

FIBER OPTIC DS-2 EXTENSION (FOX-2) UNIT
THEORY OF OPERATION

1. GENERAL

- 1.01 This section is a cover sheet for the Telco Systems Fiber Optics Corporation Fiber Optic DS-2 Extension (FOX-2) Unit Theory of Operation. This section is reproduced with permission of Telco Systems Fiber Optics Corporation and is the equivalent of Telco practice 829-100-002, Issue 2.
- 1.02 Whenever this section is reissued the reason(s) for reissue will be listed in this paragraph.
- 1.03 This section presents a functional description of the Fiber Optic DS-2 Extension (FOX-2) Unit.
- 1.04 If corrections are required in the attached document, use Form-3973 as described in Section 000-010-015.
- 1.05 If equipment design and/or manufacturing problems should occur, refer to Section SW 010-522-906 for procedures on filing an Engineering complaint.

2. ORDERING PROCEDURE

- 2.01 For information concerning equipment and parts availability contact Telco Systems, Order Administration Department, in Norwood, Massachusetts, at:

1-800-44-SALES
1-617-551-0300

- 2.02 To order additional copies of this practice, use TELC 365-407-846SW as the section number.

3. REPAIR/RETURN

- 3.01 For defective modules and assemblies contact the Repair and Return Department at the following number:

8:00 a.m. - 5:00 p.m. (617) 551-0300 - Ext. 2778

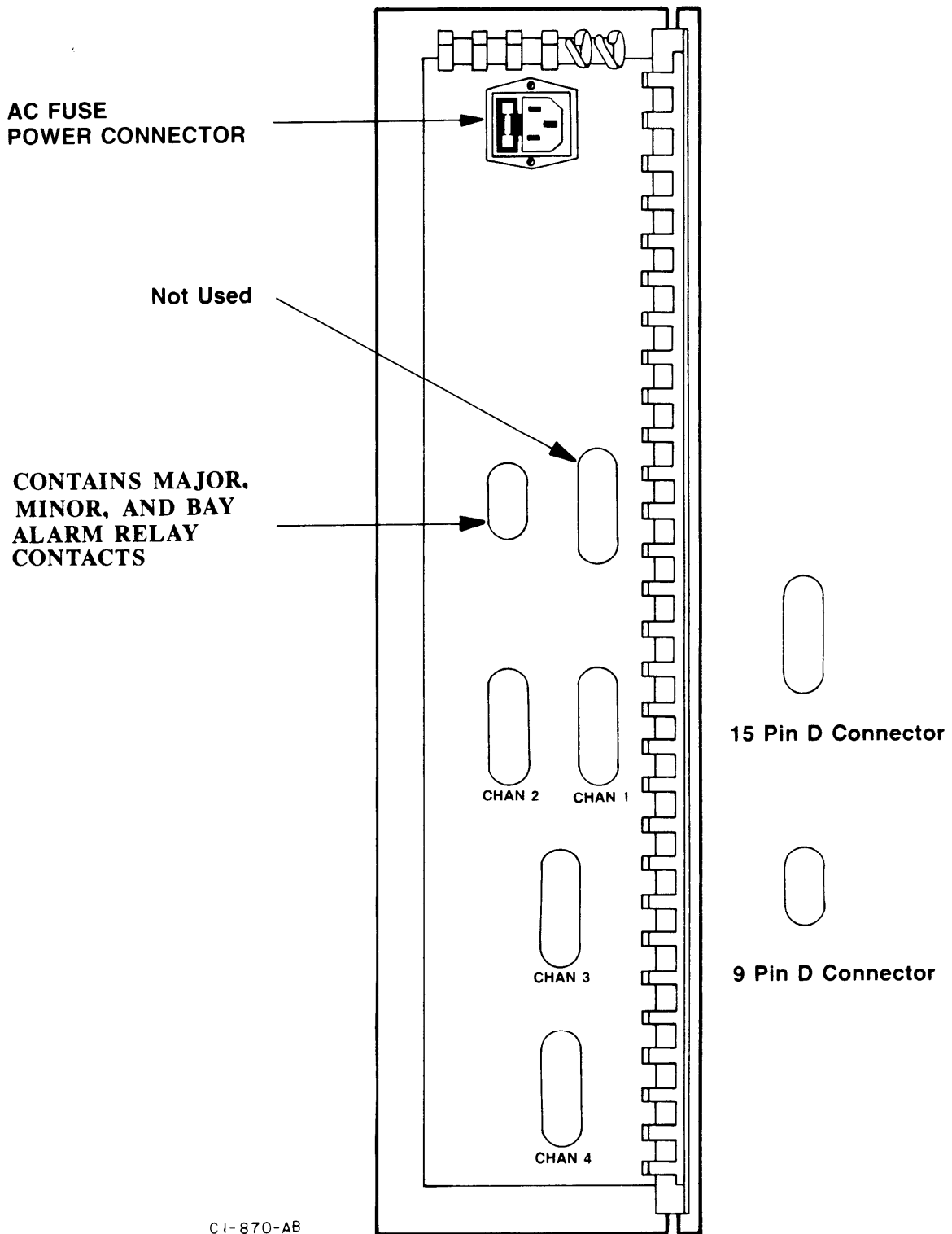
Attachment: Telco Systems Fiber Optics Corporation
Fiber Optic DS-2 Extension (FOX-2) Unit
Theory of Operation

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FIBER OPTIC DS-2 EXTENSION (FOX-2) UNIT
 THEORY OF OPERATION

CONTENTS	PAGE	2. FUNCTIONAL DESCRIPTION
1. SCOPE	1	A. General
2. FUNCTIONAL DESCRIPTION	1	1. Mechanical Detail
A. General	1	2.01 The FOX-2 is a wall-mounted, customer premise unit. The cabinet is 15 3/4 inches (402 mm) wide, 23 1/2 inches (600 mm) high and 6 1/4 inches (161 mm) deep. The unit weighs approximately 35 lbs. (77.18 kg.) fully equipped.
1. Mechanical Detail	1	
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Unit Block Diagram	6	2.02 The unit is divided into 2 sections. The main portion houses the circuit cards, fiber entry and fiber storage. This section has 2 keyed locks for security. The front cover has 2 status indicator LEDs: a green POWER ON and a red UNIT FAULT. The second section protects the interconnection points to the unit. The ac power outlet, T1 connectors and alarm cable connections are behind this hinged cover.
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829-100-002A Power Supply Card		
829-100-002B MPU Card		
829-100-002C MAIN/STBY LTU Card		
829-100-002D T1 LS Interface Card		
829-100-002E T1C LS Interface Card		
1. SCOPE		2.03 The unit provides a bottom and top removable plate for feeding fiber cable into the unit. A cable retainer is available for storage of excess fiber patchcords or pigtailed. Fiber cables are then brought to the front of the LTU card with an FC connector.
1.01 This section presents a functional description of the FOX-2. Further detailed description of the circuit cards are presented in succeeding subsections of this manual.		2.04 The T1 or T1C interfaces to the FOX-2 via 15 pin D connectors on the connector panel. See Figure 1 for a view of connector panel. Connectors labeled CHAN 1 through CHAN 4 are used to interface T1 signals, while connectors CHAN 1 and CHAN 2 are used for T1C signals. See Section 5, the Installation Section 829-100-005 TABLE C for the signal pin-out of connectors. Section 3, Parts List and
1.02 This section was reissued to add new information.		



C I-870-AB

Figure 1. Connector Panel Diagram

Ordering Section (829-100-003) provides part numbers for cables with a connector on one end and a free end for wire wrapping.

2.05 The local alarms connector, a nine pin D type connector on the connector panel, interfaces to Local office alarms of BAY, MAJOR and MINOR alarms.

2. Circuit Cards

2.06 The FOX-2 has optional unit configurations. The first is a choice of two different LS interface cards, T1 (1.544 Mb/s) or T1C (3.152 Mb/s) LS interface. The second option is a redundant optical path. This is done by using two LTU cards, STBY LTU card and MAIN LTU card. Both LTU cards are electrically identical, but the components are mounted on opposite sides. The STBY LTU mounts in a slot at the left side of the middle shelf, while the MAIN LTU mounts in a slot at the right side of the middle shelf. Traffic is bridged onto both LTU cards while one is on-line and the other off-line.

Below is a list of the FOX-2
Circuit Cards

1. CCA150G1: 117 Vac Power Supply (PS) Card
2. CCA002G5: Control Micro-processor (MPU) Card
3. CCA148G1: Main Light Terminal Unit (LTU) Card
4. CCA149G1: Standby Light Terminal Unit (LTU) Card
5. CCA050G1: T1 LS Interface Card
6. CCA124G1: T1 LS Interface Card (All zero's)
7. CCA006G1: T1C LS Interface Card
8. CCA058G1E: Maintenance Interface (MIC) card for T1 LS Interface card, or T1C LS Interface card, and MPU card replacement.

3. Redundancy

2.07 The FOX-2 unit requires two LTU cards, for optical path redundancy. Each LTU card has two FC optical connectors, one transmit and one receive. A fully redundant system would require four optical fibers.

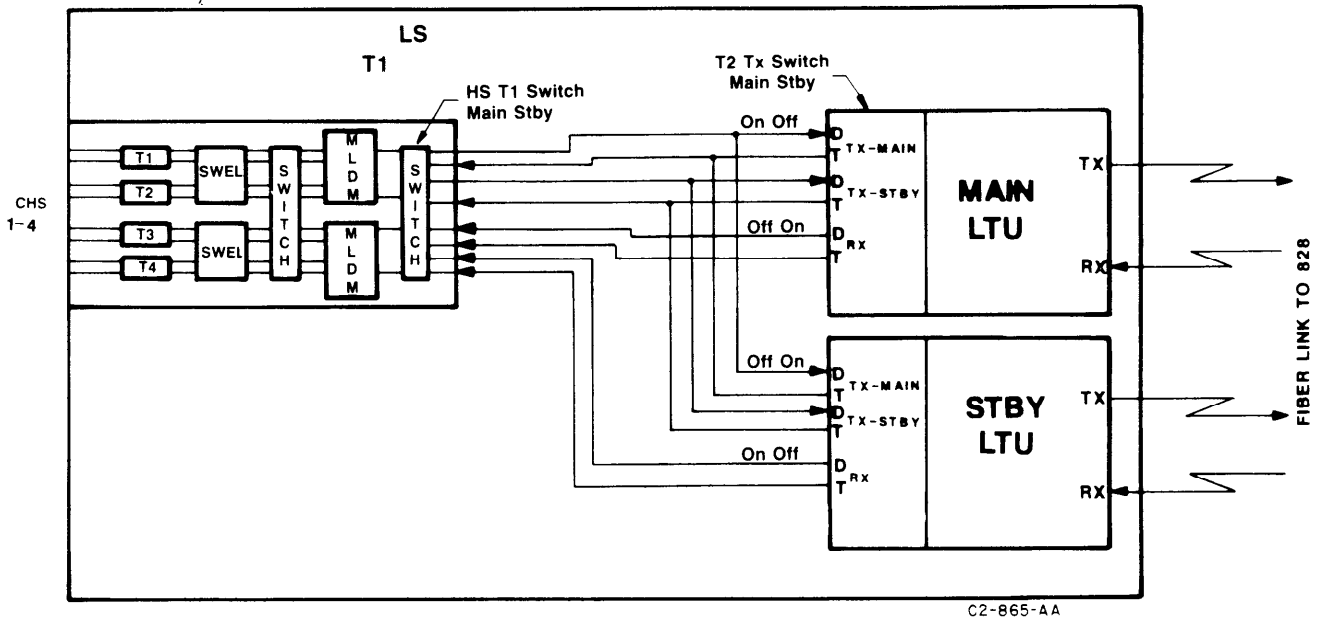
2.08 Low-speed redundancy is accomplished at the multiplexing level. Main and standby muldems are on each low-speed card to protect the signal once it is at the DS-2 level.

2.09 See Figure 2a and 2b for redundant signal paths inside the FOX-2. Internal traffic path selection and control are performed by the MPU card. The MPU selects main or standby LTU receiver DS-2 clock and data inputs, for use by the LS Interface card. The MPU illuminates a green ON LINE LED on the LTU card carrying the traffic. This LTU card also provides the master clock. This clock is used for the transmit data from the LS Interface card to the LTU transmitter. Main or standby DS-2 paths on the LS card can be selected to multiplex and demultiplex the signal. This effectively provides main and standby LS receiver paths, and main and standby LS Transmitter paths. While the main and standby HS paths use separate fibers, the MAIN and STBY LS paths are internal to the LS Interface card.

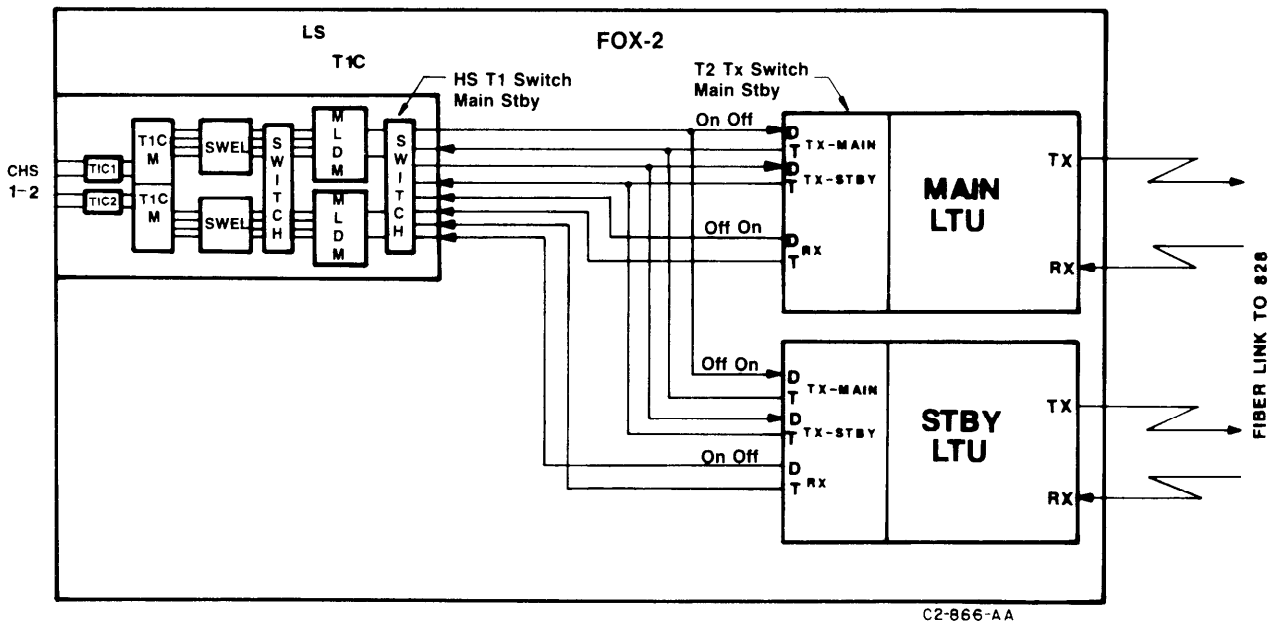
2.10 There is only one 117 Vac Power Supply card. There is no redundancy to the power supply system.

4. Fault Detection

2.11 The FOX-2 has an internal fault detection system. Each card has circuitry that detects defects in the operation of the card and outputs a signal to the backplane. The MPU monitors these signals, and uses the information to control switching.



T1 LS Interface
 Figure 2a. FOX-2 Units System Block Diagram



T1C LS Interface
 Figure 2b. FOX-2 Units System Block Diagram

2.12 The MPU also sends signals to the cards to illuminate or extinguish LEDs located on the cards, to provide a visual indication of a fault. See Figure 3 for a view of the front of all cards' LEDs and switches. This feature is used by the MPU to test all the LEDs, by illuminating them whenever the MPU performs a reset cycle.

2.13 Fault reporting is not limited to the LEDs on the circuit cards. There are two LEDs on the front cover of the FOX-2 unit. One is green and indicates locally that the FOX-2 is powered on. The other is red and indicates that the FOX-2 has a unit fault. These LEDs are driven by the Power Supply card, but commanded by the MPU card. On the connector panel, J6 provides a local alarm interface. These relays are located on the MPU card, and the contacts are isolated.

Note: MAJOR and MINOR return through the COMM connection while the BAY alarm returns through ground. See Figure 4.

2.14 When there is a failure in a FOX-2, the MPU card sets the spare bit in the DS-2 pattern to a one. This spare bit is referred to as the Overhead Bit or Overhead channel. This is detected at the other end of the FOX-2 system by the LTU card. When the remote end is another FOX-2, its' MPU will illuminate the yellow REMOTE FAIL LED on its LS INTERFACE card. When the other end is an 828 multiplexer, the LTU card illuminates the yellow EXTENDED REMOTE FAIL LED on the corresponding LTU Card in the 828 multiplexer.

2.15 The fault system also provides a manual testing system to establish correct illumination of LEDs, activation of local alarms, and protective switching. This testing

system is composed of FAULT TEST LINKS located on cards. When these links are shorted, the MPU detects an indication of a fault even though the fault does not exist. The MPU will respond as though a real fault had occurred and illuminate LEDs, command switches, and activate local alarms as required. The Initial Operation Section Fault Test Procedures (829-100-006C) tests these features.

2.16 The redundant paths of the FOX-2 are under MPU control. The MPU has an AUTO/MAIN/STBY switch on the front edge on the card. This switch can lock out the Automatic Protective Switching mode of the FOX-2 and lock the signal into a main or a standby signal path. This feature is useful for maintenance and testing operations.

2.17 The FOX-2 also offers a manually commanded DS-2 loopback. This is controlled from the Power Supply card. A rotary selector switch with selection numbers from 0 to 9 is used to select the local command. This command is activated by switching the LOOPBACK ENABLE switch on the Power Supply card to on (down) position. This is not a hardware function. The selector and switch load resistors are read by the MPU, the MPU then commands the loopbacks to take place.

The CCA002G5 MPU software only responds to two commands.

- 1 = Initiate DS-2 loopback
- 8 = Remove all loopbacks

2.18 A loopback requires two commands, one to establish it and one to remove it. For each local command, the command is selected while the Loopback Enable switch is in the OFF position (up). The Loopback Enable switch is set down to activate the command. The activated command will stay activated even after the enable

switch is set back up to Off position. To remove the loopback (8), the remove all loopbacks command must be selected and activated with the Enable switch. The Enable switch must again be returned to OFF or up position.

B. System Block Diagram

Unit Block Diagram

2.19 A fully redundant FOX-2 has separate main and standby traffic paths. There is a manual switch on the MPU card, which can be placed on automatic - allowing the MPU to select the transmission path, or it can select the main or standby traffic path. When traffic is manually selected, it is locked in for all cards. When set to STBY, the traffic uses standby circuits on LTU cards and LS Interface card. The automatic function can select different paths on different cards.

2.20 Block diagram 2a and 2b, notice the main and standby path receive signals from the LTU cards are both available to the input switch of the LS Interface card. This switch can select which input it will use. The transmit signal, or the DS-2 path from the LS Interface card to the LTU card is paralleled and sent to both LTU cards. Both LTU cards are always transmitting the same signal, and using the transmit clock from the ON LINE LTU. Both receivers always receive the optical signal from its associated LTU transmitter, at the remote end. When the LTU card detects a faulty receive signal, it alerts the MPU. The MPU commands the switch at the DS-2 bus side of the LS Interface card to select the good received signal. The MPU toggles the LS switch to STBY from MAIN or to MAIN from STBY.

3. SOFTWARE DESCRIPTION

Software Description with CCA002G5 MPU Card

3.01 The CCA002G5 MPU card software supports the following features:

- Power up diagnostic.
- Power up inventory of cards.
- Power up configuration of circuits.
- Monitors fault indicators from cards.
- Illuminates fault LEDs.
- Activates MINOR and MAJOR local office alarms.
- Activates local office Bay alarms.
- Accepts 1 and 8 commands from Power supply card switches.
- Commands (1) loopback configuration.
- Commands (8) clears loopback configuration.
- Commands traffic protecting switches to LS Interface card and LTU cards.
- Illuminates switch status on LTU cards.
- Loads spare bit in the 12.6 MHZ 3B6B optical signal code format as a one, when a fault is in effect at this unit. This bit is referred to as the Overhead Channel.
- Accepts the Overhead Channel bit from received signal and if a one, illuminates the REMOTE FAIL LED on the LS Interface card.
- When there is a main and standby channel failure, to provide a LS signal, the MPU commands the replacement of the defective signal with an all one pattern or AIS (Alarm Indicating Signal) to alert the remote LS point.

4. DETAILED CARD DESCRIPTIONS

4.01 Separate subsections are included as the last part of this section to describe the functions of the individual circuit cards. Below is a list of the circuit cards described and their subsection numbers.

- 829-100-002A Power Supply Card
- 829-100-002B MPU Card
- 829-100-002C MAIN/STBY LTU Card
- 829-100-002D T1 LS Interface Card
- 829-100-002E T1C LS Interface Card

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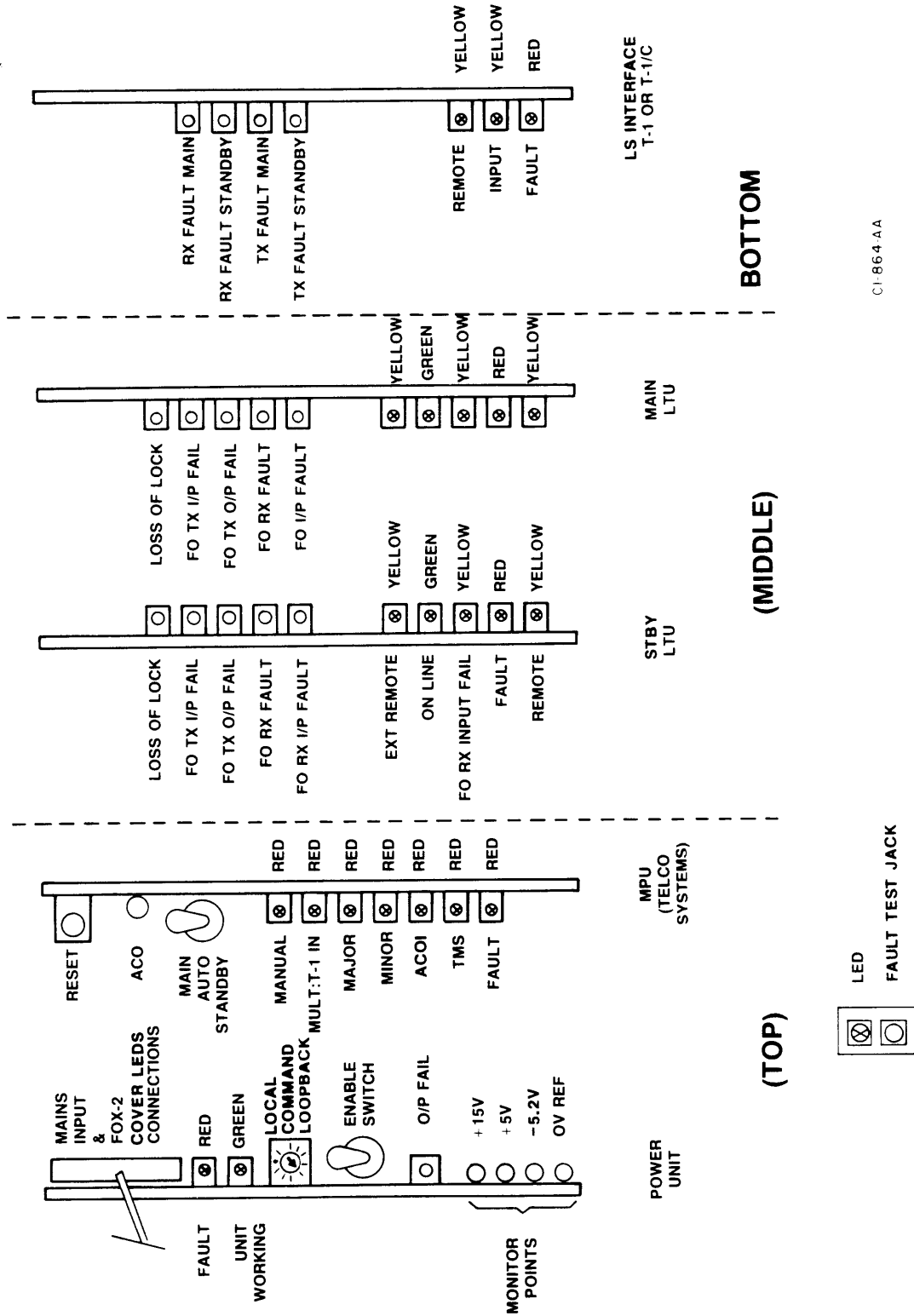
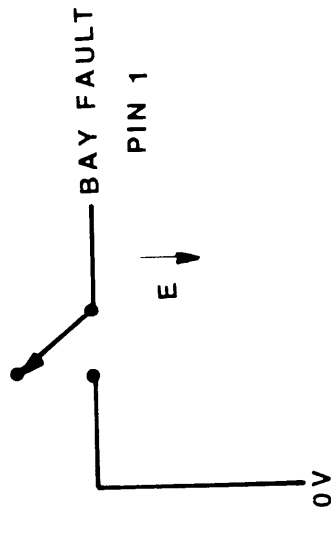
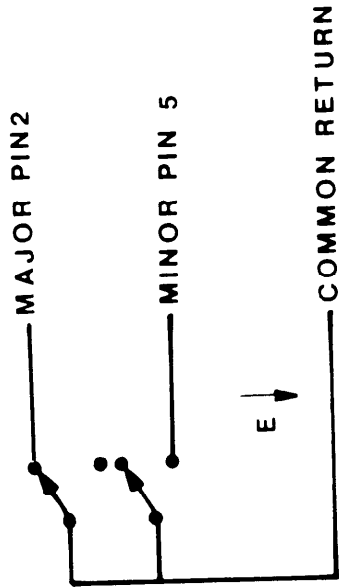


Figure 3. FOX-2 Card Fronts, LEDs and Switches



A2-931-AA

Figure 4. Local Alarm Interface

FIBER OPTIC DS-2 EXTENSION (FOX-2) UNIT
POWER SUPPLY CARD THEORY OF OPERATION
CCA150G1

CONTENTS	PAGE	
1. SCOPE	1	2.03 The Power Supply card monitors its regulated voltages and compares them to an internal manufacturer set standard. It illuminates a green WORKING LED as long as voltages are within 5% of the specified value. When the voltage output is 5% to 10% greater or less than the designated value, the compare circuit illuminates a red FAULT LED, and extinguishes the green RUN LED, on the card. This circuit also will illuminate the Unit Fault LED on the FOX-2 cover.
2. FUNCTIONAL DESCRIPTION	1	2.04 There are eight opto-isolated inputs to a buffer that can be read by the MPU card. This is for future use.
A. General	1	2.05 Four LEDs in the FOX-2 are driven by electronics on this card. Two are on the card, the green Unit Working LED and the red Fault LED. The other two are located on the FOX-2 cover and wired into the ac connector at the top front of the Power Supply card. These are the green Unit On and the red Unit Fault.
B. Block Diagram	2	2.06 There is also a buffer that interfaces the two local command loopback switches to the MPU. The Loopback Select switch is a rotary selector switch with decimal selections 0 through 9. The output of this switch is in BCD code to a buffer. The Loopback Enable switch is a toggle switch. Its position, up or down, controls a bit in the buffer interface to the MPU card. Down signals the MPU to activate the command selected, while up signals a neutral position for the switch and causes no activity by the MPU.
3. POWER SUPPLY CARD TO BACKPLANE SIGNAL DESCRIPTIONS	2	
1. SCOPE		
1.01 This subsection presents a functional description of the Power Supply (PS) card used in the FOX-2. See Figure 1, for views of the Power Supply card. Figure 2 contains a block diagram of the Power Supply card circuits. TABLE A in Section 829-100-002 describes the LEDs and Switches found on the card.		
1.02 This subsection was reissued to add new information.		
2. FUNCTIONAL DESCRIPTION		
A. General		
2.01 The major function of the Power Supply card is the conversion of the 117 Vac office power system to the voltage levels needed for operation of the FOX-2.		
2.02 The voltages supplied by the PS card to the test points on the front of the card are:		
+15 Vdc		
+5 Vdc		
-5.2 Vdc		
0 REF volts (Ground)		

2.07 The MPU interface via the backplane, allows the MPU to communicate with the Power Supply card. The MPU can read the opto-isolated alarm buffer, or the local command input switches. The MPU can control the Unit Alarm and Power On LEDs located on the FOX-2 Cover interfaced via drivers on this card.

B. Block Diagram

2.08 Figure 2 is a block diagram of the Power Supply card. The ac power is shown at the upper left of the block diagram. Here a detector detects the presence of ac current and illuminates the Unit Working LED on the PS card and the Power On LED on the FOX-2 cover.

2.09 The ac is rectified and filtered. A switching circuit working at 100 KHz drives a transformer that outputs the three voltages used in the FOX-2. These voltages are rectified and regulated, then sent to the backplane for distribution through the FOX-2.

2.10 A detector circuit monitors the secondary voltage levels. Whenever any of these voltages changes between 5% and 10%, the circuit will illuminate the Fault LED on the Power Supply card. The status of this circuit is read by the MPU and also illuminates the Unit Fault LED on the FOX-2 cover.

2.11 Address, control, and data lines interface from the backplane to buffers on this card, to interface the MPU communications to the Power Supply card.

3. POWER SUPPLY CARD TO BACKPLANE SIGNAL DESCRIPTIONS

3.01 Figure 3 is a block diagram of the Power Supply card interfacing signals.

3.02 The harness connecting to the connector at the top front of the Power Supply card passes the ac from the ac input connector on the FOX-2 connector panel to the Power Supply card. In addition, the LEDs on the FOX-2 cover interface back to the PS card via this connector.

3.03 Via the backplane, the MPU interfaces with control, address, and data lines. Seven of the eight opto-isolated inputs enter through a 15 pin connector on the connector panel, then to the PS card via the backplane. The remaining, or eighth isolated input is wired from the backplane to the FOX-2 cover closed switch. The CGA002G5 MPU card presently does not interrogate the PS card for the status of these inputs.

3.04 Three voltages and a 0 reference voltage return line interface to the backplane. These are the outputs of the +15 Vdc, +5 Vdc and -5.2 Vdc voltage regulators.

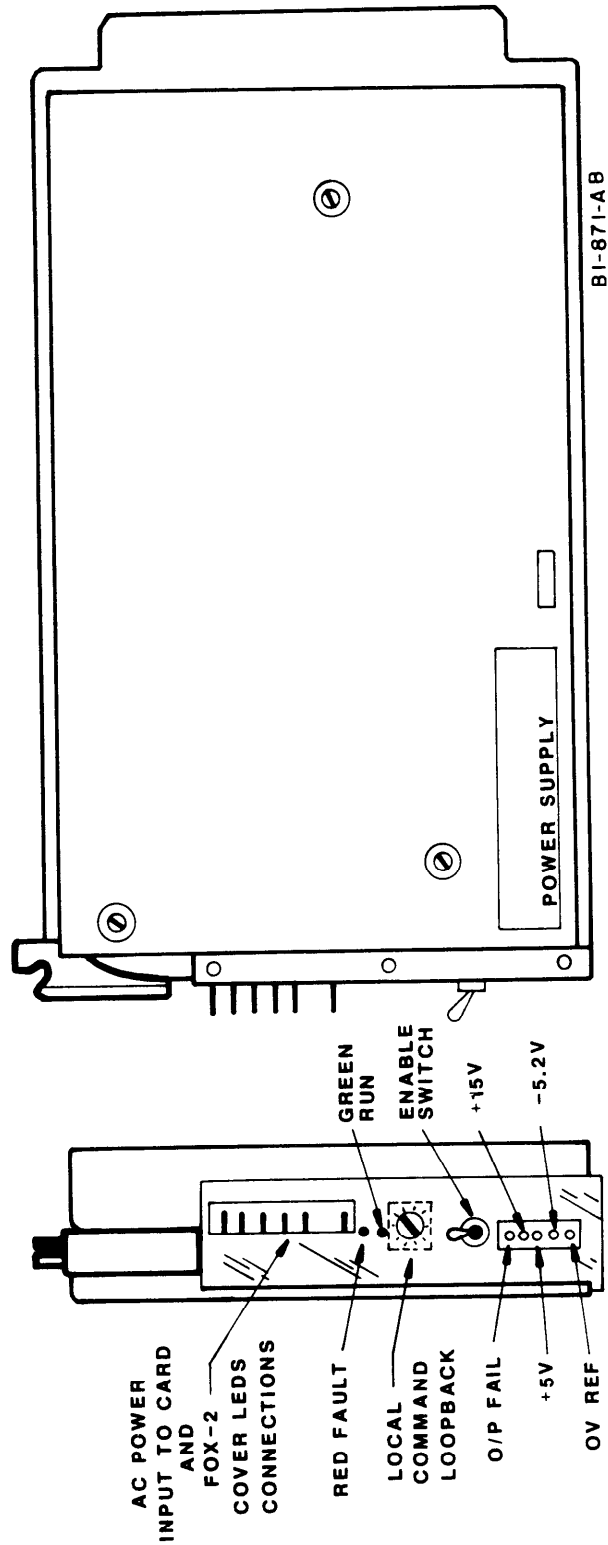
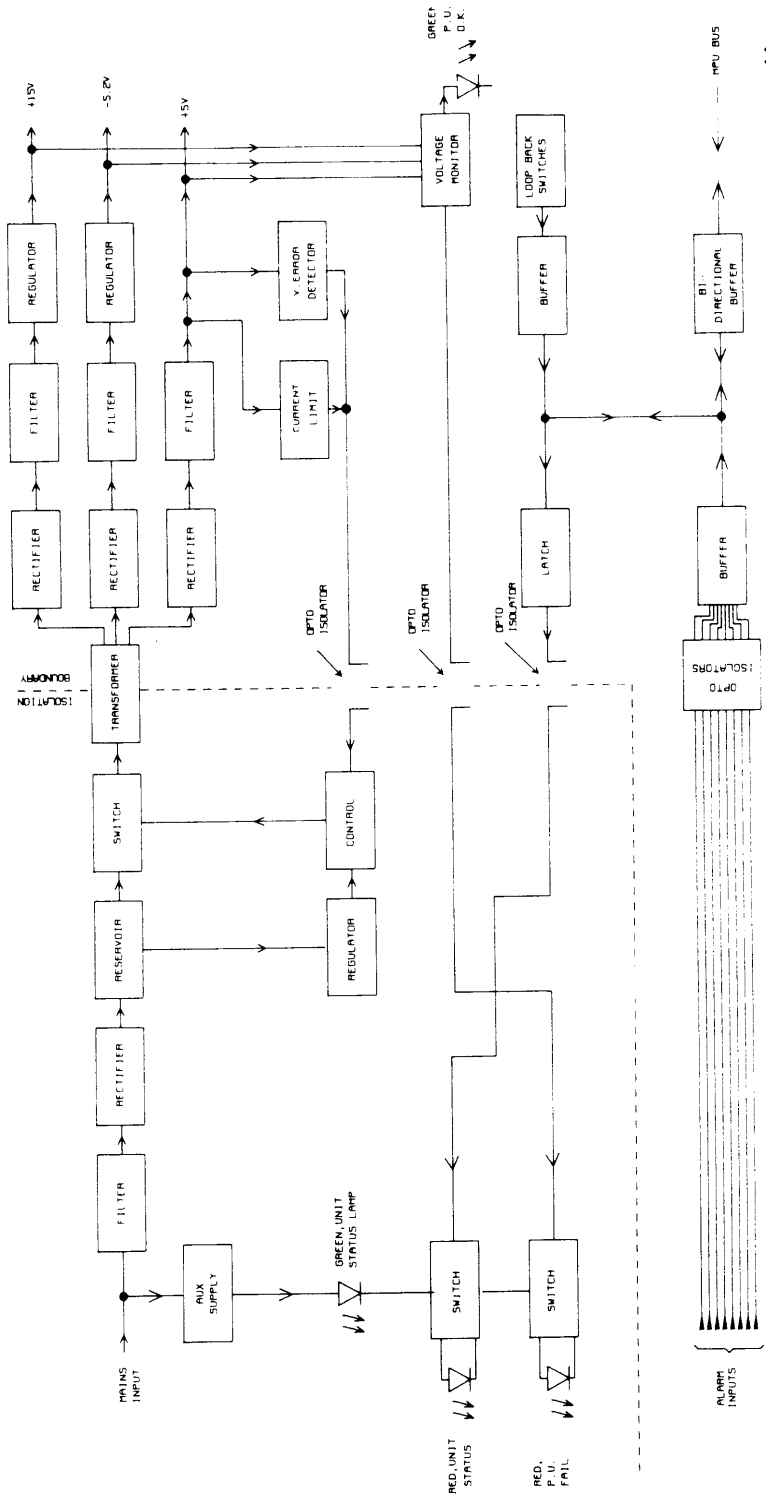


Figure 1. Power Supply Card CCA150G1



C2-879-AA

Figure 2. Power Supply Card CCA150G1 Block Diagram

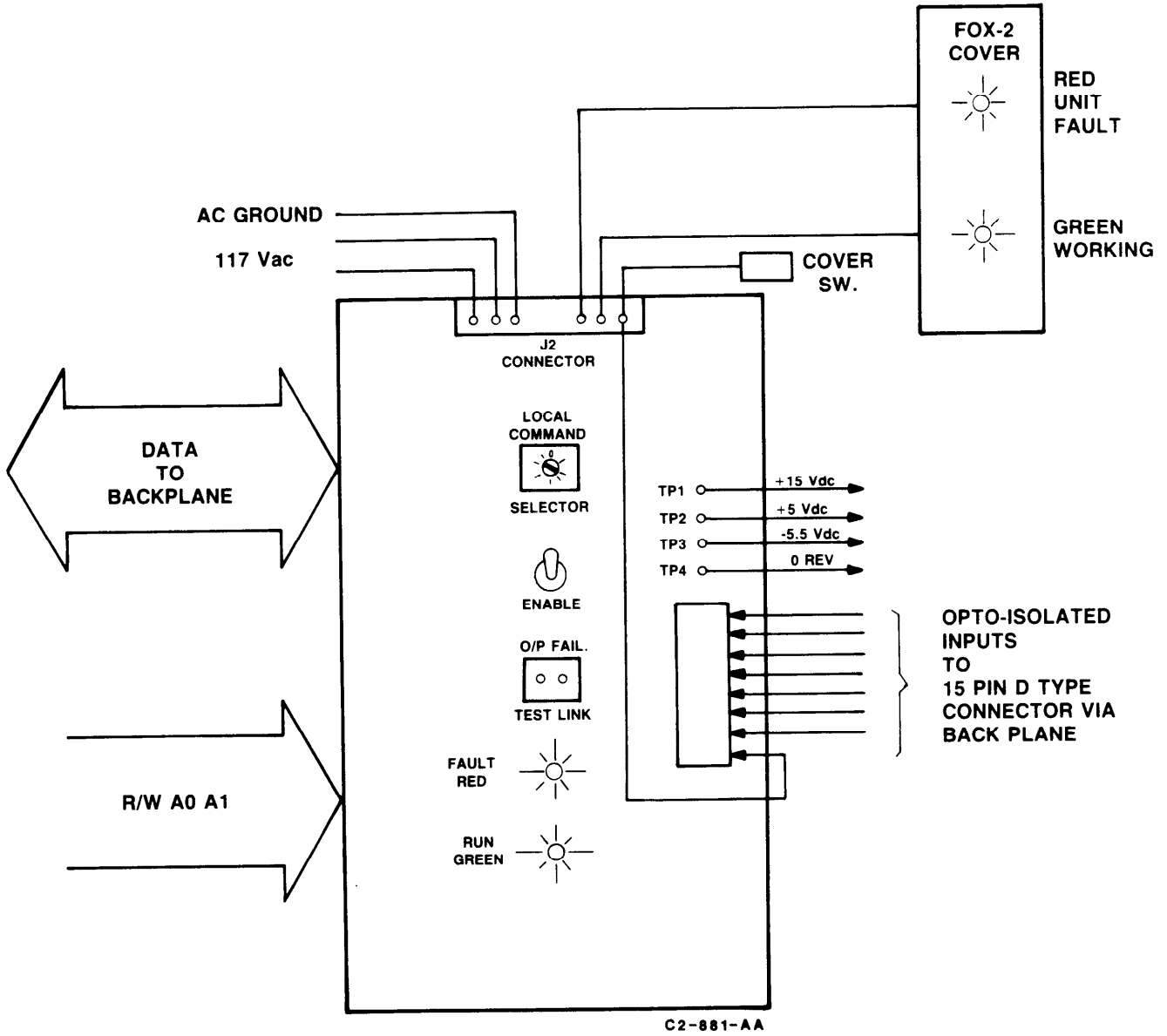


Figure 3. Diagram of Signal Interfaces

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FIBER OPTIC DS-2 EXTENSION (FOX-2) UNIT
CONTROL MPU CARD THEORY OF OPERATIONS CCA002G5

CONTENTS	PAGE	
1. SCOPE	1	- MINOR - illuminates (red) when a non-traffic-affecting fault exists in the FOX-2.
2. FUNCTIONAL DESCRIPTION	1	- FAULT - illuminates (red) when a fault exists in the Control MPU card.
A. General	1	
B. Block Diagram	3	
1. SCOPE		- MANUAL - illuminates (red) when the multiplexer has been switched manually by the MAIN/AUTO/STBY switch on the MPU.
1.01 This subsection presents a functional description of the Control Microprocessor (MPU) card, used in the FOX-2. See Figure 1, for views of the Control MPU card. Figure 2 contains a block diagram of the Control MPU card circuits. TABLE A describes the LEDs and Switches found on the card.		- ACOI - illuminates (red) when the alarm cut-off function is enabled.
1.02 This subsection was reissued to add new information.		- MULT T1 IN - illuminates (red) when more than one T1 or at least one T1C is faulty.
2. FUNCTIONAL DESCRIPTION		- TMS - monitors high-speed switchings status. Indicates that four or more automatic high-speed switches have occurred within a given 10 minute period at the LTU card.
A. General		2.03 There are three switches located on the front edge of the MPU card. They are:
2.01 The CCA002 Control MPU card is also used in the 828 multiplexer equipment. There are many G levels for this card, all referring to the software contained in the PROM on the card. The FOX-2 uses a G5 level software, so the P/N of the card is CCA002G5.		- MAIN/AUTO/STBY switch - A three position toggle switch for manually switching the LTU cards or the Main or Standby low-speed path in the LS Interface cards.
2.02 There are seven red LEDs on the MPU card front edge. They are:		- ACO button - a momentary contact pushbutton switch for disabling the <u>current</u> fault condition(s) from initiating local and remote bay alarms. However, new fault conditions are recognized.
- MAJOR - illuminates (red) when a traffic-affecting fault exists in the FOX-2.		- RESET switch - a momentary push-button switch used to reinitialize the microprocessor.

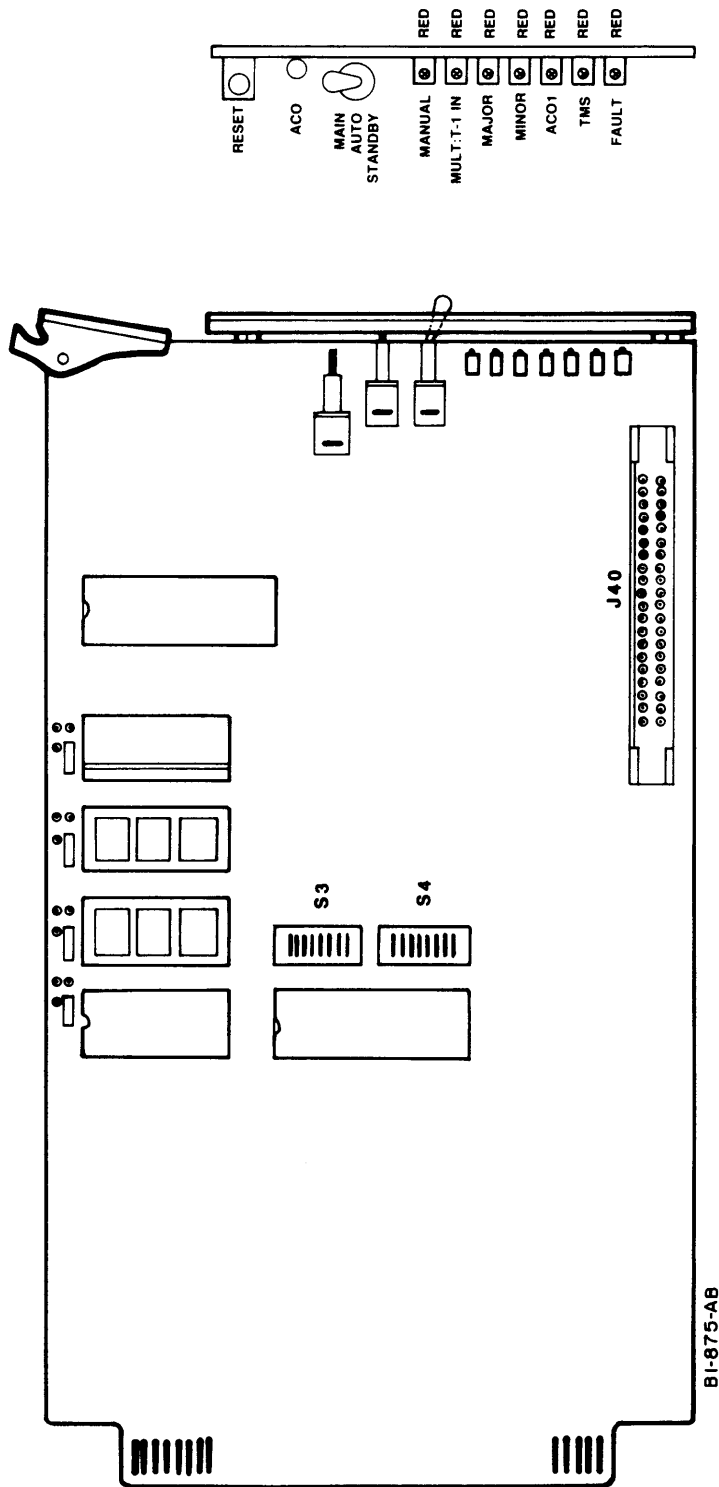


Figure 1. MPU Card CCA002G5

2.04 The Microprocessor performs a power up diagnostic. This tests all LEDs, and features of the System. The MPU then configures cards as required and takes a system inventory. The MPU performs the following operational software functions:

Keeps track of faults detected on all cards.

Illuminates and extinguishes fault and status LEDs as required on all cards.

Establishes overhead bit communications for remote alarm reporting.

2.05 The MPU hardware features are:

Watch-dog timing to restart program if a microprocessor lock up should occur.

Three 8K blocks of ROM memory for the Software.

A dual UART (Universal Asynchronous Receiver Transmitter) for serial communications from the MPU card. This is used for overhead bit communications.

Uses a Motorola 6809 MPU chip.

2K of dynamic RAM to hold the dynamic activity of the software being processed.

Relay interface for local alarm reporting.

A latch to control the MPU LEDs.

A parallel interface adapter chip allows latchable bidirectional high speed data movement in the system.

B. Block Diagram

2.06 Figure 2 is the block diagram of the MPU card. The MPU is buffered to two bus structure, an address bus, and a data bus. These bus structures are buffered out to the backplane from the MPU card, allowing the MPU to address individual cards in the system as it addresses its own on the MPU card memory. The Address bus has eight bits of address power, but only A0, A1 and A6 are extended to the backplane bus.

2.07 Six of the LEDs on the MPU card front edge are controlled via a latch. The remaining one, (FAULT LED) is controlled by the Watch-dog counter and its latch.

2.08 A dual UART interfaces the MPU bus to two serial data lines. One serial line will provide the overhead bit communication carried over the DS-2 optical fiber path. The other serial path would be to a connector interfacing an RS-422 communications path to a monitoring system like TELTRAC. This is not implemented in the FOX-2.

2.09 There is also a Parallel Interface Adapter (PIA) or Versatile Interface Adapter (VIA) that can provide a latching control signal bus to other cards in the system. This bus can be used for internal alarm reporting to the MPU from the cards in the system.

2.10 A watch-dog timer on the Control MPU card monitors system performance. This timer must be reset every 200ms by software control. If the timer does not reset automatically within 200ms, the FAULT LED on the front of the Control MPU card illuminates.

2.11 The Control MPU card is equipped with three 8K bit locations of Read Only Memory (ROM), and one 8K bit location of Random Access Memory (RAM). However, these spaces vary according to customer requirements.

2.12 There is a connector on the MPU card that interfaces to all address, data, and control lines of the microprocessor unit. This is not used in the FOX-2.

2.13 There are two eight pole DIP switches on the Control MPU card. These are read like registers by the microprocessor, and used to store system configuration data. Consult TABLE A for reference to settings.

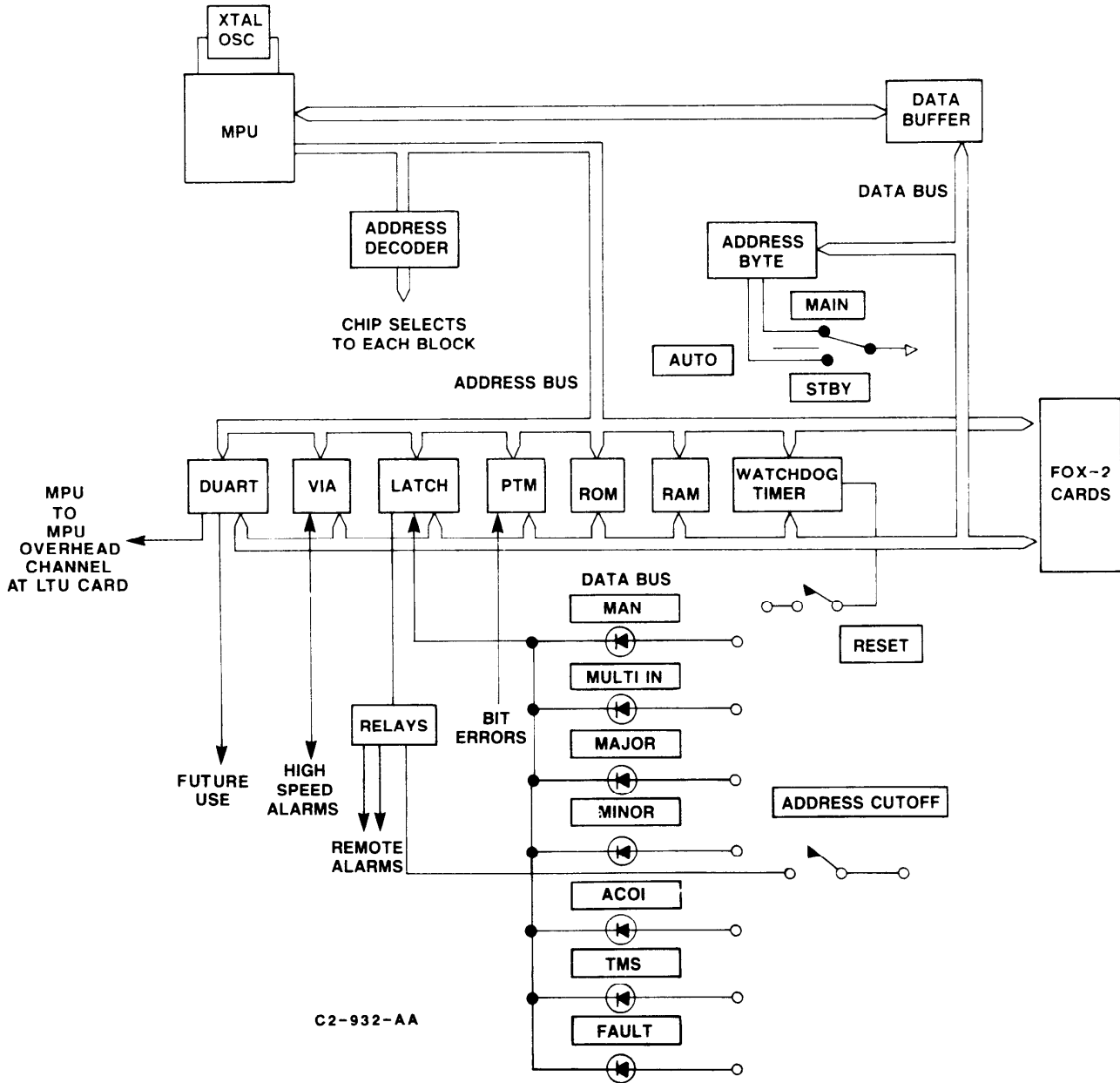


Figure 2. MPU Card CCA002G5 Block Diagram

TABLE A. MPU Card LEDs and Switches
CCA002G5 MPU Card

Type	Color	Identity	Description
LEDs	Red	MANUAL	<p>Front card LEDs listed from top down:</p> <p>Illuminates when automatic switching has been overridden.</p> <p>Illuminates with the loss of more than one T1 signal, or any T1C signal.</p> <p>Illuminates when there is a traffic affecting fault in the FOX-2 unit.</p> <p>Illuminates when a potential traffic affecting fault exists, or alarm reporting faults exist.</p> <p>Illuminates when the Alarm Cut Off (ACO) button has been pressed or Pole 3 of S3 is in the ON position.</p> <p>Illuminates for degraded operation or intermittent high speed failures, causing (Too Many Switches).</p> <p>Illuminates with an MPU FAULT.</p>
	Red	MULT T1 1N	
	Red	MAJOR	
	Red	MINOR	
	Red	ACOI	
	Red	TMS	
	Red	FAULT	
SWITCHES		RESET	At the top of the card, there is a reset button, this button will reset the microprocessor with a hard reset, also all resettable cards in the FOX-2 unit.
		ACO	This button will clear standing UNIT FAULT alarm indicators on the cover, and clear MAJOR and MINOR faults on the connector panel. Subsequent alarms will be reported normally. The MAJOR and MINOR LEDs on the MPU card are not affected by the ACO button.

TABLE A. MPU Card LEDs and Switches (Cont.)
CCA002G5 MPU Card

Type	Color	Identity	Description
Switches Cont.		MAIN, AUTO, STANDBY	This switch can set the automatic mode of switching or bypass automatic and manually set traffic to MAIN or STBY paths in the FOX-2 unit.
		DIP SWITCH 3	This switch is used to configure the MPU operation, and contains 8 poles.
		S3 pole 1	Not used in FOX-2
		S3 pole 2	Not used in FOX-2
		S3 pole 3	ON = ACO MODE permanently enabled. OFF = ACO MODE Off alarms normal
		S3 pole 4	Not used in FOX-2
		S3 pole 5	ON = FOX-2 to FOX-2 System OFF = FOX-2 to 828 System
		S3 pole 6	Not used in FOX-2
		S3 pole 7	Not used in FOX-2
		S3 pole 8	Not used in FOX-2
		DIP SWITCH 4	This switch is used to configure the MPU operation, and contains 8 poles.
		S4 pole 1	Not used in FOX-2
		S4 pole 2	Not used in FOX-2
		S4 pole 3	Not used in FOX-2
	S4 pole 4	Not used in FOX-2	
	S4 pole 5	Not used in FOX-2	
	S4 pole 6	Not used in FOX-2	
	S4 pole 7	Not used in FOX-2	
	S4 pole 8	Not used in FOX-2 Set all poles to ON position	
JUMPERS		U6 to J13 U7 to J10 U8 to J7 U9 to J4	The following jumpers are jumpered

FIBER OPTIC DS-2 EXTENSION (FOX-2) UNIT
 MAIN and STBY LIGHT TERMINATING UNITS
 (LTU CARD) CCA148G1/CCA149G1

CONTENTS	PAGE	
1. SCOPE	1	has an optical transmitter and an optical receiver.
2. FUNCTIONAL DESCRIPTION	1	2.03 The LTU transmitter is a Singlemode 1300 nm LED, while the receiver is a 1300 nm PIN diode.
A. General	1	
B. Block Diagram	6	2.04 The 6.312 Mb/s (DS-2) signal is randomized or 3B6B encoded and used to modulate the LED output, producing a 12.624 Mb/s optical signal.
3. LTU CARD TO BACKPLANE SIGNAL DESCRIPTIONS	7	
1. SCOPE		2.05 As with other cards in the FOX-2, the MPU card can communicate with the LTU card via the backplane. The MPU can receive the card fault indications, command LED illumination, and protection switching on the card. An internal electrical loopback of the optical received signal to the optical transmitter can be commanded by the MPU card.
1.01 This subsection presents a functional description of the Light Transmission Units (LTU card), used in the FOX-2. See Figure 1 for views of the LTU card. Figure 2 contains a block diagram of the LTU card circuits. TABLE A describes the LEDs and Switches found on this card.		
1.02 This subsection was reissued to add new information.		2.06 The LTU card contains the 6.312 MHz oscillator used to time the multiplexing operation on the LS Interface card. The demultiplexing operation on the LS Interface card gets its oscillation from the recovered clock at the optical receiver. The selection of the ON LINE card by the MPU is based on the quality of the received optical signal. The MPU will illuminate the ON LINE LED of the LTU selected.
2. FUNCTIONAL DESCRIPTION		
A. General		
2.01 There are two LTU cards, both are identical in terms of circuits, but not in terms of physical layout. The components are mounted so when both the main and standby cards are installed, the components side of the card will face each other. Because of this when the optical fiber pigtails are attached, they will be dressed between the cards.		
2.02 The LTU cards use FC type optical connectors. Each card		

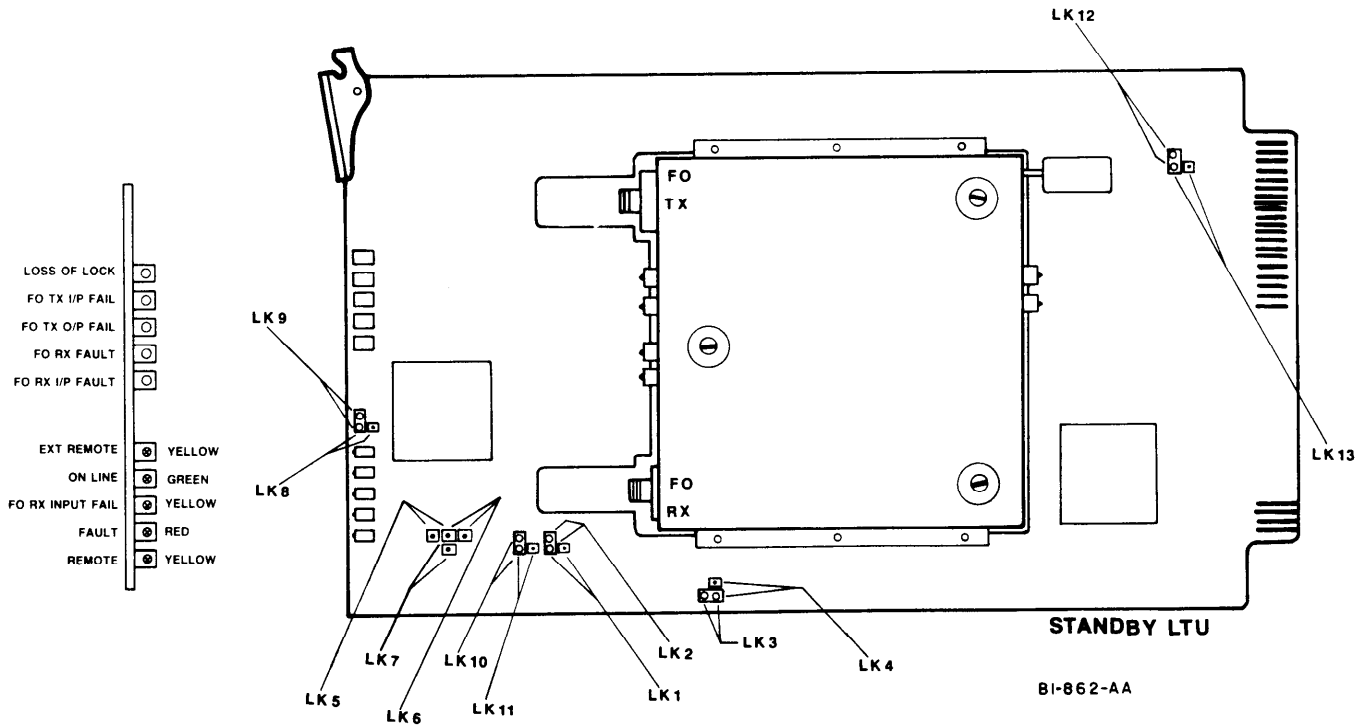
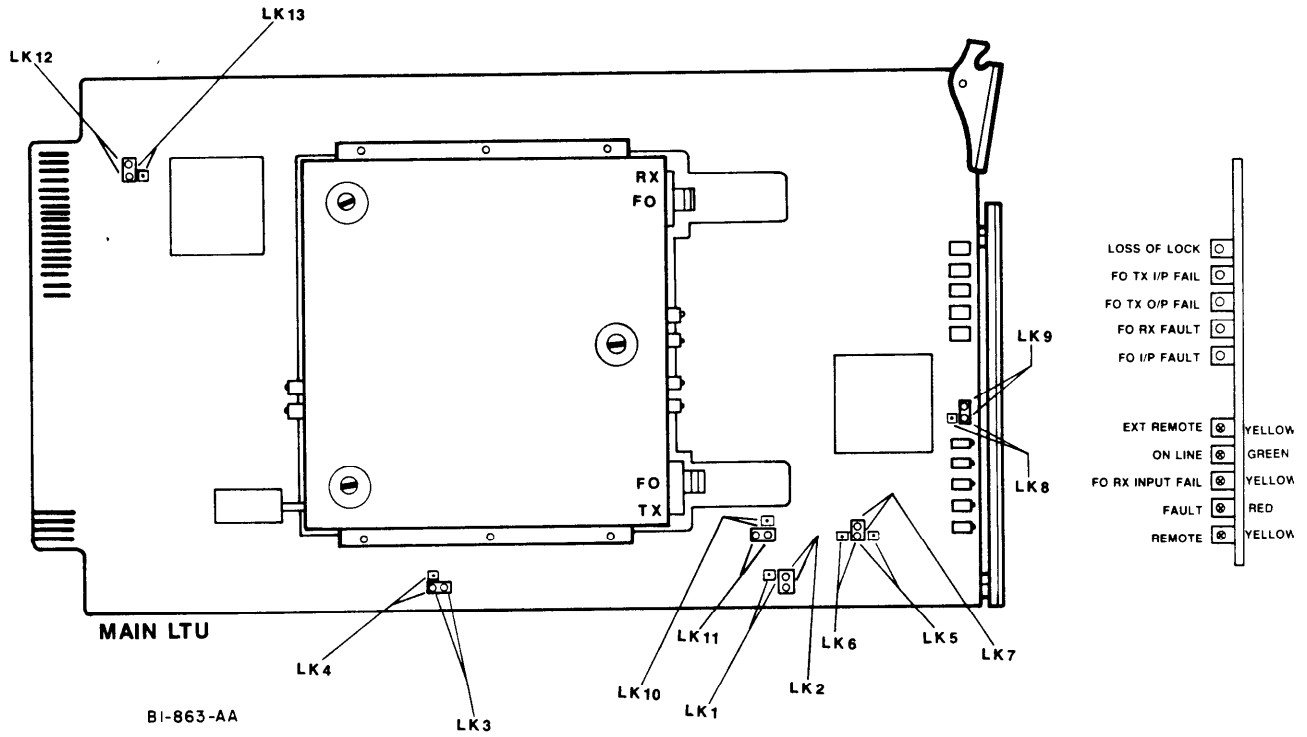


Figure 1. MAIN and STBY LTU Card CCA148G1/CCA149G1

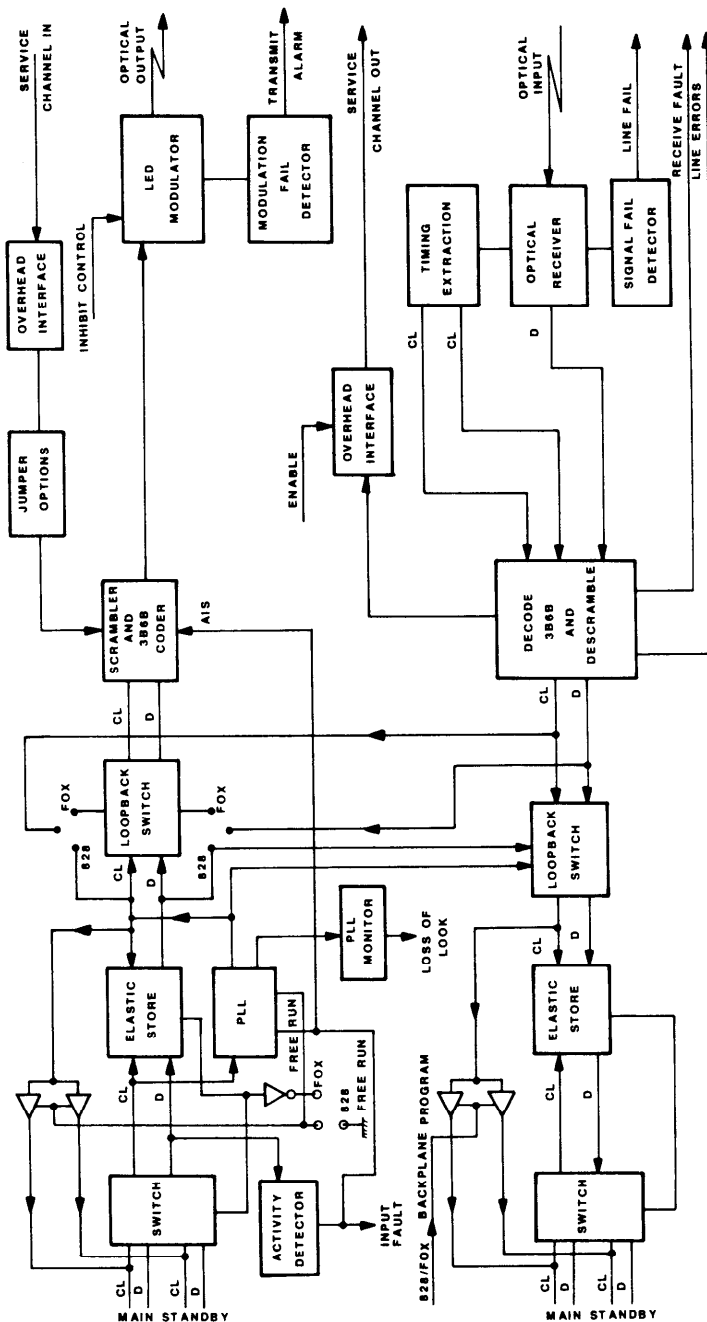


Figure 2. LTU Card CCA148G1/CCA149G1 Block Diagram

TABLE A. MAIN and STBY LTU Card LEDs and Switches
 CCA148G1 MAIN LTU Card
 CCA149G1 STBY LTU Card

Type	Color	Identity	Description
LEDs	Yellow	EXT. REMOTE	Illumination indicates a fault on the remote end of the fiber path, for FOX-2 to 828 non TELTRAC systems. The FOX-2 will toggle the overhead bit high in the DS-2 data stream. The LTU installed at the 828 will recognize this as a fault in the FOX-2, at the remote end of the fiber path.
	Green	ON LINE	Illumination signifies this card is carrying the traffic.
	Yellow	FO RX FAIL	Illumination indicates the fiber optic input has failures on this card. (The Receiver is getting no signal.)
	Red	LTU FAULT	Illumination indicates there has been a fault detected on this LTU card.
	Yellow	REMOTE	Not Used in FOX-2
FAULT TEST JACK			Top Down
	1	Loss of lock	Simulates a loss of lock on optical signal.
	2	FO TX I/P FAIL	Simulates a fiber optic transmitter input failure.
	3	FO TX O/P FAIL	Simulates fiber optic output failure.
	4	FO RX FAULT	Simulates fiber optic receiver failure.
5	FO I/P FAULT	Simulates fiber optic input failure.	

TABLE A. MAIN and STBY LTU Card LEDs and Switches (Cont.)
 CCA148G1 MAIN LTU Card
 CCA149G1 STBY LTU Card

Type	Color	Identity	Description
JUMPERS		LK1 LK2 LK3 LK4 LK5 LK6 LK7 LK8 LK9 LK10 LK11 LK12 LK13	<p>JUMPERS CLOSED CONFIGURE CARD AS FOLLOWS</p> <p>LOOPBACK timing if LTU is in 828M/828F. LOOPBACK timing if LTU is in FOX-2/828A. LOOPBACK CODEC timing if LTU is in FOX-2/828A. LOOPBACK CODEC timing if LTU is in 828M/828F. OHC (overhead channel) remote alarms if used in 828M/828F. Not Implemented (leave open). OHC (overhead channel) activated if in 828A/FOX-2. Extended Remote Alarm active if in 828M/828F. Extended Remote Alarm active if in FOX-2/828A. LOOPBACK DATA if in 828M/828F. LOOPBACK DATA if in FOX-2/828A. if used in FOX-2. if used in 828M/828F/828A.</p> <p>Jumpers for LTU card in FOX unit</p> <p style="padding-left: 40px;">LK2, LK3, LK7, LK9, LK11, LK12 are closed</p> <p>Jumpers for LTU card in 828M/828F Multiplexer unit.</p> <p style="padding-left: 40px;">LK1, LK4, LK5, LK8, LK10, LK13 are closed</p> <p>Jumpers for LTU card in 828A multiplexer unit</p> <p style="padding-left: 40px;">LK2, LK3, LK7, LK9, LK11, LK13 are closed</p>

2.07 Refer to Figure 2, the LTU card block diagram. There are four protection switches located on the LTU card available to the MPU to command. There are two separate switches on the interface to the backplane, that toggle between main and standby backplane paths to the LS Interface card. There is one for transmit signal input to the LTU card, and one for the received signal output from the LTU card. A switch prior to the elastic store and after the decoder of the optical receiver can switch the input to the optical transmitter back to the LS interface card. This will loop the LS signals back to their source. Another loopback switch is located between the elastic store and the decoder at the transmitter to loop the received signal back to the transmitter. This loops the T2 optical signal back to its source.

B. Block Diagram

2.08 Refer to Figure 2, the LTU card block diagram. The area at the upper right is the optical transmitter and the lower right is the optical receiver. To the left is the interface to the backplane.

2.09 Two DS-2 signal paths enter via the backplane from the LS Interface card, main and standby. The switch selects which will be used by the LTU card transmitter. A phase lock loop oscillator provides a clock that is locked against the selected incoming data from the LS interface card. This clock is sent to the LS Interface card, then used as the Multiplexing clock on both the Standby and Main paths. The signal passes through an elastic store, where the data speed is synchronized to the clock. The output is sent to the loopback switch where it can be passed to the scrambler.

2.10 The loopback switch can, on command from the MPU card, select the data just processed by the elastic store, or the data received at the optical receiver to be sent to the scrambler.

2.11 The Scrambler or Randomizer 3B6B encodes the data stream, ensuring a constant changing signal for the LED transmitter. The output of the scrambler is used to modulate the output of the LED transmitter.

2.12 The Randomizer 3B6B encoder takes three bits of DS-2 data and encodes it into five bits, a 6th bit used as an overhead bit is included, bringing the three bit of data to an encode of six bits. The result is a doubling of the data path frequency, from 6.312 Mb/s to 12.624 Mb/s.

2.13 The sixth bit, used in the randomizing process provides the overhead channel, for the signaling of remote faults between the FOX-2 units or FOX-2 and 828 mux units.

2.14 The transmit path through the LTU card has three fault detectors. One at the output of the switch to the Elastic Store circuit, to detect the presence of an input to the transmitter. One at the phase lock loop (PLL), where loss of lock is monitored. The action of the transmit LED modulator is monitored as a modulation failure. These faults are reported to the MPU card and will light a FAULT LED on the LTU card producing them.

2.15 The Receive path is essentially the reverse of the transmit path. A pin diode converts the optical signal to an electrical signal. The receiver extracts the timing component, then the timing and received data are passed to the descrambler or derandomizer.

2.16 The Decoder decodes the 3B6B encoded data back to 6.312 Mb/s data, recovering the overhead data bit. The overhead channel bit is interfaced out to the CCA002G5 Control MPU card. The Control MPU card will interpret the overhead bit, and light the LS REMOTE FAIL LED on the LS Interface card if it is a One.

2.17 The decoded DS-2 data signal and recovered timing are passed to two loopback switches. The loopback switch in the transmit path may select it, for a loopback of the optical data path. The loopback switch in the receive path on command from the MPU may pass the DS-2 data to the elastic store for processing and interface to the LS Interface card. This loopback switch is the one that can loopback the LS signal from the LS Interface card back to the LS interface card.

2.18 The receive path monitors three fault fail points. A signal fail fault detector monitors the receiver, and passes the status to the MPU card. The result is a yellow RX INPUT FAIL LED, indicating no signal received at the optical receiver. Fault fail detectors on the decoder signal receive circuit failures, while receive error detection is signaled on the other. The receive error detection can be used by the MPU to calculate BER.

2.19 There are jumpers placed at various locations on the LTU card. These are to adjust the operation of the LTU card slightly for use in either the FOX-2 or the 828 mux units.

3. LTU CARD TO BACKPLANE SIGNAL DESCRIPTIONS

3.01 Refer to Figure 3, the LTU card signal diagram. There are two classes of interfacing signals, those to the backplane, and those from the card surface itself.

3.02 Interfacing from the card surface, using optical fiber, connects the transmitter and receiver via FC connectors.

3.03 The remote fault signaling system uses two overhead channel connections to the backplane, in and out.

3.04 The backplane also interfaces the fault signals from on board detectors. Transmit Alarm (FO TX O/P FAIL, TX I/P FAIL, and LOSS of LOCK) for transmit detectors, (FO RX I/P FAIL and RX FAIL) for receiver faults. The receive error signal is not used by the CCA002G5 MPU card, since the MPU does not calculate BER nor use it as a criteria for switching.

3.05 The backplane inputs the main and standby DS-2 transmit data paths from the LS Interface card, and interfaces the timing for both paths from the LTU card, to the LS Interface card.

3.06 The backplane also interfaces the recovered DS-2 data from the optical receiver along with its recovered clock. There are two receive paths, main and standby.

3.07 The MPU card interface allows the control MPU to command the loopback switches on the LTU card. See Figure 4 for diagram of loopback paths.

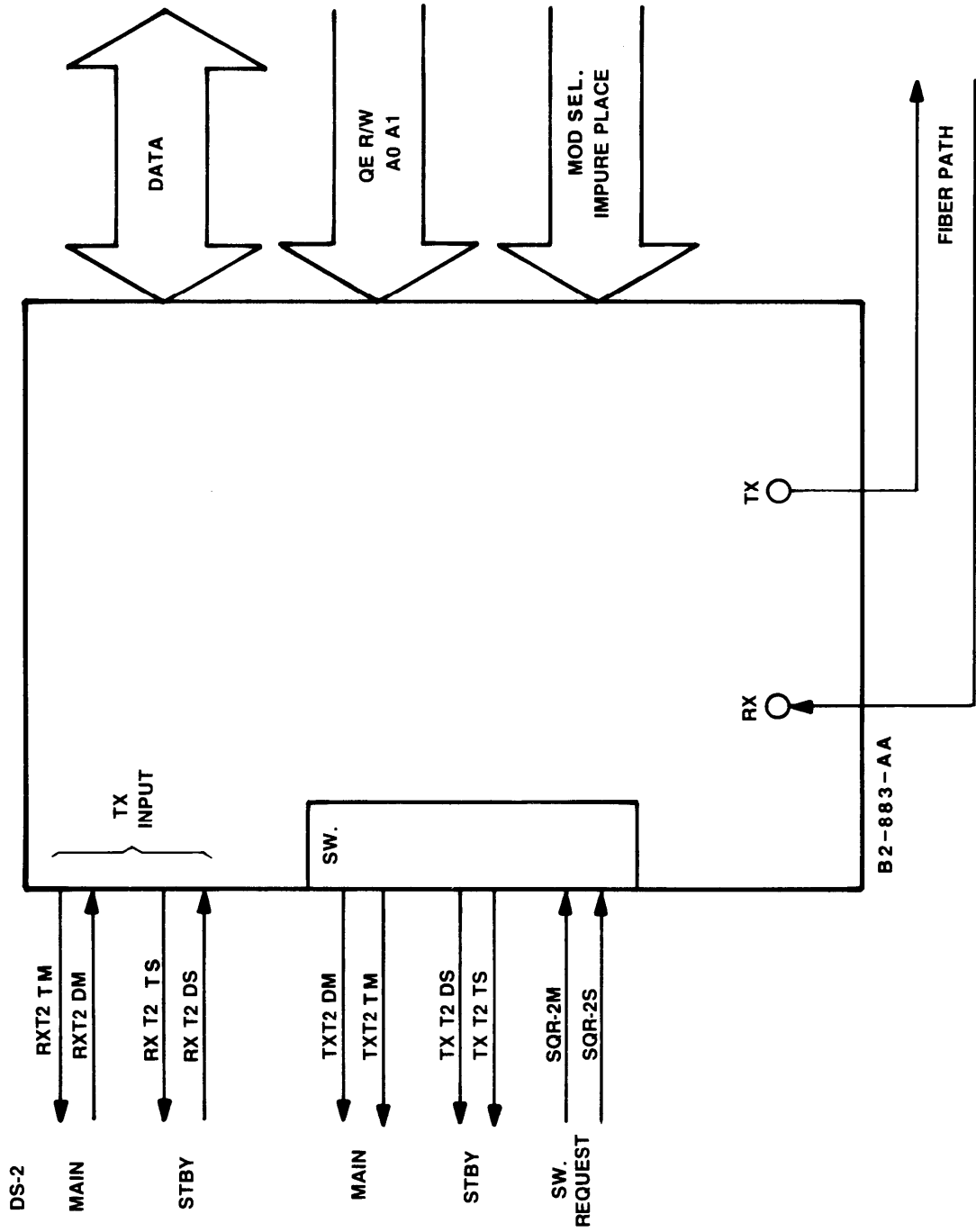


Figure 3. LTU Card Signal Diagram

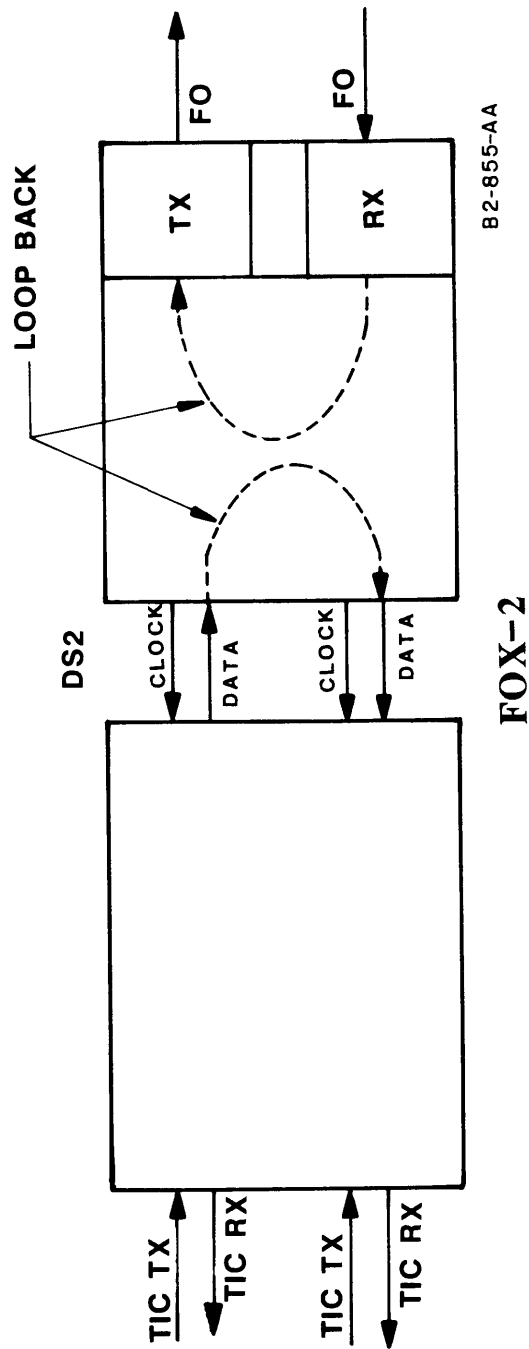


Figure 4. LTU Card Loop Back Diagram

FIBER OPTIC DS-2 EXTENSION (FOX-2) UNIT
T1 LS INTERFACE CARD CCA050G1/CCA124G1

CONTENTS	PAGE
1. SCOPE	1
2. FUNCTIONAL DESCRIPTION	1
A. General	1
1. SCOPE	
1.01 This subsection presents a functional description of the T1 LS Interface cards, used in the FOX-2. See Figures 1 and 1A, for views of the T1 LS Interface card. Figure 2 contains a block diagram of the T1 LS Interface card circuits. TABLE A describes the LEDs and Switches found on this card.	
1.02 This subsection was reissued to add new information.	
2. FUNCTIONAL DESCRIPTION	
A. General	
2.01 The T1 Low-Speed Interface (LS INTER T1) card processes transmit and receive DS-1 signals, and contains redundant transmit and receive circuitry for protection. Only transmit processing is discussed here, since receive is the reverse of transmit. A functional block diagram of the LS INTER T1 card is shown in Figure 2.	
2.02 The bipolar DS-1 (1.544 Mb/s) signals enter the card through the 15 pin connector on the backplane on the FOX-2. These DS-1 signals are applied to the four circuits where bipolar data is converted to unipolar	

data and timing. The signal is then fed to the Switching and Elastic Store (SWEL) circuit where the data rate is monitored to originate pulse stuffing information.

2.03 The four DS-1 signals are then applied to the MAIN and STBY MULDEM (MULTiplexer/DEMultiplexer) circuits. Framing bits, stuff timing, and stuff signaling are added into and multiplexed with the four DS-1 signals into one DS-2 signal. This signal is applied to a switching circuit, contained within the MULDEM circuit. The MULDEM, controlled by the Control MPU card, switches from the MAIN MULDEM circuit to STBY, or vice versa, if a fault occurs.

2.04 The T1 card outputs an All 1s Alarm Indication Signal (AIS) whenever there is a loss of input timing, or the Control MPU card detects a stream of 175 (+75) consecutive 0s. LS INTER T1 card Part Number CCA124 will output all 0s instead of All 1s.

2.05 The MPU Interface provides a data bus to and from the Control MPU card. When the Control MPU card is removed from the FOX-2, the MPU Replace (MPU RPL) signal disables the MPU Interface to prevent transient signals from simulating any commands.

2.06 The LEDs on the front of the LS INTER T1 card and their functions are listed in TABLE A.

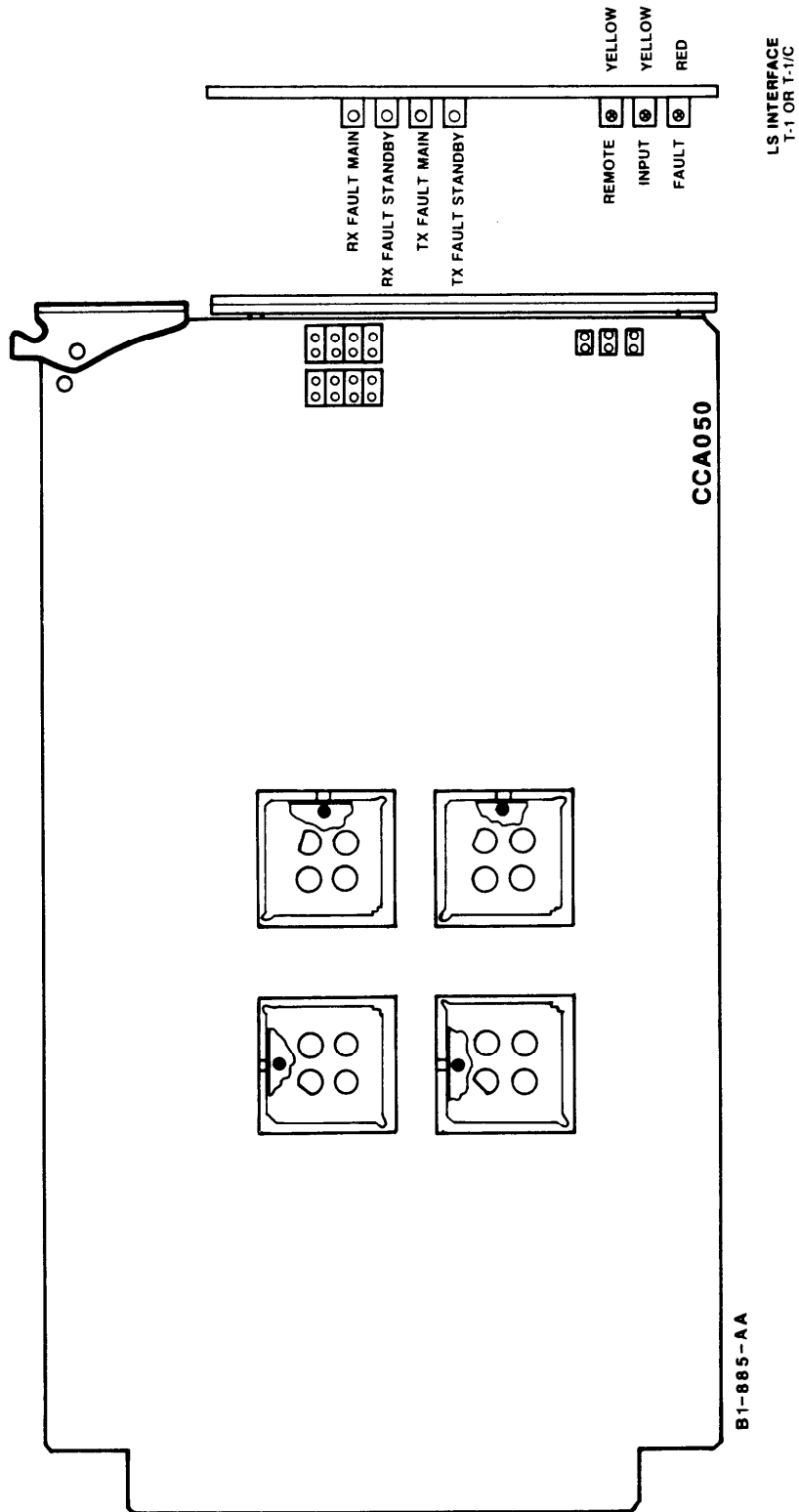


Figure 1. T1 LS Interface Card CCA050G1

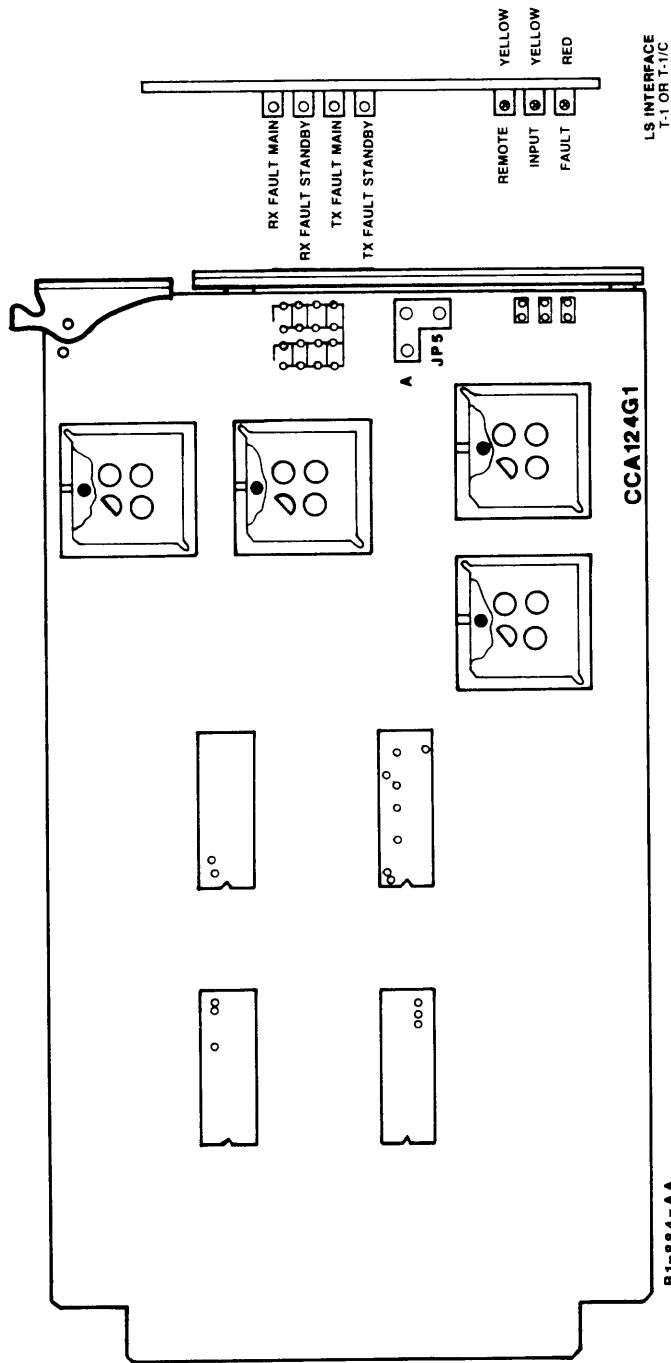


Figure 1a. T1 LS Interface Card CCA124G1

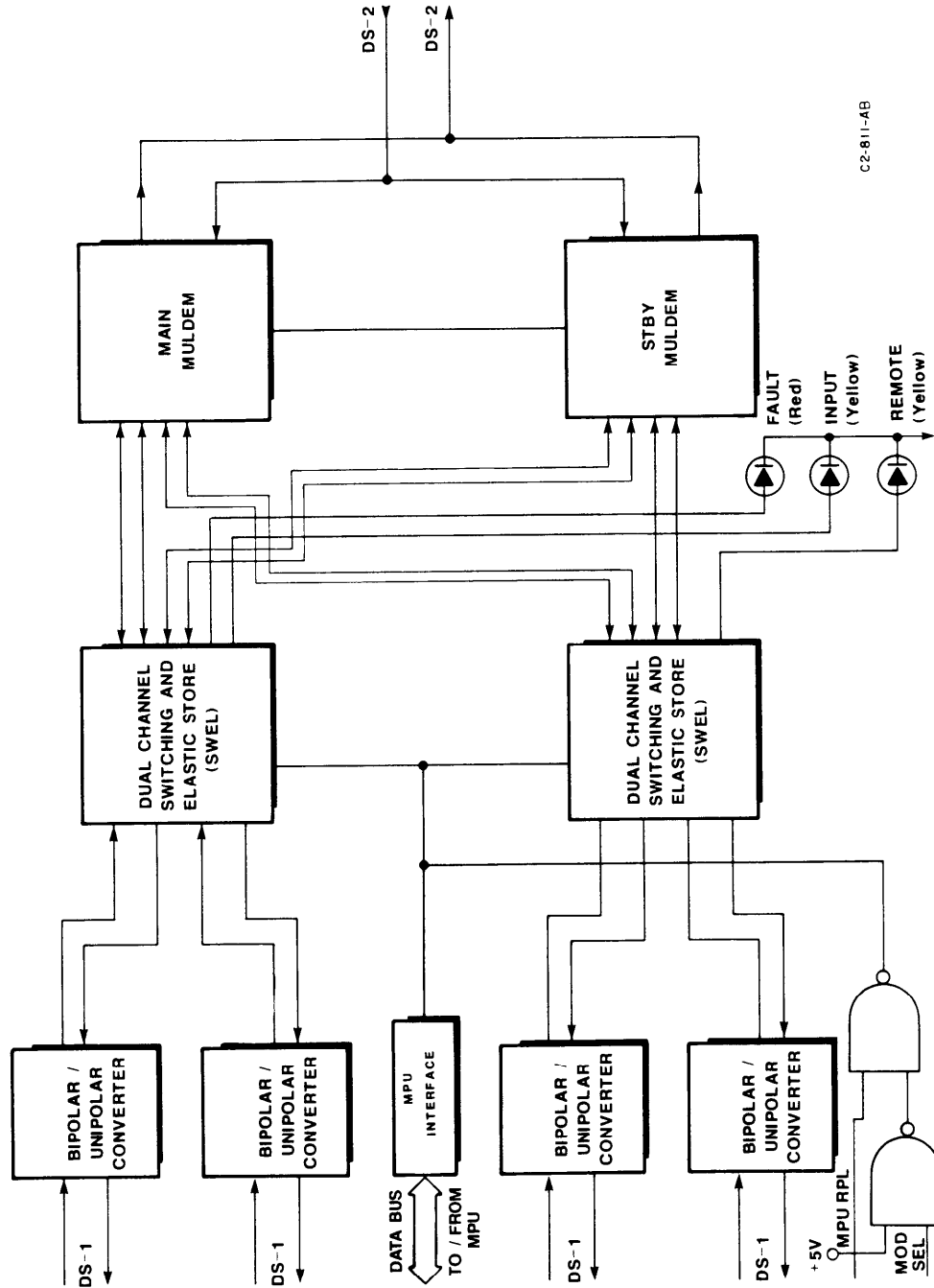


Figure 2. T1 LS Interface Card Block Diagram

TABLE A. T1 Low-Speed Interface Card Indicators

LED INDICATOR	DESCRIPTION OF MONITORED POINT	LED ILLUSTRATION
REMOTE (yellow)	Illuminates when the corresponding Low-Speed Interface card at the far end has a fault.	
INPUT (yellow)	Illuminates when a loss of DS-1 input occurs on the previously functional DS-1 channel associated with the card.	
FAULT (red)	Illuminates when the LS INTER T1 card has a failure.	

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FIBER OPTIC DS-2 EXTENSION (FOX-2) UNIT
T1C LS INTERFACE CARD CCA006G1

CONTENTS	PAGE	
1. SCOPE	1	interface circuits where the Positive (P) and Negative (N) data rails are removed from the DS-1C signals.
2. FUNCTIONAL DESCRIPTION	1	2.03 The DS-1C signals are then fed to a MULDEM circuit, where framing is checked and the DS-1C signal is processed into two DS-1 signals. The two DS-1 signals are then applied to a Switching Elastic Store (SWEL) circuit; the DS-1 signal is then monitored for origination of pulse stuffing information.
A. T1C Low-Speed Interface Card	1	2.04 The four DS-1 level signals are then fed to the MAIN and STBY MULDEM circuits. The framing bit, insertion stuff timing, and stuff signaling are generated and multiplexed with the four DS-1 signals into one DS-2 signal. This signal is applied to a switching circuit, contained within the MULDEM circuit. The MULDEM, controlled by the Control MPU card, switches from the MAIN MULDEM circuit to STBY, or vice versa, if a fault occurs.
1. SCOPE		
1.01 This subsection presents a functional description of the T1C LS Interface cards used in the FOX-2. See Figure 1, for views of the T1C LS Interface card. Figure 2 contains a block diagram of the T1C LS Interface card circuits.		
1.02 This subsection was reissued to add new information.		
2. FUNCTIONAL DESCRIPTION		
A. T1C Low-Speed Interface Card		
2.01 The T1C Low-Speed Interface (LS INTER T1C) card processes transmit and receive DS-1C signals, and contains redundant transmit and receive circuitry for protection. Only transmit processing will be discussed, since receive is the reverse of transmit.		2.05 Whenever there is a loss of input timing, the T1C card outputs an Alarm Indication Signal (AIS), which consists of two DS-1 All ls data stream with DS-1C framing.
2.02 The bipolar DS-1C (3.152 Mb/s) signals enter the card through the 15-pin connector pins on the backplane of the FOX-2. The DS-1C signals are applied to the two line		2.06 The MPU Interface provides a data bus to and from the Control MPU card. When the Control MPU card is removed from the FOX-2, The MPU Replace (MPU RPL) signal disables the MPU Interface to prevent transient signals from simulating any commands.
		2.07 The LEDs on the front of the LS INTER T1C card and their functions are listed in TABLE A.

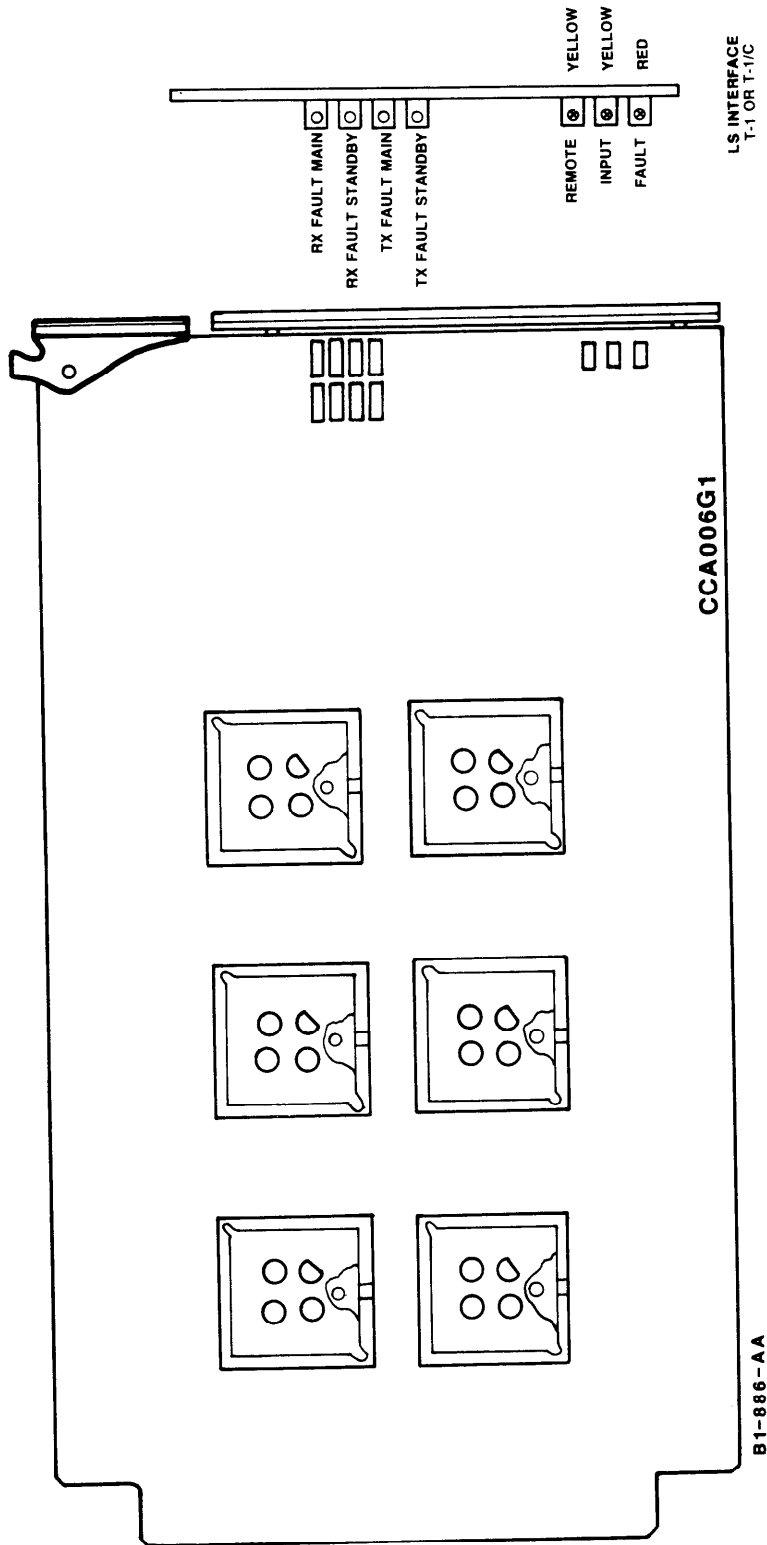


Figure 1. T1C LS Interface Card CCA006G1

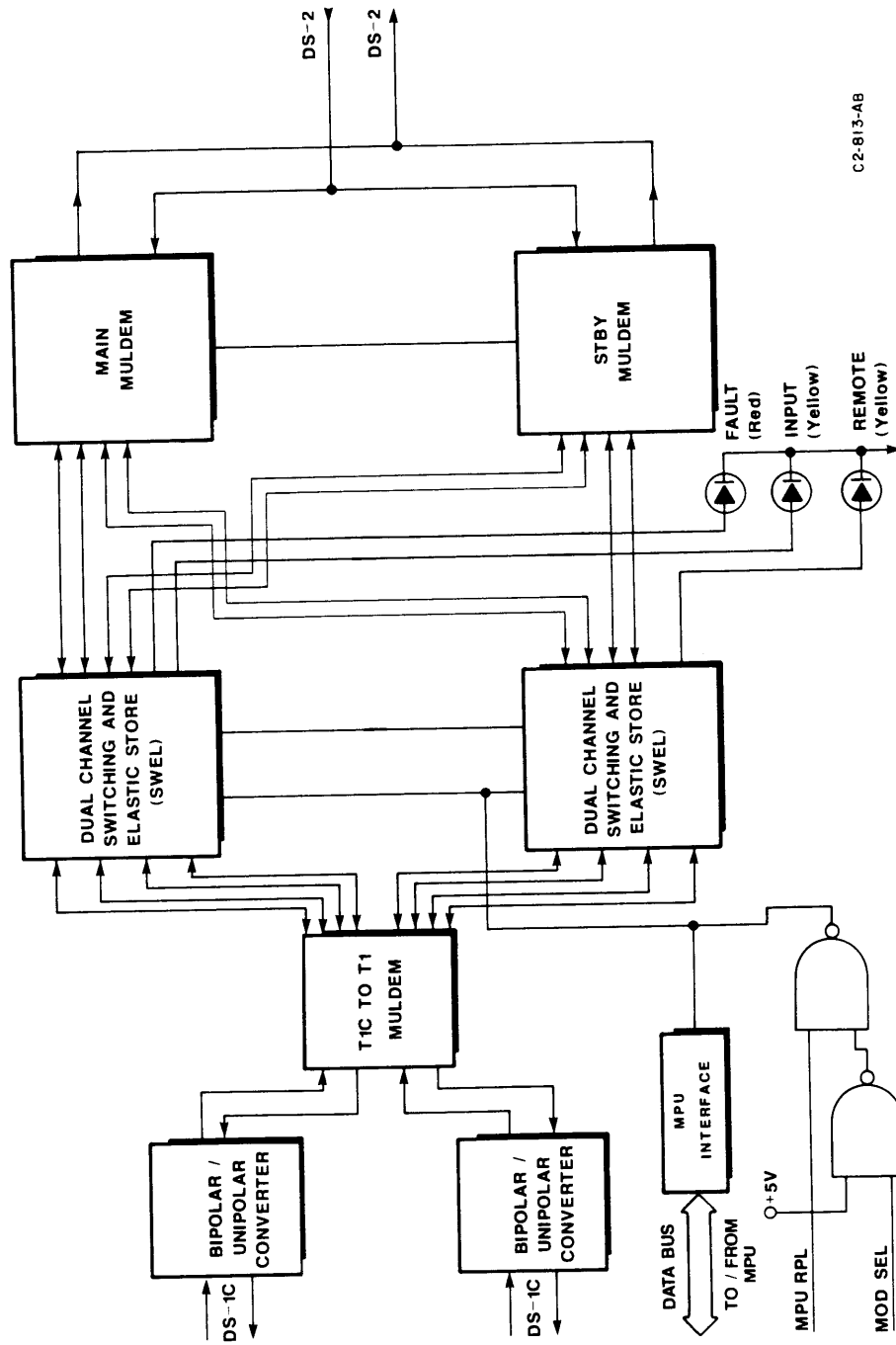
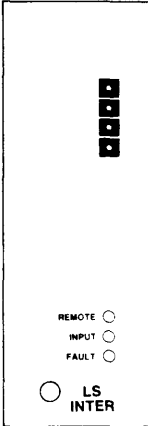


Figure 2. LS INTER T1C Card Block Diagram

TABLE A. T1C Low-Speed Interface Card Indicators

LED INDICATOR	DESCRIPTION OF MONITORED POINT	LED ILLUSTRATION
REMOTE (yellow)	Illuminates when the corresponding Low-Speed Interface card at the far end has a fault.	 <p>The illustration shows a vertical panel with four LEDs. The top three LEDs are labeled REMOTE, INPUT, and FAULT, and are shown as illuminated (filled squares). The bottom LED is labeled LS INTER and is shown as unilluminated (an empty circle). A legend below the LEDs shows the symbols for each: a filled square for REMOTE, INPUT, and FAULT, and an empty circle for LS INTER.</p>
INPUT (yellow)	Illuminates when a loss of DS-1C input occurs on the previously functional DS-1C channel associated with the card.	
FAULT (red)	Illuminates when the LS INTER T1C card has a failure.	

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