is ON. The INT indicator goes out if internal jitter is disabled. Internal jitter may be applied in all transmitter modes; i.e., any Data Rate (DS), Pattern, Framing, Error mode, and thru mode.

Special Considerations In Jitter Selection

5.106 The following special considerations apply due to jitter injection limitations:

- If the transmitter data rate is changed, the currently selected jitter frequency and/or amplitude may not be valid. For example, from Fig. 17, one can see that an amplitude of 6 unit intervals (UI) at 4 kHz is valid for DS2, but not for DS1 or DS1C data rates. Similarly, an amplitude of 1 unit interval is allowed at 100 kHz for DS1C and DS2, but 100 kHz jitter is not permitted at DS1. If the Tx data rate is changed and the currently selected jitter frequency and/or amplitude is too high, unpredictable jitter generation will result. If jitter frequency or amplitude is currently displayed and invalid, the display will flash HIGH.

- When jitter frequency is edited such that the previously selected jitter amplitude exceeds the maximum amplitude allowed for the current data rate and jitter frequency, unpredictable jitter generation can occur. If amplitude is shown and is now overrange, the display will flash HIGH.

- If the jitter option is not installed, hitting the JITTER button will cause the jitter display control indicator to light and the TRANSMITTER Display to show N/A. The jitter FREQ, AMPL, INT, and EXT indicators will remain off. Additional JITTER keyhits will be ignored.

External Jitter Injection

5.107 An externally generated jitter modulation signal may be applied to the jitter BNC connector on the rear panel of the S5104. When external jitter is enabled, this signal shall be used to modulate the transmitter clock and data. External jitter injection may not be selected while internal jitter generation is enabled. Conversely, internal jitter generation may not be enabled while external jitter is enabled. The amplitude of externally applied jitter will be measured and may be displayed. External jitter will be checked for overrange. If overrange, the display will indicate overrange, but external jitter injection will not be inhibited.

Enabling/Disabling External Jitter

5.108 When the external jitter enable state is "in edit", the EXT indicator and the TRANSMITTER Display will flash. The flashing state (ON or OFF) may be selected using the ENTER or CHANGE pushbuttons. When selected, the new state immediately takes effect. When ENTERed, the EXT indicator remains on if external jitter is ON. The EXT indicator goes out if external jitter is disabled. External jitter may be applied in all transmitter modes.

5.109 When external jitter is enabled, the JITTER pushbutton selects between amplitude display and external jitter edit state.

External Jitter Amplitude Measurement

5.110 When external jitter injection is enabled, the amplitude of the externally applied jitter modulation signal will be measured and displayed in unit-intervals. The amplitude display will be in the format nn.nn. One peak amplitude measurement is the sum of the maximum of 10 positive peak readings and the maximum of 10 negative peak readings. Both a positive and a negative peak reading are taken every 100 milliseconds. Amplitude is calculated as follows:

Amplitude = (Max (Pos Peak Reading) + Max (Neg Peak Reading)) *.025 UI

External Jitter Amplitude Overrange Check

5.111 When external jitter injection is enabled, the externally applied jitter modulation signal will be range-checked. The signal will be considered overrange if any of the following conditions are detected:

- Jitter amplitude positive peak exceeds 6 unit intervals.
- Jitter amplitude negative peak exceeds 6 unit intervals.
- High-pass filtered amplitude positive peak exceeds .25 unit intervals.
- High-pass filtered amplitude negative peak exceeds .25 unit intervals.

5.112 The first two overrange conditions above are tested for in conjunction with making the amplitude measurements described in paragraph 5.110. The other two conditions above are tested by high-pass filtering the externally applied signal, taking 10 positive peak readings and 10 negative peak readings, and examining the maximum. Readings are taken every 100 milliseconds.

5.113 If an overrange condition is found, the transmitter jitter display will alternate between the display of the measured jitter and the overrange indication (HIGH). Maximum jitter in the THRU mode is 11 unit intervals.

Receiver Jitter Measurements

5.114 With the Jitter Option installed, jitter amplitude on the receiver clock may be measured independently of transmitter jitter functions. Table H lists jitter measurements which may be made and their display formats.

TABLE H

JITTER MEASUREMENTS

JITTER MEASUREMENT	DISPLAY FORMAT
Current Jitter Amplitude	nn.nn UICUR
Maximum Jitter Amp Since Test Start	nn.nn UIMAX
Current Weighted Jitter	nn.nn WJCUR
Maximum Weighted Jitter	nn.nn WJMAX
Jitter Threshold	nn.nn UITHR
Weighted Jitter Threshold	nn.nn WJTHR
Jitter Threshold Hit Seconds	nnnnnn HSEC

Current Jitter Amplitude Measurement

5.115 When the Jitter Option is installed, current jitter amplitude shall be continually monitored and saved for display. A new current amplitude measurement is made once a second. One measurement is calculated from the sum of the maximum of 10 positive peak readings and the maximum of 10 negative peak readings. Both a positive and negative peak reading are taken every 100 milliseconds. Current amplitude is calculated as follows:

Amplitude = (Max (Pos Peak Reading) + Max (Neg Peak Reading)) *.025 UI.

5.116 Current jitter amplitude is displayed in the form nn.nn UICUR where nn.nn is the amplitude measurement in unit-intervals. If either the positive or negative peak reading exceeds 5.5 unit intervals, the amplitude measurement is overrange and "HIGH" shall flash in the nn.nn measurement field.

Maximum Jitter Amplitude Measurement

5.117 With the Jitter Option installed and testing IN PROCess, current jitter amplitude shall be monitored for a maximum peak-to-peak reading since start of test. At test start, the maximum is initialized to 0.00 unit intervals. Each new current amplitude measurement is compared against the current maximum. If the current amplitude exceeds the current maximum, it is saved as the new maximum amplitude measurement.

5.118 Maximum jitter amplitude is displayed in the form nn.nn UIMAX. If an overrange current amplitude measurement is found, the maximum amplitude is also overrange and "HIGH" will flash in the nn.nn measurement field.

Current Weighted Jitter Amplitude

5.119 With the Jitter Option installed, current weighted jitter amplitude shall be continually monitored and saved for display. A new weighted jitter measurement is made once a second. Weighted jitter measurements are made by passing the received jitter signal through a highpass frequency weighting filter, then measuring the output amplitude. One weighted jitter measurement is calculated in the same manner as current amplitude measurements:

Amplitude = (Max (Pos Peak Reading) + Max (Neg Peak Reading)* TBD.

5.120 Current weighted jitter is displayed in the form nn.nn WJCUR where nn.nn is the amplitude measurement in WJITS. If either the positive or negative peak reading exceeds TBD4, the weighted jitter measurement is overrange and "HIGH" will flash in the nn.nn measurement field.

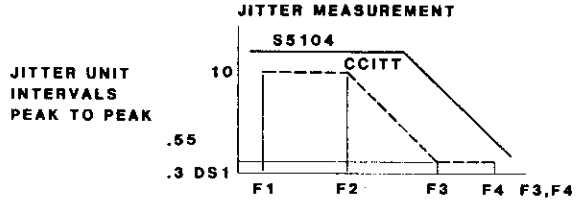
5.121 It is obvious from the curve shown in illustration Fig. 18 that the same jitter amplitude at different frequencies may have a totally different effect on system performance. This implies that jitter amplitude measurements are not an adequate indicator of jitter severity. By frequency weighting the measured jitter modulation signal, a single output can be obtained which is proportional to the jitter's detrimental effect, regardless of frequency. Up to frequency f_3, the frequency weighting function produces an output which is a constant frequency * amplitude product.

5.122 The gain of the freqency weighting function is selected such that WJITS and jitter amplitude are equal at jitter freqency = bit rate/1000.

Maximum Weighted Jitter Amplitude

5.123 If the Jitter Option is installed and testing is IN PROCess, current weighted jitter will be monitored for a maximum peak-to-peak value since start of test. At test start, the maximum is initialized to 0.00 WJITS. Each new current weighted jitter measurement is compared against the current maximum. If the current weighted amplitude exceeds the maximum, it is saved as the new maximum weighted jitter amplitude measurement.

5.124 Maximum weighted amplitude is displayed in the form nn.nn WJMAX. If an overrange current weighted measurement is found, the maximum amplitude is also overrange



	F1			F2			F3			F4		
	DS1	DS1C	DS2	DS1	DS1C	DS2	DS1	DS1C	DS2	DS1	DS1C	DS2
CCITT	10	-	10	200	-	1600	7k	-	32k	40k	-	160k

INPUT BIT RATE TOLERANCE FOR JITTER MEASUREMENT

RATE	FREQ
DS1	1.544 ± 75 PPM
DS1C	3.152 ± 30 PPM
DS2	6.312 ± 32 PPM

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Fig. 18-S5104 Jitter Measurement

and "HIGH" will flash in the nn.nn measurement field.

Jitter Thresholding

5.125 Jitter thresholding provides an additional long-term jitter measurement capability. The user may set either an amplitude or weighted amplitude threshold from the front panel. Once a second, the current amplitude or current weighted amplitude is compared against the threshold. A jitter hit second is counted whenever the current measurement meets or exceeds the preset threshold.

Setting Jitter Hit Threshold

5.126 When jitter measurements are in process, the user may display the current jitter threshold. Jitter threshold is displayed in the form nn.nn UITHR or nn.nn WJTHR where nn.nn is the threshold value, UITHR indicates amplitude threshold measurements, and WJTHR indicates weighted jitter threshold measurements.

5.127 If JITTER THRESHOLD is currently selected for display and testing is stopped, the first MEASUREMENT SELECT pushbutton puts jitter threshold in edit, causing the JITTER measurement indicator and leftmost threshold digit to flash. The flashing digit may be modified or saved by using the CHANGE or ENTER pushbuttons. When this digit is ENTERed, it will stop flashing and the next digit to the right will be placed in edit and begin flashing. When all four threshold digits have been entered, the threshold units may be switched between amplitude (UITHR) and weighted jitter (WJTHR). When threshold units are ENTERed, the display will advance to show jitter threshold hit seconds.

5.128 If testing is currently IN PROcess, jitter threshold may be displayed but may not be edited.

Jitter Hit Seconds Measurement

5.129 When testing is IN PROcess, the current measurements of the threshold type are compared against the preset threshold. Whenever the measurement meets or exceeds the threshold, a jitter hit second shall be counted.

5.130 Jitter hit seconds are displayed in the form nnnnnnHSEC. If the number of hit seconds exceeds 999999, the least significant 5 digits of the overflowed result are displayed preceded by a flashing * (*nnnnnHSEC).

Jitter Measurement Printouts

5.131 If the Jitter Option is installed, jitter measurements will be added into error seconds and summary printouts.

Jitter In Error Second Printouts

5.132 It is desirable to report current jitter measurements with error-seconds as an aid in correlating jitter to error activity. There is room for only one jitter measurement in the 40-column error second printout. An internal DIP switch or jumper plug shall select whether current amplitude or current weighted jitter amplitude shall be reported. The format of an error-second printout is shown in Fig. 19. If the Jitter Option is not installed, the jitter field will be left blank.

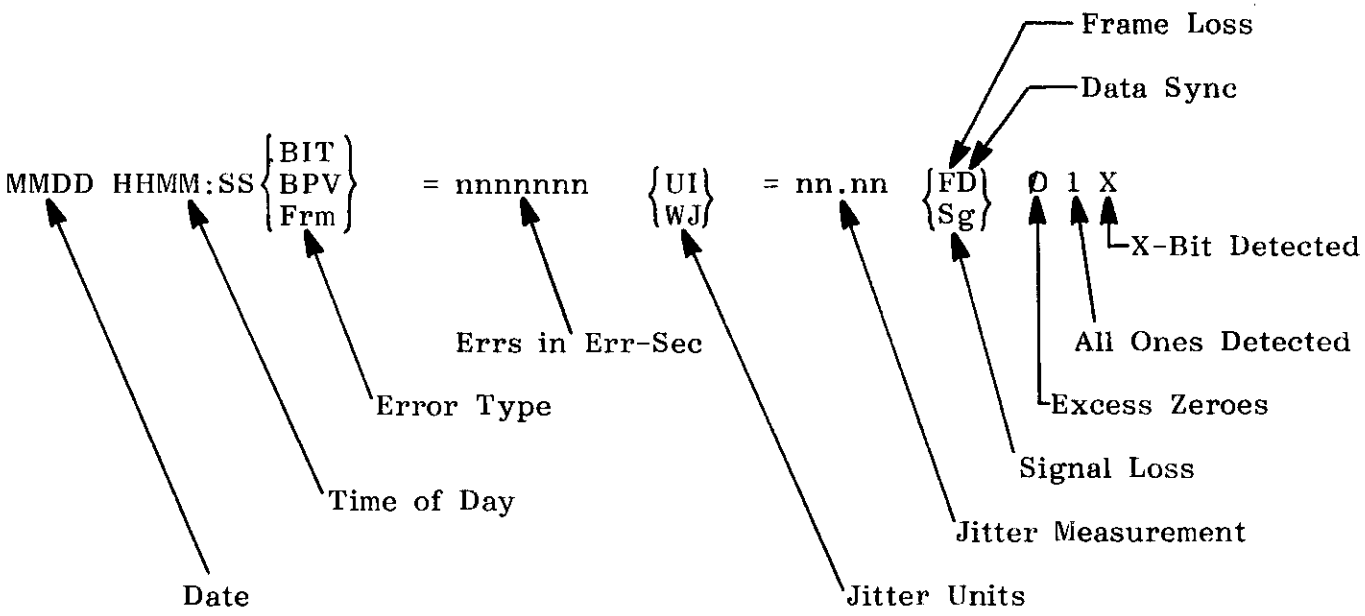


Fig. 19-Error Second Printouts with Jitter

Jitter In Summary Printouts

5.133 When the Jitter Option is installed, three lines will be added to summary printouts to report jitter measurements. Included in the printout will be the following information:

- Maximum amplitude since start of test.
- Maximum weighted jitter amplitude since start of test.
- Jitter threshold and threshold type.
- Number of jitter hit seconds since start of test.

5.134 The format of the additional three lines is shown below:

Jitter Measurement Summary:

Max Amp = nn.nn Max WJIT = nn.nn

Amp / WJIT Thr = nn.nn Hit Secs = nnnnnnn

SECTION 6

THEORY OF OPERATION

6. THEORY OF OPERATION

A. General

6.01 This section explains the theory of operation and the power distribution of the S5104 Digital Transmission Test Set.

6.02 The S5104 Digital Transmission Test Set consist of 11 plug-in printed circuit boards, a motherboard, a front panel board, a rear panel board, a power supply board, and a voltage selector board (see Fig. 20). The S5104 is powered by either 115 Vac or 230 Vac input which is converted to +5V ±.5V by the power supply for internal power distribution.

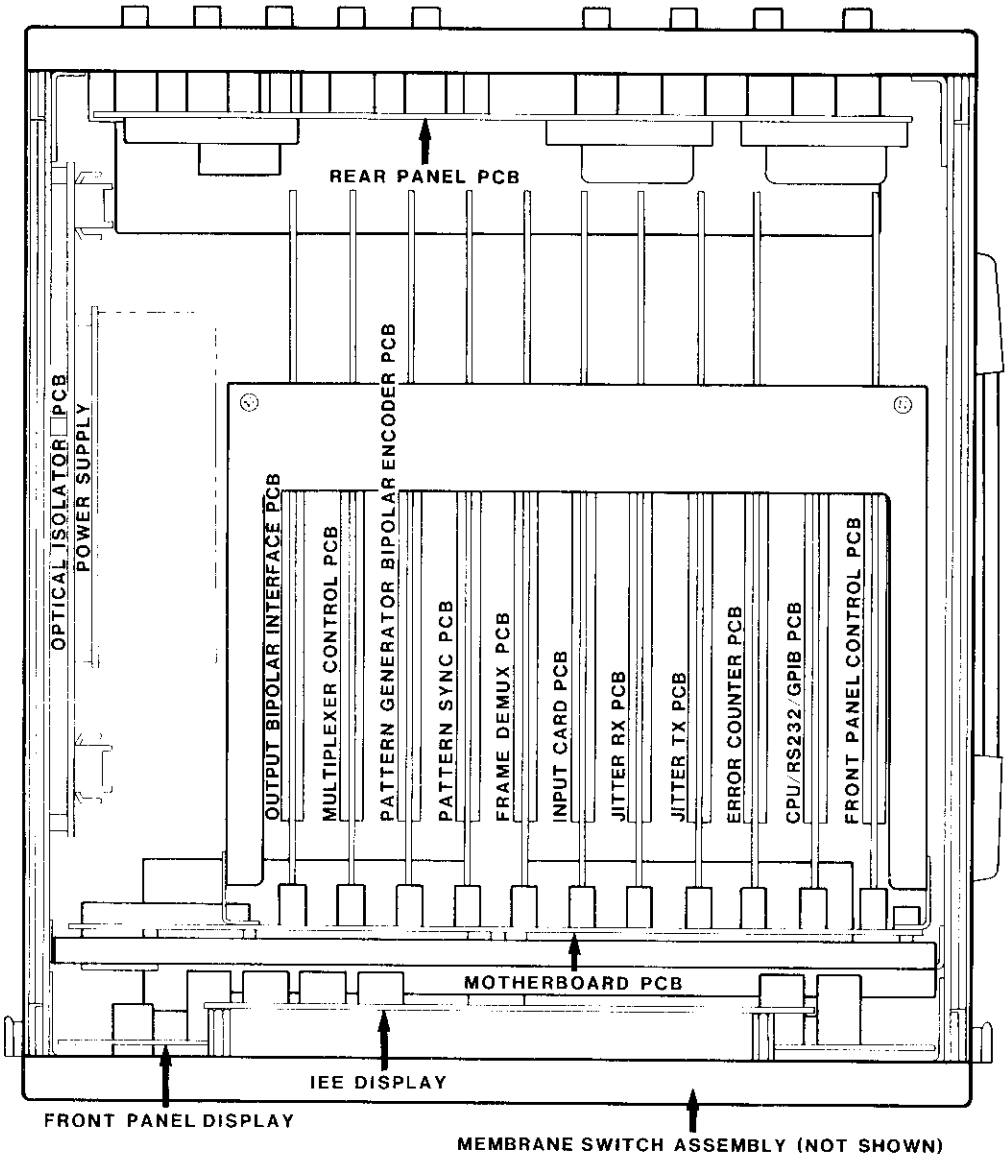


Fig. 20-S5104 Printed Circuit Board Configuration

B. System Concept

6.03 The S5104 system (Fig. 21) can be divided into three subsystems:

- Transmitter and receiver control functions and data processed through the status and control bus.
- Front panel control pushbuttons, indicators, and displays and the Error Counter, Jitter Tx, Jitter Rx, and the CPU/RS-232/GPIB PC boards which are processed through the standard bus.
- Power distribution.

6.04 The Front Panel Control PC board is the communication interface between the status and control bus and the standard bus.

Status and Control Bus

6.05 The transmitter section that uses the status and control bus consists of the Multiplexer Control PC board, the Pattern Generator Bipolar Encoder PC board, and the Output Bipolar Interface PC board.

Muliplexer Control PC Board

6.06 The Multiplexer Control printed circuit board generates the data Stream Signals. These are the DS1 (1.544 MHz), DS1C (3.152 MHz), and the DS2 (6.312 MHz) level signals and are referred to as internally generated clock signals. An external clock signal can be processed instead of the internal clock signals. The rear panel EXT CLK IN BNC connector can accept a clock signal between 1 MHz and 8.2 MHz which is sent to the Multiplexer Control PC board to be processed. A detected external clock signal overrides internal clock signals.

6.07 X-bit injection is controlled and processed by the Multiplexer Control PC board. It can be applied through the X BIT INJECT BNC connector on the rear panel.

6.08 Mark sync pulses are generated by the Multiplexer Control PC board and are sent to the M SYNC BNC connector on the rear panel.

6.09 Transmitter data and clock signals are sent to the Pattern Generator Bipolar Encoder PC board via the status and control bus.

Pattern Generator Bipolar Encoder PC Board

6.10 The Pattern Generator Bipolar Encoder printed circuit board establishes the data pattern of the DS signals. The pseudorandom bit sequence (PRBS), ALL 1'S (111...), and FIXED patterns are generated by this PC board. The FIXED pattern is set by the rear panel PROGRAMMABLE FIXED WORD DIP switches.

6.11 DS1 output pattern is generated by the Pattern Generator Bipolar Encoder PC board and selected by the rear panel DS1 OUTPUT toggle switch. Either a BIPOLAR or a B8ZS (Bipolar 8 Zero Substitution) pattern can be selected. The B8ZS pattern format is generated by taking NRZ signals and sending them to a B8ZS encoder.

6.12 NRZ (Non-Return to Zero) data and clock signals are generated from the Pattern Generator Bipolar Encoder PC board and sent to the NRZ OUTPUT DATA and CLOCK BNC connectors on the rear panel.

6.13 Error sync pulses are generated and sent to the rear panel ERR SYNC BNC connector. PR sync pulses are generated and sent, once every pseudorandom sequence (every $2^{20}-1$ bits), to the PR SYNC BNC connector on the rear panel.

Output Bipolar Interface PC Board

6.14 The Output Bipolar Interface printed circuit board accepts the DS1/1C/2 signals, amplifies them, and sends them to an output buffer. The Signals are then output to two DS1/1C/2 and two DS1/1C OUTPUT jacks on the front panel. These signals are the prime output test signals.

6.15 External errors, applied to the rear panel EXT ERR BNC connector, are inserted into the DS signals through the Output Bipolar Interface PC board. Rate clock errors generated by this PC board are sent to the Error Counter PC board. All errors received at the Error Counter PC board produce a μs error signal which is sent to the Output Bipolar Interface PC board.

6.16 The receiver section that uses the status and control bus consists of the Input PC board, the Frame/Demux PC board, and the Pattern Sync PC board.

Input PC Board

6.17 The Input printed circuit board acts as the interface for receiver input signals. DS1, DS1C or DS2 signals can be input to the Input PC board from the two front panel INPUT DS1/1C/2 jacks. NRZ data and clock signals are received from the rear panel NRZ INPUT DATA and CLOCK BNC connectors.

6.18 Errors, such as BPV and signal loss, from this board are sent to the Error Counter PC board. DS data and clock Signals received by the Input PC board are sent to the Frame/Demux PC board.

Frame/Demux PC Board

6.19 Signals received by the Frame/Demux printed circuit board are processed into patterned (framed) data and clock signals and are then sent to the Input PC board and the Pattern Sync PC board.

6.20 Frame loss and X bit errors are sent to the Error Counter PC board. Frame error is sent to the Pattern Sync PC board.

6.21 Mark sync pulses generated by the Frame/Demux PC board are sent to the rear panel RECEIVER M SYNC BNC connector. X bits generated by this PC board are monitored at the rear panel X BIT OUT BNC connector.

Pattern Sync PC Board

6.22 The Pattern Sync printed circuit board receives pattern data and clock signals and synchronizes the incoming signls, while searching for errors. The pattern sync output is sent to the rear panel PR SYNC BNC connector.

6.23 Detected bit errors are sent to the rear panel BIT ERRORS BNC connector. Sync loss and bit/frm error out errors are detected and sent to the Error Counter PC board.

Standard Bus

Error Counter PC Board

6.24 The Error Counter printed circuit board receives all errors to be counted. The errors are received by accumulators on the board which count the errors and then send the count to a storage register. The storage register makes counts available to the Front Panel Control PC board via the standard bus.

6.25 An error received by the Error Counter PC board produces a μs error signal which is sent to the Output Bipolar Interface PC board.

Jitter Tx and Rx PC Boards

6.26 The Jitter Tx and Rx printed circuit boards are used to generate and receive jitter within the system for line measurements. The Jitter Tx PC board contains a jitter frequency generator which is controlled by an internal microprocessor.

6.27 The rear panel JITTER IN/OUT BNC connector allows for external jitter modulation and is used as a jitter output monitor.

CPU/RS-232/GPIB PC Board

6.28 The CPU/RS-232/GPIB printed circuit board performs the central processing functions and the RS-232C and GPIB interfacing functions. This board contains the microprocessor system 4.9152 MHz oscillator (clock), the Z80 microprocessor, and the input/output bus interface circuitry.

6.29 A rear panel GPIB ADDRESS DIP switch and an RS-232 DIP Switch are used to configure the GPIB and RS-232C interfaces.

Front Panel Control PC Board

6.30 The Front Panel Control printed circuit board communicates between the PC boards on the status and control bus and PC boards on the standard bus. Front panel controls, indicators, and displays connect to the Front Panel Control PC board to interact with the system. A 32.768 kHz signal is generated within this board. A 3.6 Vdc rechargable battery pack on this board maintains memory and clock data during power failures.

Power Distribution

6.31 The S5104 accepts either 115 Vac or 230 Vac (configured by a rear panel voltage selector board and converts this primary power input to +5V ±.5V for internal power distribution. Primary AC power is received by the Optical Isolator PC board after being switched ON by the front panel POWER switch/indicator. This switch controls the AC power input to the power supply. The Power Supply PC board converts the AC voltage to +5V ±.5V and distributes this power as shown in Fig. 22.

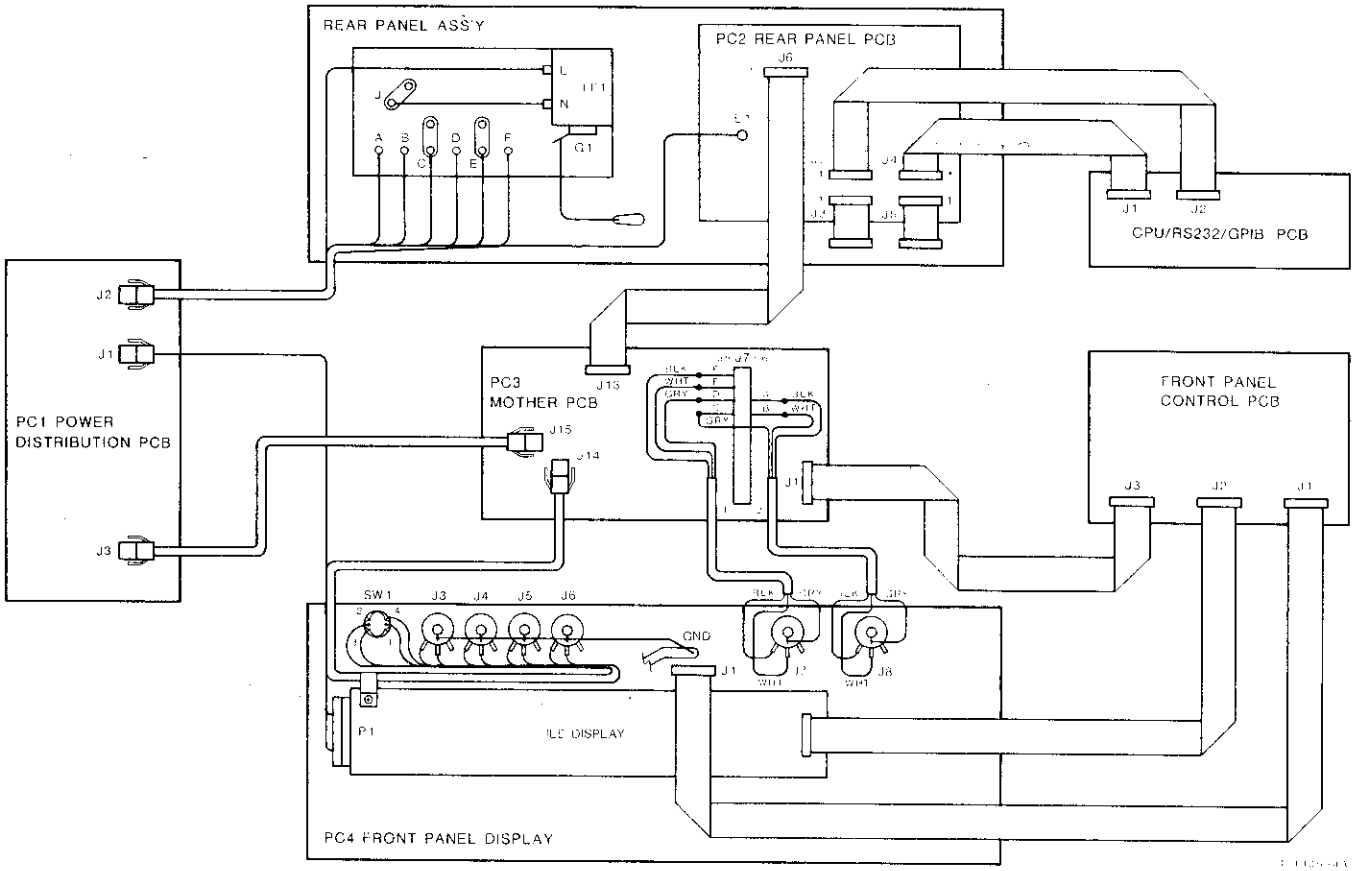


Fig. 22-S5104 Power Distribution

SECTION 7

SERVICE AND MAINTENANCE

7. SERVICE AND MAINTENANCE

A. Assistance

7.01 For service assistance call the Tau-tron Customer Service Dept., (617) 256-9013 or 1-800-TAU-TRON. Their experience and expertise can often save you valuable time in correcting any equipment malfunction.

B. Repair Returns

7.02 If it is determined that the S5104 must be returned to the factory for repair, use the Repair Returns Card at the back of this manual and follow the directions to insure prompt service.

C. Routine Service

7.03 Other then occasionally cleaning the exterior surface with a mild cleaner, no periodic maintenance of the S5104 is required.

D. General Troubleshooting

Warning: Do not attempt access to the inner printed circuit boards without disconnecting the line cord from the power receptacle.

Printed Circuit Boards

7.04 Printed circuit boards (PCBs) may have loosened in the sockets or ribbon cables may have disconnected. If so, perform the following:

STEP	PROCEDURE
1.	Remove top enclosure to get access to the PCBs in the equipment.
2.	Be sure all PCBs are properly seated in the connectors.
3.	Be sure all interconnecting ribbon cables are properly secured to the PCBs.
4.	Replace top enclosure removed in step 1.

DC Voltage

7.05 The Power Supply provides the +5V ±.5V used through out the system. An indication that the supply is operating is as follows:

STEP	PROCEDURE
1.	Set the POWER switch to on; and the POWER indicator lights.
2.	If all the indicators on the front control panel illuminate when the AC power is first applied, the power supply is producing the required voltage. (Note: After a few seconds, some of the indicators will go out putting the equipment in a ready, normal state for operation.)

Nicad Battery Cell

7.06 The unit is equipped with three nicad rechargeable battery cells of 1.2 Vdc each, producing a power-loss and recall backup. The batteries charge when the S5104 is powered ON and will fully charge overnight. Once fully charged, they will hold the charge for more than one year. If the battery cells are discharged or disconnected, the power-up, from a power failure and recall, condition will be incorrect. These cells are located on the Front Panel Control PCB and are of the GOULD 50 BL, 1.2V type. The cell performance can be checked as follows:

STEP	PROCEDURE
1.	Connect a patch cable between OUTPUT-DS1/1C/2 (left) jack and INPUT-DS1-1C/2 (left) jack.
2.	Set the equipment POWER switch to on, and all the front panel indicators light. (Note: After a few seconds, some of the indicators will extinquish and this will put the unit in a ready, normal state for operation.)
3.	Remove the unit power plug from the AC power source (do not turn the POWER switch to off on the S5104). (Note: Setup state and measurements are not retained when the POWER is turned off from the front panel switch.) All front panel indicators will extinquish.
4.	Replace the power plug removed from the AC power source; the front panel indicators will light and the RECEIVER Display will flash "POWER LOSS". The last configuration of data has been stored in memory when the power was lost. (Note: Even when the power was lost, the internal clock continues to keep time.)
5.	Press the INPUT-SELECT pushbutton once, the RECEIVER Display "POWER LOSS" extinguishes and "O TOT" is displayed.

APPENDIX A

DS SIGNAL FORMAT

APPENDIX A

DS SIGNAL FORMAT

A.01 This appendix provides a description of the DS1, DS1C, and DS2 Signal format.

DS1 Signal Format

A.02 The DS1 signal line format (Fig. 23) consists of 24 eight-bit words and one framing bit for a total of 193 bits per frame. The pulse rate of a DS1 signal is 1.544 megabits per second. The code, or form, of the signal is a bipolar (alternate mark inversion) sequence. In this sequence, zeros are transmitted at a zero volt level and ones are transmitted alternately as positive or negative pulses with respect to the zero level (i.e...1101001... is transmitted as ...+-0+00... or ...-+0-00+... depending on the sign of the previous "1").

A.03 The eighth bit of each word is used for pulse code modulation (PCM) for the first five out of six frames and for signaling every sixth frame (see Table I).

A.04 The S-Bit is time-shared between terminal framing (F_T) and signaling framing (F_S).

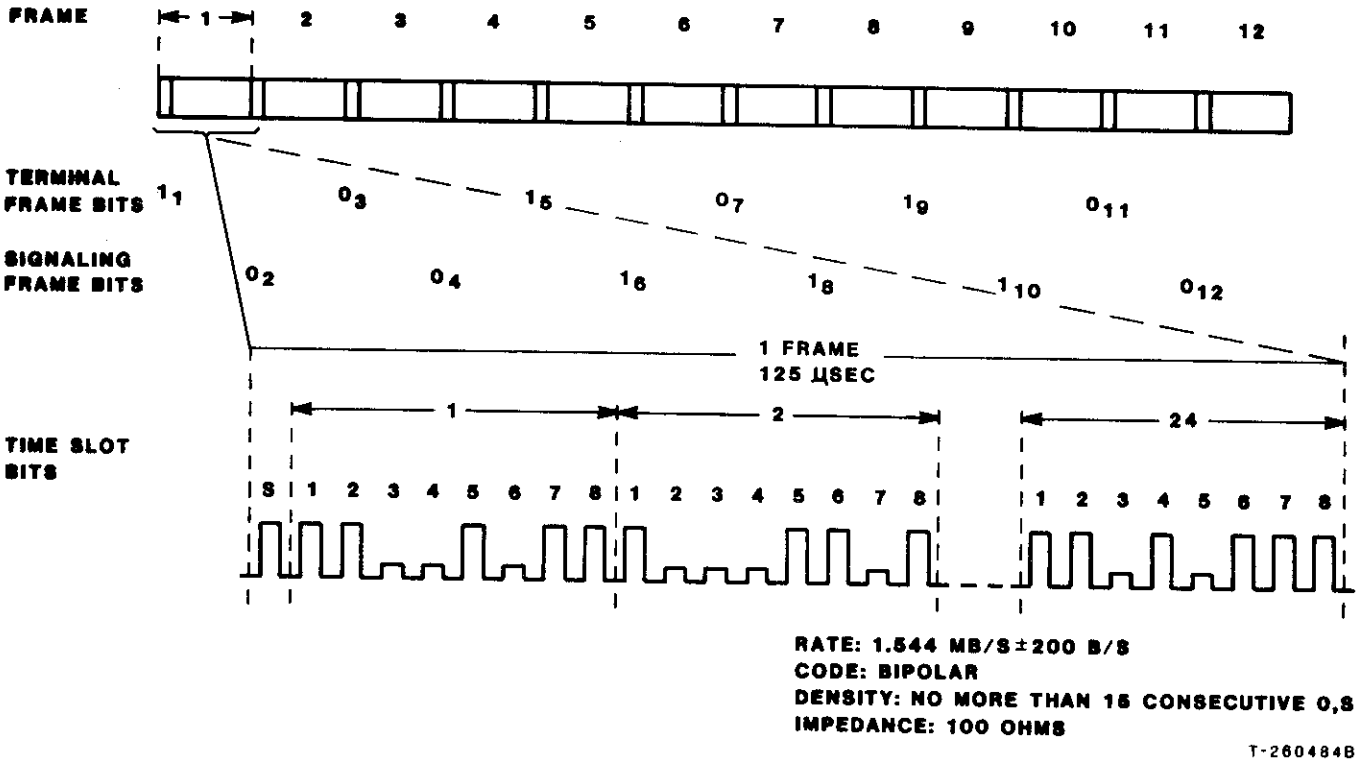


Fig. 23-DS1 Signal Format

TABLE I
S-BIT IN DS1 SIGNAL FORMAT

8-BIT WORD	S-BIT TERMINAL FRAMING F_T	S-BIT SIGNALING FRAMING F_S	INFORMATION CODING BITS	SIGNALING BIT	SIGNALING CHANNEL
1	1	-	1-8	-	
2	-	0	1-8	-	
3	0	-	1-8	-	
4	-	0	1-8	-	
5	1	-	1-8	-	
6	-	1	1-7	8	A
7	0	-	1-8	-	
8	-	1	1-8	-	
9	1	-	1-8	-	
10	-	1	1-8	-	
11	0	-	1-8	-	
12	-	0	1-7	8	B

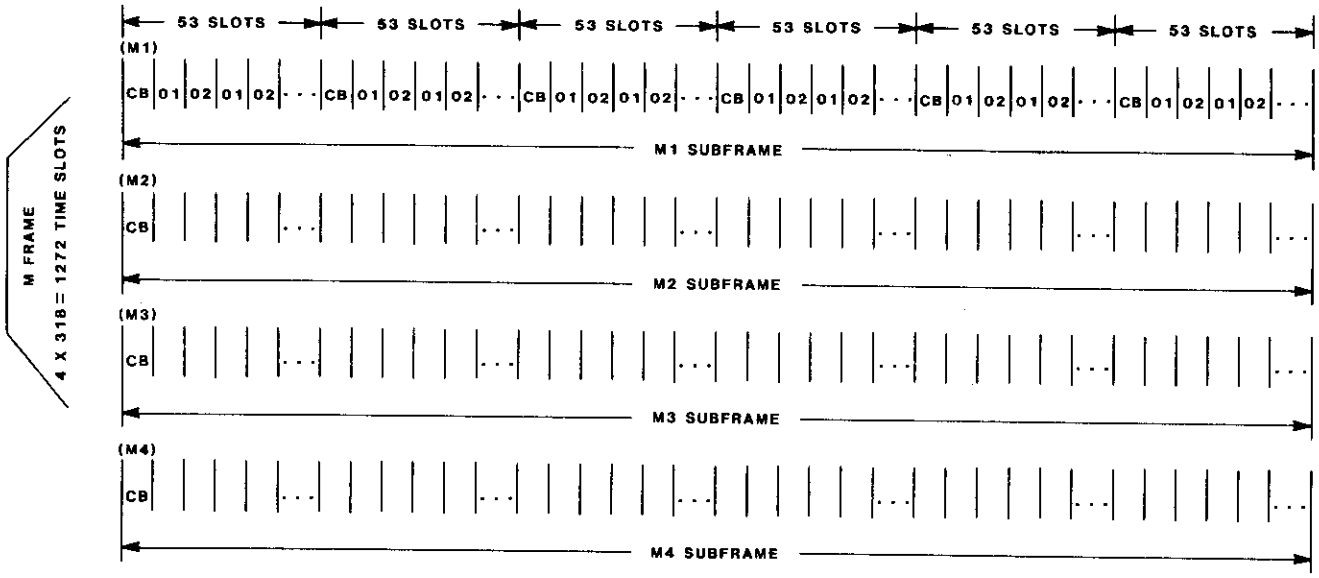
Note: The above sequence is repetitive 6 and 12 above are denoted signaling frames.

DS1C Signal Format

A.05 The DS1C signal (Fig. 24) is composed of two DS1 pseudorandom sequences multiplexed together and scrambled. In addition, control bits allow a demultiplexer to recreate the two original DS1 signals. The two DS1 signals are not in phase. The channel 2 sequence is a one time slot delayed version of the channel 1 pseudorandom sequence.

A.06 In the DS1C signal line format, one control bit is followed by 52 information bits. The information block is composed of alternating bits from DS1 channels 1 and 2. All bits in channel 2 time slots are logical inverse of channel 2 information and stuffed bits. After the two channels are multiplexed, the data is scrambled in a single stage scrambler. The scrambler output is modulo-two sum (exclusive-OR) of the present input bit and the preceding output bit.

A.07 The control bit sequence (see Fig. 25) contains two framing sequences; the F-bit and the M-bit sequence. The F-bit sequences allows the demultiplexer receiver to separate



NOTES:

(1) Ø, DESIGNATES A TIME SLOT DEVOTED TO INPUT I.
THE INFORMATION FROM INPUT 1 AND THE STUFFED BITS USED TO SYNCHRONIZE THIS INPUT ARE CONTAINED IN $Ø_1$.
THE LOGICAL INVERSE, OR COMPLEMENT, OF THE INFORMATION FROM INPUT 2 AND THE STUFFED BITS USED TO SYNCHRONIZE THIS INPUT ARE CONTAINED IN $Ø_2$.

(2) CB = CONTROL BIT.

(3) 6 X 53 = 318 TIME SLOTS PER M SUBFRAME.

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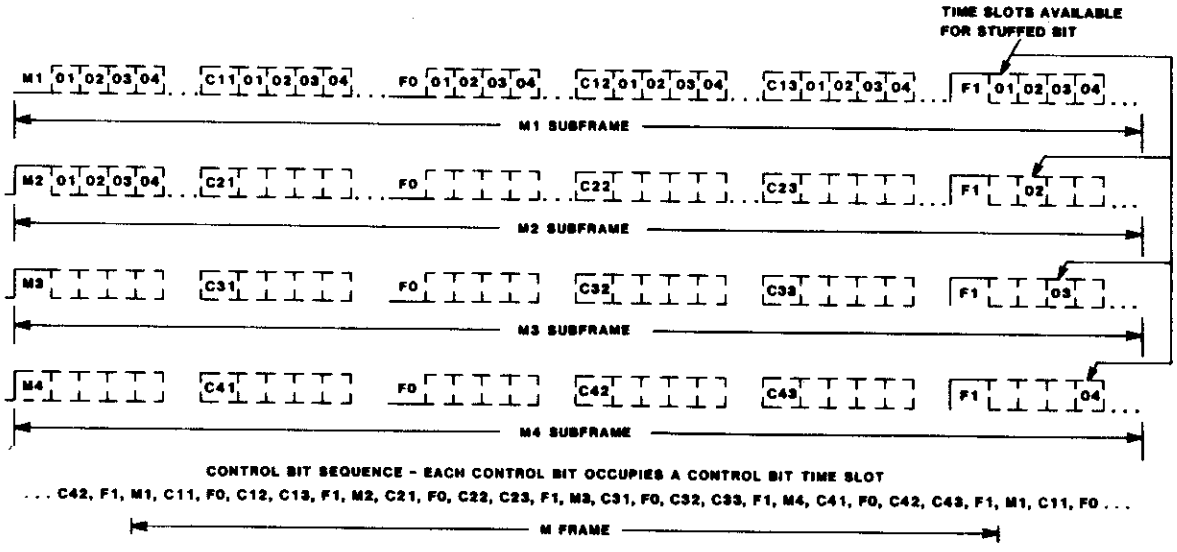
Fig. 24-DS1C Signal Format



NOTES:

(1) THE FRAME ALIGNMENT SIGNAL IS $F_0 = 0$ AND $F_1 = 1$.

(2) M1 M2 M3 M4 . . . IS THE MULTIFRAME ALIGNMENT SIGNAL AND IS 011X . . . WHERE X IS AN ALARM SERVICE DIGIT.

(3) C11 C12 C13 = STUFFING INDICATOR WORD FOR INPUT I.
000 INDICATES NO STUFFING AND 111 INDICATES STUFFING WAS DONE.

(4) THE TIME SLOT AVAILABLE FOR STUFFING INPUT I IS THE FIRST SLOT FOR INPUT I, OI, FOLLOWING F1 IN THE ITH M FRAME.

(5) THE MAXIMUM STUFFING RATE PER DS1 INPUT IS 5367 BITS/SEC.

(6) THE NOMINAL STUFFING RATE PER DS1 INPUT IS 1796 BITS/SEC.

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Fig. 25-DS1C Control Bit Sequence

the data from the control bits. The M-bits allow the demultiplexer receiver to identify the stuffed bit positions in the bit sequence.

A.08 The pulse rate of the DS1C signal is 3.152 Mb/s and the format is bipolar (alternate mark inversion).

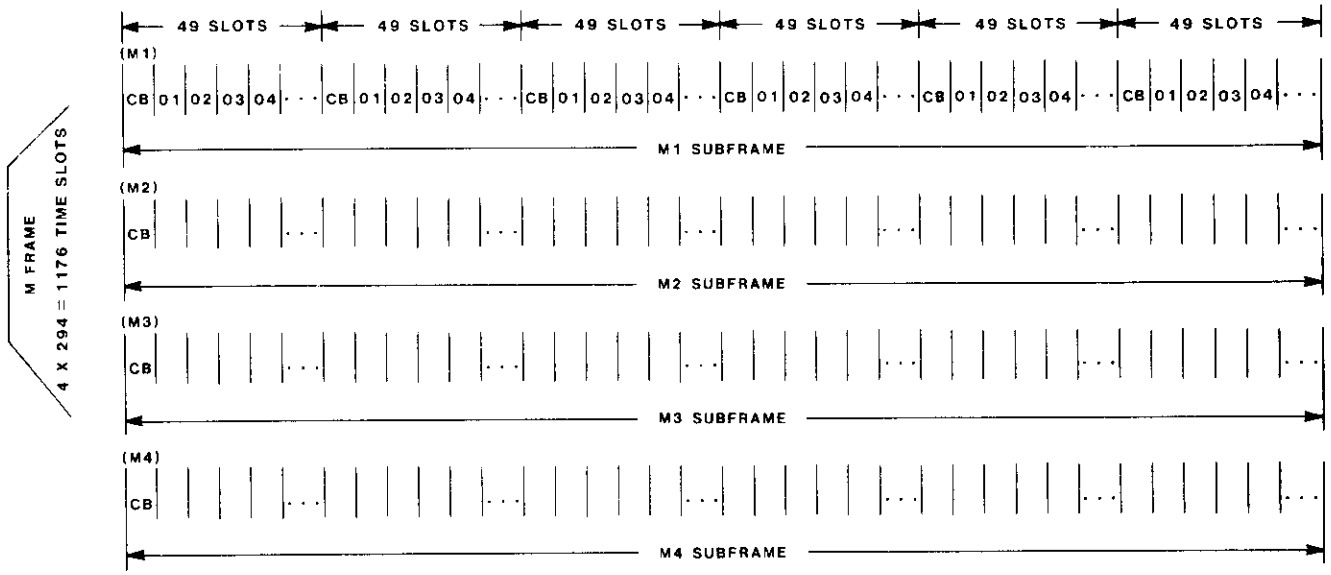
DS2 Signal Format

A.09 The DS2 signal is four DS1 signals multiplexed together along with the control bits needed for a DS2 receiver to demultiplex and destuff the signal back to four DS1 signals.

A.10 Figure 26 illustrates the DS2 signal format. In this format 48 information bits follow a control bit. These 48 information bits contain 12 sets of alternating bits from four DS1 sequences.

A.11 The control bit sequence (see Fig. 27) contains two framing sequences: the F-bit and the M-bit sequence. The F-bit sequence allows the receiver to separate information bits from control bits. The M-bits allow the DS2 receiver to identify the stuffed bits' position in the bit sequence.

A.12 The pulse rate of the DS2 signal is 6.312 Mb/s. The format is bipolar with six zero substitution (B6ZS). With the B6ZS code, each block of six consecutive zeros is removed and a predetermined six-bit code is substituted. If a + pulse precedes a six-zero block, the substituded block is 0+-0-+. If the pulse preceding a six-zero block is a - pulse, the substituted code is 0-+0+-.



NOTES:

(1) Ø, DESIGNATES A TIME SLOT DEVOTED TO INPUT i.
THE INFORMATION FROM INPUTS 1 AND 3 AND THE STUFFED BITS USED TO SYNCHRONIZE THESE INPUTS ARE CONTAINED IN $Ø_1$ AND $Ø_3$ RESPECTIVELY.
THE LOGICAL INVERSE, OR COMPLEMENT, OF THE INFORMATION FROM INPUTS 2 AND 4 AND THE STUFFED BITS USED TO SYNCHRONIZE THESE INPUTS ARE CONTAINED IN $Ø_2$ AND $Ø_4$ RESPECTIVELY.

(2) CB = CONTROL BIT.

(3) 6 X 49 = 294 TIME SLOTS PER M SUBFRAME.

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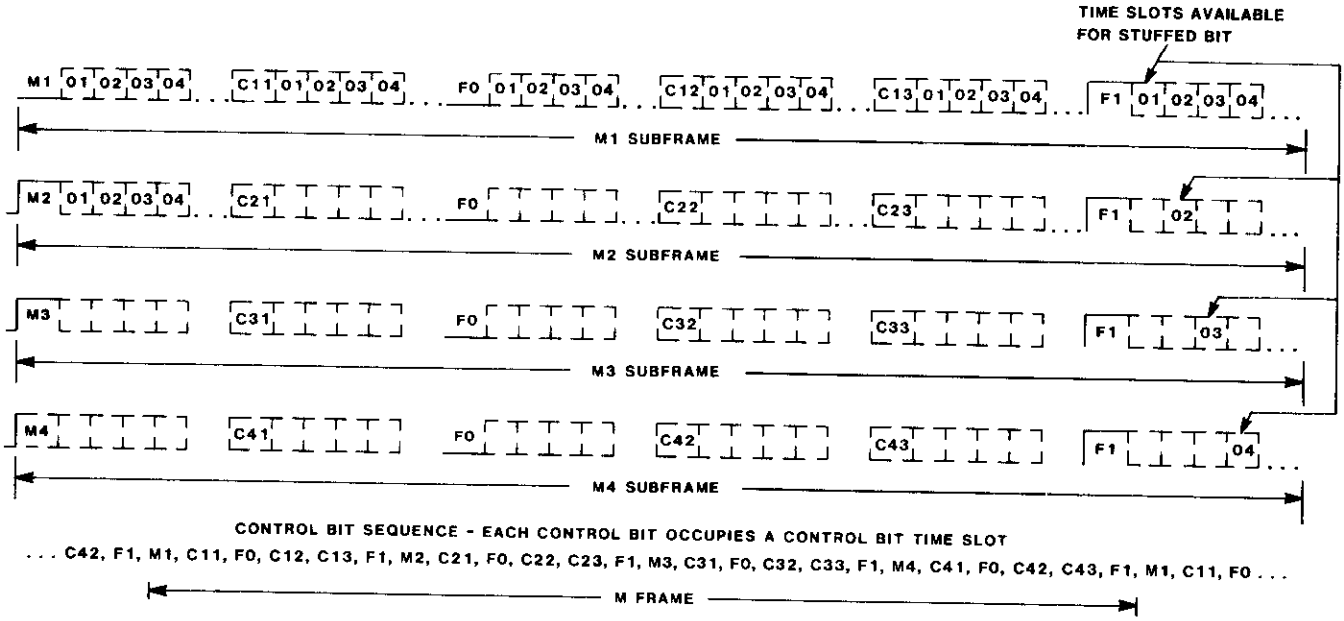
Fig. 26-DS2 Signal Format



NOTES:

(1) THE FRAME ALIGNMENT SIGNAL IS $F_0 = 0$ AND $F_1 = 1$.

(2) M1 M2 M3 M4 . . . IS THE MULTIFRAME ALIGNMENT SIGNAL AND IS 011X . . . WHERE X IS AN ALARM SERVICE DIGIT.

(3) C11 C12 C13 = STUFFING INDICATOR WORD FOR INPUT I.
000 INDICATES NO STUFFING AND 111 INDICATES STUFFING WAS DONE.

(4) THE TIME SLOT AVAILABLE FOR STUFFING INPUT I IS THE FIRST SLOT FOR INPUT I, OI, FOLLOWING F1 IN THE ITH M FRAME.

(5) THE MAXIMUM STUFFING RATE PER DS1 INPUT IS 5367 BITS/SEC.

(6) THE NOMINAL STUFFING RATE PER DS1 INPUT IS 1796 BITS/SEC.

T-100784B

Fig. 27-DS2 Control Bit Sequence

APPENDIX B

HARDWARE VERIFICATION CHECKS

APPENDIX B

HARDWARE VERIFICATION CHECKS

B.01 The S5104 verification checks consist of a step-by-step procedure for Initial Power-Up and six set-up procedures for measurements. The measurements include Transmitter Out, Error Inject, Receiver Input, Measurement Time, Printer Set-Up, and Measurements. Each procedure includes an associated illustration showing related components to support the check.

B.02 In order to simplify the operation, a few basic introductory statements should be stated. When a functional pushbutton is pressed once, it advances the function to the next step/sequence. Continued pressing of the pushbutton advances the function till the desired selection is achieved. The TRANSMITTER Display indicates the selected error inject status or value. The RECEIVER Display indicates the current selected measurement or value. The STATUS-LOSS/DETECT indicators either flash to give history status or light continuously to give current status. For the balance of the checks, a patch cable should be connected between the OUTPUT (left) jack (DS1/1C/2) to the INPUT (right) jack (DS1/1C/2) (Fig. 28).

STEP	ACTION	VERIFICATION
A.	Initial Power-Up Condition (Fig. 28)	
1	Insure 115 or 230 Vac (depending on version purchased), at 50/60 Hz is applied to rear power jack.	
2	Press POWER switch/indicator	POWER and all other indicators light for a few seconds, then the following indicators light: o POWER Transmitter Out • DSX1 • PRBS • UNFRAME Error Inject • BIT • ERR FREE • MODE Measurement Time • UNTIMED • IN PROC

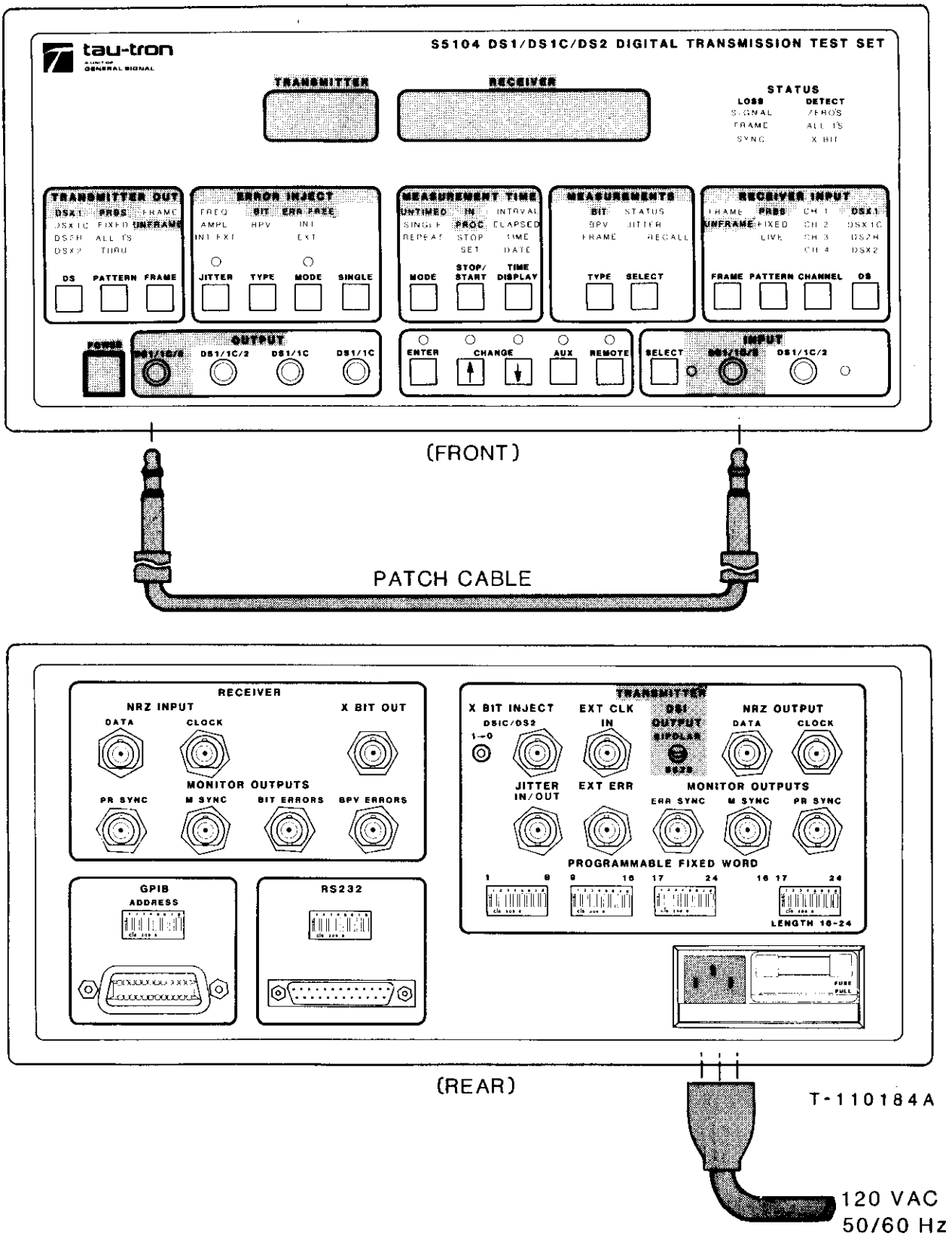


Fig. 28-Initial Power-Up Condition

STEP	ACTION	VERIFICATION
		Measurements • BIT Receiver Input • UNFRAMED • PRBS • DSX1, Input • DS1/1C/2 indicator (Left) TRANSMITTER Display • -- -- -- -- RECEIVER Display o Ø T O T.
3	Verify Transmitter - DS1 OUTPUT switch rear is set properly: BIPOLAR for normal, B8ZS for clear channel.	Up position (normal condition). Down position. Leave switch in BIPOLAR position.
B.	Transmitter Out-Measurement (Fig. 29)	
4	Sequence Transmitter Out-DS pushbutton.	Initial DSX1 indicator extinguishes and next lights, etc.. Selection depends on last depression. Leave indicator in DSX1 position.
5	Sequence PATTERN pushbutton.	Initial PRBS indicator extinguishes and next lights, etc.. Selection depends on last depression. Leave indicator in PRBS position.
6	Sequence FRAME pushbutton.	Initial UNFRAME indicator extinquishes and FRAME lights. Selection depends on last depression. Leave indicator in UNFRAME position.

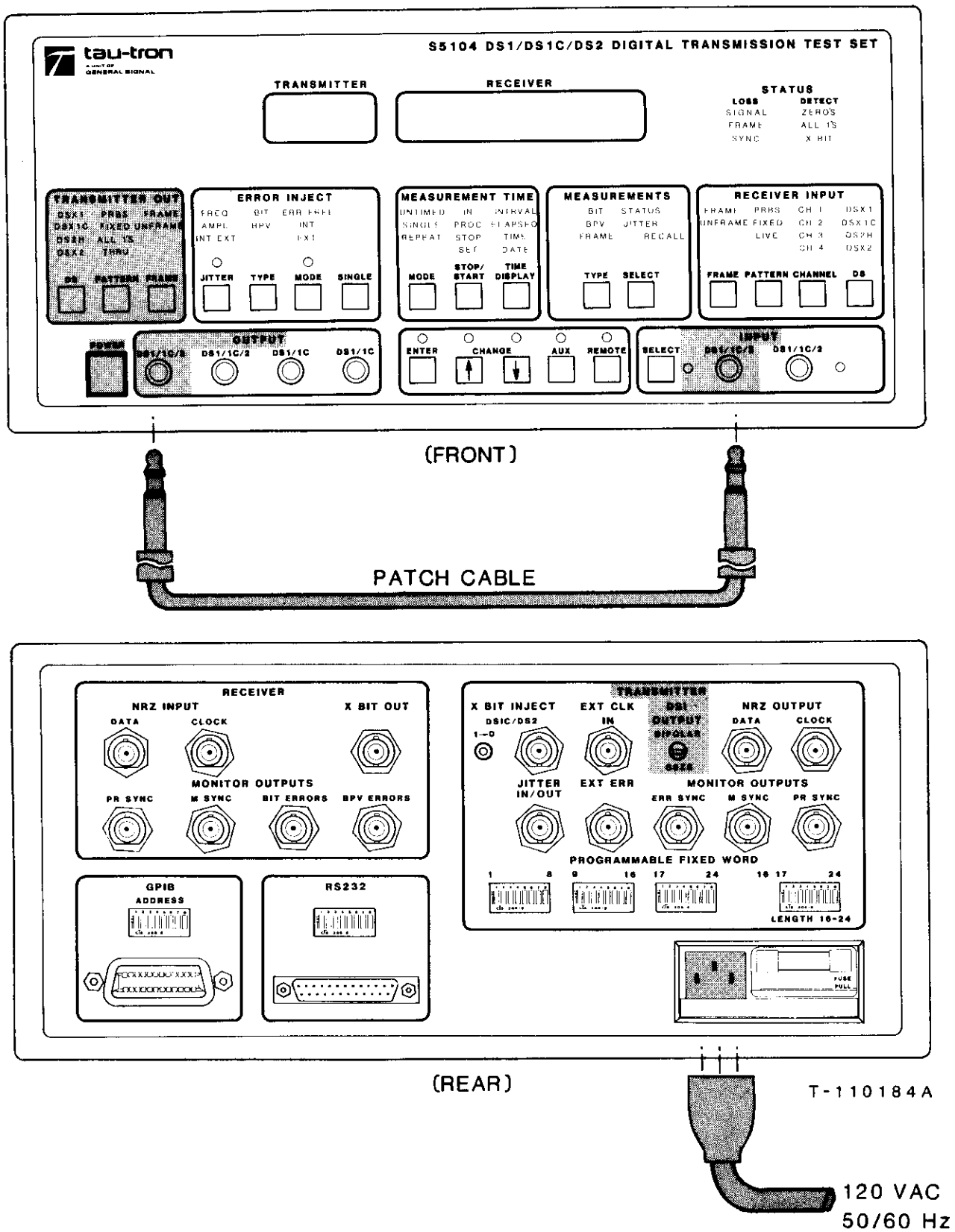


Fig. 29-Transmitter Out Measurement

STEP	ACTION	VERIFICATION
C.	Error Inject-Measurement (Fig. 30)	
7	Error Free-Sequence Error Inject-TYPE pushbutton.	Initial BIT Indicator extinguishes and BPV lights. Selection depends on last depression. Leave indicator in BIT position.
8	MODE pushbutton in ERR FREE.	Initial MODE indicator is lit. ERROR FREE indicator lights (no injected errors on TRANSMITTER display - blanked).
9	Internal - Press MODE pushbutton once.	MODE indicator is lit. INT indicator is flashing.
10	Sequence CHANGE ↑ or ↓ pushbutton to select digits in TRANSMITTER Display.	↑ (increase) pushbutton raises flashing digit in display. ↓ (decrease) pushbutton lowers flashing digit in display.
11	Press Control ENTER pushbutton once.	First digit stops flashing, an another digit starts flashing. Repeat steps 10 and 11 for each digit.
12	External - Press Error Inject MODE pushbutton once.	MODE indicator is lit. INT indicator extinguishes and EXT indicator lights. Display reads 0.0--7 (EXT ERROR RATE). (S5104 is ready to receive an external error input source at rear, Transmitter - EXT ERR BNC connector.)
13	Press MODE pushbutton once.	EXT indicates extinguishes and ERR FREE indicator lights.
14	Jitter-Press JITTER pushbutton twice.	Jitter indicator lights. Display indicates "N/A", if Jitter Option is not available, proceed to Step 25. Display indicates last selected jitter parameter (default is jitter frequency).
15	Press JITTER pushbutton twice.	FREQ indicator flashes.
16	Sequence CHANGE ↑ or ↓ pushbutton to select digits in TRANSMITTER Display.	↑ (increase) pushbutton raises flashing digits in display. ↓ (decreases) pushbutton lowers flashing digit in display.

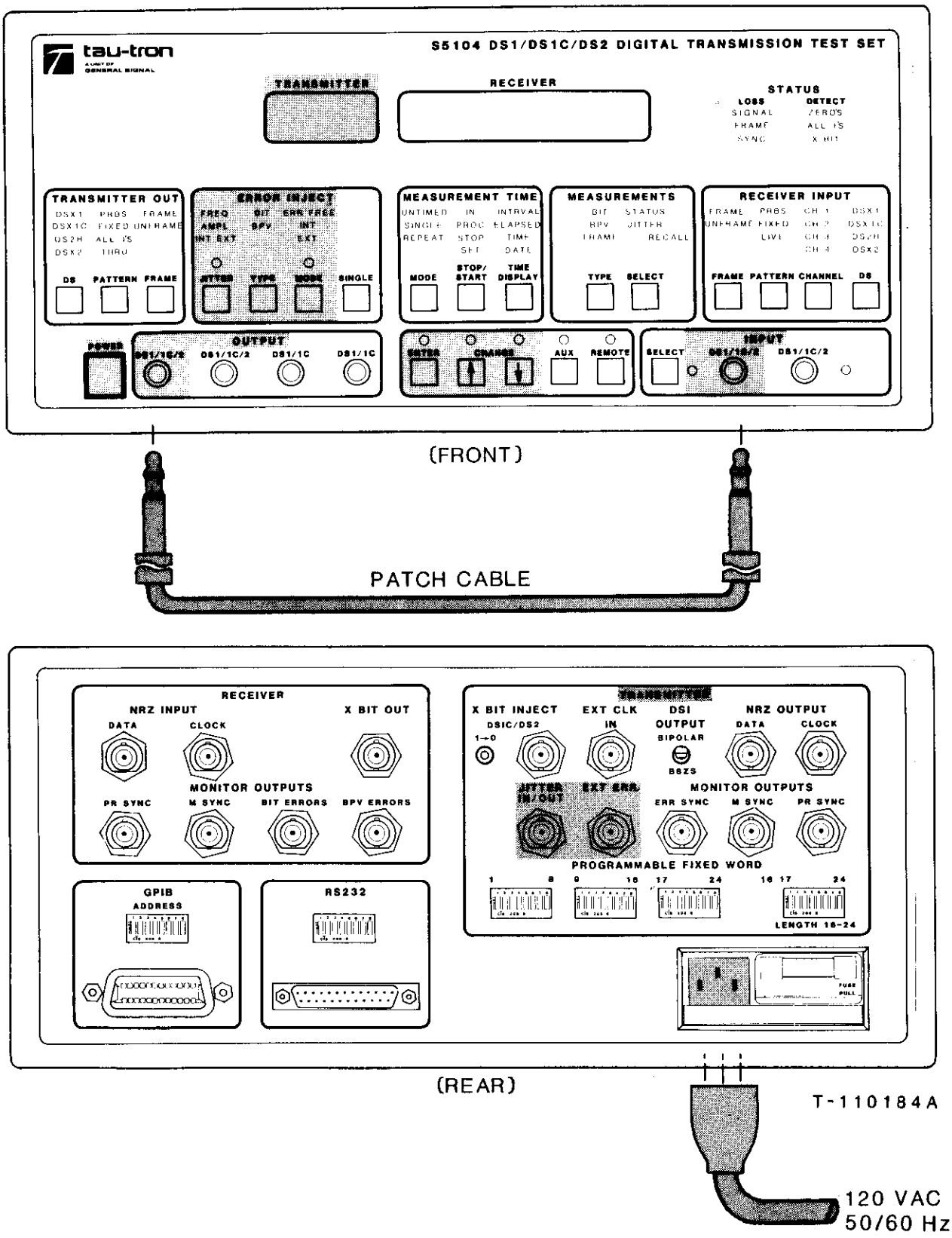


Fig. 30-Error Inject Measurement

STEP	ACTION	VERIFICATION
17	Press Control ENTER push-button once.	First digit stops flashing and another digit starts flashing. (Note: 1st and 2nd digit steps between 0-9, 3rd digit step 0 or 5, and 4th digit steps between 1-5). Repeat steps 16 and 17 for each digit. (Note: If TRANSMITTER Display indicates "HIGH", the jitter frequency and/or amplitude is set to high for a given DS input selection).
18	Press Error Inject JITTER pushbutton once.	AMPL indicator lights. Current jitter amplitude is displayed.
19	Press JITTER pushbutton once.	AMPL indicator is flashing.
20	Sequence CHANGE ↑ or ↓ push-button to select digits in TRANSMITTER Display.	↑ (increase) pushbutton raises flashing digits in display. ↓ (decreases) pushbutton lowers flashing digit in display.
21	Press Control ENTER push-button.	First digit stops flashing and another digit starts flashing. Repeat steps 19 and 20 for each digit.
22	Press Error Inject JITTER pushbutton once.	INT indicator flashes, EXT indicator is extinguished, and Display indicates OFF flashing.
23	Sequence CHANGE ↑ or ↓ push-button to select digits in TRANSMITTER Display.	↑ (increase) pushbutton changes flashing display OFF to ON. ↓ (decreases) pushbutton changes flashing display ON to OFF. Leave in OFF position.
24	Press Control ENTER push-button once.	INT indicator extinguishes, EXT indicator starts flashing. Repeat step 23. In OFF state, EXT indicator extin-guishes and FREQ indicator lights.
D.	Receiver Input - Measurement (Fig. 31)	
25	Sequence Receiver Input-DS pushbutton.	Initial DSX1 indicator extinguishes and next lights etc.. Selection depends on last depression. Leave in DSX1 position.

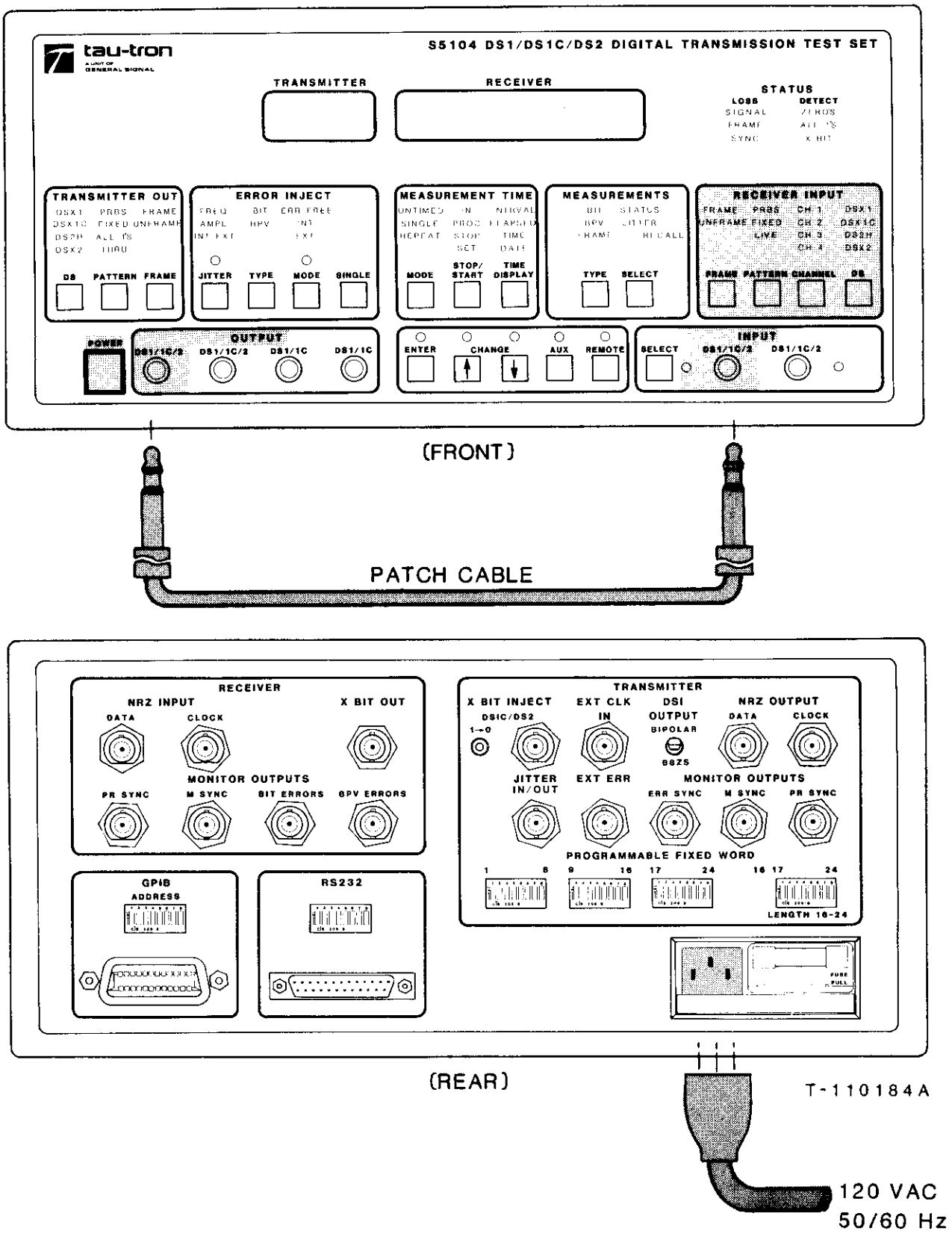


Fig. 31-Receiver Input Measurement

STEP	ACTION	VERIFICATION
26	Sequence PATTERN pushbutton	Initial PRBS indicator extinguishes and next, etc.. Selection depends on last depression. Leave in PRBS position.
27	Sequence FRAME pushbutton.	Initial UNFRAME indicator extinguishes and the FRAME indicator lights. Selection depends on last depression. Leave in FRAME position.
28	Sequence CHANNEL pushbutton.	Initial CH1 indicator extinguishes and the next lights etc.. Selection depends on last depression. Leave in CH1 position.
29	Press FRAME pushbutton once.	FRAME indicator extinguishes and UNFRAME lights.
E.	Measurement Time-Measurement (Fig. 32)	
30	Press Measurement Time STOP/START pushbutton once.	Initial IN PROC indicator extinguishes and STOP SET indicator is flashing.
31	Sequence MODE pushbutton	Initial UNTIMED indicator extinguishes and next lights, etc; selection depends on last depression. Leave in UNTIMED mode.
32	Sequence TIME DISPLAY pushbutton until INTRVAL indicator is flashing.	INTRVAL indicator is flashing.
33	Sequence CHANGE ↑ or ↓ pushbutton to select digits in RECEIVER Display.	↑ (increase) pushbutton raises flashing digits in display. ↓ (decreases) pushbutton lowers flashing digit in display.
34	Press Control ENTER pushbutton.	First digit stops flashing an another digit starts flashing. Repeat steps 33 and 34 for each digit.
35	Press Measurement Time TIME DISPLAY pushbutton twice.	INTRVAL indicator extinguishes and ELAPSED indicator lights. RECEIVER Display reads elapsed measurement time from last reset.

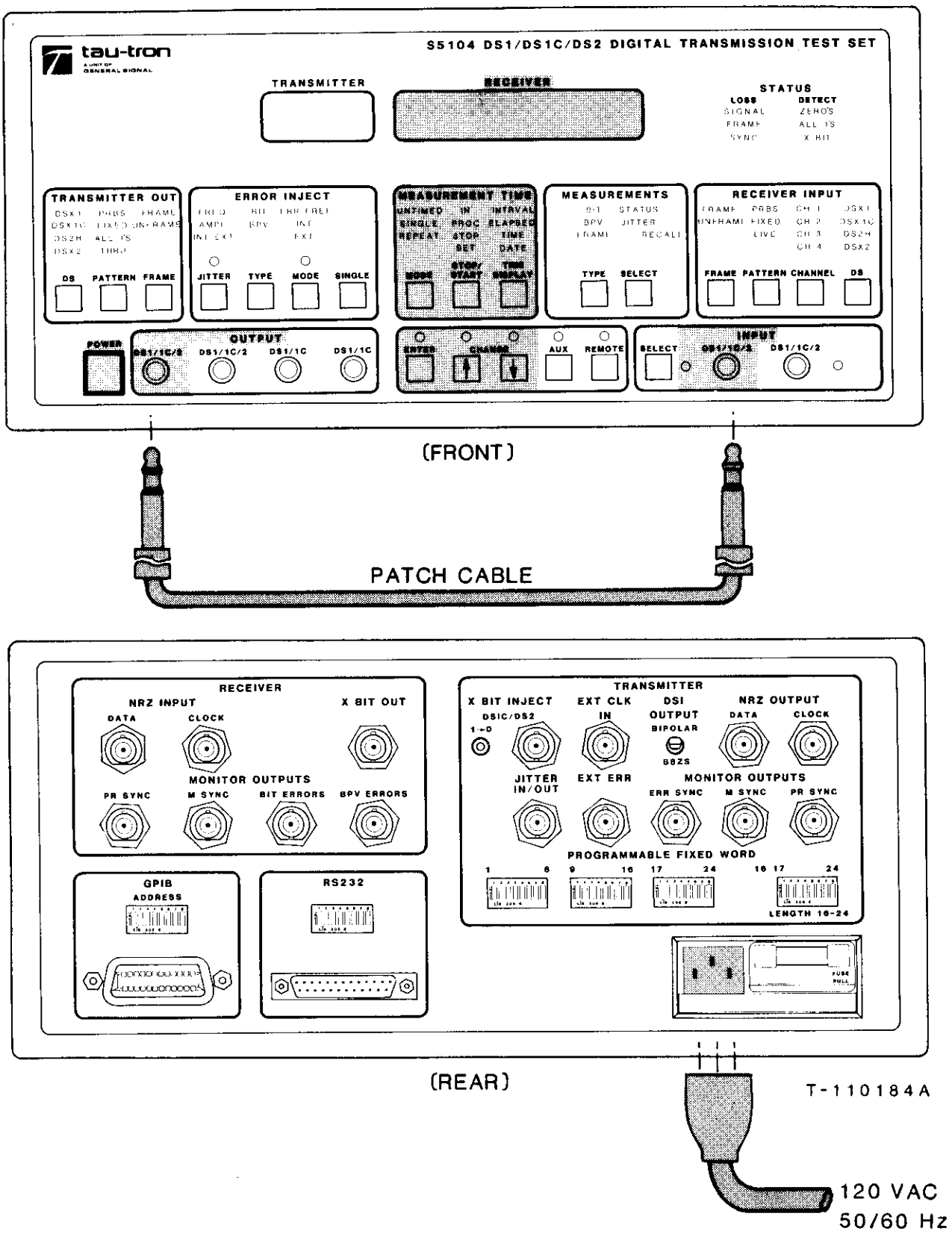


Fig. 32-Measurement Time Measurement

STEP	ACTION	VERIFICATION
36	Press TIME DISPLAY pushbutton once.	ELAPSED indciator extinguishes and TIME indicator lights. RECEIVER Displays reads real time of day.
37	Press TIME DISPLAY pushbutton once.	TIME indicator is flashing. If time displayed is correct, proceed to step 40.
38	Sequence CHANGE ↑ or ↓ pushbutton to select digits in RECEIVER Display.	↑ (increase) pushbutton raises flashing digits in display. ↓ (decreases) pushbutton lowers flashing digit in display. Set display for correct time.
39	Press Control ENTER pushbutton.	First digit stops flashing an another digit starts flashing. Repeat steps 38 and 39 for each digit (hours, minutes, seconds).
40	Press Measurement Time TIME DISPLAY pushbutton once.	TIME indicator extinguishes and DATE indicator is flashing. If data displayed is correct, proceed to step 42.
41	Sequence CHANGE ↑ or ↓ pushbutton to select digits in RECEIVER Display.	↑ (increase) pushbutton raises flashing digits in display. ↓ (decreases) pushbutton lowers flashing digit in display. Set display for correct date.
42	Press Control ENTER pushbutton.	First digit stops flashing and another digit starts flashing. Repeat Steps 41 and 42 for each digit (day, month, year). On last entry DATE indicator stops flashing.
43	If printer is not being used, proceed to G. Measurements.	

F. Printer Set-Up-Measurement (Fig. 33)

Notes: 1. If printer is not connected to the S5104 or the RS-232C DIP switch is not set, refer to subsection 5F.

2. If printer paper is not loaded, refer to inside of printer paper loading lid for instructions or refer to 5901 Printer Instruction Manual FORM 0236-1082A.

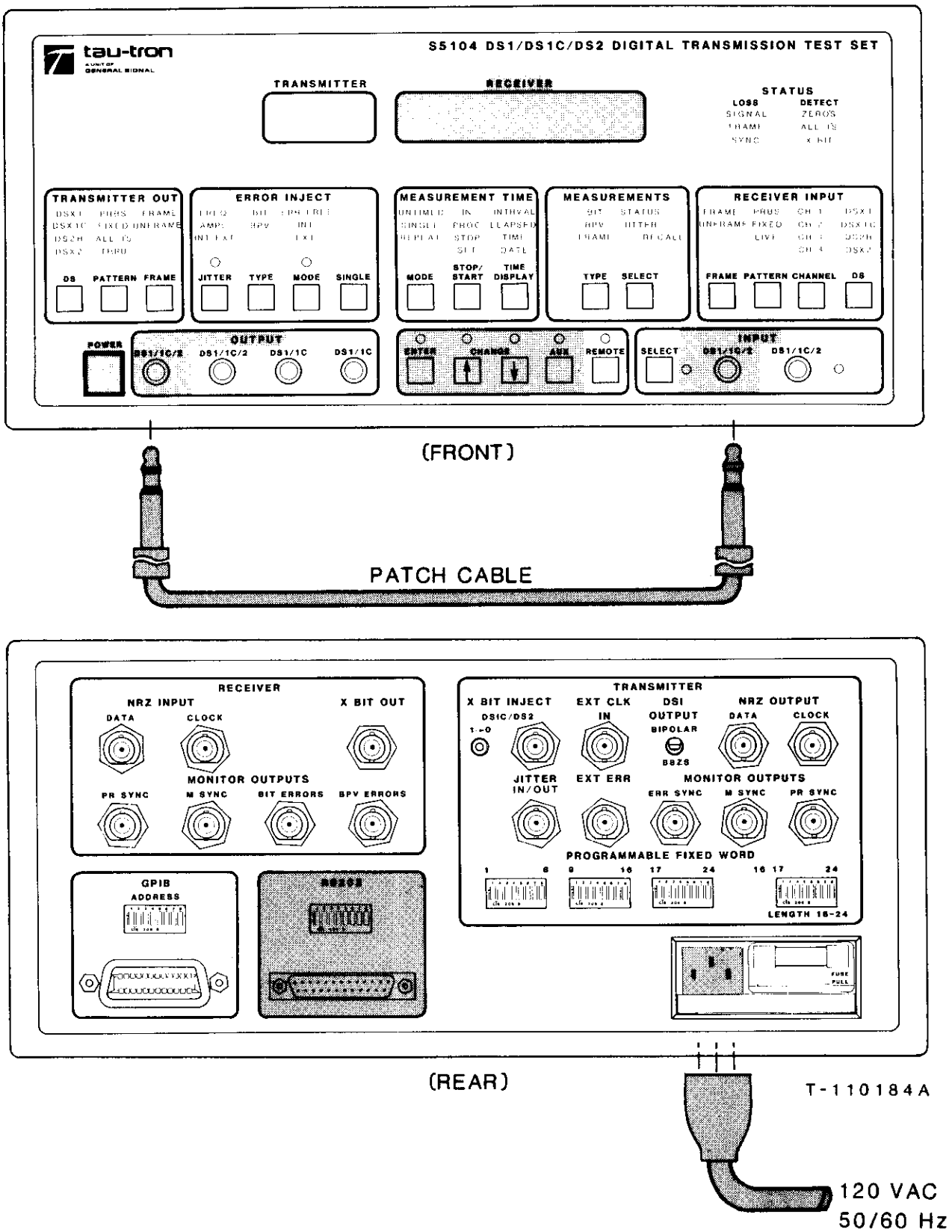


Fig. 33-Printer Set-Up Measurement

STEP	ACTION	VERIFICATION
44	Normal Print - Set printer rear AC power switch to on.	Printer front POWER indicator lights.
45	Press OFF LINE pushbutton on printer.	Pushbutton stays up (ON condition).
46	Sequence Control AUX pushbutton for "PRINTER?" on RECEIVER Display.	RECEIVER Display reads "PRINTER?".
47	Press Control ENTER pushbutton once.	Display reads "PRINTER? OFF", OFF is flashing.
48	Sequence CHANGE ↑ or ↓ pushbutton to select function.	Selects OFF, BIT or BPV Printer functions. Leave in BIT position.
49	Press Control ENTER pushbutton once.	Display reads "ERR SEC OFF", OFF is flashing.
50	Press CHANGE ↑ or ↓ pushbutton once.	Selects error seconds, ON is flashing.
51	Press Control ENTER pushbutton once.	Display reads "SQUELCH OFF", OFF is flashing.
52	Press CHANGE ↑ or ↓ pushbutton once.	Selects sequelch threshold. Display reads "OFF" or "ON ANY". Leave in ON ANY position, flashing, E-5, E-4 or E-3.
53	Press Control ENTER pushbutton once.	ENTER, CHANGE ↑ ↓, AUX indicators stop flashing.
54	Sequence Control AUX pushbutton for "SNAPSHOT?" on RECEIVER Display.	RECEIVER Display reads "SNAPSHOT?".
55	Press Control ENTER pushbutton once.	Printer starts printing out IMMEDIATE BIT SUMMARY data, ENTER, CHANGE ↑ ↓, AUX indicators are extinguished.
56	Press printer OFF LINE pushbutton once.	Printer OFF LINE pushbutton is in lower position, printer is disables.
G.	Measurements - Measurement (Fig. 34)	
57	Press Input SELECT pushbutton once.	Input - DS1/1C/2 indicator (right) lights.

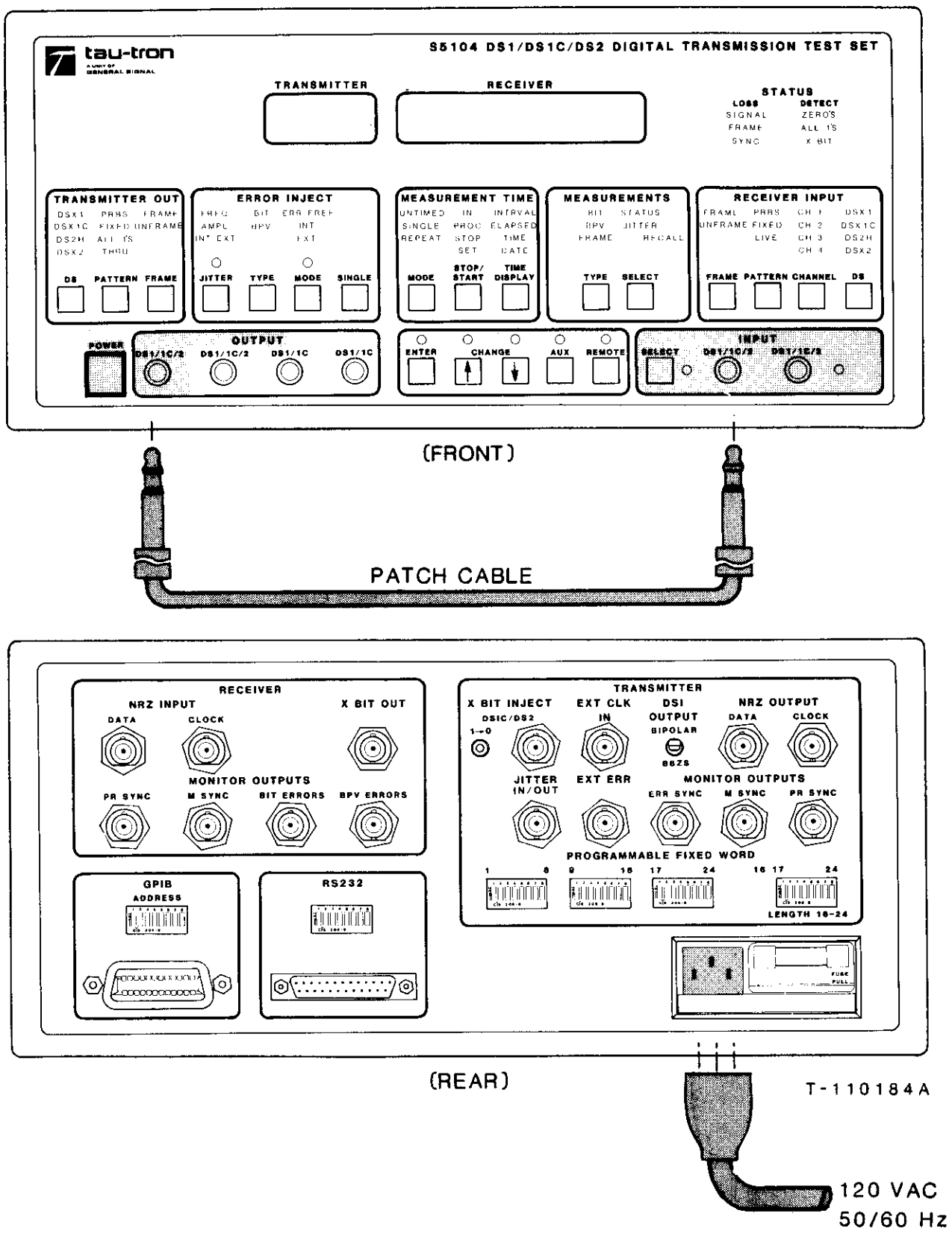


Fig. 34-Measurements Measurement

STEP	ACTION	VERIFICATION
58	Press SELECT pushbutton once.	DS1/1C/2 indicator (right) extinguishes and DS1/1C/2 indicator (left) lights (indicator coincides to patch cable jack). Measurement Time- STOP SET indicator extinguishes and the IN PROC indicator lights. (Test is in progress).
59	Set printer Power switch to OFF position.	Printer POWER indicator is extinguished.
60	Press S5104 POWER switch to OFF condition.	POWER indicator is extinguished.
61	End of Verification Checks.	

APPENDIX C

PRINTED CIRCUIT BOARD

CONFIGURATION SETTINGS

APPENDIX C

PRINTED CIRCUIT BOARD CONFIGURATION SETTINGS

C.01 This appendix describes settings (jumper and DIP switch configurations) that can be made on internal printed circuit boards. The S5104 arrives from the factory in a "normal" setting or configuration but may be changed as detailed in this appendix.

Synchronous/Asynchronous Errror Seconds.

C.02 An eight-section DIP switch on the CPU printed circuit board (Fig. 35) can be used to reconfigure the S5104 from the "normal" factory setting, of synchronous error seconds, to asynchronous error seconds. The switch numbered 1 is set ON for synchronous error seconds or OFF for asynchronous error seconds. This DIP switch is also used to configure other options. Table J lists the other settings so that the they can be reset if accidentally changed.

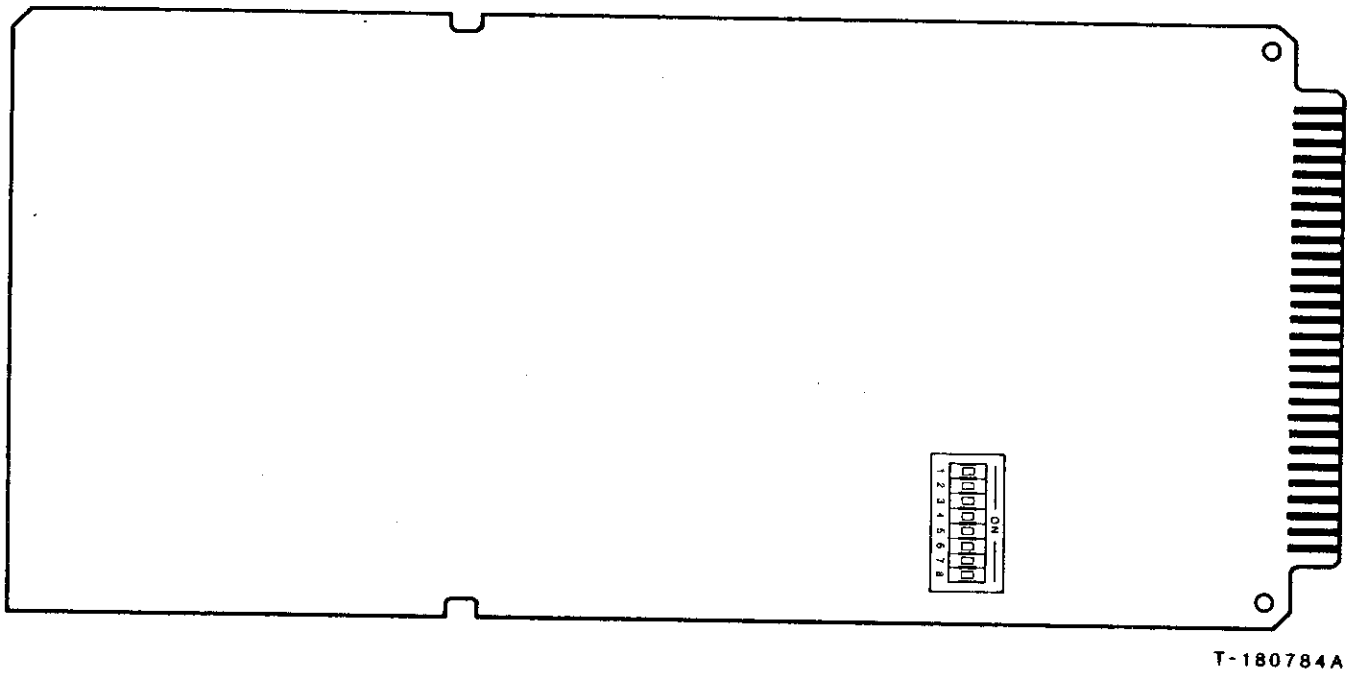


Fig. 35-CPU PCB DIP Switch Location

TABLE J

CPU/RS232/GPIB PCB DIP SWITCH SETTINGS

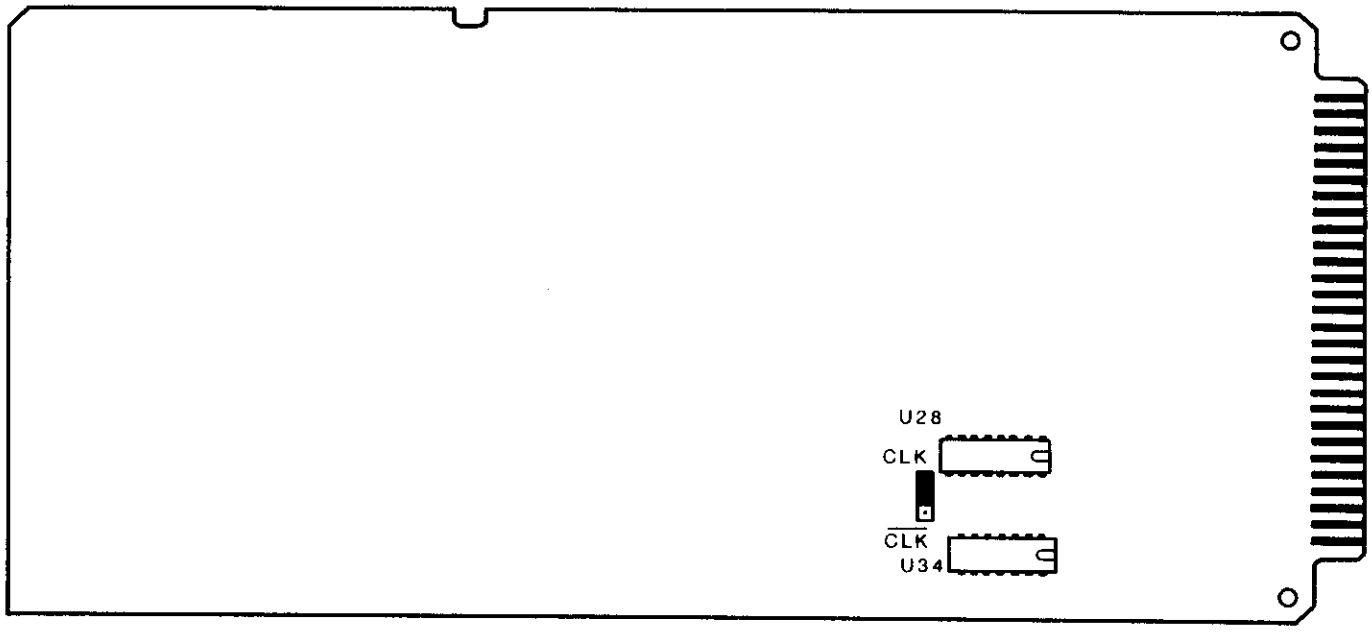
DIP SWITCH NO.	DEFINITION
1	OFF= Asynchronous ERR SECS ON= Synchronous ERR SECS
2	OFF= RS-232C not installed ON= RS-232C installed
3	OFF= Halt on failure ON= Restart on failure
4	OFF= Jitter option not installed ON= Jitter option installed
5	OFF= GPIB not installed ON= GPIB installed
6	OFF= CPU/RS-232 PCB installed ON= CPU/GPIB/RS-232 PCB installed
7	NOT USED
8	NOT USED

Clock and Data Phasing

C.03 The clock edge, or phasing, of the Transmitter and Receiver clock and data signals can be switched 180: This is accomplished by reconfiguring the jumpers on the Pattern Generator and/or the Input printed circuit boards (Fig. 20 shows the location of these PC boards).

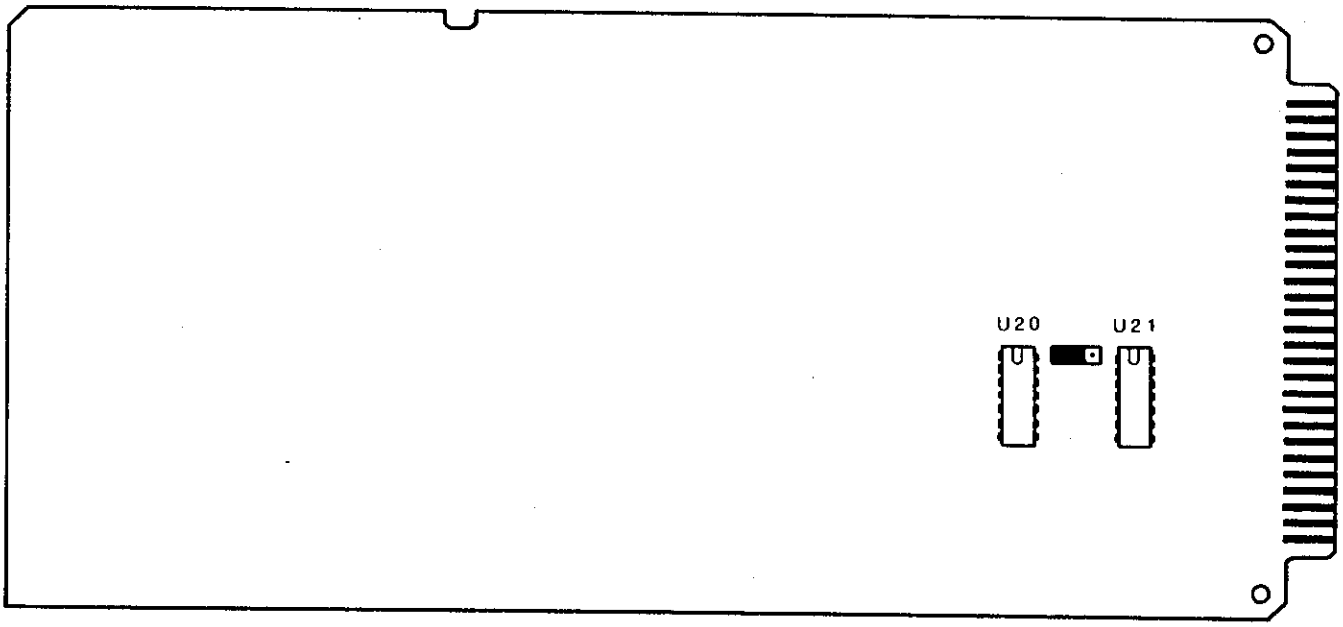
C.04 The Transmitter clock and data signals are sent out the rear panel NRZ OUTPUT DATA and CLOCK BNC connectors. The signals are generated by the Pattern Generator PCB. A jumper on this PC board (Fig. 36) allows the signals to be configured for CLK or $\overline{\text{CLK}}$. From the factory, the jumper is set over the two pins adjacent to the CLK position. CLK sets the rising edge of the output clock in the center of the data bit. Placing the jumper over the two pins adjacent to the $\overline{\text{CLK}}$ position, sets the edge of the output clock in the center of the data bit.

C.05 The Receiver clock and data signals are received by the rear panel NRZ INPUT DATA and CLOCK BNC connectors. The Signals are sent to the Input PCB. A jumper on the Input PCB (Fig. 37) allows the signals to be inverted (changed 180°). From the factory, the jumper is set over the two pins that do not invert the phasing of the signal (rising edge of input clock is in center of data bit). Positioning the jumper in the alternate position inverts the signal (falling edge of input signal is in center of data bit).



NOTE: BLACK INDICATED THE FACTORY SET JUMPER POSITION FOR Tx CLOCK. T-180784B

Fig. 36-Pattern Generator PCB Jumper Location



NOTE: BLACK INDICATED THE FACTORY SET JUMPER POSITION FOR Rx CLOCK. T-180784C

Fig. 37-Input PCB Jumper Location