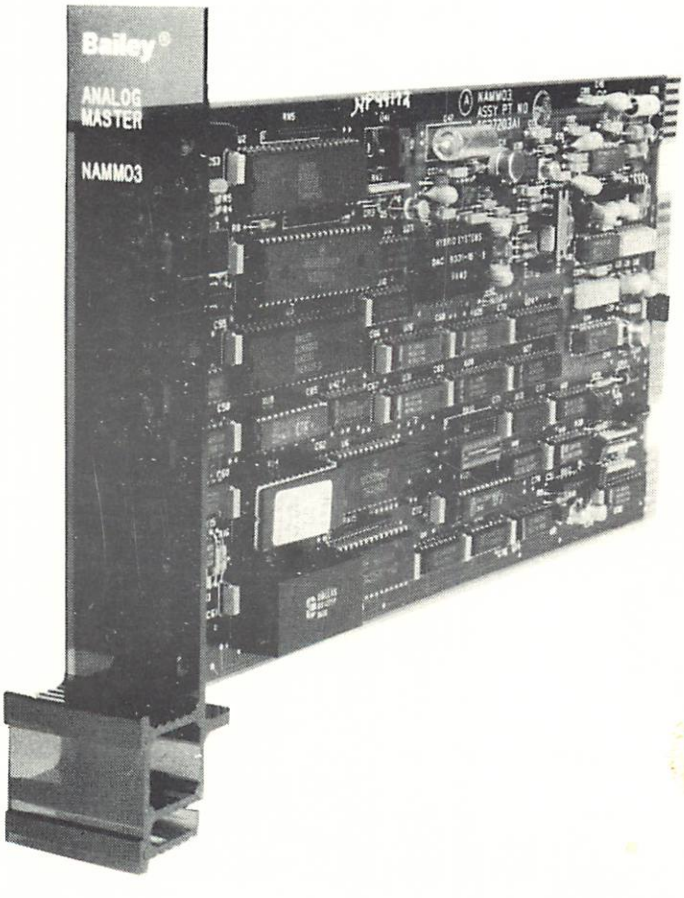
Bailey
network 90®

Analog Master Module (NAMM03)



Product Instruction

E93-912-8

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

INSTRUCTION MANUALS

DO NOT INSTALL, MAINTAIN OR OPERATE THIS EQUIPMENT WITHOUT READING, UNDERSTANDING AND FOLLOWING THE PROPER **Bailey Controls** INSTRUCTIONS AND MANUALS, OTHERWISE INJURY OR DAMAGE MAY RESULT.

RADIO FREQUENCY INTERFERENCE

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.

PERTES PROCEDE RENVERSEMENTS

L'ENTRETIEN DOIT ETRE ASSURE PAR UN PERSONNEL QUALIFIE ET EN CONSIDERATION DE L'ASPECT SECURITAIRE DES EQUIPEMENTS CONTROLES PAR CE PRODUIT. L'ADJUSTEMENT ET/OU L'EXTRACTION DE CE PRODUIT LORSQUI'IL EST INSERE A UN SYSTEME ACTIF PEUT OCCASIONINNER DES A-COUPS AU PROCEDE CONTROLE. SUR CERTAINS PROCEDES, CES A-COUPS PEUVENT EGALEMENT OCCASIONNER DES DOMMAGES OU BLESSURES.

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PREFACE

The Analog Master Module (NAMM03) interfaces high level, thermocouple and millivolt, and Resistance Temperature Dependent (RTD) analog process inputs from slave modules. This Instruction provides information on setup, installation, configuration, operation, maintenance, and troubleshooting. Also included are slave module calibration procedures and information concerning slave module/termination unit combinations.

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SAFETY SUMMARY

General Warnings

System Maintenance

System maintenance must be performed by qualified personnel and only after securing equipment controlled by the circuit. Altering or removing components from an active circuit may upset the process being controlled.

Electrical Shock Hazard During Maintenance

Disconnect power or take precautions to ensure that contact with energized parts is avoided when servicing.

Equipment Environment

All components, whether in transportation, operation, or storage must be in a non-corrosive environment.

L'entretien du Systeme

L'entretien du systeme doit etre effective par des personnes competentes et uniquement a partir du moment ou les elements controles par le circuit ont ete isoles. Le fait d'enlever ou d'alterer les composants d'un circuit sous tension peut perturber le processus controle.

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 composantes sous tension lors de l'entretien.

Environnment de l'equipment

Ne pas soumettre les composantes a une atmosphere corrosive lors du transport, de l'entreposage ou de l'utilisation.

SECTION 1 -- INTRODUCTION

GENERAL PURPOSE

The Analog Master Module (NAMM03) accepts and digitizes up to 64 high level, thermocouple (TC), millivolt and/or RTD temperature sensor analog inputs, by way of termination units and slave modules, for system use. The AMM provides values in percent and engineering units, and performs polynomial adjustment, square root, alarm and exception reporting, trending and local/remote cold junction compensation.

HOW TO USE THIS DOCUMENT

The **Introduction** Section contains a Glossary that defines terminology used in this manual, Specifications that provide a quick reference for AMM parameters and capabilities, and lists related NETWORK 90 equipment and Related Documents.

The **Theory of Operation** Section provides a more in-depth understanding of major AMM functions.

The **Installation** Section provides information on module switch settings, slave module and termination unit system configurations and cabling. The user should not operate this module until steps in this section have been completed.

The **Calibration** Section explains procedures to calibrate the slave modules in an AMM system, with specific examples.

The **Operation** section contains information on normal day-to-day operation of the AMM.

The **Configuration** section describes the process of configuring the AMM with Function Blocks, and describes Function Codes unique to the AMM and others needed for AMM configuration.

The **Troubleshooting** section provides a list of problem indications, causes, and corrective actions.

SPECIFICATIONS

INPUTS	Maximum 64 inputs from up to: 4 NASM01 Slave -- High Level (+10 to -10 V dc) (0 to 10 V dc) (0 to 5 V dc) (1 to 5 V dc) (4 to 20 mA) 8 NASM02 Slave -- Thermocouple (E, J, K, T, S, R) (Chinese E, S) Millivolt (-100 to 100 mV dc) (0 to 100 mV dc) 8 NASM03 Slave -- Resistance Temperature Detector (RTD) 100 ohm, Platinum, IPTS68 100 ohm, Platinum, U.S. Lab Std. 100 ohm, Platinum, U.S. Ind. Std. 100 ohm, Platinum, European Std. 120 ohm, Nickel, Chemically Pure 53 ohm, Copper, Chinese 8 NASM04 Slave -- RTD, 10 ohm, Copper
ACCURACY	± 0.01% of span (typical) at 25 °C (77 °F) ± 0.025% of span (max) at 25 °C (77 °F)
TEMPERATURE EFFECT	± 0.00035% / °C (± 0.00019% / °F)
AGING EFFECT	0.025% / year
COMMON MODE VOLTAGE RANGE	± 5 V dc (max)
INPUT IMPEDANCE	> 10 Megohms
A/D RESOLUTION	16 bits
GUARANTEED LINEARITY	15 bits
SPAN	-10.0 to 10.0 V dc
MEMORY	Random Access Memory (RAM): 24 Kbytes Read Only Memory (ROM): 36 Kbytes Non-volatile Random Access Memory (NVRAM): 6 Kbytes
INPUT SCANNING	Capable of scanning 64 analog inputs up to 3 times/second. Scan rate depends on module configuration.

SPECIFICATIONS (continued)

ACCURACY		With NASM01	0.1% of allowable input span at reference conditions.
		With NASM02/03/04	0.05% of allowable input span at reference conditions with external calibration source.
		With NASM02/03/04	0.125% of allowable input span at reference conditions with internal calibration source.
CROSS TALK		With NASM01	-100 db (typical), -65 db (min)
		With NASM02/03/04	-85 db (typical), -65 db (min)
NORMAL MODE REJECTION		With NASM01/02/03/04	-80 db @ 60 Hz
COMMON MODE REJECTION	DC	With NASM01	-54 db, ± 5 V dc max
		With NASM02	-100 db, ± 250 V dc, max
		With NASM03/04	-105 db, ± 250 V dc, max
	60 Hz	With NASM01	-75 db, ± 50 V ac, peak
		With NASM02	-120 db, ± 250 V ac, peak
		With NASM03	-120 db, ± 250 V ac, peak
		With NASM04	-120 db, ± 250 V ac, peak
POWER SUPPLY		Voltage	5 V dc (4.75 V dc (min), 5.25 V dc (max)) 15 V dc (14.66 V dc (min), 15.75 (max)) -15 V dc (-14.66 V dc (min), -15.75 (max))

Current

Voltage	Milliamps (Typical)	Milliamps (Max)
5 V dc	725	825
15 V dc	125	150
-15 V dc	30	40

SPECIFICATIONS (continued)

ENVIRONMENT	**Ambient Temperature:**	0 to 70 °C (0 to 158 °F)
	Humidity:	5% to 90% R.H., ± 5%, up to 55 °C (131 °F) (non-condensing) 5% to 40% R.H., ± 5% , at 70 °C (158 °F) (non-condensing)
	Altitude:	Sea level to 3 Km
	Air Quality:	Non-corrosive
CERTIFICATION		CSA certified for use as process control equipment in an ordinary (non-hazardous) location.
MOUNTING		Occupies single slot in Module Mounting Unit.

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

TABLE 1-1 -- *P1 Card Edge Connector Pinouts*

Pin	Signal	Pin	Signal
1	+5 V dc	2	+5 V dc
3	N/C	4	N/C
5	COMMON	6	COMMON
7	+15 V dc	8	-15 V dc
9	PFI*	10	PFI
11	Module Bus	12	Module Bus

* Power Fail Interrupt

TABLE 1-2 -- *P2 Card Edge Connector Pinouts*

Pin	Signal	Pin	Signal
1	Analog Bus (+)	2	Analog Bus (-)
3	A3	4	A0
5	A4	6	A1
7	A5	8	A2
9	EN	10	ACK
11	1.56 KHz Control Signal	12	1.56 KHz Bus Clock

TABLE 1-3 -- *P3 Card Edge Connector Pinouts*

Pin	Signal	Pin	Signal
1	RTD A (+)	A	RTD A (-)
2	RTD B (+)	B	RTD B (-)
3	RTD C (+)	C	RTD C (-)
4	RTD D (+)	D	RTD D (-)
5	N/C	E	N/C
6	CAL (+)	F	N/C
7	N/C	H	N/C
8	CAL (-)	J	N/C
9	N/C	K	N/C
10	Digital Out (+)*	L	Digital Out (-)
11	DIS Link (+)	M	DIS Link (-)
12	Master Status Out (+)**	N	Master Status Out(-)
13	Master Status In (+)	P	Master Status In (-)
14	Redundancy Link TxD (+)	R	Redund. Link TxD (-)
15	Redundancy Link RxD (+)	S	Redund. Link RxD (-)

* Drives relay on thermocouple termination units to switch cold junction RTD inputs between primary and secondary AMM.

** Indicates to other AMM in redundant configuration whether primary or secondary.

RELATED EQUIPMENT

NASM01/02/03/04	Analog Slave Modules
NTAI01/02/03/04/05	Analog Input Termination Units
NTAM01	Analog Master Termination Unit
NIAI01/02/03/04	Analog Input Termination Modules
NIAM02	Analog Master Termination Module
NIAC02	Analog Calibration Termination Module (Thermocouple)
NTTA01	Analog Input Translator Termination Module
NIAC03	Analog Calibration Termination Module (RTD)
NDIS01	Digital Indicator Station (DIS)
NKTU01	Termination Unit Cable
NKTU02	Termination Module Cable
NKTM01	Termination Module Cable
NKTD02	Cable from DIS to Analog Master Termination Module (NIAM02)
NKAI01	Termination Unit interconnect cable (redundant AMMs, NASM02 used)
P/N 6634408	Termination Module interconnect cable (redundant AMMs, NASM02 used)
NKMF02	Connects redundant AMMs (when NASM02 not used)
Slave Module/Termination Unit Combinations	NASM01 -- NIAI01/04, NTAI01/05 NASM02 -- NIAI02, NTAI02 NASM03/04 -- NIAI03, NTAI03/04

GLOSSARY OF TERMS

Calibration	Process which corrects input signals for errors caused by module circuitry and lead wires.
Configuration	Specifying Function Blocks to define module operation.
Configuration and Tuning Module (CTM)	Keyboard Operator Interface Device, mounted in Module Mounting Unit, which allows the user to monitor, tune, and modify module configurations, and perform diagnostics.
Digital Indicator Station (DIS)	Panel mounted station which provides simultaneous bargraph display of three analog signals. A numeric readout provides accurate display of individual values.
Expander Bus	Communication bus on the bottom of MMU backplane over which Slave Modules communicate with Masters (through P2 edge connector).
Function Block	Addressable locations for user configuration; specified with Function Codes that define a particular module function. Stored in NVRAM.
Function Code (FC)	User-specified software algorithm that defines a specific module control function.
Master Module	Intelligent module with functions configured by the user. Receives process inputs from Slave Modules.
Module Bus	Open collector serial bus at the top of the MMU backplane over which master modules communicate with other master or controller modules through P1 edge connector.
Module Mounting Unit (MMU)	Mounting rack in NETWORK 90 cabinet providing housing for up to 12 modules.
Process Control Unit (PCU)	One node on a NETWORK 90 Control System communication loop consisting of up to 32 master modules.
Slave Module	Interfaces process inputs between termination units and master modules.
Termination Mounting Unit (TMU)	Mounting rack providing housing for Termination Modules.

RELATED DOCUMENTS

Analog Slave Modules:

NASM01	E93-912-4
NASM02	E93-912-5
NASM03	E93-912-6
NASM04	E93-912-7
Digital Indicator Station	E93-904-2
Termination Units	E93-911

SECTION 2 -- THEORY OF OPERATION

MODULE FUNCTIONS

The AMM accepts and digitizes high level, millivolt, thermocouple (TC), and RTD temperature sensor analog inputs. The module provides value outputs in percent and engineering units, degrees Centigrade, degrees Fahrenheit, millivolts, volts, and square root. Also local and remote thermocouple cold junction compensation, polynomial adjustment, exception reporting and trending.

A microprocessor unit (MPU) controls AMM functions. Circuitry on the AMM provides communication over the Expander Bus and Module Bus and performs A/D conversion on inputs. Serial communication links provide communication to a redundant AMM and to Digital Indicator Stations for input monitoring. Figure 2-1 is a functional block diagram of the AMM.

MPU Functions

The MPU controls memory, I/O circuitry, Machine Fault Timer (MFT), and serial interface.

Expander Bus Interfacing

The AMM communicates with slaves and and transmits clock signals over the Expander Bus.

AMM Expander Bus Section

Each AMM or redundant AMM pair communicates with their associated slaves over a dedicated portion of the Expander Bus (separated from other Expander Bus sections containing master/slave modules).

Expander Bus Clock

In a typical system setup, one AMM is designated to provide an Expander Bus Clock signal to Analog Slave Modules (ASMs) occupying other AMM Expander Bus Sections. This synchronizes system ASMs and eliminates the problem of system data drift due to out-of-sync slave modules.

A/D Conversion

The AMM digitizes signals in the -10 to +10 V dc range utilizing a 16 bit successive approximation technique.

The following inputs are digitized:

- Analog section of the Expander Bus for reading slave values.
- Four RTD cold junction inputs for NASM02 thermocouple compensation.
- Internal 0 and 10 V references for self-calibration.
- Calibration output for self-checking.

The module checks the digitized 0 and 10 V self-calibration references against an allowable tolerance and halts (red lights) if a value is out of tolerance.

Module Bus Interface

The Module Bus Interface allows the AMM to communicate with other master modules in the same PCU. Every module on the Module Bus is identified by a unique address set by the Address Switch.

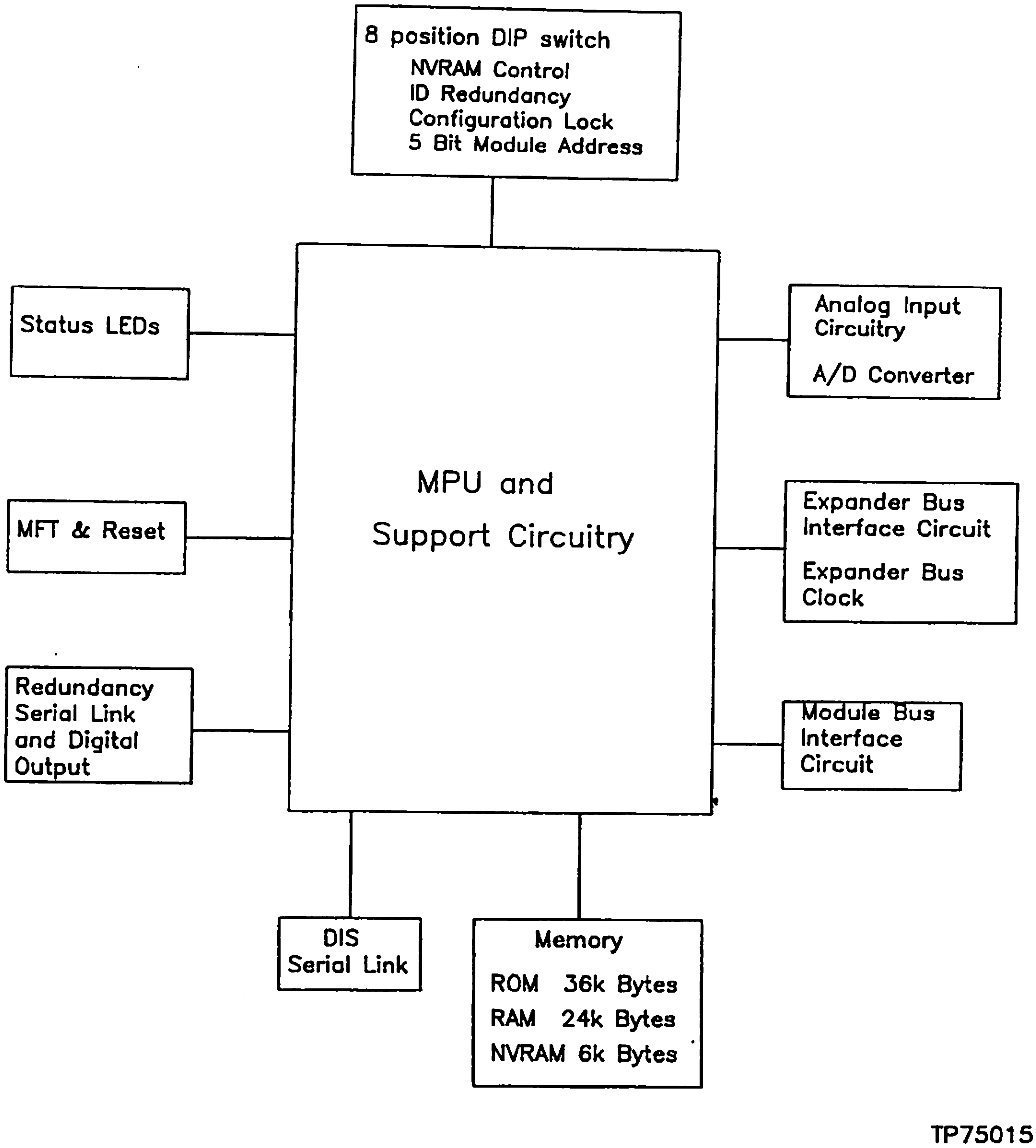

FIGURE 2-1 -- *NAMM03 Block Diagram*

Redundancy Link
Two AMMs can be connected, via a serial data link, to provide redundant I/O processing for a common group of slave modules. The primary AMM continually sends a "snapshot" of its memory to the secondary AMM. Should the Primary fail, the Backup automatically takes over, utilizing the current process data.

NOTE: When AMMs are used in a redundant configuration, ensure that the firmware revision levels are identical.

MODULE SECURITY

Machine Fault Timer
A number of on-line tests are performed by the MPU to verify the integrity of the module hardware. Should any of the tests fail, a Machine Fault Timer on the AMM times out, shutting the module down and placing it in ERROR Mode.

Control-input Security
Control-input security is provided to handle the case of errant or unavailable inputs to the AMM. All AMM inputs have a good or bad "quality" associated with them. The quality status can be used to trigger module security functions. The AMM also sets a system variable "I/O ERROR" if any input is bad quality.

SECTION 3 -- INSTALLATION

GENERAL

This section instructs the user in the setup and installation of the AMM. The section includes AMM switch settings, slave module and termination unit system diagrams, and cabling.

HANDLING

General Handling

Upon receipt of the AMM the user should:

- Examine the module immediately to make sure that it has sustained no damage in transit.
- Notify the nearest Bailey Sales/Service Office of any damage.
- File a claim for any damage with the transportation company that handled the shipment.
- Use the original packing material and/or container to store the module.
- Store the module in an environment with good air quality, free of extremes of temperature and humidity.

Specific Handling

The AMM uses metal oxide semiconductor (MOS) devices that require special precautions during shipping and handling. Static discharge, improper grounding, and careless handling can damage these devices. To prevent such damage, follow these procedures:

- Keep the module in its special anti-static bag until you are ready to install it. Save the bag for future use.
- Ground the anti-static bag before opening it.
- Make sure all of the devices to which the module connects are properly grounded before connection.
- Avoid touching the circuitry when handling the module.

PREPARATION

Before the AMM is put into operation, the following procedures must be performed:

1. Set the Module Address and other configuration switches according to the desired application.
2. Connect the Expander Bus.
3. Connect cabling.
4. Insert modules.

Setting the Hardware Configuration Switch

The user sets the AMM Redundancy ID, NVRAM Initialization, Hardware Configuration Lock, and Module Address with the Hardware Configuration Switch S2 (Figure 3-1, Table 3-1).

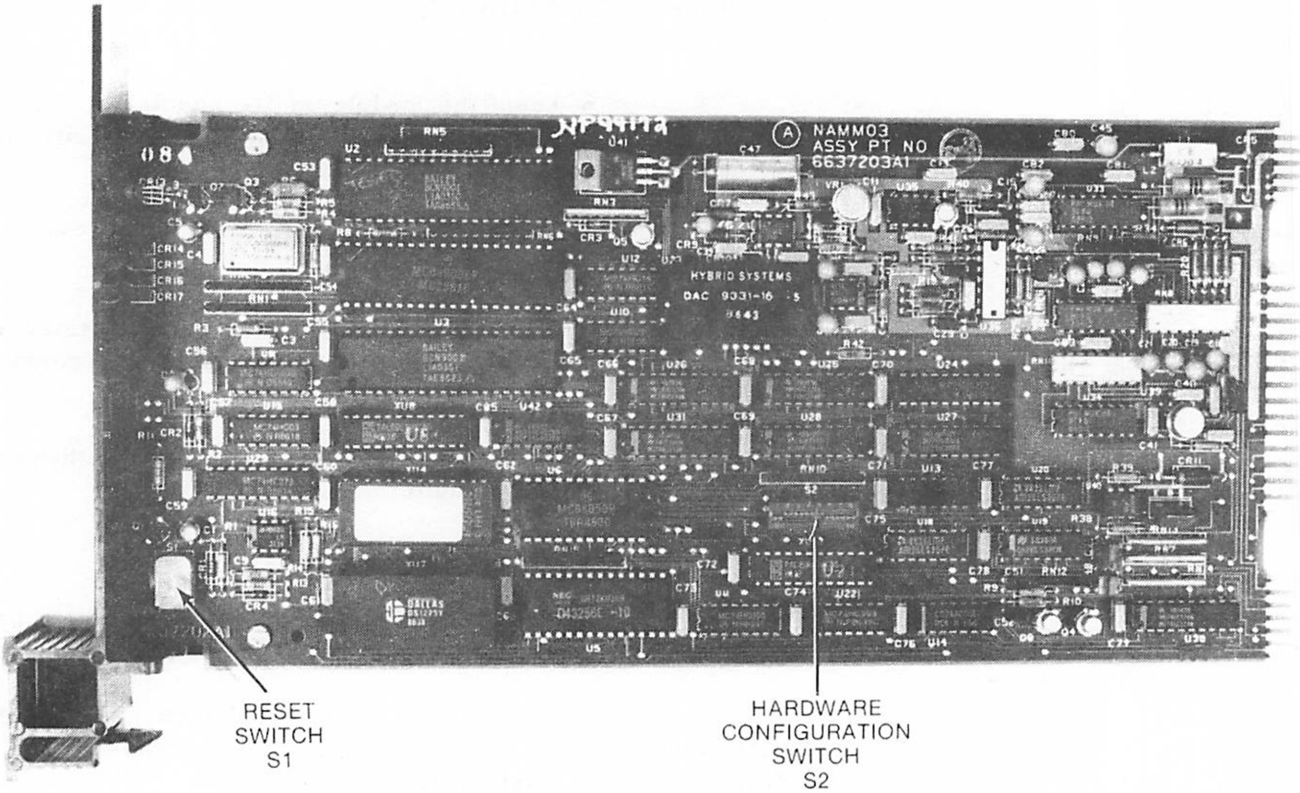

FIGURE 3-1 -- *AMM Hardware Locations*

RUN MODE Hardware Switch Settings and Operating States

Switch positions 1, 2, and 3 of the Hardware Configuration Switch determine AMM operating parameters and states (Figure 3-1). A list of definitions for the switch settings follows:

NORMAL. Module operating in normal run mode.

CONFIGURATION LOCK. This feature is operational when enabled by a specification in the Executive Block Function Code. When set to a 1, the AMM cannot be placed in Configure Mode.

INITIALIZE NVRAM. In this state the Non-volatile Memory is cleared, the module is put in Configure Mode and is ready to be configured.

INHIBIT CHECKSUMS. Prevents ROM checksum errors from halting module.

NOTE: This setting is for factory diagnostic purposes only and should NEVER be used under normal operating conditions.

PRIMARY. This hardware setting is used as a final test by redundant AMM pairs on power-up. It determines which module serves as the primary in case a conflict occurs in which both modules "remember" a primary configuration in memory (both had been acting as primaries in different systems).

NOTE: In a redundant AMM system, switch 1 on each AMM must be of opposite polarity.

PRIMARY AND CONFIGURATION LOCK. Same function as Primary setting, but also enables Configuration Lock.

TABLE 3-1 -- *AMM Hardware Configuration Switch (S2) Settings*

RUN MODE

NOTE: 1 = SWITCH OPEN or OFF --- 0 = SWITCH CLOSED or ON

MSB			SWITCH				LSB
1	2	3	4	5	6	7	8

Switches 1–3: **Run Mode Select**

Switches 4–8: **Module Bus Address**

Run Mode Select

000	Normal
001	Configuration Lock
010	Initialize NVRAM
011	Inhibit Checksums
100	Primary
101	Primary and Configuration Lock
110	Unused
111	Diagnostic Mode

DIAGNOSTIC MODE

MSB			SWITCH				LSB
1	2	3	4	5	6	7	8
1	1	1					

Switch 4: **Halt Select**

Switches 5–8: **Diagnostic Select**

Halt Select

0	Continue on Fail
1	Halt on Fail

Diagnostic Select

0000	Switches and LEDs
0001	ROM
0010	RAM
0011	TIMER
0100	DIS
0101	Redundancy Link
0110	DO and Master Status
0111	MFT
1111	ROM, RAM, and TIMER as group

Setting Module Bus Address
The AMM address is set with contacts 4 through 8 of the Hardware Configuration Switch. The address is specified as a binary number 0 through 31.

NOTE: Usually address 00000 is reserved for a BIM, 00001 for a Redundant BIM, and 11111 for the CTM. Table 3-2 shows AMM Module Addresses.

TABLE 3-2 -- *AMM Module Addresses*

DECIMAL ADDRESS	CONTACT SETTING MSB 4	5	6	7	LSB 8	
0	0	0	0	0	0	BIM
1	0	0	0	0	1	REDUNDANT BIM
2	0	0	0	1	0	
3	0	0	0	1	1	
4	0	0	1	0	0	
5	0	0	1	0	1	
6	0	0	1	1	0	
7	0	0	1	1	1	
8	0	1	0	0	0	
9	0	1	0	0	1	
10	0	1	0	1	0	
11	0	1	0	1	1	
12	0	1	1	0	0	
13	0	1	1	0	1	
14	0	1	1	1	0	
15	0	1	1	1	1	
16	1	0	0	0	0	
17	1	0	0	0	1	
18	1	0	0	1	0	
19	1	0	0	1	1	
20	1	0	1	0	0	
21	1	0	1	0	1	
22	1	0	1	1	0	
23	1	0	1	1	1	
24	1	1	0	0	0	
25	1	1	0	0	1	
26	1	1	0	1	0	
27	1	1	0	1	1	
28	1	1	1	0	0	
29	1	1	1	0	1	
30	1	1	1	1	0	
31	1	1	1	1	1	CTM

NOTE: 1 = SWITCH OPEN or OFF --- 0 = SWITCH CLOSED or ON

Connecting the Expander Bus

For communication, the Expander Bus must be made continuous between the AMM and its associated slave modules. Insert 12-strap dipshunts (with all straps intact) in the sockets on the Expander Bus between the AMM and its slaves, and in any open sockets between the slaves.

Connecting Slave Bus Clock

As explained under **Theory of Operation**, in a multiple AMM system, one AMM is designated to provide an Expander Bus Clock to AMM/ASM modules located on other dedicated AMM Expander Bus Sections.

The AMM transmits the bus clock over the Expander Bus via pins 11 and 12 of its P2 card edge connector. If the bus clock is provided to other AMMs in the same MMU, the user must insert dipshunts, with only straps 11 and 12 intact (lower two straps), in the Expander Bus sockets between the AMM Expander Bus Sections. This provides only the clock signal to the other AMMs.

The bus clock must also be provided to AMMs located in other MMUs within the same PCU cabinet. In this case the MMU Expander Buses are connected in the following manner:

1. Connect the MMUs by attaching cable NKSB01 to the Expander Bus connector at the rear of each MMU.

2. Do not place an AMM or slave module in the last MMU slot nearest the cable connections on both MMUs. A dipshunt with only straps 11 and 12 intact must be placed in the Expander Bus socket next to these vacant slots. This causes only the clock signals to be transmitted to the other MMU.

NOTE: The AMM with the highest module address provides the bus clock. In the event the bus clock fails, the AMM with the next highest module address provides the bus clock.

CABLING/SYSTEM CONFIGURATIONS

This section contains information needed to cable the AMM to its slave modules and termination units. First, the proper procedure for connecting cables to the hardware is given. Next, system connection diagrams and instructions for cabling the various hardware combinations are given.

Cable Connection Procedure

Connecting AMM to Termination Unit. Use a NKTU01 cable and follow the procedure below:

1. Attach the hooded card edge connector on the NKTU01 cable to the designated AMM slot of the MMU, from the rear (with the AMM removed). Squeeze the latches on the connector and line up the connector rib with the notch in the MMU slot. Insert the connector into the slot until the latches snap securely into place when released.

2. Attach the other end of the cable to the appropriate socket of the Termination Unit by pushing the cable plug firmly into the socket until the latches on the sides of the plug connect securely to the receptacles at the sides of the socket.

Connecting AMM to Termination Module. Use a NKTM01 or NKTU02 cable and follow the steps below:

1. Connect the cable to the AMM slot of the MMU by following Step 1 of the procedure above.

2. Connect the other cable end to the Termination Module slot of the MMU by following the procedure of step 1 (with Termination Module removed).

SINGLE AMM CONFIGURATIONS

CASE 1 -- AMM Used With NTAI01/03/04/05 or NIAI01/03/04 (and DIS)

Without DIS

In this configuration the slaves communicate with the AMM over the Expander Bus. No direct cabling to the AMM is required.

With DIS

Using NTAI01/03/04/05 Connect AMM to NTAM01 (Figure 3-2). (No connection needed from NTAM01 to NTAI01/03/04/05 Termination Unit.)

Using NIAI01/03/04 Connect AMM to NIAM02 (Figure 3-3). (No connection needed to NIAI01/03 Termination Module.)

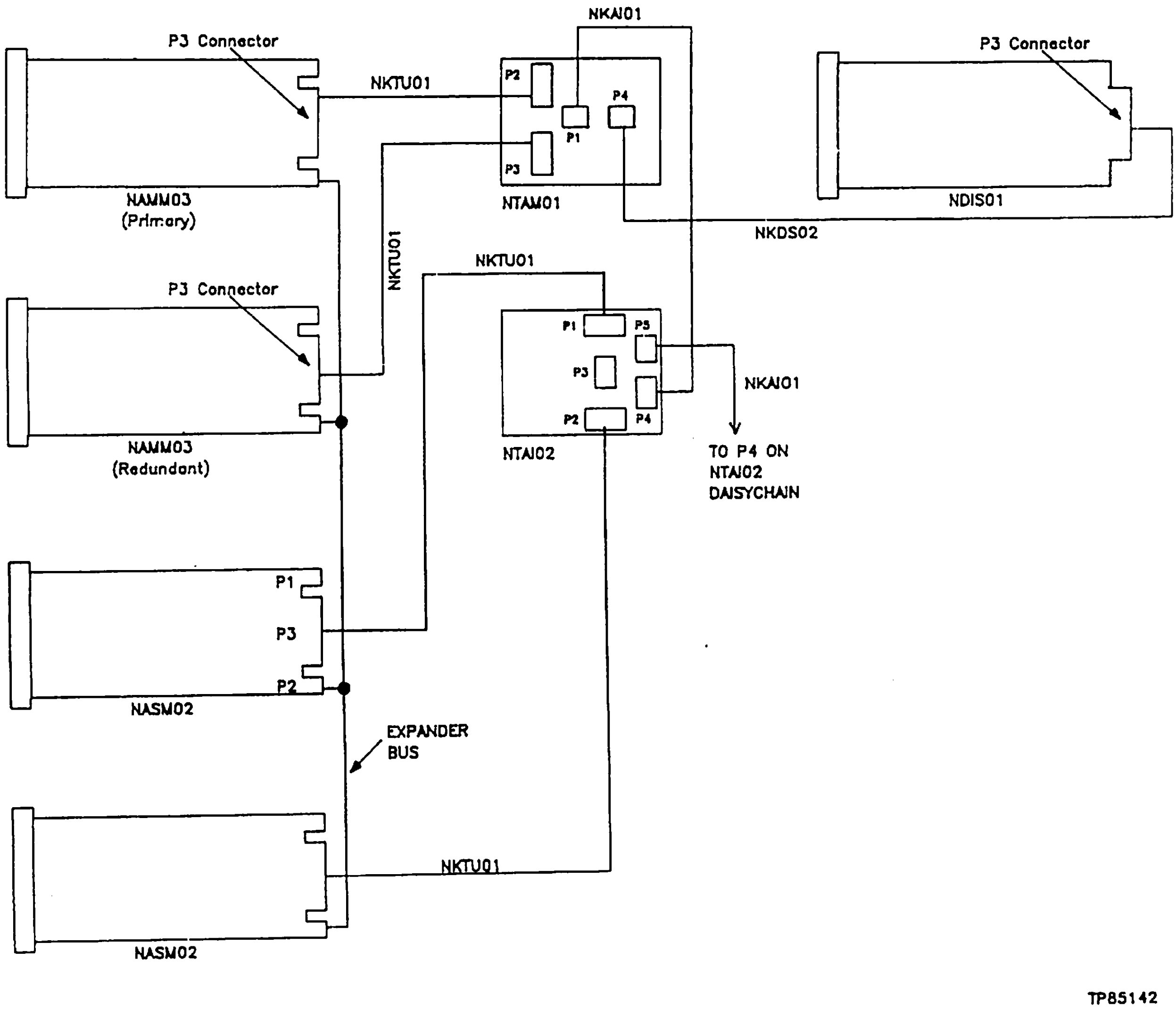

FIGURE 3-2 -- *AMM Used With NTAM01*

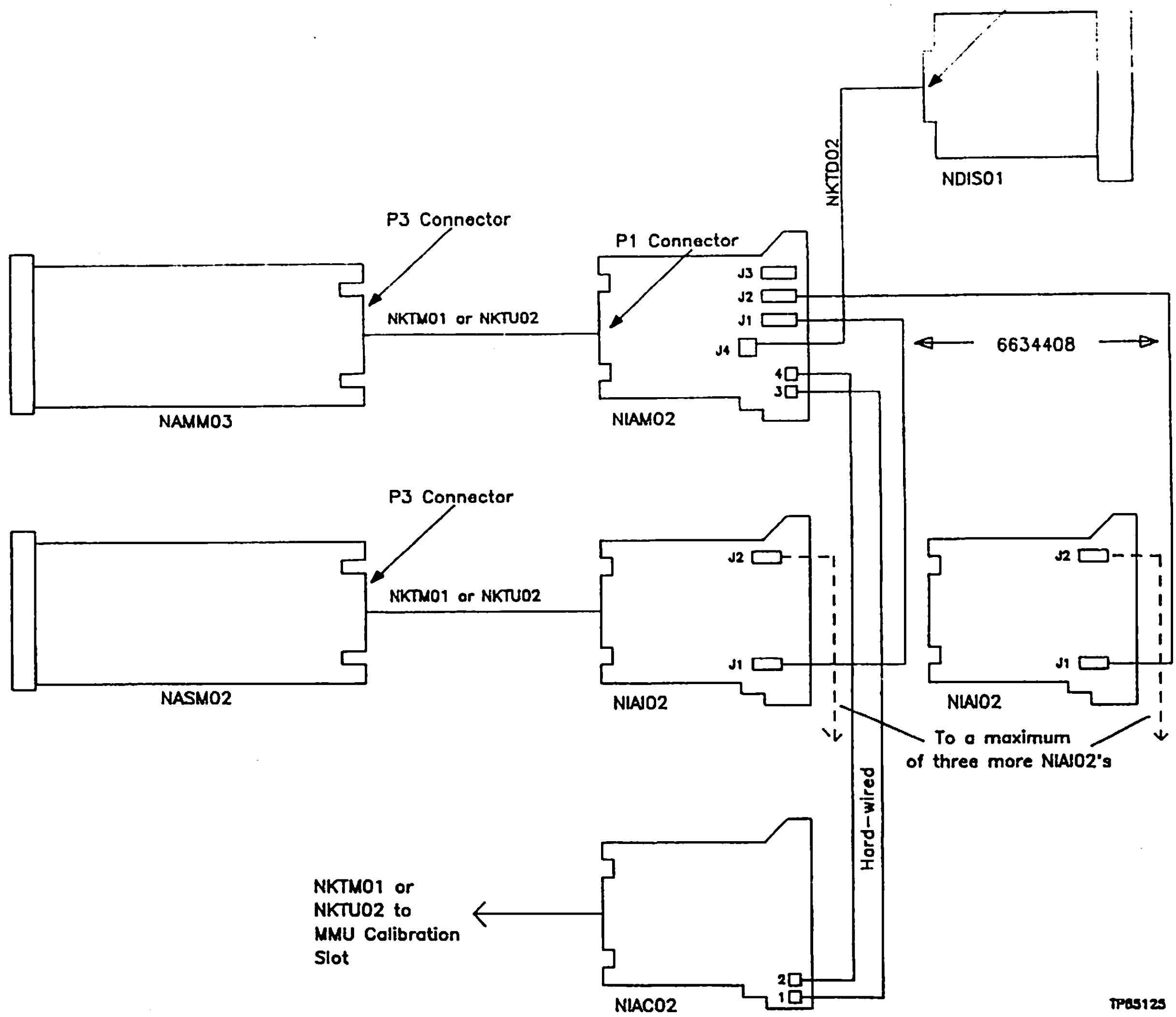

FIGURE 3-3 -- *AMM Used With NIAM02*

CASE 2 -- AMM Used With NTAI02 (DIS)

Without DIS
When used with a Thermocouple Slave NASM02 and Termination Unit, connect a NKTU01 cable from the AMM P3 connector to the P4 socket of the NTAI02 (Figure 3-4). This provides the cold junction compensation input from the NTAI02.

With DIS
Connect the AMM to the NTAM01 (Figure 3-2).

CASE 3 -- AMM Used With NIAI02 (DIS)

Without DIS
When the AMM is used with a Thermocouple Slave NASM02 and Termination Module NIAI02, the AMM is connected to an additional Termination Module, NIAM02 (Figure 3-3).

With DIS
Connect AMM to NIAM02 (Figure 3-3).

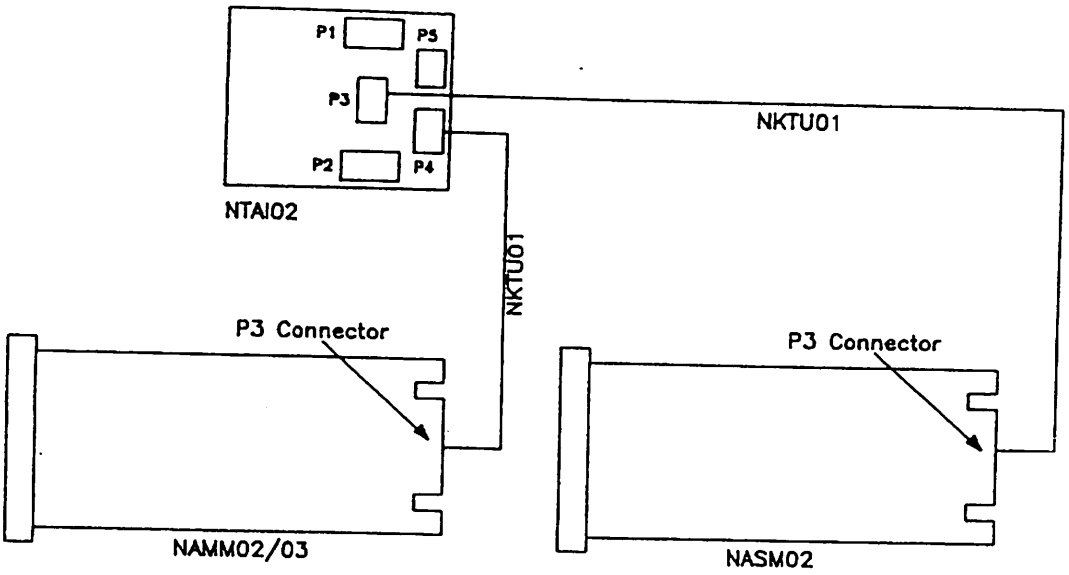

FIGURE 3-4 -- *AMM Used With NTAI02*

REDUNDANT CONFIGURATIONS

CASE 1 -- Redundant AMMs Used With NTAI01/03/04/05 or NIAI01/04/03, (DIS)

Without DIS
Attach one end of the NKMF02 cable to the MMU slot designated for one AMM and attach the other end to the MMU slot for the redundant AMM (with the AMMs removed) (Figure 3-6 or 3-7).

With DIS

With NTAI01/03/04/05 Connect AMMs to NTAM01 (Figure 3-2). (No connections needed to NTAI01/03/04/05 Termination Unit.)

With NIAI01/03/04 Connect each AMM to a NIAM02 (Figure 3-5). (No connections needed to NIAI01/04/03 Termination Modules.)

CASE 2 -- Redundant AMMs Used With NASM02, NTAI02, NTAM01, (DIS)

The AMMs are cabled to an additional Termination Module NTAM01 with cable NKTU01 as follows (Figure 3-2) :

1. Connect one end of a NKTU01 cable to the slot in the MMU designated for the Primary AMM.

2. Attach the other end of the cable to the P2 socket of the NTAM01.

3. Attach an NKTU01 cable to the slot in the MMU designated for the Secondary AMM.

4. Attach the other end of the cable to the P3 socket of the NTAM01.

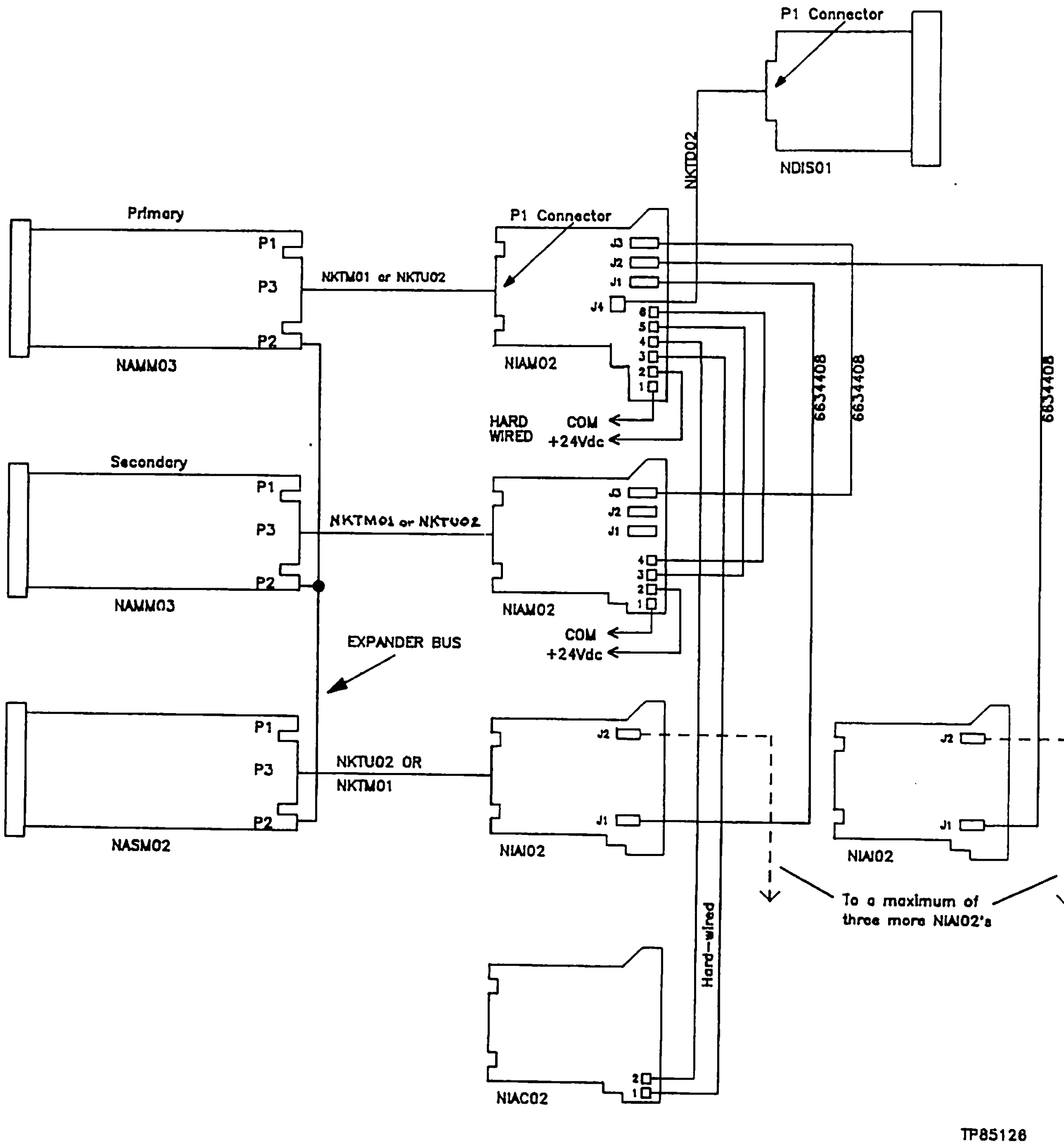

FIGURE 3-5 -- *Redundant AMM Used With NIAM02*

CASE 3 -- Redundant AMMs Used With NASM02, NIAM02, NIAI02, (DIS)

Figure 3-5 shows redundant AMMs used with one or more Thermocouple Slaves NASM02 and with the NIAI02 Termination Module. Intermediate Termination Modules NIAM02 are used in this case.

1. Connect one end of a NKTM01 or NKTU02 cable to the slot in the MMU designated for one AMM, from the rear (with the AMM removed).

2. Connect the other end of the cable to the slot designated for the NIAM02 in the TMU, from the rear (with the NIAM02 removed).

3. Connect another NKTM01 or NKTU02 cable from MMU slot for the second AMM to the TMU slot for the second NIAM02.

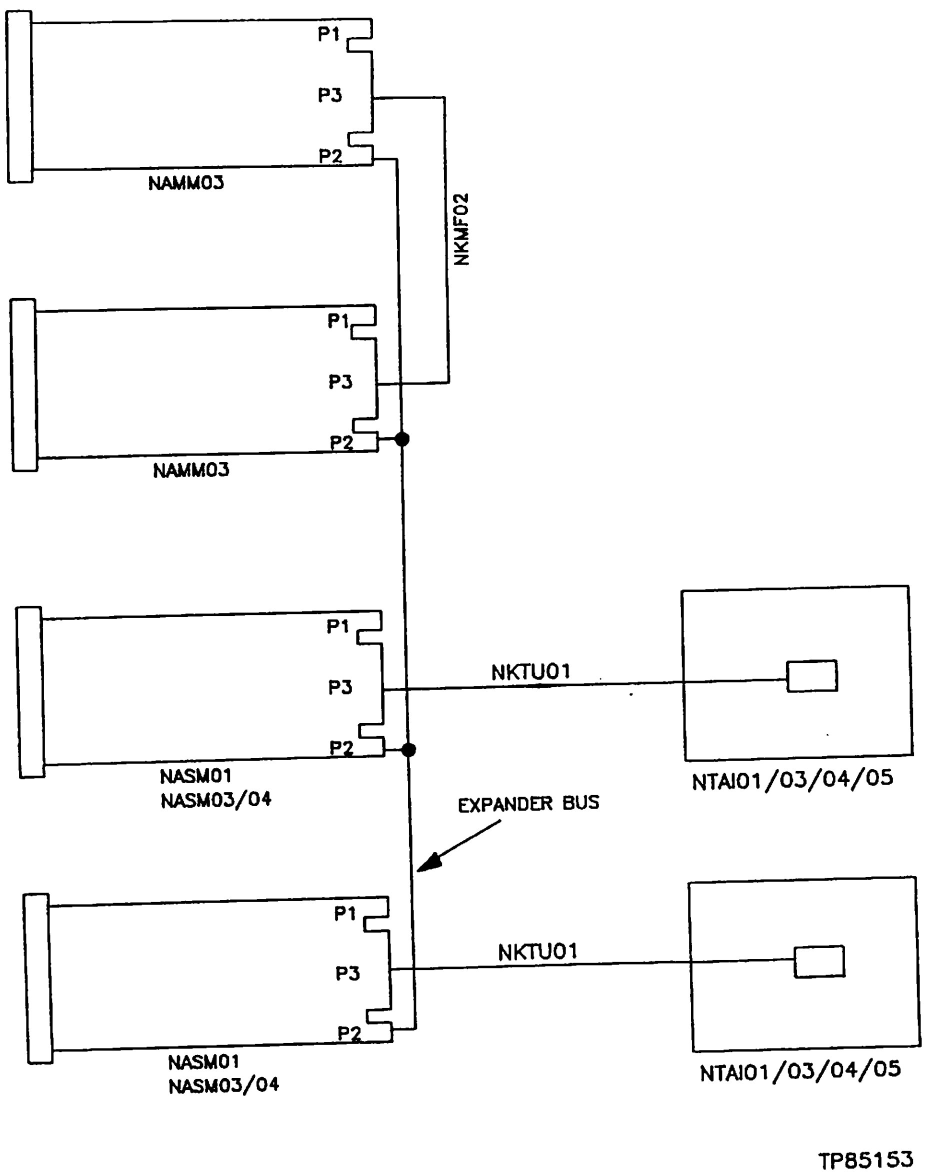

FIGURE 3-6 -- *Redundant AMM used with NTAI01/03/04/05*

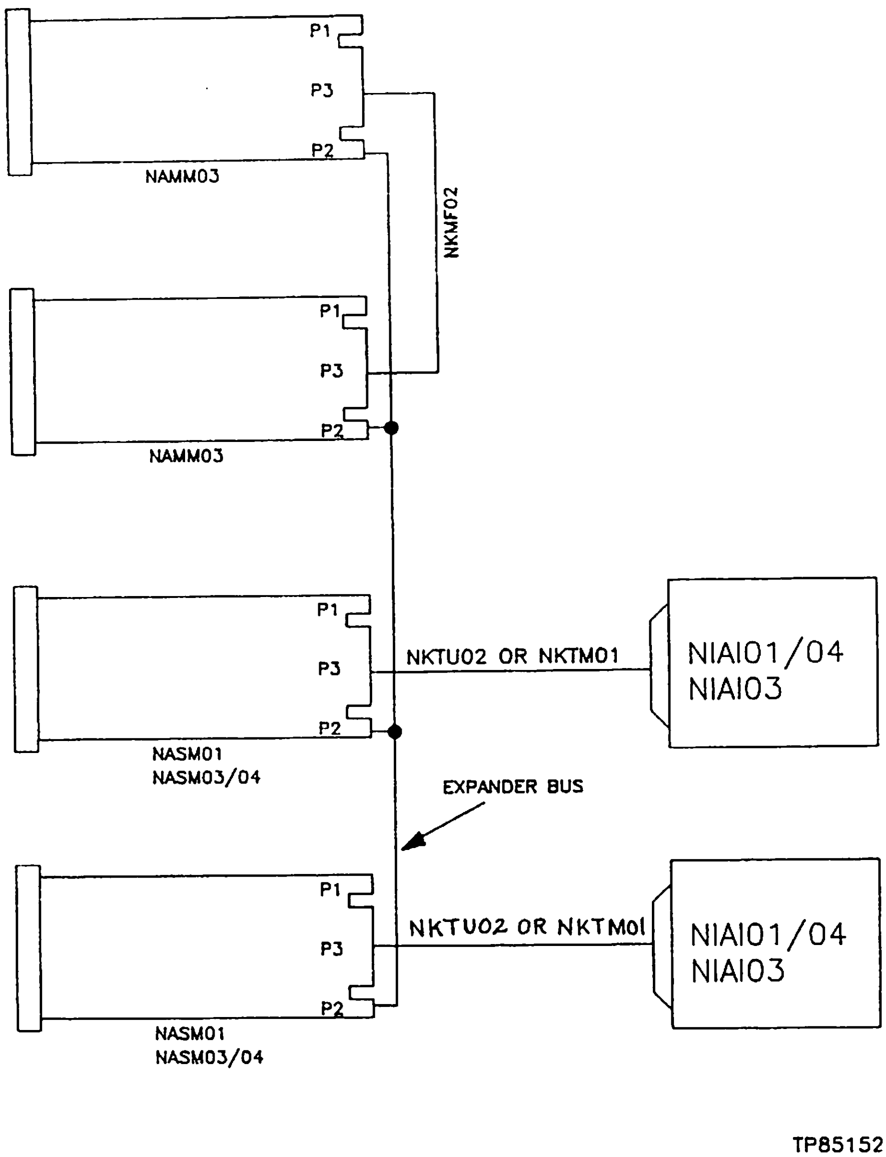

FIGURE 3-7 -- *Redundant AMM Used With NIAI01/04/03*

INSERTING THE AMM IN THE MMU

After preparing the AMM hardware settings and cabling, insert the AMM into the MMU following the steps below:

1. Verify the module slot assignment.
2. Make sure dipshunts are inserted correctly.
3. Slide the module into the MMU slot. Push until the module card edge connectors are firmly seated in the MMU backplane, and the latch at the bottom of the module snaps into the MMU frame.

SECTION 4 -- CALIBRATION

INTRODUCTION

This section describes the procedures for calibrating the slave modules used with the AMM. First, general calibration information is presented. Then Function Codes specific to calibration, and specific examples, depending on the type of calibration and slave/termination unit combination.

The calibration functions determine correction factors for errors caused by minor variations in hardware, time and temperature. These correction factors are combined with a leadwire resistance factor which corrects for errors caused by thermocouple and RTD field wiring. Hi-level slaves do not need to be calibrated.

WHEN TO CALIBRATE

Inputs must be calibrated:

- for each newly configured Analog Point Definition.
- when master and slaves are initially installed.
- when AMM is replaced (except when replacing redundant AMM).
- when a slave is changed or replaced.
- when a slave address is changed (changing the numbers of the blocks referring to it)
- when Nonvolatile Memory (NVRAM) is initialized
- when a change is made to the lead wire resistance parameter in an Enhanced Analog Point Definition (EAPD) Block (FC 158).
- when the cable length between the slave and termination unit is changed.
- periodically to adjust for component aging.

CALIBRATION STRATEGIES

A number of alternative strategies are available for calibration:

All eight points of a thermocouple slave can be calibrated at once using a precision external millivolt source, or internal voltages obtained from the termination unit hardware. Alternately, a thermocouple input can be calibrated separately without affecting the measurement or reporting of any other points on the slave. In this case, the millivolt input is applied directly to the input terminal block connections.

RTD points are calibrated one at a time. They can be calibrated without disturbing the data collection of any other slave points by attaching a precision resistor to the input terminal blocks. RTD points are also calibrated using hardware supplied on the termination units. In this case the slave must be removed from service during calibration.

Finally, calibration data can be manually inserted into the NAMM03.

CALIBRATION SPECIFIC BLOCKS

All calibration must be done with the NAMM03 in Execute Mode, since calibration is considered a tuning operation. When calibrating, the operator interacts with the NAMM03 through the use of six Function Blocks:

- Calibration Command Block (FC 74)
- Calibration Status Block (FC 75)
- Calibration Data Block (FC 73)
- Thermocouple Temperature Block (FC 76)
- Analog Point Definition Block (FC 70)
- Enhanced Analog Point Definition Block (FC 158)

Through these structures, a calibration sequence is initiated, performed, and terminated. These blocks are read, modified, or monitored over the Module Bus. The Configuration and Tuning Module (CTM), Operator Interface Unit (OIU), Management Command System (MCS), Bailey Work Station, or any other NETWORK 90 operator interface may be used to configure the Function Blocks listed above.

CALIBRATION COMMAND BLOCK (CCB), (Function Code 74 / Block 80)

The operator initiates, performs and terminates a calibration sequence through the Calibration Command Block. Commands are entered only by tuning this block. A command and a point number (1-64) must be specified. If, after tuning the block, the Configuration and Tuning Module (CTM) responds with a GOOD message, the operation was successful. If the response is C114, the operation failed, and the Calibration Status Block (Function Code 75, Block 71) must be read to determine the cause. At an Operator Interface Unit (OIU), Management Command System (MCS), or Bailey Work Station a command success/failure is indicated by the command field value of the CCB (specification 1); a value of 0 indicates an error condition. Table 4-1 summarizes CCB Specifications. The various commands of the CCB can be grouped into several categories described briefly below:

Disable Operation
A point must be disabled before calibration can begin. This is done to prevent calibration-related data from being interpreted as process data by the system. A whole slave may be disabled at once. This should be done when the calibration hardware on the termination units is used. The user may also disable only a single point. This is done to perform calibration at the termination blocks one point at a time.

Slave Commands
The slave related commands (excluding Enable/Disable) are used only when the command refers to all points on a thermocouple slave. There are two ways to calibrate all of the inputs on a thermocouple slave simultaneously:

- calibration using "internal" references generated automatically by the NAMM03.
- calibration in which the user connects and sets an "external" millivolt source.

In the external mode, the user must perform the zero and full scale calibration steps explicitly, and in that order. Regardless of which slave calibration method is used, every point on the slave must be disabled previous to the command. Any point number on the slave is sufficient to identify the slave for any of the slave commands. The write to NVRAM of the new calibration factors happens only when the entire calibration sequence is finished, specifically, after the full scale measurement has been taken.

Point Commands
The point-related commands are used for both the thermocouple and RTD input types. Furthermore, these commands are permissible whether or not the calibration sockets are used. In addition, the command must be consistent with the configuration for a successful operation to occur (i.e., point must exist and be of the type specified in the command). Again, the write to NVRAM of the correction factors happens only after the full scale measurement has been taken.

Enable Operation
A point must be enabled before normal input processing can occur. This action terminates the calibration sequence for a particular point. A whole slave can be enabled at once. The slave enable is allowed even if the points were disabled individually.

Escape Operation
The Escape command is included to allow the user to stop the calibration of a point/slave after the zero scale measurement has already taken place. Specifying any other action at this time, besides an escape or full scale measurement on the same point/slave, causes a command sequence error.

TABLE 4-1 -- *Calibration Command Block (Function Code 74 / Block 80)*

SPEC. NUMBER	SYMBOL	FUNCTION	DATA TYPE	DEFAULT	TUNABLE
1	COMMAND*	Parameter	INTEGER-1	0	YES
2	POINT	Parameter	INTEGER-1	0	YES

where:

COMMAND — Specifies a calibrate operation on the AMM.

POINT — Number of the point to be calibrated or any point on the slave to be calibrated (1 ≤ POINT ≤ 64).

COMMANDS

1 - Disable point **
2 - Disable slave
3 - Perform complete thermocouple slave calibration automatically using internal references
4 - Perform thermocouple slave external source 0 millivolt calibration
5 - Perform thermocouple slave external source 100 millivolt calibration
6 - Perform thermocouple point external source 0 millivolt calibration
7 - Perform thermocouple point external source 100 millivolt calibration
8 - Perform RTD point ZERO calibration (1)
9 - Perform RTD point SPAN calibration (1)
10 - Enable point
11 - Enable slave
12 - Escape

* On operator interface other than CTM, COMMAND field (spec. 1) of CCB is set to zero if abnormal condition is detected during calibration (see Calibration Status Block).

** The Disable Point command should be used only if the precision source or resistance is applied at the terminal blocks for the field inputs.

NOTE (1): RTD ZERO Point = 100 ohm for 100 ohm RTD and 7.35 ohm for 10 ohm RTD.

RTD SPAN Point = 400 ohm for 100 ohm RTD and 14.7 ohm for 10 ohm RTD.

Outputs

For operator interface responses to the success/failure of CCB commands, refer to Tables 4-5 and 4-6.

CALIBRATION STATUS BLOCK (Function Code 75 / Block 81)

The Calibration Status Block contains the status from the most recent calibration command on the Analog Master Module. Its specifications can be read, but not modified. When the most recent calibration command was a slave command (all eight points), Table 4-2 interprets the Calibration Status Block output. If the command was a point calibration, refer to Table 4-3.

TABLE 4-2 -- *Calibration Status Block (FC 75) (Slave Calibration)*

SPEC ID NUMBER	SYMBOL	FUNCTION	DATA TYPE	DEFAULT	TUNABLE
1	OPSTAT	Parameter	INTEGER 2	0	NO
2	POINT1	Parameter	INTEGER 2	0	NO
3	POINT2	Parameter	INTEGER 2	0	NO
4	POINT3	Parameter	INTEGER 2	0	NO
5	POINT4	Parameter	INTEGER 2	0	NO
6	POINT5	Parameter	INTEGER 2	0	NO
7	POINT6	Parameter	INTEGER 2	0	NO
8	POINT7	Parameter	INTEGER 2	0	NO
9	POINT8	Parameter	INTEGER 2	0	NO

Where: (See TABLE 4-2 (continued), next page.)

TABLE 4-2 -- *Calibration Status Block (FC 75) (continued)*

	thds.	hnds.	tens	ones	(decimal value)
OPSTAT =	EA	SL	CI	CS	

CS — Command Sequence Flag
0 - No sequence error
1 - Command out of sequence

Possibilities are:

a. Full scale calibration command entered before zero scale calibration performed.

b. Command other than escape or valid full scale calibration entered after zero scale operation performed.

CI — Command Consistency Flag
0 - Command consistent with configuration.
1 - Command inconsistent with configuration.

Possibilities are:

a. Specified slave not configured.
b. Actual slave type does not match slave type in command.

SL — Slave failure
0 - Slave responding normally.
1 - Slave configured, but not responding.

EA — NVRAM error
0 - No NVRAM error
1 - NVRAM error

NOTE: The OIU, MCS, or Bailey Work Station display all nine lines of the Calibration Status Block on one screen. The status is displayed on the CTM one line at a time using the "NEXT" key. The CTM suppresses leading zeroes.

TABLE 4-2 -- *Calibration Status Block (FC 75) (continued)*

	thds.	hds.	tens	ones	(decimal value)
$POINT_n$ =	PN		0	PS	

Point Status:

0 - Command performed without error.
1 - Point not configured.
2 - Point not disabled.
3 - Calculated gain or offset over range.
4 - NVRAM error.
5 - Operation not performed.

Point number:
Number of point to which the status applies ($1 \leq POINT_n \leq 64$).

TABLE 4-3 -- *Calibration Status Block (FC 75) (Point Calibration)*

SPEC ID NUMBER	SYMBOL	FUNCTION	DATA TYPE	DEFAULT	TUNABLE
1	OPSTAT	Parameter	INTEGER 2	0	NO
2	$POINT_n$	Parameter	INTEGER 2	0	NO

Where: OPSTAT and $POINT_n$ are defined by the same format as Table 4-2.

CALIBRATION DATA BLOCK
(Function Code 73 / Blocks 101-164)

The correction factors which are computed during calibration are stored in NVRAM and may be referenced by the Calibration Data Blocks. The data is stored in Function Blocks to facilitate restoration of an NAMM03 should a NVRAM failure occur. Calibration values can be entered via an operator interface device.

The data contained in a particular Calibration Data Block pertains to a point defined by an Enhanced Analog Point Definition (EAPD) Block. There is a fixed difference of one hundred (100) between the block numbers for a particular point (i.e., Calibration Data Block 121 corresponds to EAPD Block 21). The block is undefined if the associated point is not configured.

Offset and gain values can be modified in Configure Mode. Correction data entered explicitly is checked against predefined limits for the input type. If the correction factors are out of the normal range, the calibration quality flag is set in the exception report record. The operator can observe this information by tuning the EAPD Block number + 100 of the point in question. Table 4-4 summarizes the Calibration Data Block Specifications.

TABLE 4-4 -- *Calibration Data Block Specifications (FC 73)*

SPEC ID NUMBER	SYMBOL	FUNCTION	DATA TYPE	DEFAULT	TUNABLE
1	OFFSET	Parameter	REAL-3	-0.500	NO
2	GAIN	Parameter	REAL-3	-0.500	NO

where:

OFFSET — is the offset error correction factor for the channel as determined by calibration.

GAIN — is the gain error correction and microvolt conversion factor as determined by calibration.

NOTE: Monitoring this block provides the raw value in millivolts of the input to the AMM (no correction for slaves). This value is corrected by the master for master-induced errors.

THERMOCOUPLE TEMPERATURE BLOCK (Function Code 76 / Blocks 90-98)

Function code 76 allows monitoring of cold junction RTD temperatures of thermocouple termination units. Additionally this function code provides system trend times, module software and firmware revision levels, and AMM cycle time. These blocks, numbered 90 through 98, can only be accessed via a READ POINT or READ BLOCK Module Bus message (monitor function on the CTM).

Termination Module/Unit Cold Junction Temperatures

The AMM determines termination unit temperatures by averaging values from RTD pairs on board the termination units. Each NTAI02 has two RTDs, while each NIAI02 has one RTD.

All temperatures are given in degrees C. If a slave is not associated with an RTD pair, then the corresponding block number is undefined. The quality associated with an RTD pair is bad when the calculated temperature is outside the allowable range of 0 to 70 °C (0 to 158 °F), or when an open input is detected. The high/low alarm status available during block monitoring indicates at what extreme the calculated temperature resides.

The relationship between block numbers and NTAI02 Termination Unit RTD pair temperatures is:

Block Number	RTD Pair	Term. Unit
90	A	1st NTAI02
91	B	2nd NTAI02, if daisy-chained
92	C	3rd NTAI02
93	D	4th NTAI02

If using NIAI02 Termination Module (Figure 3-3):

Each NIAI02 Termination Module has one RTD, therefore the values from two NIAI02 modules are used to determine a temperature value for FC 76. In case an odd number of termination modules are connected, the value of the RTD from the odd module is averaged with an RTD located on the NIAM02. The RTD on the NIAM02 is switched in or out via an eight-position dipswitch located on the NIAM02.

Up to eight NIAI02 modules can be connected to the NIAM02; four daisy-chained from the J1 socket and four from the J2 socket. The first two NIAI02s (from the J1 socket) are designated as RTD pair A, and the second two modules, RTD pair B. The four NIAI02s connected to socket J2 are pairs C and D respectively.

If, for example, three NIAI02s are connected to the J1 socket of the NIAM02, the temperature of the first two NIAI02s is obtained by monitoring block 90 (RTD pair A). The temperature of the third NIAI02 is averaged with the temperature on the NIAM02 and is obtained by monitoring block 91 (RTD pair B).

The user should daisy-chain up to four NIAI02s from the J1 socket of the NIAM02 first, and then connect up to four modules to socket J2.

ENHANCED ANALOG POINT DEFINITION (EAPD -- Function Code 158 / Blocks 1-64)

The AMM accepts up to 64 inputs. Each input is defined in a fixed block (1-64) with Function Code 158. This function code defines parameters for analog inputs including alarm detection, and exception reporting. The quality of the calibration values for inputs are available by monitoring these blocks with a CTM. If an asterisk replaces the "B", then the point status for the input is abnormal. The input calibration quality can then be determined by depressing the NEXT button. If a "C" is displayed in the numeric field, the calibration quality is unsatisfactory (Refer to Troubleshooting Section for diagnostic and corrective procedures). If "C" is not displayed, the calibration quality is presumed good. If an "S" is displayed in the numeric field, the point is disabled and the calibration quality cannot be viewed until it is enabled.

CALIBRATION EXAMPLES

This section provides calibration examples for each of the hardware combinations and calibration options available to the user. Commands are entered using the Calibration Command Block (CCB) from any operator interface device (if the CTM is used, press SHIFT SEND after each command).
The calibration examples given do not consider various possible errors. The failure of any calibration command must be followed by a read of the Calibration Status Block (FC 75) to determine the exact cause.

The examples show the specific Function Code specifications values entered when calibrating, followed by the expected operator interface responses (designated as Response Index).

To interpret the Response Indexes, refer to Table 4-5 for the CTM, and Table 4-6 for the OIU, MCS, or Bailey Work Station:

TABLE 4-5 -- *CTM Calibration Response Table*

Response Index	Meaning
1	"Good" displayed within 1 second.
2	"Good" displayed within 30 seconds.
3	"Good" displayed within 60 seconds.

TABLE 4-6 -- *OIU, MCS, Bailey Work Station Calibration Response Table*

Response Index	Meaning
1	Calibration Command Block rewritten on OIU or MCS screen with "0" displayed in specification 1. Abnormal condition detected during calibration.(See Calibration Status Block).
2	Calibration Command Block rewritten on OIU or MCS screen with Command Field (S1) unchanged from operator supplied value.
3	"Module Busy" messages written on OIU screen. Operator should redisplay the Calibration Command Block at 30 second intervals.

CALIBRATING THERMOCOUPLE SLAVE (NASM02)

NOTE: When performing a thermocouple slave calibration (all eight points at once), all slave points must be configured (by EAPD blocks, FC 158) or a calibration error will occur (C114 on the CTM). It is recommended that all thermocouple slave points be defined (as TC or millivolt inputs) before a slave calibration is done. Should any errors be encountered during calibration, the Calibration Status Block shows which points are in error and the specific problem.

NASM02 Calibration Equipment (External)

When calibrating the NASM02 Thermocouple Slave, the best accuracy can be attained by performing an external calibration with quality equipment. The following equipment is recommended:

1. A good 5-1/2 digit multimeter (HP 3468A or equivalent).

2. A good millivolt source with precise control (Analogic AN3100 or equivalent).

Calibrating All Slave Points When Using NTAI02 Termination Unit

External Calibration

This example shows how to calibrate a whole thermocouple slave at once using a precision millivolt source.

1. Disable slave by tuning CCB.

		Device	Response Index
<S1> =	**2**		
<S2> =	**any slave point**	CTM	1
		OIU,MCS	2

NOTE: For Response Index, refer to Tables 4-5 and 4-6.

2. Move input cable on NTAI02 from the input socket P1 or P2 to the calibrate socket P3. Red/Green LED on affected slave should turn red.

3. Attach millivolt source and multimeter to external test input posts ("+" lead to TP1, "-" to TP2) on NTAI02.

4. Set toggle switch (S1) on NTAI02 to the external calibration position.

5. Adjust source for 0 millivolt multimeter reading between TP1 and TP2. Then tune CCB to perform 0 millivolt calibration.

<S1> = 4	**Device**	**Response Index**
	CTM	2
	OIU,MCS	2 or 3

6. Adjust source to read 100 millivolts on multimeter between TP1 and TP2, then tune CCB to perform 100 millivolt calibration.

<S1> = 5	**Device**	**Response Index**
	CTM	2
	OIU,MCS	2 or 3

7. Move the input cable on NTAI02 from the calibrate socket P3 to the input socket P1 or P2. Red/Green LED on affected slave should turn solid green.

8. Enable slave by tuning CCB.

<S1> = 11	**Device**	**Response Index**
	CTM	1
	OIU,MCS	2

Internal (Auto) Calibration

This example demonstrates the operations necessary to calibrate a whole thermocouple slave automatically using internal references.

1. Disable slave by tuning CCB:

<S1> = 2
<S2> = any slave point

Device	Response Index
CTM	1
OIU,MCS	2

2. Move input cable on NTAI02 from the input socket P1 or P2 to the calibrate socket P3. Red/green LED on affected slave should turn red.

3. Set toggle switch (S1) on NTAI02 to the internal calibrate position.

4. Tune CCB to perform slave calibration:

<S1> = 3

Device	Response Index
CTM	3
OIU,MCS	2 or 3

5. Move input cable on NTAI02 from the calibrate socket P3 to the input socket P1 or P2. Red/green LED on the affected slave should turn solid green.

6. Enable slave by tuning CCB.

<S1> = 11

Device	Response Index
CTM	1
OIU,MCS	2

Calibrating All Thermocouple Slave Points If High Density Termination Units Used (NIAI02, NIAM02, NIAC02)

This procedure calibrates all eight slave points at once:

External Calibration

1. Disable slave by tuning CCB:

<S1> = 2
<S2> = any slave point

Device	Response Index
CTM	1
OIU,MCS	2

2. Remove slave from MMU operating slot and insert in MMU slot which is cabled to the NIAC02 Calibration Module. Slave red/green LED should turn solid red.

3. Connect precision millivolt source and multimeter to EXT CAL terminals of NIAC02 ("-" lead to terminal 3 and "+" lead to terminal 4).

4. Set rocker switch S1 on the NIAC02 to the EXT CAL (C1) position.

5. Adjust source to 0 millivolts, while monitoring with the multimeter. Then tune the CCB to perform 0 millivolt calibration:

<S1> = 4

Device	Response Index
CTM	2
OIU,MCS	2 or 3

6. Adjust source to 100 millivolts, monitoring with the multimeter. Then tune CCB to perform 100 millivolt calibration:

<S1> = 5

Device	Response Index
CTM	2
OIU,MCS	2 or 3

7. Return NASM02 to its normal MMU slot. The slave red/green LED should indicate solid green.

8. Enable slave by tuning CCB:

<S1> = 11	Device	Response Index
	CTM	1
	OIU,MCS	2

Internal Calibration
This procedure shows how to calibrate a whole thermocouple slave at once when using high density termination modules.

1. Disable slave by tuning CCB:

<S1> = 2		
<S2> = any slave point	Device	Response Index
	CTM	1
	OIU,MCS	2

2. Verify that the internal calibration voltage from terminals 3 and 4 of the NIAM02 Termination Module are hard-wired to the INT CAL terminals (1 and 2) of the NIAC02 (observe polarity).

3. Remove slave from MMU operating slot and insert in MMU slot which is cabled to the NIAC02 Calibration Module. Slave red/green LED should turn solid red.

4. Set the rocker switch S1 on the NIAC02 to the INT CAL (C2) position.

5. Tune CCB for slave calibration:

<S1> = 3	Device	Response Index
	CTM	3
	OIU,MCS	2 or 3

6. Return NASM02 to the its normal MMU slot. Slave status LED should turn solid green.

7. Enable slave by tuning CCB:

<S1> = 11	Device	Response Index
	CTM	1
	OIU,MCS	2

Single Point Calibration, Thermocouple Slave (NASM02)

These examples show how to calibrate a single thermocouple input without disturbing the data collection of any other point on the slave.

Using NTAI02 Termination Unit (Internal/External calibration)

1. Disable slave point by tuning the Calibration Command Block (CCB).

<S1> = 1		
<S2> = point to disable	Device	Response Index
	CTM	1
	OIU,MCS	2

2. If using an external precision millivolt source, attach it and a multimeter to the point terminal blocks on the NTAI02 in place of the field wiring. If using the internal references, attach jumper wires from the internal test output posts (TP3,TP4) on the NTAI02 to the specific point terminal blocks on the NTAI02 in place of the field wiring.

3. If external source is used, adjust it to read 0 millivolts on the multimeter.

4. Tune CCB to perform 0 millivolt calibration.

<S1> = 6	Device	Response Index
	CTM	2
	OIU,MCS	2 or 3

5. If external source is used, adjust it to read 100 millivolts on the multimeter.

6. Tune CCB to perform 100 millivolt calibration.

<S1> = 7	Device	Response Index
	CTM	2
	OIU,MCS	2 or 3

7. Reattach field wiring, then enable point by tuning CCB.

<S1> = 10
<S2> = slave point to enable

Device	Response Index
CTM	1
OIU,MCS	2

Using NIAI02 High Density Termination Module (External Calibration)

Perform the procedure for "Single Point Calibration Using NTAI02 Termination Unit (External)", except attach the input voltage source and multimeter to the NIAI02 terminals.

RTD SLAVE CALIBRATION (NASM03, NASM04)

Single RTD Point Calibration with Minimal Data Collection Impact

These examples shows how to calibrate a single RTD input without disturbing the data collection of any other point on the slave.

100 Ohm RTD -- NASM03 Slave and NTAI03/04 or NIAI03 Termination Units.

1. Disable point by tuning the CCB.

<S1> = 1
<S2> = slave point number

Device	Response Index
CTM	1
OIU,MCS	2

2. Attach a 100 ohm, .02% precision resistor to the specific point terminal blocks on the termination units in place of the field wiring following these steps:

   a. Place the resistor between points A and B on the terminal block.

   b. Short point C to point B on the terminal block.

3. Tune CCB to perform 100 ohm (ZERO) calibration.

<S1> = 8

Device	Response Index
CTM	2
OIU,MCS	2 or 3

4. Replace the 100 ohm precision resistor at the point termination blocks with a 400 ohm, .02% precision resistor by the following steps:

   a. Place the resistor between points A and B on the terminal block.

   b. Short point C to point B on the terminal block.

5. Tune CCB to perform 400 ohm (SPAN) calibration.

<S1> = 9

Device	Response Index
CTM	2
OIU,MCS	2 or 3

6. Remove the resistor and attach field wiring.

7. Enable point by tuning CCB.

<S1> = 10

Device	Response Index
CTM	1
OIU,MCS	2

10 Ohm RTD -- NASM04 Slave and NTAI04 or NIAI03 Termination Units

Perform the same procedure as the for a 100 Ohm RTD, except substitute a 14.7 ohm resistor for the 400 ohm resistor and a 7.35 ohm resistor (or two 14.7 ohm resistors in parallel) for the 100 ohm resistor. (NOTE: All resistors .1% or better tolerance.)

Single RTD Point Calibration When Using NTAI03/04 Termination Units

These examples demonstrate how to calibrate an RTD input using the jumpers and precision resistors provided on each NTAI03 and NTAI04.

NTAI03 (100 Ohm RTD)

1. Disable the slave by tuning the CCB:

<S1> =	2		
<S2> =	any slave point	**Device**	**Response Index**
		CTM	1
		OIU,MCS	2

2. Move the input cable on NTAI03 from the input socket P1 or P2 to the calibrate socket P3. Red/green LED on the affected slave should turn red.

3. Select slave point to be calibrated with jumpers (CH1 through CH8) on NTAI03.

4. Select 100 ohm (ZERO) resistor with toggle switch (S1) on NTAI03.

5. Tune CCB to perform ZERO calibration:

<S1> =	8		
<S2> =	slave point number	**Device**	**Response Index**
		CTM	2
		OIU,MCS	2 or 3

NOTE: The point number should correspond to the point number selected with jumpers in step 3.

6. Move toggle switch (S1) on NTAI03 to select 400 ohm (SPAN) resistor.

7. Tune CCB to perform SPAN calibration.

<S1> = 9	**Device**	**Response Index**
	CTM	2
	OIU,MCS	2 or 3

8. Repeat steps 3 through 7 for each point on the slave.

9. Move input cable on NTAI03 from the calibrate socket P3 to the input socket P1 or P2. Red/green LED on the affected slave should turn green.

10. Enable slave by tuning CCB.

<S1> = 11	**Device**	**Response Index**
	CTM	1
	OIU,MCS	2

NTAI04 (10 or 100 Ohm RTDs)

1. Disable the slave by tuning CCB:

<S1> =	2		
<S2> =	any slave point	**Device**	**Response Index**
		CTM	1
		OIU,MCS	2

2. Move the input cable on NTAI04 from the input socket P1 or P2 to the calibrate socket P3. Red/green LED on the affected slave should turn solid red.

3. Select slave point to be calibrated using jumpers CH1 through CH8.

4. 100 Ohm RTD: Select 100 OHM ZERO with jumper.

   10 Ohm RTD: Select 10 OHM ZERO with jumper.

5. Tune CCB to perform ZERO calibration:

<S1> =	8		
<S2> =	slave calibration point	**Device**	**Response Index**
		CTM	2
		OIU,MCS	2 or 3

NOTE: The point number corresponds to the point selected with jumpers in Step 3.

6. 100 Ohm RTD: Select 100 OHM SPAN with jumper.

   10 Ohm RTD: Select 10 OHM SPAN with jumper.

7. Tune CCB to perform RTD SPAN calibration:

   <S1> = 9

	Device	**Response Index**
	CTM	2
	OIU,MCS	2 or 3

8. Repeat steps 3 through 7 for each point on the slave.

9. Move cable on NTAI03 from calibration socket P3 to input socket P1 or P2. The slave status LED should turn solid green.

10. Enable slave by tuning CCB:

   <S1> = 11

	Device	**Response Index**
	CTM	1
	OIU,MCS	2

Calibrating RTD Inputs When Termination Module Used

NIAI03 Termination Module

1. Disable NASM03 or NASM04 Slave by tuning the CCB:

   <S1> = 2

	Device	**Response Index**
<S2> = any slave point	CTM	1
	OIU,MCS	2

2. Move Slave from normal MMU slot to calibration slot which is cabled to the NIAC03 Calibration Module. LED on affected slave should turn red.

3. Select ZERO jumper setting on NIAC03 Calibration Module for slave point to be calibrated (CH1 through CH8). (Jumper center pin and pin labeled ZERO.)

4. Tune CCB to perform ZERO calibration:

   <S1> = 8

	Device	**Response Index**
<S2> = point being calibrated	CTM	2
	OIU,MCS	2 or 3

5. Set jumper on NIAC03 to SPAN setting for selected point.

6. Tune CCB to perform SPAN calibration:

   <S1> = 9

	Device	**Response Index**
<S2> = point being calibrated	CTM	2
	OIU,MCS	2 or 3

7. Perform steps 3 through 6 for each slave point.

8. Return slave to normal MMU slot. LED should turn solid green.

9. Enable slave by tuning CCB:

   <S1> = 11

	Device	**Response Index**
	CTM	1
	OIU,MCS	2

SLAVE CHANNEL MONITORING

The actual input value, in millivolts, is available for each slave input channel. This is only a raw value corrected for master induced errors; no slave offset or gain correction is performed. It is the actual value on the Expander Bus that the AMM is digitizing. To inspect the input, monitor the Calibration Data Block corresponding to the desired input block on an operator interface.

The raw input is not available on the first poll of the particular block. That first message informs the NAMM03 which raw value should be saved on its next pass through the input list. Consequently, the bad quality indication may be seen initially. Subsequent polls will have the true millivolt reading. The bad quality flag remains set if the value is unreadable (slave not present or the value is out of range).

MANUAL CALIBRATION DATA WRITES

The gain and offset correction factors for any slave input can be manually entered into the Calibration Data Block for that input. The operation is permissible in Configuration Mode only using the Modify Block Command.

Regardless of how the correction values are ascertained, either from the NAMM03 through calibration or from the operator through manual insertion, the values are compared against reasonable bounds, with the calibration quality set accordingly. The quality of the input correction values is accessible only in the Execute Mode by monitoring the EAPD block (1-64) of the desired point.

SECTION 5 -- OPERATION

MODES OF OPERATION

The AMM has three modes of operation: Execute, Configure, and Error mode. A description of each mode follows below:

Configure Mode

When in Configure Mode the user can modify the AMM configuration by adding, changing, or deleting function blocks such as Analog Point Definition blocks. Tunable parameters may also be adjusted. In Configure Mode the module does not scan the inputs or perform any point calculations. In Configure Mode the red/green front panel Status LED flashes green.

Execute Mode

Execute Mode is the normal operating mode. The AMM scans and digitizes the configured inputs, performs input conditioning, sends values to a DIS for display, and performs self-diagnostic routines. The configuration cannot be changed, but certain parameters can be tuned, and output blocks monitored. In Execute Mode the red/green LED is solid green.

If a NVRAM error occurs in Execute Mode, the red/green LED flashes green, and the module continues to operate. If a reset or mode change occurs, the module loses its configuration.

Error Modes

If the AMM detects a configuration error when attempting to go to Execute Mode, the module enters Error Mode. In this mode the LED flashes green.

Certain error conditions cause the module to halt all operations. If this occurs the Status LED displays solid red (Refer to Troubleshooting section). When reset, the module mode depends on the type of error detected. For example, a reference error forces ERROR mode on reset.

LED INDICATORS

The AMM has front mounted light emitting diodes (LEDs) which indicate module normal operation and error conditions. The Status LEDs consist of a single Red/Green LED, and a group of four red LEDs. Figure 5-1 shows the location of the Status LEDs. Table 5-1 shows the normal operating indications of the four red LEDs.

DIGITAL INDICATOR STATION INTERFACING

Up to four stations may be connected to the AMM to monitor up to 12 input values. The user defines function blocks for these stations in the configuration of the AMM.

MODULE RESET

To reset the AMM, momentarily press the reset push-button located near the bottom of the AMM frontplate.

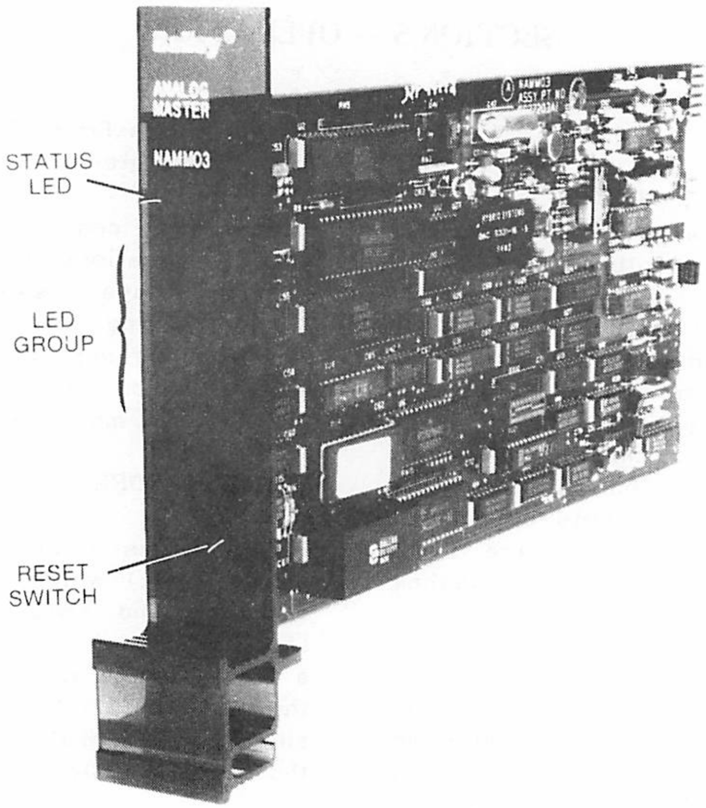

FIGURE 5-1 -- *AMM Status LED Locations*

TABLE 5-1 -- *Normal Operation LED Codes*

LED 1	2	3	4	DESCRIPTION
0	0	0	0	Backup AMM is starting up
0	0	1	0	Backup has received configuration from primary
0	0	0	1	Backup is ready to take over
0	0	1	1	Primary normal operation
1	1	1	1	Module is starting up after reset
(NOTE: 0 = LED OFF, 1 = LED ON)				

SECTION 6 -- CONFIGURATION

FUNCTION BLOCKS/ FUNCTION CODES

The user defines the input parameters and operations of the AMM by assigning Function Codes to Function Blocks. Function Codes are software algorithms, contained in the module NVRAM which define specific module functions such as polynomial calculation, input type, alarm value, etc. Function Blocks are user defined data in NVRAM which are copied to RAM for execution. There are three types of Function Blocks:

EXECUTIVE BLOCK Defines overall module operating parameters.

DATA BLOCK Contains often used data values (calibration data)

INPUT/OUTPUT BLOCK which correspond to module I/O from termination units, and slave modules.

AMM Function Blocks
All AMM Function Blocks have preassigned Function Codes (located at fixed blocks) for performing such functions as Analog Input Definition or Executive Block definition. Table 6-1 lists the AMM Function Blocks and their associated Function Codes:

TABLE 6-1 -- *NAMM03 Function Blocks*

BLOCK NUMBER	DEFINITION	FUNCTION CODE
1 to 64	Inputs 1 through 64	158 (70)*
65 to 68	Digital Indicator Station	20
75	Executive Block	71
76	Slave Definition Block	72
77	Trend Definition Block	78
80	Calibration Command Block	74
81	Calibration Status Block	75
89	Point Service Status Block	77
90 to 93	Termination Unit Temperature Blocks	76
94	Local Time -- Hours	
95	Local Time -- Minutes	
96	Local Time -- Seconds	
97	Revision Level	
98	Cycle Time (seconds)	
101 to 164	Calibration Data Blocks for inputs 1 through 64	73
165 to 196	Polynomial Adjustment	159

* FC 70 is converted to 158 on a Write Block command, when downloading a NAMM02 configuration to an NAMM03.

Function Code Definitions
Following is a list of specifications for Function Codes which are unique to the NAMM03, or those which were not contained in the Function Code Manual at the time this document was printed. For further information on AMM configuration and Function Codes, refer to the Function Code Manual, E93-900-20.

EXECUTIVE BLOCK (FUNCTION CODE 71 / BLOCK 75)

The AMM Executive Block is defined by Function Code 71 contained in Function Block 75. The Executive Block specifies the AMM Configuration Lock, Hi/Low Alarm Deadband value, cable length to thermocouple termination units, and minimum and maximum exception reporting times for groups of eight inputs. See Table 6-2 for Executive Block specifications.

TABLE 6-2 -- *Executive Block Specifications (FC 71)*

Memory Utilization: 0.0 %

SPEC. NO.	TUNE	DEFAULT VALUE	DATA TYPE	RANGE MIN	RANGE MAX	DESCRIPTION
S1	NO	0	INT(1)	0 to 255		Configure lock* X00 = unlock X01 = lock X02 = use state of configuration switch (OPEN = 1, CLOSED = 0) 0XX = backup not expected 1XX = backup expected
S2	NO	0.0	REAL(2)	FULL		Alarm deadband in % of span
S3	NO	0.0	REAL(2)	FULL		Cable length in feet from AMM to terminator
S4	NO	4	INT(1)	0 to 255		Minimum exception report time (250 msec increments) blocks 1-8
S5	NO	240	INT(1)	0 to 255		Maximum exception report time (250 msec increments) blocks 1-8
S6	NO	4	INT(1)	0 to 255		Minimum exception report time (250 msec increments) blocks 9-16
S7	NO	240	INT(1)	0 to 255		Maximum exception report time (250 msec increments) blocks 9-16
S8	NO	4	INT(1)	0 to 255		Minimum exception report time (250 msec increments) blocks 17-24
S9	NO	240	INT(1)	0 to 255		Maximum exception report time (250 msec increments) blocks 17-24
S10	NO	4	INT(1)	0 to 255		Minimum exception report time (250 msec increments) blocks 25-32
S11	NO	240	INT(1)	0 to 255		Maximum exception report time (250 msec increments) blocks 25-32
S12	NO	4	INT(1)	0 to 255		Minimum exception report time (250 msec increments) blocks 33-40

TABLE 6-2 -- *Executive Block Specifications (FC 71) (continued)*

SPEC. NO.	TUNE	DEFAULT VALUE	DATA TYPE	RANGE MIN	MAX	DESCRIPTION
S13	NO	240	INT(1)	0 to 255		Maximum exception report time (250 msec increments) blocks 33-40
S14	NO	4	INT(1)	0 to 255		Minimum exception report time (250 msec increments) blocks 41-48
S15	NO	240	INT(1)	0 to 255		Maximum exception report time (250 msec increments) blocks 41-48
S16	NO	4	INT(1)	0 to 255		Minimum exception report time (250 msec increments) blocks 49-56
S17	NO	240	INT(1)	0 to 255		Maximum exception report time (250 msec increments) blocks 49-56
S18	NO	4	INT(1)	0 to 255		Minimum exception report time (250 msec increments) blocks 57-64
S19	NO	240	INT(1)	0 to 255		Maximum exception report time (250 msec increments) blocks 57-64

* Configure lock: Once a configuration is locked with a 1, it cannot be unlocked. To change a configuration locked with a 1, the user must initialize the module and reconfigure it.

When the state of the configuration lock switch is used as the configuration lock, the configuration can be locked and unlocked without initialization by changing the position of the switch. The configuration lock switch is contact 3 of the Hardware Configuration Switch on the AMM.

When a backup is used, the "backup expected" (1XX) state must be configured. This permits the primary to report bad status for the backup if the backup is not present on a reset.

ENHANCED ANALOG POINT DEFINITION (EAPD) FUNCTION CODE 158

The Enhanced Analog Point Definition Function Code sets up the required blocks in the NAMM03 to perform analog input, analog adjustments, alternate cold junction referencing, exception reporting and alarm functions. Blocks 1 through 64 may be defined with Function Code 158 (Table 6-3).

TABLE 6-3 -- *Enhanced Analog Point Definition Specifications (FC 158)*

Module Utilization: 0/0 Bytes

SPEC. NO.	TUNE	DEFAULT VALUE	DATA TYPE	RANGE MIN	RANGE MAX	DESCRIPTION
S1	NO	0	I1	FULL		Input Type: 0 = Undefined X01 = S TC, X02 = R TC X03 = E TC, X04 = J TC X05 = K TC, X06 = T TC X07 = Chinese E TC X08 = Chinese S TC X20 = U.S. Lab Standard 100 ohm Platinum RTD X21 = U.S. Ind. Standard 100 ohm Platinum RTD X22 = European Standard 100 ohm Platinum RTD X23 = 120 ohm chemically pure Nickel RTD X24 = 10 ohm, Copper RTD X25 = Chinese 53 ohm Copper RTD X26-X29 = Unimplemented X40 = High Level (1-5 V) X41 = High Level (± 10 V) X42 = 0 to 10 V dc X43 = 0 to 5 V dc X44-X49 = Unimplemented X60 = -100 to 100 millivolt X61 = 0 to 100 millivolt *X62 = (1-5 Volt) millivolt input *X63 = (4-20 milliamps) millivolt input X64-X99 = Unimplemented 1XX** = Cold Junction Input
S2	NO	0	I1	FULL		Engineering Unit X00 = Degrees C X01 = Degrees F X02 = Engineering Unit Conversion (high level and millivolt) X03 = Square root after engineering unit conversion X04 = Square root before engineering unit conversion

TABLE 6-3 -- *Enhanced Analog Point Definition Specifications (FC 158) (continued)*

SPEC. NO.	TUNE	DEFAULT VALUE	DATA TYPE	RANGE MIN MAX	DESCRIPTION
					If Polynomial Adjustment Function Code defined for input (Spec. 10) then: 1XX = Perform polynomial on input, corrected for slave (Special applications only). 0XX = (No change to Spec.) = Perform polynomial on engineering units.
S3	NO	0	I1	FULL	Engineering unit identifier
S4	NO	0.0	R3	FULL	Zero
S5	NO	0.0	R3	FULL	Span
S6	NO	1.0	R3	FULL	Significant change, percent span
S7	YES	0.0	R3	FULL	High alarm value
S8	YES	0.0	R3	FULL	Low alarm value
S9	NO	0.0	R3	FULL	Lead wire resistance, ohms (not relevant for high levels)
S10	NO	0	I1	0, 165-196	Block number of Polynomial Adjustment block (FC 159). (0 = not defined)
S11	NO	0	I1	0-64, 255	Block number of Cold Junction (CJ) block for TC input. 0 = no block defined (use standard CJ RTD if TC input) 255 = CJ for TC input disabled 1-64= CJ input block number (this block must be configured as a CJ input)

* Using Analog Input Translator Termination Unit (NTTA01)

** When added to specification, defines input as a remote cold junction reference (used as cold junction reference by other inputs).

NOTE: Function Code 158 replaces Function Code 70 (used in the NAMM02). If a NAMM02 configuration is downloaded to a NAMM03, the NAMM03 converts all blocks containing Function Code 70 to Function Code 158. But, due to the Function Code conversion, the automatic configuration verification, performed from an OIU, will not complete successfully.

TABLE 6-4 -- *Enhanced Analog Point Definition (FC 158) Outputs*

Block Number	Data Type	Description
N	REAL-3	Input value and quality

Nonstandard Transducers

In case the user has nonstandard millivolt or high-level tranducers, values can be calculated for SPAN, ZERO, and SIGNIFICANT CHANGE PERCENT specifications to allow proper conversion to engineering units and exception reporting as follows:

Key to Variables:

AS = Actual Span (Spec. 5)
AZ = Actual Zero (Spec. 4)
ASC% = Actual Significant Change, Percent Span (Spec. 6)
Full = Desired full scale engineering units.
Zero = Desired zero scale engineering units.
Span = Desired span of engineering units.
FMV or FV = Transducer Full Scale (mV or V respectively).
ZMV or ZV = Transducer Zero Scale (mV or V respectively).
MVSPAN = Millivolt Transducer Span
HISPAN = Hi-level Transducer Span

Millivolt Transducer Formulas

TYPE 60 (Spec. 1)

$$AS = \frac{(FULL - ZERO) * 200}{FMZ - ZMV}$$

$$= \frac{SPAN * 200}{MVSPAN}$$

$$AZ = ZERO - \frac{ZMV + 100}{200} * (AS)$$

$$ASC\% = \frac{SC\% * (FULL - ZERO)}{AS}$$

$$= \frac{SC\% * SPAN}{AS}$$

Type 61

$$AS = \frac{(FULL - ZERO) * 100}{FMV - ZMV}$$

$$= \frac{SPAN * 100}{MVSPAN}$$

$$AZ = ZERO - \frac{ZMV}{100} * AS$$

$$ASC\% = \frac{SC\% * (FULL - ZERO)}{AS}$$

$$= \frac{SC\% * SPAN}{AS}$$

High Level Transducer Formulas

Type 40

$$\text{AS} = \frac{(\text{FULL} - \text{ZERO}) * 4}{\text{FV} - \text{ZV}}$$

$$= \frac{\text{SPAN} * 4}{\text{HISPAN}}$$

$$\text{AZ} = \text{ZERO} - \frac{\text{ZV} - 1}{4} * \text{AS}$$

$$\text{ASC\%} = \frac{\text{SC\%} * (\text{FULL} - \text{ZERO})}{\text{AS}}$$

$$= \frac{\text{SC\%} * \text{SPAN}}{\text{AS}}$$

Type 41

$$\text{AS} = \frac{(\text{FULL} - \text{ZERO}) * 20}{\text{FV} - \text{ZV}}$$

$$= \frac{\text{SPAN} * 20}{\text{HISPAN}}$$

$$\text{AZ} = \text{ZERO} - \frac{\text{ZV} + 10}{20} * \text{AS}$$

$$\text{ASC\%} = \frac{\text{SC\%} * (\text{FULL} - \text{ZERO})}{\text{AS}}$$

$$= \frac{\text{SC\%} * \text{SPAN}}{\text{AS}}$$

Type 42

$$\text{AS} = \frac{(\text{FULL} - \text{ZERO}) * 10}{\text{FV} - \text{ZV}}$$

$$= \frac{\text{SPAN} * 10}{\text{HISPAN}}$$

$$\text{AZ} = \text{ZERO} - \frac{\text{ZV}}{10} * \text{AS}$$

$$\text{ASC\%} = \frac{\text{SC\%} * (\text{FULL} - \text{ZERO})}{\text{AS}}$$

$$= \frac{\text{SC\%} * \text{SPAN}}{\text{AS}}$$

Type 43

$$\text{AS} = \frac{(\text{FULL} - \text{ZERO}) * 5}{\text{FV} - \text{ZV}}$$

$$= \frac{\text{SPAN} * 5}{\text{HISPAN}}$$

$$\text{AZ} = \text{ZERO} - \frac{\text{ZV}}{5} * \text{AS}$$

$$\text{ASC\%} = \frac{\text{SC\%} * (\text{FULL} - \text{ZERO})}{\text{AS}}$$

$$= \frac{\text{SC\%} * \text{SPAN}}{\text{AS}}$$

POLYNOMIAL ADJUSTMENT FUNCTION CODE 159

The Polynomial Adjustment Function Code (Table 6-5) defines a fifth order polynomial equation of the type $Y = Ax^5 + Bx^4 + Cx^3 + Dx^2 + Ex + F$. The user may define this Function Code for 32 blocks (165 - 196). EAPD blocks (FC 158) can be linked to these block. The EAPD block performs the polynomial calculation on the engineering units to calculate a new output value. Multiple EAPD blocks can use the same polynomial data. A coefficient mantissa of 0.0 effectively removes that term from the equation.

TABLE 6-5 -- *Polynomial Adjustment Specifications (FC 159)*

Module Utilization: Bytes = 0/0

SPEC. NO.	DEFAULT TUNE	DATA VALUE	TYPE	RANGE MIN	RANGE MAX	DESCRIPTION
S1	YES	0.0	R3	FULL		A coefficient mantissa
S2	YES	0	I1	FULL		A coefficient exponent
S3	YES	0.0	R3	FULL		B coefficient mantissa
S4	YES	0	I1	FULL		B coefficient exponent
S5	YES	0.0	R3	FULL		C coefficient mantissa
S6	YES	0	I1	FULL		C coefficient exponent
S7	YES	0.0	R3	FULL		D coefficient mantissa
S8	YES	0	I1	FULL		D coefficient exponent
S9	YES	0.0	R3	FULL		E coefficient mantissa
S10	YES	0	I1	FULL		E coefficient exponent
S11	YES	0.0	R3	FULL		F coefficient mantissa
S12	YES	0	I1	FULL		F coefficient exponent
S13	YES	0	I1	FULL		Pre-scale exponent

Where:

$A = S1 * 10^{S2}$ $B = S3 * 10^{S4}$

$C = S5 * 10^{S6}$ $D = S7 * 10^{S8}$

$E = S9 * 10^{S10}$ $F = S11 * 10^{S12}$

$X = Input * 10^{S13}$

NOTE: To generate a negative exponent, add 256 to the desired exponent value. For example, to produce an exponent of -1, the specification is 255 :

$$(-1) + 256 = 255$$

For (-2) : $(-2) + 256 = 254$

TABLE 6-6 -- *Polynomial Adjustment Outputs (FC 159)*

Block Number	Data Type	Description
N	R3	No meaning

TREND DEFINITION FUNCTION CODE 78

Defining a point for fast or slow trending is accomplished with Function Code 78. Memory requirements for trending in the NAMM03 are 1/4 times the NAMM02 requirement. Trending utilization is as follows:

NORMAL; .4% / point
FAST; 1.9% / point

THERMOCOUPLE TEMPERATURE FUNCTION CODE 76

The definition of function code 76 is exactly the same as contained in the Function Code Manual, except that one block has been added; block 98 contains the Cycle Time value. The Cycle Time is the amount of time (in seconds) required for the AMM to make one scan of its inputs.

The Thermocouple Temperature Function Code also provides cold junction RTD temperatures of thermocouple termination units, system trend times, and module revision levels.

The Module Revision Level has the form:

3 0 0 0

- 0 0 — Firmware Revision Level (00 = A0)
- 0 — Hardware Revision Level (0 = PCB #6637204)
- 3 — Module Nomenclature (e.g. 3 = NAMM03)

SECTION 7 -- TROUBLESHOOTING

RED/GREEN LED INDICATIONS

Red Light

A solid red light indicates a module hardware failure. The module is halted and will not communicate over the Module Bus. Also the Module Status Bytes cannot be accessed. The following errors will cause a red light condition:

1. Module calibration references voltages out of tolerance.
2. Power fail or reset during NVRAM write.
3. Error in ROM checksum.

After a red light condition, the user should:

1. Try to reset the module to bring it back on-line.
2. If the module will not reset, try to reinitialize by unplugging the module, setting the Hardware Switch to Initialize, and reinserting the module.
3. Then set the Hardware Switch to its normal operating condition, redownload the AMM configuration and attempt to place the module in Execute Mode.
4. If a ROM problem occurred and these procedures fail, replace the ROM.
5. If the problem has not been corrected, replace the module.

LED Blinking Green

A LED blinking green indicates that the module has detected an error in configuration when attempting to go from Configure to Execute Mode. The user can access the Module Status Bytes to identify the particular configuration error (Table 7-1).

This indication also occurs if an NVRAM error occurs while in Execute Mode. In this case the AMM continues to operate unless an additional error condition causes it to halt.

MODULE STATUS BYTES

The Module Status Bytes provide information concerning the primary and backup AMMs, slave modules, and AMM inputs. The Status Bytes are displayed as hexadecimal values on the CTM, and are available by displaying the module address and pressing the NEXT key. On the OIU, the Status Bytes are accessed by displaying the Module Status Screen. Table 7-1 interprets the bit representation of the Module Status Bytes.

TABLE 7-1 -- *Module Status Bytes*

	BIT	7	6	5	4	3	2	1	0
BYTE	1	ES	MODE		TYPE				
	2	FTX	BAC	XXX	LIO	XXX	NVF	NVI	XXX
	3	REF	IOP	SCF	XXX	CAL	CJR	SRV	EPF
	4	XXX	XXX	XXX	XXX	ECS			
	5	BLK							

FIELD	FIELD SIZE OR VALUE	DESCRIPTION
BYTE 1		
ES	80	Error Summary (0 = OK, 1 = Error) (Indicates error in any of the Status Bytes)
MODE	60	Module Mode (00 = CFG, 10 = ERR, 11 = EXE)
TYPE	1F	Module Type Code = 9
BYTE 2		
FTX	80	First Time in Execute (0 = NO, 1 = YES)
BAC	40	Backup Status (0 = OK, 1 = BAD)
LIO	10	Summary Local Input Status (0 = NO, 1 = YES) (Slave not responding or bad quality input)
NVF	04	NVRAM Failure (0 = NO, 1 = YES)
NVI	02	NVRAM initialized (0 = NO, 1 = YES) (NVRAM initialized and no changes made)
XXX = UNUSED		
BYTE 3		
REF	80	Master reference out of range
IOP	40	Summary open TC status (0 = OK, 1 = BAD) (Configured thermocouple point is open)
SCF	20	Slave configuration problem (0 = NO, 1 = YES) (Problem with Slave Definition block -- occurs when going from Configure to Execute Modes)
CAL	08	Summary calibration status (0 = OK, 1 = BAD)
CJR	04	Summary cold junction RTD status (0 = OK, 1 = BAD)
SRV	02	Summary of points not in service (0 = NO, 1 = YES) (Point is out of service for calibration)
EPF	01	NVRAM Power Failure during Write (0 = NO, 1 = YES)
XXX = UNUSED		

TABLE 7-1 -- *Module Status Bytes (continued)*

FIELD	FIELD SIZE OR VALUE	DESCRIPTION
BYTE 4		
ECS	0F	Error code status (0 = GOOD, NOT 0 = ERROR CODE) (Configuration errors) 1 = Slave type and point type disagree (BLK) 2 = Input type disagrees with EU type (BLK) 3 = Point input type invalid (BLK) 4 = Trend type invalid (BLK) 5 = Cold junction input is invalid (BLK) 6 = Polynomial block address is invalid (BLK) 7 = DIS block data is invalid (BLK)
BYTE 5		
BLK	FF	Block number that ECS refers to

TABLE 7-2 -- *LED Error Indications*

(NOTE: 0 = LED OFF ; 1 = LED ON)

LED 1 2 3 4	DEFINITION
1 0 0 0	Backup ID is same or Module Bus Address different. This is a problem with the hardware switch settings: **Backup ID:** This indicates that both AMMs in a redundant configuration have the same Primary/Backup ID setting. (Contact 1 of the Hardware Switch should be set differently on both AMMs). For example: If one AMM is desired to be the Primary with a "configuration lock" feature, switches 1 through 3 are set to 101. The Backup also with configuration lock, is then set to 001. **Module Bus Address:** The address should be the same on both AMMs of a redundant pair.
0 1 0 0	Backup has detected a communication problem on link. May be a problem with Primary or Backup. Check hardware and cable connections.

TABLE 7-2 -- *LED Error Indications (continued)*

1 1 0 0	Reference Error This indicates that the module has detected an error in its 0 and 10 volt reference procedure. The user should check the ± 15 V dc power supply or replace the module, if necessary.
1 0 1 0	Primary failed and Backup was not ready. Indicates that the Primary failed, and the Backup was not ready to take control of the process.
1 0 1 1	NVRAM initialized or NVRAM error. The Backup displays this code after an initialization, activated by setting the Hardware Switch, is complete. This code, displayed on the Primary, indicates a NVRAM error.
0 1 1 1	ROM checksum error. Module self-checks have determined discrepancy in ROM configuration

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