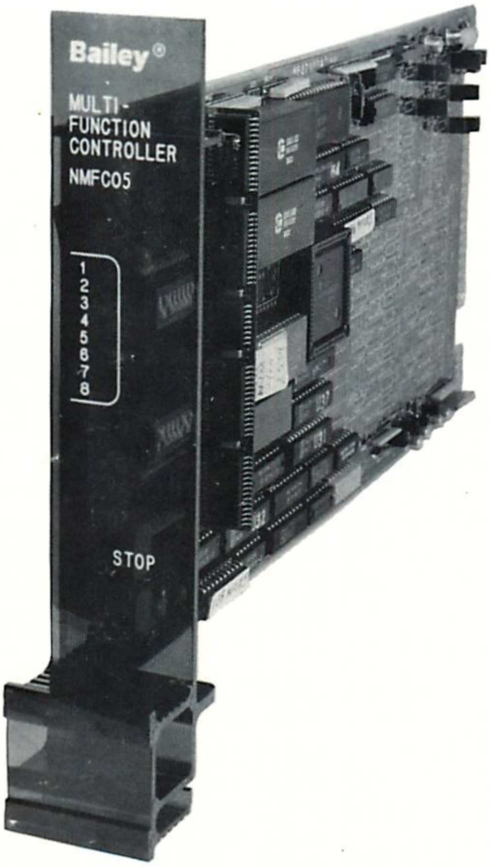
Bailey®
network 90®

Multi-Function Controller Module (NMFC05)



E93-906-13

Bailey Controls

WARNING notices as used in this manual apply to hazards or unsafe practices which could result in personal injury or death.

CAUTION notices apply to hazards or unsafe practices which could result in property damage.

NOTES highlight procedures and contain information which assist the operator in understanding the information contained in this manual.

WARNING

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MOST ELECTRONIC EQUIPMENT IS INFLUENCED BY RADIO FREQUENCY INTERFERENCE (RFI). CAUTION SHOULD BE EXERCISED WITH REGARD TO THE USE OF PORTABLE COMMUNICATIONS EQUIPMENT IN THE AREA AROUND SUCH EQUIPMENT. PRUDENT PRACTICE DICTATES THAT SIGNS SHOULD BE POSTED IN THE VICINITY OF THE EQUIPMENT CAUTIONING AGAINST THE USE OF PORTABLE COMMUNICATIONS EQUIPMENT.

POSSIBLE PROCESS UPSETS

MAINTENANCE MUST BE PERFORMED ONLY BY QUALIFIED PERSONNEL AND ONLY AFTER SECURING EQUIPMENT CONTROLLED BY THIS PRODUCT. ADJUSTING OR REMOVING THIS PRODUCT WHILE IT IS IN THE SYSTEM MAY UPSET THE PROCESS BEING CONTROLLED. SOME PROCESS UPSETS MAY CAUSE INJURY OR DAMAGE.

AVERTISSEMENT

MANUELS D'OPERATION

NE PAS METTRE EN PLACE, REPARER OU FAIRE FONTIONNER CE MATERIEL SANS AVIOR LU, COMPRIS ET SUIVI LES INSTRUCTIONS REGLIMENT AIRES DE **Bailey Controls** TOUTE NEGLIGENCE A CET EGARD PURRAIT ETRE UNE CAUSE D'ACCIDENT OU DE DEFAILLANCE DU MATERIEL.

PERTURBATIONS DE LA FREQUENCE RADIOPHONIQUE

LA PLUPART DES EQUIPEMENTS ELECTRONIQUES SONT SINSIBLES AUX PERTURBATIONS DE LA FREQUENCE RADIO. DES PRECAUTIONS DEVRONT ETRE PRISES LORS DE L'UTILISATION DE MATERIEL DE COMMUNICATION PORTATIF. LA PRUDENCE EXIGE QUE LES PRECAUTIONS A PREDRE DANS CE CAS SOIENT SIGNALEES AUX ENDROITS VOULOUS DANS VOTRE USINE.

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Preface

The Multi-Function Controller Module (NMFC05) is a powerful, configurable process control device. This manual is intended to instruct the user in how to install, configure, operate, and troubleshoot this module.

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Safety Summary

GENERAL WARNINGS

EQUIPMENT ENVIRONMENT
All components, whether in transportation, operation, or storage must be in a noncorrosive environment.

ELECTRICAL SHOCK HAZARD DURING MAINTENANCE
Disconnect power or take precautions to insure that contact with energized parts is avoided when servicing.

SPECIAL HANDLING
This module uses Electrostatic Sensitive Devices (ESD).

ENVIRONMENT DE L'EQUIPEMENT
Ne pas soumettre les composants a une atmosphere corrosive lors du transport, de l'entreposage ou de l'utilisation.

RISQUES DE CHOCS ELECTRIQUES LORS DE L'ENTRETIEN
S'assurer de debrancher l'alimentation ou de prendre les precautions necessaires a eviter tout contact avec des composants sours tension lors de l'entretien.

PRECAUTIONS DE MANUTENTION
Ce module contient des composantes sensibles aux decharges electro-statiques.

SECTION 1 – INTRODUCTION

GENERAL

The Multi-Function Controller Module (NMFC05) is a versatile and powerful member of the NETWORK 90 Controller Family. It is designed to execute user-designed analog and digital control strategies.

Physically, the NMFC05 is a multi-layered printed circuit board. On board is a CMOS 68000 microprocessor (12 MHz speed), EPROM, RAM, and NVM (battery-backed non-volatile memory), VLSI and advanced CMOS support circuitry. The board is attached to a smoked plastic faceplate. Visible through the faceplate is a group of eight LEDs and a Status LED. The eight LEDs display important module operating information and error codes; the Status LED indicates the operating state of the module.

The NMFC05 occupies one slot in the Module Mounting Unit (MMU) of the NETWORK 90 cabinet. Each MMU has the capacity for a total of 12 single-width NETWORK 90 modules. The MMU backplane provides module power, Module Bus (module-to-module communication), and Expander Bus (slave module to MFC communication).

CAPABILITIES

The main purpose of the module is to process I/O interfacing and control strategy execution. In addition, the following features are available:

Redundancy

An additional NMFC05 module, identically configured, provides back-up redundancy. In a redundant configuration, one module is the primary; performing computations, executing control functions, etc. The other, the back-up module, monitors (tracks) the primary and waits in "hot standby." There is constant communication between the primary and the back-up module. If the primary module should fail, the back-up assumes control. Since the back-up has a copy of the primary's outputs, etc., there is no interruption of the process being controlled (this is known as bumpless transfer). Redundancy is enabled with switch SW4. (Refer to **Installation** section, Table 3-2.)

Table 1-1. Related Equipment

NAME	NOMENCLATURE	FUNCTION
Termination Module*	NIMF01 NIMF02	Provides link to Digital Control Stations; redundant MFCs. **NOTE:** Termination modules are high-density versions of the termination units.
Termination Unit*	NTMF01	Provides link to Digital Control Stations; redundant MFCs.
Cables	NKMF02	Connects primary MFC to redundant MFC.
	NKTM01	Ribbon cable for high-density termination module.
	NKTU01	Standard module to termination module cable.

*Termination units/modules are required if a Digital Control Station is being used. In other cases, only the NKMF02 cable (for redundancy) is required.

On-Line Configuration
On-Line Configuration enables users with redundant MFCs to make configuration changes without affecting the primary module or interrupting the control process. This task is accomplished by taking the back-up MFC out of the tracking mode, changing the desired functions and putting it back in the tracking mode. When the new configuration in the back-up MFC is started up, the present values of all process outputs in the primary MFC are used. The procedures for on-line configuration are explained in detail in **Appendix A.**

Inputs/Outputs
For inputs/outputs (I/O), the MFC supports analog, digital, and combination slaves modules (refer to Table 1-2). Each MFC can support a total of up to 64 slaves on one Expander Bus. While high and low power slaves can be mixed, no more than 20 high power slaves can be on one Expander Bus.

MANUAL CONTENT

This manual provides installation, operation, configuration, and troubleshooting information. Users are advised to read and understand this document before putting the module into service. A summary of section content follows:

General - an overview of module capabilities, electronic specifications, glossary of unique terms, and related documents.

Theory of Operation - data transfer and security functions performed by the hardware and software.

Installation - all preparatory steps (i.e., switch settings) that the user must perform before putting the module into service are covered in this section.

Operation - LED operating status information, the STOP and RESET pushbuttons, what to look for in normal day-to-day operation.

Configuration - design of control strategy, function codes that are unique to the MFC.

Troubleshooting - error messages and corrections.

Appendix A - on-line configuration procedures.

RELATED DOCUMENTS

The documents listed below discuss related hardware and functions for the NMFC05.

E93-900-20	Function Code Application Manual
E93-902-1	Digital Control Station (NDCS03)
E93-908-21	Remote I/O Module (NRIO02)
E93-911	Termination Units/Cables(NTMF01, NIMF01/02, NKTU01, NKMF02)
E93-912-9	Analog Slave Input Module (NASI01)
E93-913-6	Pulse Input Module (NDSM04)
E93-913-7	Digital Slave (NDSM05)
E93-913-10	Digital Slave Output Module (NDSO01/02/03/04)
E93-913-15	Digital Slave Input Module (NDSI01)
E93-913-20	Digital Slave Input Module (NDSI02)
E93-913-16	Control I/O Slave (NCIS02)

Table 1-2. Slave Modules

NAME	NOMENCLATURE	FUNCTION
Digital Slave Input Module	NDSI01 (L) NDSI02 (L)	Supplies 16 contact inputs of 24 V dc, 125 V dc, or 120 V ac
Digital Slave Pulse Input Module	NDSM04 (H)	Supplies 8 pulse inputs of 4 to 6 V dc or 21.6 to 27 V dc which determine the count frequency, or period of pulse or sine-wave inputs.
Digital Slave	NDSM05 (H)	Interfaces the MFC to up to 8 Digital Logic Stations (DLS).
Digital Slave Output Module	NDSO01 (L)	Supplies 8 solid state relay outputs of 24 V ac to 240 V ac
	NDSO02 (L)	Supplies 8 solid state relay outputs of 4 V dc to 50 V dc
	NDSO03 (L)	Supplies 8 solid state relay outputs of 5 V dc to 160 V dc
	NDSO04 (L)	Supplies 16 open collector outputs of 24 V dc
Control I/O Slave Module	NCIS02 (L)	Supplies 4 analog inputs (4 to 20 mA, 1 to 5 V dc), 3 digital inputs (120 V ac, 25 V dc, or 24 V dc), 2 analog outputs (4 to 20 mA, 1 to 5 V dc), and 4 digital outputs (24 V dc).
Analog Slave Input	NASI02 (L)	Supplies 15 analog inputs with a range from -10 to +10 V dc, 1 to 5 V dc, 4-20 mA, Smart Transmitter interface.
Remote I/O	NRIO02 (L)	Acts as the interface between remote slaves (located up to 10,000 feet away) and the MFC.

NOTE: (L) denotes low power slave; (H) high power slave. Low power slaves use HCMOS and semi-custom integrated circuits to reduce power consumption and allow 64 slaves on one Expander Bus.

SPECIFICATIONS

Microprocessor	68000 (@ 12 MHz)
Memory	128 kbytes EPROM 128 kbytes Static RAM (96 kbytes available for user configuration) 64 kbytes Non-volatile RAM (NVM; battery backed) (29 kbytes available for user configuration.)
Redundancy Link	(1) RS-422 link @ 25 kbaud
Station Link	(1) RS-422 link @ 5 kbaud
Power Consumption	1.3 amps max. @ +5 V dc (6.5 watts)
Mounting	Occupies one slot in standard NETWORK 90 Module Mounting Unit (MMU)
Certification	CSA certified for use as process control equipment in an ordinary (non-hazardous) location
Environmental	
Ambient Temperature	0° to 70°C (32° to 158°F)
Relative Humidity	0 to 95% up to 55°C (131°F) (non-condensing) 0 to 45% at 70°C (158°F) (non-condensing)
Atmospheric Pressure	Sea level to 3 km.

Specifications Are Subject To Change Without Notice.

NOTE: All components, whether in transportation, operation, or storage must be in a noncorrosive environment.

Table 1-3. Edge Connector P1 Pinouts

Pin	Signal	Pin	Signal
1	+5 V dc	2	+5 V dc
3	N/C	4	N/C
5	Common	6	Common
7	Not Used	8	Not Used
9	Power Fail Interrupt	10	Power Fail Interrupt
11	Module Bus	12	Module Bus

Table 1-4. Edge Connector P2 (Expander Bus) Pinouts

Pin	Signal	Pin	Signal
1	Data Bit D1	2	Data Bit D0
3	Data Bit D3	4	Data Bit D2
5	Data Bit D5	6	Data Bit D4
7	Data Bit D7	8	Data Bit D6
9	Clock	10	Sync
11	N/C	12	N/C

Table 1-5. Edge Connector P3 (Field I/O) Pinouts

Pin	Signal	Pin	Signal
1	DCS Link (+)	A	DCS Link (-)
2	Redundancy Link Transmit Data(+)	B	Redundancy Link Transmit Data (-)
3	Redundancy Link Receive Data (-)	C	Redundancy Link Receive Data (+)
4	N/C	D	N/C
5	N/C	E	N/C
6	N/C	F	N/C
7	N/C	H	N/C
8	N/C	J	N/C
9	N/C	K	N/C
10	N/C	L	N/C
11	N/C	M	N/C
12	N/C	N	N/C
13	N/C	P	N/C
14	N/C	R	N/C
15	N/C	S	N/C

GLOSSARY

Analog	A signal with infinite values as opposed toa digital value which is either 0 or 1.
Checksum	The bytewise sum of all bytes in a memory. This sum isused in software security checks to verify software and hardware integrity.
Configuration	Defining module operations (control strategy) with function blocks.
CTM	Configuration/Tuning Module - NETWORK 90 module used to enter new configurations, modify existing configurations, read status words, etc.
C TP	Communication Terminal Port.
CTT	Configuration Tuning Terminal - Handheld module; same functionality as CTM.
Digital	A value that is either 0 or 1.
Executive Block	Fixed function block that determines overall module operating characteristics.
Expander Bus	Parallel communication link between the Multi-Function Controller and slave modules.
Function Block	An area in the MFC's user-defined memory containing a function code.
Function Code	Defines operation(s) to be performed (e.g. AND, OR, PID).
LSB	Least Significant Bit (of MFC error code).
MCS	Management Command System - similar to OIU (below), only with greater functionality and monitoring capabilities.
MFT	Machine Fault Timer - is reset by the processor during normal operation. If an error is detected, the MFT times out and the module stops.
MSB	Most Significant Bit (of MFC error code).
Module Bus	Serial communication link between Multi-Function Controller and other control modules.
NVM	Non-volatile memory; battery-backed RAM.
OIU	Operator Interface Unit - a CRT-based operator monitor and control console; also used in configuration.
PCU	Process Control Unit - rack type industrial cabinet containing control and slave modules.
Primary	The active module in a redundant configuration.
Secondary	The backup module in a redundant configuration.
TM	Termination module; high-density terminator for process wiring.
TU	Termination unit; terminator for process wiring.

SECTION 2 – THEORY OF OPERATION

GENERAL

The NMFC05 has four communication channels (Module Bus, Expander Bus, Digital Control Station Link, Redundancy Link). Through the Module Bus, the MFC can communicate with other control modules in its process control unit (PCU). The Expander Bus is an 8-bit parallel bus located on the MMU backplane. It provides the path for bi-directional communications with slave modules. This bus, through a 12 position dipshunt, can be broken to create separate busses. The Digital Control Station Link allows the MFC to communicate with a Digital Control Station or Digital Indicator Station. The Redundancy Link allows communication between a primary MFC and a backup MFC.

This section provides an overview of the theory of transactions on the Expander Bus.

DATA TRANSFER ON EXPANDER BUS

Data transfer between the MFC and its slaves occurs on the Expander Bus. The MFC is able to execute four types of data transfer functions. They are: Write a command to a slave, request a slave status, write data to a slave, and read data from a slave.

The MFC always initiates the data transfer operation. When a transfer occurs, the MFC addresses a slave, requests the function, and reads or writes the data.

SECURITY FUNCTIONS

The hardware and software handle a variety of module security functions that detect normal failures.

Hardware Module Security Functions

The hardware checks for illegal addresses, and monitors the Machine Fault Timer and the Expander Bus clock.

The hardware detects illegal addresses in and above the MFC's boundary of 16 megabytes. If the processor sources an illegal address, the address decoding hardware detects it and generates a Bus Error. The front panel LEDs illuminate with the error message.

The processor periodically resets the Machine Fault Timer (MFT). If the timer is not reset, it soon expires. When this happens, the MFC stops immediately and the Status LED turns solid red.

The hardware also monitors the free-running Expander Bus Clock. If a timeout occurs, the hardware generates an interrupt or halt depending upon whether the MFC is a primary or backup.

Internal Software Security Functions

Two functions are performed by the internal software: Module Diagnostics and Module Status Check.

Module diagnostics are performed when the MFC is powered up. If a problem is detected, the error is displayed on the front panel LEDs and the module stops immediately.

As a background "idle task," the Module Status Check constantly verifies ROM and NVM checksums. If a discrepancy is found in any ROM checksum, the error is displayed on the front panel LEDs and the module stops immediately. If a discrepancy is found in any NVM checksum (e.g. non-fatal NVM error), the module continues to operate, however, the status LED flashes green.

Control Software Security

The control software is responsible for Local I/O problems, remote I/O problems, station problems, and redundancy errors.

Local and remote I/O errors cause the MFC to assign a bad status to the slave signals. Local errors occur when:

- An I/O signal is out of range.
- The MFC is unable to drive analog or digital outputs to correct values.
- A slave status is bad.

All I/O points that have any of the preceding errors are tagged by the MFC as "bad quality." Bad quality stays with the point no matter where it goes (e.g., in the MFC, on the Module Bus, or on the Plant Loop or Superloop).

If the user selects to run the process using bad quality data, the MFC uses the last valid value it had for the process point before the quality went bad. The MFC then writes the bad quality information to its module status byte and activates an OIU or MCS alarm.

Station and redundancy failures are also noted in the module status byte. These failures do not affect the module control. Since the status byte is always available at the Bus Interface Module (in the same PCU as the MFC), it is also available to the OIU or MCS console. Therefore, the console operator can be aware of the problem and correct it before a fatal error occurs.

I/O Security

For safety reasons, slave module outputs are programmed to go to user-defined states in the event of a detected failure. Failover states (e.g., power-up value, hold at current value) are given in the product instructions for the related MFC slave modules. Refer to these documents for specifics.

SECTION 3 – INSTALLATION

GENERAL

Before the MFC can be installed and operated, several preliminary steps must be performed. They are: set module address and options. Each of these is explained in subsequent paragraphs.

Only installation instructions concerning the MFC are provided in this section. For installation information about cables, termination units (modules), etc., refer to E93-911, Termination Unit Product Instruction. For slave module installation, refer to respective product instructions.

HANDLING

Special Handling

The MFC uses Electrostatic Sensitive (ESD) devices. Follow these handling procedures:

> **NOTE:** Grounding straps (field static kits) must be used when installing or removing modules to configure or change switches.

1. Keep the module in the special anti-static bag until you are ready to install it in the system. Save the bag for future use.

2. Ground the anti-static bag before opening.

3. Verify that all devices connected to the module are properly grounded before using them.

4. Avoid touching circuitry when handling modules.

General Handling

1. Examine the MFC immediately to verify that it has not been damaged in transit.

2. Notify the nearest Bailey Controls Sales Office of any such damage.

3. File a claim for any damage with the transportation company that handled the shipment.

4. Use the original packing material and/or container to store the modules.

5. Store the module in an environment of good air quality, free from temperature and moisture extremes.

USER-CONFIGURED SWITCHES

Module Address - Switch SW3

Switch SW3, an eight-pole dipswitch, is the module address switch. Poles 4 through 8 set the address. Note that pole 4 has a binary weight of 16, while pole 8 has a weight of 1. Valid module addresses are 2 through 31 (Refer to Table 3-1 for address switch settings and Figure 3-1 for switch location.)

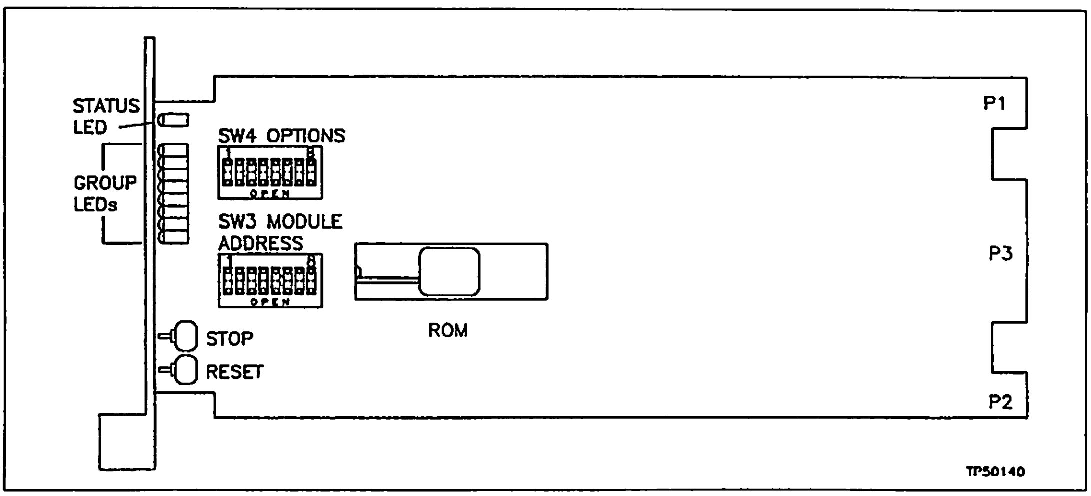


Figure 3-1. User-Configured Switch Locations

NOTE: Pole 1 must be in the open/off/logic 1 position for normal operation. Pole 2 in the open position puts the module in the diagnostic mode; closed the normal execution mode. Pole 3 setting does not matter. See Troubleshooting section for diagnostic information.

Options - Switch SW4

Switch SW4, the Option switch, is used to select variuos optional rotuines. Table 3-2 lists the settings and routines. See Figure 3-1 for switch location.

Jumpers J17-J22 are factory set (pins 1 and 2 jumpered) and **SHOULD NOT** be changed by the user. Jumpers J23 and J24 are intended for future use. Their setting does not matter at this time.

SETUP FOR LOOP ENVIRONMENT

Superloop

To configure the MFC for use in the Superloop environment, follow Steps 1 through 4.

1. Set dipswitch SW 4 poles 1 and 4 in the OFF (open/logic 1). All other poles must be in the ON (closed/logic 0) position. **Doing so does not modify the configuration.**

2. Reset the module. The Status LED turns red and LEDs 1 through 6 illuminate.

3. Set dipswitch SW 4 back to its original (or permanent setting).

4. Reset the module. This concludes setup for Superloop.

Plant Loop

To configure the MFC for use in the Plant Loop environment, follow Steps 1 through 5.

1. Set dipswitch SW4 with poles 1 and 3 in the OFF (open/logic 1) position to perform a default MFC format operation. All remaining poles must be in the ON (closed/logic 0) position.

   NOTE: This step deletes the configuration and all files.

2. Reset the module. The Status LED turns red and LEDs 1 through 6 illuminate.

3. Set dipswitch SW 4 to its original (or permanent setting).

4. Reset the module.

5. Reload Plant Loop Environment configuration.

INSERTING THE MFC IN THE MODULE MOUNTING UNIT

When the preceding steps have been completed, the MFC is ready to be installed in the Module Mounting Unit (MMU). To insert the MFC:

1. Verify the slot assignment of the module.

Table 3-1. Switch SW3 Module Address

Address	Switch Position 1 2 3 4 5 6 7 8	Address	Switch Position 1 2 3 4 5 6 7 8	Address	Switch Position 1 2 3 4 5 6 7 8
2	10X00010	12	10X01100	22	10X10110
3	10X00011	13	10X01101	23	10X10111
4	10X00100	14	10X01110	24	10X11000
5	10X00101	15	10X01111	25	10X11011
6	10X00110	16	10X10000	26	10X11010
7	10X00111	17	10X10001	27	10X11011
8	10X01000	18	10X10010	28	10X11100
9	10X01001	19	10X10011	29	10X11101
10	10X01010	20	10X10100	30	10X11110
11	10X01011	21	10X10101	31	10X11111

NOTE: X=Setting does not matter.
0=Closed or On
1=Open or Off

Table 3-2. Switch SW4 Options

Switch	Position	Function
1	0	Not used
2	0 1	Disable On-Line Configuration Enable On-Line Configuration
3	0	Not used
4	1 0	Inhibit ROM checksum routine Perform ROM checksum routine
5	0	Reserved
6		Compact configuration - moves configured blocks to the top of NVM while moving free space to the bottom (this is known as compacting). Leave switch OPEN; insert module into MMU. When front panel Group LEDs 1, 2, and 4 are ON, remove the module, put the switch in the CLOSED position; re-insert the module. The MFC comes up in the CONFIGURE mode with a compacted configuration.
7		Initialize NVM (erase configuration). Leave switch OPEN; insert module into MMU. When front panel Group LEDs 1, 2, and 4 are ON, remove the module, put theswitch in the CLOSED position; re-insert the module. The module is now ready to be configured. **NOTE:** This switch remains CLOSED for normal operation.
8	1 0	Redundant MFC. Primary MFC. **NOTE:** When redundancy is used, switches 1 through 7 on the redundant MFC must be set the same as the primary MFC.

2. If your configuration requires a cable, connect the hooded end of the cable to the rear of the MMU slot to be occupied by the MFC. Connect the other end of the cable to the termination unit (or termination module).

3. Verify that the dipshunts (supplied with the slave modules) are installed to maintain Expander Bus continuity.

4. Guide the top and bottom edges of the circuit card along the top and bottom rails of the MMU.

5. Slide the module into the slot; push until the rear edge is firmly seated in the backplane connectors and the module latch snaps in place on the bottom frame of the MMU.

The Status and CPU LEDs should illuminate for the duration of the startup period. If they do not, refer to the **Troubleshooting** section.

The module is now ready to be configured. Follow the steps in the **Configuration** section.

SECTION 4 – CONFIGURATION

GENERAL

A variety of control and math functions reside in the module's firmware. These are known as function codes. These codes, when assigned to addresses in NVM, become function blocks. Users link these function blocks sequentially to perform their control strategy.

This section explains the configuration process. (For complete information about MFC function codes, refer to E93-900-20, Function Code Application Manual).

FUNCTION BLOCKS

The NMFC05 has 2,047 function blocks available for user configuration. Of these, blocks 0 through 29 are fixed (their values are pre-assigned; the user can not alter them), and block 2,047 is reserved.

> **NOTE:** The total number of blocks actually configurable for user-selected functions depends on several critical factors: Execution time, bytes of NVM and RAM, degree of complexity, etc. Refer to the Function Code Application Manual, E93-900-20 for utilization factors for each function code.

The following example uses three function blocks and three different execution times. The steps below determine how to calculate the memory and CPU utilization based on a low cycle time of two seconds.

1. Identify NVM and RAM utilizations and execution times:

Function Code 7 Square Root:

12 Bytes NVM
44 Bytes RAM
240 microseconds execution rate

Function Code 19 PID:

36 Bytes NVM
116 Bytes RAM
690 microseconds execution rate

Function Code 82 Segment Control:

60 Bytes NVM
256 Bytes RAM
(execution time for this function is negligible)

2. Specify the number of blocks for both types. In this example, 205 Square Root blocks, 205 PID blocks, and 2 additional Segment Control blocks are configured.

3. Assign priorities to segments of these function blocks. Give the segment of blocks controlling the most critical functions the highest priority. Refer to table 4-1 for execution rates.

4. Calculate the amount of NVM the configuration uses:

a. Multiply 205 PID blocks by 36 bytes per block = 7,380 bytes of NVM.

b. Multiply 205 Square Root blocks by 12 bytes per block = 2,460 bytes of NVM.

c. Multiply 2 Segment Control blocks by 60 bytes per block = 120 bytes of NVM.

d. Add products:

7,380
2,460
+ 120
9,960 bytes of NVM

Table 4-1. Function Block Priority Execution Rates

Priority	Rate of Execution	PID Block	Square Root Block
Critical Control	20 times/sec	5	5
Normal Priority Control Loops	4 times/sec	100	100
Low Priority Control Loops	1 time/2 secs	100	100

There are 29,660 bytes available at the start, therefore, the user has 19,700 bytes of NVM remaining.

5. Calculate the amount of RAM the configuration uses:

a. PID blocks use 116 bytes. Therefore, multiply 205 PID blocks by 116 = 23,780 bytes RAM.

b. Square Root blocks use 44 bytes. Therefore, multiply 205 Square Root blocks by 44 = 9,020 bytes RAM.

c. Segment Control blocks use 256 bytes. Therefore, multiply 2 Segment Control blocks by 256 = 512 bytes RAM.

d. Add products:

```
 23,780
  9,020
+   512
 33,312 bytes of RAM
```

There are 98,304 bytes available at the start, therefore, the user has 64,992 bytes of RAM remaining.

6. Calculate the amount of CPU time the configuration requires to run. First, calculate the maximum amount of CPU time. Next, calculate how much CPU time the low-priority loops require.

a. Multiply 100 PID blocks by 690 microseconds = 0.069 seconds

b. Multiply 100 Square Root blocks by 240 microseconds = 0.024 seconds

c. Add products:

```
 0.069
+0.024
 0.093 seconds of CPU time
```

The result of this calculation gives the user the amount of CPU time that the low-priority control functions use during execution every 2 seconds.

7. Calculate the amount of CPU time used by normal priority loops of control functions:

a. Determine the number of times the normal priority loops run during the amount of CPU time specified. In this example, multiply 4 times/second by 2 seconds. Therefore, the normal priority function blocks will be executed 8 times.

b. Calculate the amount of CPU time that will be used **each time** the normal priority function blocks are executed.

100 PID blocks x 690 microseconds =	0.069 seconds
100 Square Root blocks x 240 microseconds =	+0.024 seconds
	0.093 seconds

c. Calculate the total time used by the normal priority function blocks during the available 2 seconds:

Normal priority blocks = 0.093 seconds used each time they are executed. Executed 8 times during the 2 second interval.

Therefore 8 x 0.088 = 0.704 CPU seconds used by the normal priority tasks every 2 seconds.

8. Calculate the amount of CPU time required for high priority function blocks to execute one pass of the high priority loop..

a. Multiply 5 PID blocks by 690 microseconds = 0.00345 seconds.

b. Multiply 5 Square Root blocks by 240 microseconds = 0.00120 seconds.

c. Add products:

```
 0.00345
+0.00120
 0.00465 seconds
```

d. Multiply 20 times per second by 2 seconds = 40 times in 2 seconds (number of high priority loops run within maximum CPU time allotted).

e. Multiply 0.00465 by 40 = 0.186 seconds (the amount of CPU time the high priority loops use within the 2 second maximum.

9. Add the final products.

0.093	(CPU seconds for low priority loops)
0.704	(CPU seconds for normal priority loops)
+0.186	(CPU seconds for high priority loops)
0.983	(Total CPU seconds used)

10. Finally, subtract the total CPU time from the maximum amount of CPU time specified to determine that the selected configuration will run.

2.000	seconds available
-0.983	seconds used bycontrol blocks
1.017	seconds of CPU time still available.

Function Code 81 - Executive
The Executive Function Code occupies blocks 0 through 14. Within these blocks are constant values that can be used as block inputs anywhere in the configuration. Additionally, this function is used to select the outputs of the front panel LEDs. Table 4-2 lists the system constants. Table 4-3 lists the specifications.

Function Code 82 - Segment Control
Function Code 82, Segment Control, is permanently assigned to block 15 and occupies the next four consecutive blocks. The Segment Control block is used to divide the set of function blocks into subsets (or segments), and specify the operating parametersfor each segment individually. The Segment Block has 5 outputs that can be used as inputs to other blocks. The MFC supports a maximum of eight Segment Control Blocks. The seven additional Segment Control blocks can be placed in any user-configurable block. Refer to Tables 4-4 and 4-5.

Function Code 90 - Extended Executive
Function Code 90, Extended Executive, resides at block 20 and occupies the next nine consecutive blocks. It is used in conjunction with Functions 81 and 82. This code defines a number of vairables affecting overall module operation. Refer to Table 4-6 and Table 4-7.

Table 4-2. Function Code 81 Block Outputs (System Constants)

Block Number	Data Type	Description
0	Boolean	Logic 0
1	Boolean	Logic 1
2	Boolean	0 or Real 0.0
3	Real	-100.0
4	Real	-1.0
5	Real	0.0
6	Real	1.0
7	Real	100.0
8	Real	-9.2E18 (max. negative value)
9	Real	+9.2E18 (max. positive value)
10	Boolean	Startup in progress flag 0 = no; 1 = yes
11	Real	Memory Display Value
12	Real	System free time in percent
13	Real	Revision Level (hardware and firmware)
14	Real	Reserved

Table 4-3. Function Code 81 Specifications

Spec No.	Tune*	Default Value	Data Type	Range Min. Max.	Description
S1	Yes	0	Int(2)	0 1	Front panel LED display mode. 0 = Normal (MFC status) 1 = Display memory
S2	Yes	0.000	Real(3)	Full	Most significant byte of memory display address.
S3	Yes	0.000	Real(3)	Full	Middle byte of memory display address.
S4	Yes	0.000	Real(3)	Full	Least significant byte of memory display address.

*Tune - a 'yes' indicates that these specifications can be altered during execution.

Table 4-4. Function Code 82 Specifications

Spec No.	Tune	Default Value	Data Type	Range Min. Max.	Description
S1	No	1	Int(2)	1 to 2	Segment Attributes Tune Lock and Time Units. Tune Lock 0X = Tuning allowed 1X = Tuning not allowed 2X = Modification lock 3X = Tuning and Modification lock Time Units X1 = Seconds X2 = Minutes
S2	Yes	.250	Real(3)	Full	Target period (seconds/minutes).
S3	No	0	Int(2)	0 to 32,767	Segment priority (0 = lowest).
S4	No	1	Int(2)	0 to 32,767	Checkpoint period (number of cycles per checkpoint).
S5	No	0	Int(1)	0 to 1	PID reset mode. 0 = Normal 1 = External
S6	No	10.000	Real(3)	Full	PID maximum derivative gain.
S7	No	1.000	Real(3)	0.0 to 9.2E18	Minimum report time for all exception reports in this segment (in seconds).
S8	No	60.000	Real(3)	0.0 to 9.2E18	Maximum report time for all exception reports in this segment (in seconds).
S9	No	2.000	Real(3)	0.0 to 9.2E18	Significant change parameter for all loop (i.e., Station) exception reports in this segment (in % of span).
S10	No	1.000	Real(3)	0.0 to 9.2E18	Alarm deadband for all high/low alarm reports in this segment (in % of span).
S11	No	1.000	Real(3)	0.0 to 9.2E18	Alarm deadband for all deviation alarm reports in this segment (in % of span).
S12	No	0.0	Real(3)	Full	Reserved.
S13	No	1.000	Real(3)	0.0 to 9.2E18	Module bus I/O period for this should be a multiple of the Extended MFC Executive Block 20, specification S2.
S14	Yes	9.2E18	Real(3)	0.0 to 9.2E18	Segment cycle time alarm limit (in seconds).
S15	No	0	Int(2)	0 to1	Auto sequencing. 0=Off 1=On

Table 4-5. Function Code 82 Block Outputs

Block Number	Description
N	Elapsed time of the previous execution cycle in S1 units, including any segment idle time. If the time required to run the block is less than the requested cycle time, the remainder is idle time spent waiting before starting the next cycle. Any idle time is available for lower priority segments. This output is used to verify that the cycle time specified by S2 is being met.
N+1	Elapsed time of the current execution cycle in S1 units, not including any segment idle time. It is a measure of the actual runtime of the blocks within the segment, plus the block runtime of all higher priority segments. This output is used to verify that the segment is running. A continual upward ramp indicates that the segment is not running. This occurs when higher priority segments consume all the processor time.
N+2	Processor utilization in percent.
N+3	Checkpoint overrun count number. The number of cycles executed over that specified by S4. This output is used to verify that the checkpoint period is being met. A continual upward ramp indicates that the segment is never getting the link for dynamic data transfer. A cyclic ramp indicates that dynamic data transfer is occurring, but not at the requested rate. Depending on the overrun, this may be an acceptable situation. If not, then the checkpoint period of the segment or the next highest priority segment must be increased until no overrun occurs.
N+4	Cycle time overrun in units specified by S1. If cycle time exceeds that set by S14, the overrun will be output from this block. This output enables the user to program logic to take specific action based on a given cycle time alarm limit being exceeded.

Table 4-6. Function Code 90 Specifications

Spec No.	Tune	Default Value	Data Type	Range Min. Max.	Description
S1	No	0	Int(2)	0 to 9999	Block address of configure mode lockout flag 0 = configure mode allowed 1 = configure mode locked out
S2	No	.250	Real(3)	0 to 9.2E18	Base module bus I/O period for MFC (in seconds)
S3	Yes	0	Int(2)	0 to 1	Redundant MFC configuration flag 0 = no redundancy 1 = redundancy
S4	Yes	15.000	Real(3)	0.0	Module startup time (in seconds)
S5	No	.250	Real(3)	0.0	Logic Station poll rate(in seconds)
S6	NOT USED				

Table 4-7. Function Code 90 Block Outputs

Block Number	Data Type	Description
20	Real	Time of day, hours
21	Real	Time of day, minutes
22	Real	Time of day, seconds
23	Boolean	Time/date synchronization flag 0 = time/date invalid 1 = valid
24	Real	Calendar year (0-99)
25	Real	Calendar month (1-12)
26	Real	Calendar day (1-31)
27	Real	Calendar day of week (1=Sunday, 2=Monday, etc.)
28	Real	Reserved
29	Real	Reserved

SECTION 5 – OPERATION

GENERAL

This section explains the pushbuttons, LED indicators, and the operating modes of the MFC.

PUSHBUTTONS

The Stop and Reset pushbuttons are accessible through openings in the faceplate. Each performs a different function. See Figure 5-1 for locations.

Stop Pushbutton
The Stop pushbutton performs the following:

- Forces the MFC to finish all Non-Volatile Memory write operations.
- Completes data transfers over the Expander Bus.
- Halts the primary module and forces control from the primary to the secondary MFC in redundant configurations.

The Stop pushbutton should be used:

- To force control from a primary to a backup MFC in redundant configurations.
- Before removing the MFC from the Module Mounting Unit (wait until the Status LED turns RED before removing the module).

Reset Pushbutton
The Reset pushbutton is used:

- Reset the MFC to power-up (default) status after a stop.
- Recover from a user-initiated stop or module timeout.

LED INDICATORS

A total of nine LED (eight Group LEDs, one Status LED) indicators provide the user with operating and error information.

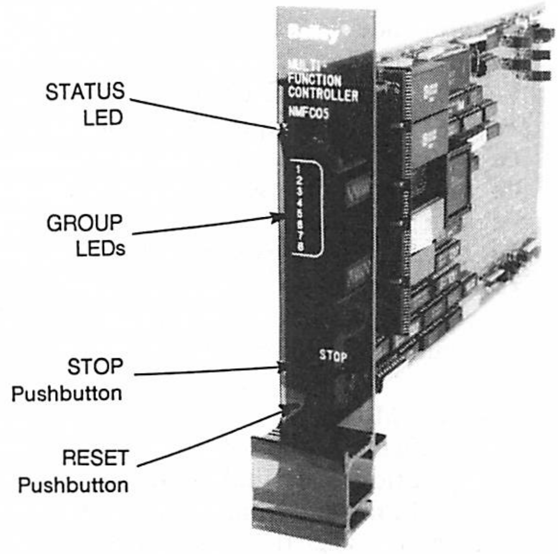


Figure 5-1. MFC Faceplate Pushbuttons and Indicators

Group LEDs
Group LEDs are numbered 1 through 8. LED 1 is the LSB; LED 8 the MSB of the error code. Illuminated LEDs display error codes and operating information. This information is provided in Table 6-1 in the **Troubleshooting** section.

Status LED
The Status LED is a red/green LED that indicates MFC operating condition. It has four possible states:

Off - indicates that the MFC is not powered.

Solid Green - indicates that the MFC is in the Execute Mode.

Flashing Green - indicates that the MFC is in Configure mode, Error Mode, or has detected a non-fatal NVM error. In the last case, the MFC continues executing the control scheme.

Solid Red - indicates that the MFC diagnostics have detected a hardware failure, configuration problem, etc. and the module has halted. Additionally, the Group A LEDs illuminate to display the error code (see Table 6-1 in **Troubleshooting** section).

OPERATING MODES

The MFC has three modes of operation: Execute, Configure, and Error.

Execute Mode

The Execute Mode is the normal mode of operation. When the MFC is in Execute, it computes algorithms, performs functions, updates outputs, and communicates with the Module and Expander busses. While in this mode, certain user-configured function block parameters can be tuned (adjusted), but configurations cannot be otherwise modified. The Status LED is solid green indicating normal operation. However, in certain non-fatal error conditions, the LED flashes green but the MFC continues to operate.

Configure Mode

The Configure Mode is used to enter or modify the configuration that makes up the user's control strategy. In this mode, function blocks can be added, modified, or deleted by using any of the standard NETWORK 90 configuration tools (e.g., MCS, OIU, CIU, CTT, CTM, Workstation). When the MFC is in the Configure mode:

- Slave analog outputs hold their current values.
- Slave digital outputs are de-energized or go to default state (which may be last value). Refer to specific slave instruction for details.
- Function algorithms are not computed.
- The module responds only to CONFIGURE messages.
- The Status LED blinks green.

Error Mode

The Error Mode is entered when one of the following occurs:

- When a configuration error is detected in going from the Configure to Execute mode.
- After resetting due to a red light condition as a result of a hardware problem (e.g., NVM or ROM checksum error).
- When the MFC is unable to communicate with other modules (non-fatal).

Diagnostic Mode

The Diagnostic Mode allows the module to execute ROM-based diagnostics. It is important to note that in certain instances, these diagnostics may erase the configuration (therefore, ensure that a backup configuration exists). Refer to the **Troubleshooting** section for details.

NOTE: The MFC is off-line during this period.

SECTION 6 – TROUBLESHOOTING

GENERAL

The Group LEDs (1 through 8) display operating and error codes. Table 6-1 lists the codes and actions the user should take to correct the error. If a code appears that is not listed, or if the code is one denoted by an asterisk, further informaton may be obtained by running on-board diagnostics.

Table 6-1. Operating/Error Codes

LED (Binary) 87654321	Hex	Meaning	Action
11000000	C0	Primary MFC (normal operation).	None.
00000000	00	Back-up MFC configuration is not initialized.	Check pole 7 (SW 4). Should be closed.
01000000	40	Back-up configuration is okay, however dynamic data is not initialized.	Check pole 7 (SW 4).
10000000	80	The back-up module has copied the primary configuration and is ready.	None.
00000001	01*	NVM checksum error.	Reset SW 4 pole 7 or replace NVM.
00000010	02	Analog input calibration error.	Check NCIS01/02 slave switch settings. Check dipshunt configurations on NTCS02 T.U. Also, check specifications of applicable function codes.
00000011	03*	Slave status error; wrong type or not responding.	Check switch settings on slave modules. Check dipshunt configuration on NTMF01 (or NIMF01). Also, check specifications of applicable function codes.
00000101	05	Configuration error (undefined block).	Check configuration. Add appropriate function codes/blocks.
00000110	06	Configuration error (data type error).	Check function code specifications in the configuration. Correct any discrepancies.
00001011	0B	Initialize NVM switch is set.	Reset SW 4 poles 6 and 7. Remove and re-insert the module.
00001100	0C	Non-volatile memory write in progress.	Initialize configuration.

Table 6-1. Operating/Error Codes (Continued)

LED (Binary) 87654321	Hex	Meaning	Action
00001101	0D*	Communication error between primary and redundant MFCs.	Check the NTMF01 Cable between the primary and secondary MFCs. Also, check the NKTU01 cable to the termination module or termination unit.
00001110	0E	Backup MFC ID switch is same as primary's ID.	Pole 8 of SW 4 on backup should be toggled.
00001111	0F	Primary failed; back-up configuration not current.	Reconfigure the primary MFC.
00010000	10	Primary failed; back-up dynamic data is not current.	Reconfigure the primary MFC.
00010001	11*	Error during write to Non-Volatile Memory.	Check configuration. Correct any faulty values. Re-execute the configuration.
00010010	12	Backup MFC module bus address is not same as primary.	Set module bus switch same as primary's.
00010011	13*	Bad UVROM.	Contact Bailey Field Service.
00010100	14	Inconsistent module/loop setup. (i.e., module configured for Plant Loop is on Superloop).	Refer to **Setup for Loop Environment** in Section 3.
00110000	30*	Primary active during failover attempt.	Replace primary with new module.
00110001	31*	Memory/Processor fault.	Replace the MFC with a known good MFC.
00110010	32*	Address/bus error.	Reset module; if error recurs, replace it.
00110011	33	Illegal instruction.	Reset module; if error recurs, replace it.
00110100	34	Trace/privilege violation.	Reset module; if error recurs, replace it.
00110101	35	Spurious exception.	Reset module; if error recurs, replace it.
00110110	36	Divide by 0/CHK instruction.	Reset module; if error recurs, replace it.
00110111	37	A "Trap" instruction was entered in the configuration.	Reset module; if error recurs, replace it.
00111111	3F	STOP pushbutton used to halt CPU normally.	None.

ON-BOARD DIAGNOSTICS

The on-board diagnostics feature is another user tool. This tool enables the user to verify the module's components and circuitry.

Diagnostic routines are selected with the module's dipswitches; results are dipslayed on the front panel LEDs. Tests can be run once or continuously, by group or individually.

A typical scenario: The user sets the dipswitches to select a test, resets the module, and observes the results on the LEDS. He then selects another test.

Some diagnostic tests require an additional module (e.g. slave or another MFC).

Setup and explanations are explained in subsequent paragraphs.

SWITCH SELECTION

Switches SW 3 and SW 4 are used to determine which diagnostic test to run, and how to run it. See Figure 3-1 for switch locations.

SW 3 pole 1 must always be in the 1 (OFF/OPEN) position. Pole 2 must set set to the 1 (OFF/OPEN) position to put the MFC in the Diagnostic Mode. Poles 3 through 8 are not used in diagnostics except in the Module Address Select Test (Test ID 14).

SW 4 poles 1 through 6 select the diagnostic test to run. Pole 1 is the least significant bit (LSB) with a binary weight of 1, while pole 6 is the most significant bit (MSB) with a binary weight of 32. Refer to Table 6-3 for test IDs.

SW 4 pole 7 selects a HALT ON ERROR feature when continuous operation is selected.

SW 4 pole 8 selects continuous mode which means the selected test is executed continuously. Each successful completion of the test increments a test pass counter and is displayed on the front panel LEDs (likewise for failures).

STATUS WORD DISPLAYS

Module status words are listed in Table 6-4. These words provide detailed information on MFC error conditions. Any of the NETWORK 90 operator interface devices can be used to access these words. Refer to the product instruction for your specific interface device for details.

LED DISPLAY

The front panel LEDs display diagnostic test results.

When the MFC is reset, all eight LEDs illuminate for approximately 10 seconds.The dipswitch settings are then read and the test ID is displayed on the LEDs. If the selected test is for single pass execution, LED 1 illuminates if the test passes; LED 8 illuminates if the test fails. One second later, the Status LED goes from green to red. This indicates the module has stopped executing. If the selected test is for continuous execution, a running tally of successes and failures is displayed on the LEDs. LEDs 1 (LSB) through 4 tally the passes; LEDs 5 (LSB) through 8 tally the failures.

For group tests (0 and 32), an error code is displayed that tells which individual test failed to pass. Refer to Table 6-5 for error codes (note that LED 1 is the LSB of the hexadecimal code).

MAINTENANCE/SERVICE

The MFC requires no periodic maintenance. Module replacement and company services are available for special maintenance requirements. Contact your nearest Bailey office for service.

Table 6-2. Digital Slave Setup for Diagnostics

	Pole							
Switch	1	2	3	4	5	6	7	8
Enable	X	1						
Address	X	X	0	0	1	1	1	1
Module Config.	1	1	0	X				
X = does not matter								
Jumper J17 - pins 2 and 3 Jumper J18 - pins 2 and 3								

Table 6-3. Diagnostic Test IDs

Test Name	Test ID	SW 4 Switch Settings 1 2 3 4 5 6	Continuous	Comments
Group	0	0 0 0 0 0 0	Yes	Refer to Table 6-5 for error codes.
CPU	1	1 0 0 0 0 0	Yes	Verifies processor instruction set.
ROM	2	0 1 0 0 0 0	Yes	Verifies checksum.
Static RAM	3	1 1 0 0 0 0	Yes	Verifies bytes, short and long words.
Expander Bus Assassin	6	0 1 1 0 0 0	No	Halts on success, else counts failures.
Dispatcher IRQ	9	1 0 0 1 0 0	Yes	Tests interrupts.
Expander Bus IRQ3	10	0 1 0 1 0 0	Yes	Tests interrupts.
68681 Timer	11	1 1 0 1 0 0	Yes	Tests interrupts.
Module Bus	12	0 0 1 1 0 0	Yes	Tests interrupts.
Expander Bus Stall	13	1 0 1 1 0 0	Yes	Tests interrupts.
MFC Expander Bus	14	0 1 1 1 0 0	Yes	Verifies Expander Bus communications. This test requires a NDSM05 Digital Slave. Refer to Table 6-2 for configuration.
Redundancy Link Primary	16	0 0 0 0 1 0	Yes	Tests communication link between redundant MFCs. This test requires an NKMF02 cable between the primary and secondary modules. The LED display on the secondary module is not an error code; it is a count of received messages.
Redundancy Link Secondary	17	1 0 0 0 1 0	Yes	Same as above.
DCS Link Primary	18	0 1 0 0 1 0	Yes	Verifies the DCS link communication circuitry. Note that this test requires redundant MFCs.
DCS Link Secondary	19	1 1 0 0 1 0	Yes	Same as above; verifies DCS link communication.
68661 DUART	24	0 0 0 1 1 0	Yes	Tests serial channels and timer.
BATRAM Test 1	25	1 0 0 1 1 0	Yes	Verifies NVM write/protect and component.
BATRAM Test 2	26	0 1 0 1 1 0	Yes	Verfies NVM write/protect and component.
LEDs	27	1 1 0 1 1 0	Yes	Tests LEDs by counting cycle.
Module Address	28	0 0 1 1 1 0	Yes	Monitors SW 3; displays the selected address on front panel LEDs.
Reset Button	29	1 0 1 1 1 0	No	None.
Stop Button	30	0 1 1 1 1 0	No	Tests interrupt; displays 3F hex (LEDs 1 - 6 illuminate).
MFC Mode Primary	32	0 0 0 0 0 1	No	Successful completion displays 55 hex on front panel LEDs. Requies NKMF02 cable between primary and secondary. Also requires NDSM05 digital slave (refer to Table 6-2).
MFC Mode Secondary	33	1 0 0 0 0 1	Yes	Displays count of messages received.

Table 6-4. Status Bytes Descriptions

Byte	7	6	5	4	3	2	1	0
1	ES	MODE		TYPE				
2	FTX	BAC	RIO	LIO	CFG	NVF	NVI	DSS
3								
4								
5								

Field	Value			Description
Byte 1				
ES		80		Error Summary (0-OK, 1-Error)
MODE		60		Module Mode (00-Config, 01-Error, 11-Exec)
TYPE		1F		Module Type Code (0B=MFC)
Byte 2				
FTX		80		First Time in Execute (0-No, 1-Yes)
BAC		40		Backup MFC Status (0-OK, 1-Bad)
RIO		20		Summary Remote I/O Status (0-OK, 1-Bad)
LIO		10		Summary Local I/O Status (0-OK, 1-Bad)
CFG		08		On-line configuration changes being made (0-No, 1-Yes)
NVF		04		NVM Checksum Error (0-OK, 1-Bad)
NVI		02		NVM default Configuration (0-No, 1-Yes)
DSS		01		Digital Station Status (0-OK, 1-Bad)
Bytes 3-5	3	4	5	
	01	01	--	NVM Error: Write Failure
		02	--	Checksum Failure
		03	--	Bad Data
		FF	--	Reset During Write
	02	(1)	(2)	Analog Input Reference Error - * = Block number of Control Interface Slave Block
	03	(1)	(2)	Missing Slave Module or Expander Board - * = Block number of slave module or Digital Station
	05	(1)	(2)	Configuration Error - undefined block - * = Block making reference
	06	(1)	(2)	Configuration Error - input data type is incorrect - * = Block making reference
	08	(1)	(2)	Trip block activated - * = Block number of Trip block
	0F	--	--	The primary MFC has failed and the redundant MFC configuration is not current.
	10	--	--	The primary MFC has failed and the dynamic RAM data in the redundant MFC is not current.

NOTE: All block numbers are encoded in BCD (binary coded decimal) with (1) = MSB (most significant byte) and (2) = LSB (least significant byte). Example: Block Number 1024 -- (1) = 10, (2) = 24.

Table 6-5. LED Error Codes

LED 8	7	6	5	4	3	2	1	Hex Value	Failed Test
0	0	0	0	0	0	0	1	01	CPU
0	0	0	0	0	0	1	0	02	ROM
0	0	0	0	0	0	1	1	03	RAM
0	0	0	0	0	1	0	0	04	NVM (Battery Backed RAM)
0	0	0	0	0	1	0	1	05	Clock-Calendar
0	0	0	0	0	1	1	0	06	Expander Bus Assassin
0	0	0	0	1	0	0	1	09	Dispatcher IRQ
0	0	0	0	1	0	1	0	0A	Expander Bus IRQ
0	0	0	0	1	0	1	1	0B	68681 Timer
0	0	0	0	1	1	0	0	0C	Module Bus
0	0	0	0	1	1	0	1	0D	Expander Bus Stall
0	0	0	0	1	1	1	0	0E	Expander Bus Transaction
0	0	0	1	0	0	0	0	10	Redundancy Link
0	0	0	1	0	0	1	0	12	DCS Link
0	0	0	1	1	0	0	0	18	68681 DUART
0	0	0	1	1	0	0	1	19	NVM Test 1
0	0	0	1	1	0	1	0	1A	NVM Test 2

SECTION 7 – ORDERING PROCEDURES

Firmware consists of a library of function codes programmed into a Read-Only Memory (ROM) integrated circuit (or chip). This firmware provides the functions for building the control strategy your MFC module executes.

Periodically, firmware is updated with enhancements and new function codes. As a result, Bailey offers a firmware update service that enables the user to obtain the latest enhancements for updating his module.

To take advantage of this service, call your Bailey Sales Representative and order Firmware Update Service AOFMFC0501.

To obtain new firmware, first you must determine the current firmware revision you have. Use your configuration tool (e.g. Configuration/Tuning Module, Engineering Workstation, etc.) to read the output of Block 13. The output is the current firmware revision level you have. An example of Block 13 output follows:

```
5000
↑↑ ↑↑
│ │ └┴── Firmware Revision Level (00 = A_0)
│ └───── Hardware Revision Level
└─────── Module Nomenclature (5 = NMFC05)
```

Call your Bailey Sales Representative with this information; tell him you want the latest version. It is that easy.

APPENDIX A – ON-LINE CONFIGURATION

INTRODUCTION

On-Line Configuration, used in conjunction with redundant Multi-Function Controllers (MFC), enables the user to make configuration changes without affecting the primary MFC or interrupting the control process.

In redundant MFC configurations, the primary MFC executes the process control logic while the backup MFC tracks the configuration of the primary. On-line configuration allows the user to remove the backup MFC from the tracking mode and make configuration changes, without interrupting the process control operation of the primary MFC. Conventional off-line changes are supported by on-line configuration. When the backup MFC has been reconfigured, it can assume control with the new configuration while the original primary MFC assumes the backup role.

During start-up of the new configuration in the backup MFC, the present values of all process outputs in the primary MFC are used. This feature permits "bumpless" transfer of control to the new configuration.

SETUP

On-Line Configuration of redundant MFCs requires two consecutive module bus addresses to be reserved. In normal operation each member of the redundant pair has the same module bus address. (If the module bus address of the redundant pair is at 4 during normal operation, then automatically the module bus address of the backup MFC is at 5 during On-Line-Configuration.)

Set Switch 2 on Dipswitch SW4 (see Figure 3-1 in **Installation** section) of the Backup and the Primary MFC to the open position. Doing so enables the use of On-Line-Configuration.

OPERATION

The following is a step-by-step procedure for performing on-line configuration. These standard NETWORK 90 configuration tools can be used to accomplish On-Line-Configuration: Configuration and Tuning Module (CTM), Configuration Tuning Terminal (CTT), Operator Interface Unit (OIU), Management Command System (MCS), and Bailey Workstation (BWS) with PC-90 Ladder Software or TEXT.

> **NOTE:** Care must be exercised when using either PC-90 Ladder Software or TEXT to avoid deleting blocks and/or adding blocks in the middle of existing ones. (See the note preceding Step 2A of the Backup Cycle for a further explanation.)

See Figure 5-1 in **Operation** section for the front panel LED positions. The status of LEDs 7 and 8 is indicated for each step of the Backup and Primary cycles. Refer to Table 6-1 for LED error codes.

CAUTION

Strict adherence must be made with regard to the rules set forth in this document. Follow all steps in the sequence given and at no time change configurations or remove the module before the LEDs instruct you to do so. Failure to heed this warning and follow proper procedures could result in unpredictable MFC operation and/or loss of output data.

ATTENTION

Les procedures decrites dans ce document doivent etre suivies a la lettre. Respecter l'ordre des etapes, et ne jamais apporter de changements a la configuration ou retirer le module du chassis de montage avant que les temoins DEL ne l'autorisent. Tout ecart a la procedure decrite peut mener a un fonctionnement anormal du MFC et/ou entrainer la perte des signaux de sortie.

For example, do not reset a MFC before its CPU LED 7 lights. When lit, this LED tells the user that a successful copy of the configuration has been made.

Resetting the MFC before this copy is complete could result in unpredictable MFC operation and/or loss of output data.

Figures A-1 and A-2 illustrate the backup and primary cycles, respectively. For clarity, the term "backup MFC" will always refer to the original backup MFC and the term "primary MFC" will always refer to the original primary MFC. When the roles are reversed for either unit, the status will be carefully noted.

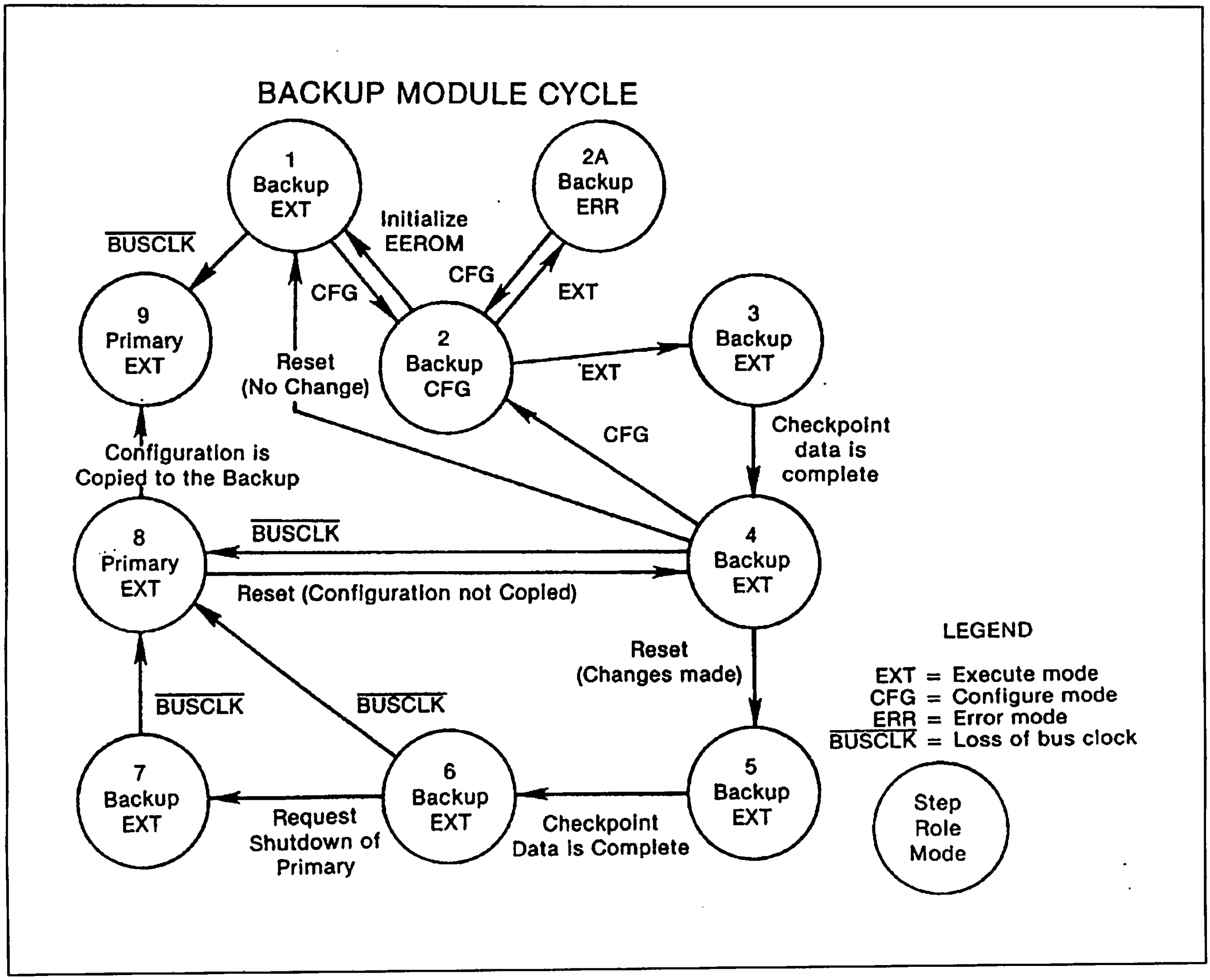
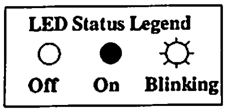


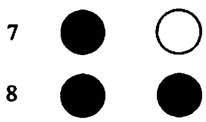
Figure A-1. Backup MFC Operation Cycle



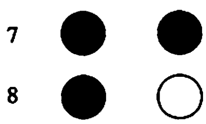
Primary Backup

Backup Cycle

(The step numbers in this cycle correspond to the states of Figure A-1.)



1. Save a copy of the old configuration. This enables it to be easily restored if needed.



2. Place the backup MFC in CONFIGURE mode. The green LED of the backup MFC will blink indicating CONFIGURE mode. Configuration Commands to the back-up MFC are sent to the address of the primary MFC plus one. The primary MFC now indicates that the backup MFC is not available for automatic failover.

To return to Step 1 without making any changes, place the backup MFC in EXECUTE mode and reset it after LED 8 illuminates. Resetting an MFC causes all the LEDs on it to light momentarily before returning to normal status.

When changes are being made to the backup MFC, LED 7 blinks indicating that the configurations of the backup and primary MFCs do not match.

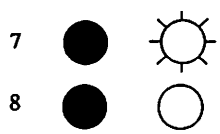
If these changes to th econfiguration are incorrect, return to step 1 by initializing NVM. Wait for LED 8 on the backup MFC to light before continuing.

NOTE: When configuring the backup MFC, the following rules are strictly enforced by the module:

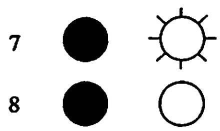
1. Blocks can only be added in the block space at the end of a segment.

2. A block existing in the primary MFC can not be deleted.

3. A specification change cannot be made to a block already existing in the primary MFC if that change will effect the module utilization factor. Any attempt to circumvent these rules will result in an appropriate error message.



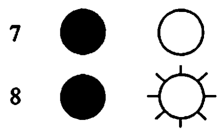
2A. When an error exists in the new configuration, the backup MFC enters ERROR mode before going to EXECUTE mode. The user must return to CONFIGURE mode to fix the error. The green LED of the backup MFC blinks to indicate it is in the ERROR or CONFIGURE mode. Group A LED 7 of the backup MFC blinks to indicate that configuration differences exist between the primary and backup.



3. The backup MFC can now be placed in EXECUTE mode provided no errors remain in the new configuration.

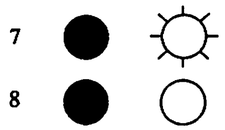
Additional configuration changes can be made by entering CONFIGURE mode (Step 2). If no changes have been made, reset returns the backup MFC to Step 1.

Primary Backup

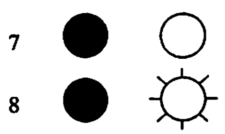


4. When the checkpoint data for the old configuration is received from the primary MFC, the reconfigured backup MFC can assume the role of the primary MFC if a failure is detected in the old configuration (see Step 8). However, the primary MFC still indicates that no backup is available when the configuration is different.

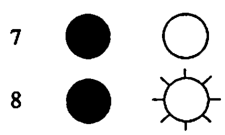
Additional configuration changes can be made by entering CONFIGURE mode (Step 2). If no changes have been made, a reset returns the backup MFC to Step 1.



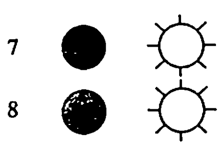
5. A reset at this step, changes having been made, is used to tell the reconfigured backup MFC to assume the role of the primary MFC. The backup MFC enters EXECUTE mode with the configuration marked as valid.



6. After the checkpoint data is updated, the backup MFC is ready to take over the duties the primary MFC.



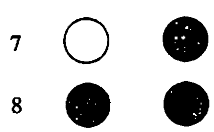
7. The backup MFC requests the primary MFC to shutdown and assume the role of a hot backup. The backup MFC waits to act as the primary MFC. (A hot backup is a backup which remains on-line and ready to assume control if an error is detected in the new configuration.)



8. The primary MFC has removed the bus clock (BUSCLK) and acts as a hot backup. The reconfigured backup MFC is now serving as the primary MFC.

To return to Step 4, reset the backup MFC. This allows the user to correct a bad configuration.

8a. Resetting the Primary MFC, currently acting as the hot backup, tells it to get a copy of the new configuration. The primary MFC must be reset at this point in order for the cycle to complete.



9. After the backup MFC copies the new configuration into the primary MFC, this cycle is complete. The backup MFC is now serving as the primary MFC while the primary handles the backup role.(Notice that the LED combination is the opposite of Step 1 indicating the role reversal.)

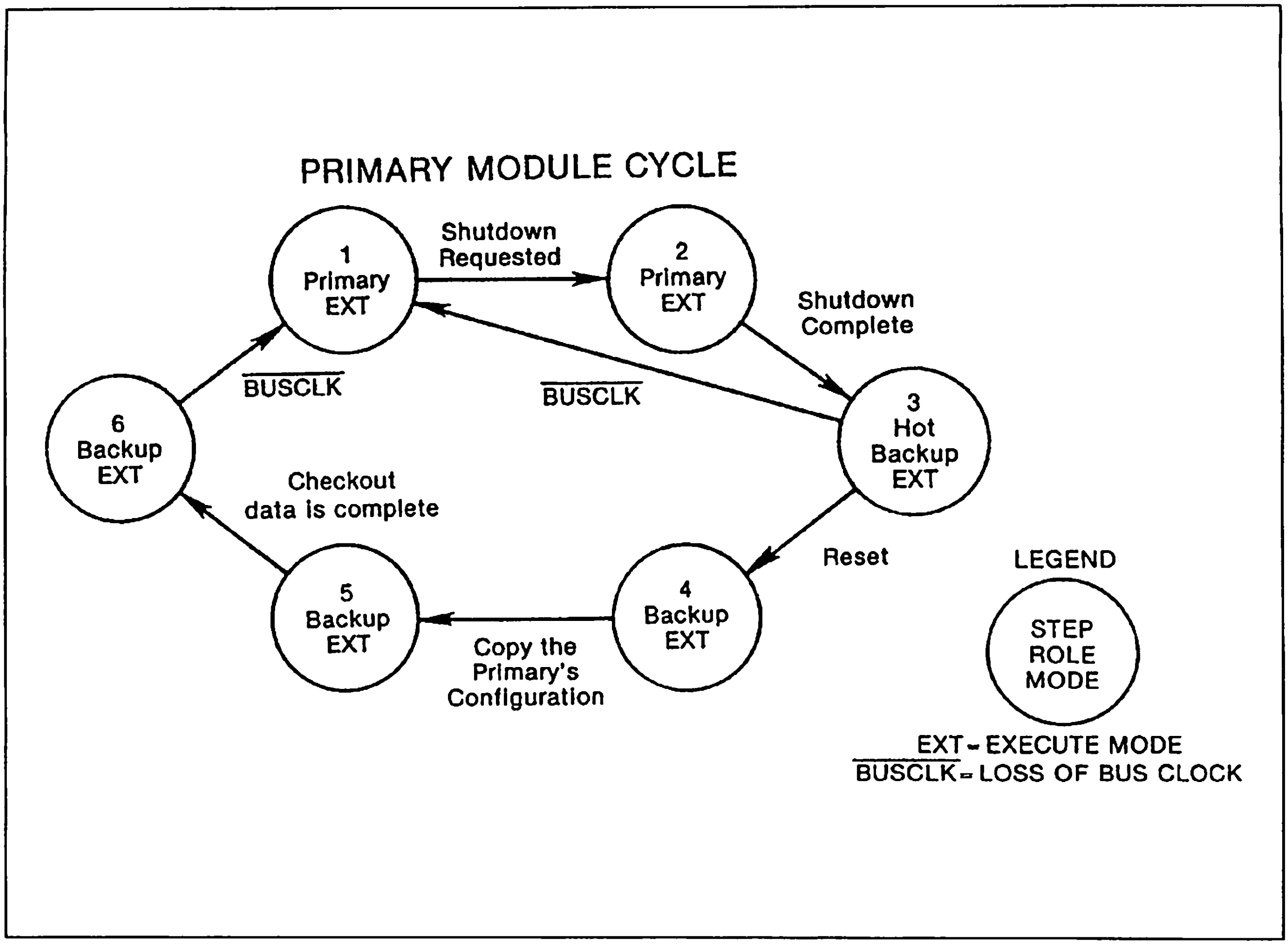
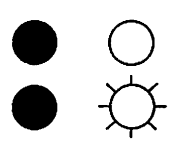


Figure A-2. Primary MFC Operation Cycle

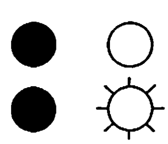
Primary Cycle

(The step numbers in this cycle correspond to the states of Figure A-2.)

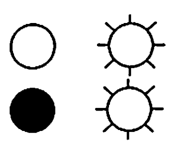
Primary Backup

7
8


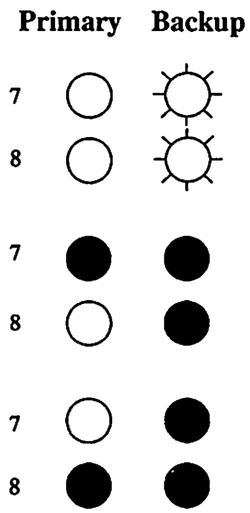
1. The primary MFC is actively controlling the process. (This represents the same juncture as Step 4 of the Backup Cycle.)

7
8


2. When the shutdown request is received from the backup MFC (Step 7 of the Backup Cycle), the primary MFC stops executing and removes the bus clock.

7
8


3. The primary MFC is now acting as the hot backup. All the old configuration and block output information remains intact from when it is shut down in Step 2. If the new configuration is not operating as expected, the primary MFC, currently acting as the hot backup, can take control using the old configuration and block output information (returns to Step 1).



4. Resetting the primary MFC, currently acting as the hot backup, tells it to get a copy of the new configuration. (Step 8 of the backup cycle.)

5. When the new configuration has been copied, the backup MFC has completed its cycle, and is now serving as the primary MFC.

6. After the checkpoint data is complete, the primary MFC is now serving as the back-up MFC and is ready to take over the control process. The Primary Cycle is complete. (This represents the same juncture as Step 9 of the Backup Cycle.)

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Multi-Function Controller Module (NMFC05)

The appendix for on-line configuration now includes Module Status Byte information. The second Module Status Byte (bits 7, 6, 3 and 1) provides the user with the primary and secondary MFC status. Users can view the byte's contents with their NETWORK 90 operator interface. Users with remotely located MFCs benefit from being able to use status byte information while doing on-line configuration.

The appendix explains on-line configuration step-by-step. It lists the state of LEDs 7 and 8 and Status Byte contents for each step.

Remove the existing Appendix A and replace with the attached pages.

Instruction Update

E93-906-13

Form I-E93-906-13A1 Litho in U.S.A. 1289

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APPENDIX A – ON-LINE CONFIGURATION

INTRODUCTION

Using on-line configuration in conjunction with redundant Multi-Function Controllers (MFC) enables the user to make configuration changes without affecting the primary MFC or interrupting the control process.

In redundant MFC configurations, the primary MFC executes the process control logic while the backup MFC tracks the configuration of the primary. On-line configuration allows the user to remove the backup (or secondary) MFC from the tracking mode and make configuration changes, without interrupting the process control operation of the primary MFC. It also supports conventional off-line changes. When the backup MFC has been reconfigured, it can assume control with the new configuration while the original primary MFC assumes the backup role.

During start-up of the new configuration in the backup MFC, it uses the current values of all process outputs in the primary MFC. This feature permits **bumpless** transfer of control to the new configuration.

SETUP

On-Line Configuration of redundant MFCs requires two consecutive module bus addresses to be reserved (n and n+1 - where n is the primary address, n+1 is the backup). In normal operation each member of the redundant pair has the same module bus address as determined by the Module Address Switch settings. (If the module bus address of the redundant pair is at 4 during normal operation, then automatically the module bus address of the backup MFC is at 5 during On-Line-Configuration.)

Set pole 2 on the Options Dipswitch of the Backup and Primary MFC to the open position to enable On-Line Configuration.

OPERATION

This appendix provides a step-by-step procedure for performing on-line configuration. These standard NETWORK 90 configuration tools can be used to accomplish On-Line-Configuration: Configuration and Tuning Module (CTM), Configuration Tuning Terminal (CTT), Operator Interface Unit (OIU), Management Command System (MCS), and Engineering Workstation (EWS) with PC-90 Ladder or CAD/TEXT software.

NOTE: Care must be exercised to avoid deleting blocks and/or adding blocks in the middle of existing ones when using either PC-90 Ladder or CAD software. (Refer to the note preceding Step 2A of the Backup Cycle for a further explanation.)

In some user applications, MFCs are remotely located and the operator is unable to view the LEDs. In these applications, the data from the second Module Status Byte must be used. This appendix provides an outline procedure for on-line configuration, and shows both the state of LEDs 7 and 8 as well as the contents of the second Module Status Byte (specifically bits 7, 6, 3 and 1). For each step of the on-line configuration process, both the contents of the Status byte as well as the state of LEDs 7 and 8 are indicated in the margin.

Refer to the **Operation** section figure for MFC faceplate location of LEDs 7 and 8.

NOTE: The value of bit 7 depends on the Superloop Bus Module (SBM) or Bus Interface Module (BIM) residing on the same Module Bus as the MFC.

The user's specific interface device determines how module status is acquired. For example: Using an Operator Interface Unit (OIU), the status is polled by selecting the module in the PCU Status Display selected from the System Status Display. With an EWS using

CAD/TEXT software, the Problem Report option must be selected. Note that this option does not continuously poll for module status. The EWS user may have to invoke it multiple times until the final module status condition arises for the given step of the On-Line Configuration cycle. The Problem Report option is available in the Modify Mode menu of the CAD/TEXT software.

CAUTION

Strict adherence must be made with regard to the rules set forth in this document. Follow all steps in the sequence given and at no time change configurations or remove the module before the LEDs or module status byte instruct you to do so. Failure to heed this warning and follow proper procedures could result in unpredictable MFC operation and/or loss of output data.

ATTENTION

Les procedures decrites dans ce document doivent etre suivies a la lettre. Respecter l'ordre des etapes, et ne jamais apporter de changements a la configuration ou retirer le module du chassis de montage avant que les temoins DEL ou les octets d'etat du module ne l'autorisent. Tout ecart a la procedure decrite peut mener a un fonctionnement anormal du MFC ou entrainer la perte des signaux de sortie.

For example, do not reset a primary MFC before the backup's LED and/or Module Status Byte indicate that backup is available. Resetting the primary MFC prematurely could result in unpredictable operation and/or loss of output data.

Figures A-1 and A-2 illustrate the backup and primary cycles, respectively. For clarity, the term **backup MFC** will always refer to the original backup MFC and the term **primary MFC** will always refer to the original primary MFC. When the roles are reversed for either unit, their status is carefully noted.

Legend		
	Primary	**Backup**
Module Address	n	n+1
Second Module Status Byte **	Bit * 7 6 5 4 3 2 1 0 0 1 x x 0 x 0 x	Bit * 7 6 5 4 3 2 1 0 1 0 x x 1 x 0 x
LEDs 7 and 8		
ON	●	●
OFF	○	○
BLINKING	☼	☼

* bit 7 = first time in Execute (Most Significant Bit (MSB))
bit 6 = backup MFC status bad
bit 3 = on-line configuration changes being made
bit 1 = NVM default configuration
** x = don't care

Backup Cycle

The step numbers in this cycle correspond to the status of Figure A-1.

Primary	Backup
n	n+1
00xx0x0x	10xx0x0x

1. Save a copy of the current configuration. This enables it to be easily restored if needed.

n	n+1
01xx0x0x	00xx0x0x

2. Place the backup MFC in **CONFIGURE** mode.

The green LED of the backup MFC blinks indicating CONFIGURE mode. The module status also indicates CONFIGURE mode. Configuration Commands to the backup MFC are sent to the address of the primary MFC plus one (n+1). The primary MFC now indicates that the backup MFC is not available for automatic failover. Bit 6 indicates this condition.

To return to Step 1 without making any changes, place the backup MFC in EXECUTE mode and RESET it after LED 8 illuminates or the primary status indicates 00xx0x0x. Resetting an MFC causes all the LEDs on it to light momentarily before returning to normal status.

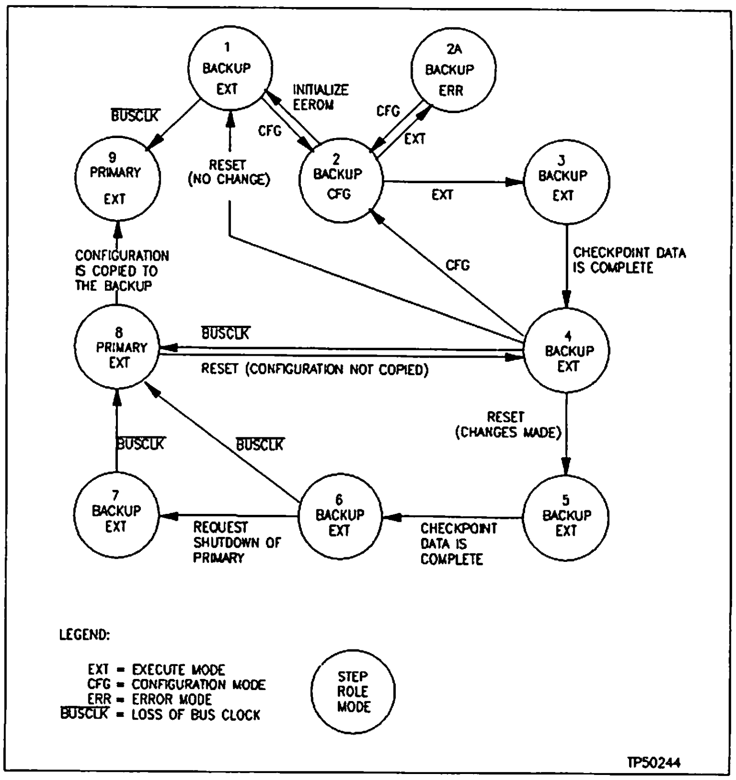

Figure A-1. Backup MFC Operation Cycle

Primary	Backup
n	n+1
01xx0x0x	00xx1x0x

When changes are being made to the backup MFC, LED 7 blinks and bit 3 of the backup module is set indicating that the configurations of the backup and primary MFCs do not match.

If these changes to the configuration are incorrect, return to Step 1 by an INITIALIZE of the backup MFC NVM while it is in CONFIGURE mode.

NOTE: When configuring the backup MFC, the following rules are strictly enforced by the module:

- Blocks can only be added in the block space at the end of a segment.

- A block existing in the primary MFC can not be deleted.

- A specification change cannot be made to a block already existing in the primary MFC if that change will affect the module RAM utilization factor (i.e. change memory requirements).

Any attempt to circumvent these rules will result in an appropriate error message.

n	n+1
01xx0x0x	00xx1x0x

2A. When an error exists in the new configuration, the backup MFC enters ERROR mode when the user initiates a transfer to EXECUTE mode command. The user must return to CONFIGURE mode to fix the error. The green LED of the backup MFC blinks to indicate it is in the ERROR or CONFIGURE mode. The first byte of the Module Status also indicates the mode. Backup MFC LED 7 blinks and bit 3 of the Module Status is set to indicate that configuration differences exist between the primary and backup.

n	n+1
01xx0x0x	00xx1x0x

3. The backup MFC can now be placed in EXECUTE mode provided no errors remain in the new configuration.

Additional configuration changes can be made by re-entering CONFIGURE mode (Step 2). If no changes have been made, a backup MFC RESET returns the backup to the state of Step 1. If changes have been made, the backup must be put into CONFIGURE mode and INITIALIZED to get to the state of Step 1.

NOTE: The backup cycle step transition 3 to 4 occurs automatically after a successful Step 3 backup MFC EXECUTE. The time it takes to complete the transition is MFC configuration dependent.

Primary	Backup
n	n+1
01xx0x0x	10xx1x0x

4. When the checkpoint data for the old configuration is received from the primary MFC, the reconfigured backup MFC can assume the role of the primary MFC if a failure is detected in the old configuration (see Step 8). However, the primary MFC still indicates that no backup is available when the configuration is different.

Additional configuration changes can be made by re-entering CONFIGURE mode (Step 2). If no changes have been made, a backup MFC RESET returns the backup to the state of Step 1. If changes have been made, the backup must be put into CONFIGURE mode and INITIALIZED to get to the state of Step 1.

n	n+1
01xx0x0x	00xx1x0x

5. A backup MFC RESET at this step, changes having been made, is used to tell the reconfigured backup MFC to assume the role of the primary MFC. The backup MFC comes up in EXECUTE mode with the configuration marked as valid.

Note that Backup Cycle step transitions 5 to 6 to 7 to 8 occur automatically after the Step 5 backup MFC RESET. The time it takes to complete these transitions is MFC configuration dependent. Therefore, the status indicated in cycles 5, 6 and 7 might not be seen depending on the actual step transition times. The important status to wait on is that which is indicated by Step 8.

n	n+1
01xx0x0x	10xx1x0x

n	n+1
01xx0x0x	10xx1x0x

6. After the checkpoint data is updated, the backup MFC is ready to take over the duties of the primary MFC.

n+1	n
01xx0x0x	11xx1x0x

7. The backup MFC requests the primary MFC to shutdown and assume the role of a hot backup (n+1). The backup MFC waits to act as the primary MFC (n). (A hot backup is a backup which retains the old configuration and control data and is ready to assume control if an error is detected in the new configuration).

Primary	Backup
n+1	n
01xx0x0x	01xx1x0x

8. The primary MFC has removed the bus clock (BUSCLK) and acts as a hot backup (n+1). The reconfigured Backup MFC is now serving as the primary MFC (n).

Before proceeding to the following commands, ensure that LED/Module Status are as shown in Step 8.

To return to Step 4, RESET the backup MFC (n). This allows the user to correct a bad configuration.

The primary MFC (n+1) must be RESET at this point in order for the On-Line Configuration cycle to complete. Resetting the primary MFC (n+1), currently acting as the hot backup, tells it to get a copy of the new configuration.

n+1	n
10xx0x0x	00xx0x0x

9. After the backup MFC copies the new configuration into the primary MFC, the cycle is complete. The backup MFC is now serving as the primary MFC (n) while the primary handles the backup role (n+1). (Note that the LED combination and module status is the opposite of Step 1 indicating the role reversal).

Primary Cycle
The step numbers in this cycle correspond to the states of Figure A-2. This information is provided for status purposes. The user should follow the Backup Cycle procedures to perform On-Line Configuration.

Primary	Backup
n	n+1
01xx0x0x	10xx1x0x

1. The primary MFC is actively controlling the process. (This represents the same juncture as Step 4 of the Backup Cycle).

Primary	Backup
n+1	n
01xx0x0x	11xx1x0x

2. When the shutdown request is received from the backup MFC (Step 7 of the Backup Cycle), the primary MFC stops executing and removes the bus clock (BUSCLK).

Primary	Backup
n+1	n
01xx0x0x	01xx1x0x

3. The primary MFC is now acting as the hot backup (n+1). All old configuration and block output information remains intact from when it is shutdown in Step 2. If the new configuration is not operating as expected, the primary MFC, currently acting as the hot backup (n+1), can take control using the old configuration and block output information (returns to Step 1).

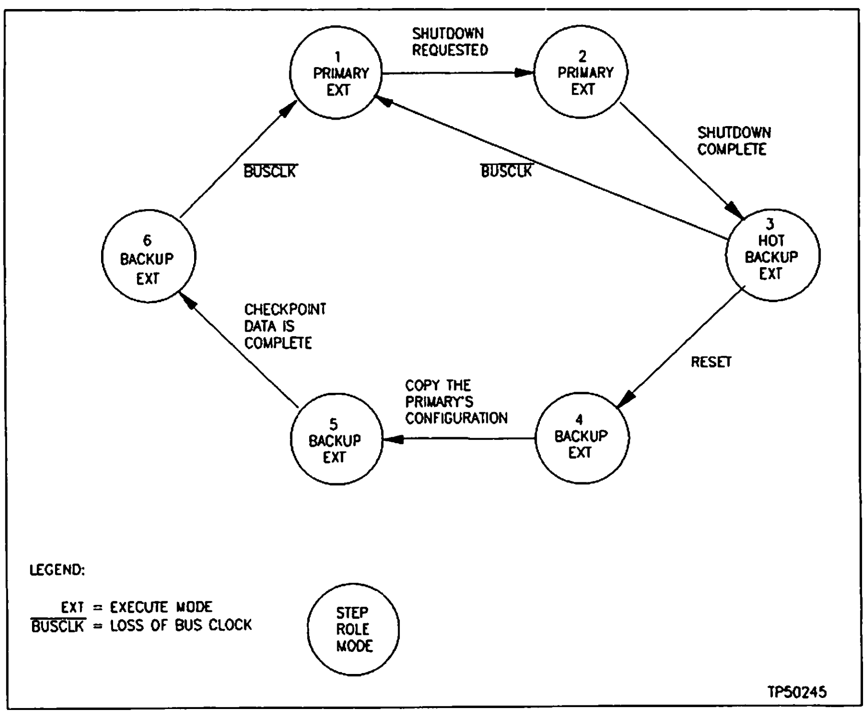

Figure A-2. Primary MFC Operation Cycle

Primary	Backup
n+1	n
00xx0x0x	00xx1x0x

4. Resetting the primary MFC (n+1), currently acting as the hot backup, directs it to get a copy of the new configuration (Step 8 of the Backup Cycle).

n+1	n
10xx0x0x	00xx0x0x

5. When the new configuration has been copied, the backup MFC has completed its cycle, and is now serving as the primary MFC.

n+1	n
10xx0x0x	00xx0x0x

6. After the checkpoint data is complete, the primary MFC is now serving as the backup MFC and is ready to take over the control process with the updated configuration. The Primary Cycle is complete. (This represents the same juncture as Step 9 of the Backup Cycle).