The intent of this manual is to provide an understanding of the MYCRO 351 Triple-Loop Digital Controller (TLDC) to assist users with utilizing the full potential of this very simple but powerful triple-loop controller.

MYCRO 351 is of a universal design which allows one instrument to be configured for the individual control requirements of three independent loops. Each control loop has a dedicated bargraph which continuously displays its process and setpoint.

Information in this manual applies to all three loops (i.e. Loop 1, Loop 2 and Loop 3). The configuration of each loop is accomplished through function blocks that are selected from a library and interconnected. The first digit of the three digit function block number signifies the loop in which the function block resides.

This manual presents the general instructions, descriptions and recommendations for using the MYCRO 351 TLDC. The following sections are included:

Section 1 includes descriptions and specifications for all Loop 1, Loop 2 and Loop 3 function blocks. A thorough understanding of each block is essential in order to utilize the controller’s full capability. Also provided are function block connection details and listings of all configuration parameters. Not all Function Blocks reside in all three loops. A table is included in Section 1 showing which Function Blocks reside in which loops.

Section 1A is a listing of all available Loop 1 "Factory Configured Options" (FCOs). These are contained in permanent memory and can be entered into configuration memory with just a few keystrokes.

Section 2 is a listing of all available Loop 2 "Factory Configured Options" (FCOs). These are contained in permanent memory and can be entered into configuration memory with just a few keystrokes.

Section 3 is a listing of all available Loop 3 "Factory Configured Options" (FCOs). These are contained in permanent memory and can be entered into configuration memory with just a few keystrokes.

Section 4 includes instruction manual SD351 which provides installation, maintenance and calibration information.

Section 5 includes AD351-30, MYCRO 351 Configuration Documentation Booklet, that can be used for keeping configuration data, and AD351-50, Function Block Output Identification, that can be used as a cross reference during configuration.
SECTION 1
LOOP 1/LOOP 2/LOOP 3
FUNCTION BLOCKS
(Numerical Order)

FB101/FB201/FB301 ............... Analog Input #1
FB102/FB202 .................... Analog Input #2
FB103/FB203/FB303 ............... Analog Output
FB104 ................................ Digital Output #1
FB105 ................................ Digital Output #2
FB106/FB206/FB306 ............... Digital Input
FB107/FB207/FB307 ............... Ratio
FB108/FB208/FB308 ................ Bias
FB109/FB209/FB309 ............... Hi/lo Limit
FB110/FB210/FB310 ............... Override Selector
FB111/FB211/FB311 ............... E/I Transfer
FB112/FB212/FB312 ............... Controller
  (1) PID Controller
  (2) PD Controller
  (3) ID Controller
  (4) PID (Adaptive Gain) Controller
FB114/FB214/FB314 ............... A/M Transfer
FB115/FB215/FB315 ................ Operator's Display
FB116/FB216/FB316 ................ Integrator/Totalizer
FB117/FB217/FB317 ............... Setpoint Track & Hold
FB118/FB218/FB318 ............... General Purpose
  Track & Hold
FB120/FB220/FB320 ............... Quad Logic
FB122/FB222/FB322 ................ Deviation Amplifier
FB123/FB223/FB323 ................ Dual Transfer Switch
FB124 ................................ Square Root Extractor
FB232/FB332 ...................... Relay Output
FB134 ................................ Math
FB198 ......................... Loop 1 Local Instrument Link
  Interface Option
FB298 ......................... Loop 2 Local Instrument Link
  Interface Option
FB398 ......................... Loop 3 Local Instrument Link
  Interface Option
FB199 ......................... #3 Analog Input Options
  V - Voltage Input
  C - Computer Pulse
  T - MV & T/C (J, K, T, E, R, S, B) Input
  D - RTD Input
  F - Frequency Input
Function Block Master Drawing

SECTION 1A
LOOP 1
FACTORY CONFIGURED OPTIONS

FCO 100 ......................... ESN Reset (ESN = 000)
FCO 101 ......................... Single-Loop PID Control (TSP)
FCO 102 ......................... Single-Loop PID Control (NTSP)
FCO 103 ......................... External-Set PID Control (TSP)
FCO 104 ......................... External-Set PID Control (NTSP)
FCO 105 ......................... Ratio-Set PID Control (TSP)
FCO 106 ......................... Loading
FCO 107 ......................... A/M Transfer
FCO 108 ......................... A/M Transfer w/Bias
FCO 109 ......................... Indicator
FCO 110 ......................... Default Configuration
FCO 111 ......................... Single-Loop PID Control (TSP)
FCO 112 ......................... Single-Loop PID Control (NTSP)
FCO 113 ......................... External-Set PID Control (TSP)
FCO 114 ......................... External-Set PID Control (NTSP)
FCO 115 ......................... Ratio-Set PID Control (TSP)
FCO 116 ......................... Loading - C/L Operation
FCO 117 ......................... A/M Transfer - C/L Operation
FCO 118 ......................... A/M Transfer w/Bias - C/L Operation
FCO 119 ......................... Indicator C/L Operation
FCO 140 ......................... Computer-Set A/M Transfer
FCO 141 ......................... DDC Control
FCO 142 ......................... Computer-Set Supervisory Control

(continued on next page)
SECTION 2
LOOP 2
FACTORY CONFIGURED OPTIONS

FCO 200 .............. ESN Reset (ESN = 000)
FCO 201 .............. Single-Loop PID Control (TSP)
FCO 202 .............. Single-Loop PID Control (NTSP)
FCO 203 .............. External-Set PID Control (TSP)
FCO 204 .............. External-Set PID Control (NTSP)
FCO 205 .............. Ratio-Set PID Control (TSP)
FCO 206 .............. Loading
FCO 207 .............. A/M Transfer
FCO 208 .............. A/M Transfer w/Bias
FCO 209 .............. Indicator
FCO 210 .............. Default Configuration
FCO 211 .............. Single-Loop PID Control (TSP) – C/L Operation
FCO 212 .............. Single-Loop PID Control (NTSP) – C/L Operation
FCO 213 .............. External-Set PID Control (TSP) – C/L Operation
FCO 214 .............. External-Set PID Control (NTSP) – C/L Operation
FCO 215 .............. Ratio-Set PID Control (TSP) – C/L Operation
FCO 216 .............. Loading – C/L Operation
FCO 217 .............. A/M Transfer – C/L Operation
FCO 218 .............. A/M Transfer w/Bias – C/L Operation
FCO 219 .............. Indicator – C/L Operation

FCO 308 .............. A/M Transfer w/Bias
FCO 309 .............. Indicator
FCO 310 .............. Default Configuration
FCO 311 .............. Single-Loop PID Control (TSP) – C/L Operation
FCO 312 .............. Single-Loop PID Control (NTSP) – C/L Operation
FCO 313 .............. External-Set PID Control (TSP) – C/L Operation
FCO 314 .............. External-Set PID Control (NTSP) – C/L Operation
FCO 315 .............. Ratio-Set PID Control (TSP) – C/L Operation
FCO 316 .............. Loading – C/L Operation
FCO 317 .............. A/M Transfer – C/L Operation
FCO 318 .............. A/M Transfer w/Bias – C/L Operation
FCO 319 .............. Indicator – C/L Operation

SECTION 4
INSTALLATION DETAILS
Installation and Service Instructions .............. SD351

SECTION 5
CONFIGURATION DOCUMENTATION
Configuration Documentation Booklet .............. AD351-30
Function Block Identification .............. AD351-50
General Configuration Procedure

Configuration is the procedure through which a user designs a control strategy to meet a specific control requirement. Configuration includes: the selection of function blocks from a library of available blocks, the interconnection of those blocks, determining the parameters associated with the blocks and the entering of this information into the controller. The following paragraphs provide a general description of the configuration procedure used for the Model 351 Triple-Loop Digital Controller (TLDC).

Function Block Selection
Function blocks are typically analogous to traditional hardware control relays (i.e. square root, multiplier, etc.). Input/output function blocks (both analog and digital) connect the TLDC to field devices through the terminal block on the rear of the case. Control and computation function blocks perform the desired control strategy used within each loop of the TLDC. The operator's display block is used to organize the operator's interaction with the TLDC via the faceplate assembly. Function blocks are identified by a unique number that is based on the loop number in which the block is used as well as the function block itself. All loop function blocks are assigned a three-digit number; loop 1 blocks begin with one, loop 2 blocks begin with two, and loop 3 blocks begin with three. The second two digits of the function block number are the same in all three loops for the same function.

Configuration
A TLDC configuration is accomplished through a menu-driven configuration procedure entered directly from the faceplate of the individual control station. The configuration procedure must be performed for each of three available loops in the TLDC. Following the entry of the configuration information for a loop, the configuration is stored in non-volatile memory (EEPROM).

The highest level of the configuration is the menu level. The menu level allows for the selection of different areas of configuration as follows:

T – Table of Function Blocks
The T mode of configuration is used to select those function blocks which are needed for a particular configuration from the library of available blocks. In order for a function block to be activated, it must be assigned an Execution Sequence Number (ESN) between 01 and 60. Each of the three independent loops in the TLDC has available ESNs between 01 and 60 (therefore all three loops could have blocks with identical ESNs). Function blocks with an ESN of 00 are not executed. The specific ESN assigned to the function blocks determines the order of block execution. Function blocks in loop 1 are executed in order of 01 to 60, then loop 2 blocks in order of 01 to 60, and finally loop 3 blocks in order of 01 to 60. The TLDC will execute the complete table of function blocks for all three loops in 100 milliseconds. Function blocks 115, 215 and 315 (the operator’s display blocks for the three loops) are always used and have been preassigned an ESN of 40 for each loop.

H – Hard Configuration Mode
The H mode of configuration is used to select function block inputs and attributes. Function block attributes include such things as the selection of block options like square root extraction or controller type. Function block inputs are selected from unique output numbers of other function blocks used in the configuration. Function Blocks have output numbers ranging from 101 to 399. The first digit of the three digit block output number specifies the loop in which the block resides (i.e. one, two or three). The second two digits specify the function output number.

S – Soft Configuration Mode
The S mode of configuration is used to define specific numerical parameters which determine the exact algorithm the block will execute. These numerical parameters include items such as block gain and bias values, alarm trip-points, tuning values, etc. Not all function blocks require soft configuration entries. Soft configuration values commonly requiring frequent change have been linked to the quick access pushbuttons on the controller faceplate.

F – Factory Configured Option Mode
Common control strategies are preconfigured and stored in memory in every TLDC as Factory Configured Options (FCOs). These FCOs are permanently stored in ROM and can be recalled using a few simple steps. Each independent loop has its own library of available FCOs. Generally, the only additional configuration required is in the S mode to determine exact numerical parameters for the individual blocks. The available FCOs are listed in Sections 1A, 2 and 3 of this manual. If the desired configuration is similar to one of the FCOs, it is usually more efficient to load the FCO and then modify it to meet the exact application requirements. Prior to entering a new configuration, it is recommended that FCO*10 (the default configuration) be loaded to erase all previously entered configuration data.

V – View Mode
The V mode is used to view the output value (in percent of scale units) for each of the block outputs in the TLDC. This mode allows for the inspection of intermediate block outputs for checking configuration parameters.

C – Calibration Mode
The C mode is used whenever the calibration data for any of the input/output blocks is changed or verified. All controllers are shipped from Moore Products Co. fully calibrated for 1-5 Vdc inputs and 4-20 mA outputs and should not require recalibration. Detailed calibration procedures are documented in SD351, the Installation and Maintenance Instructions for the TLDC in Section 4 of this manual.
Recommended Configuration Development Procedure

It is recommended that the following procedure be used to develop the configuration for each of the three available loops in the TLDC and that AD351-30, MYCRO 351 Configuration Documentation Booklet, be used to document the configuration.

Step 1. Draw a loop diagram showing the function blocks to be used in the configuration. The loop diagram should be constructed with inputs at the top, outputs at the bottom, and intermediate function blocks arranged in a logical flow path between the inputs and outputs. For examples of loop diagrams, refer to Sections 1A, 2 and 3 of this manual.

Step 2. Assign an Execution Sequence Number (ESN) to each of the function blocks on the loop diagram. The order of block execution is normally not critical, but it is recommended that the block execution follows the order of blocks on the diagram, with inputs first, then intermediate blocks, and finally outputs. Generally, some ESNs should be skipped over to leave room for future enhancements to the configuration (i.e. use ESN 5, 10, 15, etc.). The ESNs should be entered in the T column of Configuration Documentation Booklet AD351-30.

Step 3. Interconnect the selected function blocks on the loop diagram. The source for a block input will be an output from another function block. The unique block output numbers for each function block can be found in Section 1 of this manual. Block output numbers will range between 101 and 399. All hard configuration data should be recorded in the H column of Configuration Documentation Booklet AD351-30.

Step 4. Review each function block used in the configuration to determine if any block attributes (e.g. square root) must be determined and added to the loop’s hard configuration entries. This block attribute information should also be added to the H column of Configuration Documentation Booklet AD351-30.

Step 5. The soft configuration parameters (e.g. alarm limits) should be determined for those function blocks requiring them. These parameter values should be recorded in the S column of Configuration Documentation Booklet AD351-30. It may be useful to note this information on the loop diagram for future reference. Certain soft parameter values may not be known at the time of configuration (such as controller tuning), and will have to be added when the controller is installed.

Step 6. Verify calibration values for all input and outputs and enter this information on both the loop diagram and the Configuration Documentation Booklet AD351-30. The TLDC is shipped from Moore Products Co. precalibrated for 1-5 Vdc inputs and 4-20 mA outputs, and should not require recalibration. Calibration data is stored in non-volatile memory (EEPROM) along with other configuration data.

Entering The Configuration

The configuration recorded in the Configuration Documentation Booklet AD351-30 and the loop diagram, can be entered into the TLDC via the pushbuttons and pulser knob on the faceplate of the controller. Loop configurations must be entered individually for each of the three available loops. The following procedure should be used to enter a configuration for any of the three available loops:

Step 1. Select the loop to be configured by pushing the loop pushbutton until the desired loop is displayed (the loop indicator will be backlit in green).

Step 2. Press the Enter Configuration pushbutton to begin configuration for the selected loop. This level of configuration is known as the menu level. If any of the configuration modes is followed by an X (i.e. SX_), that mode has been locked out. To unlock this mode, refer to SD351, the Installation and Maintenance Instructions for the TLDC, in Section 4 of this manual.

Step 3. Select the T mode of configuration by rotating the pulser knob until T appears in the alphanumeric window of the display.

Step 4. Press the Step Down pushbutton to access the function block level of the configuration. This level of configuration provides access to all available function blocks. To select a particular function block, rotate the pulser knob until the desired function block number appears in the alphanumeric window of the display (e.g. T101).

Step 5. An Execution Sequence Number (ESN) must be assigned to those blocks used in the configuration. Each block must be individually selected at the function block level. Following block selection, press the Step Down pushbutton to enter the value level. At the value level, ESN selection can take place for each block. Rotate the pulser knob to select the ESN in the 4-1/2 digit display to match that chosen in the Configuration Documentation Booklet AD351-30. Press the Store pushbutton to store the value in memory (the ESN in the 4-1/2 digit display will blink once indicating successful storage of the value). This procedure should be repeated for each block used in the configuration. Following the assignment of all ESNs, press the Exit pushbutton.

Step 6. With the same loop selected, press the Enter Configuration pushbutton and rotate the pulser knob until H appears in the alphanumeric window. This is the Hard mode of configuration.

Step 7. Press the Step Down pushbutton to enter the function block level of configuration. Only those function blocks given an ESN during step 5, and which have hard "H" parameters, will appear as activated function blocks.

Step 8. Select each active function block individually and press the Step down pushbutton to enter the parameter level of configuration. At the parameter level, function block inputs and attributes are selected. The first parameter for
the block will appear in the alphanumeric window. The pulser knob can be rotated to change the parameter selected.
Press the Step Down pushbutton to enter the value level of the configuration.

Step 9. At the value level of the configuration, rotate the pulser knob to choose the desired value. The value will appear in the 4-1/2 digit display. Press the Store pushbutton to store the desired value in memory. The value in the 4-1/2 digit display will blink once signifying successful storage of the value. This procedure should be repeated for each parameter in each block used in the configuration. Following the configuration of all hard configuration data, press the Exit pushbutton.

Step 10. With the same loop selected, press the Enter Configuration pushbutton and rotate the pulser knob until S appears in the alphanumeric window. This is the Soft mode of configuration. Press the Step Down pushbutton to enter the function block level of configuration. Only those blocks made active in step 5 which require soft configuration entries will appear.

Step 11. Select each active function block individually and press the Step Down pushbutton to enter the parameter level of configuration. At the parameter level, function block soft parameters are selected. The first parameter for the block will appear in the alphanumeric window. The pulser knob can be rotated to vary the parameter selected. Press the Step Down pushbutton to enter the value level of the configuration.

Step 12. At the value level of the configuration, rotate the pulser knob to choose the desired value. The value will appear in the 4-1/2 digit display. Press the Store pushbutton to store the desired value in memory. The value in the 4-1/2 digit display will blink once signifying successful storage of the value. This procedure should be repeated for each parameter in each block used in the configuration. Following the configuration of all soft configuration data, press the Exit pushbutton.

Step 13. The preceding 12 steps should be repeated for the two additional loops in the TLDC.

Step 14. To verify the proper operation of the loaded configuration, the configuration should be tested off-line by simulating inputs to the station. If the configuration is not operating correctly, the View mode may be used to easily verify intermediate block outputs. Using the View mode, the particular configuration problem can be pinpointed. Select the loop to be verified and press the Enter Configuration pushbutton. By pressing the Stepdown pushbutton once, all of the individual function block output numbers are available and displayed in the alphanumeric window (i.e. V101). As the block output number is displayed, the block output will be displayed as a percent of scale value in the 4-1/2 digit display. By rotating the pulser knob, each of the block outputs can be viewed and confirmed in accordance with the configuration.
Configuration Controls

ENTER CONF

PUSH TO ENTER THE CONFIGURATION MODE
ENTERS AT THE MENU LEVEL. STEP BUTTONS
WILL MOVE YOU TO A NEW LEVEL

MENU LEVEL

ALPHANUMERIC DISPLAY

TURN PULSER TO CHANGE MENU SELECTION

STEP DOWN  STEP UP

FUNCTION BLOCK LEVEL

S101

TURN PULSER TO SELECT BLOCK NO.

STEP DOWN  STEP UP

PARAMETER LEVEL

SFB1

TURN PULSER TO SELECT PARAMETER
(IF MORE THAN ONE EXISTS WITHIN THE BLOCK)

STEP DOWN  STEP UP

VALUE LEVEL

SFB1

TURN PULSER TO CHANGE VALUE

4-1/2 DIGIT DISPLAY  10.00

STORE

PUSH TO STORE VALUE IN THE DISPLAY
(ONLY ACTIVE AT THE VALUE LEVEL)

EXIT

PUSH TO EXIT CONFIGURATION
(ACTIVE AT ANY LEVEL)