Model 3938

Bit-serial, Fiber Optic U-Port Adapter

INSTRUCTION MANUAL

May, 1987

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Model 3938-Z1C

Bit-serial, Fiber Optic U-Port Adapter

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*****Special Option*****

Model 3938-S001

Bit-serial, Fiber Optic U-Port Adapter

May, 1995

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*****Special Option*****

Model 3929-S001

The Model 3938S001 is the same as the 3938Z1C except it has been modified to be loaded with all parts except HY941004 Fiber Optic Rec #HFD3402-002

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KineticSystems Corporation

Standardized Data Acquisition and Control Systems **3938**

Bit-serial, Fiber Optic U-Port Adapter

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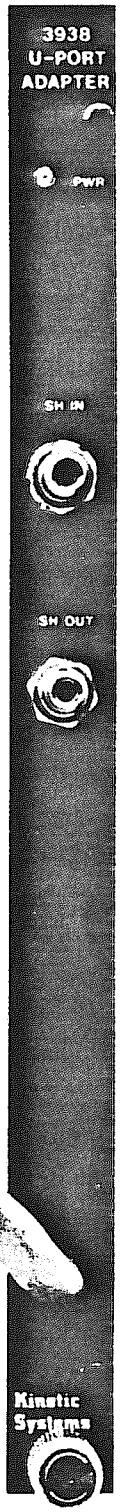
FEATURES

- **Fiber optic cable isolation of Serial Highway crates**
- **Immunity to interference and potential difference**
- **Operation to five megabits/sec and two kilometers**
- **Clock restorer for reliable operation in large systems**
- **Optional on-board battery backup**
- **Optional auxiliary fiber optic ports for timing signals, etc.**
- **Optional transformer-isolated port for mixed systems**

APPLICATIONS

- **Fiber optic isolated highway for Type L-2 serial crate controllers and Serial Highway drivers**
- **Systems requiring immunity from interference or potential difference**
- **Fiber optic isolated loop-through timing signals**
- **Serial systems requiring long distances with high-speed data transmission**



GENERAL DESCRIPTION

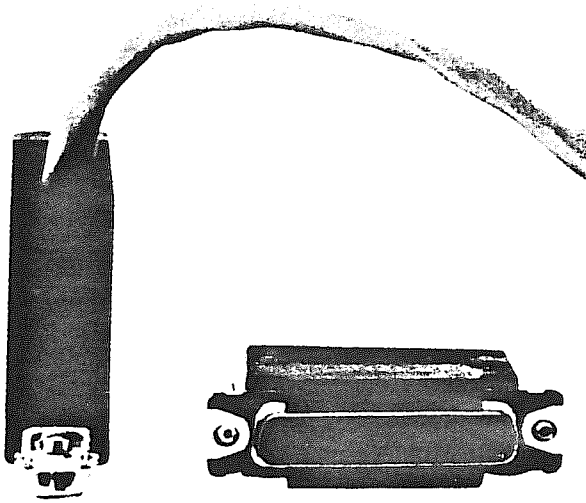
The Model 3938 is a single-width U-Port adapter providing an isolated bit-serial highway path when used with a Type L-2 serial crate controller (SCC) such as the Model 3952 or with a serial driver (SD) such as the Model 3992 or 3994. The Model 1735 or 1738 U-Port Adapter is used with the 2050- or 2160-Series Serial Drivers.

Fiber optic cable is used as the Serial Highway for the 3938. The D-Port signal from the serial driver or serial crate controller is modulated and transmitted as a biphase signal over a single fiber. This signal is received by the next U-Port adapter, demodulated, and converted to a D-Port signal.

Fiber optic transmission has the advantage that it is immune to electromagnetic interference and does not radiate signals itself. Being a nearly perfect insulator, the fiber optic cable allows operation with a high voltage potential difference between crates.

CABLE TYPE AND OPERATING SPEED

When the appropriate KSC Model 5802 Fiber Optic Cable Assemblies are used, successful operation can be obtained to five megabits per second with up to two kilometers of fiber optic cable. A special clock regeneration circuit produces a nearly jitter-free clock signal for retransmission to the next U-Port. This allows the tandem operation of up to 62 remote crates without noticeable reduction in signal quality. This circuit operates for 5 megabit or 2.5 megabit applications. For reliable operation, the driver clock rate should be within one percent of nominal. All KSC Serial Highway drivers easily meet this requirement.



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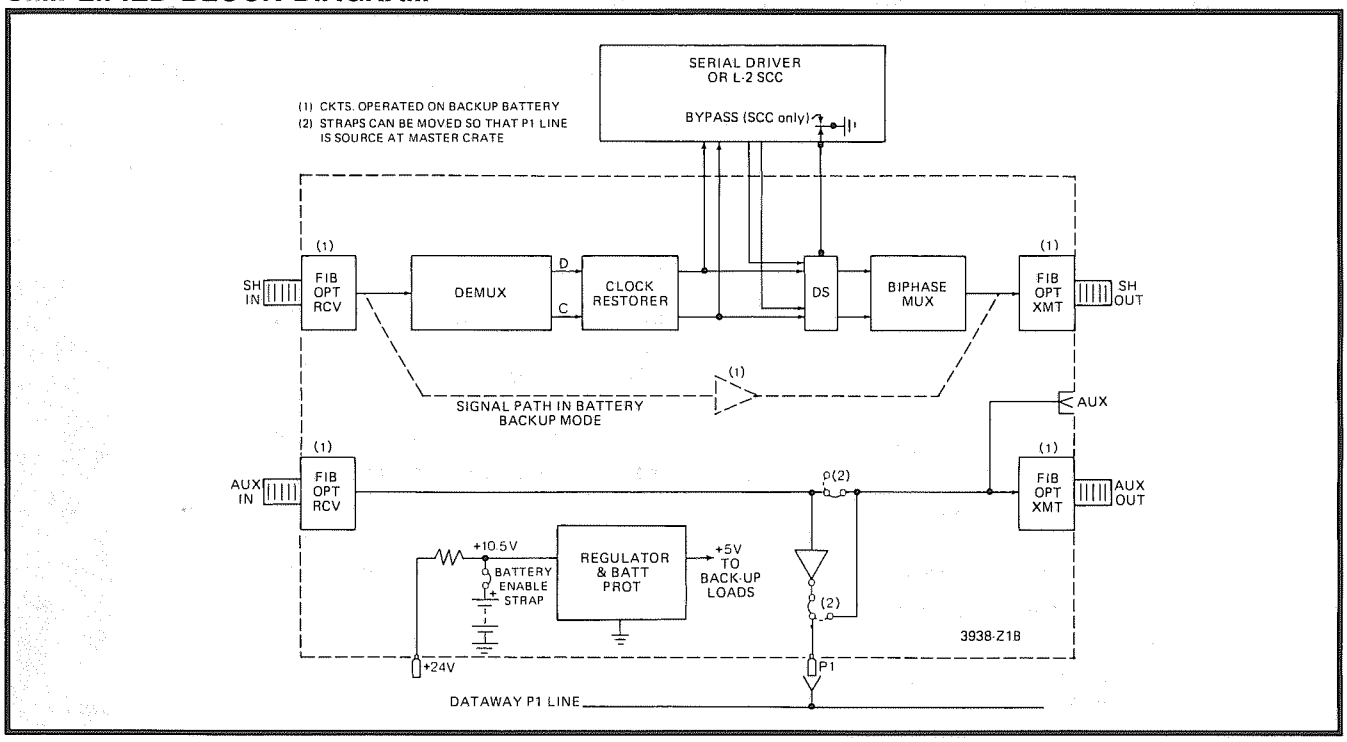
SIMPLIFIED BLOCK DIAGRAM



OPTIONS AVAILABLE

The basic 3938 U-Port Adapter contains one fiber optic transmitter and one receiver for Serial Highway operation. In addition to this, the following options are available:

1. Auxiliary fiber optic ports — These are "loop-through" ports communicating timing information via the crate Dataway P1 line. This system is compatible with the timing signal distribution for the Princeton TFTR fusion project.
2. On-board battery backup — Rechargeable nickel-cadmium batteries maintain the continuity of the Serial Highway (and timing highway, if provided) for approximately one-half hour during power failures, allowing modules to be removed.
3. Transformer port — This allows the Serial Highway IN or Serial Highway OUT path to be transformer-isolated. With this option, mixed 3936/3938 systems can be created. The 3938 can also be used full fiber optic with the transformer port disabled.

POWER REQUIREMENTS (current in milliamperes)

Voltage	3938-Z1A	3938-Z1B	3938-Z1C	3938-Z1D	3938-Z1E	3938-Z1F
+6 volts	500	750	500	750	525	525
−6 volts	175	175	175	175	175	175
+24 volts	15	15	—	—	—	15

ORDERING INFORMATION

Weight: .70 kg. (1 lb. 8 oz.)

Model	Auxiliary Timing Ports	Battey Backup	Transformer Port
3938-Z1A	No	Yes	No
3938-Z1B	Yes	Yes	No
3938-Z1C	No	No	No
3938-Z1D	Yes	No	No
3938-Z1E	No	No	Yes
3938-Z1F	No	Yes	Yes

Accessories — Model 5802-Cxyz Fiber Optic Highway Cable
Model 5930-Z1A Mating Connector (3938-Z1E, -Z1F)
Model 1735-Z1A U-Port Adapter for 2050-Series Serial Driver
Model 1738-Z1B U-Port Adapter for 2160-Series Serial Driver

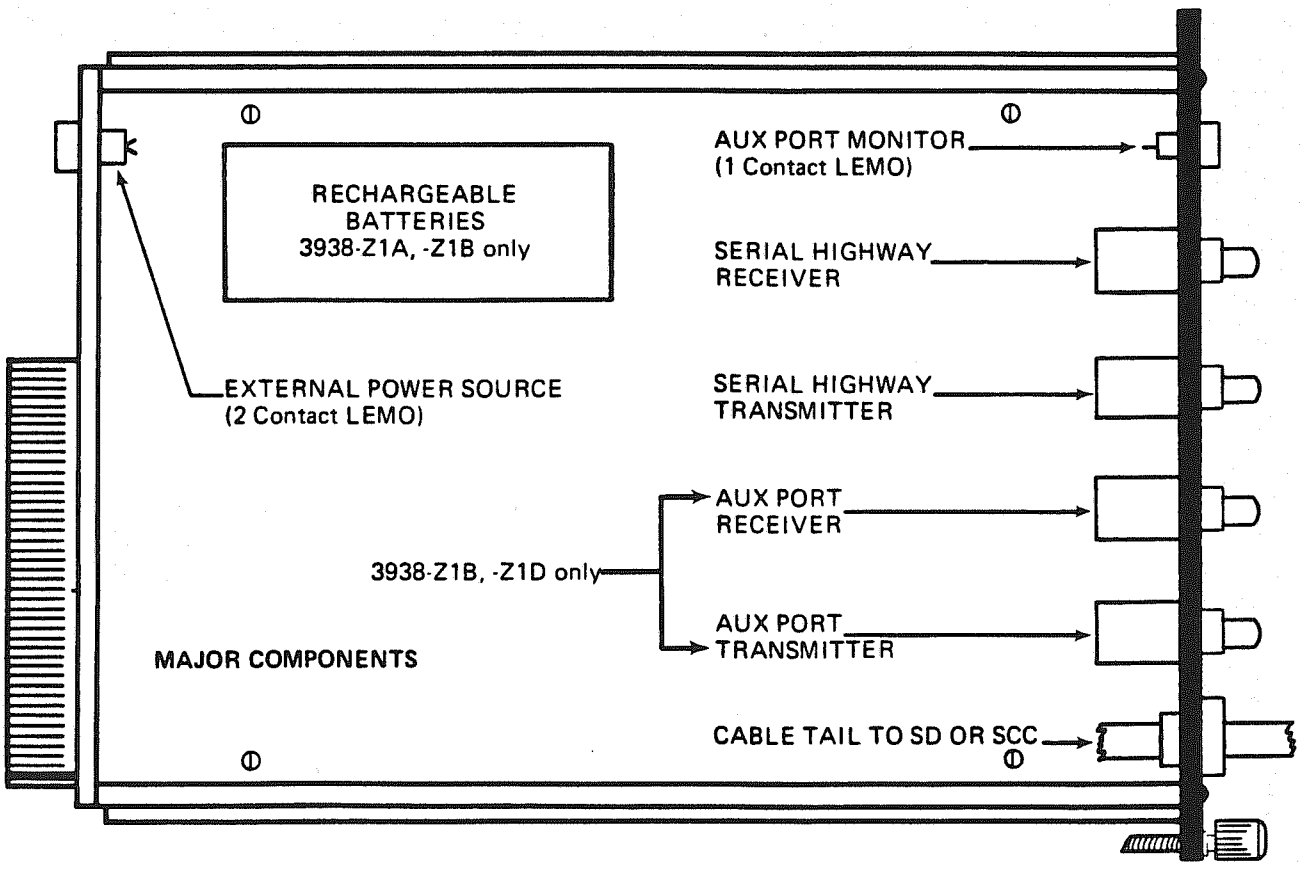
Precision control is very important so that the demultiplexer does not "drfit" out of range.

CABLE TYPE AND OPERATING SPEED

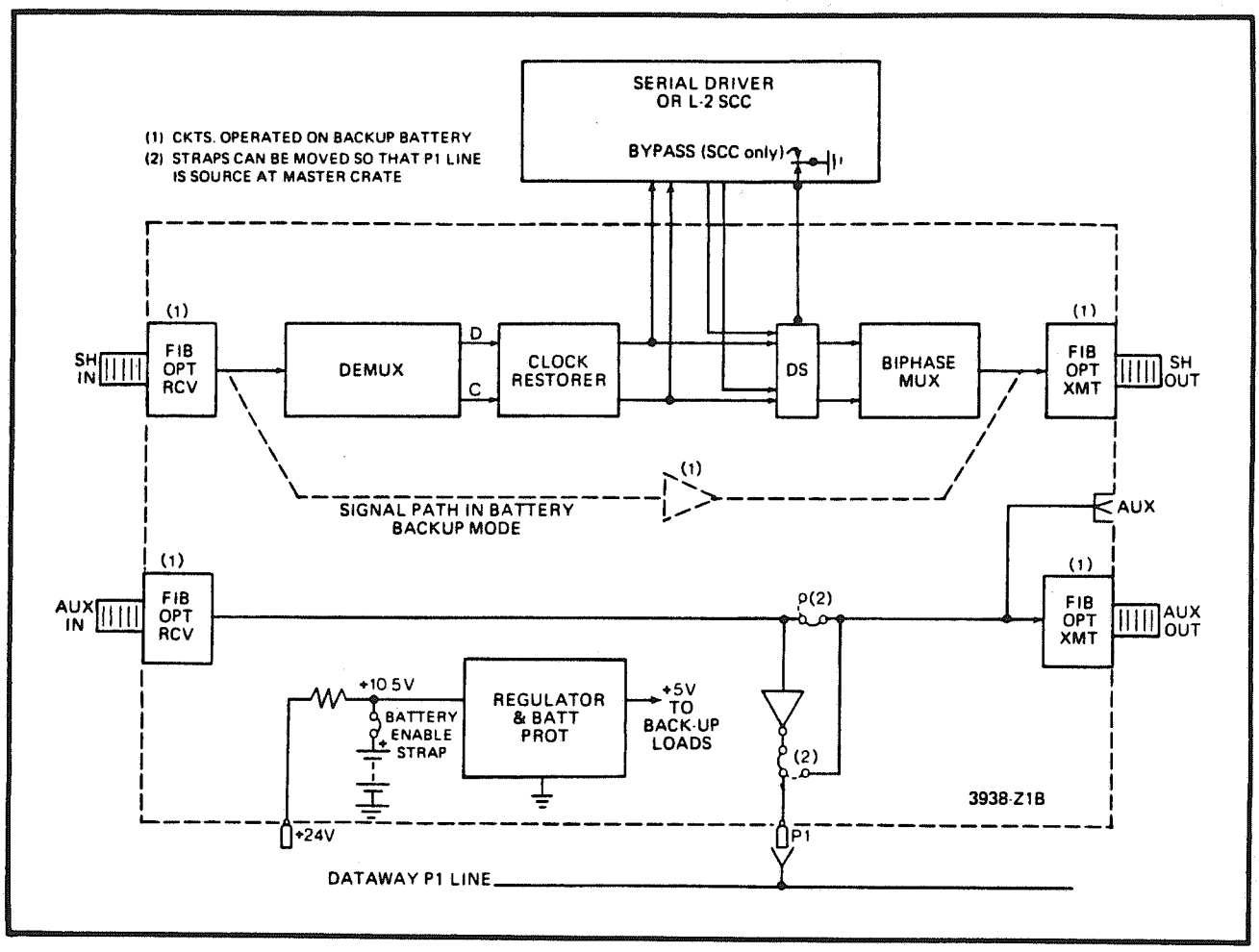
When the KineticSystems 5802 Fiber Optic Cable Assemblies (Valtec type PC-10 cables) are used, successful operation can be obtained to 5 megabits with 500 meters of cable between U-ports. A special clock regeneration circuit produces a nearly jitter-free clock signal for retransmission to the next U-port. This allows the tandem operation of up to 62 remote crates without noticable reduction in signal quality. This circuit operates for 5 megabit or 2.5 megabit applications. For reliable operation, the driver clock rate should be within one percent of nominal. The KSC drivers easily meet this requirement.

MAJOR COMPONENTS

A diagram of the major components of a 3938 is provided here. Note that the rechargeable batteries and auxiliary transmitter/receiver are optional.



BLOCK DIAGRAM



FRONT PANEL

Power LED - On steady when crate power is present. Flashes when operating from backup battery.

Connectors - Four fiber optic connectors are provided on the 3938-Z1B and -Z1D; two are included on the 3938-Z1A and -Z1C. The connectors are "SMA" size (Amphenol 905-series).

A single-pin LEMO (3938-Z1B and -Z1D only) monitors the auxiliary port signal.

Since the 3938 uses the same biphase signal coding as KSC's other U-port adapters, this module can be mixed with 3935 U-ports in the same system.

D-PORT CONNECTIONS

The 3938 is connected to the D-OUT connector of a serial driver or SCC by a cable tail from the 3938. A "turnaround" connector is provided with each 3938. This connector is mated with the SD or SCC D-IN connector. This, along with internal bus connections between the D-IN and D-OUT connectors on the SD or SCC, allows access to the input and output D-port clock/data signals.

OPTIONAL AUXILIARY FIBER OPTIC PORTS

The 3938-Z1B and -Z1D each contain two auxiliary fiber optic ports. One port (AUX IN) receives the optical signal and converts it to TTL level. This signal is placed on the Dataway P1 patch line. Also, the signal is converted to an optical signal and transmitted on the other port (AUX OUT).

This auxiliary "loop-through" fiber optic highway is useful for the transmission and use of timing signals to synchronize the activity in the remote crates with precision machine cycle timing pulses. This system is compatible with the timing signal distribution in the Princeton TFTR fusion project.

OPTIONAL ON-BOARD BATTERY BACKUP

The 3938-Z1A and -Z1B contain rechargeable nickel-cadmium batteries. These batteries maintain the continuity of the serial highway (and auxiliary timing signal highway for the 3938-Z1B) when power is removed from the crate for a modest period. This is typically to allow for insertion or removal of modules without causing a "break" in the highway(s). During normal operation, the on-board batteries are charged from the Dataway. With a full (24-hour) charge, the backup time is as follows:

Model	Guaranteed	Typical
3938-Z1A	30 minutes	60 minutes
3938-Z1B	15 minutes	30 minutes

SERIAL DRIVER AND U-PORT COMPATIBILITY

This U-port system can be used with a 3992 or 3994 serial driver (with a 3938 at the serial driver and the SCC's). Also, 3938's can be used with the 1735 U-port. Thus, remote crates with 3938's can be driven by the 1735 as part of our 2050, 2060, 2070 and 2080-series of serial highway drivers.

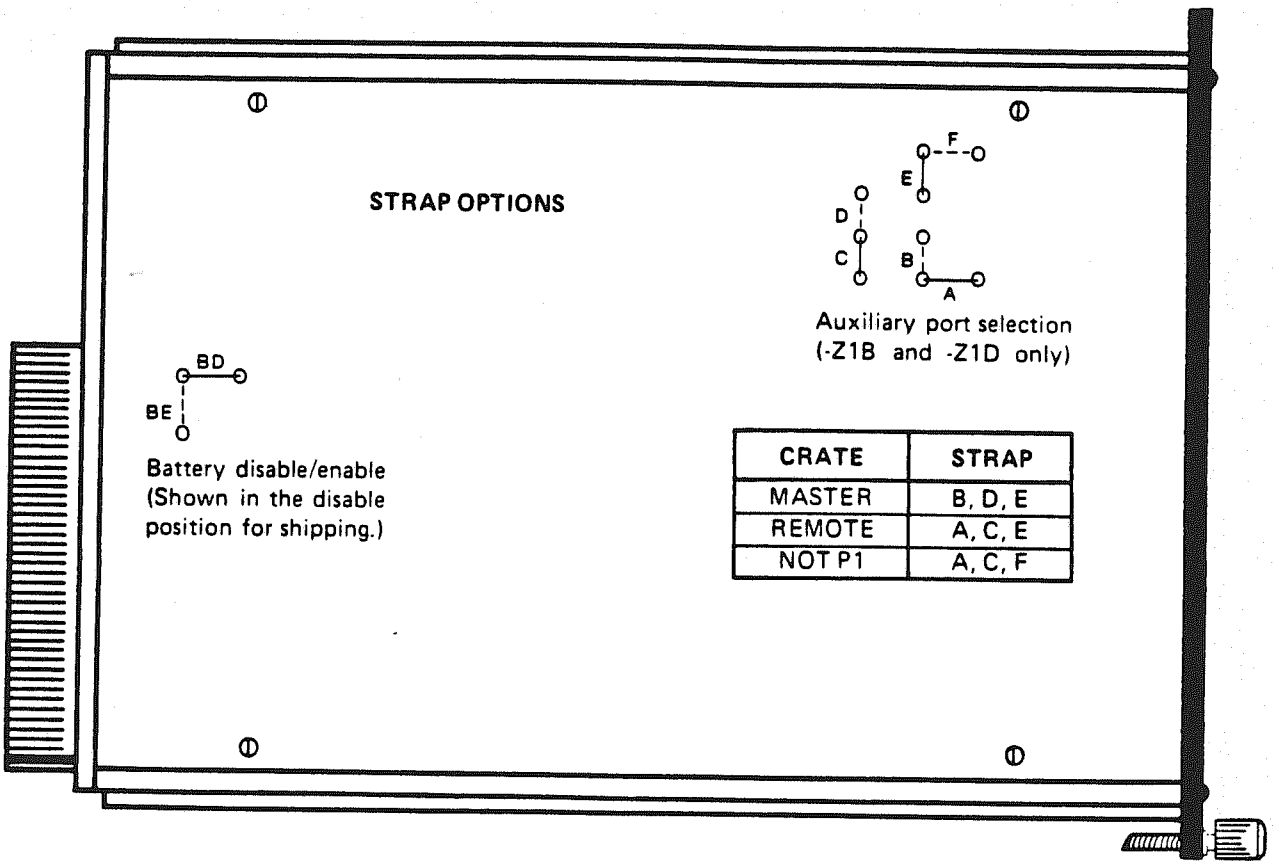
ORDERING INFORMATION

U-Port Adapter	Battery Backup	Auxiliary Timing Ports	I/O Ports
3938-Z1A	Yes	No	No
3938-Z1B	Yes	Yes	No
3938-Z1C	No	No	No
3938-Z1D	No	Yes	No
3938-Z1E	No	No	Yes
3938-Z1F	Yes	No	Yes

INSTALLATION

The 3938 is shipped with the battery (if provided) disabled (disconnected from load). This has a strap in the BD position.

The auxiliary ports (if provided) are strapped for REMOTE. If this 3938 is to be used in a master crate (P1 line driving the auxiliary highway), move the straps as indicated in the following diagram.

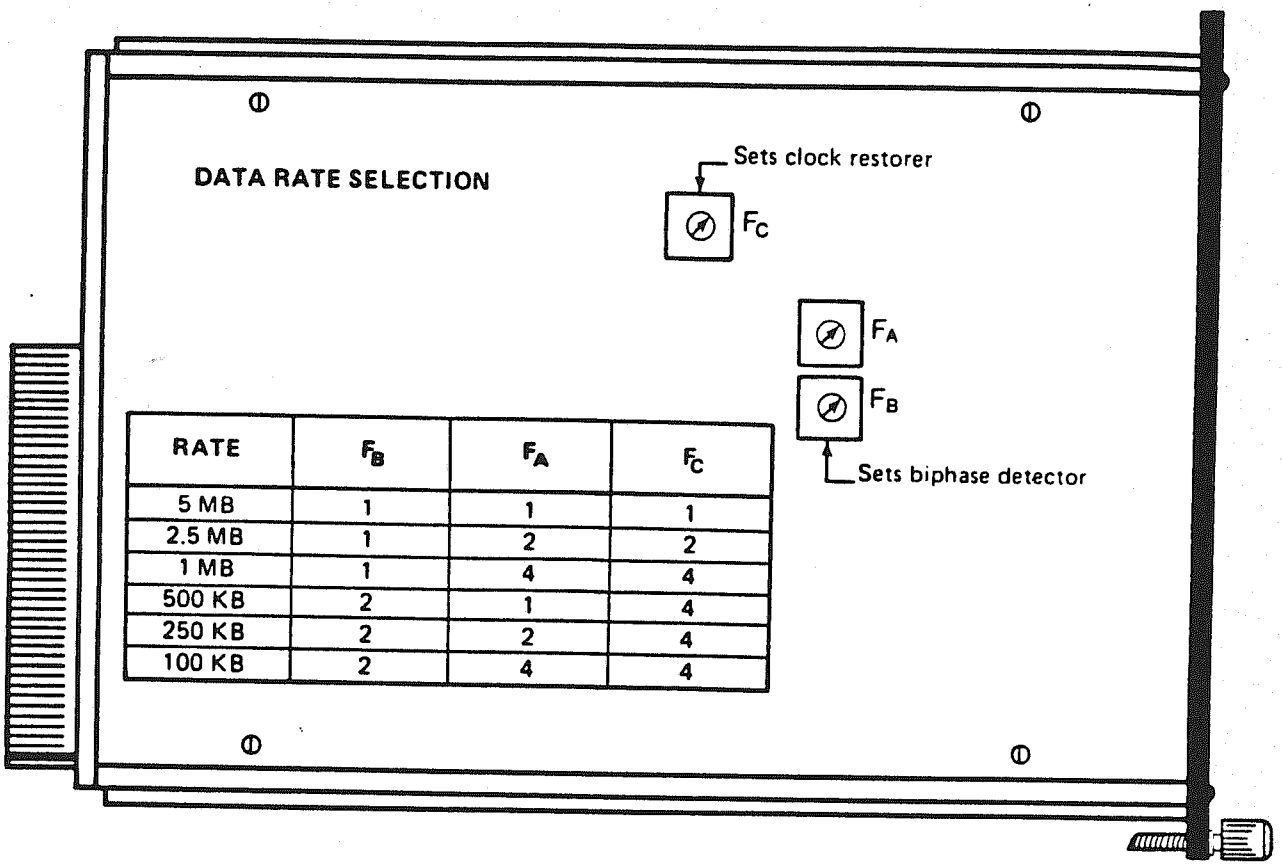


Before operation, move the strap from BD to BE (backup models). Note that the deep discharge protection circuit keeps the load disconnected until the plus six volts is applied, then removed. CAUTION: DO NOT GROUND THE STRAP WITH A TOOL. THIS WILL BLOW THE BATTERY FUSE.

DATA RATE SELECTION

The data rate is digitally selected over a range of 100 kilobits/second to 5 megabits/second. The six possible operating speeds correspond to the standard rates provided by the KineticSystems line of serial highway drivers (2050, 3992, etc.).

The clock restorer circuit provides a "flywheel effect" to give a "smooth" signal to the next U-port. This circuit is selected by switch FC. This switch must be in position one for 5 Mbit operation, two for 2.5 Mbit and four for all other speeds.



RATE	F_B	F_A	F_C
5 MB	1	1	1
2.5 MB	1	2	2
1 MB	1	4	4
500 KB	2	1	4
250 KB	2	2	4
100 KB	2	4	4

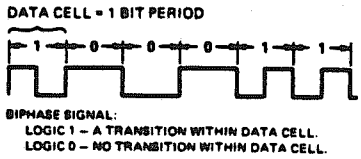
OPERATION WITHOUT A CRATE CONTROLLER

In the power-down state, the serial highway is "looped through" the 3938 with the backup battery support.

If it is necessary to operate the serial highway with the 3938 in a powered state and the crate controller has been removed (for repair, etc.), the highway path can be completed by taking the turnaround connector from the SCC and plugging it into the 3938 cable tail.

CIRCUIT OPERATION - SERIAL HIGHWAY PATHS

The normal L-2 D-Port signals consist of a clock and NRZ (non-return-to-zero) data. A logical ONE is represented by a voltage of one polarity and a ZERO by a voltage of opposite polarity. The 3938 uses both clock and data signals to produce a biphase signal. The signal format is shown here:



BIPHASE MODULATION

When used with a serial crate controller, a biphase light signal is received at SH IN. This is converted to a biphase electrical signal. This signal is changed to differentiated pulses by the dual edge detector (IC Y).

The biphase demultiplexer includes a digital timer for "no drift" operation. This digital timer contains an 80 MHz oscillator and associated frequency dividers. The switches, FA and FB, are set to provide a signal two times the data rate (point 2T). These are 100 KHz through 5 MHz (1, 2.5, 5 ratio).

IC T divides each bit time into two phases, TA and TB. Phase TA is true from 25% to 75% of the bit time. TB is true from 50% to 100% of the bit time. The circuit "looks for" a ONE (mid-bit differentiated pulse) when TA is true. Pin J5 goes HIGH if a "one" is received. When TA goes false (with TB true), the counter dividing chain is held clear until the bit cell end differentiated pulse is received. This synchronizes the counter to the incoming signal, and the process is repeated. An 80 MHz clock is used to minimize the jitter (due to a free-running clock). If a "one" had been detected, it is transferred to IC I (19 HIGH) at the bit edge.

A clock can be derived from TB and data at 19. However, these signals are subject to some distortion, primarily caused by the fiber optic link. A clock restorer circuit is provided to generate a nearly jitter-free clock signal.

The clock restorer uses L-C circuits tuned to the clock rate (L1/L2 for 5 Mbit and L3/L4 for 2.5 Mbit). They are selected by switch FC. Line receivers provide zero-crossing detection. The tuned circuits act as a "flywheel" and remove the jitter from the clock.

The data is re-clocked by the restored clock and appears at K9.

If the SCC is bypassed, then the clock/data signals are fed directly to the biphase multiplexer through IC Z. The multiplexer converts clock/data to a biphase signal. This signal is converted to light and appears at SH OUT.

If the SCC is not bypassed, the clock/data signals are fed into the SCC line receivers. The signal is processed by the SCC and fed to the biphase multiplexer via IC Z.

If the 3938 is used with a serial driver (3992), operation is the same, except that the command message starts with the SD and the reply is received by the SD line receivers. The SD does not contain a bypass source.

CIRCUIT OPERATION - AUXILIARY PATHS

The 3938-Z1B and -Z1D contain an auxiliary input and output fiber optic port. These are intended to be used with the Princeton (TFTR)-designed timing modules. These ports are not associated with the serial highway.

For remote crate operation, a one megabit biphase signal is received at AUX IN. This signal is passed to the crate P1 line by IC W. It is also passed on to the next crate via AUX OUT.

For master crate application, the straps are changed and the P1 line becomes the source of the data via AUX OUT. For this case, AUX IN is not used.

CIRCUIT OPERATION - POWER BACKUP

The 3938-Z1A and -Z1B contain rechargeable nickel cadmium batteries. These batteries allow the serial highway (and the auxiliary timing highway for the 3938-Z1B) to continue to pass signals when the crate power is removed. This allows other crates in the system to remain active when power is removed temporarily to charge modules, etc.

The batteries are trickle charged through R1. A trickle charge is used to increase battery life. When the plus six volt supply drops below 4.5 volts, Q2 turns off, allowing Q1 to turn on. This causes the power transistor (MJE 371) to turn on. A 7806 six volt regulator is used to provide a low tolerance voltage source to the fiber optic transmitter(s) and receiver(s). Only these devices and a few IC's are powered during backup.

When the crate power is removed, a transistor connected to IC X turns off. This causes the SH IN path to be "looped to" the SH OUT path. The AUX IN/AUX OUT path (if provided) remains "looped through".

IC A is a timer that is connected to the POWER LED. When crate power is present, a diode connected to A4 forces the LED on. When operating from backup power, the LED flashes.

A deep discharge battery protection circuit is included. If one cell discharges completely before the others, load current could cause polarity reversal to that cell, destroying it. This circuit disconnects the load if battery voltage drops below 8 volts. This also assures that the highway loop-through cuts off sharply so that marginal signals are not generated by low voltage.

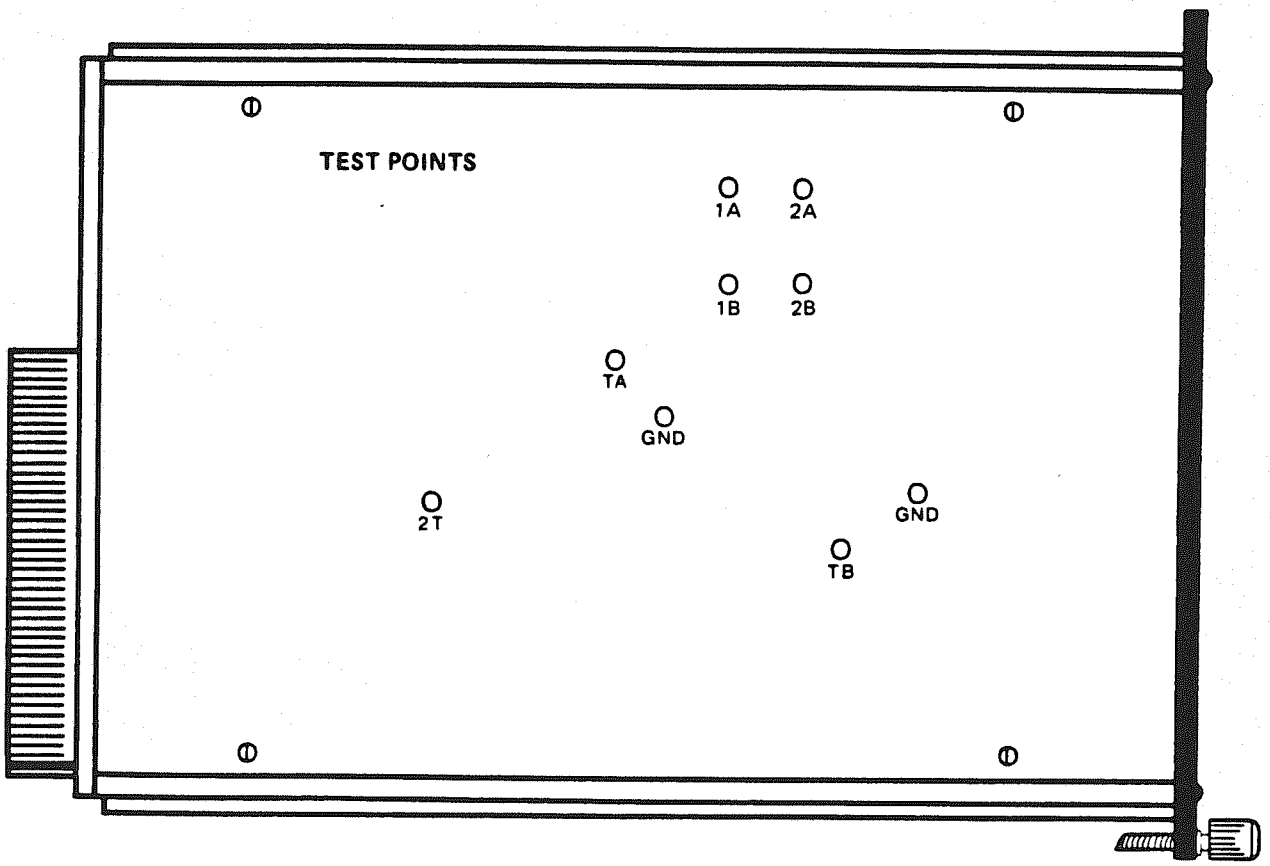
When the plus six volt crate source is present, zener diode D3 holds Q2 on and Q4 on. All circuitry is powered via D5 and D6. As the voltage drops, Q2 and Q4 turn off. Capacitor C4 had been charged to 5 volts. For approximately two seconds after power-down this capacitor holds Q3 on. This forces Q1 on, turning the MJE 371 on.

Thus, voltage is supplied to the regulator and the base of Q1 via D2 if the battery voltage is above 8 volts. When the battery voltage drops below 8 volts, D2 stops conducting, turning Q1 and the MJE 371 off. This disconnects the load and protects the batteries from deep discharge failure.

TEST POINTS

PC board sockets are provided for test points. The meaning of these is shown here. See the schematic drawing for additional details.

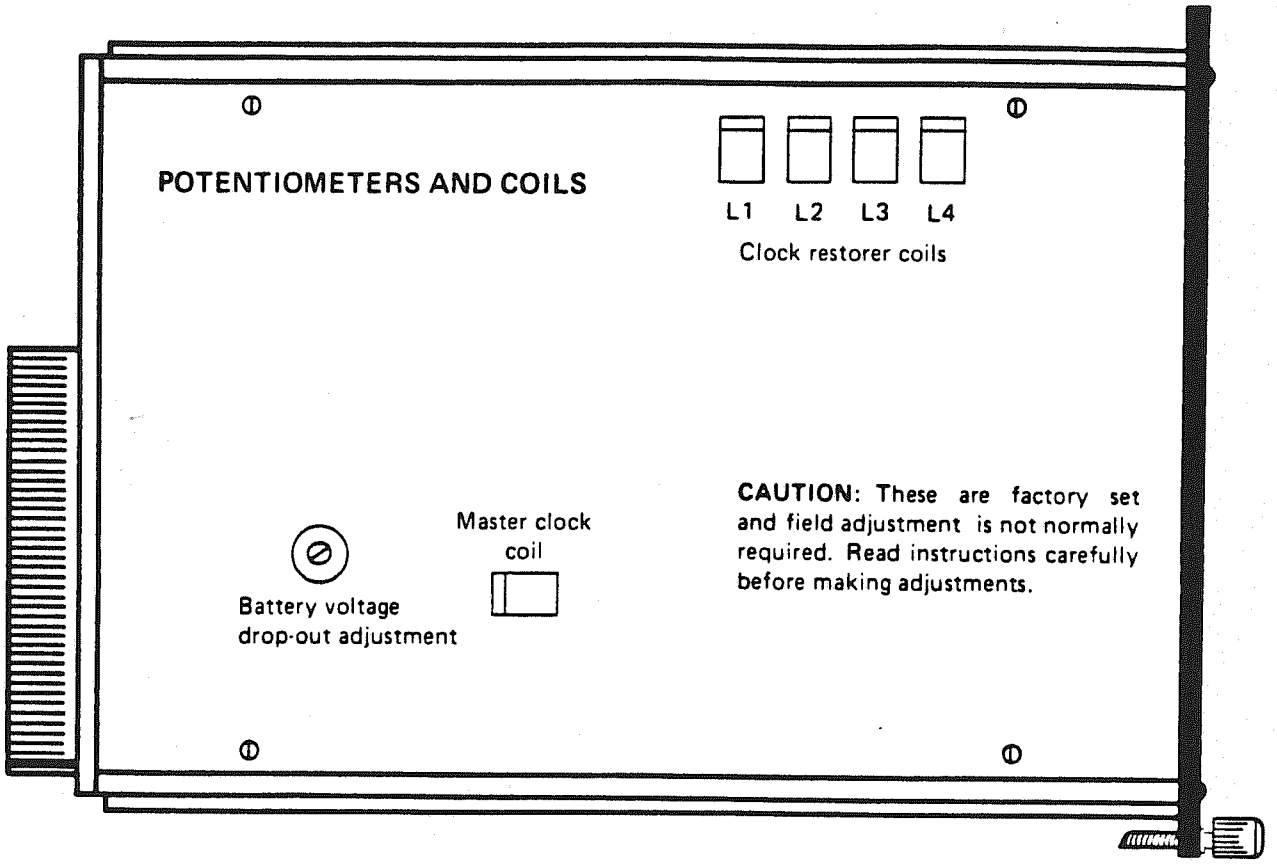
Designation	Meaning
2T	A 2X data rate signal (a continuous signal only when TB is grounded)
TA	Phase TA clock signal from the demultiplexer
TB	Phase TB clock signal from the demultiplexer
1A,1B	Monitor points for the 5 Mbit clock restorer
2A,2B	Monitor points for the 2.5 Mbit clock restorer
GND	Ground access points



CALIBRATION

It is not expected that field calibration of this unit should be necessary. If a proper set-up is not made and proper instruments are not available, misadjustment can result in impaired performance.

The location of the potentiometer adjustments is shown below:



Battery Voltage Drop-out Adjustment

NO CRATE POWER IS APPLIED FOR THIS TEST. This is adjusted by disabling the battery (strap BD) and placing a clip lead from emitter to collector of the MJE 371 transistor (middle and right-hand leads with front panel to the right). A plus eight volt source is applied to the BOTTOM of the BE strap location (with the return of this source to the module rail). The Q1 side of R4 is monitored. The cut-off potentiometer is adjusted until this point is at approximately four volts.

Clock Restorer Adjustment

The clock restorer coils are adjusted to give near-zero phase shift. With five Mbits operating rate, monitor TB and 1A. Adjust L1 for zero phase shift. Move the oscilloscope probe to 1B. Adjust L2 for zero phase shift. Change operating speed to 2.5 Mbits. Move probe to 2A and adjust L3. Move probe to 2B and adjust L4.

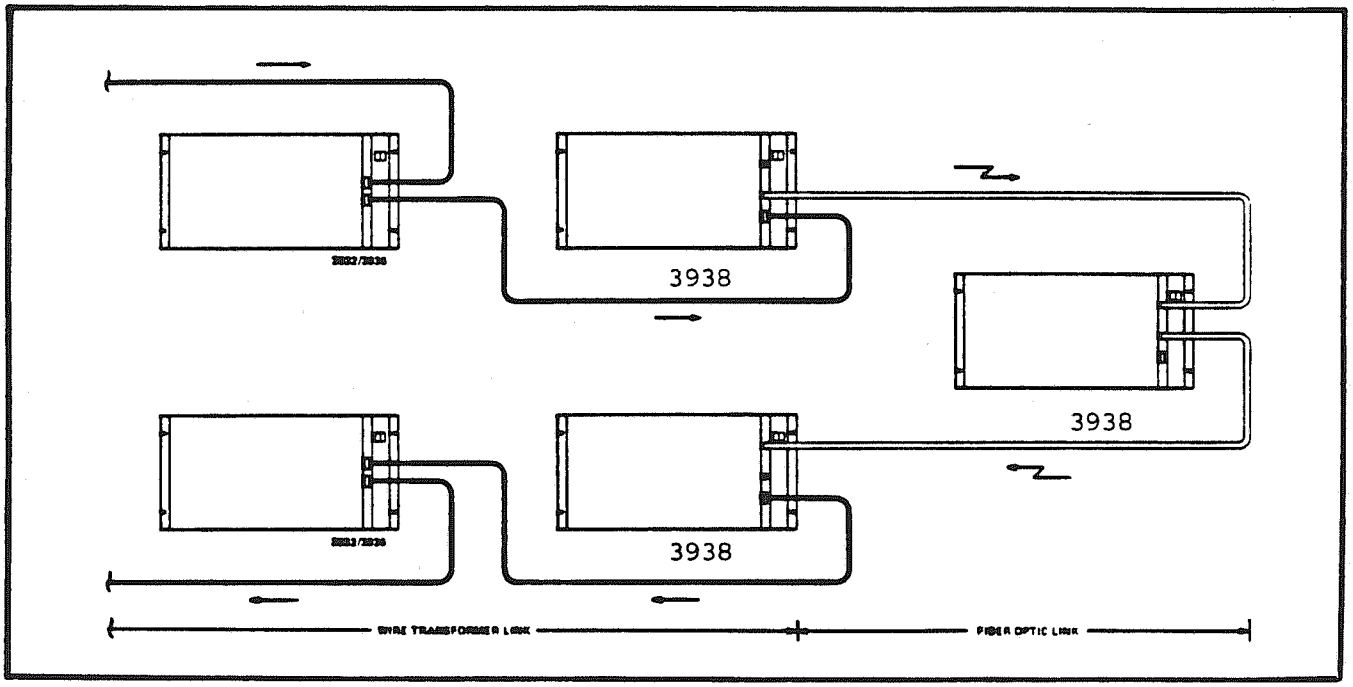
Master Clock Adjustment

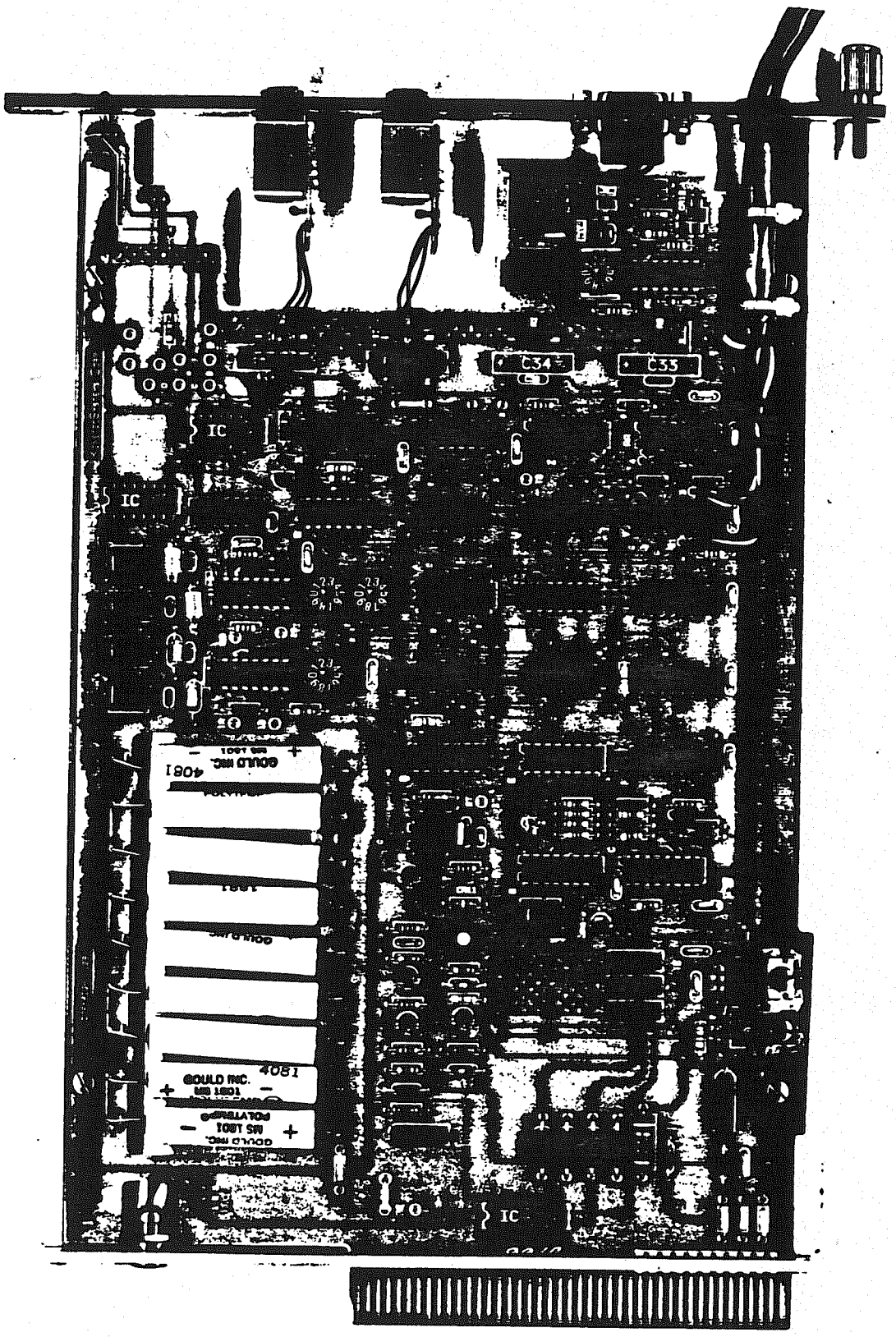
The master clock circuit can be checked by grounding TB with a short lead and monitoring at 2T. With FA=1 and FB=1, this signal should be 10 megahertz plus or minus 0.1 megahertz. If the coil is adjusted, the frequency should be set to 10 megahertz.

MIXED SYSTEMS (Using 3938-Z1E or Z1F)

A serial highway system may contain 3938s in each crate and fiber optic cable for all highway links. However, many applications may require one or more crates at a high voltage (or a "high voltage" crate added to an existing system). The 3938 contains strap options, line transformer and a 9-pin "D" connector. This allows the 3938 to be optical in/optical out, transformer in/optical out, or optical in/transformer out. These options allow the 3938 to be used in systems containing the 3932s or the successive 3936s.

TYPICAL MIXED SYSTEM (Using 3938-Z1E or Z1F)



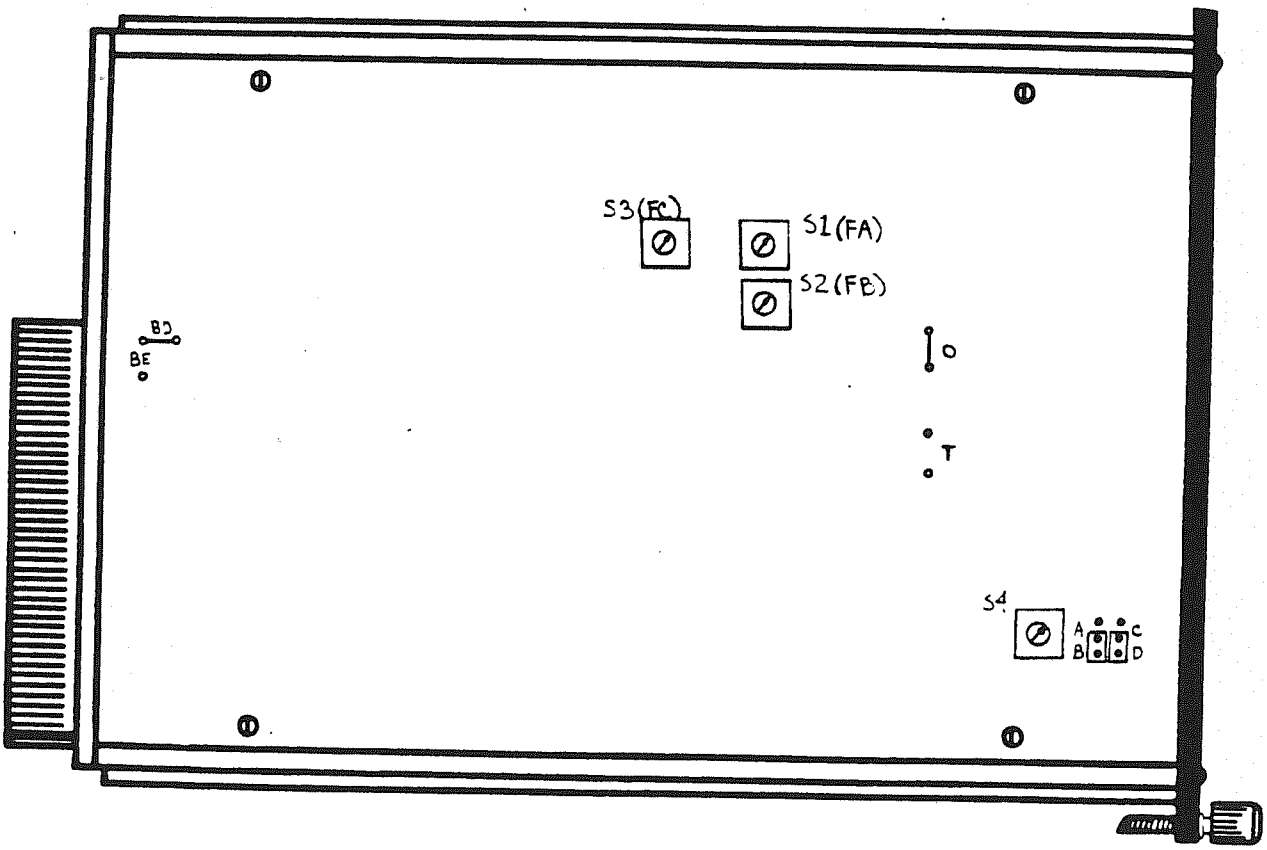

C34
C35
IC
IC
GOULD INC.
4081
IC

STRAPS AND SWITCHES

(-Z1F only)
Battery disable/enable (show in the disable position for shipping)

Strap 'T' to monitor data received via cable at I/O port (requires straps 'B' and 'D' selected)

Strap 'O' to monitor data received on optical link



Strap 'B' and 'D' to receive data at I/O port (requires strap above to be in position 'T')

Strap 'A' and 'C' to transmit data via front panel I/O port

Data Rate Selection

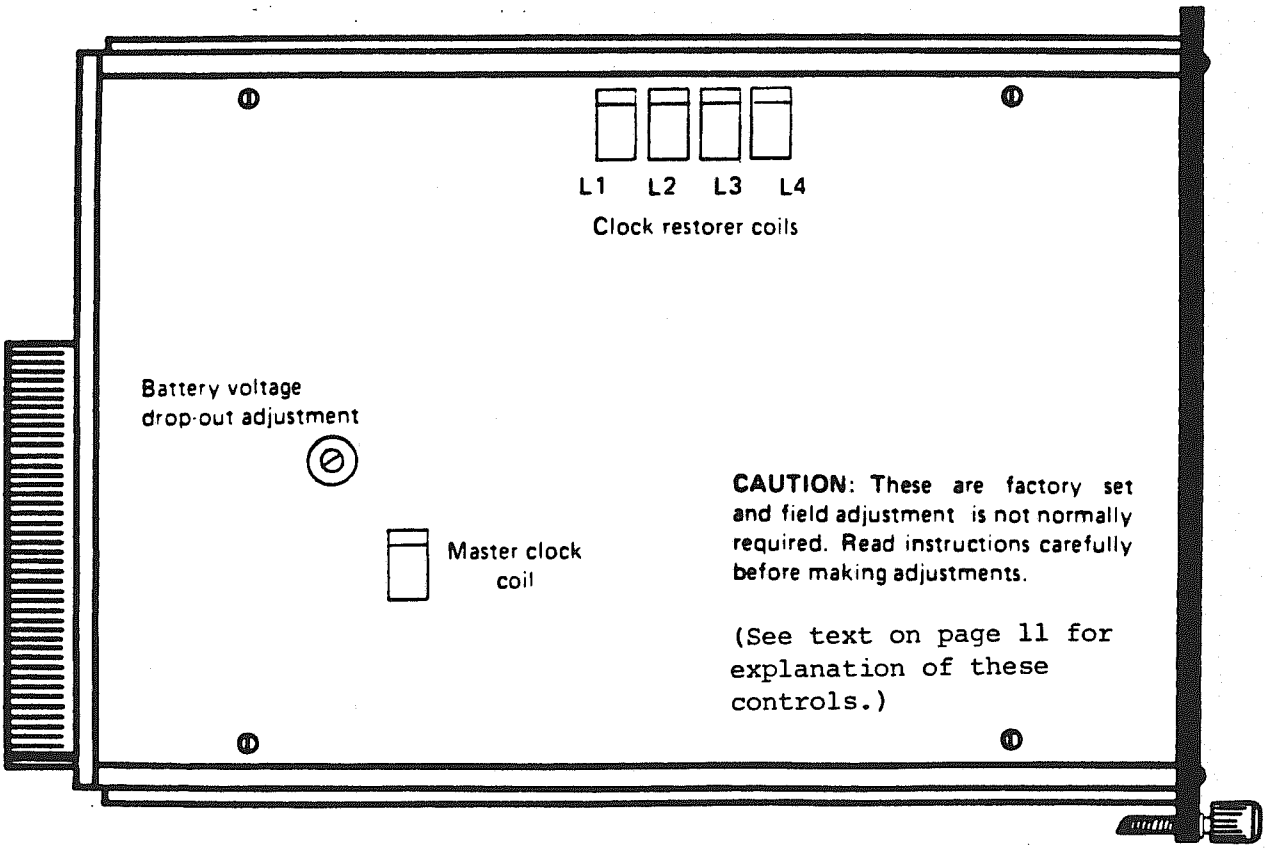
RATE	S2	S1	S3
5 MB	1	1	1
2.5 MB	1	2	2
1 MB	1	4	4
500 KB	2	1	4
250 KB	2	2	4
100 KB	2	4	4

CABLE EQUALIZATION

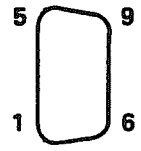
When receiving dat via a metallic cable in mixed systems, a cable equalization selection must be made.

Capacitance	Switch 'S4'	Comments
------	0	Open - not a valid position
100 pf	1	Do not use below 5 MHz.
220 pf	2	Do not use below 2.5 MHz.
320 pf	3	Do not use below 2.5 MHz.
470 pf	4	Do not use below 1 MHz.
570 pf	5	Do not use below 1 MHz.
690 pf	6	Do not use below 1 MHz.
790 pf	7	Do not use below 1 MHz.
wire	8	User selectable

POTENTIOMETERS AND COILS



Pin/Wire List



FACE VIEW

9 PIN 'D'

PIN NO.	
5	NC
4	NC
3	I/O
2	I/O
1	Ground

PIN NO.	
9	NC
8	NC
7	NC
6	NC