MODEL 351

TRIPLE-LOOP DIGITAL CONTROLLER

MOORE PRODUCTS CO., Spring House, PA 19477-0900

An ISO 9001 registered company.
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1.0 INTRODUCTION

This Installation And Service Instruction for the MYCRO 351 Triple-Loop Digital Controller is divided into six sections as follows:

Section 1, INTRODUCTION, gives general information pertaining to product description, model designation, and specifications.

Section 2, INSTALLATION, provides general installation considerations, mounting and wiring guidelines, and specific mounting procedures.

Section 3, OPERATION, defines the controls, signal displays, and operating modes.

Section 4, CALIBRATION, provides field calibration procedures for Controller and Expander Board analog inputs and outputs and optional No.3 Input Boards: Voltage Input Board, TC/mV Input Board, RTD Input Board, and Frequency Board.

Section 5, CIRCUIT DESCRIPTION, supplies general circuit descriptions of the Controller and Expander Board Assembly, No.3 Input Boards, Link Interface Board, and the Display Assembly.

Section 6, MAINTENANCE, furnishes preventive maintenance guidelines, troubleshooting, and assembly replacement procedures. A Parts List is at the end of this section.

Configuration procedures are given in the MYCRO 351 User's Manual AD351-10 and the MYCRO 351 Configuration Handbook AD351-20.

IMPORTANT

Save this Instruction and make it available for installation and maintenance of the Controller.

1.1 PRODUCT DESCRIPTION

The MYCRO 351 Triple-Loop Digital Controller (TLDC) is a microprocessor-based, self-contained, stand alone industrial controller. The TLDC can control three independent loops. Each loop is user configured for the needed control strategy through software interconnection of function blocks. Each function block performs a process control related activity such as: alarm, analog input, digital output, setpoint track and hold, logic, No.3 Input, and link interface option. By employing user configured function blocks, the TLDC can satisfy a wide range of process applications.
Optional No.3 Input Boards allow a TLDC to receive a pulse, voltage, thermocouple, resistance temperature detector, or frequency input.

A Link Interface Board option provides communication with other stations over the Local Instrument Link and, with the addition of a Model 321 Expansion Satellite, the Hi-Level Link.

Factory Configuration Options (FCOs) provide basic single loop control and advanced multivariable control strategies. A wide variety of these ROM-stored FCOs are included, and they can be customized by the user. For example, FCO-101 can be called during configuration. It supplies a PID controller, Hi/Lo process alarms, and setpoint tracking. The FCO can then be edited by the user to add other function blocks, complete hard configuration interconnections, set soft configuration values, and other configuration variations.

The TLDC is shown in Figure 1-1. Front panel dimensions conform to DIN standards. The Display Assembly contains the controls, mode switches, and signal displays required for local operation and configuration. Hardware and software for the TLDC and extra sockets for options are located on the Controller Board and the Expander Board. All user electrical connections are made to terminals on the rear of the case.

Optional boards are plug-in assemblies. They can be installed at the factory or in the field without TLDC modification -- configuration will be needed and some boards require calibration.

1.1.1 CONFIGURATION

Station configuration is performed by the user and consists of interconnecting user selected function blocks and entering gain, bias, tuning constants, and other parameter to build the needed control strategy. A Factory Configured Option, discussed above, can speed this procedure. Configuration of the TLDC is done loop by loop. Configuration data is stored in nonvolatile memory to prevent loss of data should an electrical power interruption occur.

A list of function blocks available to each loop is located in Table 1.1. Note that a No.3 input must be configured in Loop 1, while an optional Link Interface Board can be configured in Loops 1, 2, and 3.

The keyboard, displays, and controls for configuration are located on the front of the TLDC Display Assembly. A link interface equipped TLDC may be configured with the front panel or by a personal computer via an Instrument Link Interface.

Refer to the TLDC User's Manual for specific details and procedures.
FIGURE 1-1 Triple-Loop Digital Controller

* = OPTIONAL BOARD(S)
### TABLE 1.1 Function Blocks Per Loop

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### 1.1.2 STATION FUNCTIONS

TLDC loops can be configured to cover all standard industrial controller station functions. Variations which require the addition of an option board are noted along with the applicable station type. See Table 6-3 for the FCO list.

- Single-Loop PID Control with tracking setpoint
- Single-Loop PID Control without tracking setpoint
- External-Set PID Control with tracking setpoint
- External-Set PID Control without tracking setpoint
- Ratio-Set PID Control with tracking setpoint
- Loading
- Auto/Manual Transfer
- Auto/Manual Transfer with bias
- Indicator
- Default Configuration
- Single Loop PID Control with tracking setpoint
  Computer/Local Operation*
- Single Loop PID Control without tracking setpoint
  Computer/Local Operation*
- External Set PID Control with tracking setpoint
  Computer/Local Operation*
- External Set PID control without tracking setpoint
  Computer/Local Operation*
- Ratio set PID Control with tracking point
  Computer/Local Operation*
- Loading - Computer/Local Operation*
- Auto/Manual Transfer - Computer/Local Operation*
- Auto/Manual Transfer with bias *
  Computer/Local Operation*
- Indicator
  Computer/Local Operation*
- Computer Set Auto/Manual Transfer**
- Computer Set Direct Digital Control (DDC)**
- Computer Set Supervisory Control**

*Requires Link Interface option
**Configurable in Loop 1 only and requires Pulse Input Board option

1.1.3 CONTROL STRATEGIES

A sampling of the control strategies a TLDC loop can provide are listed below.

- Standby Synchronization
- Emergency Manual
- Adaptive Gain
- Override
- Ratio
- Bias
- Pressure/Temperature Compensation of Flow
- Single Station Cascade of two loops
- Feedforward
1.2 MODEL DESIGNATION

The station nameplate is located on the Controller Board and contains the station's model number. Model numbers are decoded as indicated below. Before installing a station or applying power to a station, check for the correct station model, options, power input and electrical classification.

Sample Model Number __________________________ 351 A 2 1 N N N

Basic Model No. ________________________________
Basic - 351

Power Requirement
A - 120 Vac (+10%, -15%) 47 to 63 Hz
B - 24 Vac (+10%, -15%) 47 to 63 Hz
C - 24 Vdc (+20%, -10%)
E - 220/240 Vac (+10%, -15%) 47 to 63 Hz

Mounting Case
2 - Standard 40 Screw Terminals
N - Not Required

Operator's Panel
I - Analog and Digital Displays
N - Not Required (Blank Panel)
D - Delete Panel Not Included (Delete Option can only be furnished with Mounting Case Option N)

Loop 1 Input Number 3 - Options
V - Voltage (Additional 1 to 5 Vdc)
T - Thermocouple (J, K, T, E, S, R, B) or Millivolt
D - RTD (DIN curve and US curve)
F - Frequency
C - Computer (Dual Pulse and Pulse Direction)
N - Not Required

Local Instrument Link Interface
1 - RS422, Half-Duplex
N - Not Required

Electrical Classification *
C - CSA
F - FM
N - Not Required

* See Station nameplate for classification
1.3 SPECIFICATIONS

1.3.1 MECHANICAL

DIMENSIONS
Panel Cutout .................. See Figure 2-1
TLDC ........................ See Figure 2-2
Front ........................ German standard - Deutsche Industrie
Normen-DIN 43831 - 72mm W x 144mm H

MOUNTING ....................... Single station or row mounting

1.3.2 POWER REQUIREMENTS

POWER SUPPLY OPTIONS
A - Standard .................. 120 Vac (+10%, -15%) 47 to 63 Hz
B - Optional .................. 24 Vac (+10%, -15%) 47 to 63 Hz
C - Optional .................. 24 Vdc (+20%, -15%)
E - Optional .................. 220/240 Vac (+10%, -15%) 47 to 63 Hz

POWER INPUT ................... 25 Watts, 45 VA

1.3.3 2-WIRE TRANSMITTER AND DIGITAL LOGIC POWER

VOLTAGE ....................... +26 Vdc +/-7.5%
CURRENT ....................... 80 mA at 26 Vdc (max)

1.3.4 ANALOG INPUTS

INPUT RANGE .................... 0 to 5 Vdc
STANDARD CALIBRATION ............ 1 to 5 Vdc
ZERO .......................... 0 to 1 Vdc
SPAN .......................... 4 to 5 Vdc
INPUT TYPE ..................... Single ended
NORMAL MODE REJECTION .......... 6 dB @ 2 Hz, 60 dB @ 60 Hz (2-pole filter
with breakpoint frequency @ 2 Hz)

DIGITAL FILTER RANGE .......... 0.001 to 10 Hz (breakpoint frequency)
INPUT IMPEDANCE ................ Greater than 1 Megohm
CALIBRATION ACCURACY .......... +/-0.05% of span
A/D RESOLUTION .................. 12 bits
A/D LINEARITY .................. +/-1/2 LSB
MAXIMUM CONTINUOUS INPUT ...... +/-30 Vdc
AMBIENT TEMPERATURE EFFECT .... Less than +/-0.5% of span for a 100°F
ambient temperature change
1.3.5 DIGITAL INPUTS

LOGIC "1" RANGE .................. 15 to 30 Vdc
LOGIC "0" RANGE .................. 0 to 1 Vdc
MAXIMUM CONTINUOUS INPUT ....... +/- 30 Vdc
CURRENT DRAW AT 24 Vdc .......... 10 mA maximum
ISOLATION ........................ 100 Vdc
MINIMUM "On Time" ................ 500 msec
MINIMUM "Off Time" ............... 500 msec

1.3.6 PULSE INPUT BOARD

TYPES .......................... Pulse-Direction and dual-pulse; selectable with on-board jumper
INPUT VOLTAGE .................. "ON" range: 5 to 30 Vdc
"OFF" range: <= or greater than 0.5 Vdc
MAXIMUM FREQUENCY ............. 5000 Hz
MINIMUM PULSE WIDTH ............ "ON" and "OFF" time: 100 usec
ISOLATION ....................... Input circuit isolated up to 100 Vdc from station common
MAXIMUM CONTINUOUS INPUT ....... +/- 30 Vdc
INPUT RANGE ................... 1000 to 4000 pulses full scale
AMBIENT TEMPERATURE EFFECT ..... Less than +/-0.5% for a 100°F ambient temperature change

1.3.7 THERMOCOUPLE INPUT BOARD

REF. JUNCTION COMPENSATION ...... Automatic
INPUT IMPEDANCE ................ Greater than 200,000 Ohms
MAXIMUM CONTINUOUS INPUT ...... +/- 30 Vdc
TC BURNOUT PROTECTION .......... Field selectable using jumper-plug

TYPE "J" T/C
Range Limits .................... -300°F to 2000°F or -185°C to 1095°C
Zero (configurable) ............. -300°F to 1000°F or -185°C to 540°C
Span (configurable) ............. 125°F to 2000°F or 70°C to 1110°C
Accuracy ........................ +/-0.7°F for span less than 700°F
.................................. +/-0.1% of span for span greater than 700°F
Burnout Drive Rate ............... 30°F/sec.

TYPE "K" T/C
Range Limits .................... -300°F to 2500°F or -185°C to 1370°C
Zero (configurable) ............. -300°F to 1300°F or -185°C to 700°C
Span (configurable) ............. 175°F to 2500°F or 95°C to 1390°C
Accuracy ........................ +/-0.9°F for span less than 900°F
.................................. +/-0.1% of span for span greater than 900°F
Burnout Drive Rate ............... 45°F/sec.
TYPE "T" T/C
  Range Limits .................. -300°F to 750°F or -185°C to 400°C
  Zero (configurable) ............. -300°F to 600°F or -185°C to 315°C
  Span (configurable) .............. 150°F to 900°F or 85°C to 500°C
  Accuracy ........................ +/-0.8°F
  Burnout Drive Rate .............. 40°F/sec.

TYPE "E" T/C
  Range Limits .................. -300°F to 1800°F or -185°C to 980°C
  Zero (configurable) ............. -300°F to 800°F or -185°C to 430°C
  Span (configurable) .............. 100°F to 1500°F or 55°C to 835°C
  Accuracy ........................ +/-0.6°F for span less than 600°F
                                      +/-0.1% of span for span greater than 600°F
  Burnout Drive Rate .............. 24°F/sec.

TYPE "S" T/C
  Range Limits .................. 0°F to 3000°F or -18°C to 1650°C
  Zero (configurable) ............. 0°F to 2400°F or -18°C to 1320°C
  Span (configurable) .............. 600°F to 3000°F or 330°C to 1670°C
  Accuracy ........................ +/-3°F
  Burnout Drive Rate .............. 160°F/sec.

TYPE "R" T/C
  Range Limits .................. 0°F to 3200°F or -18°C to 1760°C
  Zero (configurable) ............. 0°F to 2600°F or -18°C to 1430°C
  Span (configurable) .............. 600°F to 3200°F or 330°C to 1780°C
  Accuracy ........................ +/-3°F
  Burnout Drive Rate .............. 140°F/sec.

TYPE "B" T/C
  Range Limits .................. 0°F to 3300°F or -18°C to 1815°C
  Zero (configurable) ............. 0°F to 1800°F or -18°C to 980°C
  Span (configurable) .............. 1500°F to 3300°F or 830°C to 1830°C
  Accuracy ........................ +/-2.5°F for span less than 2500°F
                                      +/-0.1% of span for span greater than
                                      2500°F
  Burnout Drive Rate .............. 180°F/sec.

1.3.8 MILLIVOLT INPUT BOARD

  INPUT IMPEDANCE ................. Greater than 1 Megohm
  MAXIMUM CONTINUOUS INPUT ........ +/-30 Vdc
  DIGITAL FILTER RANGE ............. 0.001 to 10 Hz (breakpoint frequency)
         Wide Span
            Range Limits ............. -75 mVdc to +75 mVdc
            Zero (configurable) ....... -75 to 70 mVdc
            Span (configurable) ...... 5 to 150 mVdc
            Accuracy ................ +/-5 microvolts for span less than 10 mV
                                      +/-0.05% of span for span greater than 10 mV
INTRODUCTION

Narrow Span
Range Limits ...................... -20 mVdc to +20 mVdc
Zero (configurable) ............ -20 to 19 mVdc
Span (configurable) ............ 1 to 40 mVdc
Accuracy ........................ +/-5 microvolts for span less than 10 mV
+/-0.01% of span for span greater than 10 mV

1.3.9 VOLTAGE INPUT BOARD ........ Same as Analog Input, see section 1.3.4

1.3.10 RTD INPUT BOARD

PARAMETERS
SFB3-Filter Breakpoint Freq. ... 0.001 to 10 Hz
SRT-Range Type .................. DIN/US
SRU-Range Units .................. °F/°C
SR-L-Range Low .................. -300°F to 800°F or -185°C to 425°C
SRH-Range High .................. -275°F to 1200°F or -171°C to 650°C
CZ13-Zero Input .................. 100.00 Ohms
CF13-Full Scale Input .......... 200.00 Ohms
CV13-Verify Input ................. -3.3 to 103.3%
HINT-Input T ..................... 00 to 99
HINC-Input C ...................... 00 to 99
LEAD RESISTANCE EFFECT ........ 0.01°F/Ohm
ACCURACY ........................ +/-0.1°F for a span less than 100°F;
+/-0.1% of span for span greater than 100°F

1.3.11 FREQUENCY INPUT BOARD

PARAMETERS
SMIN-Frequency Range, Min. .... 0.0 Hz to 12.50 KHz
SMAX-Frequency Range, Max. .... 1.0 Hz to 25.00 KHz
SD0-Zero Drop Out ............... 0.0 to 100% (% of Range)
CIPV-Input Peak Voltage ........ -30.0V to +30.0V
CIVV-Input Valley Voltage ...... -30.0V to +30.0V
CIL-Input Voltage Learn .......... Learn

CALIBRATION
Input Peak Voltage (CIPV) ...... +/-30.0V
Input Valley Voltage (CIVV) ... +/-30.0V, CIVV must be less than or equal
to CIPV

Learn Mode CIL
Conversion Time .................. 20 seconds maximum
Accuracy ........................ +/-2% V peak +/-0.1V
Frequency Inputs Less Than 25 Hz
Pulse Width ....................... 25 Milliseconds minimum
INPUTS
Frequency Range ............. 0.05 Hz minimum
25.00 KHz maximum
Amplitude .................. 4.00V peak-to-peak minimum
60.00V peak-to-peak maximum
Note: The DC offset plus 1/2 the peak-to-peak voltage cannot exceed 30V.
Signal Types ................ Sine, square, pulse, triangle, contact
Pulse Width ................. 20.00 usec. minimum
Debounce Time
Fast ...................... 11 usec. +/-15%
Slow ...................... 4 usec. +/-15%
Hysteresis .................. 55% +/-3% (difference between CIPV and CIVV)
Input Impedance ............. 450 Kohms minimum

CONFIGURATION PARAMETERS
0% Frequency Range .......... 0.0 Hz minimum
12.50 KHz maximum
100% Frequency Range ....... 1.0 Hz minimum
25.00 KHz maximum
Minimum Span ............... Greater than 0% Frequency Range Value
Resolution .................. 12 bits
Accuracy ................... +/-0.01% +/-1 LSB over the specified
temperature range
Zero Drop Out ............... 0.0% of span minimum
100.0% span maximum

1.3.12 ANALOG OUTPUTS

STANDARD CALIBRATION ........ 4 to 20 mAdc
Zero ....................... 4 mAdc +/- trim
Span ...................... 16 mAdc +/- trim
SIGNAL REFERENCE .......... Negative (-) output terminal is
station common
ACCURACY ................... +/-0.1% of span
CURRENT LIMIT .............. 20.5 mA, +/-0.1 mA
OUTPUT LOAD ................ 0-800 Ohms
AMBIENT TEMPERATURE EFFECT ... less than +/-0.5% of span for a 100°F
temperature change

1.3.13 DIGITAL OUTPUTS

OUTPUT TYPE .................. Open collector transistor
(emitter tied to station common)
LOAD VOLTAGE ............... 30 Vdc maximum
LOAD CURRENT .............. 100mA maximum
TRANSISTOR "ON" VOLTAGE .... 0.3V @ 0 mA load
0.6V @ 100 mA load
1.3.14 RELAY OUTPUTS

TYPE ......................... Hermetically sealed
CONTACT CONFIGURATION ....... SPDT
CONTACT RATING ............... 1A @ 115 Vac
ACTION ....................... Direct or reverse

1.3.15 LOCAL INSTRUMENT LINK

LOCAL INSTRUMENT LINK ........ Twinaxial Cable Belden 9860, 9182 or equivalent (see SD15492 for details)

1.3.16 ENVIRONMENTAL

IEC LOCATION CLASSIFICATION ... B (IEC 654-1)
OPERATING TEMPERATURE LIMITS ... 0°C to +50°C (+32°F to +122°F); See section 2.2 for forced air ventilation statement.

OPERATING HUMIDITY AND MAXIMUM
MOISTURE CONTENT ................ 5 to 95% RH;
0.028 pounds water/pound dry air

TRANSPORTATION AND STORAGE
TEMPERATURE LIMITS ............ -40°C to +85°C (-40°F to +185°F)

TRANSPORTATION AND STORAGE
HUMIDITY LIMITS ............... 0 to 100% RH, Non-Condensing

1.3.17 ELECTRICAL CLASSIFICATION

FOR INSTALLATION IN ............ See section 1.2, Electrical Classification
2.0 INSTALLATION

This section provides general information such as installation considerations and mounting and wiring guidelines. It also provides specific information on Triple-Loop Digital Controller (TLDC) mounting and electrical connections.

2.1 INSTALLATION CONSIDERATIONS

The TLDC is intended for flush panel mounting in a vibration-free instrument panel or rack. Install the TLDC in an indoor or sheltered location, either mounted singly or row mounted in a single panel cutout. Panel cutout dimensions are shown in Figure 2-1; Station dimensions are shown in Figure 2-2.

Do not mount the TLDC where direct sunlight can strike the Display Assembly or case. Direct sunlight can make the displays difficult to read and will interfere with heat dissipation.

The TLDC should be mounted either horizontally or with a backward tilt (i.e., the front of the case higher than the rear). If the TLDC is to be mounted with electronic recorders, pneumatic recorders, or pneumatic stations, tilt back restrictions for these units may have a bearing on panel design or layout.

A TLDC is usually shipped with the circuit board cluster installed in the case and a Display Assembly attached to the front of the case. In some instances, the case is shipped separately and the cluster and Display Assembly are cartoned together for installation by the user.

For direct thermocouple inputs, a Thermocouple/Millivolt Input Board and a Reference Junction Temperature Sensor Board are needed. TC calibration includes both boards; therefore, to preserve the factory calibration, keep the Input Board and its Sensor Board together. When a TLDC is shipped completely assembled, the Sensor Board is mounted on the case rear terminals. When the Boards are shipped separately, the Sensor Board is housed in a bag attached to the Input Board.

2.2 ENVIRONMENTAL CONSIDERATIONS

See section 1.3.16 for TLDC operating temperature limits and operating humidity and maximum moisture content. The air surrounding any operating TLDC must be kept below 50°C (122°F). The temperature of the air should be checked to ensure that this specification is not being exceeded.

CAUTION

Exceeding specified operating temperature limits can adversely affect performance and may cause damage.

Forced air ventilation is recommended when TLDCs are mounted in a partially or completely enclosed panel or cabinet (e.g., NEMA1); see Figure 2-3. When clean air is present, exhaust fans are often mounted across the top of a panel and louvers formed in the panel bottom. Air is drawn upward between the station
cases. When air contains particulate matter, fans and filters are often located at the panel bottom and louvers at the top. Filtered air is now forced upward between the station cases. Filters must be serviced periodically.

Only high quality, quiet running fans should be used. Also, the fans should not generate electrical noise which could interfere with electronic instruments.

A sealed cabinet (e.g., NEMA12) containing equipment that does not generate significant heat should contain a recirculating fan for forcing air flow around equipment and throughout the cabinet preventing hot spots from developing.

Forced air conditioning may be needed in panels and cabinets with high equipment density or significant heat generating capability. Periodically change or clean air filters.

Industrial environments often contain particulate, liquid, and gaseous contaminants. Particulate matter, usually dust and dirt, is abrasive and can cause intermittent connections. A layer of dust on circuit boards can interfere with semiconductor heat dissipation. Liquid and gaseous contaminants can have a corrosive effect on metal, rubber, plastic and circuit board components. Extended exposure to these contaminants may result in malfunctions.

To reduce contaminant related equipment malfunctions:

1. Identify contaminants and implement methods to reduce their presence.

2. When cleaning equipment and surrounding area, especially the floor, either vacuum away all dust and dirt or use a dampened rag or mop. Sweeping or dry dusting recirculates dust and dirt.

3. Clean or replace all air conditioning filters, room air filters, and equipment filters regularly.

4. Inform all personnel with access to the equipment of the need for cleanliness.

2.3 MECHANICAL INSTALLATION

The following sections provide guidelines and procedures for mounting TLDCs in a panel or rack. The installation should be structurally rigid and the stations should be squared in the panel or rack.

2.3.1 PANEL AND RACK GUIDELINES

The panel face should provide a flat and rigid mounting surface. Stiffeners should be welded to the back of the panel if there is a possibility that the panel face will bow. Rear support is recommended where panel cutout density is high, and where panel face distortion may occur. Rear supports can be square
FIGURE 2-1 Panel Cutout Dimensions

NOTES:
- 15" (381MM) MINIMUM FRONT OF PANEL CLEARANCE REQUIRED FOR BOARD ASSEMBLY REMOVAL
- MOUNTING BRACKET
- CLAMPING SCREW
- 0.47 (11.9)
- 2.67 (67.8)
- USER PANEL 0.12 (3.0) TO 1.00 (25.4) THICK
- CASE 0.25 (6.4)
- 14.66 (372.4)
- 15.81 (401.8)
- USER ELECTRICAL CONNECTION TERMINALS
- 6.66 (169.2)
- 5.42 (137.7)
- 0.62 (15.7)
- DIMENSIONS: INCHES (MILLIMETERS)

FIGURE 2-2 Station Dimensions
stock, angle iron, metal channel, etc. The panel cutout should be square and flat, especially the bottom edge. Uneven cutting of the bottom edge can cause the station case(s) to cock and detract from front panel appearance.

An optional Analog Module Rack (AMR) can be used to mount up to six stations without cases. The AMR accepts circuit board clusters, fits standard 19" rails and, since the top and bottom covers are perforated, must be mounted in an enclosure. Screw terminals like those on the standard case are located at the rear of the AMR for electrical connections. Alternatively, the installer can fabricate a rack to support stations mounted in cases.

Raceways, conduit, and wiring should not interfere with the removal or accessibility of the instruments, control devices, alarms, and related equipment.

2.3.2 STATION MOUNTING

This section provides procedures for single station mounting and multiple station row mounting of the TLDC.

2.3.2.1 SINGLE STATION MOUNTING

Single station mounting consists of mounting one TLDC in a single panel cutout.

1. Loosen and remove mounting brackets. See Figure 2-2.

2. Insert TLDC into panel cutout.

3. Install and partially tighten mounting brackets.

4. Square TLDC with panel.

5. Square mounting brackets with panel.

6. Alternately tighten mounting brackets until TLDC is secured to panel. Do not overtighten.

2.3.2.2 MULTIPLE STATION ROW MOUNTING

Multiple station row mounting consists of grouping a number of TLDCs side by side within a single panel cutout.

1. Loosen and remove mounting brackets from all TLDCs. See Figure 2-2.

2. Insert an end of row TLDC into panel cutout; install and partially tighten mounting brackets.

3. Insert remaining TLDCs into panel cutout; install and partially tighten mounting brackets.
GUIDELINES

FAN: PAMOTOR TYPE 4600X SHADED POLE FAN WITH 5504 FINGER GUARD OR EQUIVALENT.

NO. OF FANS: ONE FOR EACH 16 STATIONS OR 3 FT. (0.9 METERS) OF PANEL WIDTH.

AIR INLET: 30 IN² FOR EACH FAN. IF FILTERS ARE USED, THEY MUST BE CHANGED PERIODICALLY (INCREASE INLET TO 50 IN²).

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FIGURE 2-3 Forced Air Ventilation for Enclosed Panels
4. Square and space the TLDCs in cutout.

5. Alternately tighten mounting brackets on each TLDC until all are secured to panel. Do not over tighten.

2.4 ELECTRICAL INSTALLATION

The following sections describe wiring guidelines that should be followed when wiring a TLDC installation and define the purpose of each station rear terminal.

WARNING

Remove power from all involved wires and terminals to eliminate electrical shock hazard.

2.4.1 WIRING GUIDELINES

All wiring must conform to the National Electrical Code and local codes. DC wiring should be separated from AC wiring, and away from AC powered pushbuttons, alarms, annunciators, motors, solenoids, and similar devices. Metallic and non-metallic raceway and conduit are commonly used for routing panel wiring. Wiring not installed in raceways or conduit should be clamped or supported approximately every 12 inches.

Stranded wire is recommended, however, solid wire is typically used for thermocouple extension wire. Carefully select the wire size, conductor material, and appropriate insulation. Some selection considerations are:

- Current and voltage to be carried
- Total length of each wire run
- Whether wire will be bundled or run singly
- Indoor or outdoor installation
- Temperature extremes
- Exposure to sunlight
- Vibration
- Types of contaminate

Electrical connections are made to the screw terminals on the rear of the case. To make a connection, insert a stripped wire end or crimp-on terminal under the pressure plate at a screw terminal and tighten the screw. When preparing wires and making connections, refer to Figure 2-4 and the following:

- Stranded Conductor: Strip wire end 1/4" to 5/16" or as recommended by the crimp-on terminal manufacturer
- Solid Conductor: Strip wire 3/8" to 7/16" and form a gradual bend that will hook behind the terminal screw.
- Do not nick conductor or cut away conductor strands when stripping insulation

- Crimp-on terminals must have insulated barrels; use a high quality crimping tool recommended by the terminal manufacturer

- Carefully inspect the crimped connection for mechanical strength and stray strands of wire that could short to an adjacent screw terminal; conductor should not be visible outside the crimp-on terminal body

- Insert the stripped wire end or crimp-on terminal under the pressure plate and tighten the terminal screw for a reliable electrical connection. If a crimp-on terminal is not used, wire insulation should butt against the pressure plate and the conductor should not be visible; it is not necessary to wrap wire conductor around terminal screw.

- Inspect each connection completed for strands of wire that could short to an adjacent terminal, for connection to the correct terminal, and for tightness of the terminal screw. Pay particular attention to the braided shield on twinaxial cable for the Local Instrument Link.

**FIGURE 2-4 Conductor Installation on Rear Terminals**
2.4.2 REAR TERMINAL CONNECTIONS

All electrical connections are made to the terminals located at the rear of the TLDC. Rear terminals are designated by a column letter and a row number (e.g., A1, D8) as shown in Figure 2-5 and Table 2.1. Recommended wire size for signal wiring is 18 gauge (AWG); power wiring 14 gauge (AWG).

WARNING

Remove power from all involved wires and terminals to eliminate electrical shock hazard.

Rear terminals have #6 screws and pressure plates. They accept stranded wire, solid wire, and spring spade tongue or ring tongue crimp-on terminals with insulated barrels. See Figure 2-4. For an electrical connection to be made, a terminal screw must be tightened clamping the wire or crimp-on connector between the pressure plate and spring plate on the terminal strip body to insure electrical contact.

Station common is at rear terminal A5. It should be connected to the user’s instrument bus common. Within the TLDC, station common is connected to a common reference point which in turn is connected to the two-wire power supply common, the digital output common, and all analog input and analog output commons. Station common is isolated from case ground, terminal AG. Digital input commons are isolated from the station common and case ground.

The TLDC accepts voltage inputs. When a current input (e.g., 4 to 20 mA) is to be applied to the TLDC, a precision range resistor must be placed across the input terminals. A range resistor may not be required if the input is wired in parallel with other 1 to 5 Vdc receiving instruments. Refer to loop diagrams and determine if a range resistor is required. Supplied range resistors are 250 ohms for 4 to 20 mA inputs.

2.4.3 INPUTS AND OUTPUTS

A. ANALOG INPUTS

Each analog input is connected between an Analog Input (+) terminal and an Analog Input Common terminal. All analog inputs must be 1 to 5 Vdc. For mA inputs, a range resistor must be connected across the analog input terminals. This precision (0.1%) resistor should be wire wound, 1/2 W. Supplied range resistors are 250 ohms: quantity 5. Terminal A5 (station common) to be connected to user’s common ground bus.

B. OPTIONAL NO. 3 INPUT

Pulse (Computer) Input Board

Pulse-direction or dual-pulse inputs are accepted; jumper-plug selected, see Figure 2-6. Refer to Figure 2-7 for a wiring diagram. Terminal A9 is source common, may be at ground or up to 30 Vdc. Terminal A10 is Pulse or Up. Terminal B10 is Direction or Down.
Thermocouple/Millivolt Input Board
Thermocouple or millivolt inputs are applied across A10 and B10. Reference Junction Temperature Sensor Board is connected across A8 and A9 for T/C inputs; See Figure 2-5. Refer to Calibration, section 4.2 for span and TC break jumper-plug positions.

Voltage Input Board
Analog input, 1 to 5 Vdc. For mA input, a range resistor must be connected across the input terminals.

Frequency Input Board
If input signal is less than 100 Hz, set W1 to SLOW; otherwise, leave W1 in FAST position as shown in Figure 2-8.

RTD Input Board
RTD connections for 2-wire, 3-wire, and 4-wire devices are described in the Table in Figure 2-5 and shown in Figure 4-4.

C. DIGITAL INPUTS
Each digital input is connected between a Digital Input(+) terminal and a Digital Input(-) terminal. The Input(-) terminal is isolated from station common and station ground. An inductive source, such as a relay coil, must be shunted by either a transient suppression diode or resistor/capacitor suppression network to prevent damage to a TLDC input circuit. Protection required is similar to that shown in Figure 2-9 for digital outputs.

D. ANALOG OUTPUTS
Each analog output is connected between an Analog Output(+) terminal and an Analog Output Common(-) terminal. Standard output is 4 to 20 mA with referenced to station common.

E. DIGITAL OUTPUTS
Each digital output is connected between a Digital Output(+) terminal and a Digital Output Common(-) terminal. Output circuits use open collector NPN transistors referenced to station common. Voltage source to external load can be +26 Vdc at rear terminal B5 or a separate power supply. Load must limit current to 100 mA or less. An inductive load must be shunted by either a transient suppression diode or resistor/capacitor suppression network to prevent damage to an TLDC output circuit. Refer to Figure 2-9.

F. +26 VDC TRANSMITTER SUPPLY
Terminal B5 can be used to power up to four two-wire transmitters. An inductive load, such as the relay shown in Figure 2-9B, may cause a momentary drop in transmitter output.
### TABLE 2.1 Rear Terminal Assignments

This table lists rear terminal designations, assignments, and comments. Input/output specifications are contained in section 1.3. Figure 2-5 shows the case rear terminals.

<table>
<thead>
<tr>
<th>TERMINAL</th>
<th>ASSIGNMENT</th>
<th>COMMENT/REFERENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>POWER</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AH</td>
<td>AC Hot or DC (+)</td>
<td>See Model Designation section and station nameplate for voltage input.</td>
</tr>
<tr>
<td>AN</td>
<td>AC Neutral or DC (-)</td>
<td></td>
</tr>
<tr>
<td>AG</td>
<td>Case (Safety) Ground</td>
<td></td>
</tr>
<tr>
<td>B5</td>
<td>+26 VDC Transmitter Supply</td>
<td>80 mA max; see section 2.4.3 F</td>
</tr>
<tr>
<td><strong>LOOP 1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A4</td>
<td>Analog Input 1 (+)</td>
<td>See section 2.4.3 A</td>
</tr>
<tr>
<td>A5</td>
<td>Analog Input Common (-)</td>
<td>Station Common</td>
</tr>
<tr>
<td>A6</td>
<td>Analog Input 2 (+)</td>
<td>See section 2.4.3 A</td>
</tr>
<tr>
<td>A7</td>
<td>Analog Output (+)</td>
<td>See section 2.4.3 D</td>
</tr>
<tr>
<td>A8</td>
<td>Analog Output Common (-) or TC Sensor Board</td>
<td>Station Common</td>
</tr>
<tr>
<td>A9</td>
<td>Optional No. 3 Input or TC Sensor Board</td>
<td>See Figure 2-5 and section 2.4.3 B</td>
</tr>
<tr>
<td>A10</td>
<td>Optional No. 3 Input</td>
<td>See Figure 2-5 and section 2.4.3 B</td>
</tr>
<tr>
<td>B4</td>
<td>Digital Output 1 (+)</td>
<td>See section 2.4.3 E</td>
</tr>
<tr>
<td>B6</td>
<td>Digital Output 2 (+)</td>
<td>Station Common</td>
</tr>
<tr>
<td>B7</td>
<td>Digital Output Common (-)</td>
<td>See section 2.4.3 C</td>
</tr>
<tr>
<td>B8</td>
<td>Digital Input (+)</td>
<td></td>
</tr>
<tr>
<td>B9</td>
<td>Digital Input (-)</td>
<td></td>
</tr>
<tr>
<td>B10</td>
<td>Optional No. 3 Input</td>
<td>See Figure 2-5 and section 2.4.3 B</td>
</tr>
<tr>
<td><strong>LOOP 2</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1</td>
<td>Relay Output Normally Open</td>
<td>Relay contacts isolated from station common and case ground</td>
</tr>
<tr>
<td>C2</td>
<td>Relay Common</td>
<td></td>
</tr>
<tr>
<td>C3</td>
<td>Relay Output Normally Closed</td>
<td></td>
</tr>
<tr>
<td>TERMINAL</td>
<td>ASSIGNMENT</td>
<td>COMMENT/REFERENCE</td>
</tr>
<tr>
<td>----------</td>
<td>---------------------</td>
<td>----------------------------------------</td>
</tr>
<tr>
<td>C7</td>
<td>Digital Input (+)</td>
<td>See section 2.4.3 C</td>
</tr>
<tr>
<td>C8</td>
<td>Digital Input (-)</td>
<td></td>
</tr>
<tr>
<td>D4</td>
<td>Analog Input 1 (+)</td>
<td>See section 2.4.3 A</td>
</tr>
<tr>
<td>D5</td>
<td>Analog Input Common (-)</td>
<td>Station Common</td>
</tr>
<tr>
<td>D6</td>
<td>Analog Input 2 (+)</td>
<td>See section 2.4.3 A</td>
</tr>
<tr>
<td>D9</td>
<td>Analog Output (+)</td>
<td></td>
</tr>
<tr>
<td>D10</td>
<td>Analog Output Common (-)</td>
<td>Station Common</td>
</tr>
</tbody>
</table>

**LOOP 3**

<table>
<thead>
<tr>
<th>TERMINAL</th>
<th>ASSIGNMENT</th>
<th>COMMENT/REFERENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>C5</td>
<td>Analog Output (+)</td>
<td>See section 2.4.3 D</td>
</tr>
<tr>
<td>C6</td>
<td>Analog Output Common (-)</td>
<td>Station Common</td>
</tr>
<tr>
<td>C9</td>
<td>Digital Input (+)</td>
<td>See section 2.4.3 C</td>
</tr>
<tr>
<td>C10</td>
<td>Digital Input (-)</td>
<td></td>
</tr>
<tr>
<td>D1</td>
<td>Relay Output Normally Open</td>
<td>Relay contacts isolated from station common and case ground</td>
</tr>
<tr>
<td>D2</td>
<td>Relay Common</td>
<td></td>
</tr>
<tr>
<td>D3</td>
<td>Relay Output Normally Closed</td>
<td></td>
</tr>
<tr>
<td>D7</td>
<td>Analog Input (+)</td>
<td>See section 2.4.3 A</td>
</tr>
<tr>
<td>D8</td>
<td>Analog Input Common (-)</td>
<td>Station Common</td>
</tr>
</tbody>
</table>

**LOCAL INSTRUMENT LINK**

<table>
<thead>
<tr>
<th>TERMINAL</th>
<th>ASSIGNMENT</th>
<th>COMMENT/REFERENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1</td>
<td>Link (+)</td>
<td>See Figure 2-10 and SD15492 for LIL installation information</td>
</tr>
<tr>
<td>B2</td>
<td>Link (-)</td>
<td></td>
</tr>
</tbody>
</table>

**NO CONNECTION**

<table>
<thead>
<tr>
<th>TERMINAL</th>
<th>ASSIGNMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>B3</td>
<td>Do Not Connect To This Terminal</td>
</tr>
<tr>
<td>C4</td>
<td>Do Not Connect To This Terminal</td>
</tr>
</tbody>
</table>
**COLUMN A**

- A1 - AC HOT OR DC (+)
- A2 - AC NEUTRAL OR DC (-)
- A3 - CASE GROUND
- A4 - LOOP 1 ANALOG INPUT 1 (+)
- A5 - ANALOG INPUT COMMON (-)
- A6 - LOOP 1 ANALOG INPUT 2 (+)
- A7 - LOOP 1 ANALOG OUTPUT (+)
- A8 - ANALOG OUTPUT COMMON (-)
- A9 - OPTIONAL LOOP 1 NO.3 INPUT (SEE TABLE)
- A10 - OPTIONAL LOOP 1 NO.3 INPUT (SEE TABLE)

**COLUMN C**

- C1 - LOOP 2 RELAY OUTPUT N.O.
- C2 - LOOP 2 RELAY COMMON
- C3 - LOOP 2 RELAY OUTPUT N.C.
- C4 - NO CONNECTION
- C5 - LOOP 3 ANALOG OUTPUT (+)
- C6 - ANALOG OUTPUT COMMON (-)
- C7 - LOOP 2 DIGITAL INPUT (+)
- C8 - LOOP 2 DIGITAL INPUT (-)
- C9 - LOOP 3 DIGITAL INPUT (+)
- C10 - LOOP 3 DIGITAL INPUT (-)

**COLUMN B**

- B1 - LINK (+)
- B2 - LINK (-)
- B3 - NO CONNECTION
- B4 - LOOP 1 DIGITAL OUTPUT 1 (+)
- B5 - 26VDC 80mA MAX INTR SUPPLY
- B6 - LOOP 1 DIGITAL OUTPUT 2 (+)
- B7 - DIGITAL OUTPUT COMMON (-)
- B8 - LOOP 1 DIGITAL INPUT (+)
- B9 - LOOP 1 DIGITAL INPUT (-)
- B10 - OPTIONAL LOOP 1 NO.3 INPUT (SEE TABLE)

**COLUMN D**

- D1 - LOOP 3 RELAY OUTPUT N.O.
- D2 - LOOP 3 RELAY COMMON
- D3 - LOOP 3 RELAY OUTPUT N.C.
- D4 - LOOP 2 ANALOG INPUT 1 (+)
- D5 - ANALOG INPUT COMMON (-)
- D6 - LOOP 2 ANALOG INPUT 2 (+)
- D7 - LOOP 3 ANALOG INPUT (+)
- D8 - ANALOG INPUT COMMON (-)
- D9 - LOOP 2 DIGITAL OUTPUT (+)
- D10 - ANALOG OUTPUT COMMON (-)

**NO. 3 INPUT TABLE**

<table>
<thead>
<tr>
<th>TERMINAL</th>
<th>A8</th>
<th>A9</th>
<th>A10</th>
<th>B10</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOOP 1 INPUT OPTION</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VOLTAGE</td>
<td>NOT USED</td>
<td>(-)</td>
<td>(+)</td>
<td>NOT USED</td>
</tr>
<tr>
<td>MV &amp; T/C</td>
<td>SENSOR BOARD</td>
<td>SENSOR BOARD</td>
<td>(+)</td>
<td>(-)</td>
</tr>
<tr>
<td>COMPUTER PULSE DUAL PULSE PULSE/DIRECTION</td>
<td>NOT USED</td>
<td>NOT USED</td>
<td>SOURCE COMMON</td>
<td>SOURCE COMMON</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>UP PULSE</td>
<td>DOWN PULSE</td>
</tr>
<tr>
<td>FREQUENCY</td>
<td>NOT USED</td>
<td>NOT USED</td>
<td>(+)</td>
<td>(-)</td>
</tr>
<tr>
<td>RTD 3 OR 4 WIRE 2 WIRE</td>
<td>NOT USED</td>
<td>NOT USED</td>
<td>POWER JUMPER TO A10</td>
<td>(+)</td>
</tr>
</tbody>
</table>

**NOTES:**

1. ISOLATED FROM STATION COMMON.
2. STATION COMMON (ALL INTERNALLY TIED).
NOTES:
1. ASSEMBLY VIEWED FROM BOTTOM
2. JUMPER PLUG COLORS MUST RUN PARALLEL TO CIRCUIT BOARD. DO NOT ROTATE JUMPER PLUG SO COLORS ARE PERPENDICULAR TO CIRCUIT BOARD.

PULSE INPUT BOARD JUMPER-PLUG

FIGURE 2-6 Pulse Input Board, Physical Layout
FIGURE 2-7 Typical Pulse Input Connections
NOTE:
UVEPROM (ULTRAVIOLET ERASABLE ELECTRICALLY PROGRAMMABLE READ-ONLY MEMORY)

DAC (DIGITAL/ANALOG CONVERTER)

BOARD SHIPPED WITH W1 IN "FAST" DEBOUNCE POSITION AS SHOWN. ALTERNATE POSITION IS "SLOW" DEBOUNCE. SEE INPUT SPECIFICATIONS.

PA-1214-1
A. Relay Load and User Supplied Power Supply

B. Relay Load and Station +26V Power Supply

C. Solid State Loads (e.g., Alarm Annunciator)

FIGURE 2-9 Digital Outputs to Typical Loads
A. ROW TO ROW CONNECTIONS, TWINAXIAL CABLE

B. ROW MOUNTED STATION CONNECTIONS, TWISTED PAIR WIRING

NOTES:
1. DRAIN WIRE OF SHIELD CONNECTS TO TERMINAL SG. A SHORT JUMPER OF 16 AWG. INSULATED WIRE GROUNDS SHIELD TO TERMINAL AG.
2. DRAIN WIRE OF SHIELD IS CUT BACK AND INSULATED.
3. \( \downarrow \) DENOTES 18 AWG TWISTED PAIR CONDUCTORS.
4. TWISTED PAIR WIRING IS USED TO INTERCONNECT STATIONS SEPARATED BY UP TO 2 FT. (0.5 METERS) EITHER WITHIN A ROW OR ROW-TO-ROW. TWINAXIAL CABLE IS USED FOR DISTANCES GREATER THAN 2 FT. THE MAXIMUM TWISTED PAIR LENGTH IS 10 FT (2.9 METERS).

SEE SD15492 FOR COMPLETE INFORMATION ON LOCAL INSTRUMENT LINK WIRING.

PA-1285-2

FIGURE 2-10 Link Connections
2.5 CIRCUIT BOARD INSTALLATION

This section describes field installation of circuit boards and the Display Assembly. Some shipments are made with the board cluster and Display Assembly separated from the case. They are installed in the case by the user. Also, the user can add circuit boards to a previously acquired station to increase its usefulness. Added boards must be software compatible with those previously installed; see section 6.7. Station calibration and configuration may be needed when circuit boards are added.

The Controller and Expander Board Assembly, No.3 Input Boards, Link Interface Board, and Display Assembly contain integrated circuits which can be damaged by electrostatic discharge, therefore, special handling is required. Handling guidelines and installation procedures are provided in the following sections.

2.5.1 HANDLING GUIDELINES

1. Each circuit board and Display Assembly is shipped in a static shielding bag. Keep each item in its bag until time of installation.

2. A grounding wrist strap must be used when handling a circuit board and is highly recommended when handling the Display Assembly. The display assembly bezel is made of plastic so the Display Assembly can be installed without touching the boards inside.

Moore Products Co. part numbers for a Service Kit containing a grounding wrist strap and mat and for Static Shielding Bags are given in the Maintenance section of this Instruction.

2.5.2 CIRCUIT BOARD CLUSTER AND DISPLAY ASSEMBLY

Additional circuit boards can be mounted on the Controller and Expander Board Assembly, depending upon model designation. Refer to Figure 2-11.

1. Remove board retainer.

2. Snap grounding wrist strap around wrist and attach ground clip.

3. Remove board cluster from static shielding bag and insert Controller Board into card guides.

4. Check the color coded extractor tab on the Controller Board. The colors indicate the power requirements for the Assembly.

5. Push on top and bottom of Board with equal force to slide Assembly into case.
6. Install board retainer.

**IMPORTANT**

The board retainer must be in place whenever the Controller Board is installed in the case.

7. Remove Display Assembly from static shielding bag. Handle Assembly by bezel.

8. Connect Controller Board ribbon cable to Display Assembly.

9. Detach ground clip from case.


11. Secure Assembly by tightening captive screw behind ID plate.

2.5.3 NO. 3 INPUT BOARD

A No.3 Input Board can be field-installed in a Model 351.

Only one No.3 Input Board can be added to a Station. The Parts List at the back of this instruction shows that the No.3 Input Board plugs into connector J2 of the Controller Board and that it is positioned and secured by four spacers and eight screws.

1. If Controller Board is installed in a case, remove the Board and Display Assembly by reversing the steps in section 2.5.2.

2. Place Controller Board on a grounded conductive mat, component side up.

3. Remove Expander Board by:
   A. Removing four screws and lockwashers securing Expander Board to spacers.
   B. Disconnecting Expander Board ribbon cable connector from J1 on Controller Board.

4. Remove No. 3 Input Board from static shielding bag and set jumper plugs as follows:
   Pulse Input Board - See Figure 2-6.
   Thermocouple/Millivolt Input Board - See Figure 4-1.
   Voltage Input Board - None to be set.
   RTD Input Board - None to be set.
   Frequency Input Board - See Figure 2-8.
COLOR SUPPLY
WHITE 120VAC
YELLOW 24VAC
BLUE 24VDC
GREEN 220VAC

FIGURE 2-11 Assembly Installation
5. See Figure 1-1 for No. 3 Input Board orientation. Align 40 pin connector on No.3 Input Board with connector J2 on Controller Board; while applying equal force to both ends of the No.3 Input Board connector, carefully mate the connectors.

6. Install a spacer between the No.3 Input Board and the Controller Board at each corner of the No.3 Input Board use the two, 4-40 x 3/8 lg. pan head screws with lockwashers at each corner to secure the Board.

7. Install Expander Board.

8. Install Controller Board and Display Assembly in case according to instructions in section 2.5.2.

9. For a Thermocouple/Millivolt Input Board jumpered for thermocouple input, install Sensor Board on case terminals A8 and A9. See Figure 2-5.

2.5.4 LINK INTERFACE BOARD

Figure 5-2 and the Parts List at the back of this Instruction indicate that the Link Interface Board must be connected to J3 of the Controller Board and secured with four spacers and eight screws. Follow the procedure below to install a Link Interface Board.

1. Refer to Handling Guidelines, section 2.5.1, prior to removing a Link Interface Board from its static shielding bag or removing Controller Board from case.

2. If Controller Board is installed in case, reverse procedure in section 2.5.2 and remove Display Assembly and Controller Board; otherwise, continue this procedure.

3. Place Controller Board on a grounded conductive mat - component side up.

4. See Figure 1-1 for Link Interface Board orientation. Line-up P1 of Link Interface Board with J3 of Controller Board and note positions which the 4 spacers will occupy - directly under the 4 corner screw holes in the Link Interface Board. Do not plug Link Interface Board into Controller Board at this time.

5. Mount 4 spacers on Controller Board and secure with four #4-40 x 3/8 lg. pan head screws.

6. Plug P1 of Link Interface Board into J3 of Controller Board. Secure Link Interface Board to 4 spacers with four #4-40 x 3/8 lg. pan head screws.
7. Installation is complete. Reinstall Controller Board and Display Assembly in case according to instructions in section 2.5.2.

NOTE

The Link Interface Board requires no jumper-plug settings or calibration; however, the Station's link address must be set and it must be configured under FB198, FB298, or FB398 prior to placing it into operation. Refer to the TLDC User's Manual or the Configuration Handbook AD351-20 for additional instructions.

2.5.4.1 Setting Link Address

A TLDC equipped with a Link Interface Board can communicate with other link-connected stations and/or devices providing that FB*98 (see Note at bottom of page) has been configured and the assigned station address set into the Station by the user.

IMPORTANT

A Station connected to the LIL must have the station address set to communicate on the LIL.

The following information will be required prior to setting a Station's address:

1. The user assigned Station address. (Refer to System Drawing or other applicable documentation.)

2. Execution Sequence Number (ESN) assigned to FB*98. (Refer to AD351-30, MYCRO 351 Configuration Documentation Booklet.)

Use the following procedure to set the address of a Station in Loop 1. Set the address in one loop and the others will be automatically set.

1. With power off at Station, verify that 'H/T/F' lockout switch is enabled. (Refer to Figure 5-3 for switch location.)

2. Verify Station's model number and input power requirement. The Stations's nameplate is on the Controller Board; refer to section 1.2, Model Designation, to decode the model number. Figure 2-11 shows the color coded extractor tab that also indicates the power input requirement. Apply power to Station.

3. Press ENTER CONF button to enter configuration mode at MENU level. Refer to section 3.5. (Refer to Figure 5-6 for location of buttons.)

NOTE: Replace * with Loop Designator 1, 2, or 3.
4. Rotate Pulser Knob to select 'T' (table) on left digit position of alphanumeric display. (If 'TX' appears in the display, the lockout switch on the Controller Board must be enabled.)

5. Press STEP DOWN button to enter FUNCTION BLOCK level.

6. Rotate Pulser Knob to select function block '198'.

7. Press STEP DOWN button to enter PARAMETER level. ('TESN' appears in alphanumeric display.)

8. Press STEP DOWN button to enter VALUE level.

9. Rotate Pulser Knob to ESN assigned to FB198 in user's Configuration Documentation Booklet AD351-30. (If ESN is unavailable, set Pulser Knob to any close value in order to continue with this procedure.)

10. Press STORE button to lock-in value.

11. Press EXIT button.

12. Press ENTER CONF button to enter configuration mode at MENU level.

13. Rotate Pulser Knob to select 'H' (hard configuration) mode on left digit position of alphanumeric display.

14. Press STEP DOWN button to enter FUNCTION BLOCK level.

15. Rotate Pulser Knob to select function block '198' on right side digits of alphanumeric display. (FB '198' will not be available if ESN set to 00 or not stored in accordance with steps 9 and 10.)

16. Press STEP DOWN button. ('HLSA' appears in alphanumeric display.)

17. Press STEP DOWN button. (Station address 0 to 64 appears in 4-1/2 digit display.)

18. Rotate Pulser Knob to assigned Station address. (Refer to the Configuration Booklet AD351-30.)

19. Press STORE button to lock-in desired value.

20. Press EXIT button.

This completes the procedure. Refer to SD15492, Installation and Service Instruction, Local Instrument Link, for additional information.
2.6 FACTORY CALIBRATION

Unless a special calibration is ordered, the factory calibration is as follows:

Analog input function blocks....1 to 5 Vdc

Analog output function blocks...4 to 20 mA

Pulse Input Board..............Refer to section 1.3.6

Frequency Input Board.........Min 0.0 Hz
                                   Max 25,000 Hz
                                   ZDO 0.0%

RTD Input Board...............CZI3 - 100 ohms
                                  CFI3 - 200 ohms
                                  CVI3 - -3.3 to 103.3%

RTD Input Board...............CZI3 - 100 ohms
                                  CFI3 - 200 ohms
                                  CVI3 - -3.3 to 103.3%

Thermocouple/Millivolt Input Board
Thermocouple....................Type J, Upscale Burnout

Voltage Input Board............1 to 5 Vdc

Section 4 provides calibration procedures which may be used to check or change factory calibration.

IMPORTANT

Thermocouple calibration includes the Sensor Board. Changing the Sensor Board from that supplied with the TLDC will require recalibration.

2.7 CONFIGURATION

The station must be configured before it can be placed on-line to control a process. Refer to either AD351-10, Model 351 User’s Manual or AD351-20, Model 351 Configuration Handbook for configuration information.
3.0 OPERATION

This section describes the controls and signal displays used for TLDC operation. Since the TLDC is user configured, the information provided in this section is considered typical. Refer to either User's Manual AD351-10 or Configuration Handbook AD351-20 for a configuration procedure.

Some displays and controls are used during both configuration and operation. The use of displays and controls for station operation is explained in this section; refer to the above literature for their use during configuration.

Refer to Figure 3-1 for each of the following sections.

3.1 4-1/2 DIGIT DISPLAY

The 4-1/2 digit display is used to indicate a variable from the display select group. The desired loop must be selected. Any configured variable in this group [i.e., (P) process, (S) setpoint, (V) valve, (X) user defined variable, and (Y) user defined variable] can be selected for display.

The "D" display select pushbutton is used to select the displayed variable. Pressing this pushbutton steps the display one position in the sequence P, S, V, X, and Y from any starting point within the display select group. This pushbutton is inactive during configuration modes and all variables in the display select group are off.

Each TLDC loop is configured for power-up in either automatic or manual operating mode or last position before power out. The display will show the appropriate variable upon power-up: setpoint for automatic, valve for manual.

The process, setpoint, and user defined variables can be configured for display in scaled process units (such as pressure, temperature, GPM) or for 0 to 100%. A positive range value is indicated with a (+) sign and a (-) sign indicates a negative range value.

3.2 ALPHANUMERIC DISPLAY

This display shows an activated status when a specified condition is met.

A1 - Alarm #1; FB*12; See Note 1 on the following page
A2 - Alarm #2; FB*12
A3 - Alarm #3; FB*12
A4 - Alarm #4; FB*12
AD - Deviation Alarm #3; FB*12
HI - Hi/Lo limit input equal to or higher than high limit setting; FB*09
L0 - Hi/Lo limit input equal to or lower than low limit setting; FB*09

OR - Override selector status output indicates normal "A" input being overridden by "B" or "C" input; FB*10

SS - A/M transfer block in standby synchronization mode; FB114 and FB124

EM - A/M transfer block in emergency manual mode; FB314

U1 - User configurable Input #1; FB*15; see Note 2

U2 - User configurable Input #2; FB*15; see Note 2

EI - Emergency Internal; FB*11

EL - Emergency Local; FB*98

NU - Non-Updating input; FB*98

E* - Station error; specific error code; see section 6

NOTES:
1. FB*** - Replace * with Loop Designator 1, 2, or 3. Displayed *'s have other meanings as discussed in the accompanying text.
2. U1 and U2 can be configured to be any two digit status, excluding ones defined here.

During normal operation, the alphanumeric display is blank. When a single status condition is activated, the status indicator is displayed and may be followed by an asterisk (A1, A2, A3, A4 and AD only) and the number 1 e.g., "A1*1". When multiple status conditions are activated, either simultaneously or additionally with others, one of the statuses is displayed followed by an asterisk (if, A1, A2, A3, A4 or AD is in alarm) and the total number of activated status conditions, e.g., "A1*3".

A maximum of five status indicators may be selected to trigger the flashing of a Loop's process and setpoint bargraphs when a status indication is activated. Acknowledgment of the bargraphs can be configured to be self-clearing and the flashing of the bargraphs will cease when the status condition no longer exists. A local operator can always clear the flashing by pressing the "ACK" acknowledge pushbutton.

The "ACK" pushbutton is also used to step through activated status conditions. Each time this pushbutton is pressed, the remaining active status indicators are stepped through for display.

When the station is in the operating mode, the "TAG" pushbutton is used to display the loop tag (LTN), engineering units (EU), link station address (LSA), data base revision number (DRN), station identification number (SID) and
4-1/2 DIGIT DISPLAY OF SELECTED VARIABLE

SELECTED LOOP

DISPLAY SELECT GROUP

PROCESS AND SETPOINT

INDIVIDUAL FLASHING BARGRAPHS

VALVE BARGRAPH

AUTOMATIC/MANUAL PUSHBUTTON MODE SWITCH

PULSER KNOB

DISPLAY SELECT PUSHBUTTON

ACKNOWLEDGE PUSHBUTTON

LOOP SELECT PUSHBUTTON

FIGURE 3-1 Operator Controls and Signal Displays
configuration filename of the loop as configured in FB#15 and FB#98. This data will be scrolled in the alphanumeric display. Press the EXIT pushbutton to halt scrolling of the alphanumeric display and return it normal display status.

3.3 BARGRAPH DISPLAYS

Three, red LED bargraph displays are mounted vertically, each dedicated to a particular loop’s process and setpoint. These bargraphs each contain 32 LED bars and indicate from 0% to 100%.

The horizontal valve bargraph contains 40 LEDs and displays the valve signal of the selected loop. The valve bargraph indicates the valve signal with respect to percent of valve opening from 0% to 100%. Note that the valve bargraph has the words CLOSE at 0% and OPEN at 100%. If a valve signal increases to move the valve in the open direction, the valve bargraph is configured so that a 0% valve signal is shown as 0% (CLOSE) and a 100% valve signal is shown as 100% (OPEN). If a valve signal decreases to move the valve in the open direction, the valve bargraph is configured so that a 0% valve signal is shown as 100% (OPEN) and a 100% valve signal is shown as 0% (CLOSE).

All signals must be configured by the user unless a Factory Configured Option is used. Typically, control stations (i.e., a TLDC configured with a control function) have the setpoint displayed as “S” on the vertical bargraphs, the process displayed as “P” on the vertical bargraphs, and the valve signal on the valve (horizontal) bargraph. A non-control station (i.e., a TLDC configured without a control function) typically has the station input displayed on the vertical bargraph and the valve signal on the valve bargraph.

In addition, the three process and setpoint bargraphs can be configured to flash on and off in response to an activated status condition; see section 3.2.

3.4 PULSER KNOB

The pulser knob is normally used to adjust the local setpoint and manual output. The setpoint is adjusted during automatic modes and the manual output is adjusted during manual modes.

The pulser knob action for manual operation is determined during configuration. It can be set for either direct action (i.e., clockwise turning increases the manual output) or for reverse action (i.e., clockwise turning decreases the manual output). Note that the pulser knob action applies only to manual output adjustment and is typically configured so that clockwise turning increases the process signal.

During configuration, the pulser knob is used to change the function block number selection or parameter value.
3.5 OPERATING MODES

The operating modes required for any TLDC operation are dependent upon the user configuration of the station function and control strategy. All typical operating modes for standard industrial controller types can be configured for use by the TLDC.

The Loop pushbutton is used to select which loop is currently being monitored or configured.

The A/M (Automatic/Manual), E/I (External/Internal), and C/L (Console/Local) pushbutton mode switches are used to establish the operating modes locally. Any combination of these switches can be configured for use. Each mode switch has a corresponding function block from which the switch function or functions are selected. The following paragraphs describe the typical function selections of the three mode switches.

The A/M switch may be used to select either automatic or manual control. Each mode has a corresponding LED indication; a green LED is lighted to indicate automatic and a red LED is lighted to indicate manual.

The E/I switch may be used to select either an external or internal setpoint for the controller setpoint. Each mode has a corresponding LED indication; a green LED is lighted to indicate external setpoint and a red LED is lighted to indicate internal setpoint.

The C/L switch may be used to establish the origin of loop control for a link interface equipped TLDC. Console control can be by a MYCRO Operator Console or an independent computer via an Independent Computer Interface. Local control is maintained by an operator locally. Each mode has a corresponding LED indication; a green LED is lighted to indicate console control and a red LED is lighted to indicate local control. When this switch is not configured for use, local control is assumed and no LED indication is shown.

The functions of the three mode switches can be combined to accommodate the desired station function.

For most functions, the A/M switch used alone provides control with a local operator adjusted setpoint in automatic or valve signal in manual. A link interface equipped TLDC can use the C/L switch in conjunction with the A/M switch to allow for either non-local or local control. Non-local control (Console mode) allows a MYCRO Operator Console or independent computer via an Independent Computer Interface to adjust the controller setpoint or valve signal and to switch between non-local and local control. The E/I switch can be used together with the A/M or C/L switch or with both switches. This switch allows for an external setpoint only or a choice of an external or internal setpoint for the controller. When configured so that an external or internal setpoint may be chosen, both non-local and local selection can be performed in the applicable console or local mode.
The TLDC is configured for power-up in the desired operating mode. Switching between modes can be user configured to be bumpless and procedureless.

3.6 DISPLAY TEST

Pushing the EXIT configuration button will light all display segments and LEDs. A three step test is automatically performed on the alphanumeric display to light all its segments. The Station must be in an operating mode for display test to function. If the Station is in a configuration mode when the EXIT button is pressed, the Station will exit configuration without performing a display test.

3.7 PUSHPUTTON CARE

Pushbuttons should be pressed by a finger, an unused eraser on a pencil, or a stick eraser. Use of a hard implement, such as the cap end of a pen, a blunt tool, or a fingernail, may deform the dome switch and result in pushbutton failure.
4.0 CALIBRATION

This section describes calibration and calibration verification of the following function blocks (FB):

<table>
<thead>
<tr>
<th>FB</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FB101</td>
<td>Analog Input 1 -----</td>
</tr>
<tr>
<td>FB102</td>
<td>Analog Input 2</td>
</tr>
<tr>
<td>FB103</td>
<td>Analog Output</td>
</tr>
<tr>
<td>FB201</td>
<td>Analog Input 1 :----- Refer to section 4.1</td>
</tr>
<tr>
<td>FB202</td>
<td>Analog Input 2</td>
</tr>
<tr>
<td>FB203</td>
<td>Analog Output</td>
</tr>
<tr>
<td>FB301</td>
<td>Analog Input</td>
</tr>
<tr>
<td>FB303</td>
<td>Analog Output -----</td>
</tr>
<tr>
<td>FB199</td>
<td>No.3 Input</td>
</tr>
<tr>
<td></td>
<td>Voltage Input - Refer to section 4.1</td>
</tr>
<tr>
<td></td>
<td>T/C or mV Input - Refer to section 4.2</td>
</tr>
<tr>
<td></td>
<td>RTD Input - Refer to Section 4.3</td>
</tr>
<tr>
<td></td>
<td>Frequency Input - Refer to Section 4.4</td>
</tr>
</tbody>
</table>

Stations calibrated at the factory will not need to be recalibrated for most applications. However, for critical applications, consider the following during recalibration.

- If a current signal (e.g., 4-20 mA) is applied, use a precision current source to calibrate the analog input Function Block. The 250 ohm precision resistor installed across a pair of terminals for calibration should remain with the station, connected across that set of terminals, to eliminate the voltage drop variation due to resistor tolerance.

- Allow the Station to warm-up for one hour prior to calibrating. The ambient temperature should be close to normal operating conditions.

Periodic calibration is not necessary. However, calibration and verification should be performed under any of the following circumstances:

- To check or change the calibration of a new or in-service TLDC

- When a No.3 Input Board is added by the user (configuration will be needed)

- Upon replacing one of the following Boards: Controller, Expander, Thermocouple/Millivolt, Voltage Input, RTD, or Frequency Input

- After changing the type of No.3 Input Board (configuration will be needed)

- For a Thermocouple/Millivolt Input Board:
  After changing selection of T/C or mV, or upscale or downscale break, (configuration will be needed)
  After replacing a Reference Junction Temperature Sensor Board

- As part of a troubleshooting or failure confirmation routine

10/90
Factory calibrations are listed in section 2.6. Function blocks that are not configured can also be calibrated. In this way, calibration will not be required in the event configuration is changed at a future date to include these blocks. The Station should be off-line during calibration.

Lockout Switches are located on the front edge of the Controller Board as shown in Figure 5-3. The 'C' (calibration) lockout switch is factory set to lockout the calibration mode. This prevents inadvertent changing of calibration parameters from the front panel Keyboard. However, the calibration mode may be left in an enabled condition, if desired. To gain access to and set the lockout switch:

1. Flip down the front panel ID plate to reveal the captive bezel retaining screw.
2. Loosen the screw and separate the Display Assembly from the case. Support the Assembly so it doesn’t hang by the ribbon cable.
3. Refer to Figure 5-3 to locate and set the ‘C’ configuration lockout switch to “enable”.
4. After setting the lockout switch, reinstall the Display Assembly.

The bargraphs on the Display Assembly are not used during the calibration procedure. Ignore any bargraph indications during calibration.

Calibration and calibration verification are described in the following procedures.

4.1 ANALOG INPUTS AND OUTPUTS AND VOLTAGE INPUT BOARD

The TLDC analog input and analog output function blocks have been factory calibrated for 1 to 5 Vdc inputs and 4-20 mA dc outputs.

If calibration of any of the above mentioned function blocks is necessary, use the following procedures. Be sure to select the loop you wish to calibrate by pressing the LOOP button.

1. If applicable, place the 'C' (calibration) lockout switch in the 'enable' position. This enables the Station’s calibration mode. See Figure 5-3.
2. Press ENTER CONF button to enter configuration mode at the MENU level.
3. Rotate Pulser Knob to select 'C' (calibration) on left digit position of alphanumeric display. (If 'CX' appears in the display, the lockout switch on the Controller Board must be enabled.)
4. Press STEP DOWN button to enter FUNCTION BLOCK level.
5. Rotate Pulser Knob to select desired input or output function block number on right side digits of alphanumeric display. Refer to Table 4.1.

6. At Station's rear terminals connect either:

A. For analog input or Voltage Input Board:

Electronic calibrator or a precision reference source capable of supplying a voltage between 0.000 and 5.000 Vdc connected to selected input terminals for calibrating analog input function blocks. (Ensure that terminal screws are tight.)

B. For analog output:

Electronic calibrator or digital multimeter capable of displaying a current between 4.00 and 20.00 mA dc to selected output terminals for calibrating analog output function blocks. (Ensure that terminal screws are tight.)

7. Press STEP DOWN button to enter PARAMETER level.

8. Rotate Pulser Knob to select desired parameter (e.g., 'CZ11' zero input 1 or 'CZ01' zero output 1). Parameter is indicated on alphanumeric display. See Table 4.1.

9. Press STEP DOWN button to enter VALUE level ('CAL' appears on 4-1/2 digit display).

10. For calibration, perform either A or B depending upon function block selected in step 5.

A. Analog Input:

1) Set precision voltage source to zero input value (0.000 to 1.000 Vdc).

2) Press STORE to lock-in desired value.

3) Press STEP UP button.

4) Rotate Pulser Knob to select full scale parameter (CFI_).

5) Press STEP DOWN button.

6) Set voltage source to full scale input value (4.000 to 5.000 Vdc).

7) Press STORE.

8) Proceed to step 11.
B. Analog Output

1) Rotate Pulser Knob to set zero output to 4.00 mA on digital multimeter or electronic calibrator.

2) Press STORE button to lock-in desired value.

3) Press STEP UP button.

4) Rotate Pulser Knob to select full scale parameter (CFO_).

5) Press STEP DOWN button to enter Value level ('CAL' appears on 4-1/2 digit display).

6) Rotate Pulser Knob to set full scale output to 20.00 mA.

7) Press STORE

11. To verify calibration, proceed to step 12. If verification is not needed, proceed to step 13.

12. For verification, perform either A or B depending upon function selected in step 5.

A. Analog Input

1) Press STEP UP button.

2) Rotate Pulser Knob to select verification parameter (e.g., CVII verify input 1). Parameter is shown on alphanumeric display. See Table 4.1.

3) Press STEP DOWN button to enter VALUE level.

4) Set precision voltage source to zero input voltage. The 4-1/2 digit display should read 0.0%.

5) Set source to full scale voltage. The 4-1/2 digit display should read 100.0%.

6) Proceed to step 13.
<table>
<thead>
<tr>
<th>Block Number</th>
<th>Function</th>
<th>Block Number</th>
<th>Input</th>
<th>Output</th>
<th>Loop</th>
<th>Rear Terminal Connections</th>
</tr>
</thead>
<tbody>
<tr>
<td>101</td>
<td>1</td>
<td>1</td>
<td>CZI1</td>
<td>Zero, Input #1</td>
<td>A4+; A5-</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>CFII</td>
<td>Full Scale, Input #1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>CVI2</td>
<td>Verify Input #1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>102</td>
<td>2</td>
<td>1</td>
<td>CZI2</td>
<td>Zero, Input #2</td>
<td>A6+; A5-</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>CFII</td>
<td>Full Scale, Input #2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>CVI2</td>
<td>Verify Input #2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>103</td>
<td>--</td>
<td>1</td>
<td>CZO</td>
<td>Zero, Output</td>
<td>A7+; A8-</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>CFO</td>
<td>Full Scale, Output</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>CVO</td>
<td>Verify Output</td>
<td></td>
<td></td>
</tr>
<tr>
<td>201</td>
<td>1</td>
<td>2</td>
<td>CZI1</td>
<td>Zero, Input #1</td>
<td>D4+; D5-</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>CFII</td>
<td>Full Scale, Input #1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>CVI1</td>
<td>Verify Input #1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>202</td>
<td>2</td>
<td>2</td>
<td>CZI2</td>
<td>Zero, Input #2</td>
<td>D6+; D5-</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>CFII</td>
<td>Full Scale, Input #2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>CVI2</td>
<td>Verify, Input #2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>203</td>
<td>--</td>
<td>2</td>
<td>CZO</td>
<td>Zero, Output</td>
<td>D9+; D10-</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>CFO</td>
<td>Full Scale, Output</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>CVO</td>
<td>Verify, Output</td>
<td></td>
<td></td>
</tr>
<tr>
<td>301</td>
<td>1</td>
<td>3</td>
<td>CZI1</td>
<td>Zero, Input #1</td>
<td>D7+; D8-</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>CFII</td>
<td>Full Scale, Input #1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>CVI1</td>
<td>Verify, Input #1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>303</td>
<td>--</td>
<td>3</td>
<td>CZO</td>
<td>Zero, Output</td>
<td>C5+; C6-</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>CFO</td>
<td>Full Scale, Output</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>CVO</td>
<td>Verify, Output</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
B. Analog Output

1) Press STEP UP button.

2) Rotate Pulser Knob to select verification parameter (e.g., CV01 verify output 1). See Table 4.1.

3) Press STEP DOWN button to enter VALUE level.

4) Rotate Pulser Knob to set 4-1/2 digit display to 0.0%. Output current should be 4.00 mA.

5) Rotate Pulser Knob to set 100.0%. Output current should be 20.00 mA.

6) Proceed to step 13.

13. Select one of the following:

If all points have been calibrated and verified, press EXIT button calibration mode and enter operation mode.

If additional function blocks are to be calibrated and verified, press STEP UP button twice to enter FUNCTION BLOCK level. Perform steps 5 through 13 for each function block.

14. Lock out the Station's calibration mode via the Controller Board's 'C' lockout switch.

This step is recommended.

4.2 THERMOCOUPLE/MILLIVOLT INPUT BOARD

The following provides calibration procedures for the Thermocouple/Millivolt Input Board. Calibration must be performed with the Board installed in the TLDC in which it will be used and, for a thermocouple input, the Sensor Board which will remain with the TLDC. Tables 4.2 and 4.3 list the values for hard configuration parameter HI3T and for calibration parameters CI3T, C2I3 and CFI3. Table 4.2 is for a Thermocouple Input and Table 4.3 for a Millivolt Input. The Thermocouple/Millivolt Input Board is configured under FB199.

NOTE

A No. 3 Input Board is configured in Loop 1.
4.2.1 REQUIRED EQUIPMENT

Calibration of a Thermocouple/Millivolt Input Board requires the use of some or all of the following equipment:

1. Model 351 Station with TC/mV Input Board installed. For thermocouple input, Sensor Board must be installed on Station rear terminals A8 and A9.

2. Precision millivolt or thermocouple calibration source for required millivolt calibration range or thermocouple type and calibration range. The signal source must be adjustable to an accuracy of +/-0.01% or better and provide a source resistance of 100 ohms or less.

3. Two small containers of crushed ice and water and a laboratory bulb thermometer or a commercially produced ice bath reference.

4. Two foot length of appropriate T/C extension wire.

**IMPORTANT**
Use the same gauge of wire that will be used when the Station is on-line.

5. Two 2-foot lengths of #18 gauge, insulated copper wire.


4.2.2 PRELIMINARY ADJUSTMENTS

Refer to Figure 4-1 for the location of jumper-plugs J1 and J2 used to select the desired operating modes. Set the jumper-plugs according to the table in the Figure.

4.2.3 PROCEDURE

Presented first is a thermocouple calibration procedure. A millivolt calibration procedure follows.

4.2.3.1 Thermocouple Input

The calibration procedure prepares the TLDC for the type thermocouple and the zero and full scale calibration input values in millivolts or °F for a specific thermocouple temperature range (calibration parameters). Refer to Table 4.2 for the required calibration input values. Actual operating engineering units and temperature range are entered as soft ('S') configuration parameters after calibration is completed.

Three different "off-line" methods for calibrating thermocouple inputs are illustrated in Figure 4-2. Method 1 is the most accurate and recommended.
**Thermocouple Inputs**

<table>
<thead>
<tr>
<th>J,K OR E</th>
<th>T.R.S. OR B</th>
<th>-20 mV TO +20 mV</th>
<th>-75 mV TO +75 mV</th>
</tr>
</thead>
<tbody>
<tr>
<td>WIDE J2</td>
<td>NARROW J3</td>
<td>NARROW J3</td>
<td>WIDE J2</td>
</tr>
</tbody>
</table>

**Input Break Direction and Jumper**

- Up or down J4

**Notes:**
1. As shown: Narrow span, upscale break.
2. Operation is possible with jumper-plug J4 removed; however, the "input break" feature is disabled.
3. Recalibration is required if jumper-plugs are changed in any way.
4. EROM (erasable programmable read only memory).

---

**Figure 4-1 Thermocouple/Millivolt Input Board Jumper-Plugs**
METHOD 1

PRECISION MILLIVOLT SOURCE

INSULATED COPPER WIRES

OTHER

RED

THERMOCOUPLE EXTENSION WIRES

ICE BATHS

(COMMERCIAL AVAILABLE ICE BATH EXECUTES ELIMINATE NEED FOR CONTAINERS, ICE, WATER, AND THERMOMETER.)

METHOD 2

T/C CALIBRATOR DIRECT TEMPERATURE READOUT

OTHER

THERMOCOUPLE EXTENSION WIRES

WITH COLD JUNCTION COMPENSATION

METHOD 3

PRECISION MILLIVOLT SOURCE

OTHER

RED

THERMOCOUPLE EXTENSION WIRES

UNCOMPENSATED

M MILLION

MEASURE CONTACT TEMPERATURE HERE

NOTE:
WHERE THERMOCOUPLE EXTENSION WIRES ARE SHOWN, IT IS ADVISABLE TO CALIBRATE WITH THE SAME GAUGE OF WIRE USED IN THE ACTUAL OPERATING INSTALLATION.

FIGURE 4-2 Typical Calibration Hook-Up Diagrams - Thermocouple Input
Methods 2 and 3 are provided as alternatives should circumstances prevent the use of Method 1.

Select a method from Figure 4-2 and proceed as follows:

1. With power off at Station, verify that 'C' (calibration) and 'T' (table) lockout switches are enabled on Controller Board. Refer to Figure 5-3 for switch locations.

2. Place T/C extension wires (if possible, the actual gauge wire that will be used in final installation) under rear terminals A10 (+) and B10 (-) and tighten screws.

   **IMPORTANT**
   
   Do not use alligator or similar clips for connections.

3. Connect as follows:

   **Method 1** - Connect each end of the extension wires to separate 2-foot lengths of insulated copper wire (solder or twist ends), and insert junction points into separate ice baths. Connect opposite ends of copper wires to calibration source. (Power off at calibration source.)

   **Methods 2 & 3** - Connect T/C extension wires to calibration source. Observe polarity as indicated. (Power off at calibration source.)

4. Refer to Figure 2-5 and connect Sensor Board between rear terminals A8 and A9 as shown. (Component side of Board faces case.)

5. Verify Station's model number and input power requirement. Apply power to Station.

   **IMPORTANT**
   
   Allow at least 1 hour for warm up before proceeding.

6. Press ENTER CONF button to enter configuration mode at MENU level. See Figure 5-6 for keypad button locations.

7. To set-in T/C type or check Station's configured T/C type:

   A. Rotate Pulser Knob to select 'T' (table) on left digit position of alphanumeric display. (If 'TX' appears in the display, the lockout switch on the Controller Board must be enabled.)

   B. Press STEP DOWN button to enter FUNCTION BLOCK level.
C. Rotate Pulser Knob to select function block '199'.

D. Press STEP DOWN button to enter PARAMETER level. ('ESN' appears in alphanumeric display.)

E. Press STEP DOWN button to enter VALUE level. Rotate Pulser Knob to any number except 00 in 4-1/2 digit display.

F. Press STORE button to lock-in value.

G. Press EXIT button.

H. Press ENTER CONF button to enter configuration mode at MENU level.

I. Rotate Pulser Knob to select on alphanumeric display, left hand digit, to 'C' (calibration).

J. Press STEP DOWN button to enter FUNCTION BLOCK level.

K. Rotate Pulser Knob to select function block number '199' on right side digits of alphanumeric display.

L. Press STEP DOWN button and rotate Pulser Knob until 'CI3T' appears in the alphanumeric display:

M. Refer to Table 4.2 and locate value under proper INPUT 3 TYPE column for the software and desired type T/C.

<table>
<thead>
<tr>
<th>TYPE</th>
<th>T/C TYPE</th>
<th>ZERO INPUT (CIZ3) mv</th>
<th>FULL SCALE INPUT (CIZ3) mv</th>
<th>°F</th>
<th>°F</th>
</tr>
</thead>
<tbody>
<tr>
<td>J</td>
<td>2</td>
<td>-0.885</td>
<td>53.525</td>
<td>0</td>
<td>1700</td>
</tr>
<tr>
<td>K</td>
<td>3</td>
<td>-0.692</td>
<td>52.939</td>
<td>0</td>
<td>2400</td>
</tr>
<tr>
<td>E</td>
<td>4</td>
<td>-1.026</td>
<td>70.821</td>
<td>0</td>
<td>1700</td>
</tr>
<tr>
<td>T</td>
<td>6</td>
<td>-5.341</td>
<td>19.095</td>
<td>-300</td>
<td>700</td>
</tr>
<tr>
<td>R</td>
<td>7</td>
<td>2.017</td>
<td>19.518</td>
<td>500</td>
<td>3000</td>
</tr>
<tr>
<td>S</td>
<td>8</td>
<td>1.962</td>
<td>17.347</td>
<td>500</td>
<td>3000</td>
</tr>
<tr>
<td>B</td>
<td>9</td>
<td>3.274</td>
<td>11.829</td>
<td>1500</td>
<td>3000</td>
</tr>
</tbody>
</table>
N. Press STEP DOWN button and rotate Pulser Knob until the desired value appears in the 4-1/2 digit display.

(For example, a 2 must be displayed for a type J T/C. If desired value will not appear, check position of J1.)

O. Press STORE button to lock-in desired value.

P. Press EXIT button.

Q. Press ENTER CONF button.

8. Rotate Pulser Knob to select ‘C’ (calibration) mode on left digit position of alphanumeric display.

9. To set-in Zero Input value:

A. Press STEP DOWN button to enter FUNCTION BLOCK level.

B. Rotate Pulser Knob to select function block number ‘199’.

C. Press STEP DOWN button to enter PARAMETER level. (‘CZI3’ appears in alphanumeric display.)

D. Press STEP DOWN button to enter VALUE level. (‘CAL’ appears in 4-1/2 digit display.)

E. Refer to Table 4.2 and obtain value in millivolts under Zero Input (CZI3) column for type T/C selected.

IMPORTANT

The value for full range, not the range desired, must be used.

F. For Method 1, verify that ice baths are at 32°F (0°C). Periodically, stir slurry gently with thermometer and monitor temperature. Add crushed ice as required.

G. Set calibration source as follows:

Method 1 - Apply power to calibration source and adjust output to millivolt value from Table 4.2 and step E.

Method 2 - A T/C calibrator with direct temperature readout and cold junction compensation is used. Refer to calibrator instruction manual for detailed calibrator operation. Apply power and set temperature in °F to Zero Input value listed in Table 4.2.
Method 3 - The value obtained for CFI3 from Table 4.2 must be compensated to 32°F (0°C) as follows:

a) Touch bulb end of thermometer to one of the input terminals. Allow reading to stabilize before recording temperature.

b) In the appropriate T/C Table, look up the equivalent millivolts.

c) Subtract the millivolts of step b) above from the millivolts obtained in Table 4.2 for step E.

d) Apply power to calibration source and adjust output to value obtained in step c) above.

For all methods, allow at least 10 seconds after changing applied input voltage before proceeding to next step. This is to allow the hardware filter voltage time to stabilize.

H. Press STORE button to lock-in desired value. (‘CAL’ blinks.)

I. Press STEP UP button once.

10. Rotate Pulser Knob to select 'CFI3' on alphanumeric display.

11. To set-in Full Scale Input value:

A. Press STEP DOWN button. (‘CAL’ appears.)

B. Refer to Table 4.2 and obtain value in millivolts from Full Scale Input (CFI3) column for type T/C selected.

C. For Method 1, verify that ice baths are at 32°F (0°C).

D. Set calibration source as follows:

Method 1 - Adjust calibration source to millivolt value (CFI3) from Table 4.2 and step B above.

Method 2 - Refer to calibrator instruction manual for detailed calibrator adjustment. Set calibrator temperature in °F to Full Scale Input value listed in Table 4.2.

Method 3 - The value obtained for CFI3 from Table 4.2 must be compensated to 32°F (0°C) as follows:

a) Touch bulb end of thermometer to one of the input terminals.
b) In the appropriate T/C Table, look up the equivalent millivolts.

c) Subtract the millivolts of step b) above from the millivolts obtained in Table 4.2 for step B.

d) Adjust output to value obtained in step c) above.

For all methods, allow at least 10 seconds after changing applied input voltage before proceeding to next step. This is to allow the hardware filter voltage time to stabilize.

E. Press STORE button to lock-in desired value. ('CAL' blinks.)

12. To verify calibration:

A. Press STEP UP button.

B. Rotate Pulser Knob to select 'CVI3' on alphanumeric display.

C. Press STEP DOWN button. (100% should appear in 4-1/2 digital display since calibration source is set to Full Scale Input value.)

D. Adjust calibration source to Zero Input value. (0% should appear in 4-1/2 digit display.)

13. Repeat steps 9 through 12 if Station fails calibration verification; otherwise, continue this procedure.

14. Press EXIT button. (The calibration parameters are transferred to the nonvolatile EEPROM and will remain indefinitely even if power is disconnected to the Station.)

15. To simulate a T/C break:

A. Turn off power to calibration source.

B. Simulate an open T/C by disconnecting calibration source. Observe Station bargraphs for required output signal reaction. (Example: If process (P) bargraph is configured to indicate output of FB99, it will increase if J1 is in "UP" position.) If Station calibration and configuration is complete, the valve bargraph (station output) will respond for fail-safe operation.

C. Remove power from Station.
D. Disconnect wires from terminals A10 and B10.

NOTE

The Sensor Board between terminals A8 and A9 must remain in place for on-line operation. DO NOT DISCONNECT.

This completes the calibration procedure. Lockout the 'C' (calibration) mode on Controller Board.

4.2.3.2 Millivolt Input

Refer to Figure 4-1 for jumper-plug settings and to Table 4.3 for the required calibration input values while calibrating the Thermocouple/Millivolt Input Board for a millivolt input.

The calibration procedure sets the Board for one of two fixed ranges and the zero and full scale input values in millivolts for the range selected (calibration parameters). Actual operating engineering units (zero and full scale in millivolts) are entered as soft ('S') configuration parameters after calibration is completed. Refer to Figure 4-3 for a typical calibration hook-up diagram and perform the following procedure:

1. With power off at Station, verify that 'C' (calibration) and 'T' (table) lockout switches are enabled on Controller Board. See Figure 5-3 for switch locations.

2. Connect the calibration source to the Station's rear terminals: A10 (+) and B10 (-).

3. Turn on power to calibration source and adjust for 0.000 Vdc.

4. Verify Station's model number and power input requirement. Apply power to Station.

IMPORTANT

Allow at least 1 hour for warm up before proceeding.

5. Press ENTER CONF button to enter configuration mode at MENU level.

6. To set-in range or check Station's configured range:

   A. Rotate Pulser Knob to select 'T' (table) on left digit position of alphanumeric display. (If 'TX' appears in the display, the lockout switch on the Controller Board must be enabled.)

   B. Press STEP DOWN button to enter FUNCTION BLOCK level.
C. Rotate Pulser Knob to select function block '199'.

D. Press STEP DOWN button to enter PARAMETER level. ('ESN' appears in alphanumeric display.)

E. Press STEP DOWN button to enter VALUE level. Rotate Pulser Knob to any number except 00 in 4-1/2 digit display.

F. Press STORE button to lock-in value.

G. Press EXIT button.

H. Press ENTER CONF button to enter configuration mode at MENU level.

I. Rotate Pulser Knob to select on alphanumeric display, left hand digit, to 'C' (calibration).

J. Press STEP DOWN button to enter FUNCTION BLOCK level.

K. Rotate Pulser Knob to select function block number '199' on right side digits of alphanumeric display.

L. Press STEP DOWN button and rotate Pulser Knob until 'CI3T' appears in the alphanumeric display.

M. Press STEP DOWN button and rotate Pulser Knob to 1 for 0 to 75mV range or to 5 for 0 to 20mV range.

N. Press STORE button to lock-in desired value.

O. Press EXIT button.

P. Press ENTER CONF button.

7. Rotate Pulser Knob to select 'C' (calibration) mode on left digit position of alphanumeric display.

<table>
<thead>
<tr>
<th>MILLIVOLT INPUT RANGE</th>
<th>INPUT 3 TYPE</th>
<th>ZERO INPUT (CZI3)</th>
<th>FULL SCALE INPUT (CFI3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-75 mV</td>
<td>1</td>
<td>0.000 mV</td>
<td>75.000 mV</td>
</tr>
<tr>
<td>0-20 mV</td>
<td>5</td>
<td>0.000 mV</td>
<td>20.000 mV</td>
</tr>
</tbody>
</table>
8. To set-in Zero Input value:
   A. Press STEP DOWN button to enter FUNCTION BLOCK level.
   B. Rotate Pulser Knob to select function block number '199' on right side digits of alphanumeric display.
   C. Press STEP DOWN to enter PARAMETER level. (‘CZI3’ appears in alphanumeric display.)
   D. Press STEP DOWN button to enter VALUE level. ('CAL' appears in 4-1/2 digit display.)
   E. Refer to Table 4.3 and locate 0.000 mV in Zero Input (CZI3) column for either range.
   F. Verify that calibration source is still at 0.000 mV. Allow at least 10 seconds after changing applied input voltage before proceeding to next step. This is to allow the hardware filter voltage time to stabilize.
   G. Press STORE button to lock-in desired value. ('CAL' blinks.)

9. Press STEP UP button and rotate Pulser Knob to select 'CFI3' on alphanumeric display.

10. To set-in Full Scale Input value:
   A. Press STEP DOWN button. ('CAL' appears.)
   B. Refer to Full Scale Input (CFI3) column in Table 4.3 and note that either 20.000 mV or 75.000 mV appears.
   C. Adjust calibration source to either 20.000 mV or 75.000 mV. Allow at least 10 seconds after changing applied voltage before proceeding to next step.
   D. Press STORE button to lock-in desired value. ('CAL' blinks.)

11. To verify calibration:
   A. Press STEP UP button.
   B. Rotate Pulser Knob to select 'CVI3' or alphanumeric display.
   C. Press STEP DOWN button. (100% should appear in 4-1/2 digit display as calibration source is set to Full Scale Input value.)
   D. Adjust calibration source to Zero Input value. (0% should appear in 4-1/2 digit display.)
12. Repeat steps 8 through 11 if Station fails calibration verification; otherwise, continue this procedure.

13. Press EXIT button. (The calibration parameters are transferred to the nonvolatile EEPROM and will remain indefinitely even if power is disconnected to Station.)

14. Turn off power to calibration source.

15. Turn off power to Station.

This completes calibration procedure. Lockout the 'C' (calibration) mode on Controller Board.

4.3 RTD INPUT BOARD

This section contains a list of required equipment and the procedure for calibrating an RTD Input Board to accept low level input voltages over a range from -300°F to 1200°F (-185°C to 650°C) from a 100 ohm platinum resistance temperature detector. Engineering units (F or C), type of curve (DIN or US), and actual operating temperature range are entered as soft ('S') configuration parameters after calibration is completed. Refer to the Configuration Handbook AD351-20 for configuration procedure.

The RTD Input Board is a No. 3 Input Board calibrated under function block FB199. Rear terminal connections are shown in Figure 4-4 and calibration parameters and related values are shown in Table 4.4.

Once the Board is calibrated, FB199 Block Output 33 is a scaled and linearized signal using the values entered in configuration (SRT, SRU, SRL, SRH) so that the 0-100% signal represents a specific operating range.

4.3.1 REQUIRED EQUIPMENT

Calibration of an RTD Input Board requires the following equipment:

1. Model 351 Station with software and an RTD Input Board installed.

2. Two precision resistors (100 ohms, +/-0.01%, 1/4 W and 200 ohms, +/-0.01%, 1/4 W) or a resistance decade box capable of providing the two values specified.

3. Three, 2-foot lengths of 18 gauge (AWG), insulated copper wire.

IMPORTANT

To obtain proper lead resistance compensation during calibration, equal lengths of 18 gauge (AWG) must be used as in a 3-wire RTD connection.
**FIGURE 4-3 Typical Calibration Hook-Up Diagram - Millivolt Input**

**2-WIRE CONNECTION**

**3-WIRE CONNECTION**

**4-WIRE CONNECTION**

**FIGURE 4-4 RTD Connections**
4.3.2 PROCEDURE

The calibration procedure involves storing the Zero Input value (CZI3 = 100.00 ohms) and the Full Scale Input value (CFI3 = 200.00 ohms) into Controller Board memory.

If a resistance decade box is used to provide the required input resistance, ensure that the connections to the box minimize contact resistance. Three equal lengths of 18 gauge (AWG) wire provide equal resistance in each lead.

If two precision resistors are used (100.00 and 200.00 ohms) instead of the resistance decade box, ensure that equal lead lengths make good electrical contact with the resistors. It is recommended that the wires be soldered to the resistor leads.

Install crimp-on ring or spring spade terminals on the end of each lead that connects to the terminal screws of the TLDC as shown in Figures 2-4 and 4-4, 3-wire connection.

IMPORTANT

DO NOT use alligator clips. If alligator clips are used to make the connections on either end, contact resistance may be present and alter the calibration accuracy.

Proceed as follows:

1. With power off at Station, verify that the 'C' (calibration) lockout switch is enabled. See Figure 5-3 for location of switches on Controller Board.

2. Perform either A or B.
   
   A. Set resistance decade box to 100.00 ohms and connect as shown for 3-wire in Figure 4-4.
   
   B. Connect 100.00 ohm precision resistor to rear terminals as shown for 3-wire in Figure 4-4.

3. Verify Station's model number and input power requirement. Apply power to Station.

   IMPORTANT
   Allow at least 1 hour for warm up before proceeding.

4. Press ENTER CONF button to enter configuration at MENU level.
5. Rotate Pulser Knob to select 'C' (calibration mode on left digit position of alphanumerics display).

6. To set-in Zero Input value:
   A. Press STEP DOWN button to enter FUNCTION BLOCK level.
   B. Rotate Pulser Knob to select FB199.
   C. Press STEP DOWN button to enter PARAMETER level ('CZI3' appears in alphanumerics display).
   D. Press STEP DOWN button to enter VALUE level. ('CAL' appears in 4-1/2 digit display).
   E. Allow at least 15 seconds before proceeding to next step. This will allow the hardware filter voltage to stabilize.
   F. Press STORE button to lock-in desired value. ('CAL' blinks.)
   G. Press STEP UP button once.

7. Rotate Pulser Knob to select 'CFI3' on alphanumerics display.

8. To set-in Full Scale Input value:
   A. Press STEP DOWN button. ('CAL' appears.)
   B. Refer to Table 4.4 and perform either 1) or 2):
      1) Set resistance decade box to 200.00 ohms.
      2) Connect 200.00 ohm precision resistor to rear terminals as shown in Figure 4-4 for 3-wire RTD.
   C. Allow at least 15 seconds before proceeding to next step.
   D. Press STORE button to lock-in desired value. ('CAL' blinks.)

   **TABLE 4.4 Calibration Parameters, RTD Inputs**

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>DESCRIPTION</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>CZI3</td>
<td>Zero Input</td>
<td>100.00 Ohms</td>
</tr>
<tr>
<td>CFI3</td>
<td>Full Scale Input</td>
<td>200.00 Ohms</td>
</tr>
<tr>
<td>CVI3</td>
<td>Verify Input</td>
<td>-3.3 to 103.3%</td>
</tr>
</tbody>
</table>
CALIBRATION

9. To verify calibration:
   A. Press STEP UP button.
   B. Rotate Pulser Knob to select 'CVI3' on alphanumeric display.
   C. Press STEP DOWN button. 100.00% should appear in 4-1/2 digit display since input resistance is set to Full Scale Input value.
   D. Set input resistance to Zero Input Value (100.00 ohms). (0.00% should appear in 4-1/2 digit display.)

10. Repeat steps 6 through 8 if Station fails calibration verification; otherwise, the procedure is completed.

11. Remove power from Station.

12. Disconnect wires from terminals A9, A10 and B10.

13. Lockout the 'C' (calibration) mode on Controller Board.

4.4 FREQUENCY INPUT BOARD

The Frequency Input Board may be calibrated using either the automatic (learn) mode or the manual mode; procedures for these mutually exclusive calibration methods are explained in section 4.4.2.

Before calibration is performed, the steps in section 4.4.1 should be performed to enter the actual operating range of frequency inputs be entered in an TLDC equipped with a Frequency Input Board. This will ensure proper operation of the automatic (learn mode) calibration feature.

4.4.1 FREQUENCY CONFIGURATION

In this section, the actual operating range of frequency inputs will be entered into a TLDC equipped with a Frequency Input Board prior to calibration.

Minimum and maximum frequencies are entered as soft ('S') configuration parameters SMIN and SMAX.

Perform the following procedure to set-in the operating frequency range.

1. With power off at Station, verify that 'H/T/F' and 'S' lockout switches are enabled. Refer to Figure 5-3 for switch locations.

2. Verify Station's model number and input power requirement. Apply power to Station.

3. Press ENTER CONF button to enter configuration mode at MENU level.
4. Rotate Pulser Knob to select 'T' (table) on left digit position of alphanumeric display. (If 'TX' appears in the display, the lockout switch on the Controller Board must be enabled. Refer to Figure 5-3 for switch location.)

5. Press STEP DOWN button to enter FUNCTION BLOCK level.

6. Rotate Pulser Knob to select FB199.

7. Press STEP DOWN button to enter PARAMETER level. ('TESN' appears in alphanumeric display.)

8. Press STEP DOWN button to enter VALUE level. Rotate Pulser Knob to ESN for FB199 listed in Documentation Booklet. If a value has not been assigned and configuration will continue, rotate Pulser Knob to any number except 00 in 4-1/2 digit display.

9. Press STORE button to store value in memory.

10. Press EXIT button.

11. To set-in minimum and maximum values:
    
    A. Press ENTER CONF button to enter configuration mode at MENU level. ('S'-soft- appears on left digit position of alphanumeric display. If 'SX' appears, the lockout switch labeled S on the Controller Board must be enabled. Refer to Figure 5-3 for switch location.)
    
    B. Press STEP DOWN button to enter FUNCTION BLOCK level.
    
    C. Rotate Pulser Knob to select FB199 on right side digits of alphanumeric display.
    
    D. Press STEP DOWN button to enter PARAMETER level. ('SMIN' appears in alphanumeric display.)
    
    E. Refer to AD351-20, Configuration Handbook, for input signal minimum frequency.
    
    F. Press STEP DOWN button to enter value level. Rotate Pulser Knob to minimum frequency value.
    
    G. Press STORE button to store desired value. (Value blinks.)
H. Press STEP UP button and rotate Pulser Knob to SMAX value. (Refer to Documentation Booklet for maximum frequency of input signals.)

NOTE
The lowest value obtainable for SMAX is limited by software in order to comply with the minimum span listed in the specifications.

I. Press STEP DOWN button and rotate Pulser Knob to maximum frequency. (Example: Enter 48.0 in 4-1/2 digit display if maximum frequency is 48.0 Hz.)

J. Press STORE button to store desired value. (Value blinks.)

K. Press Exit button.

This completes the frequency configuration procedure for FB199, except for parameter SZDO. SZDO will not affect the calibration procedure that follows.

4.4.2 CALIBRATION

Generally, it is recommended that the automatic (learn) method be used. This eliminates the need to check manufacturer’s specifications or measure the signal’s peak and valley voltages with an oscilloscope. However, if the input voltage amplitude varies greatly, it is recommended that either manual calibration or automatic calibration under worse case conditions (lowest waveform amplitude) be performed.

The calibration parameters listed in Table 4.5 are set-in during this procedure.

4.4.2.1 Required Equipment

Calibration of the Frequency Input Board requires the use of the following equipment:

- Model 351 Station with software and a Frequency Input Board installed.

4.4.2.2 Procedure

There are two different calibration methods: automatic (learn mode) and manual. The automatic method is the recommended on-line procedure, since it requires no external equipment and the fewest number of steps. The manual method may require the use of an oscilloscope to measure the peak and valley voltages of the input signal, if manufacturer’s specifications are unavailable, and is more complex than the automatic method.
4.4.2.3 Automatic Calibration (LEARN) Method

A. Follow prescribed maintenance and operation procedures to install the TLDC equipped with Frequency Input Board on-line.

B. With power off at Station, verify that 'C' (calibration) lockout switch is enabled. Refer to Figure 5-3 for switch location.

C. Connect frequency input wires under rear terminals A10 (+) and B10 (-) and tighten screws.

D. Verify Station's model number and input power requirements in section 1.3. Apply power to Station.

E. Verify that process is generating frequency input signals to the TLDC.

F. Press ENTER CONF button to enter configuration mode at MENU level.

G. Rotate Pulser Knob to select 'C' (calibration) mode on left digit position of alphanumeric display. (If 'CX' appears in display, the 'C' (calibration) lockout switch must be enabled. Refer to Figure 5-3 for switch location.)

H. Press STEP DOWN button to enter FUNCTION BLOCK level.

I. Rotate Pulser Knob to select FB199 on right side digits of alphanumeric display.

J. Press STEP DOWN button and rotate Pulser Knob until CIL appears in alphanumeric display.

K. Press STEP DOWN button to enter VALUE level. ('LEArn' appears in 4-1/2 digit display.)

L. Press STORE button to activate automatic calibration.

(Depending on the operating frequency range entered as parameters SMIN and SMAX, the 4-1/2 digit display will either count down from a fixed number of seconds to 1 second, then 'dONE' appears followed by 'LEArn' or indicate 'LEArn' - (blank) - 'dONE' (blank) - 'LEArn'. This time is needed to sample the input signal's peak and valley voltages.)

M. Press EXIT button. (The calibration parameters CIPV and CIVV obtained automatically from the input signal are transferred to the nonvolatile EEPROM and will remain indefinitely even if power is disconnected to Station.)

This completes the automatic calibration procedure. The calibration mode should be disabled by setting the 'C'(calibration) lockout switch on Controller Board.

10/90
4.4.2.4 Manual Calibration Method

NOTE
This method can be used to calibrate a TLDC in the shop providing that the peak and valley voltages of the frequency input signals are known and the Controller Board and Frequency Input Board remain together after calibration.

A. With power off at Station, verify that ‘C’ (calibration) lockout switch is enabled. Refer to Figure 5-3 for switch location.

B. Verify Station’s model number and input power requirement in section 1.2. Apply power to Station.

C. Press ENTER CONF button to enter configuration mode at MENU level.

D. Rotate Pulser Knob to select ‘C’ (calibration) mode on left digit position of alphanumeric display.

E. Press STEP DOWN button to enter FUNCTION BLOCK level.

F. Rotate Pulser Knob to select function block ‘199’ on right side digits of alphanumeric display.

G. Press STEP DOWN button to enter PARAMETER level. (‘CIPV’ appears in alphanumeric display.)

H. Press STEP DOWN button to enter VALUE level and rotate Pulser Knob to input peak voltage (CIPV) listed in Documentation Booklet. This value can be obtained from manufacturer’s specifications or by making an oscilloscope measurement.

I. Press STORE button to store desired value. (Value blinks.)

J. Press STEP UP button and rotate Pulser Knob to ‘CIVV’ in alphanumeric display.

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>CALIBRATION METHOD</th>
<th>DESCRIPTION</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIPV</td>
<td>MANUAl</td>
<td>INPUT PEAK VOLTAGE</td>
<td>-30.0V to +30.0V</td>
</tr>
<tr>
<td>CIVV</td>
<td>MANUAl</td>
<td>INPUT VALLEY VOLTAGE</td>
<td>-30.0V to +30.0V</td>
</tr>
<tr>
<td>CIL</td>
<td>AUTOMATIC</td>
<td>INPUT VOLTAGE LEASE</td>
<td>learn</td>
</tr>
</tbody>
</table>
K. Press STEP DOWN button and rotate Pulser Knob to input valley voltage (CIVV) listed in Documentation Booklet. This value can be obtained from manufacturer's specifications or by making an oscilloscope measurement.

**NOTE**

The maximum value obtainable for CIVV is limited by software to be less than or equal to CIPV.

L. Press STORE button to store desired value. (Value blinks.)

M. Press EXIT button. (The calibration parameters CIPV and CIVV manually entered are transferred to the nonvolatile EEPROM and will remain indefinitely even if power is disconnected to Station.)

This completes the manual calibration procedure. The calibration mode should be disabled by setting the 'C' (calibration) lockout switch on the Controller Board.
5.0 CIRCUIT DESCRIPTION

The Triple-Loop Digital Controller's hardware architecture is shown in Figure 5-1. Notice that all major plug-in assemblies interact with the Controller Board.

The MPU-based Controller Board performs many of the Station's signal processing and process control functions in addition to overseeing other Station internal operations. It controls the Expander Board, Link Interface Board, Display Assembly and No.3 Input Board (e.g., Pulse Input Board). The Controller Board's on-board power supply furnishes DC operating voltages to all plug-in assemblies and to external process transmitters connected to the rear terminal block.

The Expander Board contains hardware which extends the signal I/O and signal processing capacity of the Controller Board.

The Display Assembly provides LED indication of process related signals, station operating mode and configuration parameters. It also accepts operator entered commands and data via the Assembly's front panel controls.

A functional description, a hardware block diagram and a physical layout drawing are provided for each of the following circuit areas:

- Controller and Expander Board Assembly
- Display Assembly
- No.3 Input Boards
- Link Interface Board

5.1 CONTROLLER AND EXPANDER BOARD ASSEMBLY

A Controller Board and an Expander Board must be installed for the TLDC to function. The three-letter software compatibility codes (e.g., BBA) must be the same on all UVEEPROM's (Ultraviolet Erasable Programmable Read Only Memory) on these two boards. See section 6.7 for further details.

5.1.1 CONTROLLER BOARD

The Controller Board's hardware is supported by a large array of software based function blocks. During Station configuration, a group of function blocks are linked together to meet the control requirements of the Station's process application. While many configurations are possible, the Board is typically configured to regulate a controlled variable by working to eliminate any difference between the Station's process and setpoint signals.

As shown in Figure 5-2, the Controller Board has two analog inputs, one optional third analog input, one digital input and one optional bidirectional serial port which passes Local Instrument Link signals. The Board also has two digital outputs and one analog output. The actual inputs and outputs which are active during station operation depend on its configuration. For example, a
16 CONFIGURABLE DISCRETE I/O CHANNELS. EACH IS CONFIGURABLE AS EITHER AN INPUT OR OUTPUT.
Station configured to accept an external setpoint signal will require the Controller Board to accept at least two analog input signals (i.e., the external setpoint and process signals). To determine the actual I/O arrangement, refer to the appropriate configuration documentation.

The Controller Board contains analog and digital circuits. The analog circuitry operates in real time while the microprocessor-based digital circuitry operates at high speed under program control.

The MPU (microprocessor unit) is a single integrated circuit capable of arithmetical, logical and support circuit control functions. It directly or indirectly interacts with surrounding on-board and off-board circuitry to control the internal operation of the TLDI. To operate under program control, the MPU systematically fetches instructions from the PROM area and executes them to control data flow and organize support circuit activities.

The Clock circuit contains a precision square wave oscillator which operates at 8 MHz. It also contains a flip-flop type of frequency divider network to down count the oscillator frequency to the value required by the MPU. Timing pulses from the Clock are used to synchronize the MPU’s computing activities.

The Watchdog Timer circuit is a dual “one-shot” interval timer that will automatically reset the MPU in the event it does not complete executing its programs within a predetermined time.

On-board memory consists of UVEPROM, EEPROM (electrically erasable programmable read only memory), and RAM (random access memory). The UVEPROM stores the operating programs for the function blocks and Factory Configured Options associated with a Model 351. It also stores the general operating programs for the on-board microprocessor. The EEPROM stores hard configuration, the table of function blocks, soft configuration, calibration data, and transient data. The RAM stores configuration and transient data.

During configuration and calibration, data is entered into RAM when the STORE button is pressed. Data is transferred to the EEPROM when the EXIT button is pushed. Transient data (process, station status, alarm, and error code data) is also stored in RAM. It is transferred to the EEPROM when power is removed from the Station.

The MPU’s three bus lines are the address bus, control bus and data bus. They interconnect the MPU and the support circuits. The address bus is unidirectional while the control and data buses are bidirectional.

The Signal Selector circuit operates under MPU control to select an analog signal and feed it to the A/D Converter. It is essentially a solid state switch.

The A/D Converter circuit converts an analog input signal into a digital value. Once digitized, the signal value can easily be manipulated and stored in memory by the MPU.
FIGURE 5-2 Controller Board, Hardware Block Diagram
The D/A Converter circuit converts a digital value into an analog signal.

The Reference Voltage Source circuit provides a precision analog reference for the D/A Converter.

The Amplifier circuit provides gain and drive capability to the analog signal output of the D/A Converter.

The Opto-Coupler circuit provides signal isolation of the digital input signal.

The on-board Power Supply is a non-removable assembly that provides DC operating voltages to TLDC circuits. It also provides a +26 Vdc output to power up to four process transmitters.

The physical layout of the Controller Board is illustrated in Figure 5-3. Lockout switches are located at the front of the Board and can be set to prevent unauthorized changes to selected configuration modes. The station power fuse is located at the rear of the board near rear connector J5. J5 mates with the case-mounted connector when the board cluster is inserted into the case.

5.1.2 EXPANDER BOARD

The Expander Board's hardware is supported by a large array of software-based function blocks. As with the Controller Board, during station configuration, a group of function blocks are linked together to meet the control requirements of the Station's process application.

As shown in Figure 5-4, the Expander Board has three analog inputs and two digital inputs. The Board also has two relay outputs and two analog outputs. The actual Expander Board inputs and outputs which are active during station operation depend upon station configuration.

The Expander Board's circuitry operates under the control of the MPU-based Controller Board. The Expander Board, like the Controller Board, is a hybrid assembly. The analog circuitry operates in real time while the microprocessor controlled digital circuitry operates at high speed under program control.

Many signal processing circuits on the Expander Board are very similar to those of the Controller Board. This can be seen by comparing block diagrams in Figures 5-2 and 5-4.

The on-board UVÉPROM stores operating programs for the function blocks associated with the Expander Board and is addressable by the Controller Board's MPU.

The on-board bus lines interconnect the Expander Board's circuits and the Controller Board MPU. The address bus is unidirectional while the data and control buses are bidirectional.
FIGURE 5-4 Expander Board, Hardware Block Diagram

FIGURE 5-5 Expander Board, Physical Layout

NOTE:
UVEPROM (ULTRAVIOLET ERASEABLE ELECTRICALLY PROGRAMMABLE READ-ONLY MEMORY)

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PA-0636-2
CIRCUIT DESCRIPTION

The Signal Selector circuit operates under the direction of the off-board MPU. It selects an analog input signal, depending upon the control operation at the time, and feeds it to the input of the A/D Converter circuit. It is essentially a solid state switch.

The A/D Converter circuit converts an analog input signal into an equivalent digital value. Once digitized, the signal value can easily be manipulated or stored in memory by the off-board MPU.

The D/A Converter circuits convert a digital value to analog signals.

The Amplifier circuits provide gain and drive capability to the analog output signals of the D/A Converters.

Relay 1 and Relay 2 are triggered by the off-board MPU to provide relay contact type outputs to the rear terminals of the TLDC. Each SPDT relay output can be connected in a normally open or normally closed contact state.

The Opto-Coupler circuits provide signal isolation for digital input signals.

The physical layout of the Expander Board is provided in Figure 5-5. There are no user adjustments on the Expander Board.

5.2 DISPLAY ASSEMBLY

The Display Assembly consists of four interconnected subassemblies:

- Display Interface Board
- Display Driver Board
- Display Board
- Keyboard

The Display Assembly functions under the direction of the Station's MPU-based Controller Board. It provides LED indication (both analog and digital) of process signals, accepts operator entered data during hard and soft configuration procedures, and supports the front panel operator controls. Refer to the hardware block diagram in Figure 5-6.

5.2.1 DISPLAY INTERFACE BOARD

The Display Interface Board performs several functions. It interfaces the Display Assembly to the Controller Board, supports operation of the front panel Pulser Knob, scans the Keyboard for operator initiated keystrokes and forwards display data to the Display Driver Board.

The Dual Optical Switch functions in conjunction with the front panel Pulser Knob to produce two pulse trains whenever the knob is rotated. 'Direction' pulses will either lead or lag 'step' pulses by 90° depending upon the direction in which the Pulser Knob is rotated. Since their lead-lag relationship is dependent on the direction of knob rotation, as illustrated in
FIGURE 5-6 Display Assembly, Hardware Block Diagram
Figure 5-7, the Digital Up/Down Counter knows whether to increment or decrement (direction pulses) and by how much (step pulses).

The number of pulses generated is counted by the Digital Up-Down Counter which places binary pulse counts on the data bus where they can be retrieved and used by the Controller Board to adjust process signals (e.g., setpoint or valve) or adjust configuration selections.

The Keyboard Scanner circuit has a built-in oscillator and scans the Keyboard at regular time intervals to sense a complete keystroke. If a keystroke is detected, data identifying that key is placed on the data bus where it can be interpreted by the Controller Board’s MPU. The Display Interface Board also acts as a bus feed-through by connecting the address and data buses of the Controller Board to the Display Driver Board.

5.2.2 DISPLAY DRIVER BOARD

The Display Driver Board performs two main functions. It decodes display data received from the MPU-based Controller Board (via the Display Interface Board) and forwards decoded display data to the Display Board.

The Segment And Digit Driver circuitry uses standard digital decoding and latching techniques. The circuit accepts encoded display data from the Display Interface Board and forwards decoded segment and digit/bargraph signals to the Display Board. It also decodes display data for a loop’s six on-board indicator LEDs.

5.2.3 DISPLAY BOARD

The Display Board contains the various LED devices used to display process and configuration information. It accepts decoded display drive signals from the Display Driver Board. Section 3 describes each display’s purpose.

All on-board LED devices are red, except for the C, E, and A LEDs which are green. At the top of the Board is a 4-1/2 digit numeric readout; at the upper right side is a 5-segment array; at the lower center is a 40-segment bargraph; and at the bottom is a 4-character alphanumeric readout. For each loop, there are a 32-segment vertical bargraph and six LEDs grouped into three pairs.

LEDs indicate the active states for C/L, E/I, and A/M front panel mode selector switches. A loop’s six LEDs are arranged in three vertical pairs with each pair consisting of one green (top) and one red (bottom) LED. Only one LED in each pair can be lit when the associated mode selector switch has been either configured or activated by a station option. The C/L switch is active when the optional Link Interface is present. The E/I switch is active when the EXTERNAL/INTERNAL function block is used and the A/M switch is active when the AUTO/MANUAL TRANSFER function block is used. Switches that have not been configured or do not have an associated option will have the corresponding LEDs off at all times.
FIGURE 5-7 Pulse Train Phase Relationship

FIGURE 5-8 Pulse Input Board, Hardware Block Diagram
5.2.4 KEYBOARD

The Keyboard is a membrane keypad that contains 15 switches. The layout of these switches is shown in the Keyboard section of Figure 5-6. Each switch has tactile feedback. The nine configuration switches, located at the bottom of the keypad, are accessible by opening the front panel flip-down door. Operator initiated keystrokes are sensed by circuitry on the Display Interface Board. The Keyboard has a built-in shield to prevent false triggering from static or EMI (electromagnetic interference). The switch contacts (1 Kohm closed resistance) are arranged in a matrix.

5.3 NO. 3 INPUT BOARD

Each following section describes a No.3 Input Board type that plugs into the Controller Board. Function Block (FB) 199, INPUT 3, must be configured for the Station to accept a No.3 input.

5.3.1 PULSE INPUT BOARD

The Pulse Input Board provides the Station with the capability of accepting computer pulse inputs. Typically, these pulses are used to increment or decrement a configuration defined signal within the Station. One application is the computer adjustment of the Station's setpoint signal. The on-board circuitry operates under the control of the Controller Board's MPU.

Refer to the hardware block diagram in Figure 5-8. Note that the Pulse Input Board plugs into the Controller Board. Therefore, the two pulse inputs are routed from the Station's rear terminals through the Controller Board to the Pulse Input Board. There are two modes of operation associated with the Pulse Input Board: the Dual-Pulse mode and the Pulse-Direction mode.

The Dual-Pulse mode of operation requires the application of a pulse train to Pulse Input 1 to increment a configuration defined signal or a pulse train to Pulse Input 2 to decrement the signal. Pulse characteristics are listed in the Specifications section of this Instruction.

The Pulse-Direction mode of operation requires the application of a pulse train to Pulse Input 1 and a logic level voltage (high or low) applied to Pulse Input 2. The pulse train will change the magnitude of a configuration defined signal while the logic level voltage determines if the signal is to be incremented or decremented. Pulse details are listed in the Specifications section of this Instruction.
As indicated in Figure 2-6, the pulse mode is selected by the position of the Board’s Pulse Mode jumper-plug P1. The jumper-plug is factory positioned in the Dual-Pulse mode before shipment.

On-board memory consists of a factory prepared UVEEPROM. It is used to store operating program information including Factory Configured Options associated with the Pulse Input Board. This information is required by the Controller Board’s MPU for configuration and to operate the Pulse Input Board.

The Pulse Rectifier circuit delivers positive going pulses to the Opto-Coupler circuit regardless of the input pulse polarity.

The Opto-Coupler circuit isolates incoming pulses to prevent circuit loading and ground loop signal interference.

The Up/Down Counter circuit is a 12 bit binary counter. It incrementally changes its output state (either up or down) in response to incoming pulses.

The Buffer circuit buffers the Up/Down Counter’s output to prevent loading the data bus.

5.3.2 THERMOCOUPLE/MILLIVOLT INPUT BOARD

The Thermocouple/Millivolt Input Board (FB199) can be configured to accept an input signal from one of the below sources:

- Millivolt source, -20 to 20 mVdc
- Millivolt source, -75 to 75 mVdc
- T/C type J, K, or E
- T/C type, T, R, S, or B

The hardware block diagram in Figure 5-9 indicates that the Board plugs into the Controller Board. Therefore, either the thermocouple signal and Sensor Board current input or the millivolt signal input is routed from the station’s rear terminals through the Controller Board to the Thermocouple/Millivolt Input Board.

A thermocouple input requires a Sensor Board. The Board contains a reference junction temperature sensing transistor that inputs a current proportional to temperature. The Current To Voltage Converter accepts this current and outputs a voltage (IN3) to the Controller Board for automatic reference junction temperature compensation.
DC operating voltages (+12V and -12V) are supplied from the Controller Board. The remaining circuitry on the Board is powered by 5V from the Controller Board; although, the stages in the thermocouple/millivolt signal path are powered by an isolated 5V supply from the isolated DC-DC Converter.

The thermocouple or millivolt input signal appears at the Overvoltage Protection And Open T/C Detection stage. The components in this stage function as transient suppressors and protect the input circuitry from accidental application of excessive plus or minus voltages.

The stage also contains jumper-plugs J1 and J2 (see Figure 4-1) for selecting Span (Narrow or Wide) and Direction (Up or Down) and the components which function to detect and respond to a T/C break or an open in the input wiring or terminal connections. The setting of J1 determines the gain of the Gain Block And Filter stage. When J1 is in the "Wide" position, the gain of the stage is set to process either a millivolt input between -75 and 75mV or T/C type J, K, or E. When J1 is in the "Narrow" position, the gain of the stage is set to process either a millivolt input between -20 and 20mV or T/C type T, R, S or B. Filter circuits remove noise appearing at the input of the Gain Block.

The amplified and filtered analog signal representing the thermocouple or millivolt signal appears at the input to the A/D Converter. The Converter produces a digital output consisting of a train of pulses whose count is proportional to the amplitude of the analog input. This output is routed through the Opto-Coupler to the digital serial count line. The Converter also outputs a logic level based upon whether the number undergoing conversion is plus or minus. This is called the sign line. A logic level from the Control Interface to the A/D Converter on the conv./stop line allows the Controller Board's MPU to control the action of the Converter.

The digital and sign inputs to the Control Interface circuitry are under the control of the Controller Board's MPU and exit via separate lines of the data bus. The MPU can also initiate a read operation and access the configuration information stored in the UVEPROM Memory. The address and data buses serve to transmit the request and respond with the required data.

### 5.3.3 VOLTAGE INPUT BOARD

The Voltage Input Board is capable of processing a 1-5 Vdc signal. Like other analog inputs, this input is applied to the rear terminals of the Station and routed through the Controller Board before being processed by the Voltage Input Board.

The block diagram in Figure 5-10 shows that the voltage input signal is filtered and buffered by U1 before its output is returned to the Controller Board. The on-board memory U3 is a factory programmed UVEPROM. It is used to store the operating program and the Factory Configured Options (FCO) associated with the Voltage Input Board. This information is required by the Controller Board's MPU for configuration and operation of the Voltage Input Board.
FIGURE 5-9 Thermocouple/Millivolt Input Board, Hardware Block Diagram

FIGURE 5-10 Voltage Input Board, Hardware Block Diagram
J1 CONNECTOR TO CONTROLLER BOARD CONNECTOR J2

SERIAL NUMBER LABEL

SOFTWARE COMPATIBILITY LABEL (SCID)

DRAWING REF. 15824-112, ISSUE 7

ASSEMBLY NUMBER LABEL

NOTE:
UVEPROM (ULTRAVIOLET ERASEABLE ELECTRICALLY PROGRAMMABLE READ-ONLY MEMORY)

NO USER SETTABLE JUMPER-PLUGS

PA-1066-1

FIGURE 5-11 Voltage Input Board, Physical Layout
When the Controller Board’s MPU addresses the Voltage Input Board, Memory chip U3 and Decoder U2 are enabled, placing the contents of Memory on the data bus. A “Read” signal (R) from the MPU to the Decoder produces an output signal that gates the contents of Memory through Buffer U4 to the Controller Board via the data bus.

A physical layout of the Voltage Input Board is illustrated in Figure 5-11.

5.3.4 RTD INPUT BOARD

The RTD Input Board is capable of processing a low level voltage from a 100 ohm platinum resistance temperature detector (RTD) exposed to a temperature range of -300°F to 1200°F (-185°C to 650°C).

The RTD Input Board provides excitation to and accepts a low level input voltage representing a temperature from an RTD. This analog input voltage is converted to a 16-bit digital value for application to the MPU on the Controller Board. The value is stored in the Station's data base as a No. 3 Input under function block FB199. Twice a second, the MPU reads the digital value from the Board and updates the data base.

Refer to the block diagram of the RTD Input Board shown in Figure 5-12 while reading the following circuit description. The physical layout of the Board is shown in Figure 5-13.

A constant current of 0.5 mA is established through the field-connected RTD by the action of the 1 mA Current Source and the 0.5 mA Current Sink. As a result, when the measured temperature changes, the RTD resistance varies to produce an equivalent millivolt DC signal. The Gain & Offset stage conditions this analog voltage to meet the input requirements of the A/D Converter. The A/D Converter outputs a 16-bit value onto the Data Bus every 500 ms or twice a second.

When a conversion from analog to digital is completed, the Data Valid line to the MPU goes low. The MPU addresses the Decoder and a Read signal is produced that enables the Multiplexer and gates the high byte from the output of the Converter through the Multiplexer. Simultaneously, a Read signal gates the high byte through the Buffer to the Data Bus.

A timer on the Controller Board produces an Initiate Conversion signal that disables the high byte, and through the Control stage, enables the low byte. For approximately 10 ms, the low byte input is enabled and the output of the Converter contains the low byte. During this time, another Read signal is produced and the low byte is gated from the output of the Converter through the Multiplexer. Simultaneously, a Read signal gates the low byte through the Buffer to the Data Bus. This completes one conversion and data transfer.
FIGURE 5-12 RTD Input Board, Hardware Block Diagram
NOTE:
UVEPROM (ULTRAVIOLET ERASEABLE ELECTRICALLY PROGRAMMABLE READ-ONLY MEMORY)

NO USER SETTABLE JUMPER-PLUGS

DRAWING REF. 15945-11, ISSUE 4
SOFTWARE COMPATIBILITY LABEL (SCID)

FIGURE 5-13 RTD Input Board, Physical Layout
CIRCUIT DESCRIPTION

Operating programs stores in the UVEPROM permit the MPU on the Controller Board to perform the following functions:

1. Linearization
2. Calibration
3. Filtering
4. Output Scaling

The Reference Voltage circuitry accepts -V, +12V and -12V inputs and produces +V and +1.2V outputs for on-board use.

5.3.5 FREQUENCY INPUT BOARD

The Frequency Input Board is capable of accepting sine, square, pulse or triangle waves at a frequency between 0.05 Hz and 25.00 KHz and at an amplitude from 4.00V to 60.00V peak-to-peak. It can also accept contact closure inputs at a maximum frequency of 100 Hz.

The Frequency Input Board converts a frequency input signal to a 12-bit digital value for application to the MPU on the Controller Board. The value is stored in the TLDC data base as a No. 3 input under FB 199. Refer to the block diagram of the Frequency Input Board in Figure 5-14 while reading the following circuit description. The physical layout of the Board is shown in Figure 2-8.

The Controller Board communicates with the Frequency Input Board via the MPU Data Bus and the Address Bus. Data is transferred to and from the Controller Board through the Data Bus Buffer which buffers the data and reduces loading on the MPU Data Bus. The on-board devices accessed from the Internal Data Bus are:

- An 8K x 8 UVEPROM that contains the MPU instructions, or programming, to operate the Frequency Input Board

- A 12-bit D/A Converter (DAC) used during the learn mode to calibrate the Controller Board's A/D Converter and, during normal operation, to update or refresh the analog voltages of the peak and valley sample and hold circuits located in the Signal Conditioner

- A Control Latch, whose TTL signal lines are used to control various "soft", or program-controlled, switches located in the Signal Conditioner

- A Data Latch which enables the software to read back the control status from the Frequency Input Board

- A Programmable Timer that converts the frequency input signals to an equivalent 12-bit digital output for application to the TLDC's data base

The Address Decoder assures orderly accessing of the various devices which interface with the Internal Data Bus.
FIGURE 5-14 Frequency Input Board, Hardware Block Diagram
Automatic calibration of the Frequency Input Board is made possible by the learn mode (CIL). Under program control, negative and positive zeroes, and negative and positive gain coefficients, are derived and stored in a data base in the Controller Board's RAM. In addition, peak and valley voltages are obtained automatically from the frequency input signals entering the Signal Conditioner. These voltages are conditioned and applied via the Absolute Value line labeled IN3 to the Controller Board's A/D Converter. The resulting digital values, labeled calibration parameters CIPV and CIVV and representing the input's peak and valley voltage levels, are then stored in the data base for later use.

The automatic calibration described above takes place in the learn mode (CIL) after the STORE button is pressed. Depending on the configured values of SMIN and SMAX (minimum and maximum input frequency), the entire calibration sequence can occur instantaneously or take as long as 20 seconds. Any value greater than 1 second will be displayed on the 4-1/2 digit display and decremented at about once a second to give the operator an indication that the learn mode is in progress. The learn mode can be aborted at any time by pressing the EXIT button (while the display is decrementing); any values obtained during the learn process are discarded.

During normal operation and under program control, the line labeled Peak & Valley Voltages to the Signal Conditioner is refreshed about 12 times a minute with the values held in the peak and valley sample and hold circuit. These voltages, representing data base parameters CIPV and CIVV, establish a hysteresis band in hardware that yields a TTL level output from the Signal Conditioner. Automatic calibration in the learn mode assures that the input signal is capable of traversing around the hysteresis band to produce an output. In the manual calibration mode, an accurate oscilloscope measurement of the peak and valley voltages is required prior to storing the CIPV and CIVV values or the Board will fail to function properly.

The actual conversion from frequency input to 12-bit digital output takes place in the Programmable Timer. During normal operation, a command to Begin Conversion starts the process. At the prescribed time, the MPU commands the Timer to End Conversion and the digital value, equivalent to the frequency input, is read from the Board via the Data Bus Buffer.

5.4 LINK INTERFACE BOARD

The Link Interface Board provides communications over the Local Instrument Link (LIL) between TLDCs and various other link-connected devices such as a Model 320 Independent Computer Interface or a Model 321 Expansion Satellite to the Hi-Level Link (HLL).

Refer to the block diagram of the Link Interface Board shown in Figure 5-15 while reading the following circuit description. The physical layout of the Board is shown in Figure 5-16.
FIGURE 5-15 Link Interface Board, Hardware Block Diagram
NOTE:
UVEPROM (ULTRAVIOLET ERASEABLE ELECTRICALLY PROGRAMMABLE READ-ONLY MEMORY)
MPU (MULTI-PROCESSING UNIT)

PA-1683-1

FIGURE 5-16 Link Interface Board, Physical Layout
Operating programs stored in the UVEPROM permit the Link Interface Board to communicate on the LIL. These programs perform the following functions:

1. Receive messages containing commands or data from other Stations and devices on the LIL.
2. Send commands or data to other Stations and devices on the LIL.
3. Perform error checking on the messages.
4. Handle link protocol (token-passing).

When the Link Interface Board is receiving a message from the LIL, encoded data (Manchester II) is received by the LIL Modem and separated into clock and data for the Data-Link Controller. The Link Status Receiver recognizes the presence of link data and sends status signals to the Link MPU. The Data-Link Controller converts serial data into parallel and calculates an error code check [Cyclic Redundancy Check (CRC)] on the message.

The Link MPU transfers, via Data Transceiver U3, data from the Data-Link Controller to a temporary receive message buffer located in the Dual Port RAM. After the message is verified and found to be error free, data is transferred to another area in the Dual Port RAM and made available, via Data Transceiver U1, for the Controller Board MPU to read and process. The Link MPU executes an EPROM-stored program that sends an acknowledge message to the sending station indicating that the message was received. This message is routed by the Link MPU to the LIL through the Data-Link Controller and the LIL Modem. If the original incoming message contained an error, the Link MPU would not acknowledge but would wait for the sending station to retry sending the message.

Data to be transmitted is placed in the Dual Port RAM by the Controller Board’s MPU. When the MPU addresses the RAM through the Multiplexer And Decoder, data is transferred from the MPU to the RAM over the data bus and Data Transceiver U1. The Link MPU then executes an EPROM-stored program that reads the data from the Dual Port RAM. The Address Decoder enables the Data-Link Controller allowing the data to be stored by the MPU in the Controller. The Data-Link Controller converts the parallel data to serial form and sends it to the LIL Modem.

The LIL Modem combines the transmit clock and data to produce encoded data (Manchester II). Within the Modem, the encoded data is sent to a differential driver producing RS-422 signals. These signals pass through a station isolation transformer and a station disconnect relay, operated by the Relay Latch, also contained in the LIL Modem. After transmitting a message on the LIL, the Link MPU waits for an acknowledge from the receiving station. If one is not received, the Link MPU will try to transmit the message up to three times.
6.0 MAINTENANCE

TLDC maintenance requirements are minimal. Activities such as cleaning and visual inspection should be performed at regular intervals. The severity of the TLDC's operating environment will determine the frequency of maintenance. Additional topics including troubleshooting, assembly replacement, and software compatibility are also covered.

6.1 TOOL AND EQUIPMENT REQUIREMENTS

The following tools and equipment are necessary for servicing:

A. Common electronic hand tools

B. Digital Multimeter (DMM)
   Voltmeter section
   Accuracy ........... +/-0.01% of reading
   Resolution ........ 1.0 millivolt
   Input impedance .. 10 Megohms

   Ammeter section
   Accuracy ........... +/-0.1% of reading
   Resolution ........ 100 microamperes

C. Maintenance Kit, P/N 15545-110, containing wrist strap and conductive mat. This kit, or an equivalent, is required when a circuit board is handled for any reason.

6.2 PREVENTIVE MAINTENANCE

The objective for establishing a preventive maintenance program is to provide maximum operating efficiency. Every preventive maintenance operation should assist in realizing this objective. Unless a preventive measure reduces a Station's down time, it is unnecessary.

6.2.1 ENVIRONMENTAL CONSIDERATIONS

The TLDC has been designed to operate within specified environmental parameters (temperature and humidity). These parameters are listed in the Specifications section of this Instruction. Additional information concerning environmental contaminants is presented in the Installation section.

6.2.2 VISUAL INSPECTION

As part of a periodic maintenance program the TLDC must be visually inspected. When viewing the assembly, scan for abnormalities such as loose, broken or stressed ribbon cables. Look for damaged circuitry and heat stressed parts. Check for excessive dirt or dust build-up which may impede air flow and inhibit proper heat dissipation.

10/90 6-1
6.2.3 CLEANING

Circuit boards should not be cleaned unless accumulated foreign material is causing a problem. The enclosed station design should prevent particulate material from building up. If cleaning becomes necessary, remove debris with either a soft brush or low velocity deionized air.

The bezel is cleaned with a mild, nonabrasive liquid cleaner and a soft, lint-free cloth—do not use a paper towel.

6.2.4 CIRCUIT BOARD HANDLING

Special handling procedures are required whenever a circuit board assembly is removed, tested, repaired, adjusted or installed in the Station’s case. These procedures are required to prevent component damage from the electrostatic discharge hazard to which most semiconductors are vulnerable. When handling an assembly, follow the procedures outlined in the Assembly Replacement section of this Instruction.

6.3 FUSE LOCATION

A power input fuse is located on the rear of the Controller Board as shown in Figure 5-3. This is the TLDC’s main power fuse. A replacement fuse may be obtained from any local electronics supplier or may be ordered from the factory. See the Parts List at the back of this Instruction for fuse part number and description.

To replace the fuse, refer to section 6.5 for removal and installation of the Display Assembly and Controller Board. While Station is disassembled, visually inspect the assemblies. After inserting a new fuse and assembling the Station, apply power. Operate the Station off-line for several minutes to be sure that a condition does not exist which will cause the replacement fuse to fail.

6.4 TROUBLESHOOTING

Troubleshooting the TLDC is primarily done by error codes. Refer to Tables 6.4 through 6.9 for information on a particular error code.

Error codes are indicated on the alphanumeric display in response to a failed power-up diagnostic test or to an on-line station error. Section 6.4.1 provides a quick reference to the identification of these codes. Section 6.4.2 discusses each code with respect to the type of test or error check, station response, problem confirmation, and corrective action.

In the event a malfunction within the TLDC is suspected, troubleshooting by assembly substitution is recommended to get the Station back on-line in the shortest possible time. The plug-in design of station assemblies permits rapid removal and replacement to isolate a defect.
### TABLE 6.1 Troubleshooting Guide

<table>
<thead>
<tr>
<th>SYMPTOM</th>
<th>COMMENT</th>
<th>POSSIBLE CAUSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>No station output signal</td>
<td>Completely inoperative station</td>
<td>Station Fuse (F1), power not applied, Controller Board unseated from rear terminal connector, Controller Board</td>
</tr>
<tr>
<td>No bargraph indications</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No alphanumeric indications</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Pulsar Knob response</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No front panel displays</td>
<td>Station operates normally otherwise</td>
<td>Display Assembly unplugged or failed</td>
</tr>
<tr>
<td>No switch action</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Pulsar Knob response</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Missing segments from one or more front panel displays</td>
<td>Station operates normally otherwise</td>
<td>Display Assembly, Controller Board</td>
</tr>
<tr>
<td>No Pulsar Knob response</td>
<td>All applicable conditions</td>
<td>Display Assembly</td>
</tr>
<tr>
<td>Fluctuating station</td>
<td>Seemingly abnormal process signal on bargraph</td>
<td>Faulty process signal from external transmitter, turbulent process conditions, Controller Board</td>
</tr>
<tr>
<td>Certain soft/hard configuration and/or calibration parameters can not be adjusted or reset</td>
<td>“X” appears on alphanumeric display when attempting to make adjustments</td>
<td>Lockout switch on Controller Board is set to prevent changes</td>
</tr>
<tr>
<td>Station will not operate properly after editing existing hard or soft configuration</td>
<td>Conditions depend on application</td>
<td>Configuration error (see A0351-20 Configuration Handbook)</td>
</tr>
<tr>
<td>No response from “A/M” switch on front panel</td>
<td>Both associated LEDs are off</td>
<td>Auto/Manual Transfer Block not configured, Display Assembly</td>
</tr>
<tr>
<td>Erratic Station operation</td>
<td>Fluctuating displays on output signals</td>
<td>Controller Board, Expander Board, very low supply voltage</td>
</tr>
<tr>
<td>Relay output(s) will not change state</td>
<td>Station operates normally otherwise</td>
<td>Expander Board</td>
</tr>
<tr>
<td>No response from “E/I” switch on front panel</td>
<td>Both associated LEDs are off</td>
<td>External/Internal Transfer Block not configured</td>
</tr>
</tbody>
</table>

Additional troubleshooting avenues are also possible. For example, a series of test configurations may be generated and implemented off-line to 'exercise' different function block areas within the TLDC. Tables 6.2 and 6.3 list the function blocks and FC0s associated with each loop.
If a problem develops upon initial installation of the Station, a check should be made of the installation wiring and the Station's hard and soft configuration parameters. In addition, check the wiring of any associated external process devices (e.g., as a process transmitter). Field servicing experience indicates that most initial service incidents are of this nature. A troubleshooting guide is provided in Table 6.1 as a service reference.

On-line checks of the TLDC's input and output signals (i.e. analog and digital) can be performed without affecting station operation. However, this type of signal tracing is usually carried out behind instrument panel. Refer to Table 2.1 and Figure 2-5 of this Instruction for rear terminal assignments.

After replacing a Controller Board, configuration and calibration parameters must be re-entered. See the Configuration Handbook, Configuration Documentation Booklet, and Calibration section of this Instruction.

Factory repaired Stations must also be configured.

### TABLE 6.2 Function Block Allocation

<table>
<thead>
<tr>
<th>LOOP 1</th>
<th>LOOP 2</th>
<th>LOOP 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>FB101 Analog Input 1</td>
<td>FB201 Analog Input 1</td>
<td>FB301 Analog Input</td>
</tr>
<tr>
<td>FB102 Analog Input 2</td>
<td>FB202 Analog Input 2</td>
<td>FB302 Analog Input</td>
</tr>
<tr>
<td>FB103 Analog Output</td>
<td>FB203 Analog Output</td>
<td>FB303 Analog Output</td>
</tr>
<tr>
<td>FB104 Digital Output 1</td>
<td>FB206 Digital Input</td>
<td>FB306 Digital Input</td>
</tr>
<tr>
<td>FB105 Digital Output 2</td>
<td>FB207 Ratio</td>
<td>FB307 Ratio</td>
</tr>
<tr>
<td>FB106 Digital Input</td>
<td>FB208 Bias</td>
<td>FB308 Bias</td>
</tr>
<tr>
<td>FB107 Ratio</td>
<td>FB209 Hi/Lo Limit</td>
<td>FB309 Hi/Lo Limit</td>
</tr>
<tr>
<td>FB108 Bias</td>
<td>FB210 Override Selector</td>
<td>FB310 Override Selector</td>
</tr>
<tr>
<td>FB109 Hi/Lo Limit</td>
<td>FB211 E/I Transfer</td>
<td>FB311 E/I Transfer</td>
</tr>
<tr>
<td>FB110 Override Selector</td>
<td>FB212 Alarms</td>
<td>FB312 Alarms</td>
</tr>
<tr>
<td>FB111 E/I Transfer</td>
<td>FB213 Controller</td>
<td>FB313 Controller</td>
</tr>
<tr>
<td>FB112 Alarms</td>
<td>FB214 A/M Transfer</td>
<td>FB314 A/M Controller</td>
</tr>
<tr>
<td>FB113 Controller</td>
<td>FB215 Operator's Dis.</td>
<td>FB315 Operator's Dis.</td>
</tr>
<tr>
<td>FB114 A/M Transfer</td>
<td>FB216 Integ./Totalizer</td>
<td>FB316 Integ./Totalizer</td>
</tr>
<tr>
<td>FB115 Operator's Display</td>
<td>FB217 Setpoint T &amp; H</td>
<td>FB317 Setpoint T &amp; H</td>
</tr>
<tr>
<td>FB116 Integrator/Totalizer</td>
<td>FB218 General Purpose</td>
<td>FB318 General Purpose</td>
</tr>
<tr>
<td>FB117 Setpoint Track &amp; Hold</td>
<td>Track &amp; Hold</td>
<td>Track &amp; Hold</td>
</tr>
<tr>
<td>FB118 General Purpose Track &amp; Hold</td>
<td>FB219 General Purpose</td>
<td>FB318 General Purpose</td>
</tr>
<tr>
<td>FB120 Quad Logic</td>
<td>FB220 Quadratic Logic</td>
<td>FB320 Quadratic Logic</td>
</tr>
<tr>
<td>FB122 Deviation Amplifier</td>
<td>FB222 Deviation Amp.</td>
<td>FB322 Deviation Amplifier</td>
</tr>
<tr>
<td>FB123 Dual Transfer Switch</td>
<td>FB223 Dual Transfer Sw.</td>
<td>FB323 Dual Transfer Sw.</td>
</tr>
<tr>
<td>FB124 Square Root Extractor</td>
<td>FB232 Relay Output</td>
<td>FB332 Relay Output</td>
</tr>
<tr>
<td>FB134 Math</td>
<td>FB298 Local Instrument Interface Option</td>
<td>FB398 Local Instrument Link Interface Option</td>
</tr>
<tr>
<td>FB198 Local Instrument Link Interface Option</td>
<td>FB298 Local Instrument Link Interface Option</td>
<td></td>
</tr>
</tbody>
</table>
### TABLE 6.3 Factory Configured Options

**LOOP 1**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FC0100</td>
<td>ESN Reset (ESN=000)</td>
</tr>
<tr>
<td>FC0101</td>
<td>Single-Loop PID Control (TSP)</td>
</tr>
<tr>
<td>FC0102</td>
<td>Single-Loop PID Control (NTSP)</td>
</tr>
<tr>
<td>FC0103</td>
<td>External-Set PID Control (TSP)</td>
</tr>
<tr>
<td>FC0104</td>
<td>External-Set PID Control (NTSP)</td>
</tr>
<tr>
<td>FC0105</td>
<td>Ratio-Set PID Control (TSP)</td>
</tr>
<tr>
<td>FC0106</td>
<td>Loading</td>
</tr>
<tr>
<td>FC0107</td>
<td>A/M Transfer</td>
</tr>
<tr>
<td>FC0108</td>
<td>A/M Transfer with Bias</td>
</tr>
<tr>
<td>FC0109</td>
<td>Indicator</td>
</tr>
<tr>
<td>FC0110</td>
<td>Default Configuration</td>
</tr>
<tr>
<td>FC0111</td>
<td>Single-Loop PID Control (TSP)</td>
</tr>
<tr>
<td></td>
<td>- C/L Operation</td>
</tr>
<tr>
<td>FC0112</td>
<td>Single-Loop PID Control (NTSP)</td>
</tr>
<tr>
<td></td>
<td>- C/L Operation</td>
</tr>
<tr>
<td>FC0113</td>
<td>External-Set PID Control (TSP)</td>
</tr>
<tr>
<td></td>
<td>- C/L Operation</td>
</tr>
<tr>
<td>FC0114</td>
<td>External-Set PID Control (NTSP)</td>
</tr>
<tr>
<td></td>
<td>- C/L Operation</td>
</tr>
<tr>
<td>FC0115</td>
<td>Ratio-Set PID Control (TSP)</td>
</tr>
<tr>
<td>FC0116</td>
<td>Loading - C/L Operation</td>
</tr>
<tr>
<td>FC0117</td>
<td>A/M Transfer - C/L Operation</td>
</tr>
<tr>
<td>FC0118</td>
<td>A/M Station with Bias</td>
</tr>
<tr>
<td></td>
<td>- C/L Operation</td>
</tr>
<tr>
<td>FC0119</td>
<td>Indicator C/L Operation</td>
</tr>
<tr>
<td>FC0140</td>
<td>Computer-Set A/M Transfer</td>
</tr>
<tr>
<td>FC0141</td>
<td>DDC Control</td>
</tr>
<tr>
<td>FC0142</td>
<td>Computer-Set Supervisory Control</td>
</tr>
</tbody>
</table>

**LOOP 2**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FC0200</td>
<td>ESN Reset (ESN=000)</td>
</tr>
<tr>
<td>FC0201</td>
<td>Single-Loop PID Control (TSP)</td>
</tr>
<tr>
<td>FC0202</td>
<td>Single-Loop PID Control (NTSP)</td>
</tr>
<tr>
<td>FC0203</td>
<td>External-Set PID Control (TSP)</td>
</tr>
<tr>
<td>FC0204</td>
<td>External-Set PID Control (NTSP)</td>
</tr>
<tr>
<td>FC0205</td>
<td>Ratio-Set PID Control (TSP)</td>
</tr>
<tr>
<td>FC0206</td>
<td>Loading</td>
</tr>
<tr>
<td>FC0207</td>
<td>A/M Transfer</td>
</tr>
<tr>
<td>FC0208</td>
<td>A/M Transfer with Bias</td>
</tr>
<tr>
<td>FC0209</td>
<td>Indicator</td>
</tr>
<tr>
<td>FC0210</td>
<td>Default Configuration</td>
</tr>
<tr>
<td>FC0211</td>
<td>Single-Loop PID Control (TSP)</td>
</tr>
<tr>
<td></td>
<td>- C/L Operation</td>
</tr>
<tr>
<td>FC0212</td>
<td>Single-Loop PID Control (NTSP)</td>
</tr>
<tr>
<td></td>
<td>- C/L Operation</td>
</tr>
<tr>
<td>FC0213</td>
<td>External-Set PID Control (TSP)</td>
</tr>
<tr>
<td></td>
<td>- C/L Operation</td>
</tr>
<tr>
<td>FC0214</td>
<td>External-Set PID Control (NTSP)</td>
</tr>
<tr>
<td></td>
<td>- C/L Operation</td>
</tr>
<tr>
<td>FC0215</td>
<td>Ratio-Set PID Control (TSP)</td>
</tr>
<tr>
<td>FC0216</td>
<td>Loading - C/L Operation</td>
</tr>
<tr>
<td>FC0217</td>
<td>A/M Transfer - C/L Operation</td>
</tr>
<tr>
<td>FC0218</td>
<td>A/M Transfer with Bias</td>
</tr>
<tr>
<td></td>
<td>- C/L Operation</td>
</tr>
<tr>
<td>FC0219</td>
<td>Indicator C/L Operation</td>
</tr>
</tbody>
</table>

**LOOP 3**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FC0300</td>
<td>ESN Reset (ESN=000)</td>
</tr>
<tr>
<td>FC0301</td>
<td>Single-Loop PID Control (TSP)</td>
</tr>
<tr>
<td>FC0302</td>
<td>Single-Loop PID Control (NTSP)</td>
</tr>
<tr>
<td>FC0303</td>
<td>External-Set PID Control (TSP)</td>
</tr>
<tr>
<td>FC0304</td>
<td>External-Set PID Control (NTSP)</td>
</tr>
<tr>
<td>FC0305</td>
<td>Ratio-Set PID Control (TSP)</td>
</tr>
<tr>
<td>FC0306</td>
<td>Loading</td>
</tr>
<tr>
<td>FC0307</td>
<td>A/M Transfer</td>
</tr>
<tr>
<td>FC0308</td>
<td>A/M Transfer with Bias</td>
</tr>
<tr>
<td>FC0309</td>
<td>Indicator</td>
</tr>
<tr>
<td>FC0310</td>
<td>Default Configuration</td>
</tr>
<tr>
<td>FC0311</td>
<td>Single-Loop PID Control (TSP)</td>
</tr>
<tr>
<td>FC0312</td>
<td>Single-Loop PID Control (NTSP)</td>
</tr>
<tr>
<td></td>
<td>- C/L Operation</td>
</tr>
<tr>
<td>FC0313</td>
<td>External-Set PID Control (TSP)</td>
</tr>
<tr>
<td></td>
<td>- C/L Operation</td>
</tr>
<tr>
<td>FC0314</td>
<td>External-Set PID Control (NTSP)</td>
</tr>
<tr>
<td></td>
<td>- C/L Operation</td>
</tr>
<tr>
<td>FC0315</td>
<td>Ratio-Set PID Control (TSP)</td>
</tr>
<tr>
<td>FC0316</td>
<td>Loading - C/L Operation</td>
</tr>
<tr>
<td>FC0317</td>
<td>A/M Transfer - C/L Operation</td>
</tr>
<tr>
<td>FC0318</td>
<td>A/M Transfer with Bias</td>
</tr>
<tr>
<td></td>
<td>- C/L Operation</td>
</tr>
<tr>
<td>FC0319</td>
<td>Indicator C/L Operation</td>
</tr>
</tbody>
</table>
6.4.1 ERROR CODE QUICK REFERENCE

An error code is indicated on the alphanumeric display in response to a power-up test failure or an on-line error. This section serves as a quick reference for error code identification.

6.4.1.1 Power-Up Error Code Designation

Sample Error Code

\[ E \quad 1 \quad 1 \quad 0 \]

Error Indicator

Board Type

1-Controller
2-Expander
3-No. 3 Input
4-Link Interface

Test Type

0-RAM
1-ROM CRC
2-Software ID
3-Database ID
4-EEPROM Transient Data CRC
5-EEPROM Constant Data CRC
6-EEPROM Calibration Data CRC
7-Power-Down

6.4.1.2 Power-Up Error Codes

Table 6.4 gives the definition and affected board for each power-up error code. The codes are grouped by error type and listed in the sequence in which diagnostic tests are run.

Multiple database errors can occur. Pressing ENTER CONF button will display additional errors before configuration mode can be entered.
### TABLE 6.4 Power-Up Error Codes

<table>
<thead>
<tr>
<th>ERROR CODES</th>
<th>DEFINITION/TEST</th>
<th>AFFECTED BOARD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HARDWARE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E110</td>
<td>RAM</td>
<td>CONTROLLER</td>
</tr>
<tr>
<td>E111</td>
<td>ROM CRC</td>
<td>CONTROLLER</td>
</tr>
<tr>
<td>E121</td>
<td>ROM CRC</td>
<td>EXPANDER</td>
</tr>
<tr>
<td>E122</td>
<td>SOFTWARE COMPATIBILITY</td>
<td>EXPANDER</td>
</tr>
<tr>
<td>E124</td>
<td>BOARD TYPE</td>
<td>EXPANDER</td>
</tr>
<tr>
<td>E131</td>
<td>ROM CRC</td>
<td>NO. 3 INPUT</td>
</tr>
<tr>
<td>E132</td>
<td>SOFTWARE COMPATIBILITY</td>
<td>NO. 3 INPUT</td>
</tr>
<tr>
<td>E134</td>
<td>BOARD TYPE</td>
<td>NO. 3 INPUT</td>
</tr>
<tr>
<td><strong>DATABASE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E213</td>
<td>DATABASE ID</td>
<td>CONTROLLER</td>
</tr>
<tr>
<td>E214</td>
<td>EEPROM TRANSIENT DATA CRC</td>
<td>CONTROLLER</td>
</tr>
<tr>
<td>E215</td>
<td>EEPROM CONSTANT DATA CRC</td>
<td>CONTROLLER</td>
</tr>
<tr>
<td>E216</td>
<td>EEPROM CALIBRATION DATA CRC</td>
<td>CONTROLLER</td>
</tr>
<tr>
<td>E217</td>
<td>POWER DOWN</td>
<td>CONTROLLER</td>
</tr>
<tr>
<td>E223</td>
<td>DATABASE ID</td>
<td>EXPANDER</td>
</tr>
<tr>
<td>E233</td>
<td>DATABASE ID</td>
<td>NO. 3 INPUT</td>
</tr>
<tr>
<td>E234</td>
<td>BOARD TYPE ID</td>
<td>NO. 3 INPUT</td>
</tr>
</tbody>
</table>

### 6.4.1.3 On-Line Error Code Designation

An on-line error code is treated as a status change incrementing the alphanumeric display's right-most digit.

**Sample Error Code** ---------------------- E 1 * 3

**Error Indicator** ---------------------- :

**Error Type** ---------------------- :
1-Controller Board A/D :
2-Expander Board A/D :
3-No. 3 Input Board :
4-Link Interface Board :
5-Watch Dog Time Out-Controller Board :
6-EEPROM Stores Exceeds 10,000 :
   -Controller Board :
7-EEPROM Activity Did Not Verify :
   -Controller Board :
Alarm (Configured through FB12) ---------------------- :
*-Uncleared :
Blank-Cleared :

**Number of Statuses On Stack** ----------------------
6.4.1.4 On-Line Error Codes

Table 6.5 gives the definition and affected board for each on-line error code.

<table>
<thead>
<tr>
<th>LINK CODE</th>
<th>DISPLAY CODE</th>
<th>DEFINITION</th>
<th>AFFECTED BOARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>$01</td>
<td>E1</td>
<td>A/D ERROR</td>
<td>CONTROLLER</td>
</tr>
<tr>
<td>$02</td>
<td>E2</td>
<td>A/D ERROR</td>
<td>EXPANDER</td>
</tr>
<tr>
<td>$03</td>
<td>E3</td>
<td>BOARD ERROR</td>
<td>NO. 3 INPUT</td>
</tr>
<tr>
<td>$04</td>
<td>E4</td>
<td>BOARD ERROR</td>
<td>LINK INTERFACE</td>
</tr>
<tr>
<td>$05</td>
<td>E5</td>
<td>WATCHDOG TIMEOUT</td>
<td>ALL</td>
</tr>
<tr>
<td>$06</td>
<td>E6</td>
<td>EEPROM STORES EXCEEDS 10,000</td>
<td>CONTROLLER</td>
</tr>
<tr>
<td>$07</td>
<td>E7</td>
<td>EEPROM ACTIVITY DID NOT VERIFY</td>
<td>CONTROLLER</td>
</tr>
<tr>
<td>$AA</td>
<td>NU</td>
<td>NON-UPDATING INPUT 170</td>
<td>LINK INTERFACE</td>
</tr>
<tr>
<td>$AB</td>
<td>NU</td>
<td>NON-UPDATING INPUT 171</td>
<td>LINK INTERFACE</td>
</tr>
<tr>
<td>$10E</td>
<td>NU</td>
<td>NON-UPDATING INPUT 270</td>
<td>LINK INTERFACE</td>
</tr>
<tr>
<td>$10F</td>
<td>NU</td>
<td>NON-UPDATING INPUT 271</td>
<td>LINK INTERFACE</td>
</tr>
<tr>
<td>$172</td>
<td>NU</td>
<td>NON-UPDATING INPUT 370</td>
<td>LINK INTERFACE</td>
</tr>
<tr>
<td>$173</td>
<td>NU</td>
<td>NON-UPDATING INPUT 371</td>
<td>LINK INTERFACE</td>
</tr>
</tbody>
</table>

6.4.2 ERROR CODE DISCUSSION

This section discusses the diagnostic test or error check, station response, problem confirmation, and corrective action for each error code. Tables 6.6, 6.7, and 6.8 are for power-up codes; Table 6.9 is for on-line codes.
### TABLE 6.6 E110 Through E134 - Power-Up Error Codes

<table>
<thead>
<tr>
<th>ERROR CODE</th>
<th>DIAGNOSTIC TEST</th>
<th>STATION RESPONSE</th>
<th>CORRECTIVE ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>E110</td>
<td>RAM - Verifies that memory location can be written to and read from</td>
<td>1. Display blank except for alphanumeric display</td>
<td>Replace Controller Board</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Operator controls inoperative</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Outputs failsafed:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>A. Analog set to -3.3%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>B. Digital nonconducting</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>C. Relay de-energized</td>
<td></td>
</tr>
<tr>
<td>E111</td>
<td>ROM CRC - Verifies factory entered data and that it can be read</td>
<td>1. Display blank except for alphanumeric display</td>
<td>Replace Board:</td>
</tr>
<tr>
<td>E121</td>
<td></td>
<td>2. Operator controls inoperative</td>
<td>E111 - Controller</td>
</tr>
<tr>
<td>E131</td>
<td></td>
<td>3. Outputs failsafed:</td>
<td>E121 - Expander</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A. Analog set to -3.3%</td>
<td>E131 - No. 3 Input</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B. Digital nonconducting</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>C. Relays de-energized</td>
<td></td>
</tr>
<tr>
<td>E122</td>
<td>Compatibility - Checks for software compatibility between boards</td>
<td>1. Display blank except for alphanumeric display</td>
<td>Install software compatible board(s); Refer to section 6.7 for software compatibility</td>
</tr>
<tr>
<td>E132</td>
<td></td>
<td>2. Operator controls inoperative</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Outputs failsafed:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>A. Analog set to -3.3%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>B. Digital nonconducting</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>C. Relays de-energized</td>
<td></td>
</tr>
<tr>
<td>E124</td>
<td>Compatibility - Checks for hardware compatibility between boards</td>
<td>1. Display blank except for alphanumeric display</td>
<td>Install hardware compatible board(s)</td>
</tr>
<tr>
<td>E134</td>
<td></td>
<td>2. Operator controls inoperative</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Outputs failsafed:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>A. Analog set to -3.3%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>B. Digital nonconducting</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>C. Relays de-energized</td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:** For problem confirmation, remove and reapply station power
## TABLE 6.7 E213, E223, E233 - Power-Up Database Error Codes

<table>
<thead>
<tr>
<th>ERROR CODE</th>
<th>LINK CODE</th>
<th>DIAGNOSTIC TEST</th>
<th>STATION RESPONSE</th>
<th>CORRECTIVE ACTION</th>
</tr>
</thead>
</table>
| E213       | D5        | ID - Checks for | 1. Displays blank except | Before pressing a key-
| E223       | DF        | correctness of | for alphanumeric; | board button, check the |
| E233       | E9        | configuration for boards | Displays active for configuration only | following: |
|            |           | for boards installed | 2. Operator controls operative for configuration only | 1. Expander Board not |
|            |           |                  | 3. Outputs failsafed: | plugged-in or not |
|            |           |                  | A. Analog to -3.3% | installed |
|            |           |                  | B. Digital non-conducting | 2. Wiring No. 3 Input |
|            |           |                  | C. Relays de-energized | Board installed for |
|            |           |                  |                  | present condition |

NOTE: For problem confirmation, remove and reapply station power
### TABLE 6.8 E214 Through E217, E234 - Power-Up Database CRC Error Codes

<table>
<thead>
<tr>
<th>ERROR CODE</th>
<th>LINK CODE</th>
<th>STATION DIAGNOSTIC TEST</th>
<th>CORRECTIVE RESPONSE</th>
<th>CORRECTIVE ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>E214 D6</td>
<td>EEPROM CRC - Verifies transient data</td>
<td>1. Display active for configuration only</td>
<td>Press ENTER CONF button.</td>
<td>Re-enter configuration or download new database via Local Instrument Link</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Operator controls operative for configuration only</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Outputs failsafed: A. Analog to -3.3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>B. Digital nonconducting</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>C. Relays de-energized</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E215 D7</td>
<td>EEPROM CRC - Verifies constant data</td>
<td>1. Displays blank except for alphanumeric: Displays active for configuration only</td>
<td>If correct Boards are installed, press ENTER CONF button and re-enter configuration or download database via Local Instrument Link</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Operator controls operative for configuration only</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Outputs failsafed: A. Analog to -3.3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>B. Digital nonconducting</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>C. Relays de-energized</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E216 D8</td>
<td>EEPROM CRC - Verifies calibration data</td>
<td>1. Display active for configuration only</td>
<td>Press ENTER CONF button. (Station loads default calibration data and enters normal mode) At earliest convenience, re-calibrate all inputs and outputs</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Operator controls operative for configuration only</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Outputs failsafed: A. Analog to -3.3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>B. Digital nonconducting</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>C. Relays de-energized</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E217 D9</td>
<td>Controller Board Power-Down</td>
<td>1. Display active for configuration only</td>
<td>Press ENTER CONF button.</td>
<td>Re-enter configuration or download new database via Local Instrument Link</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Operator controls operative for configuration only</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E234 EA</td>
<td>No. 3 Input Board - Type</td>
<td>3. Outputs failsafed: A. Analog to -3.3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>B. Digital nonconducting</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>C. Relays de-energized</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:** For problem confirmation, remove and reapply station power.
### TABLE 6.9 E1 Through E7 - On-Line Error Codes

<table>
<thead>
<tr>
<th>LINK CODE</th>
<th>DISPLAY CODE</th>
<th>DIAGNOSTIC TEST</th>
<th>STATION RESPONSE</th>
<th>PROBLEM CONFIRMATION</th>
<th>CORRECTIVE ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>01 E1</td>
<td>A/D Converter - Tests for conversion in required time.</td>
<td>Apparent normal operation. Since A/D converter is not functioning properly, some displays may not change even though process is changing.</td>
<td>Enter configuration mode (T) or (H), step to value level, push store, then exit configuration. If error code remains or reappears, proceed to corrective action column.*</td>
<td>Replace Board: E1 - Controller E2 - Expander</td>
<td></td>
</tr>
<tr>
<td>02 E2</td>
<td>Pulse Input Board - Check for abnormal condition of input.</td>
<td>Apparent normal operation. Since pulse input is incorrect or being improperly processed, signal input display may not be correct or respond to changing input signal.</td>
<td>Enter configuration mode (T) or (H), step to value level, push store, then exit configuration. If error code remains or reappears, proceed to corrective action column.*</td>
<td>1. Check input signal for noise or out of frequency range. 2. Replace Pulse Input Board.</td>
<td></td>
</tr>
<tr>
<td>03 E3</td>
<td>TC/MV or RTD Input Board - A/D Converter - Tests for conversion in required time.</td>
<td>Apparent normal operation. Since A/D converter is not functioning properly, some displays may not change even though process is changing.</td>
<td>Enter configuration mode (T) or (H), step to value level, push store, then exit configuration. If error code remains or reappears, proceed to corrective action column.*</td>
<td>3. Replace TC/MV Input Board or RTD Input Board.</td>
<td></td>
</tr>
<tr>
<td>DISPLAY LINK ERROR CODE</td>
<td>CODE</td>
<td>DIAGNOSTIC TEST</td>
<td>STATION RESPONSE</td>
<td>PROBLEM CONFIRMATION</td>
<td>CORRECTIVE ACTION</td>
</tr>
<tr>
<td>------------------------</td>
<td>------</td>
<td>----------------</td>
<td>------------------</td>
<td>----------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>-- E4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dual Port RAM</td>
<td>Off-Line</td>
<td>Extended power-up condition, then apparent normal operation. Since Link Interface Board not operating, some displays may not change.</td>
<td>Enable H/T/F lockout switch. Enter configuration mode (T) or (H), step to value level, push store, then exit configuration. If error code remains or reappears, proceed to corrective action column.*</td>
<td>Replace Link Interface Board</td>
<td></td>
</tr>
<tr>
<td>Power-Up</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dual Port RAM</td>
<td>On-Line</td>
<td>Apparent normal operation. Since Link Interface Board is not operating, some displays may not change.</td>
<td>Enable H/T/F lockout switch. Enter configuration mode (T) or (H), step to value level, push store, then exit configuration. If error code remains or reappears, proceed to corrective action column.*</td>
<td>Replace Link Interface Board</td>
<td></td>
</tr>
<tr>
<td>Operation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>05 E5</td>
<td></td>
<td></td>
<td>Station executes power-up diagnostic test routines (4 seconds). 1. Display blank except for alphanumeric display (4 seconds). 2. Controls inoperative (4 seconds).</td>
<td>Enable H/T/F lockout switch. Enter configuration mode (T) or (H), step to value level, push store, then exit configuration. If code remains or reappears, proceed to corrective action column.*</td>
<td>Replace Controller Board</td>
</tr>
</tbody>
</table>

MPU - Check to see if program has been executed in required time.
### TABLE 6.9 E1 Through E7 - On-Line Error Codes - Continued

<table>
<thead>
<tr>
<th>DISPLAY LINK CODE</th>
<th>ERROR CODE</th>
<th>DIAGNOSTIC TEST</th>
<th>STATION RESPONSE</th>
<th>PROBLEM CONFIRMATION</th>
<th>CORRECTIVE ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>06</td>
<td>E6</td>
<td>EEPROM - Check to determine if number of EEPROM stores (writes) has exceeded 10,000.</td>
<td>Normal operation.</td>
<td>Enable H/T/F lockout switch. Enter configuration mode (T) or (H), step to value level, push store, then exit configuration. If error code remains or reappears, proceed to corrective action column.*</td>
<td>1. Replace Controller Board at next convenient periodic maintenance check. 2. Check power supply for erratic output (can be indicated by momentary display blanking).</td>
</tr>
</tbody>
</table>

| 07                | E7         | EEPROM activity did not verify. | Normal operation. | Enable H/T/F lockout switch. Enter configuration mode (T) or (H), step to value level, push store, then exit configuration. If error code remains or reappears, proceed to corrective action column.* | 1. Replace Controller Board at next convenient periodic maintenance check. (If not replaced, next power cycle will result in a 200 series error and the Station will go off-line.) 2. Check power supply for erratic output (can be indicated by momentary display blanking). |

* If error code does not reappear, an environmental problem (e.g., excessive power input voltage excursion or out-of-specification operating temperature) can exist or an intermittent electrical problem can be present, see corrective action column.
6.5 ASSEMBLY REPLACEMENT

Controller, Expander, Link Interface and No. 3 Input Boards all contain software. The software on a replacement board must be compatible with the software on the other boards in an TLDC. Refer to section 6.7 for software compatibility guidelines.

As is the case with most electronic assemblies populated with semiconductor components, precautions must be observed to prevent component damage from ESD (i.e., electrostatic discharge). Accordingly, a maintenance kit containing a wrist strap and a conductive mat must be used whenever an assembly, such as a Controller Board, is removed from or installed in the station case. Refer to Figure 2-11, notice how a wrist strap can be conveniently grounded by clipping it to the bezel screw retainer block.

Whenever an assembly is not installed in a Station, it must be stored in a static shielding bag. These bags are 8" x 12" (20.3cm x 45.7cm) and are available from the factory under material code X6080. The Controller Board requires a larger bag (30.4cm x 45.7 cm) under material code Z74A.

When unplugging ribbon cable from an assembly be sure to grip the connector, not the ribbon wire. Do not let the Display Assembly hang by the connecting ribbon cable. Care should be exercised when seating and unseating circuit boards.

Station calibration will be necessary after replacing any of the following circuit boards: Controller, Expander, Thermocouple/Millivolt Input or Voltage Input.

6.5.1 DISPLAY ASSEMBLY

To replace the Display Assembly use the following procedure:

REMOVAL:

1. Flip down bezel ID plate and loosen captive bezel retaining screw.
2. Separate Assembly from station case by five inches (12.7 cm); support the Assembly so it doesn’t hang by the ribbon cable.
3. Ground wrist strap to bezel screw retainer block.
4. Disconnect ribbon cable from Assembly.
5. Place Assembly in static shielding bag.
6. Disconnect wrist strap from block.
INSTALLATION

1. Ground wrist strap to screw retainer block.
2. Remove Assembly from static shielding bag.
3. Connect ribbon cable to Assembly.

NOTE
When changing a Display Assembly with the Station power-up and an error code present, the displays will light in a random pattern except for the alphanumeric display which will show the error code. Clear the error to clear displays.

4. Disconnect wrist strap from block.
5. Position Assembly in front of case and line up captive bezel screw.
6. Make sure ribbon cable is not pinched.
7. Tighten screw and flip up ID plate.

6.5.2 CONTROLLER BOARD

To replace the Controller Board or the station fuse use the following procedure:

REMOVAL:

1. In a hazardous area, remove input power from Station.
2. Remove Display Assembly as described in section 6.5.1.
3. Remove board retainer by extracting board retainer screw (see Figure 2-11).
4. Ground wrist strap to bezel screw retainer block.
5. Pivot the Controller Board's extractor tab to unseat the Board from the rear terminal connection block (refer to Figure 5-3).
6. Slide the Board from the Station case.
7. Place the Board in a static shielding bag.
8. Disconnect wrist strap from block.
INSTALLATION:

1. Ground wrist strap to bezel screw retainer block.
2. Remove Board from static shielding bag.
3. Set lockout switches as on removed Board (see Figure 5-3).
4. Position end of Board into top and bottom card guide channels.
5. Push top and bottom of Board with equal force and slide it into case.
6. Disconnect wrist strap.
7. Install board retainer (see Figure 2-11).
8. Install Display Assembly as described in section 6.5.1.

NOTE

Station must be configured when Controller Board is replaced.

6.5.3 EXPANDER, No. 3 INPUT, AND LINK INTERFACE BOARDS

These board types are removed and installed in a similar manner. Refer to the Parts List at the back of this instruction for location of boards and mounting hardware. Note that the Expander Board must be removed before a No. 3 Input Board can be removed.

REMOVAL:

1. Remove Display Assembly as described in section 6.5.1.
2. Remove Controller Board as described in section 6.5.2.
3. On a grounded conductive mat, remove retaining screws and washers which hold board to be removed to Controller Board.
4. Carefully remove Board being sure not to bend connector pins.
5. Place Board in static shielding bag.
6. Repeat steps 3, 4 and 5 for each Board to be removed.

INSTALLATION:

1. Ground wrist strap to grounded conductive mat.
2. Remove Board from static shielding bag and set jumper plugs as on Board removed or as follows:

Pulse Input Board - See Figure 2-6.
Thermocouple/Millivolt Input Board - See Figure 4-1.

Expander, Voltage Input and Link Interface Boards - None to be set.

3. Position Board as shown in Parts List drawing; carefully align board connector with mating Controller Board connector and press connectors together; see Table 6.10.

<table>
<thead>
<tr>
<th>BOARD TO BE INSTALLED AND CONNECTOR</th>
<th>CONTROLLER BOARD CONNECTOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expander, P1</td>
<td>J1</td>
</tr>
<tr>
<td>Pulse Input, J1</td>
<td>J2</td>
</tr>
<tr>
<td>Thermocouple/Millivolt Input, J3</td>
<td>J2</td>
</tr>
<tr>
<td>Voltage Input, J1</td>
<td>J2</td>
</tr>
<tr>
<td>RTD Input, J1</td>
<td>J2</td>
</tr>
<tr>
<td>Link Interface, P1</td>
<td>J3</td>
</tr>
</tbody>
</table>

4. Install retaining screws and washers (and spacers, if necessary) to secure Board to Controller Board.

5. Repeat steps 2, 3 and 4 for each Board to be installed.

6. Perform sections 6.5.2 and 6.5.1 to install Controller Board and display Assembly.

6.6 RECOMMENDED SPARE AND REPLACEMENT PARTS

It is recommended that one spare of each of the following items be stocked for every 1 to 10 units in service: Fuse, Display Assembly, Controller Board, Expander Board, No. 3 Input Board, and Link Interface Board. Part numbers are provided in the Parts List at the back of this Instruction.

Replacement circuit boards, assemblies and recommended spare parts are available from the factory. Part numbers are provided in the Parts List at the back of this Instruction.

IMPORTANT

When ordering a replacement or spare circuit board, provide the following data from the board to be replaced or spared: part number, software compatibility code, and serial number.
An item being returned to the factory should be packaged in its original shipping container. Otherwise, package for safe shipment or contact the factory for shipping recommendation. Send package to one of the addresses given in the Warranty Statement.

**IMPORTANT**

A circuit board must be placed in a static shielding bag before it is packaged for shipment.

6.7 SOFTWARE COMPATIBILITY IDENTIFICATION

When adding or changing a circuit board, consideration must be given to the software compatibility of the boards. A three level, alphanumerical, software compatibility code is used to signify the compatibility and identity of TLDC software. This code is added to the end of an EPROM (UVEPROM) part number. Each EPROM carries a label with the EPROM part number and a code as follows:

Sample ------------------------14728-3000- B B A
EPROM Part Number ----------------------------- : : :
System ------------------------------------- :
Station ------------------------------------- :
EPROM Revision -----------------------------

The System code letter applies to software which defines and formats communications between TLDCs (and other stations) connected to the Local Instrument Link. This letter must be the same on all boards within a TLDC, whether or not it is connected to a Local Instrument Link.

The Station code letter applies to software which defines communications between boards within a TLDC. This letter must be the same on Controller, Expander and No. 3 Input Boards within a TLDC. The Link Interface Board's station code letter does not need to be the same.

**IMPORTANT**

All Local Instrument Link connected TLDCs must have Link Interface Boards with the same System code letter and the same Station code letter.

The EPROM Revision Code letter indicates the software version. All EPROMs on a board must have the same code letter. This letter (and all letters) must be the same on the Controller and Expander Boards.
6.8 MAINTENANCE RECORDS

An accurate record keeping system for maintenance operations should be established and kept up to date. Data extracted from the record can serve as a basis for ordering supplies such as spare parts. In addition, it's useful as a troubleshooting tool by providing historical maintenance data. Scheduled and unscheduled maintenance should be recorded.

WARRANTY

The Company warrants all equipment manufactured by it and bearing its name plate, and all repairs made by it, to be free from defects in material and workmanship under normal use and service. If any part of the equipment herein described, and sold by the Company, proves to be defective in material or workmanship and if such part is within twelve months from date of shipment from the Company's factory, returned to such factory, transportation charges prepaid, and if the same is found by the Company to be defective in material or workmanship, it will replaced or repaired, free of charge, f.o.b. Company's factory. The Company assumes no liability for the consequence of its use or misuse by Purchaser, his employees or others. A defect in the meaning of this warranty in any part of said equipment shall not, when such part is capable of being renewed, repaired or replaced, operate to condemn such equipment. This warranty is expressly in lieu of all other warranties, guaranties, obligations, or liabilities, expressed or implied by the Company or its representatives. All statutory or implied warranties other than title, are hereby expressly negated and excluded.

Warranty repair or replacement requires the equipment to be returned to one of the following addresses.

Equipment manufactured or sold by MOORE PRODUCTS CO.:
    MOORE PRODUCTS CO.
    Sumnerytown Pike
    Spring House, PA 19477

Equipment manufactured or sold by MOORE INSTRUMENT CO.:
    MOORE INSTRUMENTS LTD/LTEE
    2KM West of Mississauga Rd. Hwy. 7
    Brampton, Ontario, Canada

Equipment manufactured or sold by MOORE PRODUCTS CO. (U.K.) LTD.:
    MOORE PRODUCTS CO. (U.K.) LTD.
    Copse Road,
    Lufton, Yeovil,
    Somerset, BA22 8RN
    England

The warranty will be null and void if repair is attempted without prior authorization by a member of the MOORE PRODUCTS CO. Service Department.
### Parts List

**Model 351**
TRIPLE-LOOP DIGITAL CONTROLLER

**Drawing No. 16100-8PL**

#### Models

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Models</th>
</tr>
</thead>
<tbody>
<tr>
<td>351A21NNN</td>
<td>16100-2</td>
</tr>
<tr>
<td>351A21N1N</td>
<td>16100-3</td>
</tr>
<tr>
<td>351A21TNN</td>
<td>16100-4</td>
</tr>
</tbody>
</table>

---

**PUSH CONTROLLER ASSEMBLY INTO BOTTOM REAR CONNECTOR IN SOCKET. POSITION ITEM 202 AGAINST EDGE OF P.C. BOARD & LOCK IN PLACE.**

**THERMOCOUPLE SENSOR BD. TO BE ASSEMBLED ACROSS TERMINALS 6A & 6A. COMPONENTS MUST FACE FRONT OF STATION.**

---

**Item** | **Part No.** | **Description** | **Req'd** |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>*201A</td>
<td>16100-28</td>
<td>Display Assy. (See Parts Dwg. 15738-68FL)</td>
<td>1</td>
</tr>
<tr>
<td>201B</td>
<td>15918-16</td>
<td>Blank Panel</td>
<td>1</td>
</tr>
<tr>
<td>*202</td>
<td>15738-242</td>
<td>Board Retainer (incl. next 4 Items)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>15738-111</td>
<td>Board Retainer (incl. with Item 202)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>3175-149</td>
<td>Captive Screw (incl. with Item 202)</td>
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<tr>
<td></td>
<td>15738-240</td>
<td>Washer (incl. with Item 202)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>12351-4</td>
<td>Truarc Ring (incl. with Item 202)</td>
<td>1</td>
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<tr>
<td></td>
<td></td>
<td>Mounting Case (See Parts Dwg. 15738-79FL)</td>
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</tr>
<tr>
<td>*</td>
<td>16100-41</td>
<td>Controller &amp; Expander Assy. 120VAC</td>
<td>1</td>
</tr>
<tr>
<td>*</td>
<td>16100-31</td>
<td>Controller &amp; Expander Assy. 24VAC</td>
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</tr>
<tr>
<td>*</td>
<td>16100-21</td>
<td>Controller &amp; Expander Assy. 220/240V</td>
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</tr>
<tr>
<td>*</td>
<td>16100-11</td>
<td>Controller &amp; Expander Assy. 24VDC</td>
<td>1</td>
</tr>
<tr>
<td>*</td>
<td>7447-123</td>
<td>Fuse 2A, 3AG, Slo-Blo (24VDC and 24VAC Stations)</td>
<td>1</td>
</tr>
<tr>
<td>*</td>
<td>7447-52</td>
<td>Fuse 0.5A, 3AG, Slo-Blo (220/240VAC Stations)</td>
<td>1</td>
</tr>
<tr>
<td>*</td>
<td>7447-54</td>
<td>Fuse 0.5A, 3AG, Slo-Blo (120VAC Stations)</td>
<td>1</td>
</tr>
<tr>
<td>*</td>
<td>15853-31</td>
<td>Link Interface Board Kit</td>
<td>1</td>
</tr>
<tr>
<td>*</td>
<td>15943-11</td>
<td>RTD Input Board Kit</td>
<td>1</td>
</tr>
<tr>
<td>*</td>
<td>15768-112</td>
<td>Pulse Input Kit</td>
<td>1</td>
</tr>
<tr>
<td>*</td>
<td>15824-112</td>
<td>Voltage Input Kit</td>
<td>1</td>
</tr>
<tr>
<td>*</td>
<td>15950-11</td>
<td>Frequency Input Kit</td>
<td>1</td>
</tr>
<tr>
<td>*</td>
<td>16005-51</td>
<td>Thermocouple &amp; Sensor Input Kit (incl. the following 2 Items)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>16005-1</td>
<td>Thermocouple Input Board (incl. with Thermocouple &amp; Sensor Input Kit)</td>
<td>1</td>
</tr>
<tr>
<td>*</td>
<td>15819-21</td>
<td>Sensor Board (incl. with Thermocouple &amp; Sensor Input Kit)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>All Kits Include The Following: Spacer (incl. in 15738-243 Access Kit)</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Coated Screw (incl. in 15738-243 Accessories Kit)</td>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

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**IMPORTANT**

When ordering a replacement or spare circuit board, provide the following data to ensure a compatible assembly:
- **part number**
- **three-letter software compatibility code**
- **serial number**

---

*Recommended on-hand spare parts. Always specify range, serial no., or other nameplate information when ordering Spare Parts.*
CONNECT KEYBOARD CABLE TO P2 ON INTERFACE BD.

CONNECT TO J1 ON INTERFACE BD.

<table>
<thead>
<tr>
<th>Item</th>
<th>Part No</th>
<th>Description</th>
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<tbody>
<tr>
<td>2A</td>
<td>16040-7</td>
<td>Keyboard/Bezel (Model 383)</td>
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<tr>
<td>2B</td>
<td>16100-27</td>
<td>Keyboard/Bezel (Model 351)</td>
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<td>2C</td>
<td>15738-330</td>
<td>Keyboard/Bezel (Model 352)</td>
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<td>5</td>
<td>15738-44</td>
<td>Bracket</td>
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<td>6</td>
<td>15738-96</td>
<td>Shaft Bearing</td>
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<td>7</td>
<td>See Note</td>
<td>Display Board</td>
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<tr>
<td>8</td>
<td>See Note</td>
<td>Display Driver Board</td>
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<td>9</td>
<td>See Note</td>
<td>Display Interface Board</td>
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<td>10</td>
<td>15738-58</td>
<td>Keeper Spring</td>
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<td>15738-69</td>
<td>Cylinder &amp; Shaft Assembly</td>
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<td>12</td>
<td>15738-57</td>
<td>Keyboard Cover</td>
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<td>13</td>
<td>15738-290</td>
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<td>Knob Cap</td>
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<td>I.D. Card</td>
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<td>6772-9</td>
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<td>15738-96</td>
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<td>18</td>
<td>15738-45</td>
<td>Bezel Screw</td>
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<td>19</td>
<td>1-0330</td>
<td>2-56 x 1.88 Pan Hd.</td>
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<tr>
<td>20</td>
<td>1-7216</td>
<td>2 Medium Lockwasher</td>
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<tr>
<td>21</td>
<td>1-0648</td>
<td>4-40 x 1.13 Bd.</td>
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<td>1-7238</td>
<td>4 Medium Lockwasher</td>
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*NOTE: Shown for reference only.*
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<th>Part No.</th>
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<td>Receptacle</td>
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<td>12740-263</td>
<td>Mounting Stud</td>
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<td>Rear Plate (20 Terminal Case)</td>
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<td>(40 Terminal Case)(Not Shown)</td>
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