T-Carrier

Training Manual

Lynch® COMMUNICATION SYSTEMS

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T-CARRIER
TRAINING MANUAL

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T-CARRIER

TRAINING MANUAL

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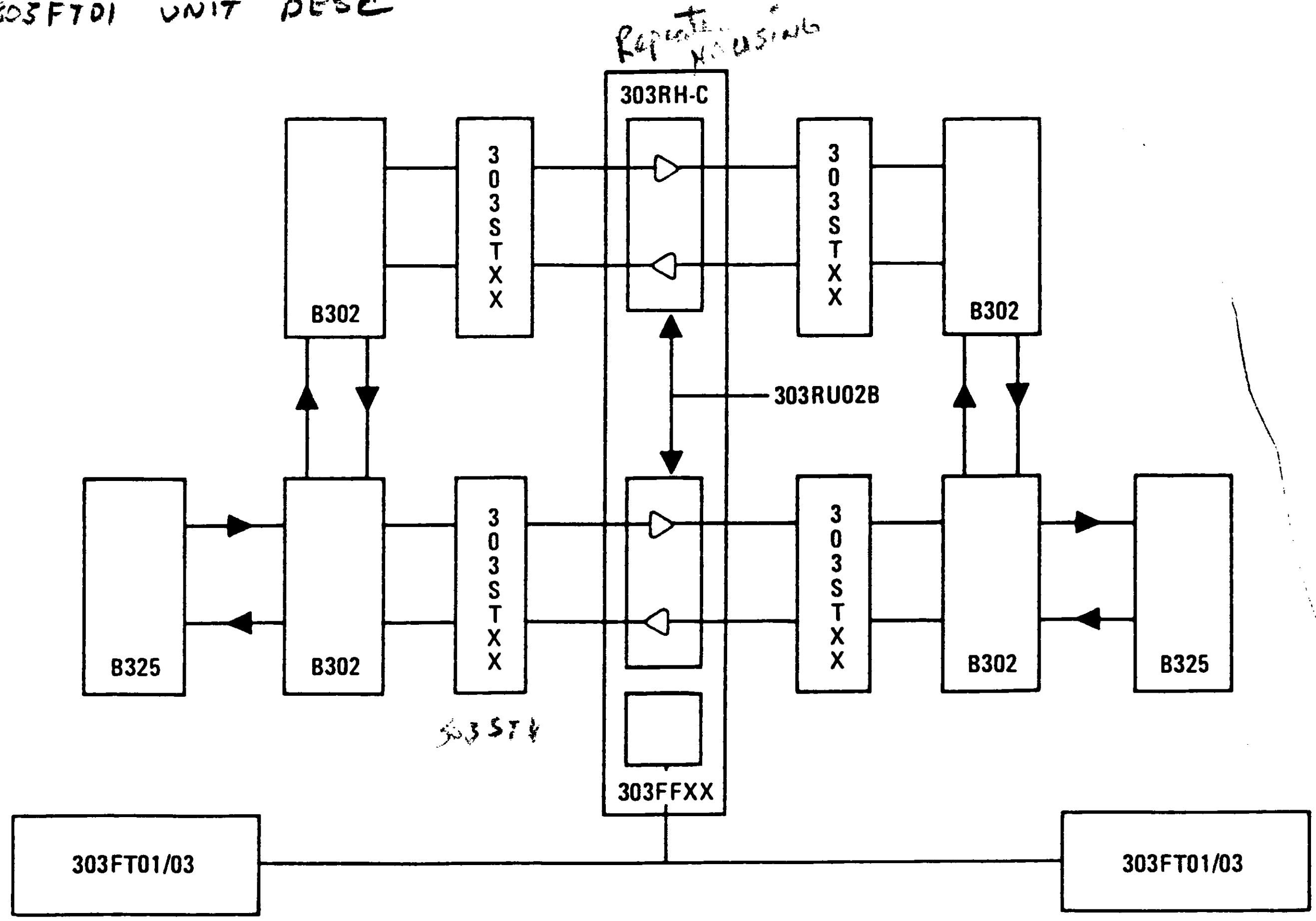
INTRODUCTION

This training manual covers all Lynch-manufactured T-carrier equipment. It is designed for use by craftspersons in direct equipment support capacities and should be used with qualified classroom instruction.

Much of the information herein can be found in and augmented by the following list of Lynch technical publications:

(707) 786-4070

B325 D3, D4 Channel Bank Technical Manual
B325 D4 Channel Bank Technical Manual Supplement
B303 Span Line Terminating Equipment Technical Manual
B303 T-1 Carrier Outside Line Engineering Considerations and Design Procedures
B302 Automatic Protection Switch (APS) Technical Manual
303RU38/39 Outside Line Repeaters Technical Manual
303RH-C/D Series Repeater Housings Description and Installation Manual
325TA03 Test and Alignment Panel Unit Description
325PR01 Pulse Link Repeater Unit Description
325PR03 Pulse Link Repeater Unit Description
325TD01 Tandem Channel Unit Description
325FA02 Fuse and Alarm Unit Description
325FA03 Fuse nand Alarm Unit Description
303FT01 UNIT DESC



SECTION I

B325 CHANNEL BANK SYSTEM DESCRIPTION

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1. GENERAL

1.01 The channel bank is designed to provide two-way signal conversion for pulse-code modulation (PCM) transmission over T1/T1C repeatered span lines. The basic system provides the standard 24-channel configuration; however, with the addition of an optional D4 converter unit, two channel banks can be operated in tandem providing a 48-channel system operating over T1C span line equipment. The following discussion covers the basic 24-channel system without the D4 converter.

1.02 The B325 circuitry is organized so that no multiplex switching buses are required (see Fig. 1-1). This is achieved by performing all multiplexing operations in a single common control unit, the transmit converter. Demultiplexing operations are accomplished in a second common control unit, the receive converter. With this common CODEC design in comparison to a CODEC per channel design, a failure of a single channel does not "hang up" the terminal, failing all channels. Correcting the fault is then simple since only the offending channel needs to be replaced and tested.

1.03 This is in contrast with the bus-oriented channel banks, in which a single failure may cause the testing of several channels to localize the fault. The common CODEC design of the B325 does, however, prevent the use of digital dataport channels, as the output of a B325 channel must be analog.

2. FUNCTIONAL DESCRIPTIONS

2.01 The B325 is comprised of channel units and common control units. All of the channels can be of the same type or comprised of any combination of any of the available channel types. The common control consists of the transmit converter (325TC01B), the receive converter (325RC01B), and the alarm and power unit (325AP01A). Refer to Table 1-1 for unit nomenclature.

TABLE 1-1

B325 TERMINAL PLUG-IN UNITS

PART NUMBER	NOMENCLATURE	FUNCTION	UNITS PER TERMINAL
325AP01A	Alarm and Power Unit	Provides −48-Vdc, ±12-Vdc and +5-Vdc power to the terminal's electronics. Provides terminal fusing. Contains all alarm and CGA circuitry. Also provides bipolar conversion for XMT direction.	1
325BR01	2-Wire Bridge Ringing CO Channel Unit	Central office 2-wire bridge ringing foreign exchange type signaling with VF channel unit provides loop-start operation only designed for use with B281 ESSS.	1 to 24
325BR51	2-Wire Bridge Ringing Subscriber Channel Unit	Subscriber end of bridge ringing tandem channel units.	1 to 24
325DP01	Dial Pulse Originating Channel Unit	Works end-to-end with terminating dial pulse channel unit (325DP02) or equivalent. Provides 2-wire to 4-wire conversion, XMT and RCV signaling, reverse battery supervision and CGA alarm conditioning circuits.	1 to 24
325DP02	Dial Pulse Terminating Channel Unit	Provides 2-wire to 4-wire conversion with signaling for terminating office functions to match the 325DP01 channel unit.	1 to 24
325DP11	Dial Pulse Originating Channel Unit	Identical to the 325DP01 in operation, but some signaling interface leads are pinned out differently for special installation situations.	1 to 24
325DP21A	Dial Pulse Originating Channel Unit	Identical to the 325DP11, but allows strapping options for B1 and B2 leads as well as for loaded cable interface applications.	1 to 24
325DP22	Dial Pulse Terminating Channel Unit	Identical to the 325DP02, but with strapping options for loaded cable interface applications.	1 to 24
325EM01	4-Wire, 600-Ohm E & M Channel Unit	Two-way speech and signaling unit. Works end-to-end with any 325EMXX channel unit. Includes amplifiers, filters, XMT and RCV signaling circuits, test points/level controls and circuits for conditioning trunks during alarm conditions (CGA feature).	1 to 24
325EM02	2-Wire, 600-Ohm E & M Channel Unit	Same as 325EM01, except 2-wire to 4-wire conversion with 600-ohm hybrid. A and B leads are provided as Option 1.	1 to 24
325EM03	2-Wire, 900-Ohm E & M Channel Unit	Same as 325EM02, except 900-ohm hybrid. A and B leads are provided.	1 to 24
325ET01	Electronic Trunk Channel Unit	2-wire, 900-ohm channel unit with options such as remote make-busy when B325 channel bank will interface with a digital central office.	1 to 24

TABLE 1-1 (Cont.)

B325 TERMINAL PLUG-IN UNITS

PART NUMBER	NOMENCLATURE	FUNCTION	UNITS PER TERMINAL
325FX01	Originating Foreign Exchange Channel Unit	Provides 2-wire to 4-wire conversion (station end) with 900-ohm hybrid. Provides loop supervision; opens T & R to stop charges and make-busy during CGA. Also, provides loop- and ground-start operation as a strap option.	1 to 24
325FX02	Terminating Foreign Exchange Channel Unit	Same as 325FX01, except used at central office.	1 to 24
325MA01	Mounting Assembly	Provides a mounting facility for all terminal plug-in assemblies. Backplane is configured for D3 channel numbering sequence.	1 to 24
325PR01	Pulse-Link Repeater Channel Unit	Identical in function to the 325EM01, but also provides strapping options for gain ranges and signaling converting for pulse-link repeater applications.	1 to 24
325PR03	Pulse-Link Repeater Channel Unit	2-wire, 900-ohm E & M signaling channel unit provides strapping options for gain ranges and signaling converting.	1 to 24
325PY01	Pay Station Terminating Channel Unit	2-wire speech and signaling for semipostpay paystation applications. Office End.	1 to 24
325PY51	Pay Station Originating Channel Unit	Remote mating end of semipostpay paystation channel unit.	1 to 24
325RC01B	Receive Converter	Provides all receive-direction functions. Includes RCV timing, serial-to-parallel conversion, D/A conversion and VF demultiplexing.	1
325TA01/ 325TA03	Test and Alignment Panel	Provides test and alignment facilities and access jacks for external test equipment.	Can be shared by several terminals.
325TC01B	Transmit Converter	Provides all transmit-direction functions, except bipolar conversion. Includes XMT timing, VF multiplexing, A/D conversion and parallel-to-serial conversion.	1
325TD01	Foreign Exchange (Tandem) Channel Unit	4-wire, 600-ohm tandem channel unit for tandem foreign exchange applications.	1 to 24
325VF01	4-Wire VF Channel Unit	Provides 4-wire VF transmit and receive paths, with no signaling provision.	1 to 24

2.02 All channel units have circuitry in common. Refer to Fig. 1-2. Variation of the basic channel unit provides for 4-wire/600-ohm connection, 2-wire/600-ohm connection, or 2-wire/900-ohm connection. Voice frequency (VF) signals are filtered by a 180-Hz to 3450-Hz bandpass filter in the transmit direction after passing through a variable-gain amplifier and a 3450-Hz low-pass filter in the receive direction. The receive and transmit gain adjustments provide for approximately 6 dB of gain adjustment. Some channels provide strapping options allowing a 25-dB adjustment range. A comparison of the block diagrams of the 325EM01 (Fig. 1-2) and the 325VF01 (Fig. 1-3) shows the two gain options.

2.03 The channels vary greatly in the way they handle signaling, from E & M signaling in the 325EM01/02/03 (Figs. 1-2 and 1-5) to loop signaling control, as in the 325DP01 (Fig. 1-6), and loop- or ground-start operation of the foreign exchange units (325FX01) in Fig. 1-7.

2.04 Normal channel operation is determined by the busy switch and the CGA leads of the channel. The carrier group alarm function in the channels is controlled by the alarm and power unit (325AP01A). When an alarm occurs in the system preventing the normal operation of the channels, the 325AP01A will, through the receive converter (325RC01B), force all receive signaling leads to their idle state, forcing the cutting off of any conversation currently active in the system. After a 2- or 12-second delay selected in the 325AP01A, all channels will then be forced to a busy state to prevent any further traffic being sent to the system. The channels are returned to their idle in-service condition 15 seconds after the fault causing the original failure is cleared.

2.05 Each channel is equipped with a busy switch that performs two functions. One function is to open 2- or 4-wire connections to the MDF to prevent office equipment from interfering with any testing. The second function is to make busy the signaling leads to the office at the near end and to transmit a busy condition to the far end to produce a make-busy/out-of-service condition.

2.06 It should be noted that there is one exception in that the transmit VF leads are not opened in the 325EM01 4-wire channel unit when the busy switch is pressed. The tip and ring must be opened external to the channel bank.

2.07 Each channel unit has strapping options that may need to be considered. The factory strapping is correct for most applications. The strapping options are stenciled on each channel unit. A complete list of options and why they might be changed is found in the last few pages of this manual.

2.08 With some of the channels there are some unusual applications or installation requirements that need to be mentioned. When using a 325DP01 dial pulse originating (DPO) channel card (Fig. 1-6), a strap must be added to the backplane between pins 21 and Y in each channel position where the DPO is going to be used. Without the strap there will be no talk battery supplied to the channel.

2.09 When using a subscriber-end 325FX01 (FXS) foreign exchange channel unit (Fig. 1-7), 20-Hz ring voltage must be wired to the system from an external source. There are wire-wrap pins supplied on the backplane of the channel bank for this input. The ringing source must be uninterrupted and battery biased.

2.10 Lynch provides three channel units specially designed for 4-wire data and tandem connections. For 4-wire circuits use the 325PR01 (Fig. 1-4) or the 325VF01 (Fig. 1-3) if no signaling data is required, the 325PR03 (Fig. 1-8) for 2-wire tandem, and the 325TD01 (Fig. 1-9) for foreign exchange tandem.

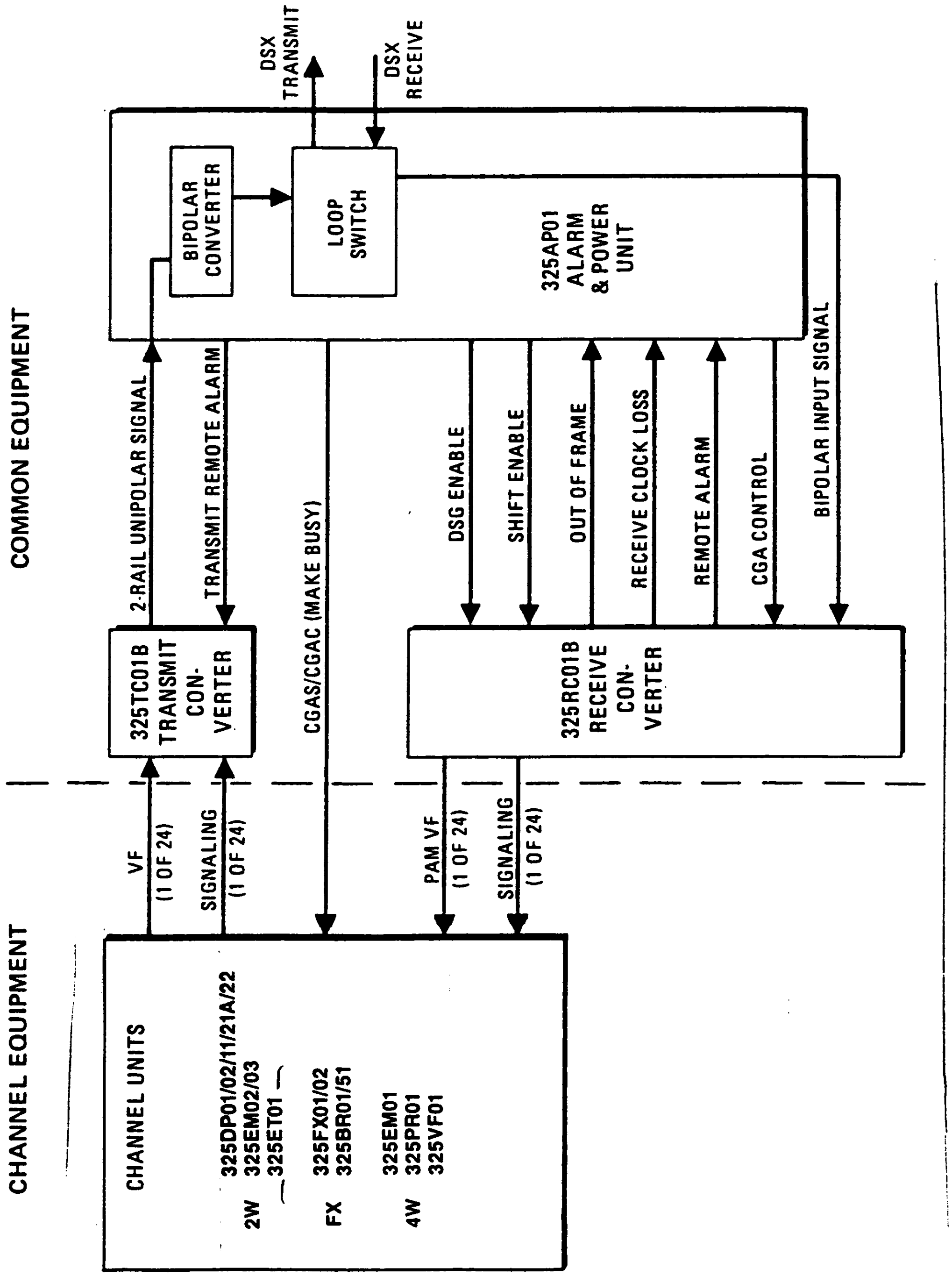


Fig. 1-1 — B325 Terminal Block Diagram

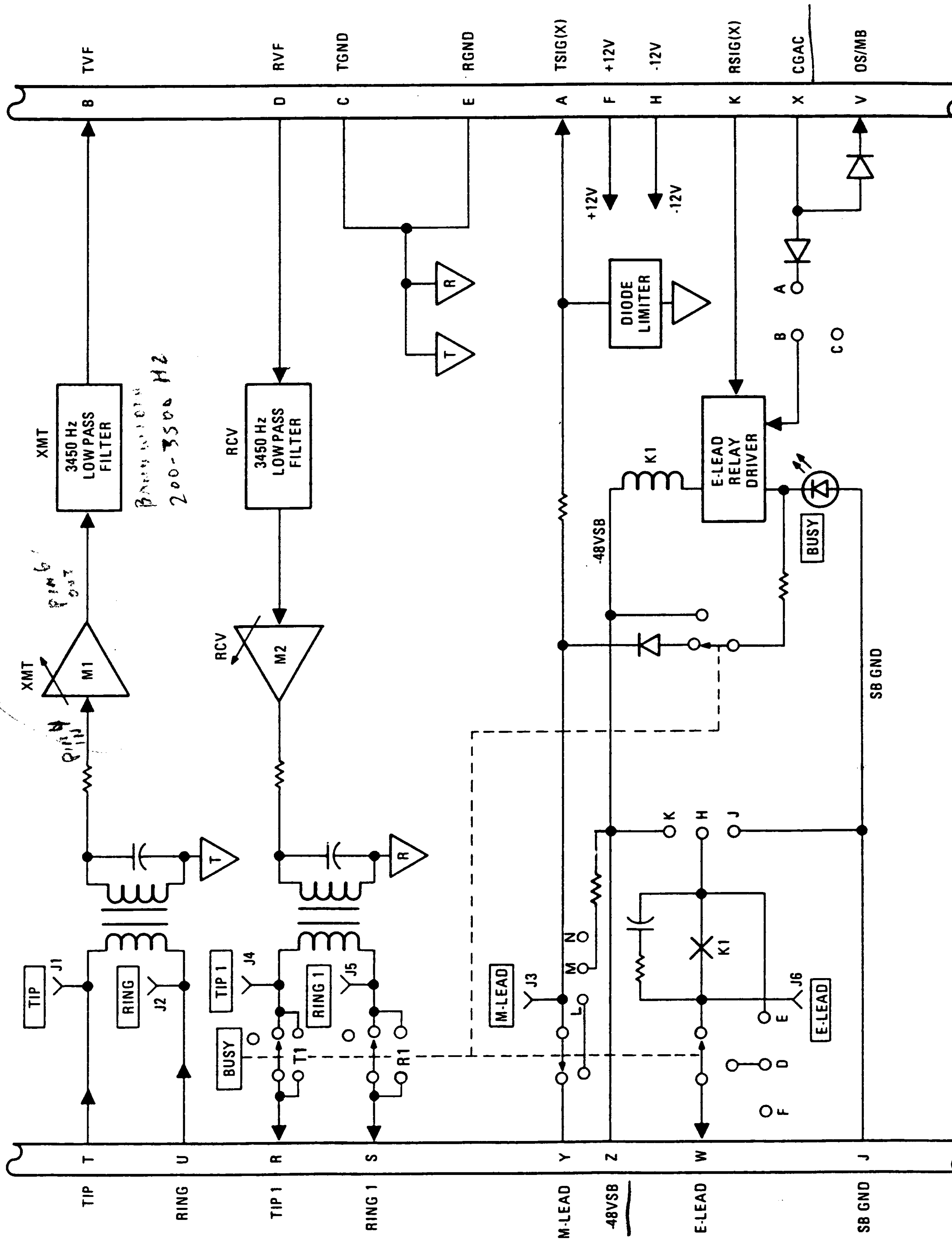


Fig. 1-2 — 325EM01 Channel Unit Block Diagram

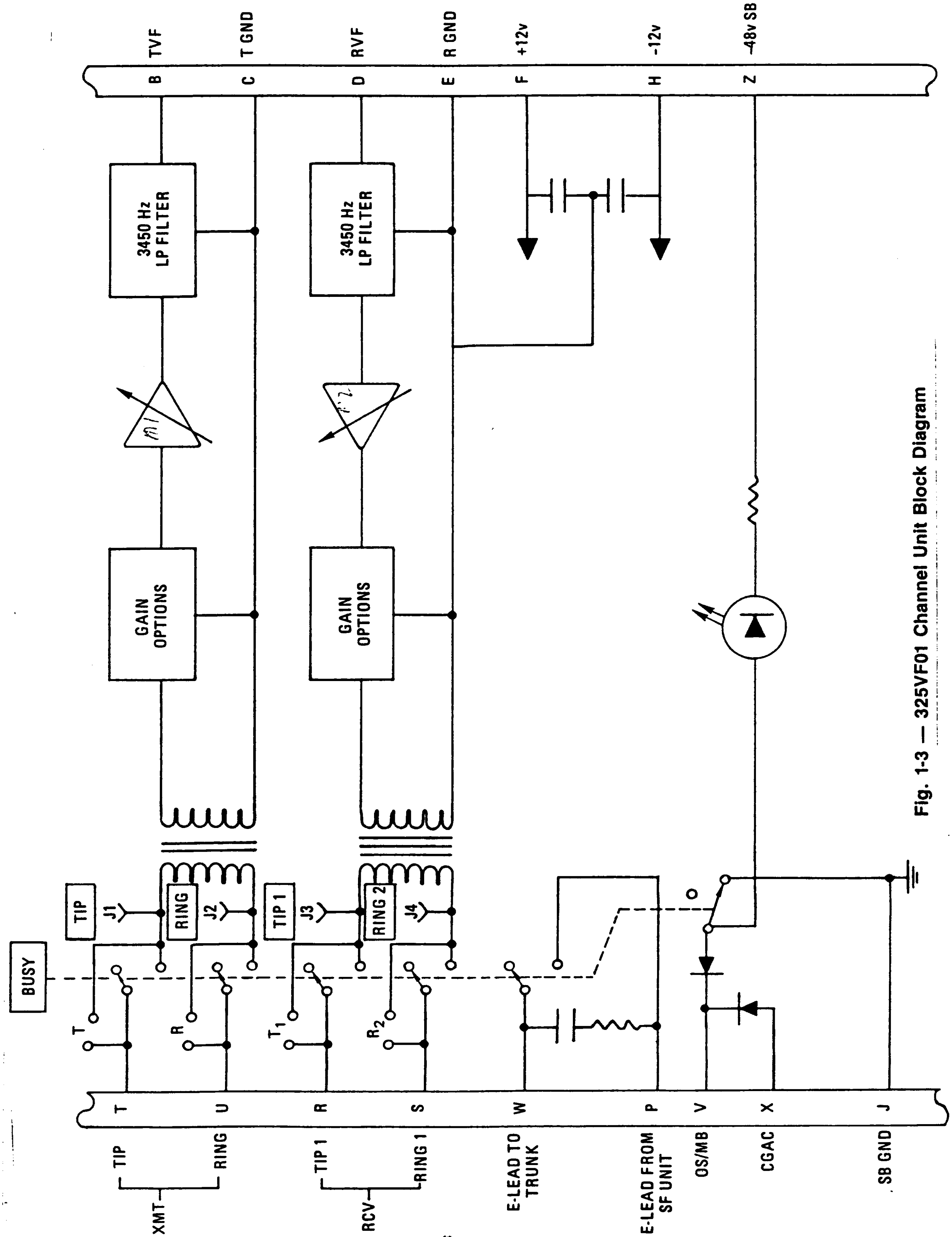


Fig. 1-3 — 325VF01 Channel Unit Block Diagram

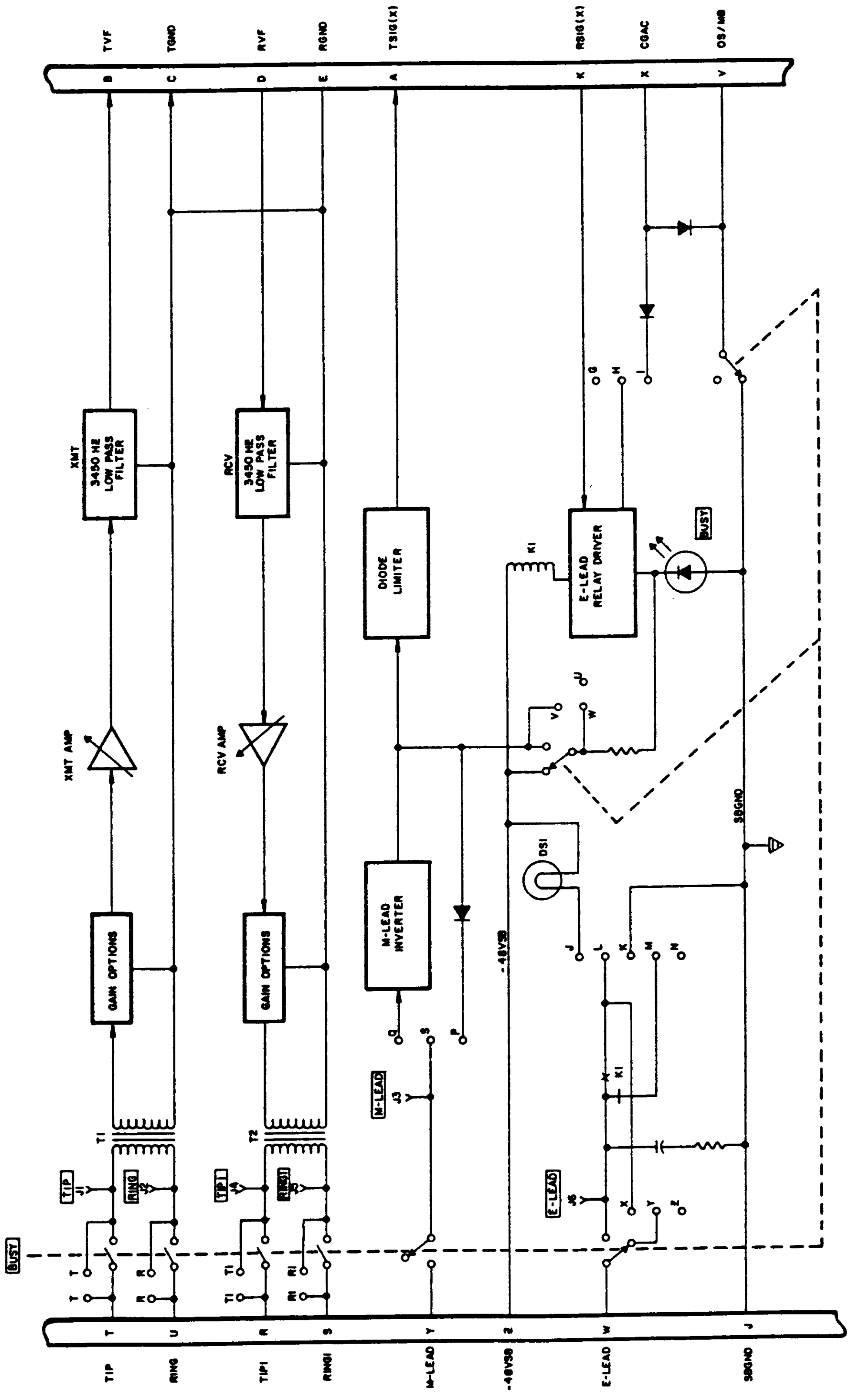


Fig. 1-4 — 325PR01 Channel Unit Block Diagram

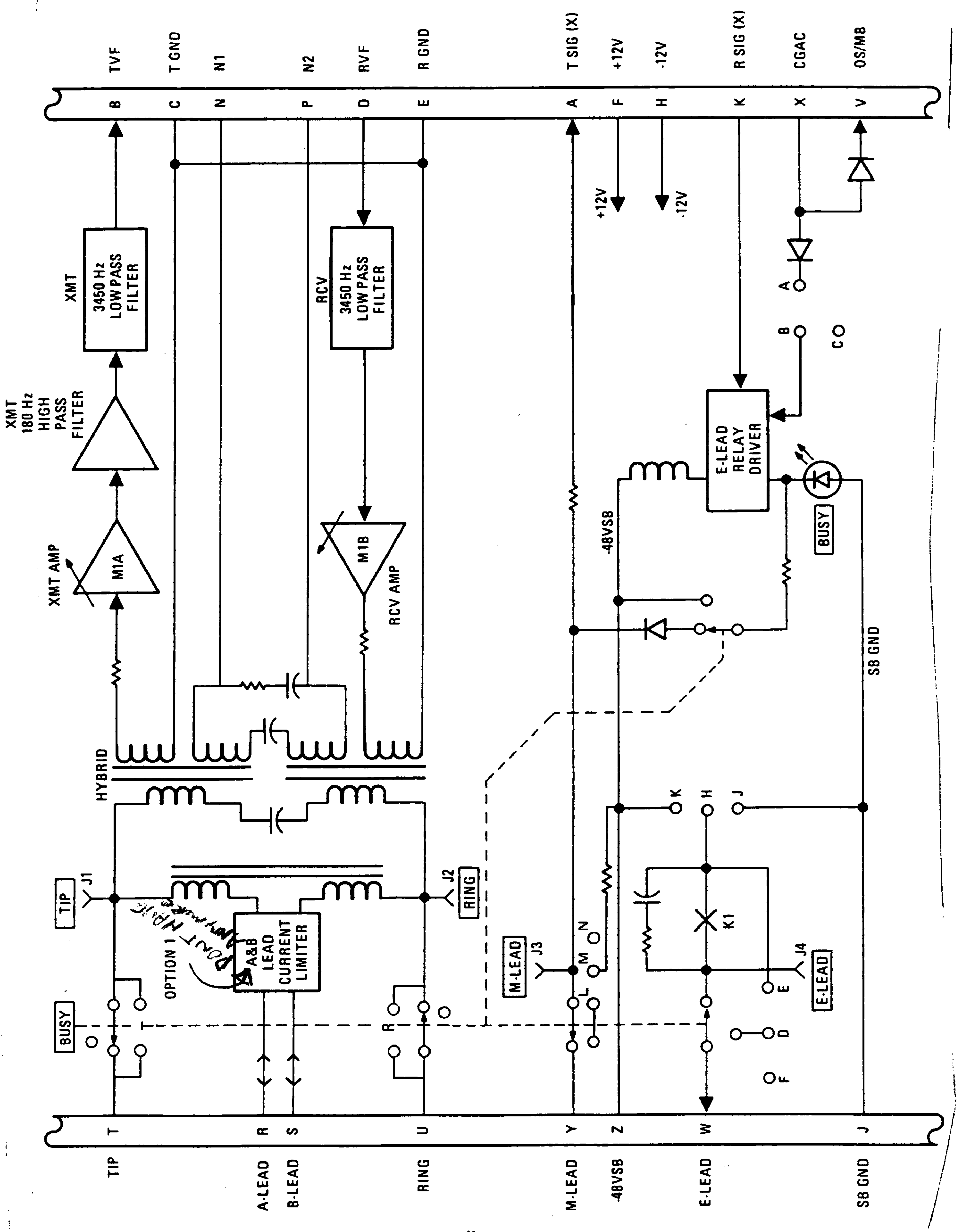


Fig. 1-5 — 325EM03 Channel Unit Block Diagram

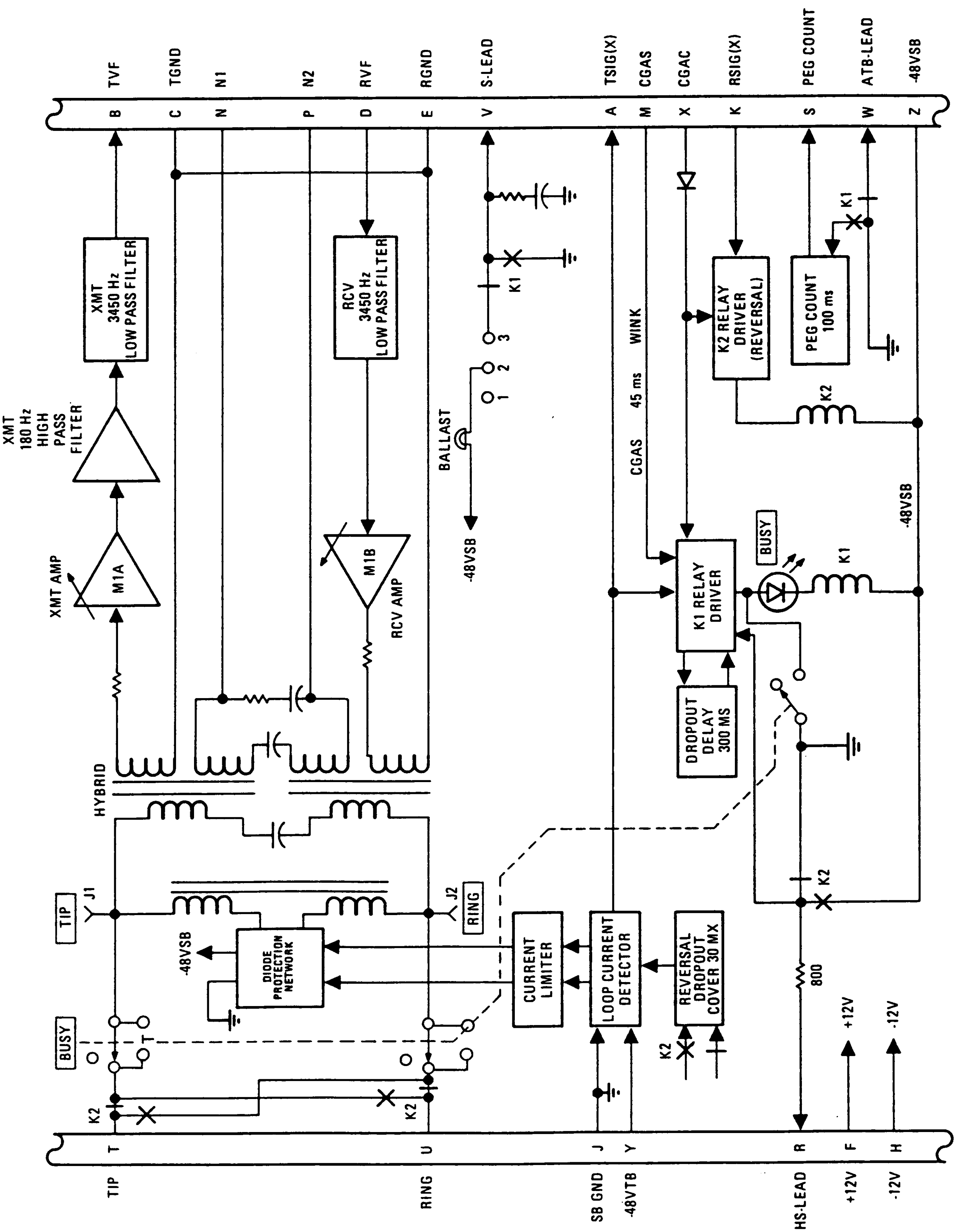


Fig. 1-6 — 325DP01 Channel Unit Block Diagram

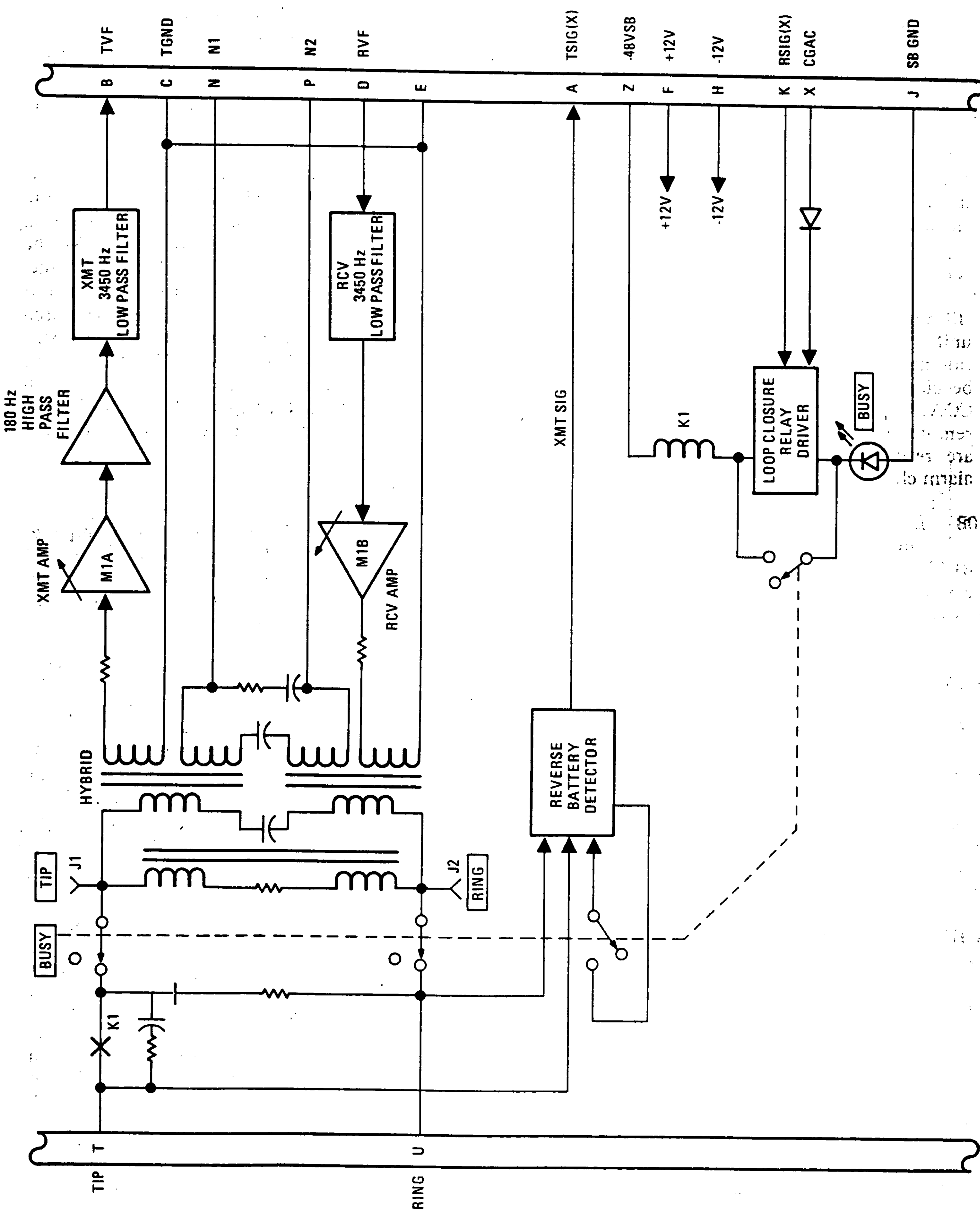


Fig. 11–Dial Pulse Terminating Channel Units (325DP02) Block Diagram

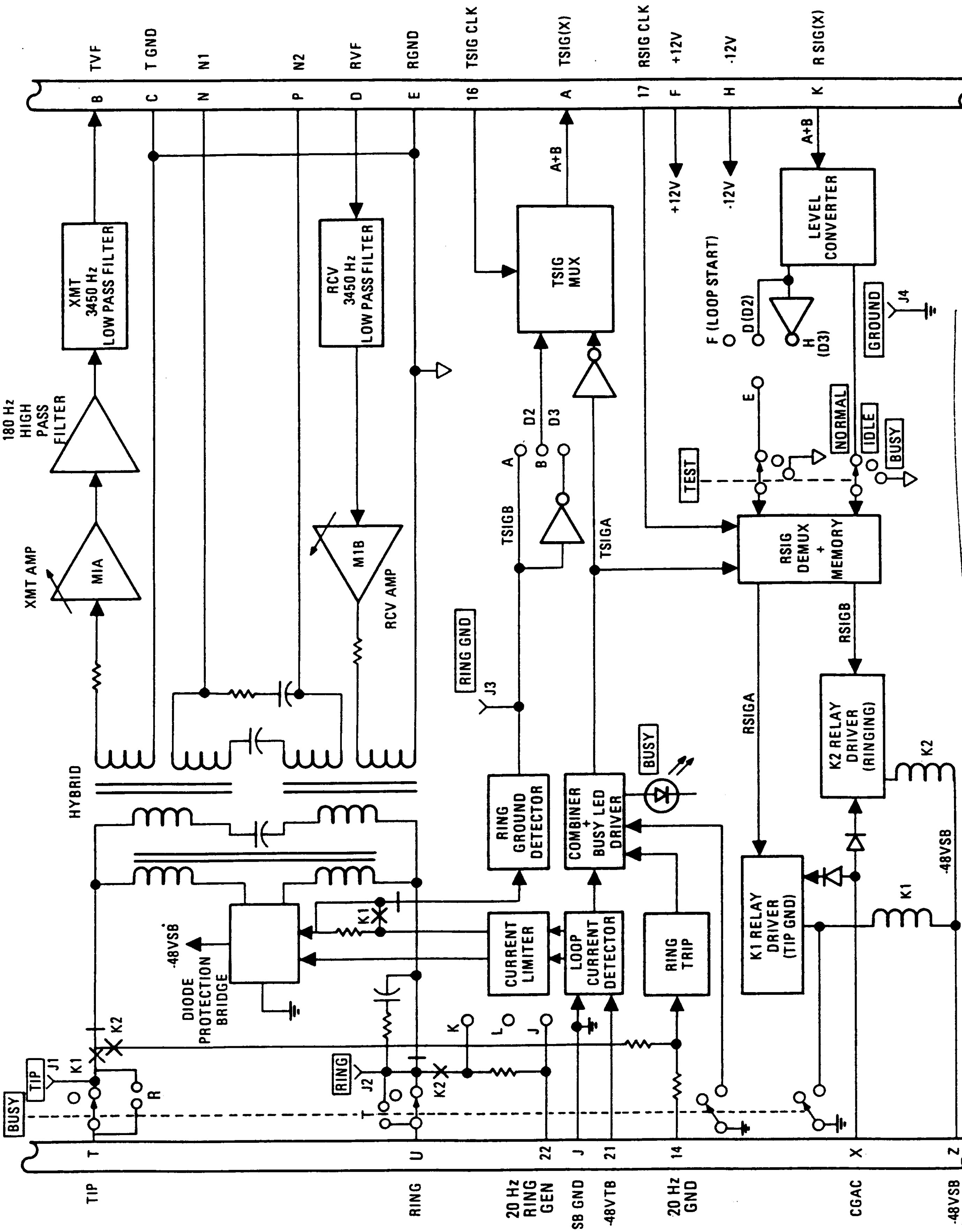


Fig. 1-7 — 325FX01 Channel Unit Block Diagram

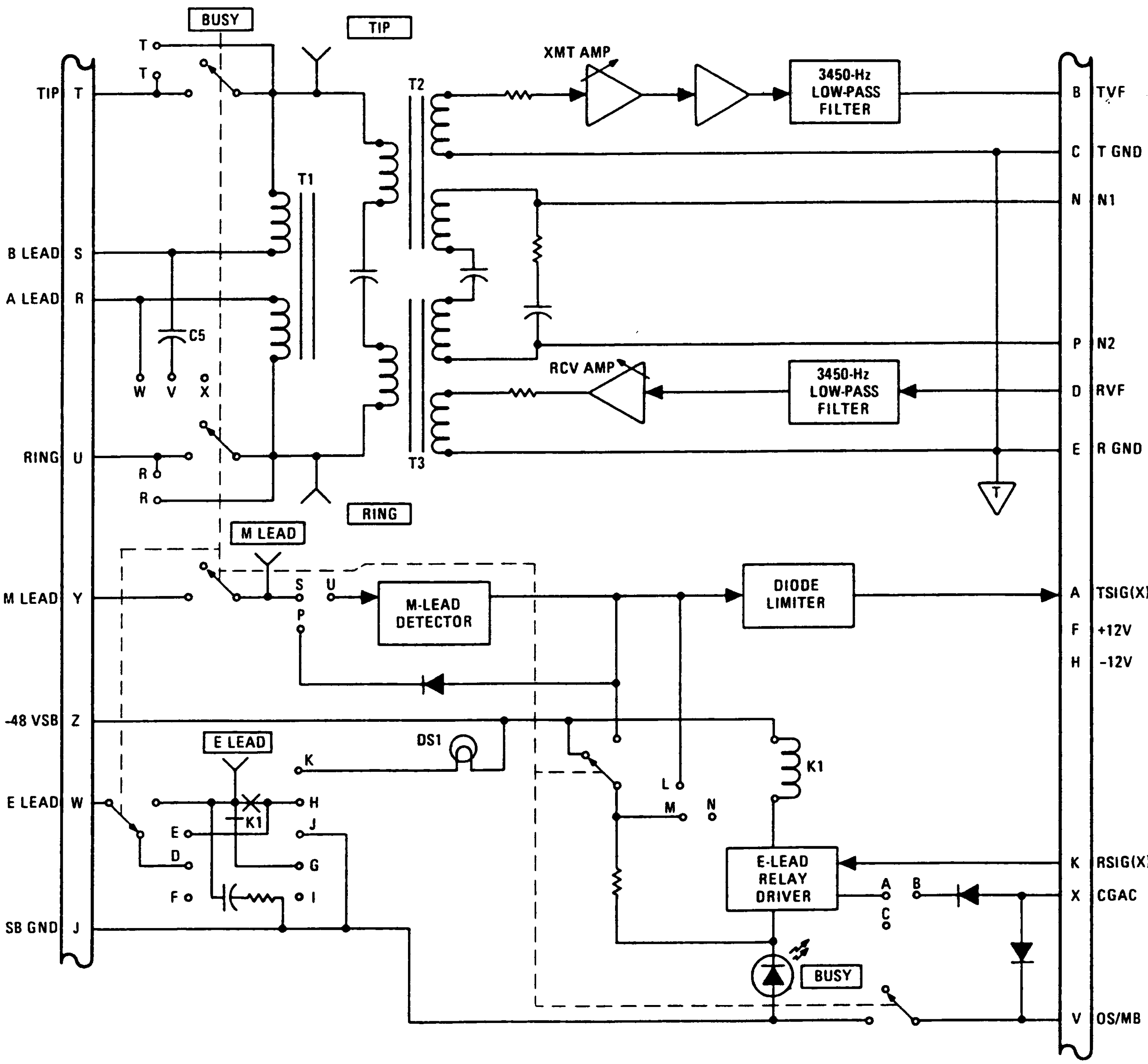


Fig. 1-8 — 325PR03 Channel Unit Block Diagram

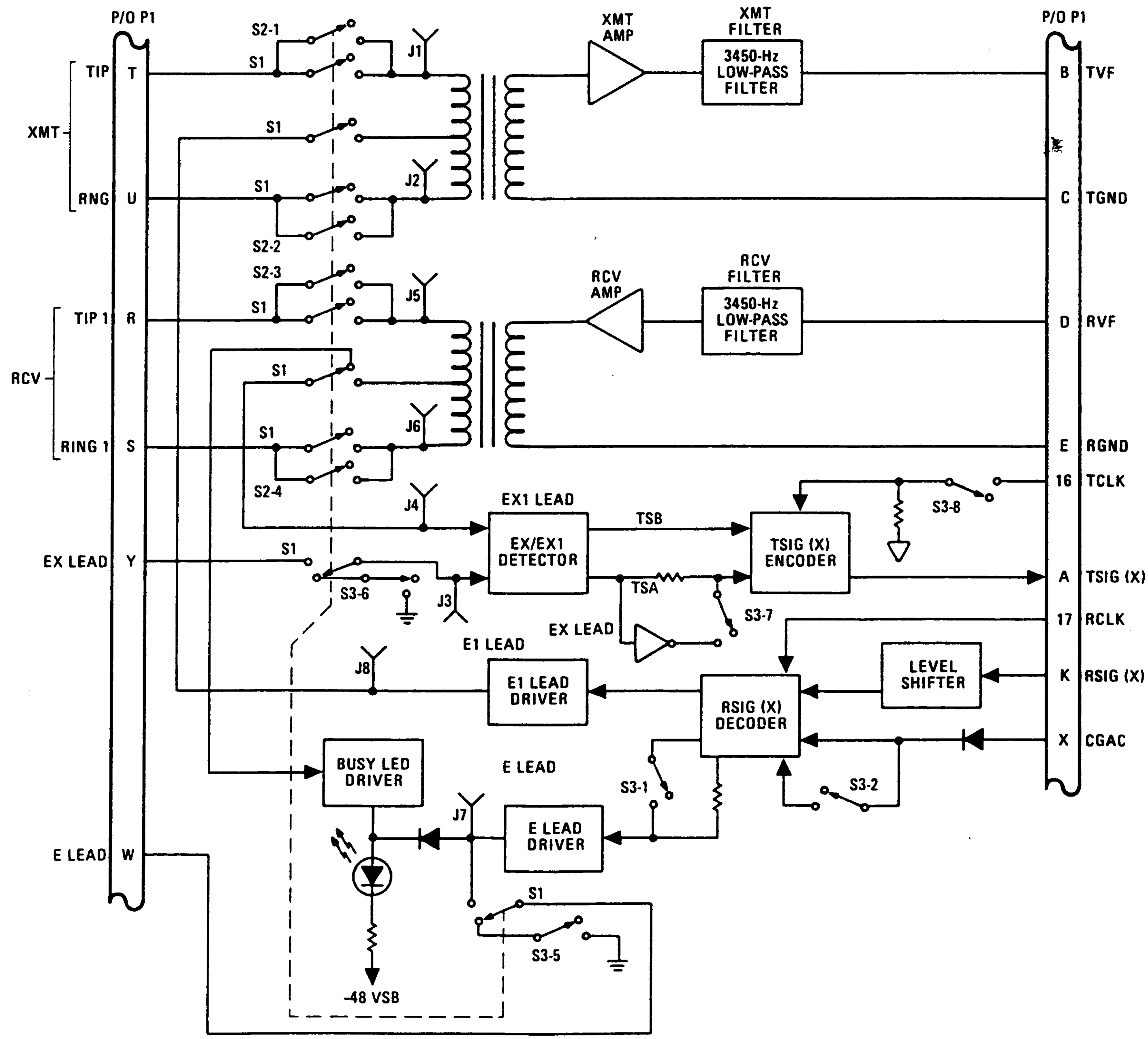


Fig. 1-9 — 325TD01 Channel Unit Block Diagram

3. PULSE-CODE MODULATION (PCM)

3.01 Because of the industry's expanding use of digital equipment, particularly at the T1 bit rate (1.544 Mb/s), it is important to understand how these signals are created and what the structure is of a standard T1 bit stream found in a span line. There are no adjustments, no options, no way to change this process in the equipment. The equipment either works or it doesn't. Since this whole process takes place in two common control cards in the B325, repair is simple. Therefore, a complete detailed understanding is basically useless. Following is a simplified explanation.

3.02 It is necessary to understand the following three terms:

ANALOG: A signal that continuously varies in value. Like a sine wave, shown in Fig. 1-10, detail A, the instantaneous voltage value of that waveform continuously varies from 0 to some positive peak, back to 0, then to the corresponding negative value. All points along the waveform are important. To change any value is to distort or degrade the signal.

DIGITAL: A signal that instantaneously changes from one voltage value to another. The signal may be bipolar as in Fig. 1-10, waveform D, or unipolar as in C, but the signal instantaneously changes between the values. In general, a circuit does not care about the exact peak value, only that the value is greater or less than some value. This would mean, then, that if the peak values were +5 and -5, then any voltage greater than +2.5 would be considered +5 and any value less than -2.5 would be considered -5. Any value less than 2.5 but greater than -2.5 would be considered zero.

BIT: One logical piece of information, stated in ones and zeroes. A time period where one state or the other exists. A T1 span line operating at 1,544,000 bits per second has 1.544 million time periods of equal length where a one or zero is present in each. Each bit is of equal importance even though a zero seems like nothing.

3.03 Refer to Fig. 1.10, moving from left to right, during the following discussion of analog-to-digital (A/D) conversion. The figure depicts one channel of a multichannel system with a 1-kHz test tone applied. The test tone is an analog signal. Most carrier systems utilize clipping circuitry in their channel to limit the input to some peak value. If the limit is exceeded, the waveform will clip or distort. This defines a dynamic input range for the channel, from nothing to the clipping point.

3.04 The A/D conversion process is taken in two steps. First, the analog test tone is sampled; then the sample is digitized or converted to pulse-code modulation (PCM). The D/A process is just the reverse: receive the digital, create the sample, average the samples together to recreate the original test tone.

3.05 At the transmit end of the channel, common control circuitry momentarily turns on the output of the channel. This creates what looks like a pulse whose amplitude will vary, analog, depending on where in the analog waveform the sample is taken. Waveform B shows several consecutive samples taken of the 1-kHz test tone. Each channel is sampled 8000 times a second. After this channel is sampled the next channel is sampled, then the next, through the 24 channels of the system. Then the order is repeated, 8000 times a second. This sampling is called pulse-amplitude modulation (PAM). That's worth telling your mother-in-law about!

3.06 Each of the samples taken have some voltage value between zero and the clipping point. The first sample of waveform B might be 2.9 volts, the second 3.7, and so on. In the A/D process each voltage value is assigned a pulse code. The pulse code is an eight-bit word that equates to the amplitude of the sample taken. The digital code is transmitted to the opposite terminal where the code is interpreted to mean a sample of a known amplitude. The sample is recreated and routed to the correct receive channel where consecutive samples are averaged together to reconstruct the original 1-kHz test tone.

3.07 To confuse the issue further, go back to waveform B and the original sample taken. The sample is not referenced in volts and tenths of volts as we might assume, but in segments and steps. There are eight segments both in the positive and negative direction, and each segment is divided into 16 steps. There are, therefore, 16 segments with 16 steps in each, for a total of 256 steps from the positive clipping point to the negative point. With an eight-bit word there are 256 different pulse codes from all ones to all zeroes. Therefore, each step upon which any sample might fall has its own unique code.

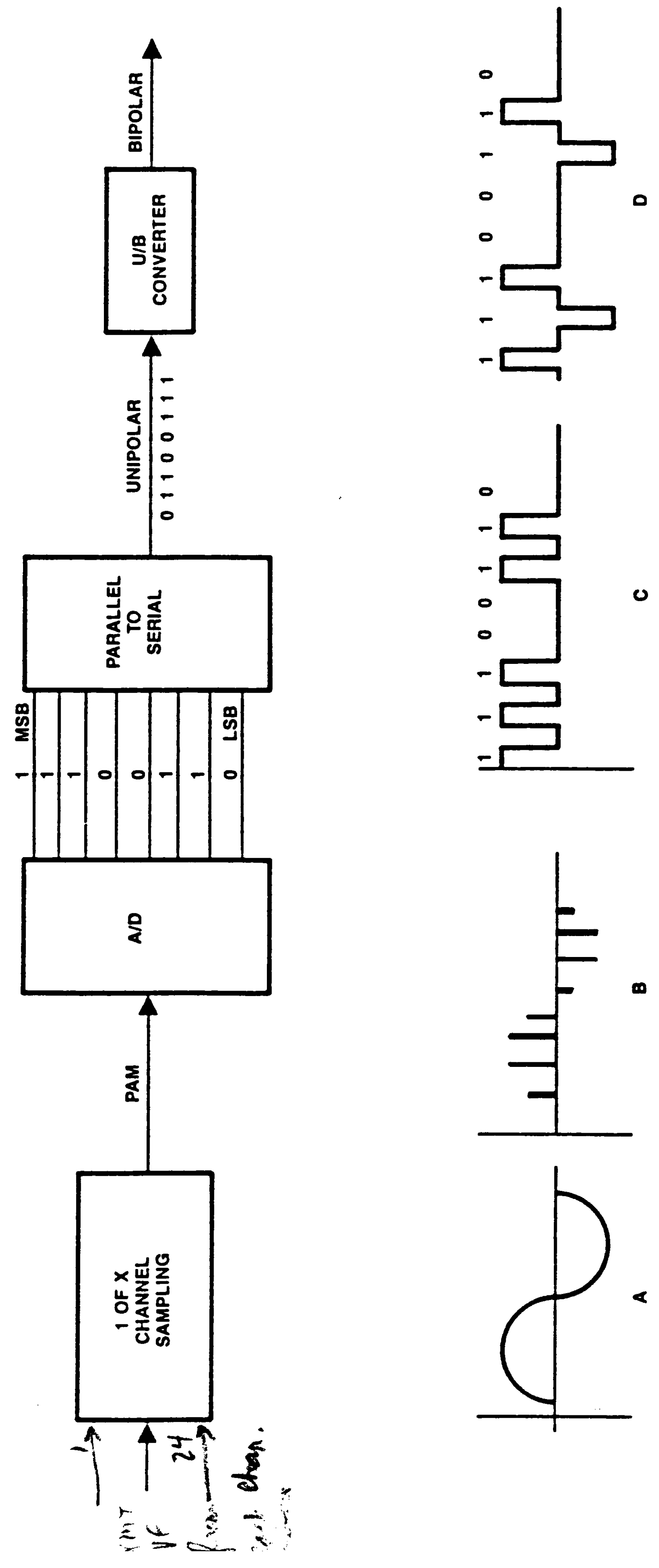


Fig. 1-10 — Analog-to-Digital Conversion Block Diagram

3.08 The PCM word first appears at the output of the A/D converter in a parallel format, all eight bits at the same time on eight different conductors. The data is then converted to a serial format where the most significant bit (MSB) or bit 1 is set first, followed by bit 2 to the least significant bit (LSB), bit 8. The serial bit stream is in a unipolar format. This T1 signal is going to be applied to a cable pair for transmission where the loss to the signal will get worse with the length of the cable, capacitance, and the frequency of the signal in it. At 1.544 Mb/s the loss is extreme. To increase repeater separation the unipolar signal is converted to bipolar by turning over every other one in the bit stream. The effect of the conversion is to halve the effective frequency of the signal to 772 kHz, thereby doubling the distance before regeneration is required.

3.09 The receive conversion back to analog is the reverse of the transmit conversion. The incoming bipolar PCM is converted to unipolar, the pulse codes create a sample in the D/A converting process, and multiple samples are averaged together to reconstruct the original analog test tone.

4. T1 FRAMING

4.01 The two ends of a carrier system must be synchronized with each other so that information transmitted on channel one shows up on channel one at the other end. To frame the two terminals, every time the transmitting terminal sends the codes for 24 channels, a single bit is added to the bit stream, called the frame bit. The frame bit occurs once every 193 bits: 8 bits per channel x 24 channels + 1 frame bit = 193 bits.

4.02 The transmitted bit stream is shown in Fig. 1-11. First, 192 VF data bits are sent, followed by the frame bit. This 193rd bit will progress through a known, 12-frame sequence of ones and zeroes shown in Fig. 1-12. The receive terminal knows this sequence and searches the incoming bit stream for it. Finding this 193rd bit then defines all the rest. If the receiving terminal cannot locate the frame bit and loses synchronization with the far terminal, a FRAME alarm is displayed in the alarm and power unit (325AP01A).

5. SIGNALING

5.01 To this point no signaling information has been transmitted. Up to this point all data sent has been for VF sampling only. When a VF sample is taken from a channel the state of the signaling leads is also sampled. During the sixth frame in the 12-frame sequence, the eighth bit in each channel's word will be dedicated to carry that channel's A signaling bit. During the twelfth frame the B signaling bit is transmitted.

6. RECEIVE CLOCK RECOVERY

6.01 The clock rate at which a terminal operates is determined for a direction of transmission by a crystal controlled clock in the transmit converter. It is critical that the receive converter operate at the exact same clock rate as the transmit converter sending to it. Therefore, instead of generating a new clock in the receiver, a clock is recovered from the incoming bit stream, thereby locking the receiver at the same frequency as the transmitting end. If a clock cannot be generated from the incoming signal through loss of signal, a CLOCK alarm is displayed in the alarm and power unit (325AP01A).

7. ALARM GENERATION AND FAULT RECOVERY

7.01 No alarm conditions are monitored on the transmit end of a system. The receive end monitors for a loss of clock or a loss of terminal frame. As shown in the detailed block diagram (Fig. 1-13), either of these two failures will cause a LOCal alarm to be displayed on the alarm and power unit (325AP01A). When a terminal fails two results occur within the system.

7.02 First, carrier group alarm (CGA) functions take over the signaling functions in the channel units. When the alarm occurs a force idle function forces to an idle state all signaling in the channels, cutting off all conversations and stopping toll ticketing. After a 2- or 12-second delay, according to 325AP01A strapping, all channels are forced to a busy state, preventing any further call assignments to the failed bank. When the alarm clears the channels return to their normal idle state.

7.03 Second, the fault condition is transmitted to the far terminal. To instruct the far terminal to process its channels out of service and to show the failed condition, the second bit, B2, in each channel's transmitted word is forced to a zero state. The normal state for B2 is a one or at least a changing state. The terminals monitor bit B2. When the far terminal sees B2 go low for a short time period, it assumes it to mean a failure of the opposite terminal. The REMote alarm is turned on, and the channels fall under the control of CGA.

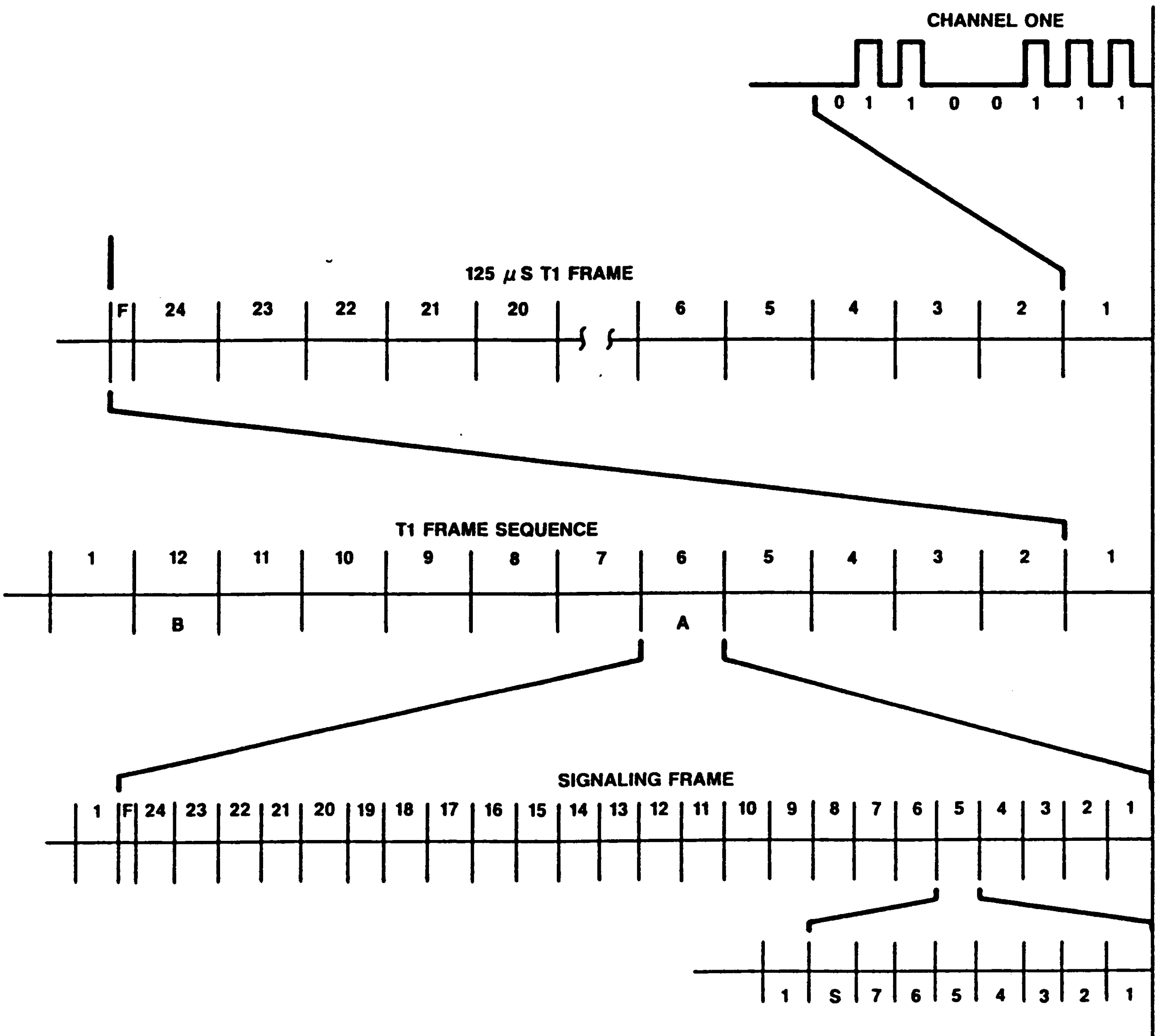


Fig. 1-11 — T1 Frame Contents

TIME →												
FRAME NO.	1	2	3	4	5	6	7	8	9	10	11	12
SEQUENCE	1	0	0	0	1	1	0	1	1	1	0	0
TERMINAL FRAME	1		0		1		0		1		0	
SIGNALING FRAME		0		0		1		1		1		0
INFORMATION CODING BITS	8	8	8	8	8	7	8	8	8	8	8	7
SIGNALING CHANNEL						A						B

Fig. 1-12 — T1 Frame Bit Sequence

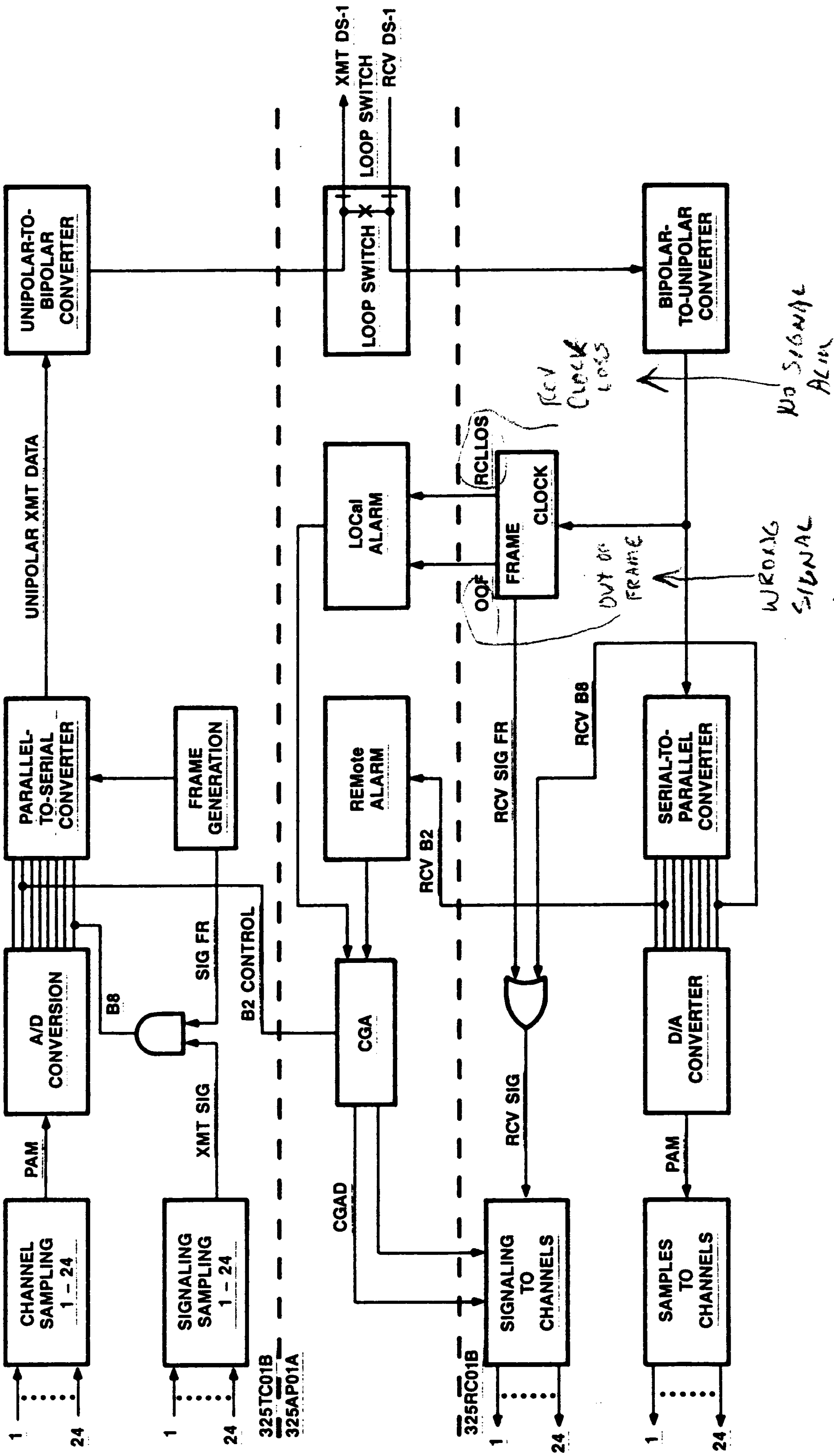


Fig. 1-13 — B325 Terminal Detailed Block Diagram

8. FAULT ISOLATION

8.01 Each channel bank has a loop switch on the 325AP01A to help in fault isolation. The loop switch connects to the output of the transmit converter directly to the receiver removing all external equipment. By analyzing the alarm state in and out of loop condition, the equipment at fault can be determined.

8.02 First, the LOCal alarm indicates a failure of the far to near terminal direction of transmission. The REMote alarm indicates near to far. Both indicate the same direction. With the addition of the loop switch, only four conditions are possible pointing to the failed equipment.

LOCAL → LOOP → CLEAR = NO TERMINAL FAULT
LOCAL → LOOP → LOCAL = BAD 325RC01B

REMOTE → LOOP → CLEAR = NO TERMINAL FAULT
REMOTE → LOOP → LOCAL = BAD 325TC01B

If both terminals are looped and show no alarms, the fault is isolated to the span equipment.

Caution: Always remove system power before removing or inserting common control units. Use wrist straps to prevent static damage!

SECTION II

B325 CHANNEL BANK TEST AND ALIGNMENT

CONTENTS **PAGE**

Figures

Table

1. B325 CHANNEL BANK TEST AND ALIGNMENT

1.01 This section provides step-by-step instructions for adjusting each channel's transmit and receive gain adjustments as well as performance testing for idle channel noise, distortion and crosstalk. The procedure requires the use of a test oscillator and a transmission and noise measuring set (TNMS).

1.02 The entire test procedure requires the terminal to be placed in LOOP mode. All channels will be out of service. The procedure is therefore a pre-service test. If the bank is in service and cannot be placed out of service, refer to the periodic test procedure following the installation test procedure.

1.03 Two different test and alignment panels are available for the following test procedures: the 325TA01 and the 325TA03. This procedure addresses the 325TA03 with respect to switch settings and operation. With the exception of the periodic alignment procedure, the function of the two panels is identical. The 325TA01 is not capable of performing the steps found in the periodic test procedure.

325TA03 TEST AND ALIGNMENT PANEL

1.04 The 325TA03 provides all of the functions of the 325TA01 as well as the in-service test and alignment of each channel. The controls and jacks of the 325TA03 are shown in Fig. 2-1. The test panel is

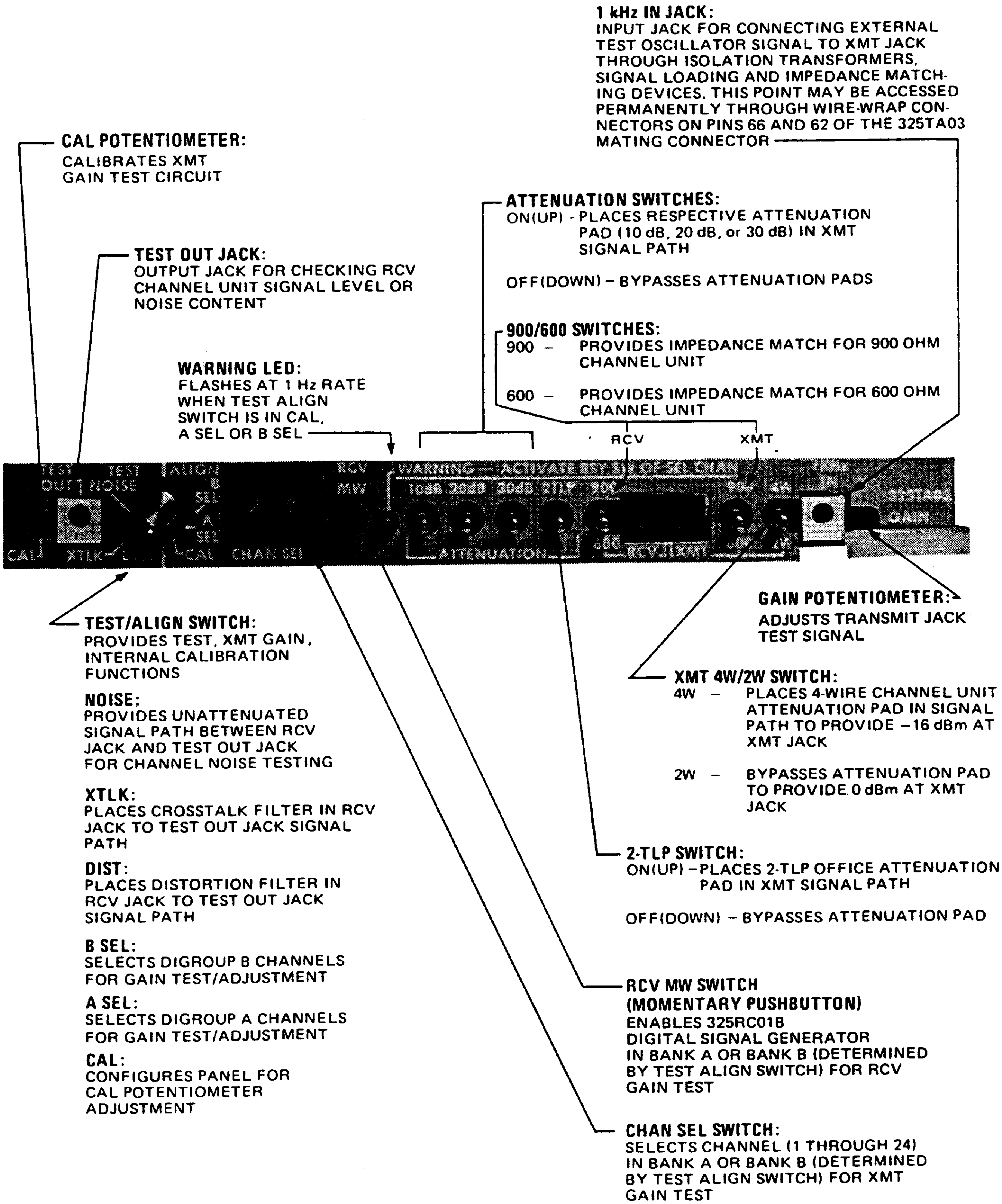


Fig. 2-1 — 325TA03 Test and Alignment Panel

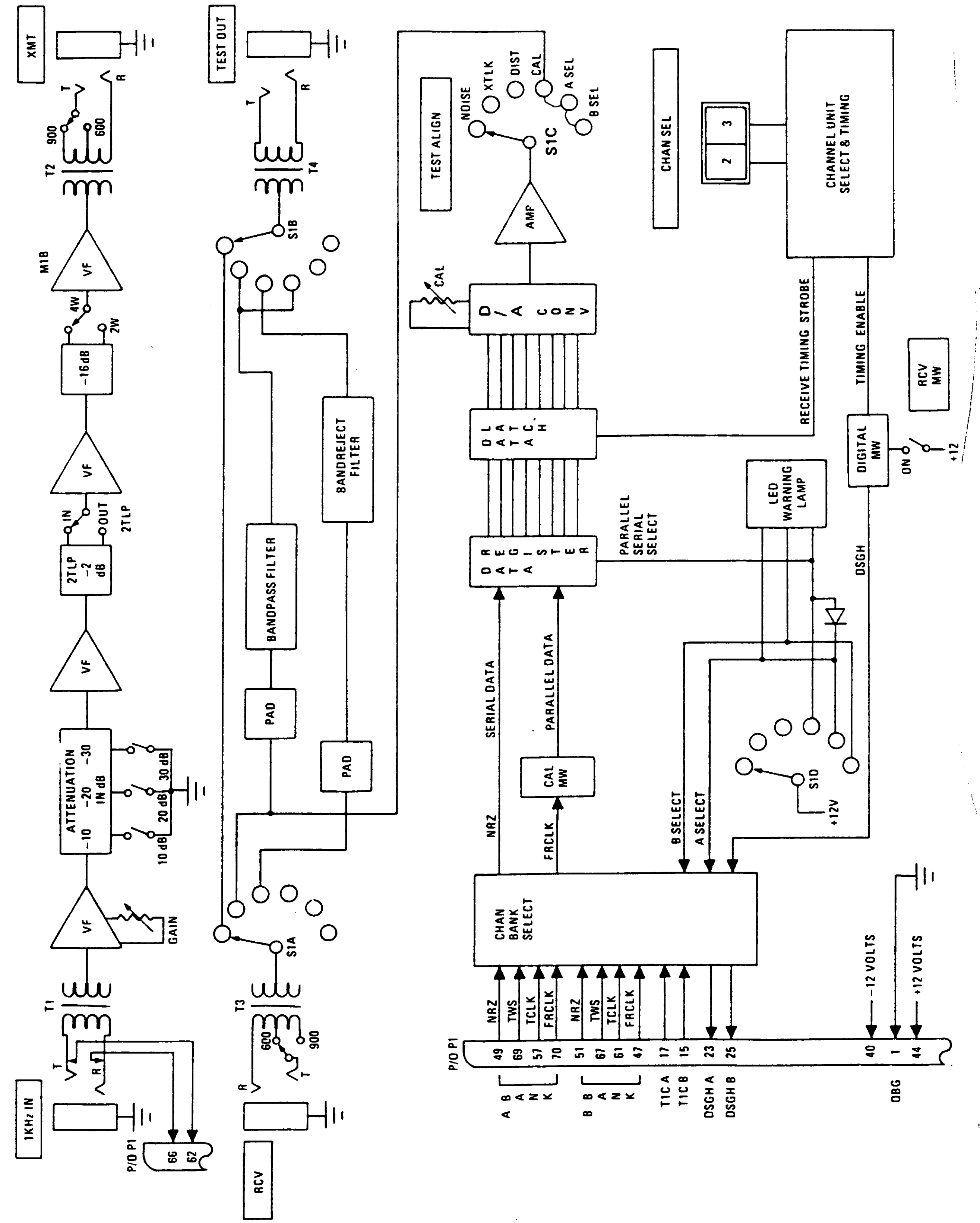


Fig. 2-2 — 325TA03 Test and Alignment Panel Block Diagram purely a convenience and is not required for testing, provided the filters required for distortion (1-kHz notch) and crosstalk (1-kHz bandpass) are available in the TNMS.

1.05 The test panel is a two-sided device (Fig. 2-2). One side provides for connections between the test oscillator and the channel unit, while the other side interfaces the channel unit to the TNMS. The transmit side has input and output bantam jacks for cord connections, an impedance matching switch to match the test panel impedance to the channel under test, and attenuator pads used in distortion testing. The receive side also has an impedance switch for the receive jack impedance along with the distortion and crosstalk filters required for performance testing.

B325 TEST AND ALIGNMENT FEATURES (DSG AND SHIFT)

1.06 When the channel bank is in loop condition, as controlled by the loop switch on the right front panel of the 325AP01A, the digital signal generator (DSG) and the shift (SHIFT) are enabled. The switches controlling these two features are located in the lower left corner of the 325AP01A. The setting of these switches does not matter when the terminal is not in loop condition, as they are internally disabled.

1.07 The DSG when used will cause the receive converter to supply all 24 channel positions with a test tone for adjusting the receive gain adjustment for the desired level. The shift feature causes the looped channel bank to route a channel's transmit to a channel's receive eight channels ahead. Refer to the chart in Fig. 2-6 to see how the channels will match up.

2. LOOP CHANNEL TEST AND ALIGNMENT PROCEDURE SETUP

2.01 Because the test equipment used for testing commonly is not periodically calibrated and tested, the first procedure will set the correct operating level for the test panel as well as test the test oscillator for a distortion-free output to be used in channel distortion testing.

(a) Arrange the test panel, oscillator and TNMS as shown in Fig. 2-3. Place test panel switches in positions shown.

(b) Set controls for the TNMS for 600-ohm terminated level measurement.

Note: Throughout this procedure there will be requirements to match circuit impedances. The switches that set the test panel to channel unit impedances must be set to match the channel whenever they are used. The impedance of the oscillator and TNMS must also match the circuit to which they are connected. If you are using a combination test set it may be impossible to have a different impedance for both transmit and receive. If this is the case, set the TNMS impedance switch to match the impedance of the majority of channels in the system under test and do not change it throughout this procedure even though a mismatch might occur.

(c) Adjust the test oscillator for 1 kHz at 0 dBm.

(d) Adjust the test and alignment panel GAIN control for a reading of 0 dBm.

(e) Move the oscillator input from the 1 kHz IN jack to the RCV jack on the test panel. See Fig. 2-4.

(f) Move the TNMS from the XMT jack to the TEST OUT jack. See Fig. 2-4.

(g) On the test panel set the TEST ALIGN switch to DIST.

(h) Set the TNMS for a noise measurement C-message weighting.

(i) Slightly tune the oscillator frequency until a null or lowest level is produced in the noise reading.

(j) Indication must be less than 32 dBrnC. If not, the oscillator is unsuitable for distortion testing.

(k) Disconnect test setup.

3. LOOP CHANNEL RECEIVE AND TRANSMIT GAIN ADJUST

3.01 The following procedure will guide you through the adjustment of both the receive and transmit gain adjustment in each of the channels in a channel bank. The previous setup procedure should have been completed first.

(a) Press and latch all channel busy switches.

(b) On the 325AP01A, press and latch the LOOP switch, turn the DSG and SHIFT switches on.

Note: Whenever the DSG is turned on, the REM alarm light will come on. This is a normal condition.

(c) Connect the test circuit as shown in Fig. 2-5. Initial test panel switch settings are shown in the figure.

(d) Set the TNMS for a level measurement, terminated at the same impedance as the receiving channel under test.

Note: Remember this step may not be recommended if you are using a combination test set with only one impedance switch for both sides of the set. See note following paragraph 2.01 (b).

(e) The XMT impedance switch on the test panel must be set to match the channel the XMT jack is connected to.

(f) The 2W/4W switch must be set to match the channel type connect to the XMT jack. This sets the correct input level.

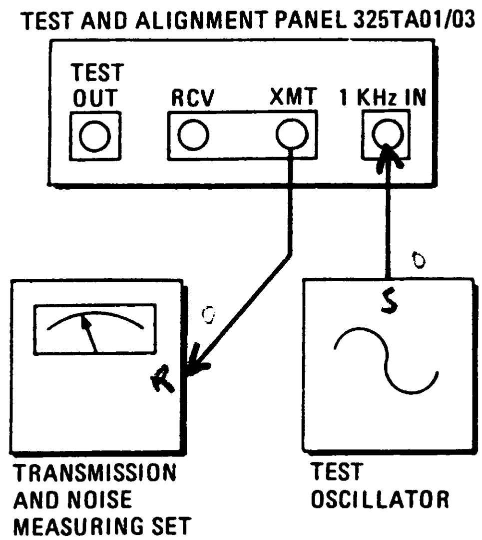
(g) Adjust the receive channel RCV gain adjustment for the correct receive level.

CHANNEL	IMPEDANCE	LEVEL	SPECIAL
2 Wire	900	-2 dBm	_______
4 Wire	600	+7 dBm	_______

(h) Turn the DSG off. Adjust the transmitting channel XMT gain adjust for the same receive level. Turn the DSG back on.

(i) Repeat steps (d) through (h) until all channels have had both gain adjustments correctly set.

(j) Disconnect test panel from channel units.



325TA01 SWITCH SETTINGS

CROSSTALK–	OFF (DOWN)
DISTORTION–	OFF (DOWN)
ATTENUATION–	ALL SWITCHES OUT
2TLP–	OUT
RCV 900/600Ω –	600Ω
XMT 900/600Ω –	600Ω
XMT 4W/2W–	2W

Fig. 2-3 — Test Oscillator Adjustment Setup

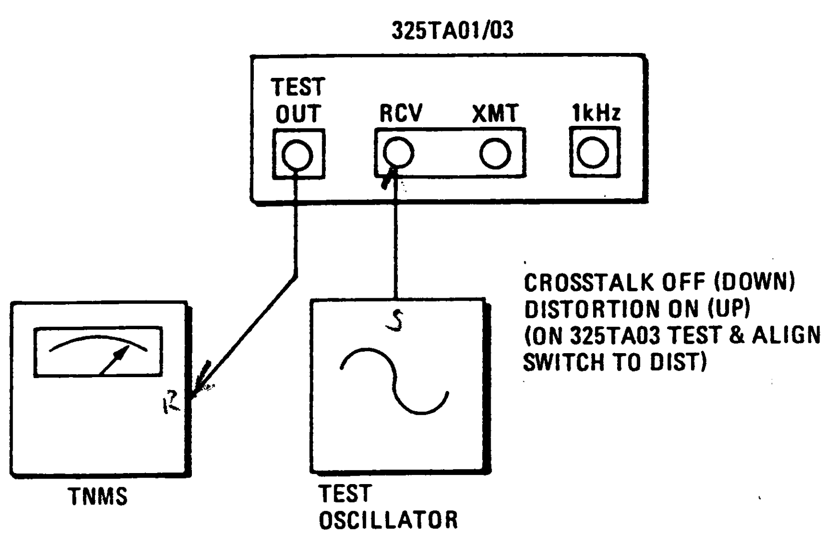
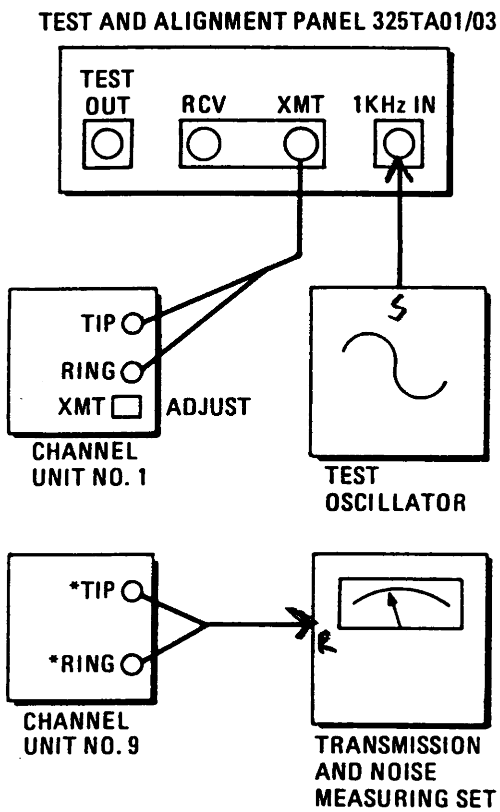


Fig. 2-4 — External Oscillator Test



*Make connections to TIP 1 and RING 1 jacks on 4-wire channel units.

MATE CHANNEL UNITS IN SHIFTED LOOP MODE	
XMT	RCV
1	9
2	10
3	11
4	12
5	13
6	14
7	15
8	16
9	17
10	18
11	19
12	20
13	21
14	22
15	23
16	24
17	1
18	2
19	3
20	4
21	5
22	6
23	7
24	8

Fig. 2-5 — RCV and XMT Gain Adjustments Hookup

4. LOOP CHANNEL IDLE CHANNEL NOISE TEST

4.01 The following procedure will test for the idle channel noise performance of all channels in the channel bank. The proper alignment of the terminal must have been accomplished first.

(a) Ensure all channels have their busy switches latched, the 325AP01A is in LOOP condition, the DSG is off, and the SHIFT is on.

(b) Connect the equipment as shown in Fig. 2-6. The TEST/ALIGN switch must be set to the NOISE position.

(c) Set the TNMS for 600 ohms terminated noise measurements through C-message weighting filters.

(d) Set the RCV impedance switch on the test panel to match the connected channel.

(e) Terminate the transmitting channel with a correct terminating impedance for that channel.

(f) The noise level measured must not exceed the specifications given in Table 2-1.

(g) Repeat steps (d) through (f) for all remaining channels.

(h) Disconnect channel connections.

TABLE 2-1

B325 PERFORMANCE TEST LIMITS

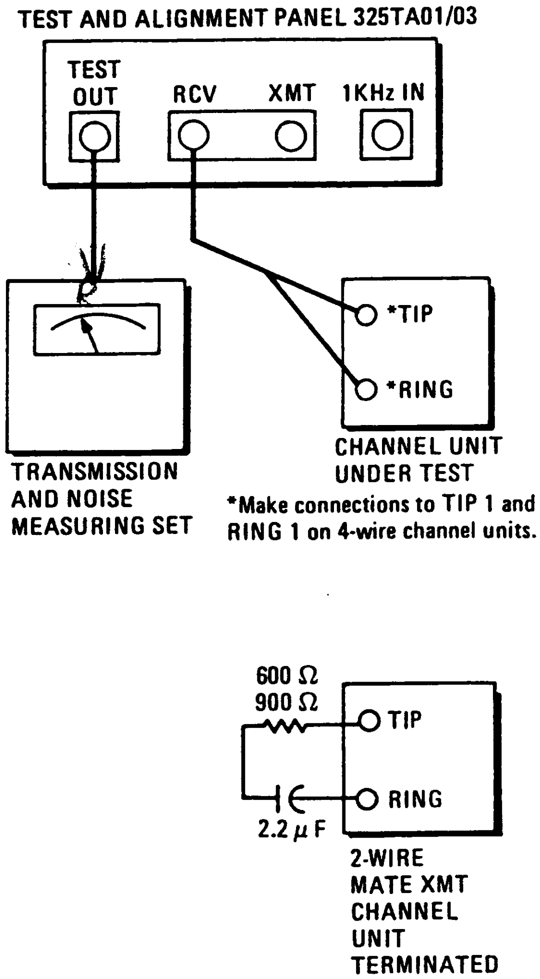
CHANNEL UNIT TYPE*	IDLE NOISE	DISTORTION				CROSSTALK	
		0 dB	10 dB	20 dB	30 dB	I	II
2-Wire Units 325DP01 325DP02 325EM02 325EM03 325FX01 325FX02	19.7 dBrnC0	46 dBrnC0	36 dBrnC0	26 dBrnC0	16 dBrnC0	18.4 dBrnC0	14.4 dBrnC0
4-Wire Units 325EM01 325VF01	28.7 dBrnC0	55 dBrnC0	45 dBrnC0	35 dBrnC0	25 dBrnC0	27.4 dBrnC0	23.4 dBrnC0

* Refers to receive channel unit (connected to RCV jack on test and alignment unit).

Note:

(1) If 2-wire units are aligned for receive levels other than -2 TLP, the noise reading shown above must be corrected. For example, a -3 channel must meet noise levels 1 dB lower than shown in this table.

(2) Values listed in this table are corrected for insertion loss in tests and alignment unit.



MATE CHANNEL UNITS IN SHIFTED LOOP MODE	
XMT	RCV
1	9
2	10
3	11
4	12
5	13
6	14
7	15
8	16
9	17
10	18
11	19
12	20
13	21
14	22
15	23
16	24
17	1
18	2
19	3
20	4
21	5
22	6
23	7
24	8

Fig. 2-6 — Idle Channel Noise Test Hookup

5. LOOPED CHANNEL DISTORTION TEST

5.01 In the following procedure each channel is checked for distortion by transmitting a 1-kHz test tone through the transmit and receive circuitry, then filtering out that tone. The remaining noise (quantizing noise) is the distortion caused by the A/D and D/A process.

(a) Ensure the 325AP01A is in LOOP condition, the DSG is off, the SHIFT is on, and all channel busy switches are latched.

(b) Set up the equipment as shown in Fig. 2-7. Move the TEST/ALIGN switch on the test panel to DIST. The TNMS must be 600-ohm terminated with C-message weighting.

(c) The XMT and RCV impedance switch must always match the channels connected to them. All attenuator switches must be off (down).

(d) The noise measured must be less than the specification in the 0-dB column in Table 2-1.

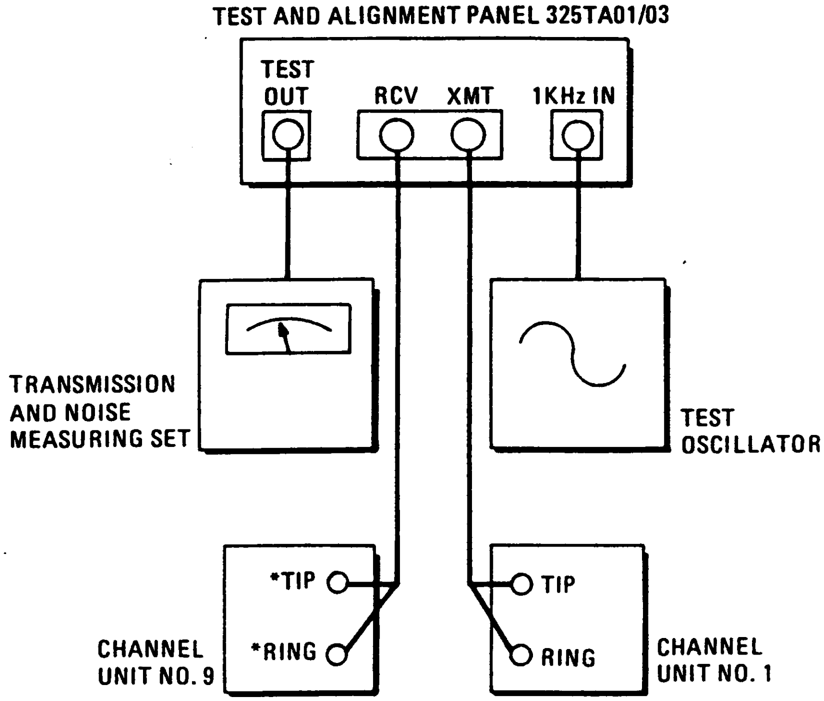
(e) Turn on the 10-dB attenuator switch. The noise measured must not exceed the specification in the 10-dB column in Table 2-1.

(f) Turn off the 10-dB switch and turn on the 20-dB switch. The noise measured must not exceed the specification in the 20-dB column in Table 2-1.

(g) Turn off the 20-dB attenuator and turn on the 30-dB attenuator. The noise measured must not exceed the specification in the 30-dB column in Table 2-1.

(h) Repeat steps (c) through (g) for all remaining channels.

(i) Disconnect the channels from the test panel.



*Make connections to TIP 1 and RING 1 on 4-wire channel units.

MATE CHANNEL UNITS IN SHIFTED LOOP MODE	
XMT	RCV
1	9
2	10
3	11
4	12
5	13
6	14
7	15
8	16
9	17
10	18
11	19
12	20
13	21
14	22
15	23
16	24
17	1
18	2
19	3
20	4
21	5
22	6
23	7
24	8

Fig. 2-7 — Looped Distortion Test Hookup

6. LOOPED CHANNEL INTERCHANNEL CROSSTALK TEST

6.01 The following procedure tests all channels for interchannel crosstalk. This test is a bit ridiculous on a channel bank looped back on itself. The results on a properly aligned terminal are usually zero, but the "powers that be" say test... so, test. If you don't, I won't tell anybody.

6.02 In measuring crosstalk, a tone must be received on the channel adjacent to one being measured. This would be considered interfering channel one while a tone received two channels away will be considered interfering channel two.

(a) Ensure the bank is still in LOOP, the DSG off, the SHIFT on, and all channel busy switches are latched.

(b) Set up the equipment as shown in Fig. 2-8. The TEST/ALIGN switch must be in the XTLK position and all attenuator switches off.

(c) Set the TNMS for 600 ohms terminated measurements through C-message weighting filters.

(d) The XMT and RCV impedance switches on the test panel must always match the channels connected.

(e) Terminate the relating channels shown in column 4.

(f) The crosstalk measured must not exceed the column I specification.

(g) Move the transmit tone back one channel (column 3) and terminate the channels shown in column 5.

(h) The measurement must not exceed the specification given for interfering channel II.

(i) Repeat steps (d) through (h) for all remaining channels.

(j) Testing is complete. Disconnect entire setup.

(k) Release the loop and all channel busy switches. LUNCH.

7. PERIODIC CHANNEL TEST AND ALIGNMENT

7.01 Once a channel bank is placed in service, it would be undesirable to loop the bank, taking all 24 channels out of service just to test or adjust one channel. With the aid of the features in the 325TA03 test and alignment panel, one channel can be tested and aligned independently of the other channels in the system and independently of help from the opposite terminal end.

7.02 If a channel is replaced, the new channel gain adjustments can be set using a tone end-to-end, assuming the far-end channel is correctly adjusted and there is someone there to assist. Otherwise, the 325TA03 will provide a digital generator to supply a test tone for receive gain adjustment and a D/A converter to decode a transmitted test tone for adjusting the transmit gain.

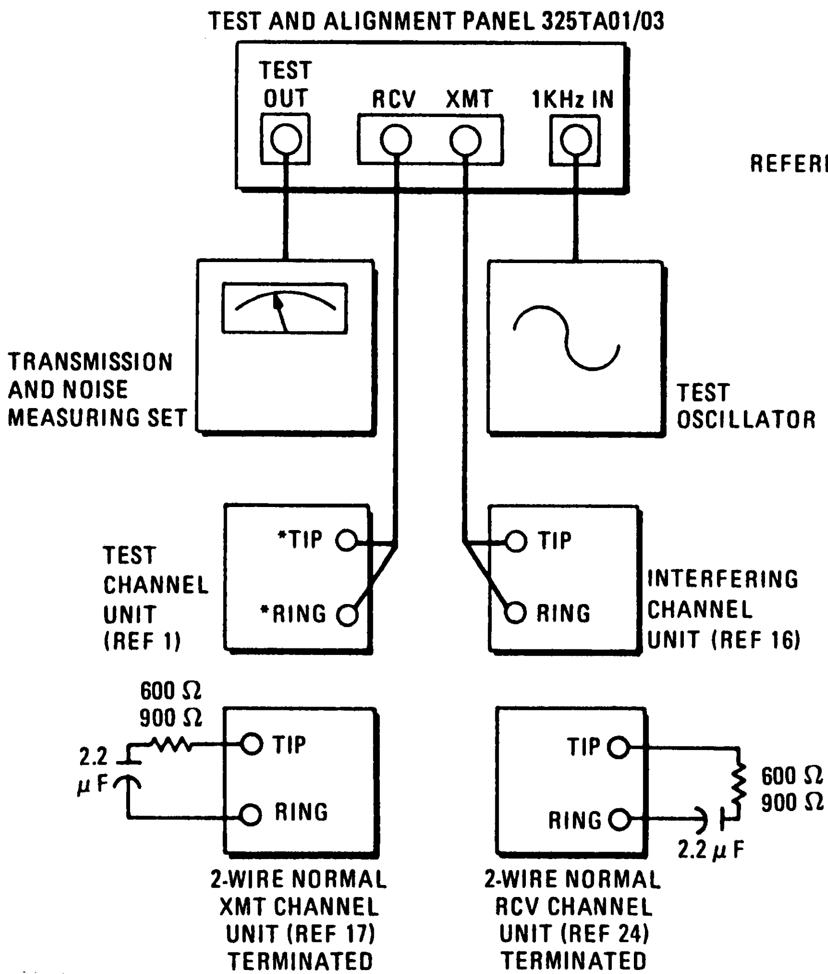
7.03 Adjustments are achieved through selecting the desired channel with the CHAN/SEL switches on the 325TA03 test panel. By holding down the receive milliwatt (RCV MW) button, a digital 0-dB tone is sent to the receive side of the channel where the RCV gain adjustment can be made, resulting in a correct output level. The XMT gain is adjusted to be transmitting a correct level test tone on the selected channel and having the test panel decode the tone as the far-end channel bank would. A correctly adjusted channel will result in a 0-dBm level measured at the TEST OUT jack on the test panel.

7.04 The right side of the TEST/ALIGN switch on the 325TA03 indicates a SEL A, SEL B and CAL settings. The first part of the procedure will be to calibrate the D/A converter in the test panel using the CAL position. The SEL A and SEL B positions are used for digroup selections. A D3, 24-channel system will always use SEL A. A D4 channel bank will use SEL A for digroup one, channels 1 through 24, and SEL B for digroup two, channels 24 through 48.

7.05 Calibrate the 325TA03 D/A converter as follows:

(a) Set the TNMS for 600-ohm terminated level measurement and connect it to the TEST OUT jack on the test panel.

(b) Position the TEST/ALIGN switch to CAL. The warning light will flash to warn of possible service interruption to the channel selected on



REFERENCE

TEST CHANNEL (RCV Jack)	INTERFERING CHANNEL (XMT Jack)		RELATED CHANNEL UNITS (Terminate If 2-Wire)	
	I	II	I	II
1	16	15	17, 24	17, 23
2	17	16	18, 1	18, 24
3	18	17	19, 2	19, 1
4	19	18	20, 3	20, 2
5	20	19	21, 4	21, 3
6	21	20	22, 5	22, 4
7	22	21	23, 6	23, 5
8	23	22	24, 7	24, 6
9	24	23	1, 8	1, 7
10	1	24	2, 9	2, 8
11	2	1	3, 10	3, 9
12	3	2	4, 11	4, 10
13	4	3	5, 12	5, 11
14	5	4	6, 13	6, 12
15	6	5	7, 14	7, 13
16	7	6	8, 15	8, 14
17	8	7	9, 16	9, 15
18	9	8	10, 17	10, 16
19	10	9	11, 18	11, 17
20	11	10	12, 19	12, 18
21	12	11	13, 20	13, 19
22	13	12	14, 21	14, 20
23	14	13	15, 22	15, 21
24	15	14	16, 23	16, 22

*Make connections to TIP 1 and RING 1 jacks on 4-wire channel units.

Fig. 2-8 — Looped Interchannel Crosstalk Test Hookup

the select switches. Select a channel, 1 to 24, to be tested. 00 is not acceptable.

(c) Adjust the 325TA03 CAL adjustment for a 0-dBm measurement.

8. CHANNEL TRANSMIT GAIN ADJUSTMENT

8.01 Use the following procedure to adjust a channel unit's transmit gain. The calibration procedure must have been done first as well as the test panel gain adjust found in paragraph 2.01 (a) through (d). During the procedure, any traffic on the channel being adjusted will be cut off.

(a) Connect the TNMS to the TEST OUT jack on the test panel, 600 ohms terminated. Refer to Fig. 2.9.

(b) Adjust a test oscillator for 600 ohms, 1 kHz, 0 dBm and connect it to the 1-kHz IN jack. Select the correct channel input level with the 2W/4W switch on the test panel.

Note: Any nonstandard special service level can be used at this point. Consult the channel unit strapping options if required.

(c) With the CHAN SEL switches select the number for the channel for testing. Push and latch the busy switch on that channel.

(d) Patch the XMT jack on the test panel to the tip and ring of the channel, selecting the correct impedance for the channel with the switch next to the XMT jack.

(e) Adjust the channel XMT gain adjust for a 0-dBm level indication.

9. CHANNEL RECEIVE GAIN ADJUSTMENT

9.01 Use the following procedure to correctly adjust the channel's receive gain. The transmit gain adjustment does not need to be done first. Any traffic on the channel will be cut off during this procedure. Refer to Fig. 2-10.

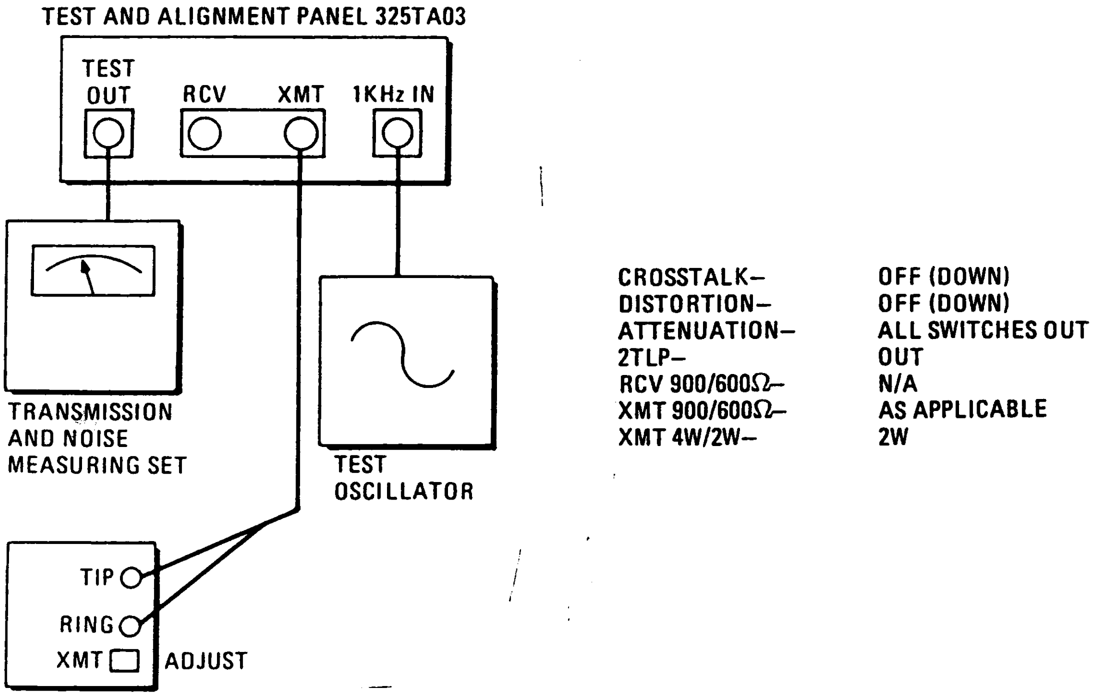
(a) Push and latch the busy switch on the channel to be adjusted.

(b) With CHAN SEL switches select the channel number.

(c) Connect a TNMS, terminated to the channel's impedance, to the tip and ring, Tip1 Ring1 for 4-wire channel test points.

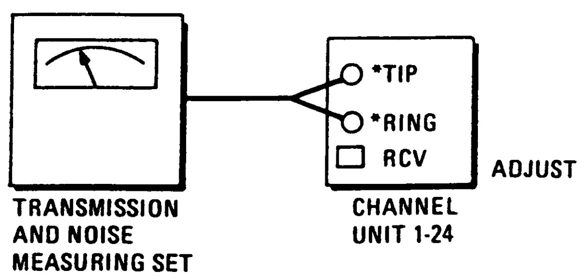
(d) Depress and hold the RCV MW switch and adjust the channel's RCV gain for the desired output level.

(e) Disconnect the test setup. Release the channel's busy switch.



XMT Gain Adjust Test Hookup

Fig. 2-9 — Periodic Channel Transmit Gain Adjustment



*Make connections to TIP-1 and RING-1 jacks on 4-wire channel units.

Fig. 2-10 — Periodic Channel Receive Gain Adjustment

SECTION III

B303 SPAN LINE EQUIPMENT

CONTENTS PAGE

Figures

Tables

1. GENERAL

1.01 A span line is defined as a repeatered line that begins and ends with a span terminating unit (office repeater) and requires two cable pairs (XMT and RCV). The total cross section of span lines between the end office repeaters is called a span.

1.02 At the equipment or terminal point of connection to a span terminating unit, the signal levels are at a standard 0-dB, T1 signal level (6 volts peak-to-peak; 3 volts peak-to-base) and therefore may be connected to any T1 service port. All span lines in a given span are electrically identical and are therefore interchangeable. Span lines may be connected in tandem to an approximate span limit of 200 miles before timing errors (phase jitter) become intolerable in overall system performance.

1.03 A span line is a simple three-component system consisting of a span terminating unit at each end (303STxx), a number of line repeater units (303RUxx) spaced periodically in the line, and the interconnecting cable.

1.04 The span terminating unit (office repeater) is the interface unit between the office terminal equipment and the outside plant. The units provide all the required electronics to pass receive and transmit signals. Bantam jacks are provided for signal testing/patching of both the terminal equipment and the span equipment. Fault interrogation capabilities are provided at the output of the regenerator, and a means of providing power to the unit itself and to the span line are provided. The span line will be discussed, first with respect to the T1 signal, then to powering scheme.

2. SPAN LAYOUT

2.01 The equipment spacing between the terminal device and the span terminating unit is not critical to the 303ST, but is to the terminal device. Refer to Fig. 3-1. Generally, the maximum separation is 150 feet before the received signal at the terminal is too low. Lynch offers an option with its span terminating units that allows separation up to 820 feet. Shielded cable is recommended (Belden 8450); ground only one end to prevent ground loops.

2.02 In the transmit direction the input signal from the terminal is normally at the 0-dB T1 level so there is no regeneration electronics required in this direction. The signal is connected to the unit, passes through XMT OUT, XMT IN, and XMT MON jacks, through a balancing, power simplexing transformer, on to the transmit cable pair. As a general engineering specification, the first span section out of an office is designed to 23 dB of loss at 772 kHz; subsequent sections are designed to 32 dB. The near-end sections are

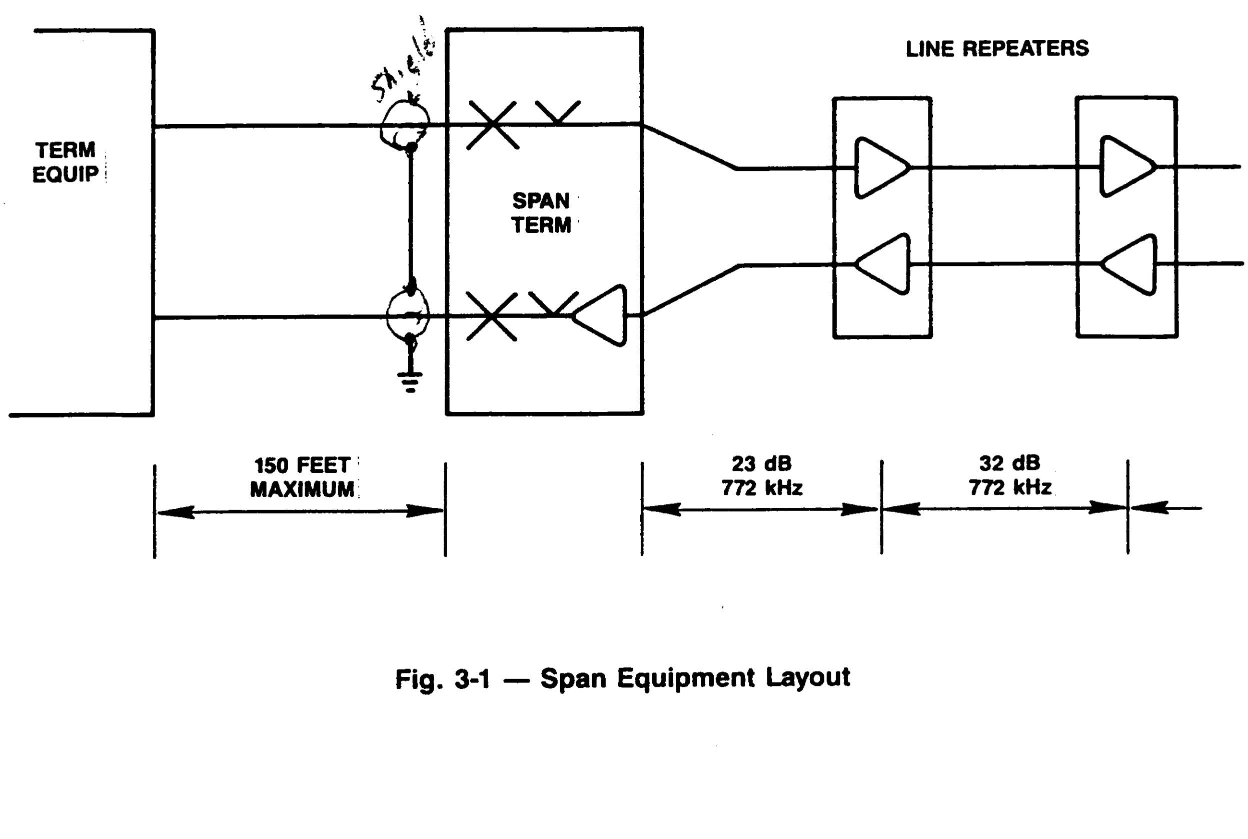


Fig. 3-1 — Span Equipment Layout

kept 9 dB shorter to maintain an adequate signal-to-noise ratio at the input to the repeaters (field and office), to prevent impulse noise from creating errors in the transmission signal. If, in a bipolar signal, all pulses are present in the bit stream, the bit rate would be 1.544 Mb/s. The effective frequency becomes 772 kHz. As the frequency is never higher, this is then worst-case frequency for loss and is used for cable section loss calculations.

2.03 Because of the attenuation to the receive signal in the end section, a regenerator is required in the receive side of the span terminating unit to provide the terminal with the normal T1 signal level. The signal is regenerated, coupled through a transformer to the RCV MON test jack. After passing through the RCV OUT and the RCV IN test jacks, the signal is connected to the terminal device.

3. REPEATERS

3.01 The output of a repeater is shown in Fig. 3-2, detail C. After passing through a nominal length of cable, the bipolar signal is both attenuated and distorted due to the cable's electrical characteristics. An approximate repeater input waveform is shown in Fig. 3-2, detail B. With the exception of their input level ranges, the regenerator in the 303ST (0 to 27 dB) and the two (side 1 and side 2) in the 303RU (6 to 36 dB) units are identical.

3.02 The distorted and attenuated signal from the cable section is coupled through surge protection resistors (5.6 ohms) and transformer T1 to the input stage of the repeater. The signal is amplified, regulated and shaped by the equalizer and preamplifier circuitry. It is then fed to the clock extraction and threshold detector circuitry.

3.03 The clock extraction circuit is a high Q resonator, tuned to 1.544 MHz. The resonator provides a continuous timing signal, even though the input signal may have missing pulses, at the exact bit rate of the incoming signal.

3.04 The threshold detector consists of two set/reset flip-flops. One flip-flop provides the drive signal for the positive side of the balanced regenerator; the other flip-flop provides the drive for the negative side.

3.05 When an incoming signal goes over the threshold, represented by the dashed lines in Fig. 3-2, detail A, in either the positive or negative direction, the threshold detector will output a pulse of that same polarity with all noise removed. The balanced regenerator will then drive the transmit cable pair with a like polarity pulse.

4. REPEATER OPTIONS

4.01 Notice in Fig. 3-3 the additional winding on the repeater output transformer T2. This winding is associated with the fault interrogation system. These outputs (pins 2 and 7) must be grounded if not properly terminated with a fault filter to prevent errors in the output PCM signal. In the 303RU repeater units, two fault windings may be optionally strapped combined or separated. This function will be discussed under fault interrogation.

4.02 The 303RU line of repeaters has strapping options for various cabling configurations (options A, B, C), powering functions (options loop or through), and fault interrogation (options combined or separated). The 303RU01B/02B repeaters have all three of these options strap selectable. The 303RU38A/39A repeaters have the power and fault options, but are wired for cabling option A. The 303RU38B/39B and 303RU38C/39C repeaters have cabling options B and C, respectively.

4.03 The 303RU01B and 303RU38 types of repeaters are considered unprotected repeaters in that the receive and transmit leads to the units do not have the 5.6-ohm resistors present in the 303RU02B and 303RU39 units. These resistors are designed to explode open in a high current surge condition, opening the line to protect repeater electronics.

5. CABLING OPTIONS

5.01 A repeatered span line can be designed with both directions of transmission in the same cable sheath (one cable), or with the two directions in different cables or using one cable with an electrostatic screen between transmit and receive directions (T or D screen). With the options available in the repeater as well as in the repeater housing (303RH), there are several possible configurations. In the following discussion, refer to Figs. 3-4 and 3-5.

5.02 Although there are five different configurations shown in Fig. 3-5, only the installation options A and D will be discussed since these are the most common. Pin assignments for the 303RU for the two

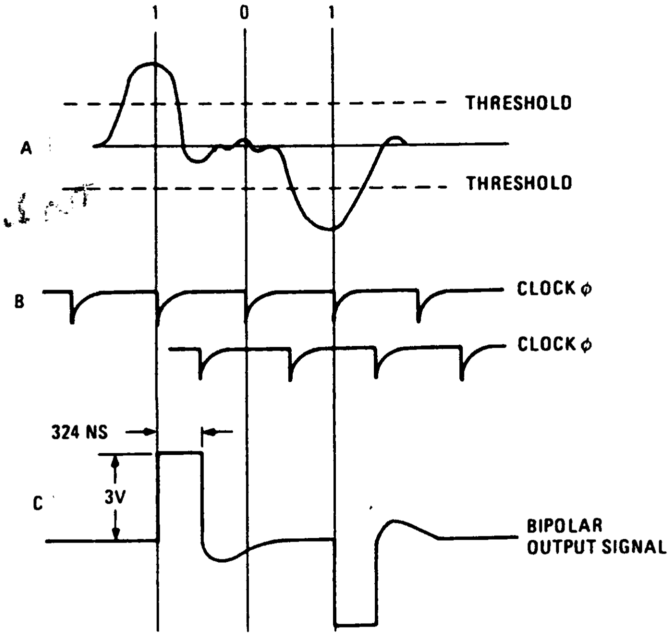


Fig. 3-2 — Repeater Wave Forms

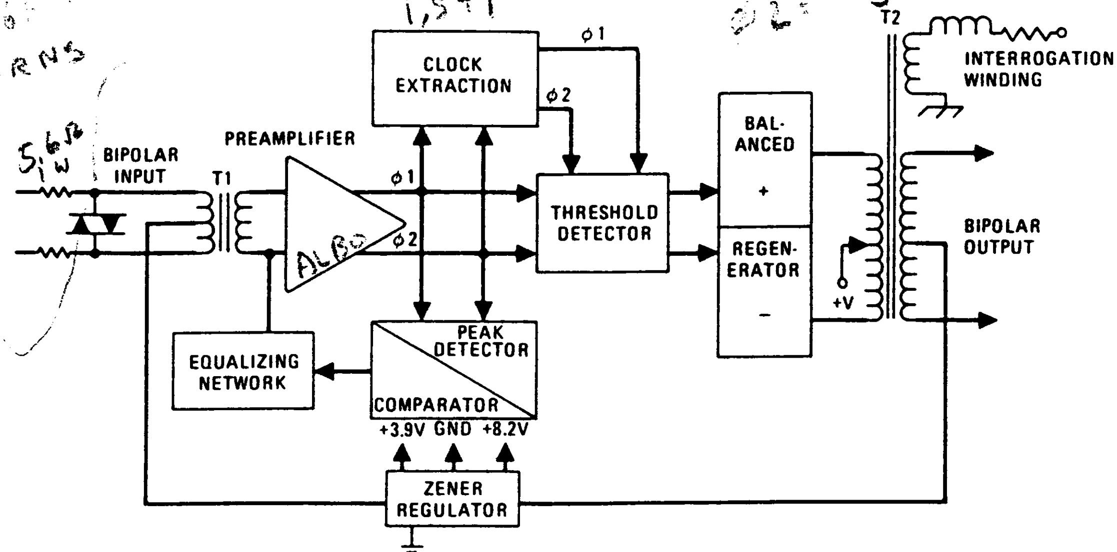


Fig. 3-3 — Repeater Block Diagram

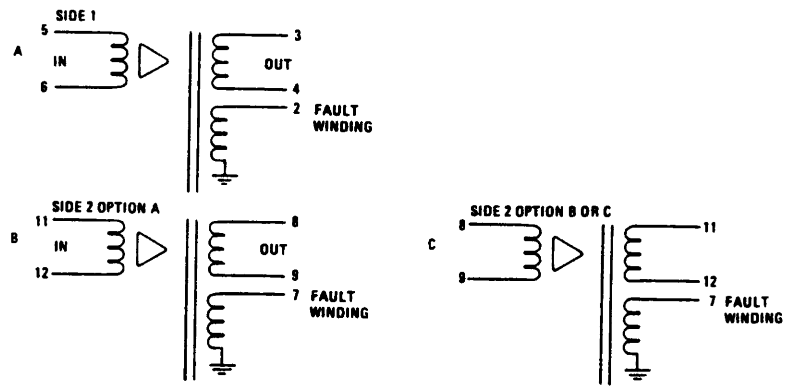


Fig. 3-4 — 303RU Pin Allocation

common options are given in Fig. 3-4. Notice that the only difference is the reversing of input and output pins for side two.

5.03 The option A installation uses an option A repeater and a repeater housing factory wired for option A. In this configuration stub 2 of the housing is designated the receive stub. All receive level signals will be wired in this stub to help prevent cross coupling of the receive and transmit signals (near-end crosstalk). The option A repeater is designated a bidirectional repeater, meaning the two sides of the unit face in opposite electrical directions. The housing wiring routes the signals to the correct repeater pins.

5.04 The problem with this type of installation is that the two cable stubs, when spliced to the span cable, must be split to splice in both directions. This creates a splicing nightmare for the craftsperson in the field. Most often a new customer not familiar with Lynch housings will splice stub to cable, pair for pair, and will end up with side two of the repeaters reverse wired. Then all the splices need to be respliced.

5.05 In the option D installation, the housing is wired for option C. Side two of the repeaters has been reverse wired, causing stub 2 to be electrically facing toward office A with the receive and transmit leads in that one stub. Stub 1 faces toward office B and carries all its receive and transmit leads.

6. REPEATER HOUSING INSTALLATION OPTIONS

6.01 High-current surge protection is designed into the line repeaters. High-voltage protection is an option which must be provided in each housing by the customer. On each repeater receptacle a printed circuit board (7A3616-1) is press applied to the pins of the receptacle. Each pc board will mount four gas tubes (P/N 5920-0036). (The 7A4103 provides both the pc board and four gas tubes.) Shown in Fig. 3-6, the housing also provides mounting space for a loading panel. Fault interrogation and order-wire circuits are normally wired through a repeatered span line. These circuits are VF circuits and must be common-mode loaded to equalize the frequency response of the cable. The loading panel (7A4116) will optionally mount gas tube protection, two load coils for the order-wire and fault pairs, and two dc blocking capacitors for the order wire. The dc blocking is used midspan to isolate the two end offices so dial tone is not supplied from both ends of the span.

6.02 Common-mode loading is normally required on all voice frequency (VF) circuits along a span line. Because of the frequency response, mainly due to capacitance, of distribution cable, some form of equalization is required for long lines. Load coils are commonly available in two sizes, D66 (66 mH) and H88 (88 mH). The D66 load coils are used at 4500-foot intervals and the H88 at 6000-foot intervals. The loading panel in a repeater housing may mount a D66 (7A4117) or an H88 (7A4118) load coil for either or both the order-wire and fault interrogation pairs. In the housings, the spare wire pairs in the cable stubs are used for these circuits.

6.03 Three repeater line test units are available. The 303LA01 is a looparound extender board for an A-option repeater and the 303LA02 is for B-option repeaters. When the repeater is extended from the housing in a 303LA unit, it will loop the received signals through the repeater facing back to the originating office without interrupting the powering scheme.

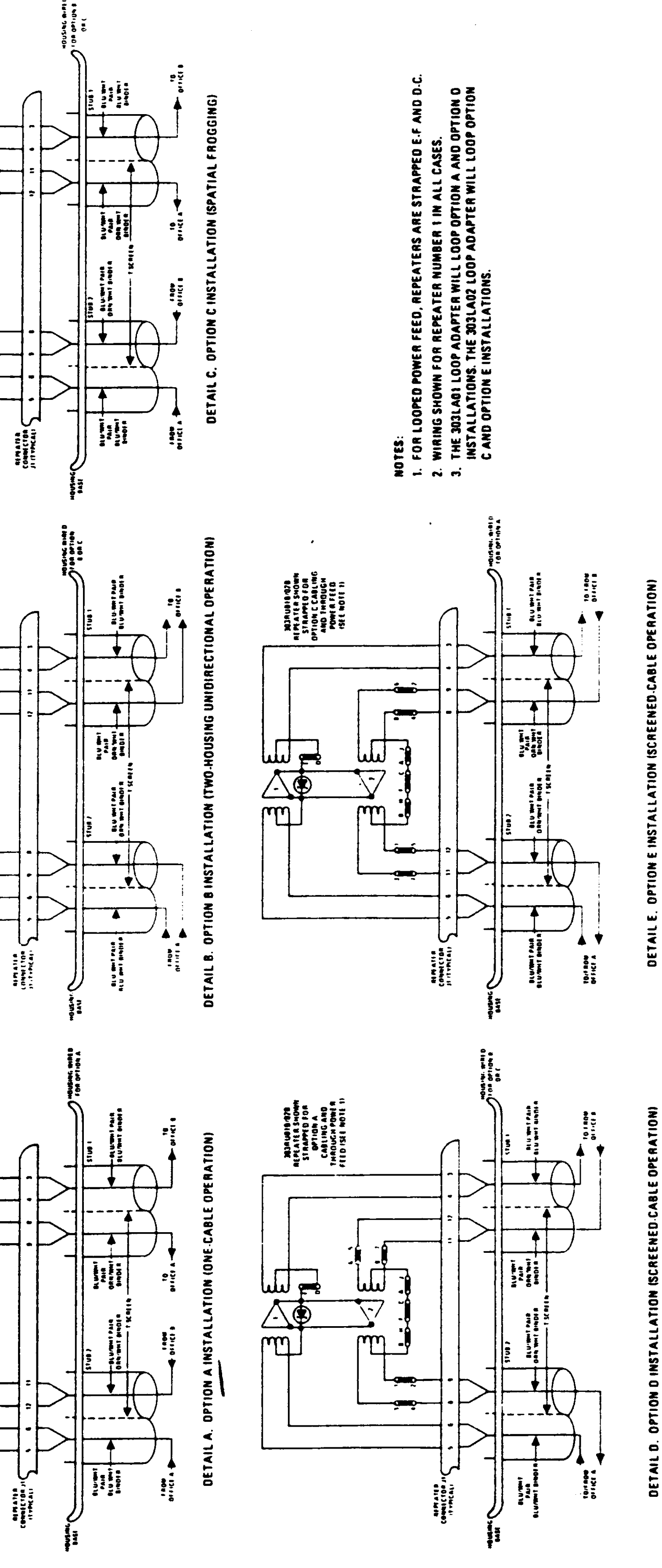


Fig. 3-5 — Repeater Housing Wiring Details

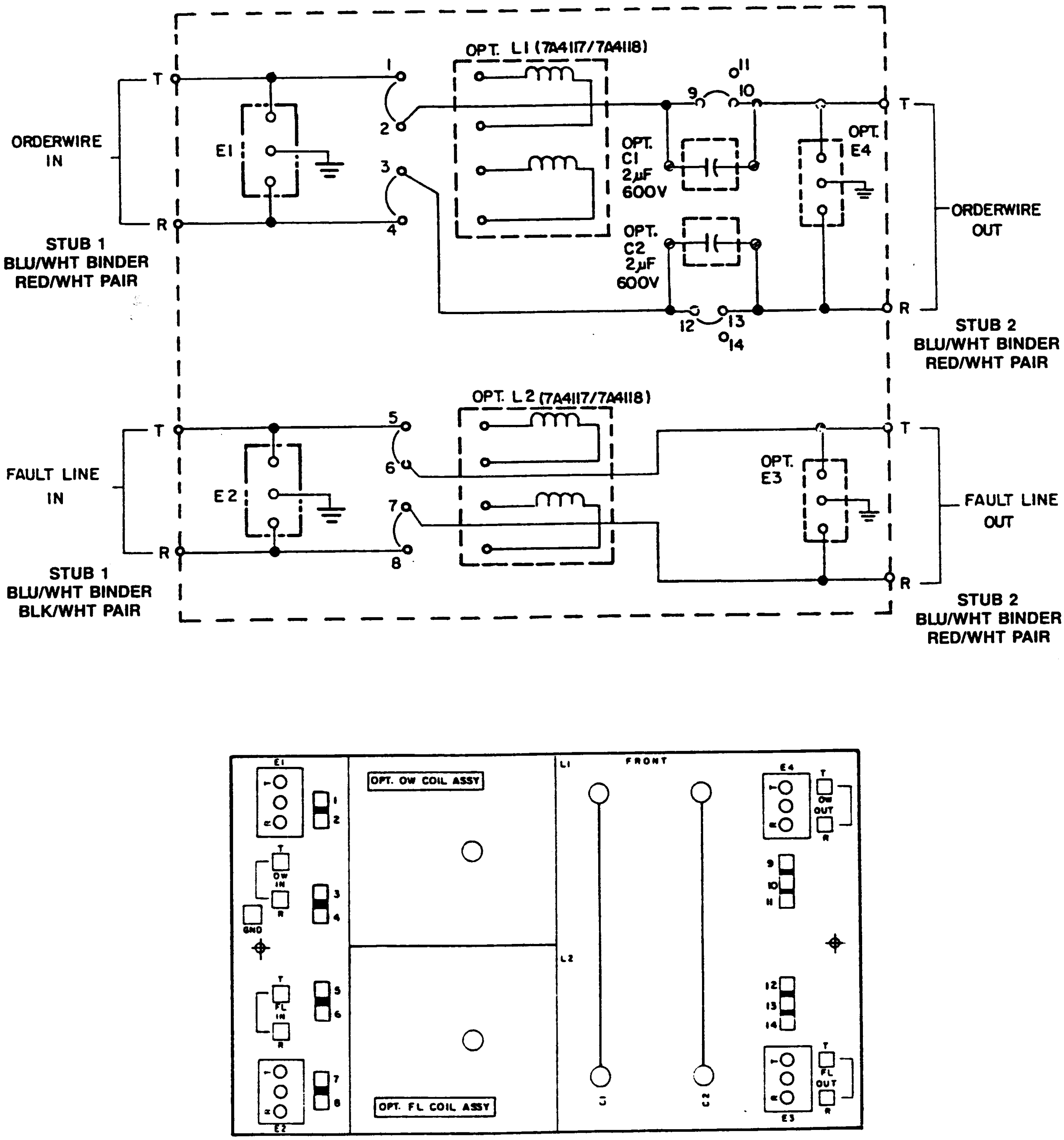


Fig. 3-6 — 7A4116 Order-Wire and Fault Pair Loading Panel

6.04 The 303CA01 is a cable access unit which, when inserted in a repeater slot, will extend the pins used by the repeater to test points on the leading edge of the board for cable testing. The 303CT01 cut-through card may be inserted in a repeater slot in one of two directions. One direction will ground all pins used in that position. The other direction provides continuity on the receive and transmit pairs in both directions for that repeater slot.

7. SPAN LINE POWERING

7.01 Span lines are powered through simplex or series powering. The dc operating voltages for the span terminating and line repeaters are superimposed on the transmission pairs. Each repeater will alternately remove and reinsert the power on the line for self-powering purposes.

7.02 The traditional mode for powering is shown in Fig. 3-7. Typically, a power converter was used to convert office battery potentials to potentials used on the span, typically plus and minus 130 Vdc. Each span line was fed power through a current regulator which supplied a fixed current to the line (50 to 110 mA). An office repeater or send-receive unit then interfaced to the line to route power toward the field.

7.03 The simplex power is applied to the center tap of the transmit output and receive input transformers as shown in Fig. 3-8. Simplex current flow is opposite in direction to signal flow with respect to the powering office. Negative voltages are imposed on the receive pair and positive on the transmit pairs.

7.04 As shown in Fig. 3-8, a 303ST11 supplies regulated operating voltages for the span line. The negative voltage is fed through a current regulator and a zener diode to the receive transformer to the receive span line pair. The voltage drop across the zener diode will provide the operation voltage for the 303ST receive repeater.

7.05 To determine current flow a voltage measurement is taken across one or both of the two ten-ohm resistors that are in series with the current loop. Each tenth of a volt measured represents 10 milliamps: 6 mA = 0.6 Vdc.

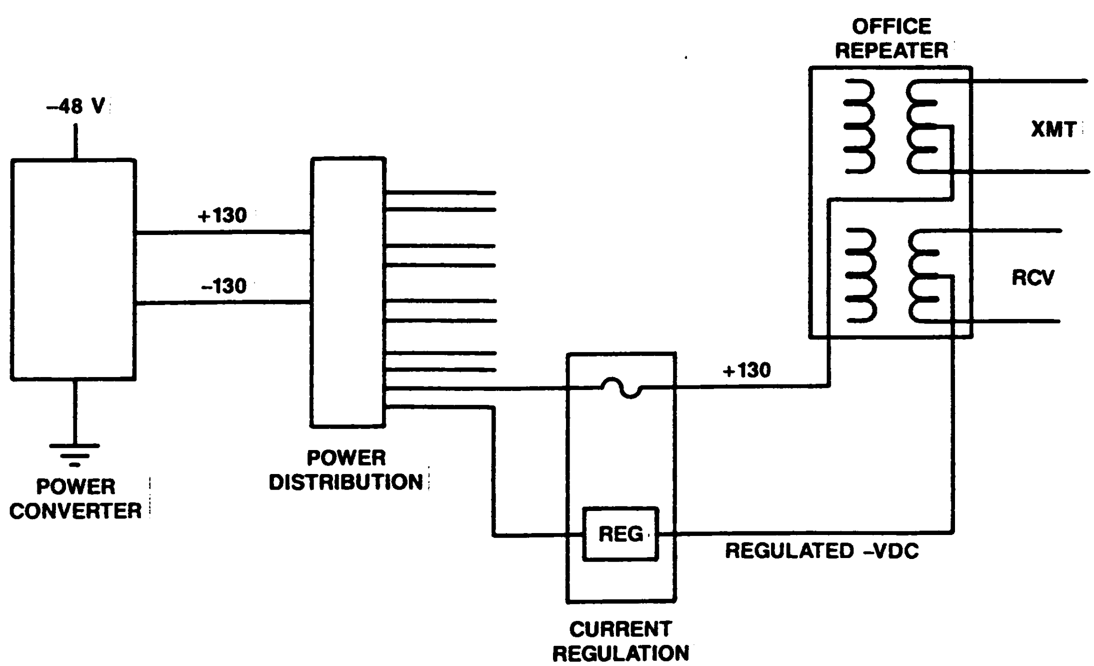


Fig. 3-7 — Traditional Span Powering Block Diagram

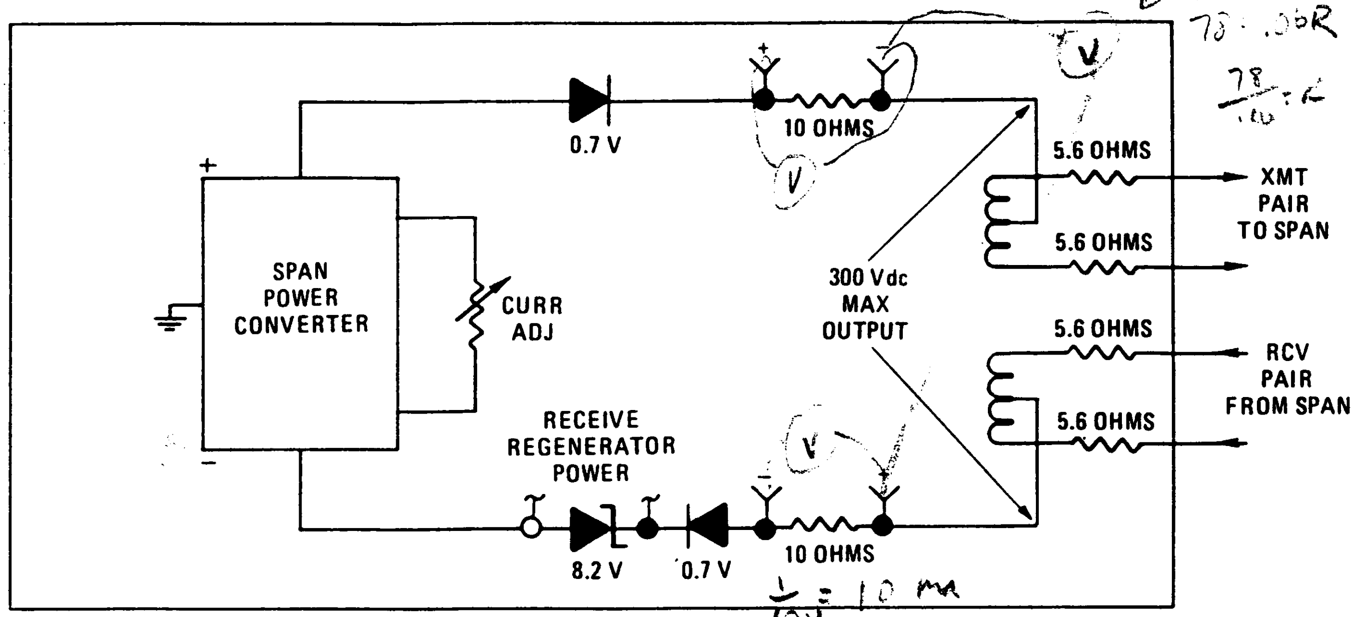


Fig. 3-8 — 303ST11/13 14/15 Span Powering Block Diagram

7.06 At each repeater, the same input and output circuits are encountered. The 303RU repeaters have two regenerators in each unit. Most commonly, side one of the repeater will be in the A to B office transmit direction, side two in the B to A direction. The operating power for the unit is tapped off at the input to side one and either passed through toward the next repeater site in the line or looped back toward the supplying office.

7.07 In the through powering configuration of Fig. 3-9, the negative voltage arrives at the B to A transmit pair. Remember that current flow is opposite to signal flow. As the receive regenerators are powered from the repeater side 1 RCV transformer, the side 2 power is simply passed through to the B to A receive pair to be sent to the next repeater in the span line. When the power arrives at office B, it is routed through a zener diode to power that office repeater and is looped back onto side one to return to the supplying office.

7.08 Normally the regenerator of the 303ST10 is powered as part of the span powering loop and R31 must be shorted out. R31 is installed in the unit to limit current when the repeater is to be locally powered. Other 303ST units will also provide power looping with other optional features.

7.09 The power being returned to office A on side one of the repeater string is tapped off at the transmit output of side one. After flowing through the zener diode network which supplies operating voltages to both repeaters, the power is routed to the input transformer for side one and sent toward office A.

7.10 With the simplex configuration of Fig. 3-9, the 300-Vdc supply in the power converter of the 303ST unit is capable of powering approximately 16 line repeaters and the 303ST10 at the far end. If the span is beyond the capabilities of this configuration, a powering 303ST is used at both ends with a loop repeater in the middle of the span line as shown in Fig. 3-10. (See Table 3-1.)

8. COMPONENT DESCRIPTIONS

8.01 All Lynch 303ST span terminating units provide passive transmit circuitry and a regenerator in the receive direction. All units have transmit/receive IN, OUT, MONITOR and LOOP CURRENT test jacks. Optionally, the unit may also provide a pulse/error detector, receive looparound, extended temperature range and transmit padding and receive equalization. Fig. 3-11, 303ST18A Span Terminating Unit Block Diagram, is an example of a span terminating unit equipped with several of these options. Table 3-2 shows a listing of all 303ST units and their capabilities.

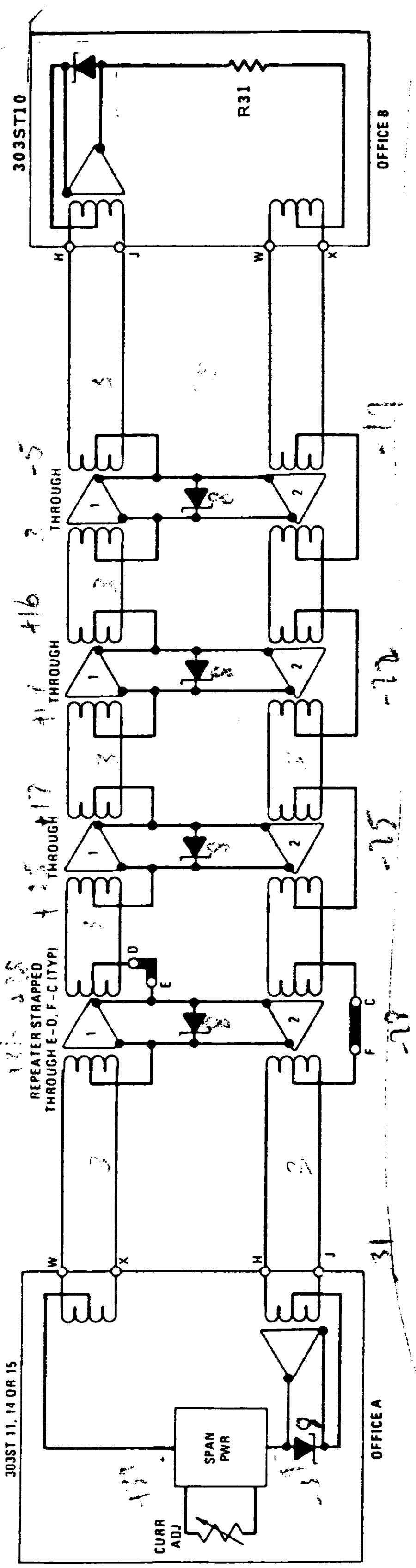


Fig. 3-9 — Bidirectional Span Powering (Looped at Far End)

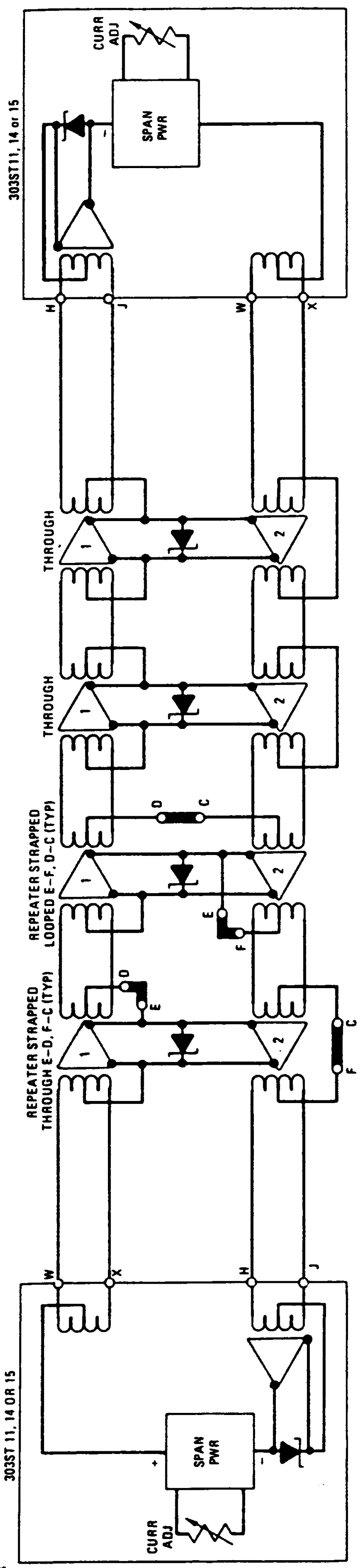


Fig. 3-10 — Bidirectional Span Powering (Looped at Midspan)

TABLE 3-1

TRANSMISSION CABLE CHARACTERISTICS

WIRE GAUGE	LOSS 55° F dB/kft.	TEMP. COEFFICIENT @ 10° F dB/kft.	RESISTANCE ohms/kft.	BURIED (100° F)		AERIAL (140° F)	
				SECTION LOSS	LENGTH FEET	SECTION LOSS	LENGTH FEET
19	2.94	.036	8.5	32.7	11,120	31.3	10,610
22	3.99	.047	17	32.8	8,220	31.4	7,870
24	4.92	.060	27	32.7	6,640	31.3	6,360
26	6.65	.082	43	32.7	4,910	31.2	4,690

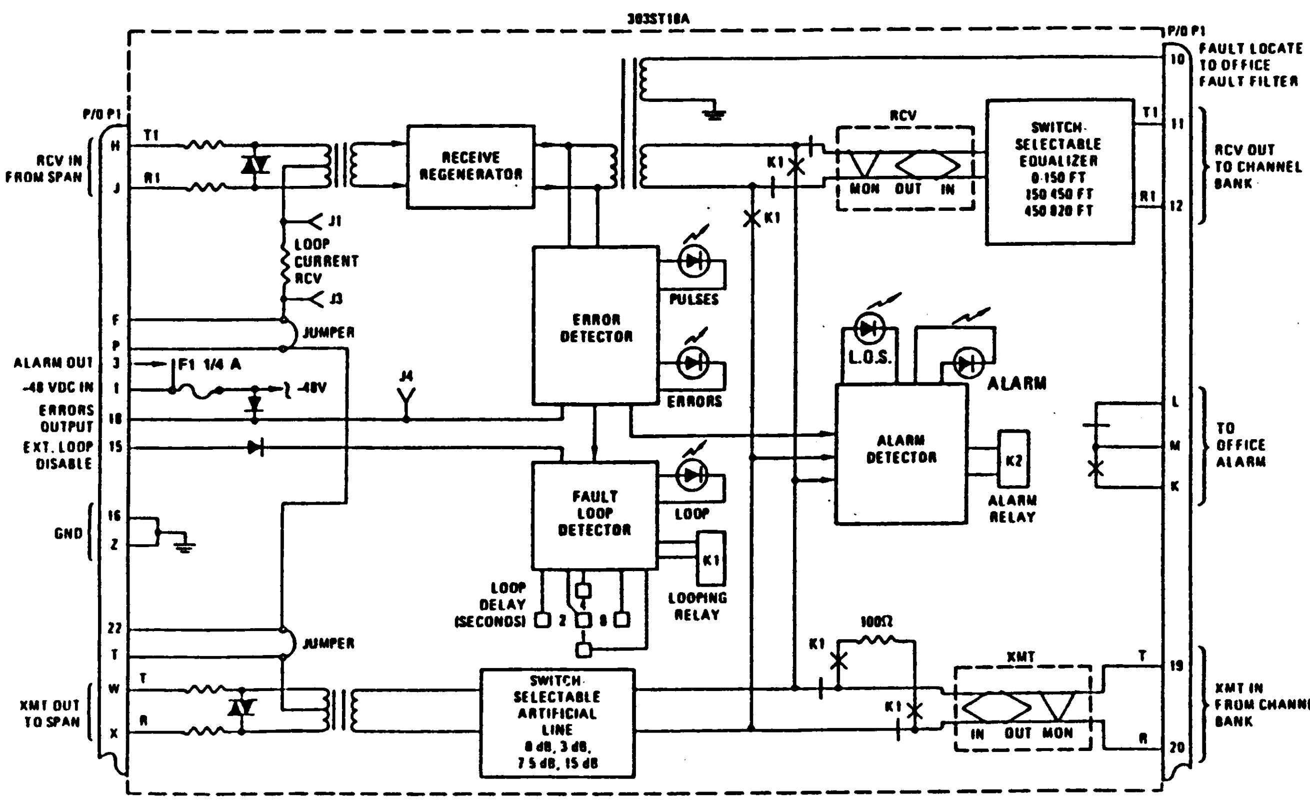


Fig. 3-11 — 303ST18A Span Terminating Unit Block Diagram

TABLE 3-2

B303 SPAN TERMINATING UNIT FEATURES

					TEMP RANGE		INPUT				RPTR V DROP	SPAN POWER OUTPUT		SPAN APPLI-CATION		NOTES
	CURRENT REGULATOR	POWER CONVERTER	ERROR DETECTOR	LOOPAROUND	32° – 131° F (0° – 55° C)	-40° – 167° F (-40° – 75° C)	-50 VDC ± 6V	-50 VDC ±6V AND 130 VDC	I MAX. mA	8.2V @ 60 mA	±150 VDC MAX.	±130 VDC MAX.	mA ADJUST RANGE	BIDIRECTIONAL (ONE-CABLE OPER)	UNIDIRECTIONAL (TWO-CABLE OPER)	
303ST10						X	X		50	X				X	X	5
303ST10A						X	X		50	X				X	X	5, 11
303ST11	X	X			X		X		500	X	X		60-80	X		1
303ST12	X				X			X	500	X		X	75-140	X		6
303ST13	X	X			X		X		500	X	X		60-80	X	X	1
303ST14	X	X	X		X		X		500	X	X		60-80	X		1
303ST15	X	X	X	X	X		X		500	X	X		60-80	X		1
303ST16			X		X		X		50	X				X	X	2, 3
303ST16A			X		X		X		50	X				X	X	2, 3, 11
303ST17A				X	X		X		50	X				X	X	2, 3, 4
303ST17B				X	X		X		50	X				X	X	2, 3, 4, 11
303ST18			X	X	X		X		50	X				X	X	2, 3, 4
303ST18A			X	X	X		X		135	N/A				X	X	3, 4, 7, 8
303ST21	X	X				X	X		500	X	X		60-80	X		1, 5
303ST24	X	X	X			X	X		500	X	X		60-80	X		1, 5
303ST25/25A	X	X	X	X		X	X		500	X	X		60-80	X		1, 5
303ST27				X		X	X		50	X				X	X	2, 3, 4, 5
303ST34	X	X	X		X		X		500	X	X		60-100	X		5
303WE31	X				X		X		500					X	X	9, 10
303WE32					X									X	X	10, 13
303WE33	X	X			X		X		500			X		X	X	10, 12, 13

Note 1: Input fused at 1 A.
Note 2: Input current is for error detector and/or looparound. Input fused at 1/4 A.
Note 3: Field strappable for two-cable operation; factory shipped strapped for one-cable operation.
Note 4: Strappable for 1-, 2-, 4- or 8-second loop initiation delay.
Note 5: Has conformal coating.
Note 6: Current adjustment range depends on span voltages applied. Input fused at 1/2 A.
Note 7: Office-powered looped end-office applications only.
Note 8: Alarm relay contact connections and ALARM LED.
Note 9: Input fused at 0.5 A. Span current is 60 mA or 140 mA.
Note 10: Replacements for AT&T model 231 series units; install in AT&T—T 220 ORB type mechanics or Lynch 303MA30/303MA31/303MA32 mounting assemblies.
Note 11: Has switch-selectable XMT artificial line and RCV cable equalizer circuits.
Note 12: Has switch-selectable RCV OUT voltage (3 V or 6 V), XMT artificial line and span powering voltage (±130 V or -130 V).
Note 13: Repeater voltage drop is 10.6 V @ 60 mA.

303ST10 OFFICE REPEATER

8.02 The 303ST10 office repeater, shown in Fig. 3-12, does not provide any of the 303ST options. The 303ST10 is envisioned for use in two applications:

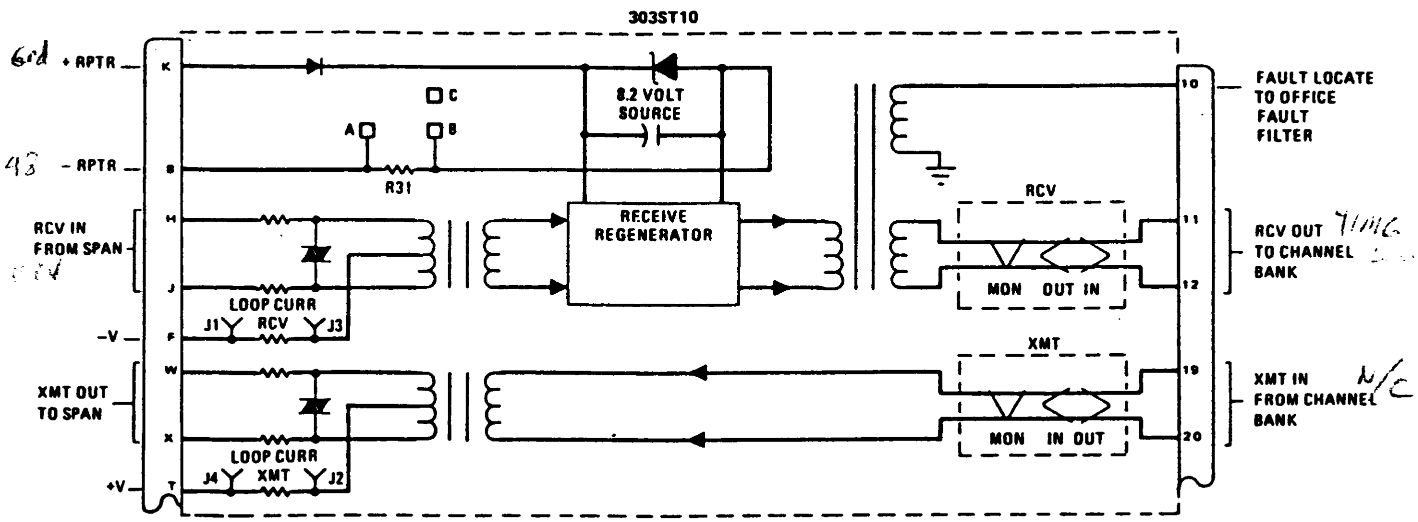
(a) In looping offices, where it is powered from the simplex loop where power has been supplied from the distant office or from the local office battery.

(b) In powering office, where user supplies external simplex current regulation and external span powering voltages.

8.03 The 303ST10 office repeater is supplied from the factory with a 500-ohm, 5-watt, current-limiting resistor installed in the RPTR input power line. This resistor (R31) limits current to approximately 78 mA when the unit is connected to -48-Vdc office supply. When the unit is powered from the simplex loop, R31 should be bypass strapped.

303ST11 OFFICE REPEATER

8.04 A block diagram of the span power converter is provided in Fig. 3-12. Once R44 is adjusted for the desired loop current in the range of 60 mA to 80 mA, the pulse wide modulator and switching transistors will provide only the required voltage to operate the span line at the current selected. Excess voltages are not generated.



Note 1: For looped simplex current end-office installation with 303ST10/10A powered from span, externally jumper connector pins F-K and T-8. Strap A to B to shunt circuit board mounted resistor R31.

Note 2: For office powering installation externally jumper connector pins K-F. Apply current regulated source to connector pins 8 (-) and T (+).

Note 3: For end-office installation where 303ST10/10A receive regenerator ***only*** is powered locally, externally jumper connector pins F-T. Apply -48 Vdc to connector pins K (+) and 8 (-). R31 limits current to approximately 78 mA.

Fig. 3-12 — 303ST10 Span Terminating Unit Block Diagram

Looping

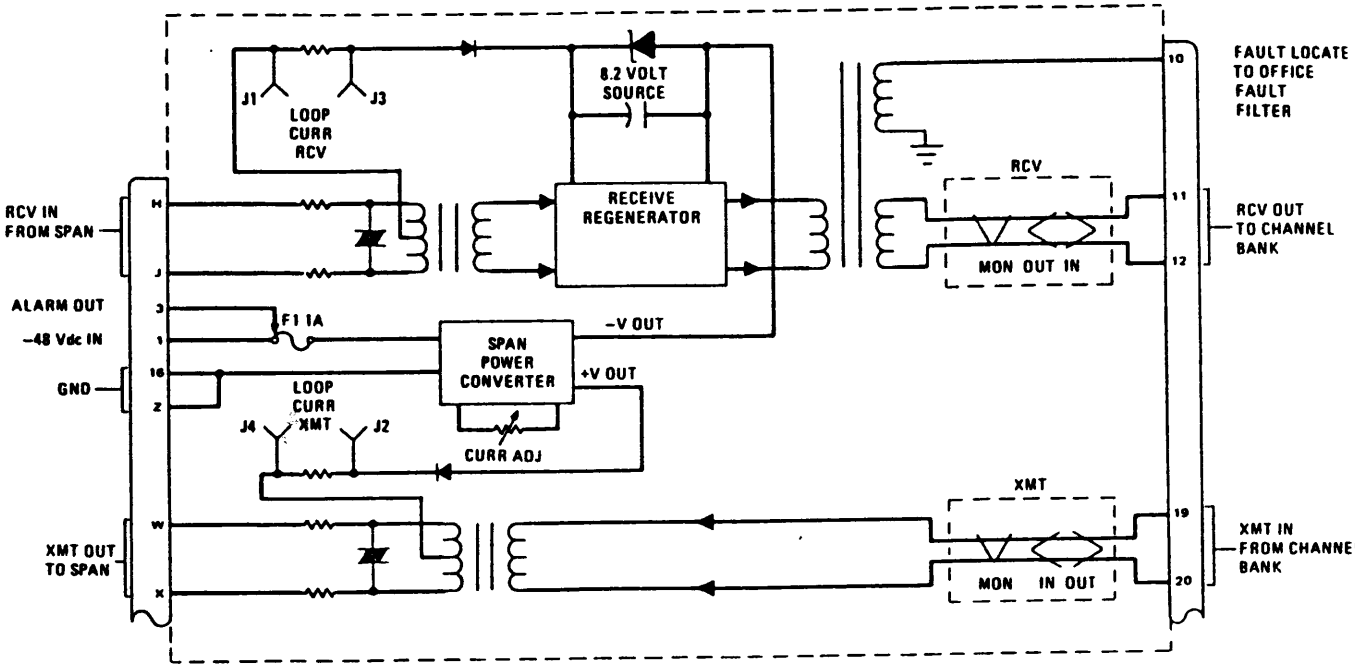


Fig. 3-13 — 303ST11 Span Terminating Unit Block Diagram

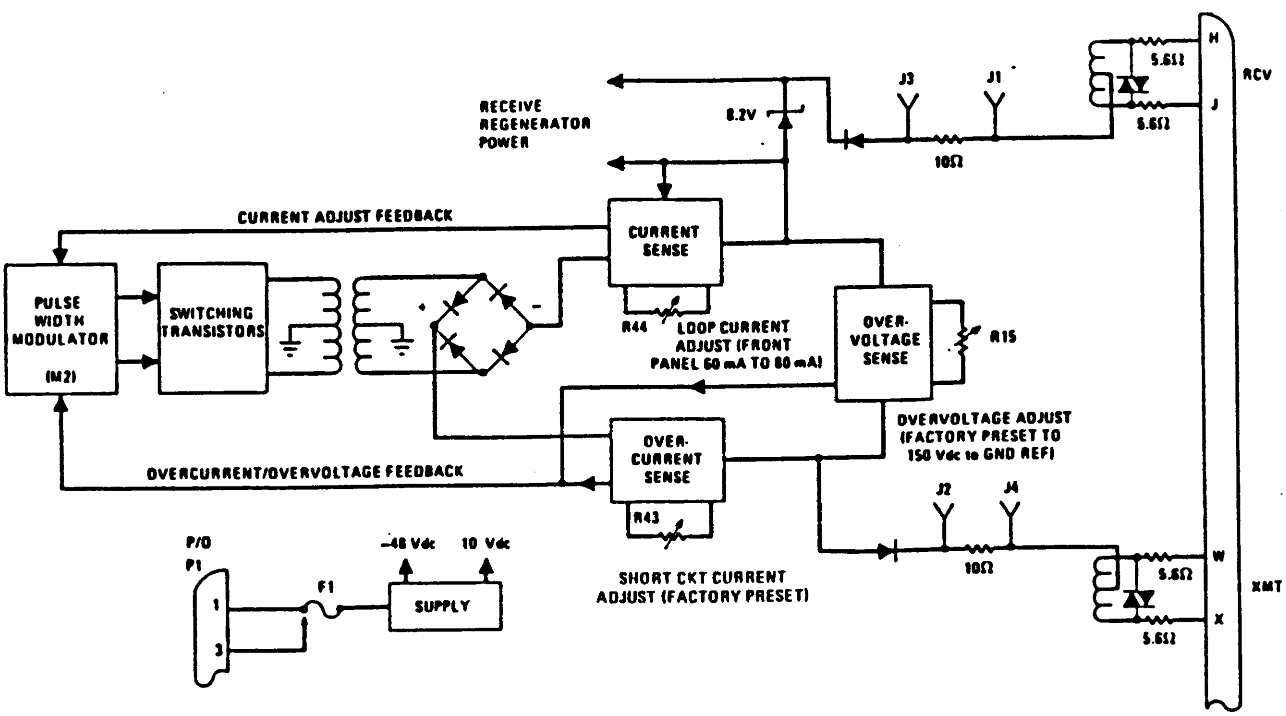


Fig. 3-14 — Span Power Converter Block Diagram

Powering

SECTION IV

SPAN LINE FAULT INTERROGATION

CONTENTS PAGE

1. GENERAL

1.01 The purpose of fault interrogation is to allow a craftsperson to locate a bad repeater while testing in the central office rather than driving up and down a span, spending hours finding a problem that could have been found in minutes.

1.02 There are definite limitations to a fault interrogation system. Three aspects will be stressed here to maximize the capabilities of the system. First, you must be familiar with the procedure for testing. Merely reading the instructions on the lid of the test set may just as often lead you astray as lead you to the right repeater location. Second, knowledge that your system works and how it is installed is obviously a requirement. Third, record-keeping is very important. The more you know about how the span worked when it worked, the easier it will be to find the fault. It is also possible with good fault interrogation records to find repeaters that are going bad before they become service affecting. Then you can replace the bad one when you want to, rather than on Friday at 5 p.m.

1.03 There are three or four different ways to utilize an interrogation system, depending on the number of fault pairs available, how many repeater sites on a span are to be tested, and whether active or passive filters are used. In this section we will only discuss active, dual/bidirectional interrogation systems. A majority of spans are done this way. For more information on the others, refer to the technical manuals listed in the contents section of this manual.

2. FAULT INTERROGATION SYSTEM OPERATION

2.01 Each repeater on a span line has a fault interrogation output. Whether it is an office repeater or either of the two sides of a field repeater, each has its own output. Those outputs are wired to the inputs of the fault filter. There are two inputs to a filter for separation of the outputs of a field repeater. A span terminating unit has a repeater only on the receive side and therefore utilizes only half of a filter. The output of the fault filter is bridged onto the fault interrogation test pair. The fault test pair is terminated in the central office in the fault test panel.

2.02 Fig. 4-1 shows these aspects of a dual interrogation system. Each repeater along a span line provides an output to the fault filter mounted in the repeater housing. Each repeater housing has a different fault filter option determined by a letter option A through M, not including I " 'cause you cannot tell the difference between I and 1." (Of course, if you cannot tell the difference, how could you have read that last sentence correctly?) Every repeater on the span can be uniquely identified one from the other by side, one or two, and location, A through M, not including I because you cannot tell the difference between I and 1.

2.03 To locate a fault on the span, a test signal, generated in a fault interrogation test set, is connected to the TRANSMIT IN jack of the office repeater and transmitted down the span line. At each repeater site, assuming a good repeater, the signal is regenerated and passed down the line to the next repeater. Each repeater also feeds a copy of the signal to the fault filter. The test set generates 12 different codes labeled A through M, not including I because you cannot tell the difference between I and 1. Same problem.

2.04 If the code sent matches the filter option, the filter will have an output to the fault test pair. The signal is returned to the CO where it is accessed at the fault test panel in the office and connected to the interrogation test set, fault line in jack. The return signal is measured and compared to previous test levels to determine the condition of the repeater. The test code can also be modified to further test the repeater. The next few paragraphs describe these signals and their use in fault interrogation. Understanding this is by no means required to perform the interrogation procedure.

2.05 In review, the signal transmitted by a channel bank was converted to the bipolar format to divide the effective frequency of the signal from 1.544 MHz to 772 kHz. This allowed the repeaters to be spaced farther apart because the loss to the PCM signal increases with distance or frequency. The other result in converting to bipolar is of importance to fault interrogation.

2.06 When the bipolar signal is generated from a unipolar one, the circuitry is designed so that a positive pulse is created with exactly the same amplitude as a negative pulse. As well, in the converting process, every pulse is always of opposite polarity to the one before and the one after it. The criterion is to keep

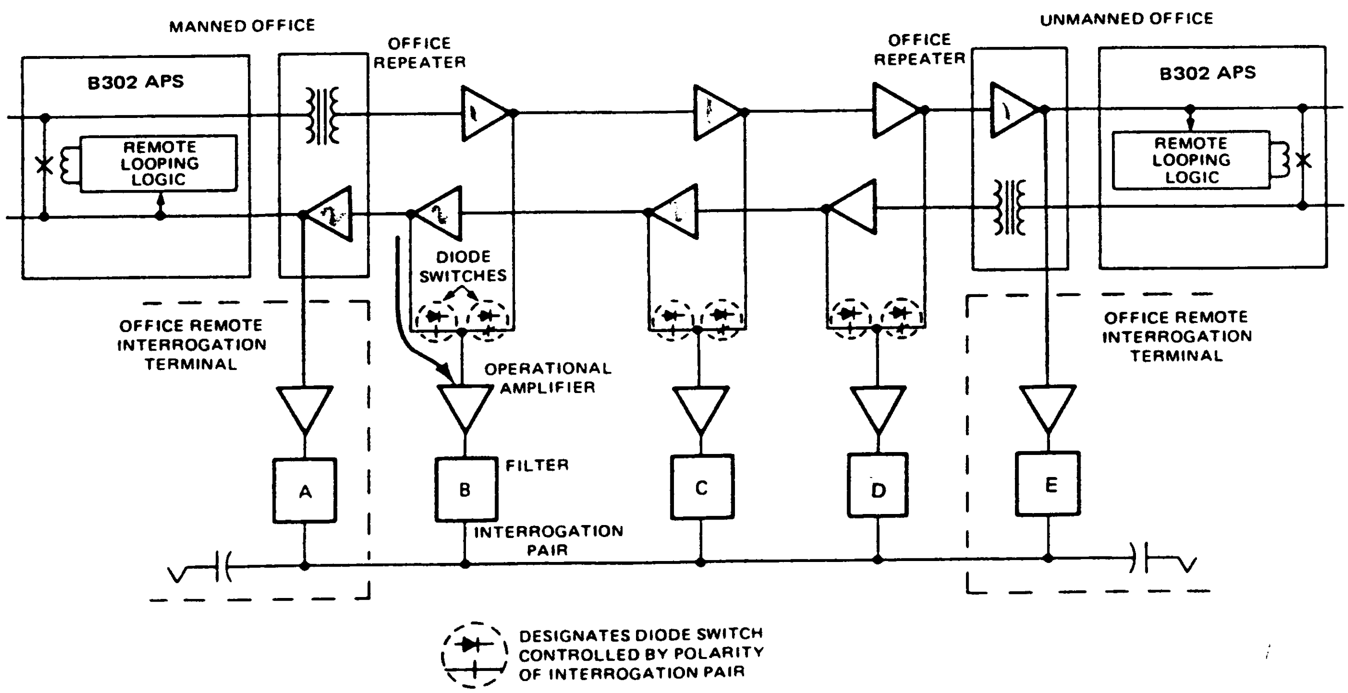


Fig. 4-1 — Basic Dual Interrogation System With Active Filters

the average effective voltage of the PCM signal at zero volts.

2.07 Look at the waveforms in Fig. 4-2. In a unipolar pulse stream an average dc voltage always exists. In Fig. 4-2, detail A, a pulse at +5 is followed by a zero period, another +5, then another zero. Therefore, 5 + 0 + 5 + 0 = 10, and 10 divided by 4 equals 2.5. The average voltage present in this unipolar signal is +2.5 volts.

2.08 In the bipolar signal of Fig. 4-2, detail B, a 3-volt positive pulse is followed by a 3-volt negative pulse. In this case, +3 added to -3 equals 0, and 0 divided by 4 equals 0. The effective voltage of one pulse is balanced or zeroed by the following pulse of the opposite polarity. The average voltage present is zero. Said in a different way, if the positive pulse was 6 volts and the negative, 2 volts, the average would be 1 volt: 6 + -2 = 4; 4 / 4 = 1, creating a positive offset in the wave shape from the zero-volt base line.

2.09 The same effect can be had by adding bipolar violations to a signal. If two positive pulses are followed by only one negative pulse, the average voltage will shift positive away from zero. A fault interrogation code—letters A through M, not including I because you cannot tell the difference between I and 1, or one ... OH! ONE!!! I understand it now!!...—has a massive amount of bipolar violations injected into the signal, creating offsets in the wave shape. The manner in which the violations are added to the signal is controlled in such a way as to cause the average voltage to shift, first positive, then negative, inducing an ac voltage into the bipolar waveform.

2.10 Check out Fig. 4-3. In the waveform shown in Fig. 4-3, detail A, measure one, bipolar violations are injected into the signal. The effect is to cause the reference or base line to shift positive. These errors are injected for a specific time period, say 0.5 millisecond. Then the errors are injected in the negative polarity to create the same offset in the negative direction for the same period of time. If this signal is then filtered to remove the high-frequency component, what remains is a waveform created by the offset with a one-millisecond period: 1000 Hertz. The amplitude of the tone will depend on the amplitude of the offset, which is determined by the number of bipolar violations injected into the signal.

2.11 The fault filter is tuned to the frequency generated by the offset. Twelve different frequencies are used, as shown in Table 4-1. The letter codes of the line filter switch on the fault interrogation test set match those of the filter option, of course, A through M, not including I because you cannot tell the difference between I and 1.

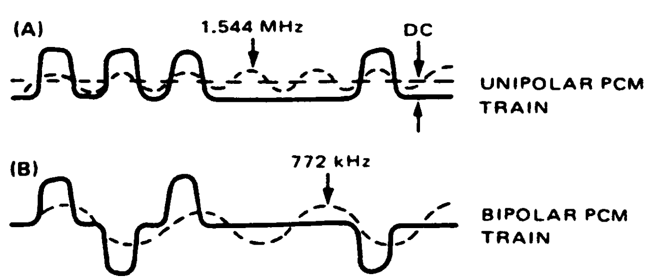
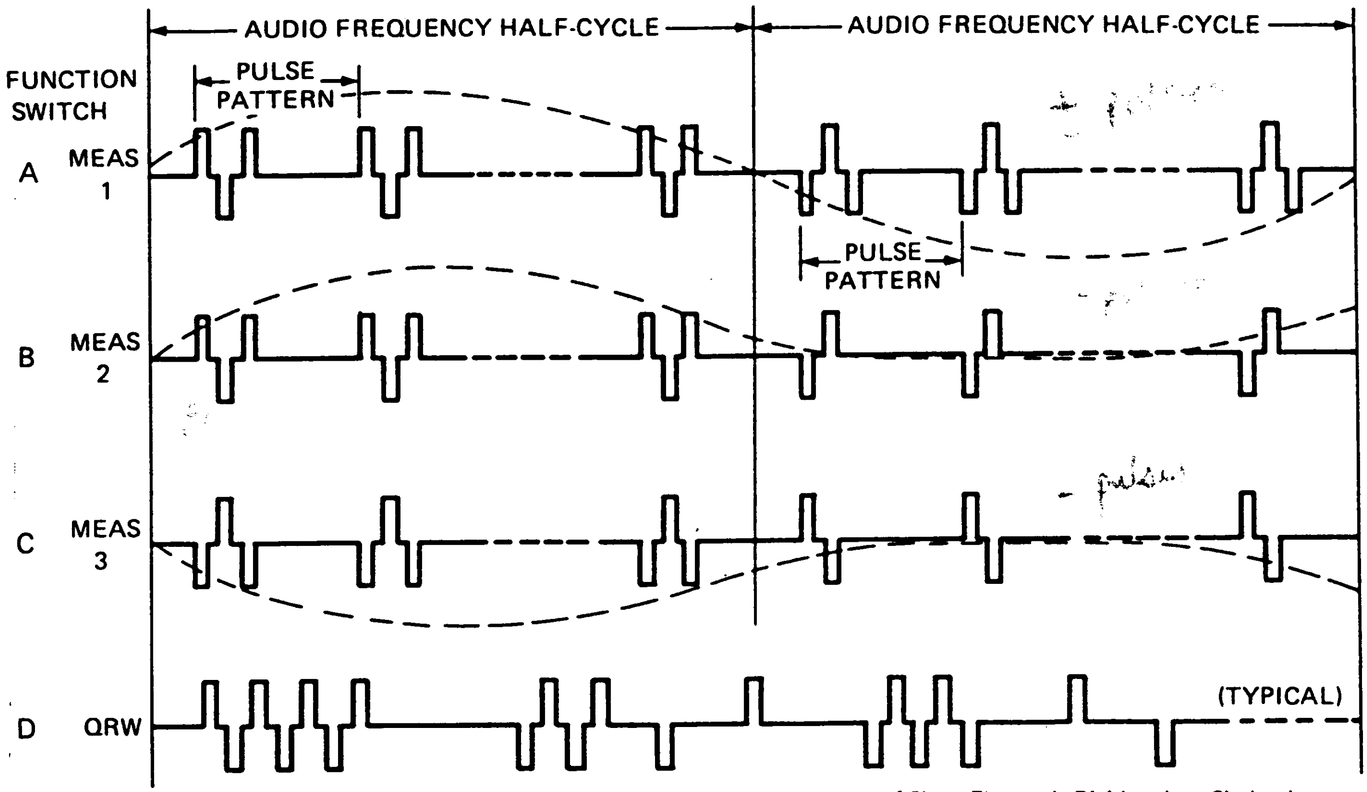


Fig. 4-2 — Unipolar and Bipolar Waveforms



Courtesy of Sierra Electronic Division, Lear Siegler, Inc.

Fig. 4-3 — Interrogation Test Signal Waveforms

TABLE 4-1

INTERROGATION FREQUENCIES

OPTION*	FREQUENCY (Hz)
A	832
B	928
C	1048
D	1206
E	1340
F	1508
G	1722
H	2008
J	2198
K	2413
L	2680
M	3017

*Code letter.

2.12 In comparing the three measure signals, measure 1 will generate both the positive and negative half cycles of the audio signal while measure 2 only generates the positive half cycle and measure 3 the negative. The effect is to stress test the balance of the output waveform of a repeater. If the positive pulse is greater than the negative pulse, measure 2 will return a greater test level than measure 3.

2.13 The test signal is further modified with the pulse period function switch. In advancing from period 11 to 4 the pulse density is increased from 3 pulses in 11 periods to 3 in 4. This will test the repeater's capability to handle the wide bandwidth of a normal PCM signal.

2.14 The intention is to utilize all the above to performance test each repeater in a span line, establishing a performance record. Once the record is filled out, when a span fails, the current performance is compared to the past performance to determine where the fault lies.

2.15 Record keeping is of obvious importance. Chart 4-1 is a performance test procedure. It should be performed at least once a year to maintain some sort of accurate record as well as to familiarize the craftsperson with the equipment and procedure. Chart 4-2 is a fault-finding procedure and would be used in case of a span failure.

3. UNIT DESCRIPTIONS

3.01 One of the common problems run into is that the interrogation system never worked in the first place. Again, you don't particularly need to know how the units work, but it will be helpful in getting your equipment working if it is not.

303FF FAULT FILTERS

3.02 Lynch manufactures three different types of fault filters. The active filters, shown in Fig. 4-6, are the 303FF11, which provides 45-dB gain, and the 303FF12, which provides 33-dB gain. These are compatible with AT&T—T (WECo) active filters. The 303FF03, in Fig. 4-7, is a passive unit, no amplification, and, in my opinion, should be avoided at any cost. If you were paying attention in class you would know why. The filter types cannot be mixed in a span; all filters must be of the same type, but of a different option.

3.03 The letter option cannot be repeated on a given fault pair because you could not distinguish between two like filters. If there are more than 12 repeater sites in a repeater route, a second fault pair must be added for a second set of filters. The fault test panel will terminate up to four fault test pairs.

3.04 In the block diagram of the 303FF11, the fault signal input from the repeater is fed into the filter on pins 2 and 7 for sides one and two, respectively. These pins are multipled in the housing, as can be seen in the housing wiring lists in the installation section. What must be remembered is that if a filter is to be removed or not used at all, fault windings must be grounded, either in the field or in the office. The output is bridged onto the fault pair which is wired to pins 3 and 5.

3.05 Power for the active filters comes from the test panel in the office over the fault test pairs. The polarity of the power will determine which side of the repeater is to be tested. If the tip is negative and the ring positive, CR1 will be forward biased, allowing the input from side one to pass into the filter. If the polarity is reversed, CR2 will be turned on, testing side two.

3.06 Fig. 4-8 is the fault test panel, 303FT03. Down the left side are the fault line select switches. Four lines can be terminated at the test panel. Each fault pair must be powered. A jumper must be installed between the -48-volt or -130-volt outputs to the fault line power in pins, one for each. Up to 22 filters can be powered with -48. Conversely, one can be powered with -130.

3.07 The fault filter for the office repeaters is mounted inside the test panel. The output of the repeater must be wired to the test panel to provide an input to the filter. If the receive of the span is side one of the repeaters, pin 10 of the office repeater is wired to pin 10 of the 303FT03. If the receive is side two, then it is wired to pin 9. In the far-end office a 303FT03 can be substituted with a 303OW51 or 303AL01 for the mounting of the fault filter to save the expense of the test panel that would not likely be used in the remote office. Refer to the manuals referenced in the contents section for further information.

3.08 The output of the filter must then be bridged onto the correct fault pair. Jumper pins 21 and 22 to the tip and ring of the appropriate fault pair.

3.09 The remaining consideration is a strapping option found in the span line repeaters. The option provides for separating or combining the two fault outputs from the repeater.

> ***Caution: Every repeater in a span must be strapped the same. One repeater strapped incorrectly will affect the test response of the entire span.***

If the span is equipped with active filters, all repeaters should be strapped separately. If a passive system is used, all repeaters will be strapped combined. Chart 4-3 is provided so that you can determine if any of your repeaters are incorrectly strapped.

BIDIRECTIONAL TESTING

3.10 To utilize the capability of testing both directions of the span line, a sign loop must be provided at the far end of the span. This loopback can be accomplished in one of three ways. One, of course, is by using a physical patch, but that requires someone at the far end to accomplish it. Two, several of the span terminating units available provide an option which, upon receiving the massive errors contained in the fault interrogation signal, energizes a relay to loop the received signal in the transmit direction.

3.11 The third method by which loopback can be accomplished is the same as with the span terminating unit, but as a function in the B302 APS system, if it is utilized. The 302SS01 switch card will provide a loop only under specific conditions. When a span line fails, a loop is required only at one end, the end where the transmit failed. The switch card will turn on the XMT FAIL at the end of the span where the transmit failed, that is, where the loop circuitry will be enabled. When the interrogation signal is received, the card will loop it back. Notice that step 1B in the span performance test requires an opening plug to be inserted in the office repeater. This will cause a transmit fail at the far end to enable the loop.

CHART 4-1

SPAN LINE PERFORMANCE TEST PROCEDURE

APPARATUS:
Sierra Electronics Model 415A-2 Span and Repeater Test Set

STEP	PROCEDURE
	TEST PREPARATION
1	If the span line is to be looped for testing, perform (a), (b), or (c) as applicable.
	(a) If both end offices are equipped with 303ST15 office repeater, ensure that the near-end office repeater fault signal looping capability is blocked.
	(b) If the span line is equipped with a B302 APS system and 303ST15 office repeaters are ***not*** installed, install an opening plug (nonconductive mini-tel plug) in the RCV OUT jack of the office repeater associated with the span line under test.
	Note: A simulated failure in the line under test will cause the B302 APS to switch to a protection line. After switching service, the B302 APS will internally loop the line under test upon detection of the 415A-2 test set MEASURE signal.
	(c) If neither 303ST15 office repeaters nor B302 APS are part of installed equipment, manually loop the span line by installing patch cords at the far-end office (see Fig. 4-4) or by installing a Lynch loop adapter (303LA01 or 303LA02) at an outside line repeater location.
2	Connect a patch cord between the 415A-2 test set GEN XMT jack and the office repeater XMT IN jack; see Fig. 4-4.
3	Connect a patch cord between the 415A-2 test set FAULT LOC LINE IN jack and the 303FT03 fault locate test panel TEST SET jack. The 303FT03 READY light will come on.
	REPEATER TESTING
4	On the 303FT03 fault locate test panel, depress the appropriate FAULT LINE pushbutton (1 through 4).
	Note: The 303FT03 polarity switch selects side 1 or side 2 testing ***only*** when 303FF01 or 303FF02 filters are installed. Filter and repeater must be strap selected for side 1/side 2 outputs.
5	On the 303FT03 fault test panel, select either side 1 (polarity switch in) or side 2 (polarity switch out) testing.
	Note: To prevent overloading 415A-2 test set meter, REC LEVEL dBm control should be preset to -10 before applying electrical power.
6	Connect 415A-2 test set to electrical power source and place POWER/LAMP TEST switch to POWER.
	Note: The 415A-2 test set controls not listed are not part of the test circuit and may be left in any position.

CHART 4-1 (Cont.)

SPAN LINE PERFORMANCE TEST PROCEDURE

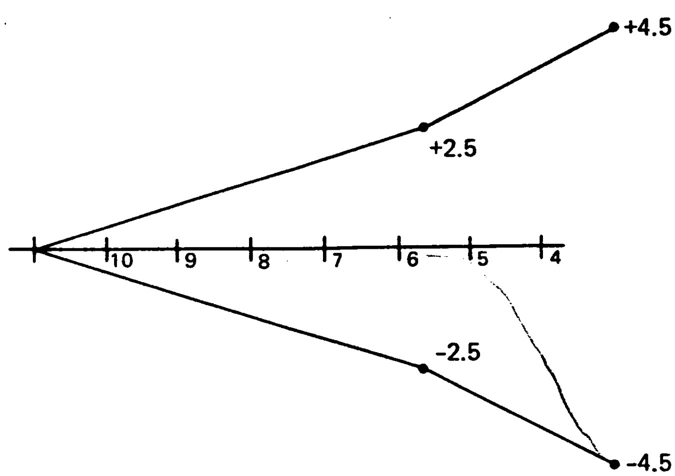
STEP	PROCEDURE
7	Place 415A-2 test controls to positions indicated below:
	LINE FILTER — To match code letter of fault filter location to be tested
	Note: Fault filter locations should be tested in a near-end to far-end sequence for ease of test data recording.
	PULSE PERIOD — 11 REF
	FUNCTION — MEAS 1
	REC LEVEL dBm vernier (red knob) — Full clockwise to 0 CAL
	REC LEVEL dBm — Position to obtain on-scale meter indication
	Note: If opening plug was installed in RCV OUT jack according to Step 1 (b), remove the plug now to ensure proper office repeater termination.
	Requirement: Meter indicates fault line return level from selected filter location.
	Note: If the fault locate signal overloads the 415A-2 meter, depress 20-dB or 40-dB pushbuttons on the 303FT03 fault test panel to attenuate the return signal. Overloading is most likely to occur when testing the ***near-end*** office repeater or the first three fault filters from the ***near end.***
8	Subtract 415A-2 meter indication from REC LEVEL dBm control setting. Then add attenuation of 303FT03 test panel (if any selected). Record resultant value in RETURN LEVEL dBm column of test record form. See Fig. 4-5.
	Note: In the following steps the 415A-2 meter is preset to a reference dBm level; then all subsequent readings are made directly at the meter, disregarding the REC LEVEL dBm control setting which remains in the position established in Step 7.
9	Adjust 415A-2 REC LEVEL dBm vernier control to obtain a meter indication of 0 dB.
10	Set 415A-2 FUNCTION switch to MEAS 2 and record meter indications.
	Requirement: The 415A-2 meter indicates between −5 dB and −7 dB.
11	Set 415A-2 FUNCTION switch to MEAS 3.
	Requirement: Meter indication does not deviate more than 1.5 dB from indication recorded in Step 10.
12	Set 415A-2 FUNCTION switch to MEAS 1.
	Requirement: The 415A-2 meter indicates 0 dB.

CHART 4-1 (Cont.)

SPAN LINE PERFORMANCE TEST PROCEDURE

STEP	PROCEDURE
13	Rotate 415A-2 PULSE PERIOD switch clockwise from 11 REF, pausing at each switch position to record meter indication in appropriate TEST PULSE PERIOD column of test record form. Enter a zero (0) for meter indications within ±0.5 dB of the 0-dB preset value. Enter deviations from the 0-dB reference level rounded off to the nearest 0.5 dB.
	ADDITIONAL REPEATER LOCATIONS
14	Repeat Steps 7 through 13 for each succeeding repeater location in the span line under test.
	Note: If the span line under test is monitored by two or more fault location pairs, the FAULT LINE pushbutton selection (Step 4) will require a change at some repeater location(s) test.
15	If the span line under test is configured for side 1/side 2 testing (303FF01 or 303FF02 filters ***only***), select the opposite position of the 303FT03 polarity switch selected in Step 5 and repeat Steps 7 through 13.
	Note: The steps of this procedure are organized to reflect a logical test sequence for a looped bidirectional span line. Cognizant maintenance or engineering personnel should carefully review Steps 14 and 15, and expand or resequence the steps, as necessary, to match a particular span line, fault locate system organization.

After installation in the apparatus case, a Lynch 303RU repeater is operating correctly if a meter deviation occurs which does not leave the reference area of 0.5 dB per pulse period step. There is no specification for pulse period 5 and 4.



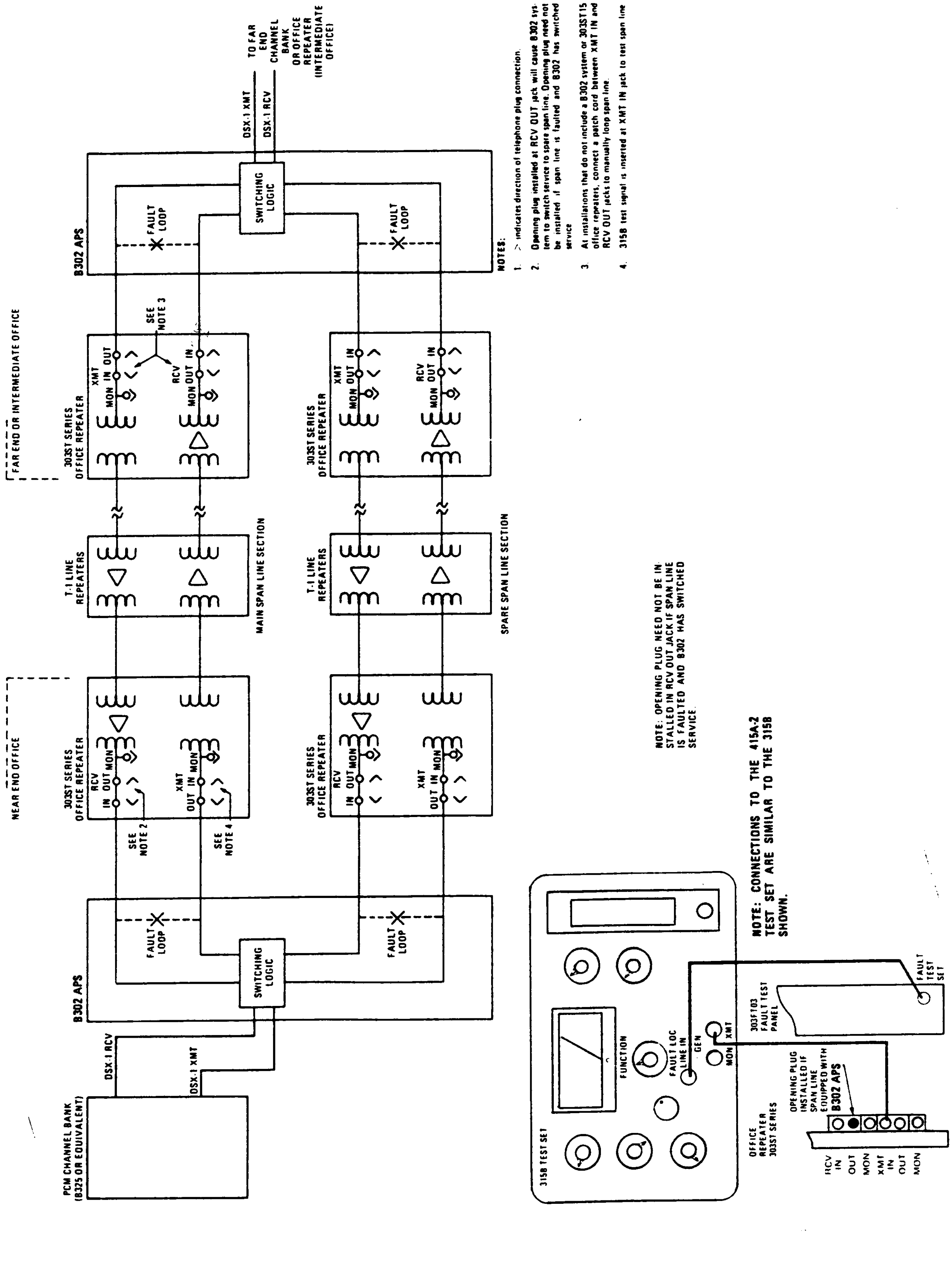


Fig. 4-4 — Span Performance Test Setup

Fig. 4-5 — Fault Interrogation Test Record Sheet

**PERFORMANCE MARGIN MEASUREMENT FORM
FOR T1 REPEATER SPAN LINE**

FILTER TYPE	RETURN LEVEL dBm	MEASURE 2 & 3	TEST PULSE PERIOD*							COMMENTS (NOTE ANY FAULT)
			10	9	8	7	6	5	4	

SIDE 1

SIDE 2

*FOR EACH FILTER LOCATION, ENTER THE PERFORMANCE MARGIN NOTATION (0, –, OR +) IN THE PULSE PERIOD COLUMN THAT CORRESPONDS TO THE CONTROL SETTINGS OF THE FAULT LOCATING SET.

DATE ______________________ TESTER'S NAME ______________________

FROM ______________________ TO ______________________

SPAN ______________________ FAULT LINE ______________________

TEST RECORD

PERFORMANCE MARGIN MEASUREMENT FORM FOR T1 REPEATER SPAN LINE

SIDE 1

	FILTER TYPE	RETURN LEVEL dBm	MEASURE 2 & 3	TEST PULSE PERIOD* 10	9	8	7	6	5	4	COMMENTS (NOTE ANY FAULT)
✓	B	-12.5	OK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-4	
✓	C	-12.0	OK	0	0	0	0	-2	-2	-4	
	D	-12.5	OK	0	0	0	0	-.5	-1	-2.5	
HI	E	-11.5	OK	0	0	0	0	0	1.5	3.5	
6DB LO	F	-10.5	OK	0	0	0	0	0	1.5	3.5	ALL 0'S
HI	G	-11.0	OK	0	0	0	0	0	1.5	3.5	
	H	-8.0	OK	0	0	0	-.5	-1.5	-3	-6	
	J	-9	OK	0	0	0	0	0	-1.5	-3.5	
	K	-7.0	OK	0	0	0	0	1.5	-3	-5	
	L	-10.5	OK	0	0	0	0	+.5	0	-2.5	

SIDE 2

FILTER TYPE	RETURN LEVEL dBm	MEASURE 2 & 3	10	9	8	7	6	5	4	COMMENTS
M										
L	-11.5									
K	-8									
J	-8									
H	-10.5									
G	-11.5									
F	-10.5									
E	-8									
D	-12.5									
C	-11									
B	-13									
A	-13									

*FOR EACH FILTER LOCATION, ENTER THE PERFORMANCE MARGIN NOTATION (0, –, OR +) IN THE PULSE PERIOD COLUMN THAT CORRESPONDS TO THE CONTROL SETTINGS OF THE FAULT LOCATING SET.

DATE ____________ TESTER'S NAME ____________

FROM ____________ TO ____________

SPAN ____________ FAULT LINE ____________

CHART 4-2

FAULT INTERROGATION TEST PROCEDURE

STEP	PROCEDURE
	PREOPERATIONAL SETUP
1	Turn on power.
2	If the span is equipped with a Lynch B302 Automatic Protection Switch, then a span line failure alarm will originate in the B302 rather than the terminal. Upon a span line failure, the B302 will transfer both ends of the span line to a protection (spare) line. In addition, subsequent to transfer, the B302 will be conditioned to loop back the interrogation signal so that both directions of transmission can be checked from one office.
3	With a patch cord, connect GEN XMT jack to transmit input of span line under test. See Fig. 4-4.
4	With another patch cord, connect FAULT LOC LINE IN jack to fault locating pair associated with span line under test.
	TEST FIRST REPEATER
5	Turn LINE FILTER switch to code letter of fault locating filter at nearest repeater location.
6	Set FUNCTION switch to MEAS 1.
7	Turn PULSE PERIOD switch to REF 11.
8	Adjust REC LEVEL dBm control and vernier knob for an accurate meter reading.
9	Compare this level to previously recorded level.
10	Level differences of 6 to 8 dB or more should indicate failure location.
	Note: For more accurate fault finding on intermittent or marginal failures, performing pulse period testing is recommended. Refer to Step 13 of Chart 4-1, Span Line Performance Test Procedure.
11	Repeat Steps 5 through 10 for remaining repeaters.

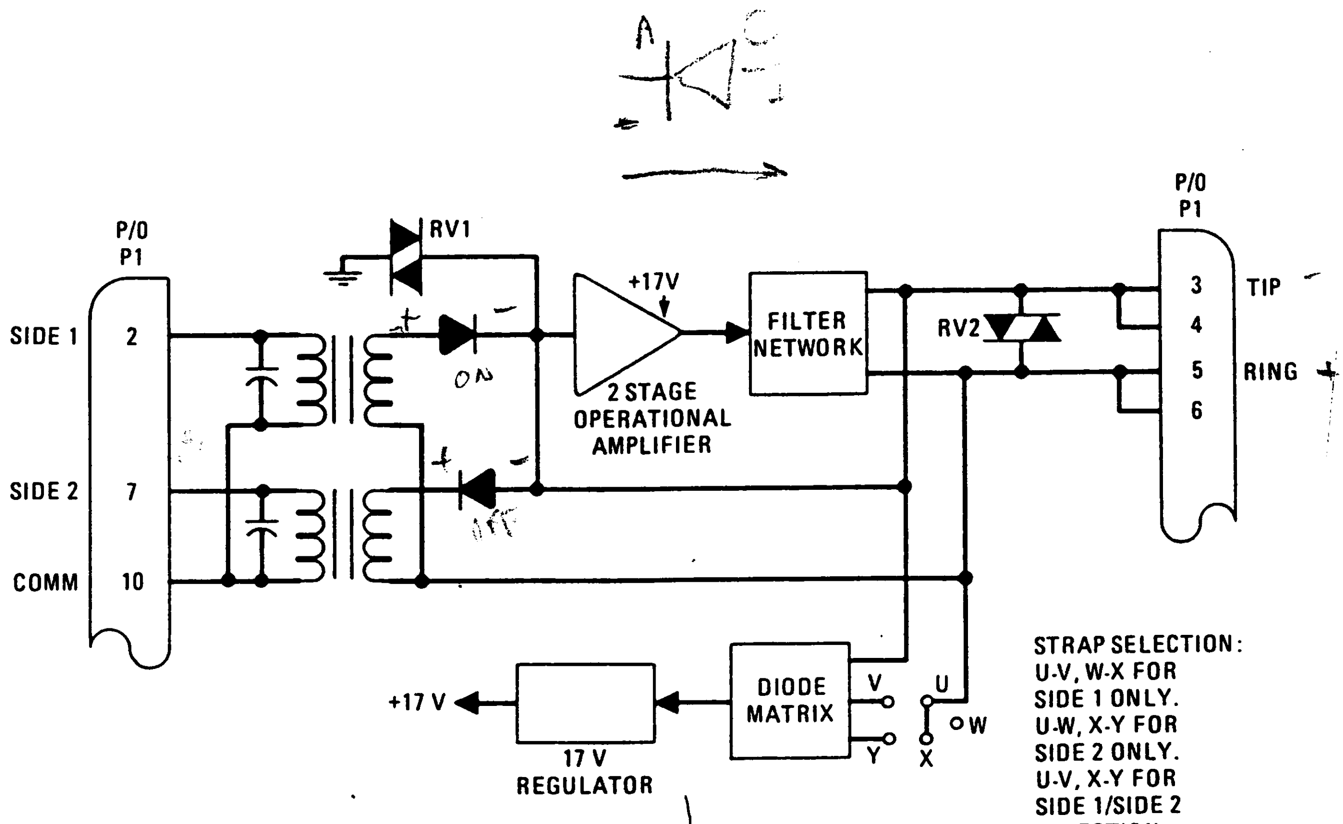


Fig. 4-6 — 303FF11/12 Fault Filter Block Diagram

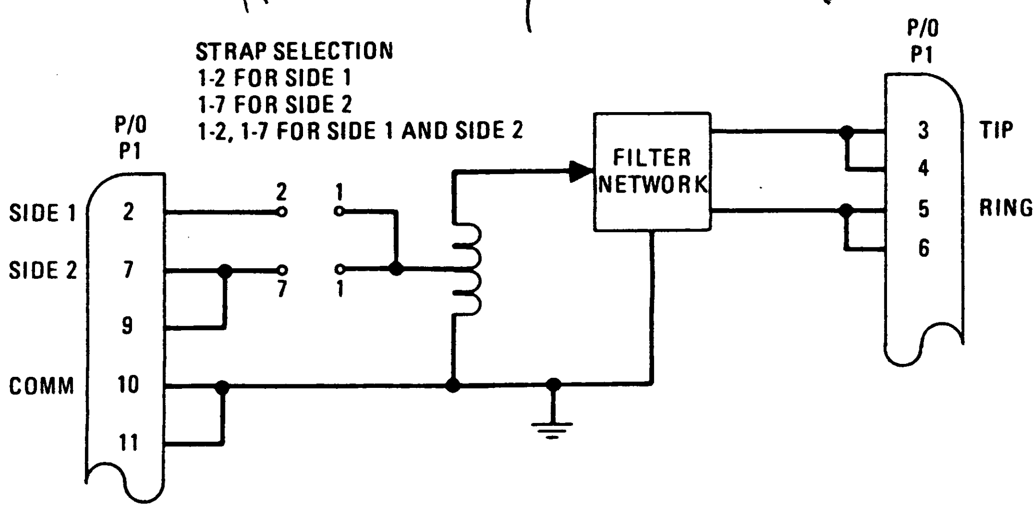


Fig. 4-7 — 303FF03 Fault Filter Block Diagram

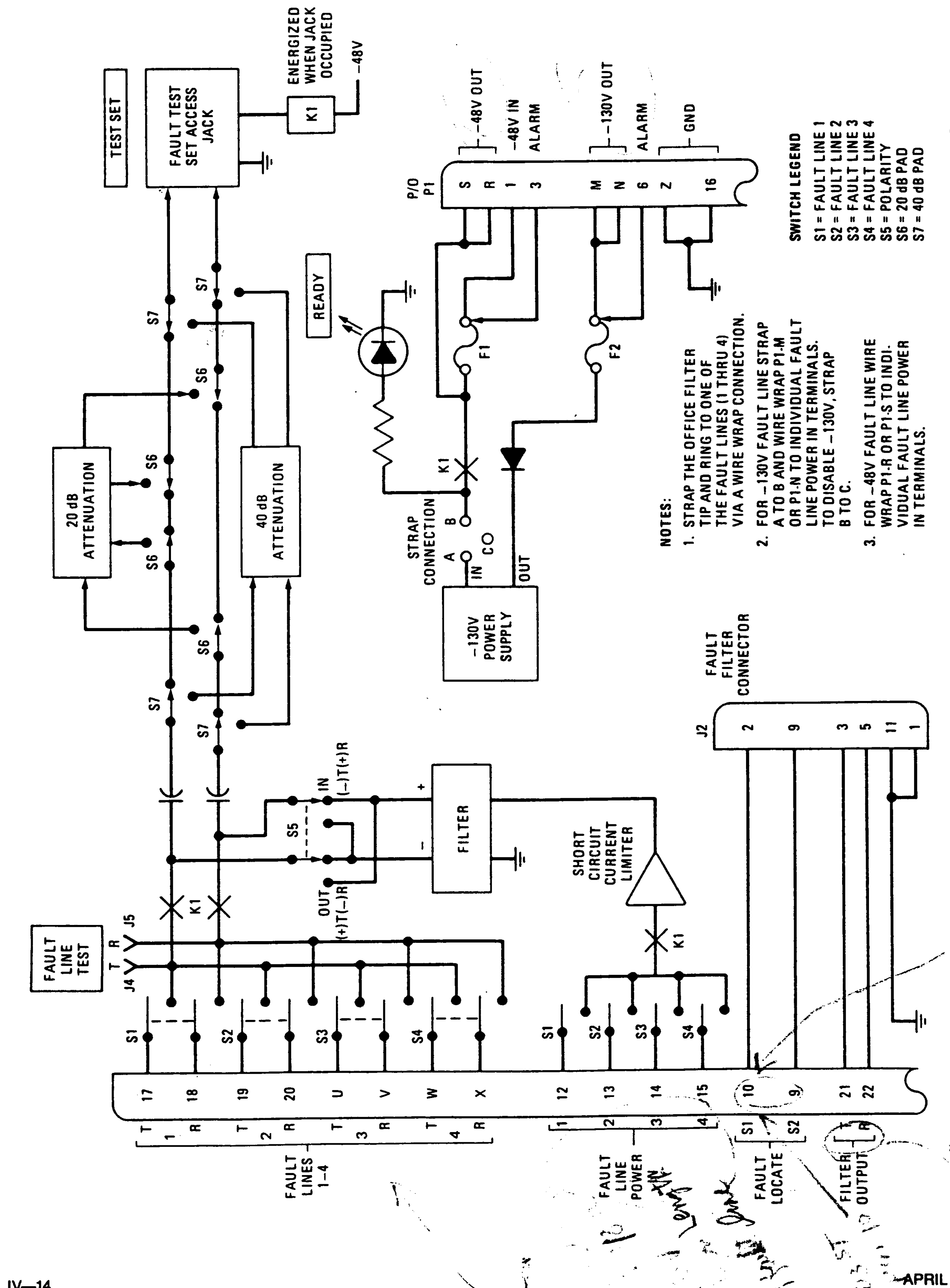


Fig. 4-8.— 303FT03 Fault Locate Test Panel Block Diagram

CHART 4-3

FAULT INTERROGATION REPEATER STRAPPING OPTION DETERMINATION TEST

STEP	PROCEDURE
	Note: This procedure can be performed on an active interrogation system to determine if any repeaters in a span line are strapped for combined (incorrect) operation. At any location failing the test, all the repeaters at that location must be removed and checked. It is impossible to determine which repeaters are strapped incorrectly without removing them. Any span line in a span can be used for this test; all will give the same result.
1	Connect the interrogation test set GEN XMT to the XMT IN jack of the test span. Any span line in a span can be utilized for this test. Select MEAS 1, pulse period 11. ***Note:*** If the span line is equipped with a span terminating unit with looping capabilities at the far end, an opening plug must be installed in the XMT IN jack of that far-end unit.
2	On the 303FT03 select the polarity for the receive direction.
3	Connect the TEST SET jack of the 303FT03 to the FAULT LINE IN jack on the interrogation test set.
4	Step through all filters on all fault pairs. List any location that indicates an output comparable to the output levels found by reversing the fault pair polarity (transmit direction).
5	Go to the locations indicated in step 4 and check all repeaters for correct fault interrogation option.

SECTION V

B302 AUTOMATIC SPAN LINE PROTECTION

CONTENTS PAGE

Figures

Table

1. GENERAL

1.01 The Lynch B302 Automatic Protection Switch (APS) provides protection for one to twenty-four T1 service (working) lines with a single protection (spare) line. Bipolar violation rate and pulse density of the service lines are monitored, with transfer to the protection line being made when the violation rate exceeds a certain level, or when the pulse density falls below a certain level. The terminal equipment switches from a failing service line to a protection line, only in the affected section of the span line, freeing the protection line for use by other sections of the service span lines.

1.02 The B302 APS also provides for automatic reset. Approximately 21 seconds after the fault has been removed, the B302 circuitry retransfers the T1 signal from the protection line to the restored service line.

1.03 The B302 APS protects a PCM span on a section-by-section basis. Many PCM cable routes contain unmanned intermediate offices. Some method of remotely monitoring and controlling the B302 switch activity in these remote offices is necessary for proper maintenance. The status reporting and control (SRC) system fulfills this requirement.

1.04 Since a number of service lines are guarded by a single protection line, some form of priority control over the transfers is required; therefore, the B302 is wired at the factory with a priority arrangement based on slot location within the shelf. The highest priority to seize the protection line prevents transfer by a lower priority. If a lower priority seizes the protection line and a higher priority fails, the higher priority overrides the lower priority and seizes the protection line. If the protection line fails, transfers are prevented. If a transfer occurs and the protection line subsequently fails, the transfer is canceled.

1.05 An optional priority unit (302PR01) permits any service line to be selected for first, second or third priority. These priorities override the factory-wired priority arrangement and permit the switch-selected priority to seize the protection line in place of a higher factory-wired priority.

2. UNIT DESCRIPTIONS

SPAN SWITCH UNITS

2.01 The span switch unit, 302SS01A/B/C, accomplishes all switching and control functions. It is interchangeable in all shelf slot locations that have been wired to interface with a service or a protection line. The shelf backplane wiring determines whether the span switch unit performs as the switch for a service line or a protection line.

2.02 The connectors are the shorting type; therefore, any unit can be removed at any time without affecting the operation of the associated span line.

2.03 The span switch unit is designed for protecting span lines used for the AT&T—T SLC-40 subscriber carrier system. The front-panel controls and indicators of the 302SS02 unit are identical to the 302SS01C unit. See Fig. 5-1.

ALARM UNIT

2.04 The alarm unit (302AL02) generates all code signals. It provides alarm indications and relay closures for service or protection line failures. The alarm unit also monitors its own performance, as well as the performance of other units in the B302 shelf. It provides alarms when a malfunction occurs in the B302 shelf. One alarm unit serves up to 24 service lines and the associated protection line(s). See Fig. 5-2.

LOOPED INTERROGATION

2.05 The B302 APS provides looparound fault interrogation. As a result, line interrogation can occur at the near end or far end of a section. Looped interrogation is on a section-by-section basis. Interrogation ***cannot*** occur through an intermediate office. Looped interrogation is useful when either end is unmanned.

2.06 To utilize the looparound feature of the B302 APS system, an opening plug must be inserted into a receive jack of the span terminating unit. The failure of the receive causes a transmit fail at the far end. It is the end where transmit failed which is loop enabled. If the span line has already failed, the fail condition cannot be changed. The loop will be enabled at the end where transmit failed. During fault interrogation either the fault will be found before a loop is needed or the loop will provide a loop to get back to the fault.

2.07 This loop function can be utilized only with active interrogation systems. The 302SS01C switch units come from the factory strapped with the looping feature enabled. This strapping must be disabled if a passive interrogation system is used.

SYSTEM OPERATION

2.08 Sectionalized switching and an ordered priority scheme are important features of the B302 APS. Fig. 5-3 shows four service lines guarded by a protection line. The first service span line section, between the near-end office and its adjacent through office, has failed. The failed section seizes the protection line in its section only, leaving the protection line in the other sections undisturbed. Subsequently the fourth service span line, between the far-end office and its adjacent through office, fails; therefore, this line seizes the protection line in its section only, leaving the protection line in the other sections free for use by service lines in those sections.

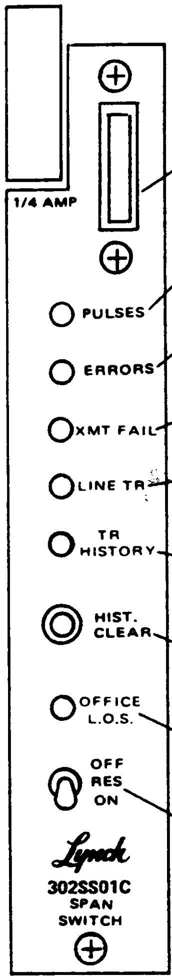
RULES OF PRIORITY

2.09 The protection line is assigned to a failed service line, according to the priority rules, as follows:

(a) The highest priority service line seizes the protection line first.

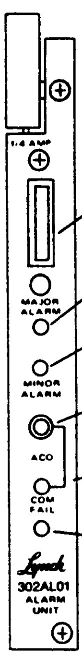
(b) If a lower priority seizes the protection line and a higher priority fails, the higher priority overrides the lower priority and seizes the protection line.

2.10 If the protection line fails, transfer is prevented.



FUSE:	Dont Remove fuse before plugging in or unplugging card 1/4 amp "grasshopper"
PULSES:	Continuous green lamp indicates normal pulse density. Extinguished lamp indicates loss-of-PCM.
ERRORS:	Flashing red lamp indicates that errors are occurring on span line. Continuous red lamp indicates error rate has exceeded 10^{-4} errors/bit.
XMT FAIL:	When illuminated (red), indicates a failure in the transmit direction of the failed section.
LINE TR:	When illuminated (red), indicates which section has failed and that the protected service line has transferred to the protection line (causes a minor alarm).
TR HISTORY:	When illuminated (red), indicates a transfer has occurred. Lamp "remembers" intermittent failures. It illuminates upon failure in the failed section.
HISTORY CLEAR:	When depressed, extinguishes HISTORY and XMT FAIL lamps.
OFFICE L.O.S.:	When illuminated (red), indicates a failure on office side of the B302.
OFF-RES-ON:	When OFF, prevents automatic reset. When ON, enables auto reset circuits.

Fig. 5-1 — Span Switch (302SS01A) Front-Panel Controls and Indicators



FUSE:	1/4 amp "grasshopper"
MAJOR ALARM:	Illuminates upon a line fail with no transfer, or at fuse failure. Associated with relay closure for office alarm.
MINOR ALARM:	Illuminates at line transfer or common equipment failure. Associated with relay closure for office alarm.
ACO SWITCH:	When illuminated, indicates that the ACO function has occurred.
ACO LAMP:	Pushbutton momentary switch. When depressed, cuts off office alarm. When alarm condition clears, the alarm and the ACO automatically turn off.
COM FAIL:	When illuminated, indicates a failure in the common (alarm unit) equipment. Causes a MINOR ALARM.

Fig. 5-2 — Alarm Unit (302AL02) Front-Panel Controls and Indicators

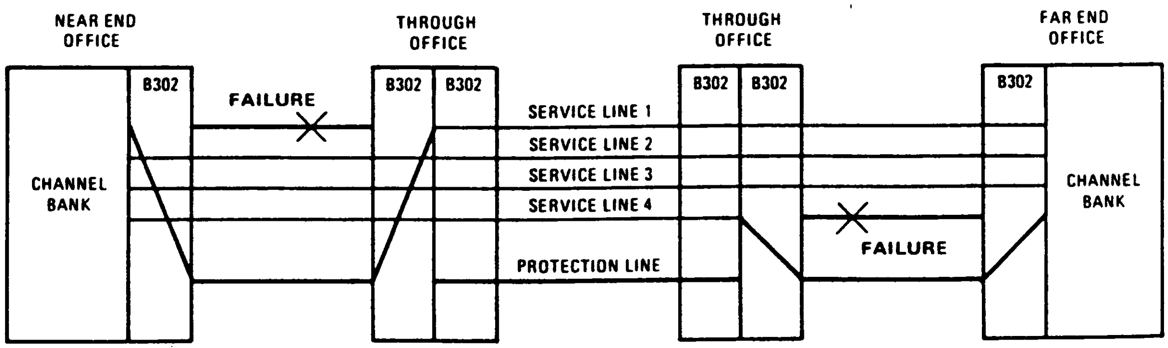


Fig. 5-3 — Sectionalized Switching

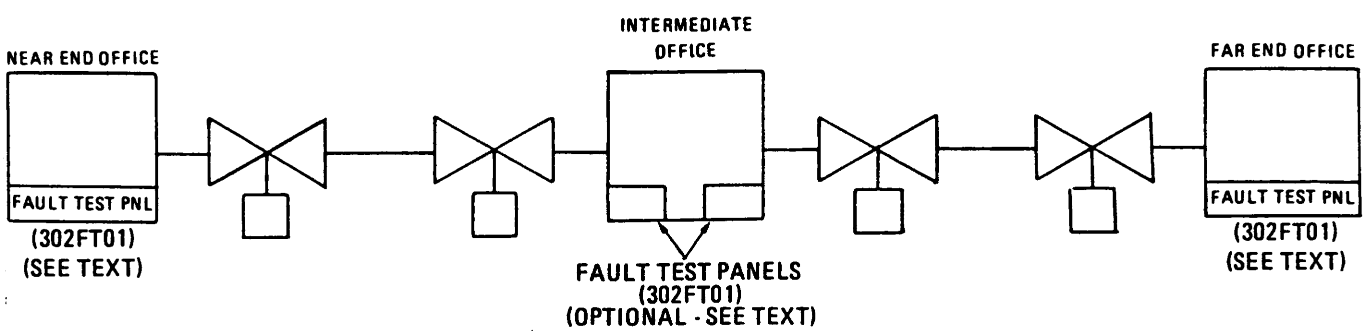


Fig. 5-4 — Fault Test Panel

2.11 If a transfer occurs and the protection line fails, the transfer is canceled.

TRANSFER

2.12 Figs. 5-5 through 5-10 show the B302 transfer process. Table 5-1 shows the symbols for Figs. 5-6 through 5-10. The near end and the far are shown with their associated span switches and alarm units. The APS connects each PCM signal to its service span line; thus, normal two-way transmission occurs. The protection line switch units supply both directions of the protection line with a ones signal (generated in the alarm unit) that performs two functions (see Fig. 5-5):

(a) It provides a "keep-alive" signal for the line repeaters to prevent line oscillations.

(b) It provides the protection line switch units with a "normal" PCM signal. The absence of this signal indicates a failure on the protection line.

2.13 See Fig. 5-6. The transmit direction of the near-end service line has failed. The far end detects a loss-of-signal or excessive bipolar violations. Loss-of-signal detection from the line side begins with the reception of 48 consecutive zeros. (Terminal failure is discussed in paragraph 2.21.) The far end listens for an additional five milliseconds; if the last 48 bits in the 5-millisecond period were all zeros, the loss-of-signal is confirmed. If a signal is present, but contains bipolar errors, the errors are counted. The bipolar violation rate threshold is strappable to 10^{-3}, 10^{-4}, 10^{-5} or 10^{-6} violations per bit. If the strapped rate is exceeded, an

TABLE A

SYMBOLS FOR FIGURES

The following symbols apply to Figures 6 through 10 of this section.			
Normal PCM	————————	Switch Closed	——┼——
CODE C1	—— · · —— · · —	Switch Open	——X——
CODE C2	—— —— · —— ——	"1"	– – – – – –

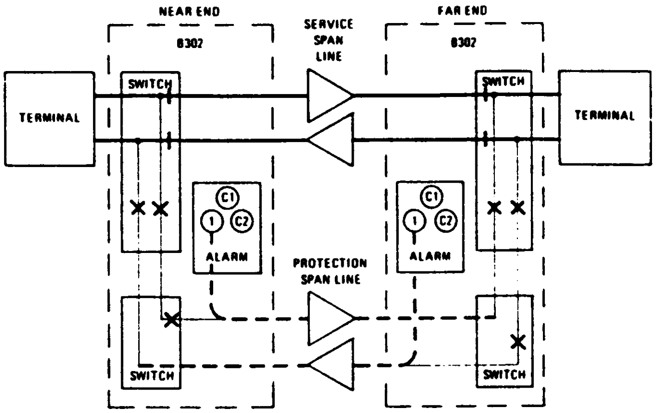


Fig. 5-5 — Normal PCM Transmission

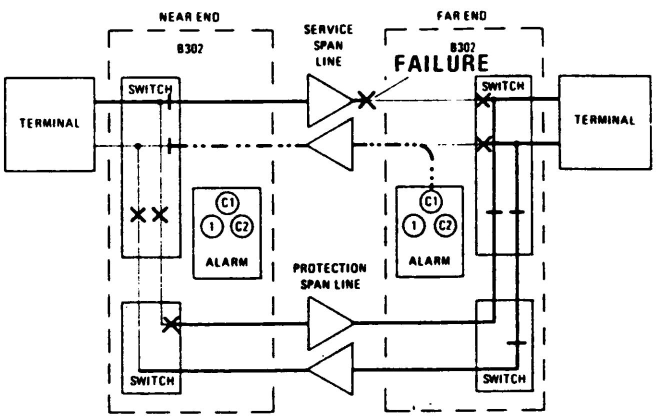


Fig. 5-6 — Service Line Fails. Far End Switches and Sends Code C1

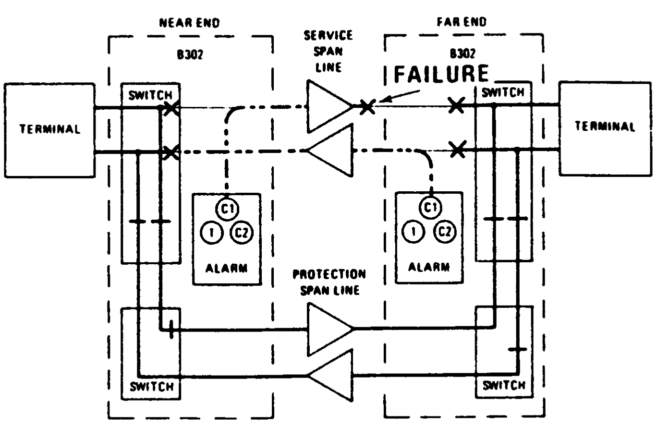


Fig. 5-7 — Near End Switches and Sends Code C1. Transfer Is Complete.

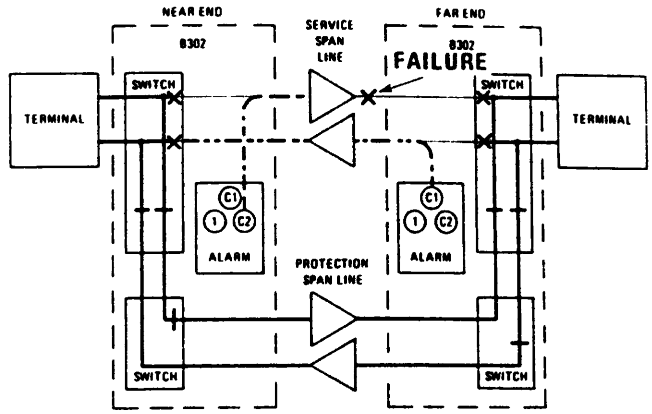


Fig. 5-8 — Twenty-One Seconds Elaps and Near End Sends Code C2.

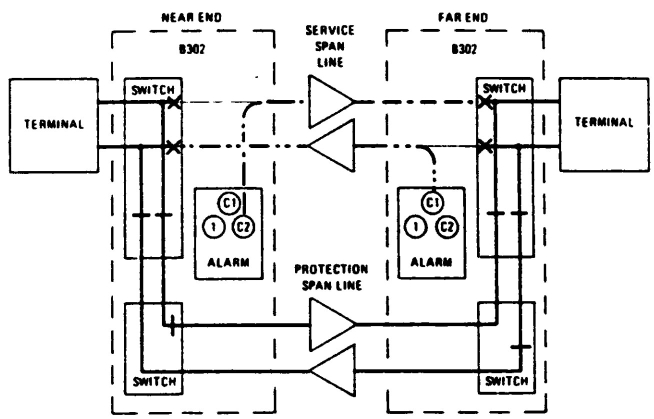


Fig. 5-9 — Fault Clears. Far End Sees Good Data (Code C2) For 21 Seconds.

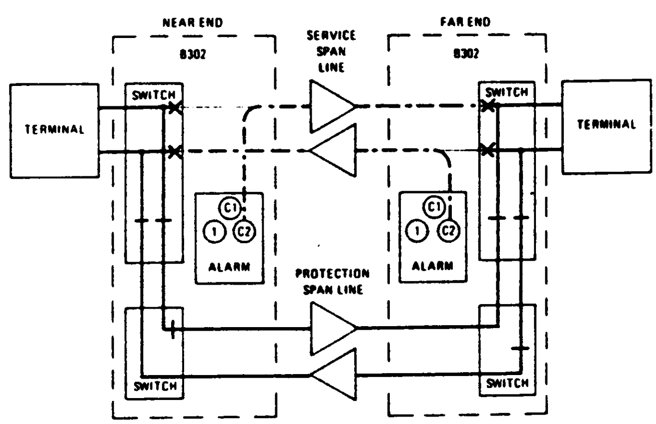


Fig. 5-10 — Twenty-One Second Period Ends. Both Ends Sending Code C2.

excessive violation condition is confirmed. Violation burst protection is provided by counting a maximum of one bipolar violation every 300 microseconds.

2.14 When the far end detects either condition described in paragraph 2.13, it searches for an internal "transfer-permitted" condition. A transfer-permitted condition exists when the protection line is operational and a higher priority has not seized the protection line. If the transfer-permitted condition exists, the far end simultaneously switches the far end to the protection line; consequently, it sends, via the service line direction that has not failed, a "transfer-made" code that is known as C1 (binary 100) to the near end. The C1 code informs the near end that the far end has transferred.

2.15 See Fig. 5-7. When the near end detects a C1 code for 30 microseconds, it determines that the far end has transferred; therefore, it transfers immediately to the protection line. Transfer is now complete at both ends of the section. At the same time, the near end generates a C1 code (binary 100) signal and transmits it along the failed span-line direction to keep that section alive and to provide a usable PCM bit stream to initiate reset, should the failure subsequently clear.

2.16 The rule for transfer is as follows: ***When either end switches, it immediately begins sending a C1 code. The C1 code causes the opposite end to switch, thereby completing transfer.***

RESET

2.17 See Fig. 5-8. Subsequent to transfer, the near end continues to receive the C1 code from the far end. It acknowledges the C1 code for 21 seconds and interprets it as normal data before sending a new code toward the far end in the failed direction. The new code is "request-for-reset" and is known as the C2 code (binary 110).

2.18 See Fig. 5-9. The failure clears. The C2 code is received by the far end and is recognized as normal data for 21 seconds. At the end of 21 seconds, the far end identifies it as the C2 code. The far end simultaneously inspects the C2 code and transmits it to the near end. Thus, both ends are sending and receiving the C2 code.

2.19 See Fig. 5-10. At the end of 30 microseconds of C2 code reception, both ends reset. Normal PCM traffic, via the service line, resumes. The protection line switch units transmit a ones signal (generated in the alarm units) in both directions on the protection line.

2.20 The rules for reset are as follows:

(a) Each end's switching unit waits for 21 seconds of normal PCM data from the span line; then it begins sending the request-for-reset code (C2).

(b) When both ends are sending and receiving the C2 code, reset occurs.

(c) Both ends reset to a restored service line 21 seconds after a fault has been removed.

TERMINAL FAILURE

2.21 If a service line is working correctly and a terminal fails, the B302 APS is equipped with circuitry on its office (terminal) side that prevents a transfer.

2.22 If the office side of the B302 determines there is a loss of PCM, a loss-of-PCM detector senses this and gates through an all-ones signal to the transmit direction of the service span line. The B302 detects 32 consecutive zeros as a loss-of-PCM signal from the equipment side.

2.23 The far end interprets the all-ones signal as normal PCM; therefore, it does not switch.

2.24 The receiving terminal loses frame on the all-ones signal and goes into local alarm. It transmits the alarm to the near-end terminal. All bipolar violations originating on the office side of the B302 are corrected to prevent the opposite terminal from detecting them as a span line failure.

Caution: The alarm relay closures incorporated in the B302 are not intended to switch unprotected inductive loads. Therefore, it is imperative that external inductive loads (office alarm relays, etc.) be provided with protection diodes, shunted across their coils. These protection diodes suppress the transients that will occur when an alarm closure on the B302 is released. Such transients can exceed 400-volt peak, causing abnormal operation of the B302 and the channel banks associated with it.

SECTION VI

T-CARRIER SYSTEM INSTALLATION

CONTENTS PAGE

Figures

Tables

1. INSTALLATION NOTES

1.01 Installation of a dial pulse originating (DPO) channel unit requires a jumper to be added on each channel connector between pins 21 and Y to supply talk battery to the unit. One strap is required for each DPO used.

1.02 Installation of foreign exchange subscriber (FXS) channel units requires an external battery biased 20-Hz ringing generator to be connected to the appropriate wire-wrap pins on the backplane of the channel bank.

1.03 Use 16-gauge power feeds for both quiet battery (QB) and signal battery (SG). Do not combine to one feed.

1.04 DSX1 leads must not exceed 150 feet without utilizing the equalization options available in the 303STxxA span terminating units.

1.05 The alarm outputs from the 302AL02 cannot control unprotected inductive loads. Provide external diode protection for inductive audible alarms.

1.06 Fuse alarms for 303MAxx or 302MAxx shelves is extended to pin 3 on any fused unit (–48 Vdc on alarm).

1.07 Each fault pair terminated to a fault test panel must have a power option wired. Refer to Section IV.

1.08 Fault interrogation wiring must be completed in the CO whether or not filters are used. Pin 10 of the 303STxx units is a multiple and must be wired somewhere. If there will be no office fault filter, ground pin 10. If the receive span is side one of the field repeaters, wire pin 10 to pin 10 of the 303FT03 or 303OWxx.

1.09 All fault outputs from 303RU or 303ST repeaters must be grounded when not terminated with a filter.

1.10 All repeater housings have several options to be considered. If no loading is done in the housing for order-wire and fault test pairs, those pairs will be open in each housing. Refer to the B303 span line equipment ordering information for all options available; there are a bunch. There is lots of room for making a mistake.

1.11 If the 303ST10 is the span terminating unit used in an office, it is expected to be a power looping unit. Strap the unit A–B. Add wire jumpers to connector pins 8–T and F–K.

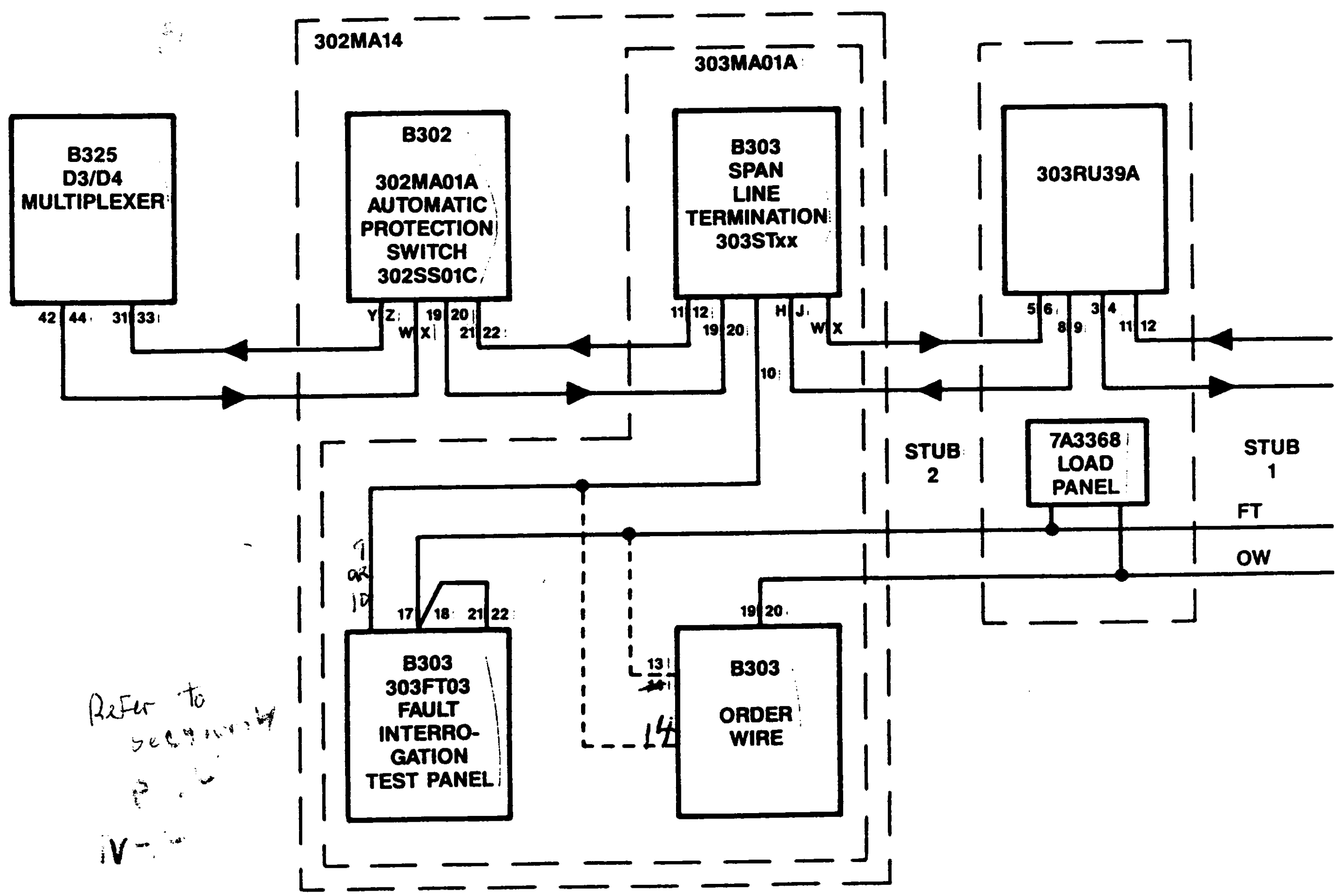
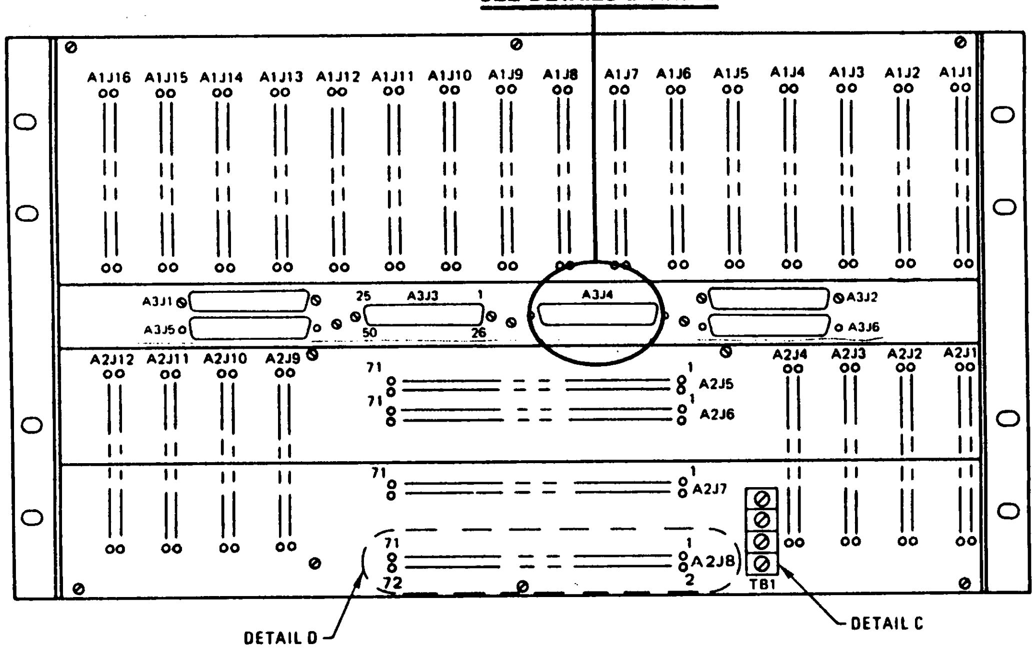


Fig. 6-1 — General Installation Diagram

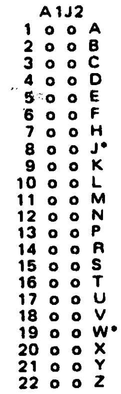
SEE DETAILS D AND B



DETAIL A

SHOWING PIN LOCATIONS OF CONNECTOR

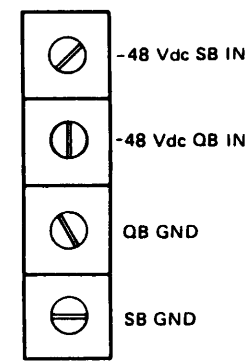
TYPICAL 24 PLACES



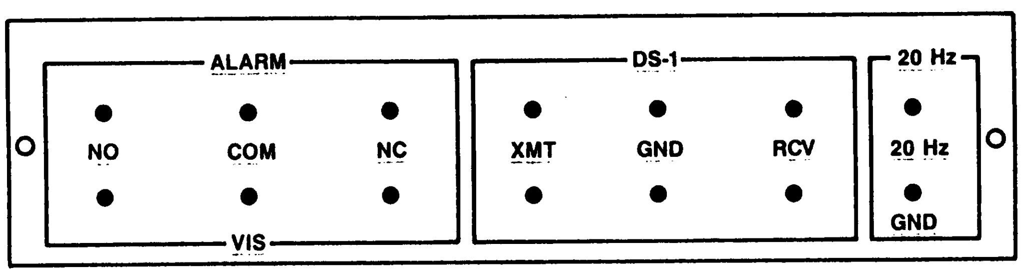
*Contact closure shorts corrections 8 to J and 19 to W, when channel unit removed.

DETAIL C

TB1 WIRING



DETAIL B



DETAIL D

ALARM AND POWER UNIT CONNECTOR A2J8 WIRING

A2J8 CONNECTOR PINS	LEAD DESIGNATION
31	HI } DSXI RECEIVE
33	LO } DSXI RECEIVE
11	SHIELD GND
42	HI } DSXI TRANSMIT
44	LO } DSXI TRANSMIT
13	SHIELD GND
56	HI } DSXI ALL ONES
58	LO } DSXI ALL ONES
	VISUAL ALARM RELAY CONTACTS
62	N.C.
64	COMMON
66	N.O.
	AUDIBLE ALARM RELAY CONTACTS
68	N.C.
70	COMMON
72	N.O.

Wiring Installation (Hard-Wired Model)

Fig. 6-2 — B325 Installation Details

WIRING LIST				
DESIGNATOR	FROM CONNECTOR	FROM PIN NO	TO CONNECTOR	TO PIN NO
T	A3J1	26	A1J1	T
R	A3J1	1	A1J1	U
T	A3J1	27	A1J2	T
R	A3J1	2	A1J2	U
T	A3J1	28	A1J3	T
R	A3J1	3	A1J3	U
T	A3J1	29	A1J4	T
R	A3J1	4	A1J4	U
T	A3J1	30	A1J5	T
R	A3J1	5	A1J5	U
T	A3J1	31	A1J6	T
R	A3J1	6	A1J6	U
T	A3J1	32	A1J7	T
R	A3J1	7	A1J7	U
T	A3J1	33	A1J8	T
R	A3J1	8	A1J8	U
T	A3J1	34	A1J9	T
R	A3J1	9	A1J9	U
T	A3J1	35	A1J10	T
R	A3J1	10	A1J10	U
T	A3J1	36	A1J11	T
R	A3J1	11	A1J11	U
T	A3J1	37	A1J12	T
R	A3J1	12	A1J12	U
T	A3J1	38	A1J13	T
R	A3J1	13	A1J13	U
T	A3J1	39	A1J14	T
R	A3J1	14	A1J14	U
T	A3J1	40	A1J15	T
R	A3J1	15	A1J15	U
T	A3J1	41	A1J16	T
R	A3J1	16	A1J16	U
T	A3J1	42	A2J1	T
R	A3J1	17	A2J1	U
T	A3J1	43	A2J2	T
R	A3J1	18	A2J2	U
T	A3J1	44	A2J3	T
R	A3J1	19	A2J3	U
T	A3J1	45	A2J4	T
R	A3J1	20	A2J4	U
T	A3J1	46	A2J9	T
R	A3J1	21	A2J9	U
T	A3J1	47	A2J10	T
R	A3J1	22	A2J10	U
T	A3J1	48	A2J11	T
R	A3J1	23	A2J11	U
T	A3J1	49	A2J12	T
R	A3J1	24	A2J12	U
		50		
		25		

WIRING LIST				
DESIGNATOR	FROM CONNECTOR	FROM PIN NO	TO CONNECTOR	TO PIN NO
T1	A3J2	26	A1J1	P
R1	A3J2	1	A1J1	S
T1	A3J2	27	A1J2	R
R1	A3J2	2	A1J2	S
T1	A3J2	28	A1J3	R
R1	A3J2	3	A1J3	S
T1	A3J2	29	A1J4	R
R1	A3J2	4	A1J4	S
T1	A3J2	30	A1J5	R
R1	A3J2	5	A1J5	S
T1	A3J2	31	A1J6	R
R1	A3J2	6	A1J6	S
T1	A3J2	32	A1J7	R
R1	A3J2	7	A1J7	S
T1	A3J2	33	A1J8	R
R1	A3J2	8	A1J8	S
T1	A3J2	34	A1J9	R
R1	A3J2	9	A1J9	S
T1	A3J2	35	A1J10	R
R1	A3J2	10	A1J10	S
T1	A3J2	36	A1J11	R
R1	A3J2	11	A1J11	S
T1	A3J2	37	A1J12	R
R1	A3J2	12	A1J12	S
T1	A3J2	38	A1J13	R
R1	A3J2	13	A1J13	S
T1	A3J2	39	A1J14	R
R1	A3J2	14	A1J14	S
T1	A3J2	40	A1J15	R
R1	A3J2	15	A1J15	S
T1	A3J2	41	A1J16	R
R1	A3J2	16	A1J16	S
T1	A3J2	42	A2J1	R
R1	A3J2	17	A2J1	S
T1	A3J2	43	A2J2	R
R1	A3J2	18	A2J2	S
T1	A3J2	44	A2J3	R
R1	A3J2	19	A2J3	S
T1	A3J2	45	A2J4	R
R1	A3J2	20	A2J4	S
T1	A3J2	46	A2J9	R
R1	A3J2	21	A2J9	S
T1	A3J2	47	A2J10	R
R1	A3J2	22	A2J10	S
T1	A3J2	48	A2J11	R
R1	A3J2	23	A2J11	S
T1	A3J2	49	A2J12	R
R1	A3J2	24	A2J12	S
		50		
		25		

WIRING LIST				
DESIGNATOR	FROM CONNECTOR	FROM PIN NO	TO CONNECTOR	TO PIN NO
E	A3J3	26	A1J1	W
M	A3J3	1	A1J1	Y
E	A3J3	27	A1J2	W
M	A3J3	2	A1J2	Y
E	A3J3	28	A1J3	W
M	A3J3	3	A1J3	Y
E	A3J3	29	A1J4	W
M	A3J3	4	A1J4	Y
E	A3J3	30	A1J5	W
M	A3J3	5	A1J5	Y
E	A3J3	31	A1J6	W
M	A3J3	6	A1J6	Y
E	A3J3	32	A1J7	W
M	A3J3	7	A1J7	Y
E	A3J3	33	A1J8	W
M	A3J3	8	A1J8	Y
E	A3J3	34	A1J9	W
M	A3J3	9	A1J9	Y
E	A3J3	35	A1J10	W
M	A3J3	10	A1J10	Y
E	A3J3	36	A1J11	W
M	A3J3	11	A1J11	Y
E	A3J3	37	A1J12	W
M	A3J3	12	A1J12	Y
E	A3J3	38	A1J13	W
M	A3J3	13	A1J13	Y
E	A3J3	39	A1J14	W
M	A3J3	14	A1J14	Y
E	A3J3	40	A1J15	W
M	A3J3	15	A1J15	Y
E	A3J3	41	A1J16	W
M	A3J3	16	A1J16	Y
E	A3J3	42	A2J1	W
M	A3J3	17	A2J1	Y
E	A3J3	43	A2J2	W
M	A3J3	18	A2J2	Y
E	A3J3	44	A2J3	W
M	A3J3	19	A2J3	Y
E	A3J3	45	A2J4	W
M	A3J3	20	A2J4	Y
E	A3J3	46	A2J9	W
M	A3J3	21	A2J9	Y
E	A3J3	47	A2J10	W
M	A3J3	22	A2J10	Y
E	A3J3	48	A2J11	W
M	A3J3	23	A2J11	Y
E	A3J3	49	A2J12	W
M	A3J3	24	A2J12	Y
		50		
		25		

WIRING LIST				
DESIGNATOR	FROM CONNECTOR	FROM PIN NO	TO CONNECTOR	TO PIN NO
N1	A3J5	26	A1J1	N
N2	A3J5	1	A1J1	P
N1	A3J5	27	A1J2	N
N2	A3J5	2	A1J2	P
N1	A3J5	28	A1J3	N
N2	A3J5	3	A1J3	P
N1	A3J5	29	A1J4	N
N2	A3J5	4	A1J4	P
N1	A3J5	30	A1J5	N
N2	A3J5	5	A1J5	P
N1	A3J5	31	A1J6	N
N2	A3J5	6	A1J6	P
N1	A3J5	32	A1J7	N
N2	A3J5	7	A1J7	P
N1	A3J5	33	A1J8	N
N2	A3J5	8	A1J8	P
N1	A3J5	34	A1J9	N
N2	A3J5	9	A1J9	P
N1	A3J5	35	A1J10	N
N2	A3J5	10	A1J10	P
N1	A3J5	36	A1J11	N
N2	A3J5	11	A1J11	P
N1	A3J5	37	A1J12	N
N2	A3J5	12	A1J12	P
N1	A3J5	38	A1J13	N
N2	A3J5	13	A1J13	P
N1	A3J5	39	A1J14	N
N2	A3J5	14	A1J14	P
N1	A3J5	40	A1J15	N
N2	A3J5	15	A1J15	P
N1	A3J5	41	A1J16	N
N2	A3J5	16	A1J16	P
N1	A3J5	42	A2J1	N
N2	A3J5	17	A2J1	P
N1	A3J5	43	A2J2	N
N2	A3J5	18	A2J2	P
N1	A3J5	44	A2J3	N
N2	A3J5	19	A2J3	P
N1	A3J5	45	A2J4	N
N2	A3J5	20	A2J4	P
N1	A3J5	46	A2J9	N
N2	A3J5	21	A2J9	P
N1	A3J5	47	A2J10	N
N2	A3J5	22	A2J10	P
N1	A3J5	48	A2J11	N
N2	A3J5	23	A2J11	P
N1	A3J5	49	A2J12	N
N2	A3J5	24	A2J12	P
		50		
		25		

WIRING LIST				
DESIGNATOR	FROM CONNECTOR	FROM PIN NO	TO CONNECTOR	TO PIN NO
S	A3 J6	26	A1 J1	V
E	A3 J6	1	A1 J1	W
S	A3 J6	27	A1 J2	V
E	A3 J6	2	A1 J2	W
S	A3 J6	28	A1 J3	V
E	A3 J6	3	A1 J3	W
S	A3 J6	29	A1 J4	V
E	A3 J6	4	A1 J4	W
S	A3 J6	30	A1 J5	V
E	A3 J6	5	A1 J5	W
S	A3 J6	31	A1 J6	V
E	A3 J6	6	A1 J6	W
S	A3 J6	32	A1 J7	V
E	A3 J6	7	A1 J7	W
S	A3 J6	33	A1 J8	V
E	A3 J6	8	A1 J8	W
S	A3 J6	34	A1 J9	V
E	A3 J6	9	A1 J9	W
S	A3 J6	35	A1 J10	V
E	A3 J6	10	A1 J10	W
S	A3 J6	36	A1 J11	V
E	A3 J6	11	A1 J11	W
S	A3 J6	37	A1 J12	V
E	A3 J6	12	A1 J12	W
S	A3 J6	38	A1 J13	V
E	A3 J6	13	A1 J13	W
S	A3 J6	39	A1 J14	V
E	A3 J6	14	A1 J14	W
S	A3 J6	40	A1 J15	V
E	A3 J6	15	A1 J15	W
S	A3 J6	41	A1 J16	V
E	A3 J6	16	A1 J16	W
S	A3 J6	42	A2 J1	V
E	A3 J6	17	A2 J1	W
S	A3 J6	43	A2 J2	V
E	A3 J6	18	A2 J2	W
S	A3 J6	44	A2 J3	V
E	A3 J6	19	A2 J3	W
S	A3 J6	45	A2 J4	V
E	A3 J6	20	A2 J4	W
S	A3 J6	46	A2 J9	V
E	A3 J6	21	A2 J9	W
S	A3 J6	47	A2 J10	V
E	A3 J6	22	A2 J10	W
S	A3 J6	48	A2 J11	V
E	A3 J6	23	A2 J11	W
S	A3 J6	49	A2 J12	V
E	A3 J6	24	A2 J12	W
		50		
		25		

Fig. 6-3 — B325 Cable Connector Wiring List

B325 CHANNEL UNIT PIN ASSIGNMENT

PIN NO.	CHANNEL UNIT TYPE												
	EM01 PR01	VF01	EM02 EM03 EM13	ET01	FX02	BR01	FX01	BR51	DP01	DP11 DP21A	DP02 DP22	TD01	PR03
N			N1	MB	N1		N1		N1	N1	N1		
P		E-OUT	N2	ATB	N2		N2		N2	N2	N2		
R	T1		A	C					HS			T1	A
S	R1		B	TM					PC			R1	B
T	T	T	T	T	T	T	T	T	T	T	T	T	T
U	R	R	R	R	R	R	R	R	R	R	R	R	R
V	OS/MB			BA					S	ATB/B1		E	E
W	E	E-IN	E	TB					ATB	S/B2		EX	M
Y	M		M	S									
14							20-Hz GND	20-Hz GND					
22							20 Hz	20 Hz					
21-Y*									JUMPER				

*Wire jumper is installed only for 325DP01 to supply talk battery.

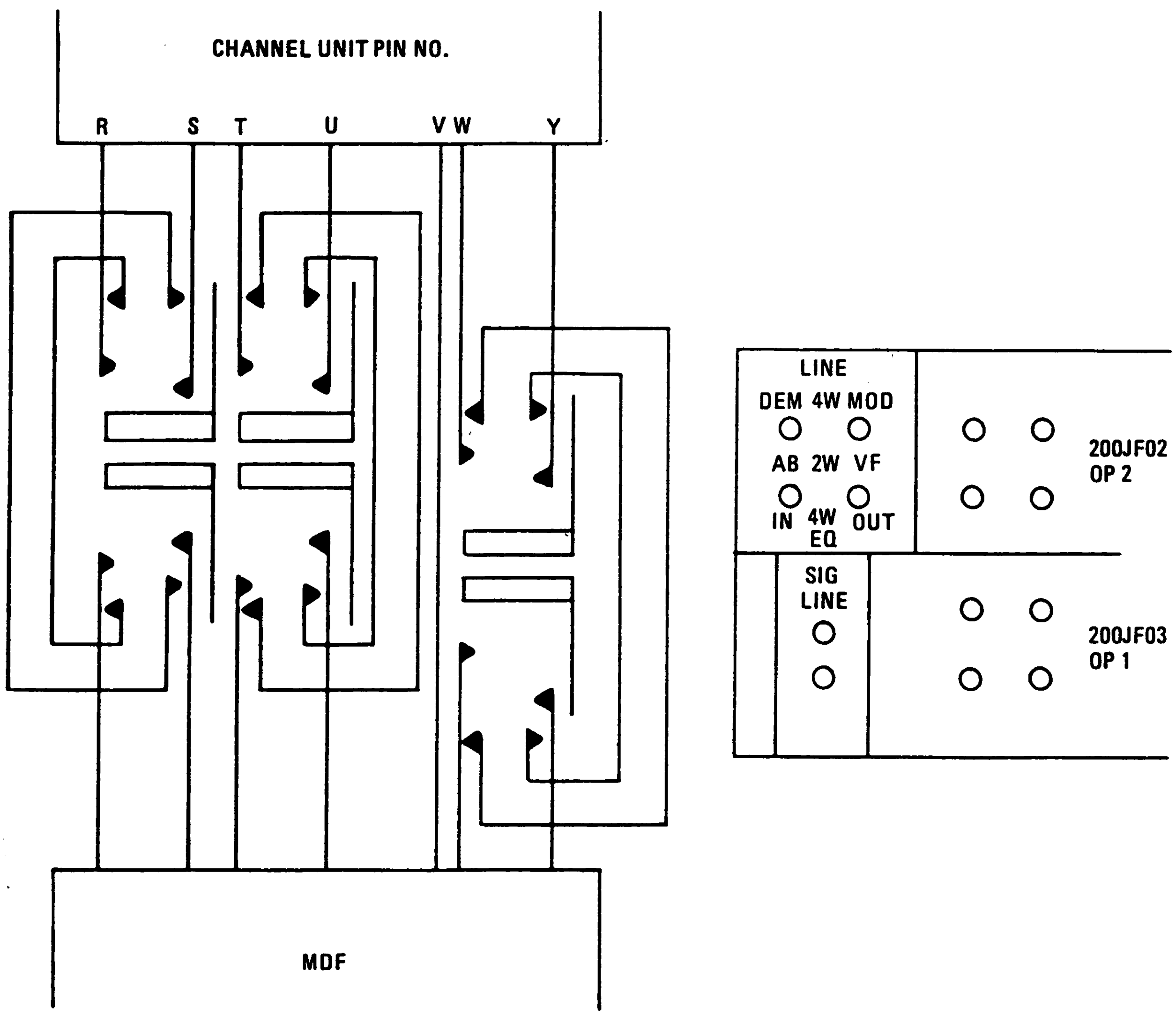


Fig. 6-4 — 200JF02 Jackfield Configuration

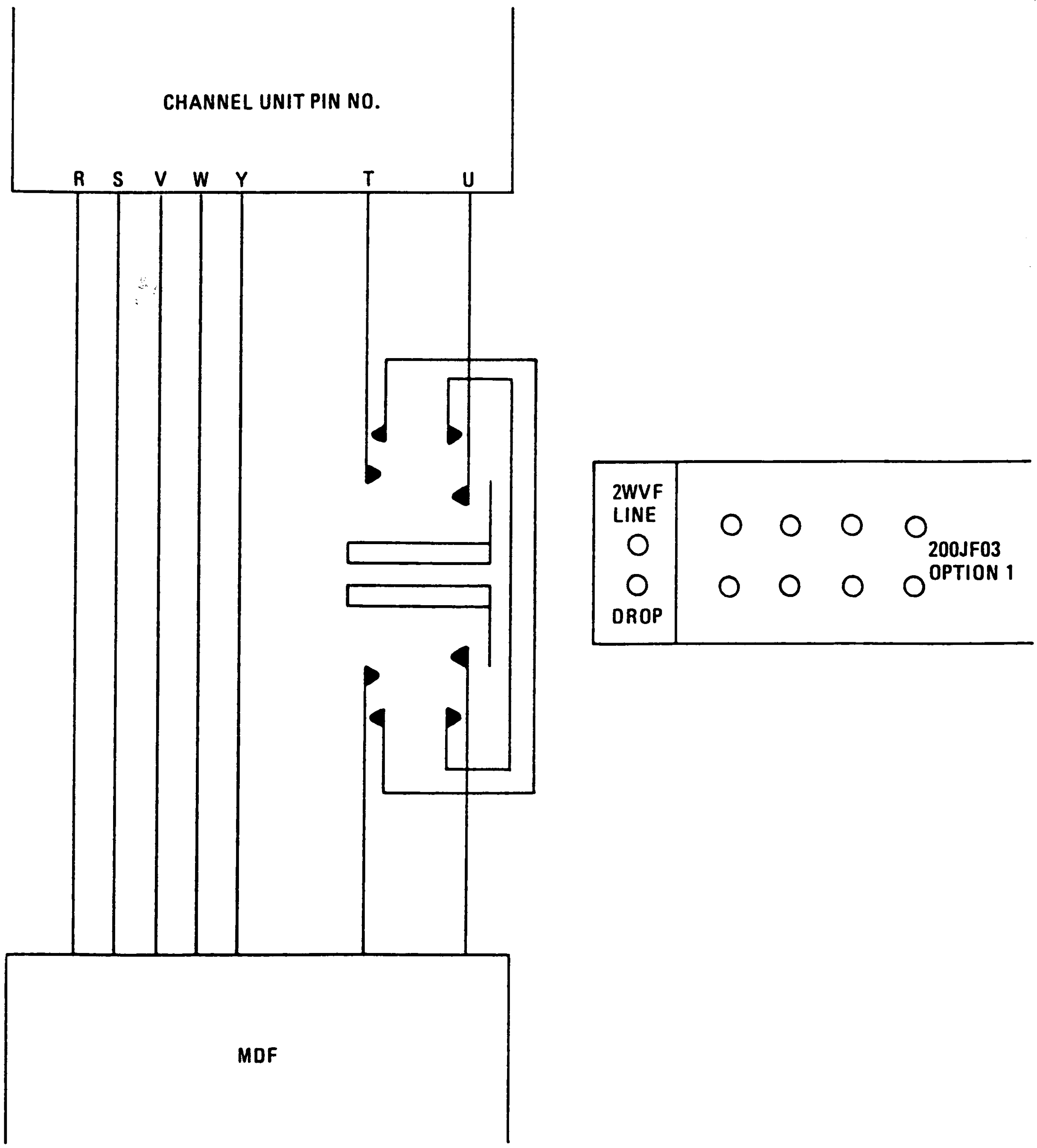
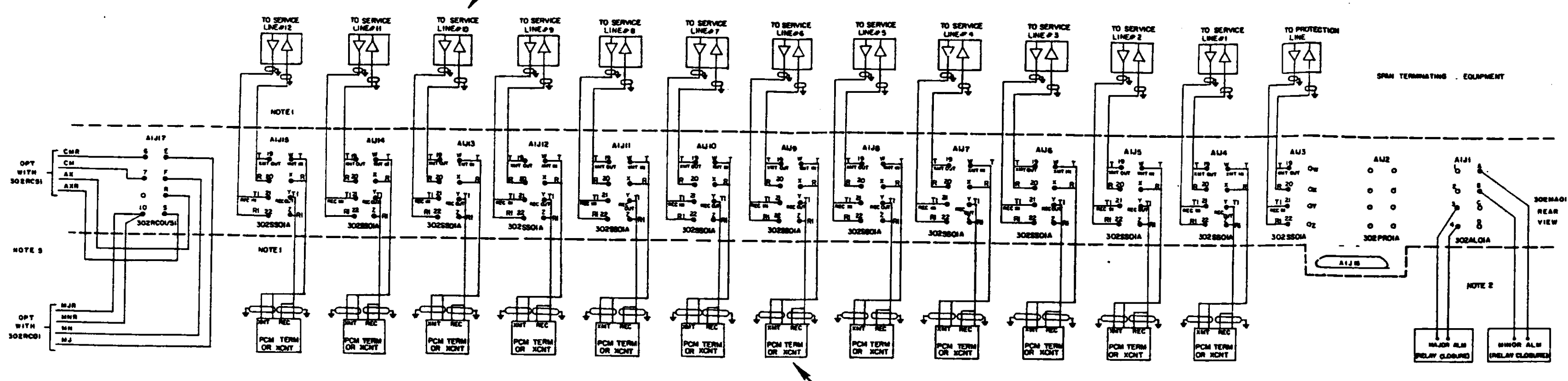


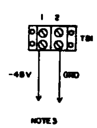
Fig. 6-5 — 200JF03 Jackfield Configuration

303ST	PIN NO.
RCV OUT	11
	12
XMT IN	19
	20

EQUIPMENT



OPT. A



TERMINAL PIN DESIGNATION

CONNECTOR A2J8	LEAD DESIGNATION
31	DSX1 Receive (Hi)
33	DSX1 Receive (Lo)**
42	DSX1 Transmit (Hi)
44	DSX1 Transmit (Lo)**
56	DSX1 All Ones (Hi)
58	DSX1 All Ones (Lo)**
12	
14	QB Ground**

**Located on 325AP01 Connector

NOTES:
1. ALL PCM SIGNAL PAIRS ARE ±3V BALANCED. USE SHIELDED TWISTED PAIRS BDR CONNECTIONS.
2. USE 22ga. SOLID WIRE FOR ALARM CONNECTIONS.
3. USE 18ga. STRANDED WIRE FOR POWER CONNECTIONS.
4. DEFAULT PRIORITY ASSIGNMENTS (WITHOUT 302PR01) RUN FROM HIGHEST FOR SERVICE LINE #1 TO LOWEST FOR SERVICE LINE #12 (OR #24).
5. FOR EXPLANATION OF OPTIONAL CONNECTIONS FOR SRC, SEE B302 TECH MANUAL.

Fig. 6-6 — B302 Installation Details

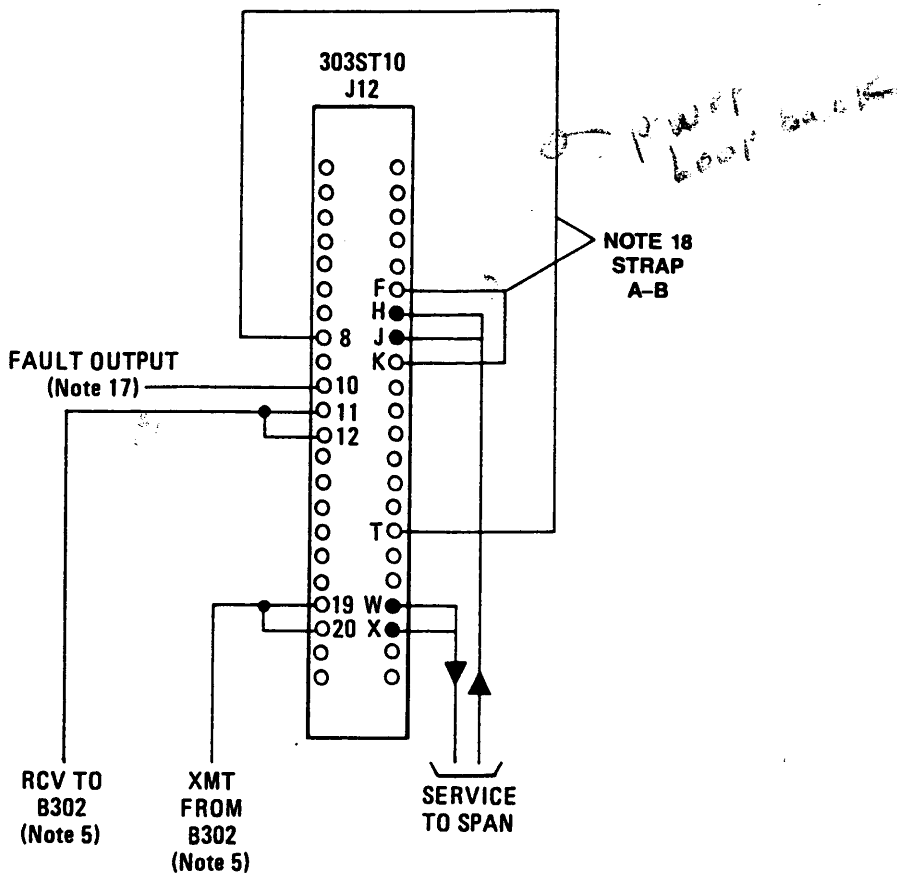


Fig. 6-7 — 303ST10 Installation Details

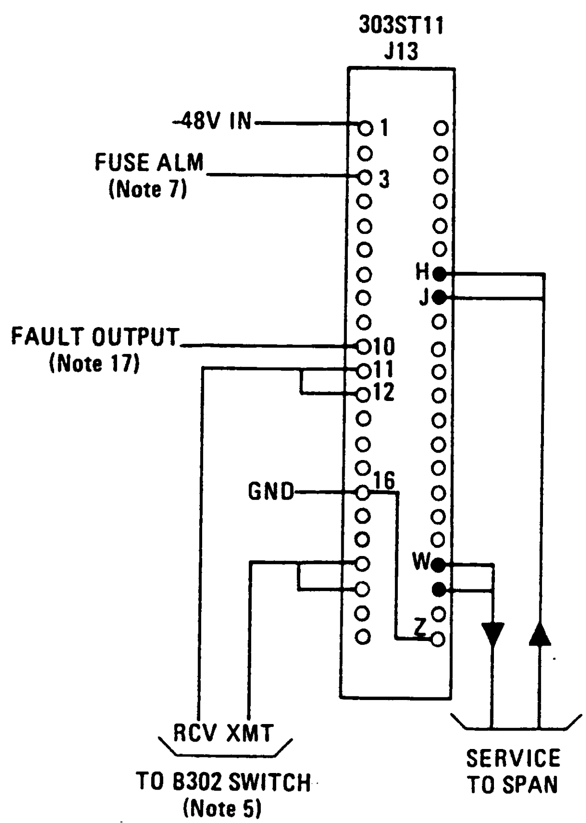


Fig. 6-8 — 303ST11 Installation Details

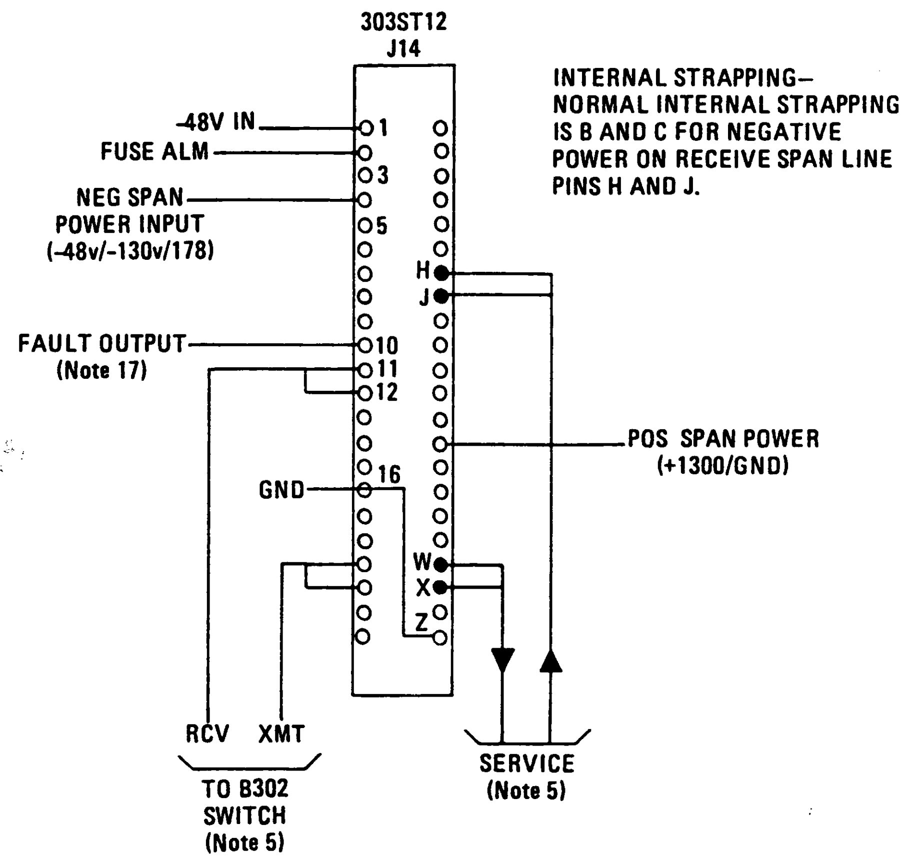


Fig. 6-9 — 303FT03 Installation Details

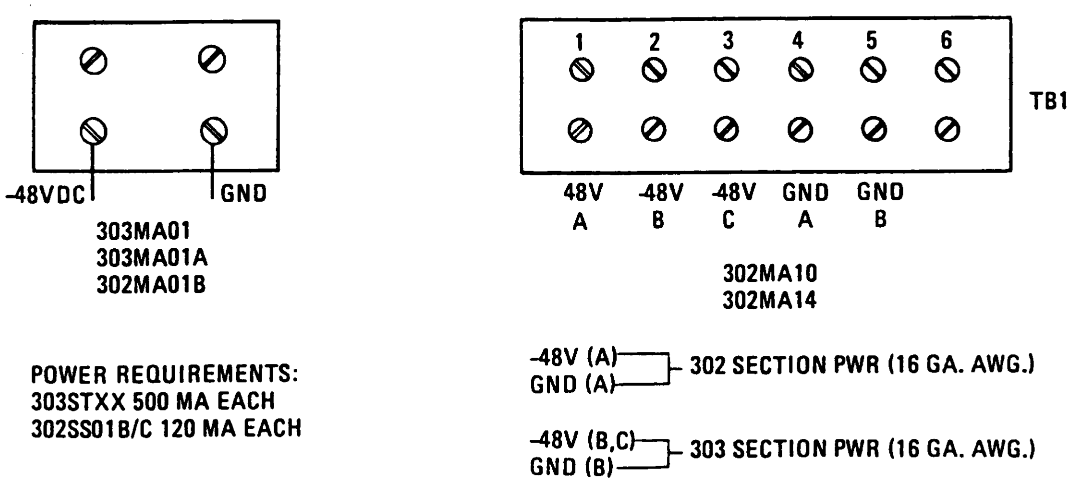
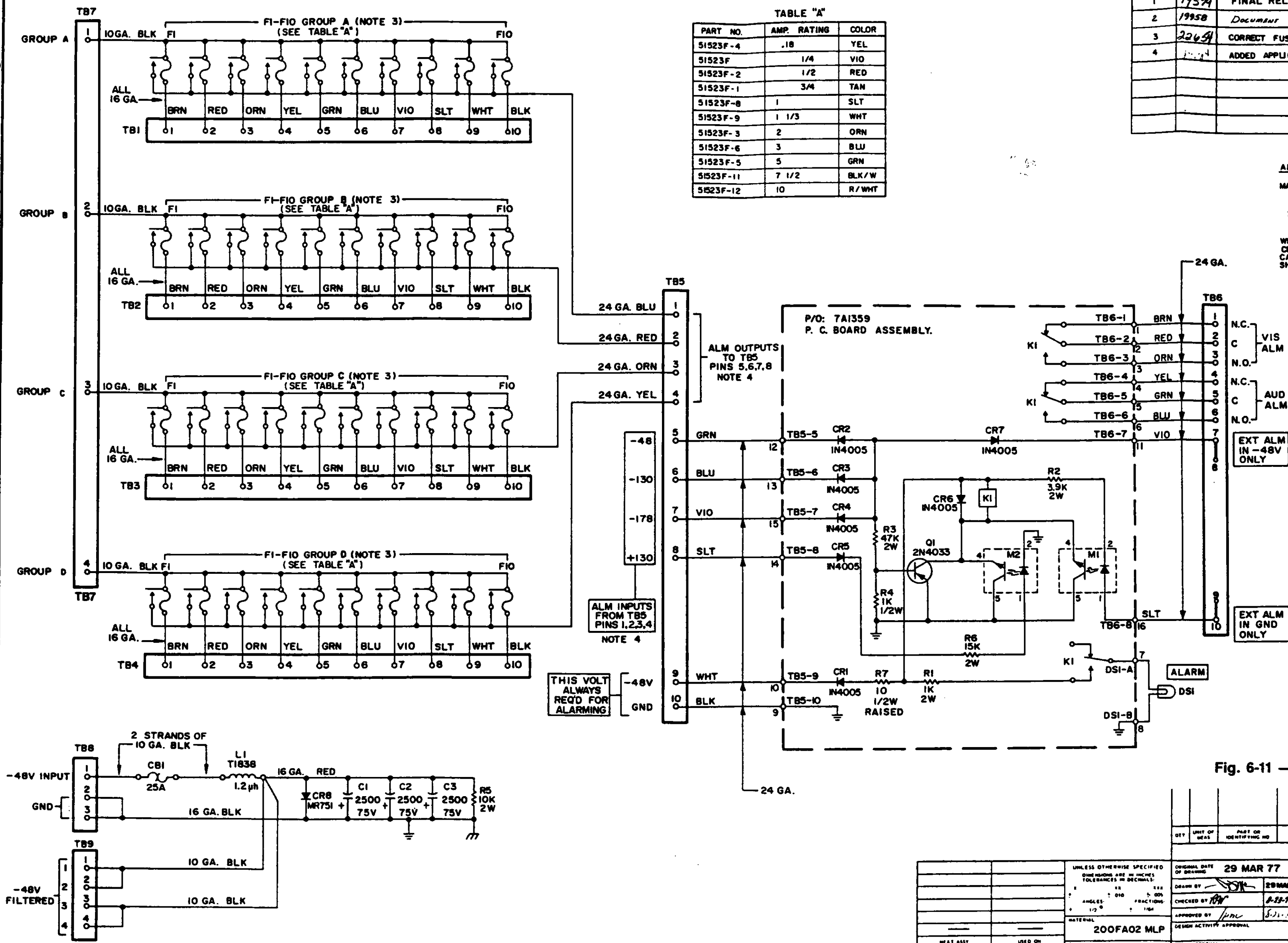


Fig. 6-10 — Typical power Input Blocks

REVISIONS				
ISSUE	EN NO	DESCRIPTION	DATE	APPROVED
1	19579	FINAL RELEASE	9-22-77	
2	19958	Document Update	2-7-78	
3	22651	CORRECT FUSE OUTPUT DESIG.	6-27-80	
4		ADDED APPLICATION NOTE.	7-28-81	

TABLE "A"

PART NO.	AMP. RATING	COLOR
51523F-4	.18	YEL
51523F	1/4	VIO
51523F-2	1/2	RED
51523F-1	3/4	TAN
51523F-8	1	SLT
51523F-9	1 1/3	WHT
51523F-3	2	ORN
51523F-6	3	BLU
51523F-5	5	GRN
51523F-11	7 1/2	BLK/W
51523F-12	10	R/WHT



APPLICATION NOTE

MAXIMUM CURRENT DRAIN LIMITS:

1. PER FUSE POSITION: 5 AMPS
2. PER FUSE BLOCK (10 FUSE GROUP): 25 AMPS
3. FILTERED -48V (TB9 PINS 1-4 TOTAL): 25 AMPS

WHEN ASSIGNING FUSE POSITIONS, THE MAXIMUM CURRENT DRAIN OF THE EQUIPMENT SHOULD BE CALCULATED. THE EQUIPMENT CURRENT DRAIN SHOULD NOT EXCEED THE ABOVE MAXIMUM LIMITS.

NOTES:

1. UNLESS OTHERWISE SPECIFIED ALL RESISTANCES ARE IN OHMS AND ALL CAPACITANCES ARE IN MICROFARADS.
2. HIGHEST REFERENCE DESIGNATIONS

HIGHEST REFERENCE DESIGNATIONS						
C3	CB1	CR8	DS1		K1	L1
M2	Q1	R7	TB9			

REFERENCE DESIGNATIONS OMITTED						

3. FUSES SUPPLIED PER CUSTOMER ORDER ONLY.
4. CONNECT FUSE GROUP ALARM OUTPUTS TO APPROPRIATE VOLTAGE ALARM INPUTS BY ADDING CONNECTING WIRES ON TB5 AS REQUIRED. WHEN TWO OR MORE FUSE GROUPS ARE AT THE SAME VOLTAGE, ALARM WIRE MAY BE MULTIPLIED.

NOTES ARE CONTINUED ON SHT 2

Fig. 6-11 — 200FA02 Installation Details

LIST OF MATERIALS

ORIGINAL DATE OF DRAWING: 29 MAR 77
MATERIAL: 200FA02 MLP

LYNCH COMMUNICATION SYSTEMS
204 EDISON WAY, RENO, NEVADA

TITLE: SCHEMATIC & PARTS LOCATION TYPE 200FA02 FUSE AND ALARM UNIT W/BATTERY FILTER
SIZE: D — DRAWING NO. 200FA02-01 — ISSUE 4
SCALE: NONE — SHEET 1 OF 2

ISSUE	EN NO	DESCRIPTION	DATE	APPROVED
8	22883	ADDED TABLES 3 & 4 TO SHEETS 1,2,4 & 5	8-7-80	

REVISIONS

ISSUE	EN NO	DESCRIPTION	DATE	APPROVED
1	19631	FINAL RELEASE	4-22-77	
2	19848A	CHANGED CABLE STUB TABLE. SH. 3 REDRAWN.	3-20-78	
3	20423	ADDED CABLE CHART FOR 104 PR CABLE	8-15-78	
4	20455	ADDED OPTION "D", MOVED "REAR VIEW" SHT 3 TO SHT 1. ADDED NOTES 3-2, 3-3 AND 3-4.	8/30/78	
5	20564	ADDED OPT "E" & FIG 1 WAS FIG XX	9-29-78	
6	21055	DEL OPT E FR SH1. DEL OPT D FR SH 2 ADD XX DESG. REV COLOR OF FF & OW PRS. CHG. NOTES 3-4 & 3-5. ADD NOTE 3-6 & SH 4 & 5.	4/25/79	
7	22116	ADDED TABLE 2 FOR 104 PAIR CABLE ON SHT. 1,2,4,5	2-25-80	

OPTION "A"

CONNECTOR # PIN #	ARRESTER GROUND	FAULT LINE SIDE #1	BLU/WHT BINDER ORN/WHT BINDER CABLE STUB #1 XMIT SIDE #1		BLU/WHT BINDER GRN/WHT BINDER CABLE STUB #2 RCVSIDE #1		FAULT LINE SIDE #2	ORN/WHT BINDER BRN/WHT BINDER CABLE STUB #1 XMIT SIDE #2		FAULT LINE GROUND (NOTE 1-5)	ORN/WHT BINDER BRN/WHT BINDER CABLE STUB #2 RCV SIDE #2		303RH12XX REQ'D WIRING	303RH25XX REQ'D WIRING	303RH50XX REQ'D WIRING	REMARKS
	1	2	3	4	5	6	7	8	9	10	11	12				
J1 RPTR 1	•	•	BLU	WHT	BLU	WHT	•	BLU	WHT	•	BLU	WHT	THIS SECTION COMPLETES REQUIRED WIRING FOR 303RH12XX	THIS SECTION COMPLETES REQUIRED WIRING FOR 303RH25XX	THIS SECTION COMPLETES REQUIRED WIRING FOR 303RH50XX	
J2 RPTR 2	•	•	ORN		ORN		•	ORN		•	ORN					
J3 RPTR 3	•	•	GRN		GRN		•	GRN		•	GRN					
J4 RPTR 4	•	•	BRN		BRN		•	BRN		•	BRN					
J5 RPTR 5	•	•	SLT		SLT		•	SLT		•	SLT					
J6 RPTR 6	•	•	BLU	RED	BLU	RED	•	BLU	RED	•	BLU	RED				
J7 RPTR 7	•	•	ORN		ORN		•	ORN		•	ORN					
J8 RPTR 8	•	•	GRN		GRN		•	GRN		•	GRN					
J9 RPTR 9	•	•	BRN		BRN		•	BRN		•	BRN					
J10 RPTR 10	•	•	SLT		SLT		•	SLT		•	SLT					
J11 RPTR 11	•	•	BLU	BLK	BLU	BLK	•	BLU	BLK	•	BLU	BLK				
J12 RPTR 12	•	•	ORN		ORN		•	ORN		•	ORN					
J13 FAULT FILTER	•									•						
J14 RPTR 13	•	•	GRN	BLK	GRN	BLK	•	GRN	BLK	•	GRN	BLK				NOTE 1-1
J15 RPTR 14	•	•	BRN		BRN		•	BRN		•	BRN					
J16 RPTR 15	•	•	SLT		SLT		•	SLT		•	SLT					
J17 RPTR 16	•	•	BLU	YEL	BLU	YEL	•	BLU	YEL	•	BLU	YEL				
J18 RPTR 17	•	•	ORN		ORN		•	ORN		•	ORN					
J19 RPTR 18	•	•	GRN		GRN		•	GRN		•	GRN					
J20 RPTR 19	•	•	BRN		BRN		•	BRN		•	BRN					
J21 RPTR 20	•	•	SLT		SLT		•	SLT		•	SLT					
J22 RPTR 21	•	•	BLU	VIO	BLU	VIO	•	BLU	VIO	•	BLU	VIO				
J23 RPTR 22	•	•	ORN		ORN		•	ORN		•	ORN					
J24 RPTR 23	•	•	GRN		GRN		•	GRN		•	GRN					
J25 RPTR 24	•	•	BRN		BRN		•	BRN		•	BRN					
J26 RPTR 25	•	•	SLT		SLT		•	SLT		•	SLT					
J27 RPTR 26	•	•	BLU	WHT	BLU	WHT	•	BLU	WHT	•	BLU	WHT				NOTE 1-2
J28 RPTR 27	•	•	ORN		ORN		•	ORN		•	ORN					
J29 RPTR 28	•	•	GRN		GRN		•	GRN		•	GRN					
J30 RPTR 29	•	•	BRN		BRN		•	BRN		•	BRN					
J31 RPTR 30	•	•	SLT		SLT		•	SLT		•	SLT					
J32 RPTR 31	•	•	BLU	RED	BLU	RED	•	BLU	RED	•	BLU	RED				
J33 RPTR 32	•	•	ORN		ORN		•	ORN		•	ORN					
J34 RPTR 33	•	•	GRN		GRN		•	GRN		•	GRN					
J35 RPTR 34	•	•	BRN		BRN		•	BRN		•	BRN					
J36 RPTR 35	•	•	SLT		SLT		•	SLT		•	SLT					
J37 RPTR 36	•	•	BLU	BLK	BLU	BLK	•	BLU	BLK	•	BLU	BLK				
J38 RPTR 37	•	•	ORN		ORN		•	ORN		•	ORN					
J39 RPTR 38	•	•	GRN		GRN		•	GRN		•	GRN					
J40 RPTR 39	•	•	BRN		BRN		•	BRN		•	BRN					
J41 RPTR 40	•	•	SLT		SLT		•	SLT		•	SLT					
J42 RPTR 41	•	•	BLU	YEL	BLU	YEL	•	BLU	YEL	•	BLU	YEL				
J43 RPTR 42	•	•	ORN		ORN		•	ORN		•	ORN					
J44 RPTR 43	•	•	GRN		GRN		•	GRN		•	GRN					
J45 RPTR 44	•	•	BRN		BRN		•	BRN		•	BRN					
J46 RPTR 45	•	•	SLT		SLT		•	SLT		•	SLT					
J47 RPTR 46	•	•	BLU	VIO	BLU	VIO	•	BLU	VIO	•	BLU	VIO				
J48 RPTR 47	•	•	ORN		ORN		•	ORN		•	ORN					
J49 RPTR 48	•	•	GRN		GRN		•	GRN		•	GRN					
J50 RPTR 49	•	•	BRN		BRN		•	BRN		•	BRN					
J51 RPTR 50	•	•	SLT		SLT		•	SLT		•	SLT					NOTE 1-3

REAR VIEW
303RH12XX

FAULT FILTER		12	11	10	9	8
7	6	5	4	3	2	1

REAR VIEW
303RH25XX

	25	24	23	22	21	20
19	18	17	16	15	14	13
FAULT FILTER		12	11	10	9	8
7	6	5	4	3	2	1

REAR VIEW
303RH50XX

		50	49	48	47	46
45	44	43	42	41	40	39
	38	37	36	35	34	33
32	31	30	29	28	27	26
	25	24	23	22	21	20
19	18	17	16	15	14	13
FAULT FILTER		12	11	10	9	8
7	6	5	4	3	2	1

TABLE 3
104 PR CABLE

XMIT CABLE STUB # 1					RCV CABLE STUB # 2				
CONNECTOR	BINDER	PAIR	PIN	CIRCUIT	CONNECTOR	BINDER	PAIR	PIN	CIRCUIT
J13	BLU/WHT	WHT/RED	4,6	FF IN	OW BOARD	BLU/WHT	WHT/RED	TR	FF OUT
OW BOARD	ORN/WHT	WHT/RED	TR	OW IN	OW BOARD	ORN/WHT	WHT/RED	TR	OW OUT
	GRN/WHT	WHT/RED		SPARE		GRN/WHT	WHT/RED		SPARE
	BRN/WHT	WHT/RED		SPARE		BRN/WHT	WHT/RED		SPARE

TABLE 4
104 PR
CABLE

XMIT CABLE STUB # 1					RCV CABLE STUB # 2				
CONNECTOR	BINDER	PAIR	PIN	CIRCUIT	CONNECTOR	BINDER	PAIR	PIN	CIRCUIT
J13	BRN/WHT	WHT/RED	4,6	FF IN	OW BOARD	BRN/WHT	WHT/RED	TR	FF OUT
OW BOARD	ORN/WHT	WHT/BLK	TR	OW IN	OW BOARD	ORN/WHT	WHT/BLK	TR	OW OUT
	ORN/WHT	WHT/RED		SPARE		ORN/WHT	WHT/RED		SPARE
	BRN/WHT	WHT/BLK		SPARE		BRN/WHT	WHT/BLK		SPARE

NOTES :

1-1. THE FAULT FILTER CONNECTOR COMPLETES THE WIRING FOR THE 303RH12XX TYPE REPEATER HOUSING. THE DASHED LINE BETWEEN PIN 1 & PIN 10 ON J13 MUST BE CONNECTED FOR THIS CONFIGURATION ONLY.

1-2. REPEATER POSITION 25 COMPLETES THE WIRING FOR THE 303RH25XX TYPE REPEATER HOUSING. THE DASHED LINE BETWEEN PIN 1 & PIN 10 ON J26 MUST BE CONNECTED FOR THIS CONFIGURATION ONLY. (THE JUMPER BETWEEN PIN 1 & PIN 10 ON J13 SHOULD NOT BE CONNECTED ON THE 303RH25XX).

1-3. REPEATER POSITION 50 COMPLETES THE WIRING FOR THE 303RH50XX TYPE REPEATER HOUSING. THE JUMPER BETWEEN PIN 1 & PIN 10 ON J51 MUST BE CONNECTED FOR THIS CONFIGURATION ONLY. (THE JUMPER BETWEEN PIN 1 & PIN 10 ON J26 SHOULD NOT BE CONNECTED ON THE 303RH50XX).

1-4. BANJO WIRING IS DENOTED AS FOLLOWS •—•—•—• AND IS USED ON PINS 1,2,7 & 10 OF ALL CONNECTORS

1-5. SEE FIGURE I FOR CHASSIS GROUND WIRING INFORMATION.

1-6. FOR SPARE PAIR SPLICING ASSIGNMENTS IN THE 303RH50 HOUSING USE WHICH EVER CABLE MATCHES TABLE 1,2,3 OR 4.

104 PR CABLE

TABLE 1

XMIT CABLE STUB #1					RCV CABLE STUB #2				
CONNECTOR	BINDER	PAIR	PINS	CIRCUIT	CONNECTOR	BINDER	PAIR	PINS	CIRCUIT
J13	BLU/WHT	WHT/RED	4& 6	FF IN	OW BOARD	BLU/WHT	WHT/RED	TR	FF OUT
OW BOARD	ORN/WHT	WHT/BLK	TR	OW IN	OW BOARD	ORN/WHT	WHT/BLK	TR	OW OUT
–	GRN/WHT	WHT/RED	-	SPARE	–	GRN/WHT	WHT/RED	-	SPARE
–	BRN/WHT	WHT/BLK	-	SPARE		BRN/WHT	WHT/BLK	-	SPARE

104 PR CABLE

TABLE 2

XMIT CABLE STUB #1					RCV CABLE STUB #2				
CONNECTOR	BINDER	PAIR	PINS	CIRCUIT	CONNECTOR	BINDER	PAIR	PINS	CIRCUIT
J13	BRN/WHT	WHT/RED	4& 6	FF IN	OW BOARD	BRN/WHT	WHT/RED	TR	FF OUT
OW BOARD	GRN/WHT	WHT/BLK	TR	OW IN	OW BOARD	GRN/WHT	WHT/BLK	TR	OW OUT
–	GRN/WHT	WHT/RED	-	SPARE	–	GRN/WHT	WHT/RED	-	SPARE
–	BRN/WHT	WHT/BLK	-	SPARE		BRN/WHT	WHT/BLK	-	SPARE

24 PR CABLE

XMIT CABLE STUB #1					RCV CABLE STUB #2				
CONNECTOR	BINDER	PAIR	PINS	CIRCUIT	CONNECTOR	BINDER	PAIR	PINS	CIRCUIT
J13	BLU/WHT	WHT/RED	4&6	FF IN	OW BOARD	BLU/WHT	WHT/RED	TR	FF OUT
OW BOARD	BLU/WHT	WHT/BLK	TR	OW IN	OW BOARD	BLU/WHT	WHT/BLK	TR	OW OUT
–	ORN/WHT	WHT/RED	–	SPARE	–	ORN/WHT	WHT/RED	–	SPARE
–	ORN/WHT	WHT/BLK	–	SPARE		ORN/WHT	WHT/BLK	–	SPARE

ADDITIONAL HOUSING WIRING

FROM	TO	WIRE	DESIGNATION
CONN J7 PIN 10	HOUSING CONN.	24 GA. SOL	PROT. GRD
CONN J13 PINS 4 AND 6	LOAD COIL AND CAP ASSY. "FAULT FILTER IN T AND R"	24 GA. PR	FAULT FILTER IN
LOAD COIL AND CAP ASSY. "GRD"	HOUSING CONN.	24 GA. SOL	PROT. GRD.
LOAD COIL AND CAP ASSY. "ORDERWIRE OUT T AND R"	EXTERNAL ORDERWIRE CONNECTOR	24 GA. PR.	ORDERWIRE LINE

LEGEND

SYM	DESCRIPTION
XX	THE XX FOLLOWING THE REPEATER HOUSING NUMBER DENOTE THE TYPE OF HOUSING, I.E. A, PA, B OR PB

Fig. 6-12 — 303RH Option A Wiring List

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES IN DECIMALS .XX ± .XXX ± ANGLES FRACTIONS

MATERIAL — FINISH — NEXT ASSY — USED ON — APPLICATIONS

ORIGINAL DATE OF DRAWING 2/10/77
DRAWN BY — 2/10/77
CHECKED BY —
APPROVED BY
DESIGN ACTIVITY APPROVAL
FINAL APPROVAL

LYNCH COMMUNICATION SYSTEMS
204 EDISON WAY, RENO, NEVADA

TITLE: INTER-UNIT WIRING

SIZE D — DRAWING NO 303RH00-15/-52 — ISSUE 8

SCALE — SHEET 1 OF 5

OPTION D

CONNECTOR # / PIN #	ARRESTER GROUND 1	FAULT LINE SIDE #1 2	BINDER	P/O STUB #1 XMT SIDE #1 PAIR 3	4	BINDER	P/O STUB #2 RCV SIDE #1 PAIR 5	6	FAULT LINE SIDE #2 7	BINDER	P/O STUB #2 XMT SIDE #2 PAIR 8	9	FAULT LINE (NOTE 4-5) 10	BINDER	P/O STUB #1 RCV SIDE #2 PAIR 11	12	303RH12XX REQ'D WIRING	303RH25XX REQ'D WIRING	303RH50XX REQ'D WIRING	REMARKS
J1 RPTR 1	●	●	ALL HOUSINGS BLUE/WHITE	BLU	WHT	ALL HOUSINGS BLUE/WHITE	BLU	WHT	●	303RH12XX & 25XX ORANGE/WHITE, 303RH50XX GREEN/WHITE	BLU	WHT	●	303RH12XX & 25XX ORANGE/WHITE, 303RH50XX GREEN/WHITE	BLU	WHT	THIS SECTION COMPLETES REQUIRED WIRING FOR 303RH12XX	THIS SECTION COMPLETES REQUIRED WIRING FOR 303RH25XX	THIS SECTION COMPLETES REQUIRED WIRING FOR 303RH50XX	
J2 RPTR 2	●	●		ORN			ORN		●		ORN		●		ORN					
J3 RPTR 3	●	●		GRN			GRN		●		GRN		●		GRN					
J4 RPTR 4	●	●		BRN			BRN		●		BRN		●		BRN					
J5 RPTR 5	●	●		SLT			SLT		●		SLT		●		SLT					
J6 RPTR 6	●	●		BLU	RED		BLU	RED	●		BLU	RED	●		BLU	RED				
J7 RPTR 7	●	●		ORN			ORN		●		ORN		●		ORN					
J8 RPTR 8	●	●		GRN			GRN		●		GRN		●		GRN					
J9 RPTR 9	●	●		BRN			BRN		●		BRN		●		BRN					
J10 RPTR 10	●	●		SLT			SLT		●		SLT		●		SLT					
J11 RPTR 11	●	●		BLU	BLK		BLU	BLK	●		BLU	BLK	●		BLU	BLK				
J12 RPTR 12	●	●		ORN			ORN		●		ORN		●		ORN					
J13 FAULT FILTER	●								●				●							NOTE 4-1
J14 RPTR 13	●	●		GRN	BLK		GRN	BLK	●		GRN	BLK	●		GRN	BLK				
J15 RPTR 14	●	●		BRN			BRN		●		BRN		●		BRN					
J16 RPTR 15	●	●		SLT			SLT		●		SLT		●		SLT					
J17 RPTR 16	●	●		BLU	YEL		BLU	YEL	●		BLU	YEL	●		BLU	YEL				
J18 RPTR 17	●	●		ORN			ORN		●		ORN		●		ORN					
J19 RPTR 18	●	●		GRN			GRN		●		GRN		●		GRN					
J20 RPTR 19	●	●		BRN			BRN		●		BRN		●		BRN					
J21 RPTR 20	●	●		SLT			SLT		●		SLT		●		SLT					
J22 RPTR 21	●	●		BLU	VIO		BLU	VIO	●		BLU	VIO	●		BLU	VIO				
J23 RPTR 22	●	●		ORN			ORN		●		ORN		●		ORN					
J24 RPTR 23	●	●		GRN			GRN		●		GRN		●		GRN					
J25 RPTR 24	●	●		BRN			BRN		●		BRN		●		BRN					
J26 RPTR 25	●	●		SLT			SLT		●		SLT		●		SLT					NOTE 4-2
J27 RPTR 26	●	●	303RH50XX HSG ORANGE/WHITE	BLU	WHT	303RH50XX HSG ORANGE/WHITE	BLU	WHT	●	303RH50XX HSG BROWN/WHITE	BLU	WHT	●	303RH50XX BROWN/WHITE	BLU	WHT				
J28 RPTR 27	●	●		ORN			ORN		●		ORN		●		ORN					
J29 RPTR 28	●	●		GRN			GRN		●		GRN		●		GRN					
J30 RPTR 29	●	●		BRN			BRN		●		BRN		●		BRN					
J31 RPTR 30	●	●		SLT			SLT		●		SLT		●		SLT					
J32 RPTR 31	●	●		BLU	RED		BLU	RED	●		BLU	RED	●		BLU	RED				
J33 RPTR 32	●	●		ORN			ORN		●		ORN		●		ORN					
J34 RPTR 33	●	●		GRN			GRN		●		GRN		●		GRN					
J35 RPTR 34	●	●		BRN			BRN		●		BRN		●		BRN					
J36 RPTR 35	●	●		SLT			SLT		●		SLT		●		SLT					
J37 RPTR 36	●	●		BLU	BLK		BLU	BLK	●		BLU	BLK	●		BLU	BLK				
J38 RPTR 37	●	●		ORN			ORN		●		ORN		●		ORN					
J39 RPTR 38	●	●		GRN			GRN		●		GRN		●		GRN					
J40 RPTR 39	●	●		BRN			BRN		●		BRN		●		BRN					
J41 RPTR 40	●	●		SLT			SLT		●		SLT		●		SLT					
J42 RPTR 41	●	●		BLU	YEL		BLU	YEL	●		BLU	YEL	●		BLU	YEL				
J43 RPTR 42	●	●		ORN			ORN		●		ORN		●		ORN					
J44 RPTR 43	●	●		GRN			GRN		●		GRN		●		GRN					
J45 RPTR 44	●	●		BRN			BRN		●		BRN		●		BRN					
J46 RPTR 45	●	●		SLE			SLT		●		SLT		●		SLT					
J47 RPTR 46	●	●		BLU	VIO		BLU	VIO	●		BLU	VIO	●		BLU	VIO				
J48 RPTR 47	●	●		ORN			ORN		●		ORN		●		ORN					
J49 RPTR 48	●	●		GRN			GRN		●		GRN		●		GRN					
J50 RPTR 49	●	●		BRN			BRN		●		BRN		●		BRN					
J51 RPTR 50	●	●		SLT			SLT		●		SLT		●		SLT					NOTE 4-3

54 PR CABLE

XMIT CABLE STUB # 1					RCV CABLE STUB # 2				
CONNECTOR	BINDER	PAIR	PINS	CIRCUIT	CONNECTOR	BINDER	PAIR	PINS	CIRCUIT
J13	BLU/WHT	WHT/RED	4&6	FF IN	OW BOARD	BLU/WHT	WHT/RED	T R	FF OUT
OW BOARD	BLU/WHT	WHT/BLK	T R	OW IN	OW BOARD	BLU/WHT	WHT/BLK	T R	OW OUT
–	ORN/WHT	WHT/RED	–	SPARE	–	ORN/WHT	WHT/RED	–	SPARE
–	ORN/WHT	WHT/BLK	–	SPARE	–	ORN/WHT	WHT/BLK	–	SPARE

ADDITIONAL HOUSING WIRING

FROM	TO	WIRE	DESIGNATION
CONN J7 PIN 10	HOUSING CONN.	24 GA. SOL.	PROT. GRD
CONN J[illegible] PINS 4 AND 6	LOAD COIL AND CAP ASSEMBLY "FAULT FILTER IN" T AND R"	24 GA. PR. RED/WHT	FAULT FILTER IN
LOAD COIL AND CAP. ASSY. "GRD"	HOUSING CONN.	24 GA. SOL.	PROT. GRD.
LOAD COIL AND CAP. ASSY. "ORDERWIRE OUT T AND R"	EXTERNAL ORDERWIRE CONNECTOR	24 GA. PR.	ORDERWIRE LINE

TABLE 3
104 PR
CABLE

XMIT CABLE STUB # 1					RCV CABLE STUB # 2				
CONNECTOR	BINDER	PAIR	PIN	CIRCUIT	CONNECTOR	BINDER	PAIR	PIN	CIRCUIT
J13	BLU/WHT	WHT/RED	4,6	FF IN	OW BOARD	BLU/WHT	WHT/RED	TR	FF OUT
OW BOARD	ORN/WHT	WHT/RED	TR	OW IN	OW BOARD	ORN/WHT	WHT/RED	TR	OW OUT
	GRN/WHT	WHT/RED		SPARE		GRN/WHT	WHT/RED		SPARE
	BRN/WHT	WHT/RED		SPARE		BRN/WHT	WHT/RED		SPARE

TABLE 4
104 PR
CABLE

XMIT CABLE STUB # 1					RCV CABLE STUB # 2				
CONNECTOR	BINDER	PAIR	PIN	CIRCUIT	CONNECTOR	BINDER	PAIR	PIN	CIRCUIT
J13	BRN/WHT	WHT/RED	4,6	FF IN	OW BOARD	BRN/WHT	WHT/RED	TR	FF OUT
OW BOARD	ORN/WHT	WHT/BLK	TR	OW IN	OW BOARD	ORN/WHT	WHT/BLK	TR	OW OUT
	ORN/WHT	WHT/RED		SPARE		ORN/WHT	WHT/RED		SPARE
	BRN/WHT	WHT/BLK		SPARE		BRN/WHT	WHT/BLK		SPARE

NOTES :

4-1. THE FAULT FILTER CONNECTOR COMPLETES THE WIRING FOR THE 303RH12XX TYPE REPEATER HOUSING. THE DASHED LINE BETWEEN PIN 1 & PIN 10 ON J13 MUST BE CONNECTED FOR THIS CONFIGURATION ONLY.

4-2. REPEATER POSITION 25 COMPLETES THE WIRING FOR THE 303RH25XX TYPE REPEATER HOUSING. THE DASHED LINE BETWEEN PIN 1 & PIN 10 ON J26 MUST BE CONNECTED FOR THIS CONFIGURATION ONLY. (THE JUMPER BETWEEN PIN 1 & PIN 10 ON J13 SHOULD NOT BE CONNECTED ON THE 303RH25XX).

4-3. REPEATER POSITION 50 COMPLETES THE WIRING FOR THE 303RH50XX TYPE REPEATER HOUSING. THE JUMPER BETWEEN PIN 1 & PIN 10 ON J51 MUST BE CONNECTED FOR THIS CONFIGURATION ONLY. (THE JUMPER BETWEEN PIN 1 & PIN 10 ON J26 SHOULD NOT BE CONNECTED ON THE 303RH50XX).

4-4. BANJO WIRING IS DENOTED AS FOLLOWS ●—●—●—● AND IS USED ON PINS 1,2,7 & 10 OF ALL CONNECTORS

4-5. SEE FIGURE 1 FOR CHASSIS GROUND WIRING INFORMATION.

4-6. OPTION D HOUSINGS REQUIRE THAT REPEATER UNITS BE STRAPPED FOR OPTION A.

4-7. SPLICING FOR SPARE PAIR ASSIGNMENTS IN THE 303RH50 HOUSING USE WHICH EVER CABLE MATCHES TABLE 1,2,3 OR 4.

104 PR CABLE

TABLE 1

XMIT CABLE STUB #1					RCV CABLE STUB #2				
CONNECTOR	BINDER	PAIR	PINS	CIRCUIT	CONNECTOR	BINDER	PAIR	PINS	CIRCUIT
J13	BLU/WHT	WHT/RED	4& 6	FF IN	OW BOARD	BLU/WHT	WHT/RED	TR	FF OUT
OW BOARD	ORN/WHT	WHT/BLK	TR	OW IN	OW BOARD	ORN/WHT	WHT/BLK	TR	OW OUT
–	GRN/WHT	WHT/RED	-	SPARE	–	GRN/WHT	WHT/RED	-	SPARE
–	BRN/WHT	WHT/BLK	-	SPARE		BRN/WHT	WHT/BLK	-	SPARE

104 PR CABLE

TABLE 2

XMIT CABLE STUB #1					RCV CABLE STUB #2				
CONNECTOR	BINDER	PAIR	PINS	CIRCUIT	CONNECTOR	BINDER	PAIR	PINS	CIRCUIT
J13	BRN/WHT	WHT/RED	4& 6	FF IN	OW BOARD	BRN/WHT	WHT/RED	TR	FF OUT
OW BOARD	GRN/WHT	WHT/BLK	TR	OW IN	OW BOARD	GRN/WHT	WHT/BLK	TR	OW OUT
–	GRN/WHT	WHT/RED	-	SPARE	–	GRN/WHT	WHT/RED	-	SPARE
–	BRN/WHT	WHT/BLK	-	SPARE		BRN/WHT	WHT/BLK	-	SPARE

Fig. 6-13 — 303RH Option C Wiring List

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES, TOLERANCES IN DECIMALS	
ORIGINAL DATE OF DRAWING	2/10/77
DRAWN BY	2/10/77
CHECKED BY	
APPROVED BY	
DESIGN ACTIVITY APPROVAL	
FINAL APPROVAL	
LYNCH COMMUNICATION SYSTEMS, 204 EDISON WAY, RENO, NEVADA	
TITLE	INTER-UNIT WIRING
SIZE	D
DRAWING NO.	303RH00-15/-52
SHEET	4 OF 5
NEXT ASSY / USED ON	APPLICATIONS

TABLE 6-1

COMPOSITE STRAPPING OPTIONS

PART NUMBER	UNIT NOMENCLATURE	FUNCTION	STRAP
325AP01 (See Note)	Alarm and Power Unit	12-Second Trunk Processing	J-K
		2-Second Trunk Processing (F)	J-H
		280-Millisecond Local Alarm Detection (F) NORMAL	B-C E-F L-N
		2-Second Local Alarm Detection USE WITH MICROWAVE	A-B D-E L-M
325DP01	Dial Pulse Originating Channel Unit	Absence of Ground Searching Battery Searching	1-2 2-3
325EM01 325EM02 325EM03	E & M Channel Units (E & M Trunk Types):		
	1-Way Incoming	E lead is forced open for alarm duration E lead is opened with busy switch	A-B E-F
	1-Way Outgoing or 2-Way Dial Service Calling Party Control	E lead is forced open at T = 0, busy (ground or battery) after *T seconds. (*T = 12-second nominal, 2-second optional strapping in 325AP01 alarm and power unit.) E lead is busied with busy switch. USE WITH 1-W INC	B-C E-D
	2-Way Outgoing Dial Access Incoming Operator Direct	E lead is forced open at T = 0 for entire alarm. MS (OS) lead is grounded at T = 0 for entire alarm to step idle relay chain CKT.	A-B E-F
	2-Way Service in Common Control Office	E lead is forced open at T = 0 for entire alarm. MB lead is grounded at T = 0 to make that trunk busy to the common control processor.	A-B E-F
	E-Lead Options	***On-Hook*** / ***Off-Hook***	
		Open / GND	H-J
		Open / BAT	H-K

Note: Alarm and power unit (325AP01), transmit converter (325TC01), and receive converter (325RC01) contain a number of straps marked "test." These test straps are ***not*** option straps. ***Strap clips should not be removed in the field.***

TABLE 6-1 (Cont.)

COMPOSITE STRAPPING OPTIONS

PART NUMBER	UNIT NOMENCLATURE	FUNCTION	STRAP
325FX01	Foreign Exchange Channel Units	Ground Start (D2)*	B–A E–D
		Ground Start (D3)*	B–C E–H
		Loop Start (D2)*	B–A E–F
		Loop Start (D3)*	B–C E–F
		Ring Generator Loops > 600 ohms shorter loop Loops < 600 ohms Longer loop	 J–K K–L
325FX02	Foreign Exchange Channel Units	Ground Start (D2)*	B–A E–D
		Ground Start (D3)*	B–C E–H
		Loop Start (D2)*	B–A E–F
		Loop Start (D3)*	B–C E–F
325TA01	Test and Alignment Panel	Internal Amplifier (1 kHz IN) Operational use this one	J–H N–M
		Internal Amplifier (1 kHz IN) Bypassed	J–K L–M
325TC01B (See Note)	Transmit Converter	Local Transmit Timing.	A–B
	can only be on 1 end	Loop Timing Slave transmit clock to received data. Required for No. 4 ESS and other electronic-type offices.	B–C
325VF01	Voice Frequency (No Signaling)	VF Level Options XMT (Input) –17 to –4 dBm –4 to +8 dBm RCV (Output) –17 to –5.5 dBm –5.5 to +8 dBm	 A–B B–C E–F D–E

* D2 and D3 reference denotes foreign exchange channel unit signaling format, ***not*** channel bank type.

Note: Alarm and power unit (325AP01), transmit converter (325TC01), and receive converter (325RC01) contain a number of straps marked "test." These test straps are ***not*** option straps. ***Strap clips should not be removed in the field.***

TABLE 6-1 (Cont.)

COMPOSITE STRAPPING OPTIONS

PART NUMBER	UNIT NOMENCLATURE	FUNCTION	STRAP
325PR01	Pulse-Link Repeater	VF Level Options	
		XMT (Input)	
		-17 to -4 dBm	A-B
		-4 to +8 dBm	B-C
		RCV (Output)	
		-17 to -5.5 dBm	E-F
		-5.5 to +8 dBm	D-E
		E-Lead Options	
		IDLE BUSY	
		OPEN GND	L-K, M-N
		OPEN BATT	L-J, M-N
		GND BATT	L-J, M-K
		M-Lead Options	
		IDLE BUSY	
		OPEN BATT	S-P
		OPEN GND	S-Q
		Busy Switch Options	
		Send Busy to Far End	W-V
		No Busy to Far End	W-U
		E Lead to Busy	Y-X
		E Lead Open	Y-Z
		Opens T-R and T1-R1	Remove T, R, T1, R1
		Leaves T, R and T1, R1, Cut Through	T, R, T1, R1
325PR03	2-Wire Pulse-Link Repeater	M-Lead Options	
		IDLE BUSY	
		OPEN BATT	S-P
		GND BATT	S-P
		OPEN GND	S-U
		E-Lead Options	
		ON-HOOK OFF-HOOK	
		OPEN GND	H-J, G-I
		OPEN BATT	H-K, G-I
		GND BATT	H-K, J-G
	E & M Trunk		
	1-Way Incoming	E lead is forced idle for alarm duration.	A-B, E-F, L-M
	1-Way Outgoing or 2-Way Dial Service Calling Party Control	E lead is forced idle, then after *T seconds forced busy. (*T = 10-second nominal, 2-second optional strap option in alarm unit.)	B-C, E-D, M-N
	2-Way Outgoing Dial Access Incoming Operator Direct	E lead is forced idle for entire alarm. MB (OS) lead is grounded at T = 0 for entire alarm to step idle indicator relay chain CKT.	A-B, E-F, M-N
	2-Way Service in Common Control Office	E lead is forced idle for entire alarm. MB lead is grounded for entire alarm to make that trunk busy to the common control processor.	A-B, E-F, M-N

TABLE 6-1 (Cont.)

COMPOSITE STRAPPING OPTIONS

PART NUMBER	UNIT NOMENCLATURE	FUNCTION	STRAP
325DP21A	Dial Pulse Origination	S Lead Absence of Ground Searching Battery Searching B1 and B2 Leads 900Ω 2W Terminations Loaded Cable External Precision Networks	 1-2, 11-6 2-3, 11-6 1-2, 4-5, 11-6 4-5 4-6 6-7
325DP22	Dial Pulse Terminating	900Ω 2W Terminations Loaded Cable External Precision Networks 950Ω Loop Resistance 660Ω Loop Resistance	4-5 4-6 6-7 1-3 1-2
325ET01	Electronic Trunk	Called Party Hold (IN) (OUT) Remote Busy (IN) (OUT) Battery Reversal (ENABLE) (DISABLE)	A-B B-C D-E E-F G-H G-I
All Channels	VF Busy Switch Function	Open VF Leave Path Cut Through	Remove T, R, T1, R1 T, R, T1, R1
303ST12	Office Repeater	Simplex Power Polarity: Negative (-) simplex power connection to RCV XFMR (pins H & J). Positive (+) simplex power connection to XMT XFMR (pins W & X). Positive (+) simplex power connection to RCV XFMR (pins H & J). Negative (-) simplex power connection to XMT XFMR (pins W & X).	 "B" space bridged and "C" space bridged "A" space bridged and "D" space bridged
325ST15	Office Repeater	Fault test signal detection period (loop delay).	1, 2, 4 or 8 sec post to center (common) post
325ST16	Office Repeater	One-Cable (Bidirectional) Operation Two-Cable (Unidirectional) Operation	Factory strapped Remove straps on circuit trace posts intercon-necting pins F-F and T-22

TABLE 6-1 (Cont.)

COMPOSITE STRAPPING OPTIONS

PART NUMBER	UNIT NOMENCLATURE	FUNCTION	STRAP
303ST17 303ST17A 303ST18 303ST18A 303ST27	Office Repeater	Fault Signal Detection Period (Loop Delay)	1-, 2-, 4-, or 8-second post to center (common) post
		One-Cable (Bidirectional) Operation	Factory strapped
		Two-Cable (Unidirectional) Operation ***Note:*** 303ST18A unit equalizer and artificial line range switches must be positioned prior to installation.	Remove straps on circuit trace posts intercon-necting pins F-P and T-22
303FT03	Fault Locate Test Panel	-130-Vdc Power Supply Enable Disable	 A-B B-C
303OW01	Order-Wire Unit	End-Office Application: 1. Order wire ***is*** connected to CO selector. Order wire is ***not*** fed through.	H-I, J-K, M-P
		2. Order wire is ***not*** connected to CO selector. Order wire is ***not*** fed through.	G-H, K-L, M-P
		Intermediate-Office Application: Order wire feed through. Order wire is ***not*** connected to CO selector.	G-H, K-L, M-N
		Note 1: Central office selector ***cannot*** be wired when order wire is fed through. ***Note 2:*** Order wire is connected to access jack in all options.	
303FF01 and 303FF02	Fault Filters	Fault Locate Line Selection: Side 1 only Side 2 only Side 1 or side 2 (as selected by 303FT02 S1/S2 test switch)	 U-V, W-X U-W, X-Y U-V, X-Y
303FF03	Fault Filter	Fault Locate Line Selection: Side 1 only Side 2 only Side 1 and 2 (wired together)	 1-2 1-7 1-2, 1-7

TABLE 6-1 (Cont.)

COMPOSITE STRAPPING OPTIONS

PART NUMBER	UNIT NOMENCLATURE	FUNCTION	STRAP
302SS01B 302SS01C	Span Switch Unit	Remote Looping Enable Disable Bipolar Violation Rate* 10^{-3} 10^{-4} NORMAL 10^{-5} 10^{-6} *Use a threshold of 10^{-4} when a span switch unit is used in conjunction with a voice terminal. Use a threshold of 10^{-6} when a span switch unit is used with a data terminal.	 (F) X Y B–D (F) A–D B–C A–C
303RU01B 303RU02B	Repeater Units (AT&T—T 238 and 239 equivalents, respectively)	Bidirectional (One-Cable) Operation Lynch Option A AT&T—T 238A/239A Option	H–B J–A 5–6 7–8 1–2 3–4
		Unidirectional (Two-Cable) Operation Lynch Option B AT&T—T 238B/239B Option	H–J B–A 5–1 6–2 7–3 8–4
		Unidirectional (Two-Cable) with Spatial Frogging Lynch Option C ***Note:*** There is no 238/239 equivalent to Option C.	H–B J–A 5–1 6–2 7–2 8–4
		Simplex Power Feed Looped POWR LOOP RPTR Through ALL THE REST	 E–F C–D E–D F–C
		Fault Locating Option with Side 1 and Side 2 fault line connected together Fault Locating Option with Side 1 and Side 2 connected for separate output NORMAL	10–11 (F) 11–12