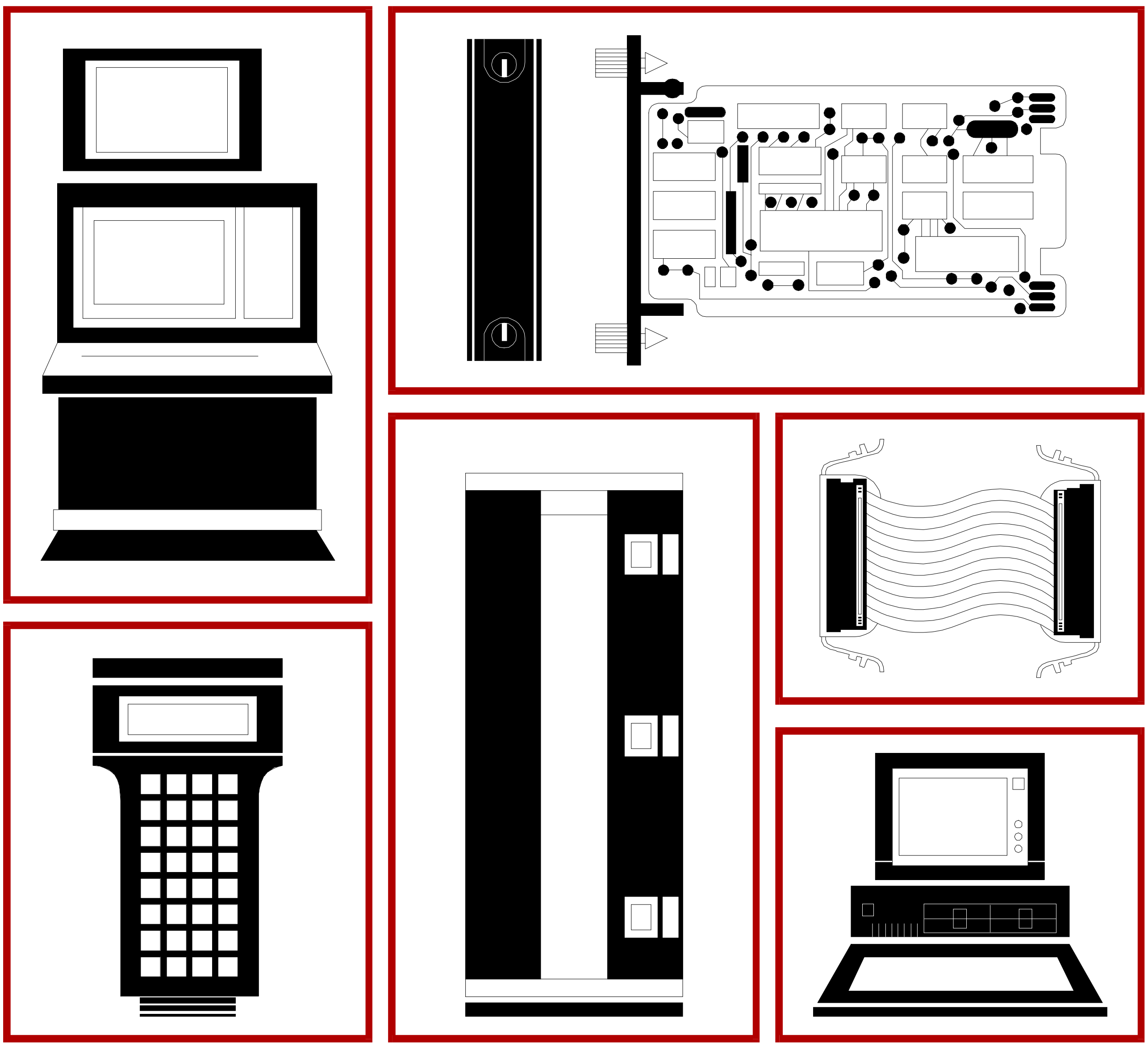
E96-205

Bailey infi 90

Instruction

Analog Master Module and Analog Slave Modules
(IMAMM03 and IMASM01/02/03/04)



Bailey
Process Control and
Automation Solutions
from Elsag Bailey Group

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

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

NOTES highlight procedures and contain information that assists the operator in understanding the information contained in this instruction.

WARNING

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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.

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Preface

The Analog Master Module (IMAMM03) enables the INFI 90 Process Management System to accept up to 64 high level, thermocouple, millivolt or resistive temperature device analog signals from a process. An IMAMM03 requires an Analog Slave Module (IMASM01/02/03/04) to condition and interface process signals. Each Analog Slave Module (ASM) provides a different input capability. A configuration made up of function codes in Analog Master Module (AMM) memory determines the operations an AMM performs on its inputs.

This instruction explains both the AMM and ASM features, specifications and operation. It details the procedures to follow to set up and install an AMM and its associated ASM. It explains troubleshooting, maintenance and module replacement procedures.

The system engineer or technician using the AMM/ASM combination should read and understand this instruction before installing and operating the modules. In addition, a complete understanding of the INFI 90 system is beneficial to the user.

List of Effective Pages

Total number of pages in this instruction is 119, consisting of the following:

Page No.	Change Date
Preface	Original
List of Effective Pages	Original
iii through ix	Original
1-1 through 1-12	Original
2-1 through 2-21	Original
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A-1 through A-10	Original
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C-1 through C-6	Original
Index-1 through Index-3	Original

When an update is received, insert the latest changed pages and dispose of the superseded pages.

NOTE: On an update page, the changed text or table is indicated by a vertical bar in the outer margin of the page adjacent to the changed area. A changed figure is indicated by a vertical bar in the outer margin next to the figure caption. The date the update was prepared will appear beside the page number.

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 insure that contact with energized parts is avoided when servicing. **Equipment Environment** All components, whether in transportation, operation or storage, must be in a noncorrosive environment. **Special Handling** This module uses Electrostatic Sensitive Devices (ESD).

SPECIFIC WARNINGS	Input terminals and circuits of the IMASM02/03/04, NTAI02/03/04, NTTA01 and NIAI02/03 may be at 250 volts. (p. 3-6) Disconnect power before installing dipshunts for slave modules on the MMU backplane (slave expander bus). Failure to do so could result in severe or fatal shock. (p. 3-9)

Sommaire de Sécurité

AVERTISSEMENTS D'ORDRE GÉNÉRAL	**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 perterber le processus controle. **Possibilité de chocs électriques durant l'entretien** Débrancher l'alimentation ou prendre les précautions pour éviter tout contact avec des composants sous tension durant l'entretien. **Environnement de l'équipement** Ne pas soumettre les composants à une atmosphère corrosive lors du transport, de l'entreposage ou l'utilisation. **Precautions de Manutention** Ce module contient des composantes sensibles aux decharges electro-statiques.

AVERTISSEMENTS D'ORDRE SPÉCIFIQUE	La tension aux bornes et circuits d'entrees d'un IMASM02/03/04, NTAI02/03/04, NTTA01 et NIAI02/03 puet etre de 250 V. (p. 3-6) Couper l'alimentation avant d'installer les dipshunts sur la plaque arriere du chassis de montage de modules (MMU). Toute negligence a cet egard constitue un risque de choc pouvant entrainer des blessures graves, voire moretiles. (p. 3-9)

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SECTION 1 - INTRODUCTION

OVERVIEW

The Analog Master Module (IMAMM03) is a microprocessor based INFI 90 module that accepts up to 64 high level, thermocouple, millivolt or Resistive Temperature Device (RTD) analog inputs. Analog Slave Modules (ASM) interface the analog signals directly from process field devices to the Analog Master Module (AMM). These include the IMASM01, IMASM02, IMASM03 or IMASM04. Each slave interfaces a different type of signal (e.g., high level, thermocouple, millivolt or RTD). The INFI 90 Analog Master and Slave Modules are direct functional replacements for corresponding Network 90 Analog Master and Slave Modules.

Function Codes (FC) configured in an AMM are algorithms that define specific functions performed by the AMM. An AMM can be configured to:

- Calculate fifth order polynomial adjustment.
- Calculate square root conversion before Engineering Unit (EU) conversion.
- Calculate square root conversion after EU conversion.
- Provide degree (°C or °F), millivolt, volt or EU values to the INFI 90 system.
- Send real values to an INFI 90 indicator station for display.

It also generates exception reports and alarms, and performs trending, thermocouple linearization and local/remote cold junction compensation.

This manual explains the purpose, operation, calibration and maintenance of analog master and slave modules. It addresses handling precautions and installation procedures. Figure 1-1 illustrates the INFI 90 communication levels, and the position of the AMM and ASM within these levels.

INTENDED USER

System engineers and technicians should read this manual before installing and operating the analog modules. A module should NOT be put into operation until this instruction is read and understood. Refer to the Table of Contents or Index to find specific information after the module is operating.

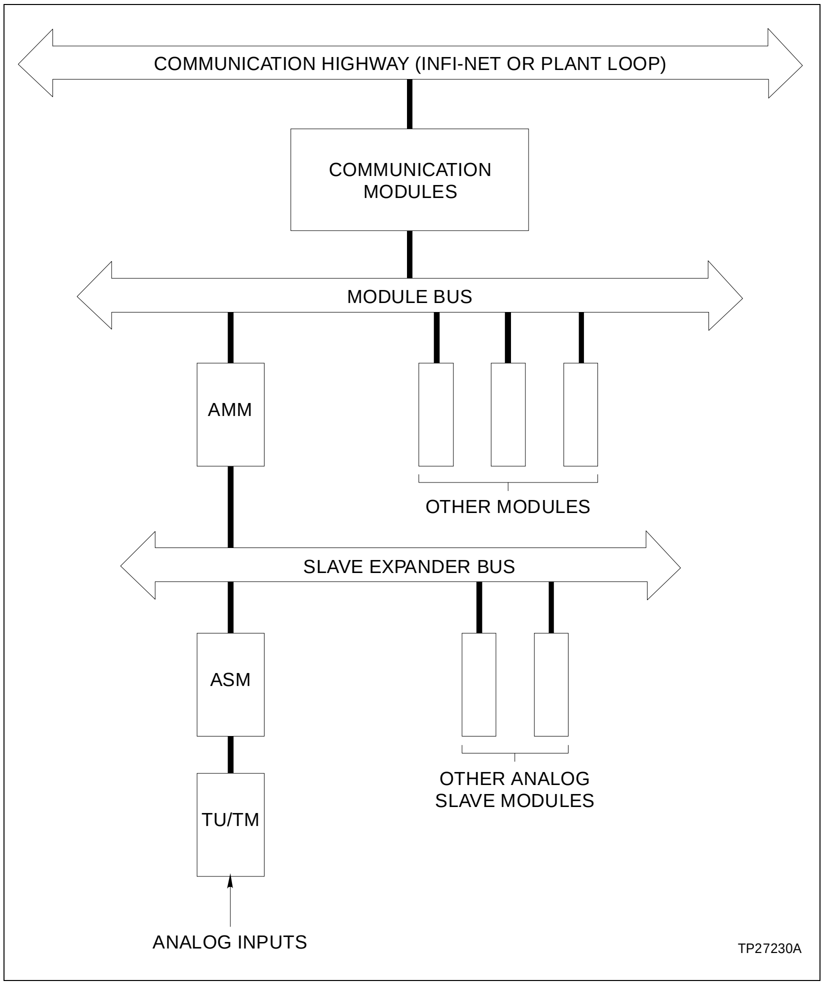


Figure 1-1. INFI 90 Communication Levels

MODULE DESCRIPTION

An AMM requires an ASM to condition and interface process field inputs; it can accept up to 64 individual inputs. To do this, it addresses up to eight separate input groups, each group with eight points. An IMASM01 can interface up to 16 inputs (two groups); an IMASM02, IMASM03 or IMASM04 can each interface up to eight inputs (one group).

The AMM and ASM are single printed circuit boards. Each module occupies one slot in a standard INFI 90 Module Mounting Unit (MMU). Two captive screws on the faceplate of a module secure it to the MMU.

Analog Master Module

The AMM has five front panel LEDs. The top LED indicates the module operating mode (i.e., EXECUTE, CONFIGURE or ERROR), and the remaining four indicate normal operation and error conditions. A module reset switch (S1), accessed through the faceplate, can be used to reset the module circuitry. A hardware configuration switch (S2) sets the module run or diagnostic mode and address.

The AMM has three card edge connectors for external signals and power (P1, P2 and P3). P1 connects to the module bus to provide logic power (+5 VDC and ±15 VDC) to operate the module logic circuits, and to establish communication with other modules (refer to Table 6-5). P2 connects to the slave expander bus to communicate with its slave modules (refer to Table 6-6). P3 cable connects the AMM either directly to a redundant AMM or to a Termination Unit (TU) or Termination Module (TM) (refer to Table 6-7).

Analog Slave Module

High Level ASM

An IMASM01 can input 16 individual 4 to 20 mA, 1 to 5 VDC, 0 to 5 VDC, 0 to 10 VDC or -10 to +10 VDC (high level) analog signals; two groups of eight inputs. Switches (S1 and S2) on the module set the address (0 to 7) for each input group. Jumpers (JP1 and JP2) on the module can be used to disable or enable a group.

NOTE: When used with the NIAI04 Termination Module, the IMASM01 inputs 15 signals.

Thermocouple ASM

An IMASM02 can input eight isolated thermocouple, -100 to +100 mV or 0 to 100 mV analog signals. A single switch (S1) on the module sets the input group address (0 to 7). A front panel LED indicates the module operating status (i.e., calibration or normal operation).

100 Ohm RTD ASM

An IMASM03 can input eight isolated three wire RTD inputs. An address switch (S1) on the module sets the input group address (0 to 7). A front panel LED indicates the module operating status.

10 Ohm Copper RTD ASM

An IMASM04 can input eight isolated three wire 10 ohm copper RTD inputs. Address switch (S1) on the module sets the input group address (0 to 7). A front panel LED indicates the module operating status.

Each slave module has three card edge connectors for external signals and power (P1, P2 and P3). P1 connects to logic power (+5 VDC and ±15 VDC) to operate the module logic circuits (refer to Table 6-8). P2 connects it to the slave expander bus to communicate with an AMM (refer to Table 6-9). A cable connects analog inputs from a TU/TM to P3 of the ASM (refer to Tables 6-10 thru 6-12). The terminal blocks (physical connection points) for field wiring are on the TU/TM.

FEATURES

Modular Design AMM and ASM modular designs allow for flexibility when creating a process management strategy, also easy installation and removal.

Accurate Enables remote/local cold junction temperature compensation. Provides fifth order polynomials to linearize non-standard inputs. Maintains 16 bit A/D resolution with 15 bit guaranteed linearity.

Versatile Can be used in conjunction with four different slave modules to provide a wide variety of input signal processing capability. Handles trending, exception reporting and alarming for up to 64 points.

Adaptable Can input high level, thermocouple, millivolt and RTD signals depending on the ASM being used. This capability allows the INFI 90 system to match the process requirements.

Redundant Operation Redundant operation capability allows a backup AMM to take control during a primary AMM failure. It does this using current process data to ensure uninterrupted INFI 90 processing and control.

Self Diagnosis Performs on-line self tests to verify module integrity and to trigger module security functions. Conducts diagnostics to test module and data integrity, and associated point quality. Front panel LEDs provide a visual indication of module status and mode to aid in system test and diagnosis.

Indicator Stations Supports up to four indicator stations, providing indication for up to 12 points.

Minor Maintenance Other than routine maintenance as defined in the Maintenance section, the AMM and ASM do not require any special maintenance. A module can be removed or installed without powering the system down.

INSTRUCTION CONTENT

This manual consists of nine sections:

Introduction Is an overview of the AMM and ASM: Features, description and specifications.

Description and Operation Explains module operation, input and control circuitry, and configuration function codes.

Installation Describes precautions to observe when handling modules, and setup procedures required before module operation. This section discusses switch and jumper settings, and installation procedures.

Calibration Outlines the steps to follow to calibrate the ASM inputs.

Operating Procedures Explains the front panel indicator, and start-up of the master and slave modules.

Troubleshooting Describes the error indications and corrective actions to take.

Maintenance Has a maintenance schedule for modules and other INFI 90 assemblies.

Repair/Replacement Procedures Details the procedures to replace an AMM and ASM.

Support Services Provides replacement part ordering information. It explains other areas of support that Bailey Controls provides.

HOW TO USE THIS MANUAL

Read this manual through in sequence. It is important to become familiar with the entire contents of this manula before using the AMM and ASM combination. The manual is organized in sections to enable finding specific information quickly.

1. Read and do the steps in the ***INTRODUCTION*** section. Refer to the Appendices while installing the modules.

2. Read and do the steps in the ***CALIBRATION*** section.

3. Refer to the ***OPERATING PROCEDURES*** section to evaluate operating indications.

4. Refer to the ***TROUBLESHOOTING*** section if a problem occurs.

5. Refer to the ***MAINTENANCE*** section for scheduled maintenance requirements.

6. Use the ***SUPPORT SERVICES*** section when ordering replacement parts.

REFERENCE DOCUMENTS

Document Number	Document
I-E93-911	Termination Unit Manual
I-E96-100	Operator Interface Station
I-E93-916	Engineering Work Station
I-E92-501-2	Configuration and Tuning Terminal
I-E93-901-21	Management Command System
I-E93-900-20	Function Code Application Manual

GLOSSARY OF TERMS AND ABBREVIATIONS

Term	Definition
Analog	A continuous time signal with an infinite number of values.
CTT	Configuration and Tuning Terminal; hand held module that provides a local means for system configuration, tuning and diagnostics.
Checksum	The sum of all bytes in memory. Software security checks use this to verify software and hardware integrity.
Configuration	A control strategy with function blocks.
Dipshunt	Dual in-line package with shorting bars.
Dipswitch	A dual in-line package that contains single pole switches.
EWS	Engineering Work Station; an integrated hardware and software personal computer system for configuring and monitoring INFI 90 modules.
Executive	Fixed function block that determines overall module block operating characteristics.
Function Block	A function code located in the user defined memory of a module.
Function Code	An algorithm which defines specific functions. These functions are linked together to form the control strategy.
LED	Light Emitting Diode; the module front panel indicator that shows status and error messages.
LSB	Least Significant Bit; the bit of a binary number that carries the least numerical weight.
Master Module	One of a series of controller modules designed to direct field processes through a slave module. The multi-function processor is an example.
MCS	Management Command System; integrated operator console with data acquisition and reporting capabilities. It provides a window into the process for control and monitoring.
MFT	Machine Fault Timer; reset by the processor during normal operation. If an error is detected, the MFT times out and the module stops.
MMU	Module Mounting Unit; a card cage that provides electrical and communication support for INFI 90 modules.
Module Bus	A peer-to-peer communication path for status and point data transfer between intelligent modules within a process control unit.

Term	Definition
MSB	Most Significant Bit; the bit of a binary number that carries the most numerical weight.
Node	Device(s) on the INFI 90 Plant Loop, Superloop or INFI-NET (maximum of 63 on Plant Loop, 250 on Superloop/INFI-NET). A node can be an Operator Interface Station (OIS), a Process Control Unit (PCU) containing modules or Network Interface Unit (NIU) in any combination.
NVRAM (BATRAM)	Nonvolatile Memory (Battery-backed Memory); retains stored information when power is removed.
OIS	Operator Interface Station; integrated operator console with data acquisition and reporting capabilities. It provides a window into the process for flexible control and monitoring.
PAL	Programmable Array Logic; an integrated circuit that performs logic functions based on a program that is downloaded to it. This program is permanently fixed into the circuit.
PCU	Process Control Unit; rack type industrial cabinet that contains master, slave and communication modules, and their communication paths.
PROM	Programmable Read Only Memory; a memory that can be programmed by electrical pulses. Once programmed, it is read-only.
RAM	Random Access Memory; processor memory that has both read and write capability. This memory is volatile; its contents are lost when power is removed.
Slave Expander Bus	Parallel address/data bus between the master module and the slave that point data and slave status data are exchanged over.
TM	Termination Module; provides input/output connection between plant equipment and the INFI 90 process modules. The termination module slides into a slot in the termination mounting unit.
TU	Termination Unit; provides input/output connection between plant equipment and the INFI 90 process modules. The termination unit is a flat circuit board for panel mounting.

NOMENCLATURE

The following is a list of related hardware.

Nomenclature	Description
Master Module	
IMAMM03	Analog Master Module
I/O Modules	
IMASM01/02/03/04	Analog Slave Module
Station	
NDIS01	Digital Indicator Station (DIS)
Termination Units	
NTAI02/03/04/05	Analog Input
NTAM01	Analog Master
NTTA01	Analog Input Translator
Termination Modules	
NIAI02/03/04	Analog Input
NIAM02	Analog Master
NIAC02/03/04	Analog Calibration
Cables	
NKMP01	IMAMM03 to IMAMM03 (redundant)
NKTU01	IMAMM03 to termination unit
NKTU01	IMASM01/02/03/04 to termination unit
NKTU02/NKTM01	IMAMM03 to termination module
NKTU02/NKTM01	IMASM01/02/03/04 to termination module
NKDS01/02	Termination unit to station
NKTD02	Termination module to station
NKAI01	Termination unit to termination unit
P/N 6634408-4	Termination module to termination module
P/N 1948502A0340	Slave expander bus extender

SPECIFICATIONS

IMAMM03	
Memory	
Random Access Memory (RAM)	24 kbytes
Read Only Memory (ROM)	36 kbytes
Battery-backed Random Access Memory (BATRAM)	6 kbytes
Power Requirements	
Voltage	+5 VDC (±5%) +15 VDC (-2.5%, +5%) -15 VDC (+2.5%, -5%)
Current (maximum)	825 mA (+5 VDC) 150 mA (+15 VDC) 40 mA (-15 VDC)
Power Dissipation (maximum)	4.13 watts (+5 VDC) 1.88 watts (+15 VDC) 0.45 watts (-15 VDC)
Inputs (maximum)	64 from up to 4 IMASM01 or 8 IMASM02/03/04
Type	High level (refer to IMASM01) Thermocouple (refer to IMASM02) Millivolt (refer to IMASM02) RTD (refer to IMASM03) RTD, 10 ohm copper (refer to IMASM04)
Input Span	-10 to +10 VDC
Common Mode Voltage Range	±5 VDC (maximum)
Common Mode Rejection	
With IMASM01	-54 db, ±5 VDC (maximum) -75 db, ±50 VAC at 60 HZ (peak)
With IMASM02	-100 db, ±250 VDC (maximum) -120 db, ±250 VAC at 60 HZ (peak)
With IMASM03/04	-105 db, ±250 VDC (maximum) -120 db, ±250 VAC at 60 HZ (peak)
Normal Mode Rejection	
With IMASM01/02/03/04	-80 db at 60 HZ
Input Impedance	>10 Mohm
Accuracy (at 25°C (77°F))	
Not including slave accuracy	±0.01% of span (typical) ±0.025% of span (maximum)
Including slave accuracy	
IMASM01	0.1% of allowable input span
IMASM02/03/04	0.05% of 200 mV input span using an external calibration source.

IMAMM03 (continued)	
Accuracy (at 25°C (77°F)) (continued)	
Not including slave accuracy	±0.01% of span (typical) ±0.025% of span (maximum)
Including slave accuracy IMASM01	 0.1% of allowable input span
IMASM02/03/04	0.05% of 200 mV input span using an external calibration source.
IMASM02/03/04	0.05% of 200 mV input span using an external calibration source.
IMASM02/03/04	0.125% of 200 mV input span using the internal calibration source
Cold Junction Accuracy Aging Effect Temperature Effect	0.5°C (0.9°F) 0.025%/year ±0.00035%/°C (±0.00019%/°F)
A/D Resolution	16 bits
Guaranteed Linearity	15 bits
Cross Talk	
With IMASM01 With IMASM02/03/04	-100 db (typical), -65 db (minimum) -85 db (typical), -65 db (minimum)
IMASM01	
Power Requirements	
Voltage	+5 VDC (±5%) +15 VDC (-2.5%, +5%) -15 VDC (+2.5%, -5%)
Current (maximum)	110 mA (+5 VDC) 80 mA (+15 VDC) 40 mA (-15 VDC)
Power Dissipation (maximum)	0.055 watts (+5 VDC) 1.2 watts (+15 VDC) 0.06 watts (-15 VDC)
Inputs	16 high level
Voltage	1 to 5 VDC 0 to 5 VDC -10 to +10 VDC 0 to +10 VDC
Current Resistance Normal mode rejection Common mode voltage Common mode rejection	4 to 20 mA >1 Mohm -60 db at 60 HZ ±5 V -50 db at 60 HZ
Termination	NTAI05, NIAI04

IMASM02	
Power Requirements	
Voltage	+5 VDC (±5%) +15 VDC (-2.5%, +5%) -15 VDC (+2.5%, -5%) +24 VDC (+12%, -10%) (from TU/TM)
Current (maximum)	400 mA (+5 VDC) 80 mA (+15 VDC) 45 mA (-15 VDC) 5 mA (+24 VDC)
Power Dissipation (maximum)	2.0 watts (+5 VDC) 1.2 watts (+15 VDC) 0.7 watts (-15 VDC) 0.015 watts (+24 VDC)
Inputs	8 low level
Thermocouple	E, J, K, R, S, T OR Chinese E, S
Millivolt	-100 to +100 mVDC 0 to +100 mVDC
Resistance	200 Kohm
Normal mode rejection	-80 db at 60 HZ (minimum)
Common mode voltage	±250 V (maximum)
Common mode rejection	-120 db at 60 HZ (minimum)
Termination	NTAI02, NTTA01, NIAI02
IMASM03	
Power Requirements	
Voltage	+5 VDC (±5%) +15 VDC (-2.5%, +5%) -15 VDC (+2.5%, -5%) +24 VDC (+12%, -10%) (from TU/TM)
Current (maximum)	400 mA (+5 VDC) 80 mA (+15 VDC) 45 mA (-15 VDC) 5 mA (+24 VDC)
Power Dissipation (maximum)	2.0 watts (+5 VDC) 1.2 watts (+15 VDC) 0.7 watts (-15 VDC) 0.015 watts (+24 VDC)
Inputs	8 RTD
Types	100 ohm, Platinum, IPTS 68 100 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

IMASM03 (continued)	
Inputs (continued) Normal mode rejection Common mode voltage Common mode rejection	 -80 db at 60 HZ (minimum) ±250 V (maximum) -120 db at 60 HZ (minimum)
Termination	NTAI03/04, NIAI03
IMASM04	
Power Requirements	
Voltage	+5 VDC (±5%) +15 VDC (-2.5%, +5%) -15 VDC (+2.5%, -5%) +24 VDC (+12%, -10%) (from TU/TM)
Current (maximum)	400 mA (+5 VDC) 80 mA (+15 VDC) 45 mA (-15 VDC) 5 mA (+24 VDC)
Power Dissipation (maximum)	2.0 watts (+5 VDC) 1.2 watts (+15 VDC) 0.7 watts (-15 VDC) 0.015 watts (+24 VDC)
Inputs Normal mode rejection Common mode voltage Common mode rejection	8 RTD, 10 ohm Copper -80 db at 60 HZ (minimum) ±250 V (maximum) -120 db at 60 HZ (minimum)
Termination	NTAI04, NIAI03
Mounting	
Each module occupies one slot in a standard INFI 90 Module Mounting Unit.	
Environmental	
Ambient Temperature	0° to 70° C (32° to 158° F)
Relative Humidity	0% to 95% up to 55° C (131° F) (noncondensing) 0% to 45% at 70° C (158° F) (noncondensing)
Altitude	Sea Level to 3 Km (1.86 miles)
Air Quality	Noncorrosive
Certification	
CSA certified for use as process control equipment in an ordinary (nonhazardous) location.	

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

SECTION 2 - DESCRIPTION AND OPERATION

INTRODUCTION

This section explains the functions, module circuitry (block diagram), data and connections for the Analog Master Module (AMM) and its associated Analog Slave Modules (ASM). It also details the function codes available to configure an AMM.

ANALOG MASTER MODULE

An IMAMM03 enables the INFI 90 system to accept up to 64 high level, millivolt, thermocouple and Resistive Temperature Device (RTD) analog signals from a process. Refer to the individual ASMs described later in this section for the voltage and current ranges, and thermocouple and RTD types the AMM can process.

Module Functions

Depending on the configuration, an AMM can convert analog inputs to degree (°C or °F), millivolt, volt or Engineering Unit (EU) values, which are available to requesting INFI 90 devices (i.e., master modules or operator interfaces). It generates exception reports and alarms, and performs trending, thermocouple linearization and local/remote cold junction compensation. A configuration loaded into module memory determines the conversion and calculations (e.g., polynomial adjustment or square root) to be performed on each input.

If configured, up to 12 input values can be sent over a station serial link to Indicator Stations (NDIS01) for display. The AMM drives a serial link that supports up to four indicator stations, each displaying up to three values.

Process field devices connected directly to Termination Units (TU) or Termination Modules (TM) provide the input signals. An ASM must be used to interface and condition process signals sent to an AMM from a TU/TM. The AMM controls the input selection. These slave modules are discussed later in this section.

Calibrations must be performed to establish values the AMM uses to correct for minor variations in hardware, time and temperature. AMM circuits use a calibration configuration to determine correction values, and store the values in memory. It combines these values with lead wire resistances to adjust for errors caused by thermocouple and RTD field wiring. The AMM provides an internally generated calibration signal. A TU/TM uses this signal to develop references that can be used to calibrate a thermocouple slave module. An external source can be used in place of the internal reference. Refer to Section 4 for further explanation and procedures for performing calibrations.

A redundant (backup) AMM can be configured and installed to provide control if a primary AMM fails. This secondary AMM communicates with a primary over a serial link. From data continuously received over the link, the secondary contains the same configuration, data and operating mode as the primary. This allows it to provide uninterrupted control using current process data during a primary module failure.

An INFI 90 device communicates with an AMM over a serial module bus as shown in Figure 1-1. Each module on the module bus has a unique address set by its address dipswitch. Messages are directed to the AMM using this address.

Module Block Diagram

An AMM is a stand alone INFI 90 module. It contains all control circuitry required to receive analog input signals from its slave modules, convert the signals to digital values and transmit these values, and other data, in messages when requested.

Figure 2-1 is a block diagram of the AMM that illustrates signal flow through the module. An explanation of the functions performed by each block follows.

CONTROL LOGIC

A Central Processing Unit (CPU) controls the AMM memory, I/O circuitry, serial interfaces and Machine Fault Timer (MFT). It does this using a configuration loaded into nonvolatile memory (NVRAM) and routines permanently stored in ROM.

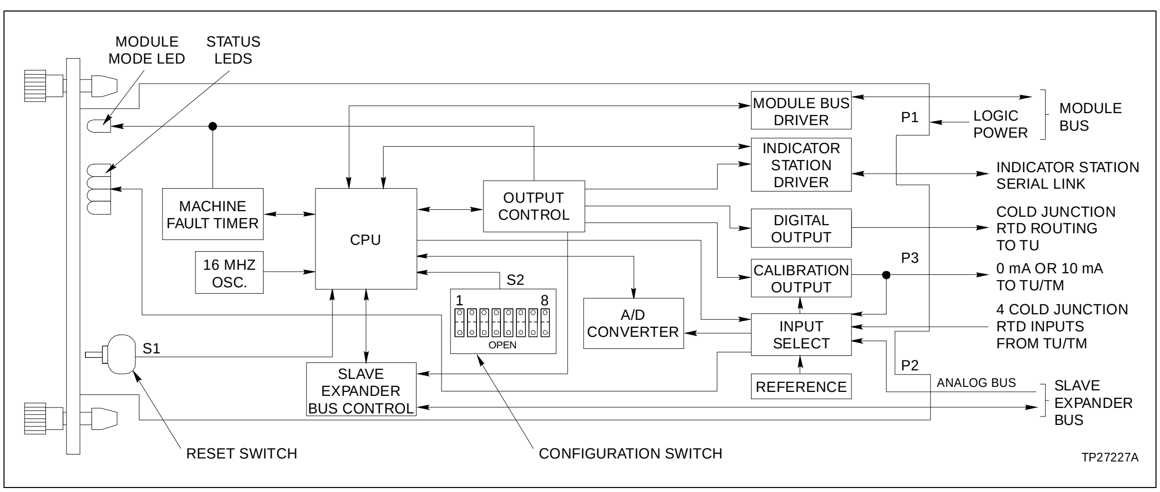


Figure 2-1. Analog Master Module Block Diagram

Central Processing Unit

The CPU block consists of an eight bit microprocessor, support circuits and memory; it is the heart of the module. The microprocessor controls all AMM functions through support circuits. These include:

- Processor Support.
- Module Bus Interface.
- Programmable Array Logic (PAL).
- Universal Asynchronous Receiver/Transmitter (UART).
- Memory (Static RAM, PROM and NVRAM).

An eight bit bidirectional data bus and 16 bit address bus connect the different components. A variety of signals direct the operation of the module circuits.

Processor Support Circuit

The processor support circuit is a custom integrated circuit (IC) that:

- Generates internal chip and external AMM clocks.
- Performs Indicator Station (NDIS01) interface.
- Controls Digital to Analog (D/A) converter functions.
- Generates processor interrupts.
- Allows Direct Memory Access (DMA) activity.
- Provides status and control registers.

The IC also decodes microprocessor address inputs to generate signals to:

- Reset the MFT.
- Read module address.
- Read miscellaneous buffers.
- Write to miscellaneous latches.

Refer to ***Machine Fault Timer*** in this section for an explanation of MFT.

Module Bus Interface

The module bus interface circuit is a custom IC. This IC contains all control logic and communication protocol to perform module bus interface functions. The functions it performs are:

- Automatic address detection and comparison.
- Module bus data buffer.
- Serial to parallel conversion of module bus serial input data.
- Parallel to serial conversion for AMM data sent on the module bus.
- Module bus control.
- Address decoding for internal functions.
- Slave clock (1.56 KHZ) generation.

PAL A PAL circuit provides memory mapping functions. It decodes address inputs from the microprocessor to generate signals to select the different memory devices:

- PROM
- RAM
- NVRAM
- UART

It also selects module bus interface and processor support circuit functions, clocks data to the output control block to enable output functions (e.g., serial link), and clocks slave address data to the slave expander bus control block.

UART The microprocessor uses a UART to direct data transfer between it and a redundant AMM (primary or secondary). The UART receives parallel data from the microprocessor and converts it to serial data that it sends to the redundant serial link driver block. It also performs serial to parallel data conversion on data received serially from the driver block.

Memory CPU memory is a 36K PROM, 24K RAM, and 6K NVRAM. A static RAM provides read and write capability to store values while the microprocessor performs its calculations. A PROM contains preprogrammed, read only, microprocessor executable code. The microprocessor reads this code to perform frequently used routines. Once loaded, the NVRAM holds the module configuration; this is nonvolatile memory.

The module configuration is function codes placed in function blocks (i.e., defined memory locations) that define specific algorithms performed by the module. This configuration is loaded into memory using an operator interface (e.g., Engineering Work Station, Configuration and Tuning Terminal, Management Command System or Operator Interface Station). Refer to *CONFIGURATION* in this section for a description of available AMM function codes.

16 MHZ Oscillator

The processor support and module bus interface circuits use an on board 16 MHZ crystal oscillator input to develop required internal and external clocks.

Hardware Configuration Switch

The hardware configuration switch (S2) sets the module operating mode and address. A buffer holds the values set on switch S2. The CPU reads eight bits of information from the buffer that correspond to the eight S2 dipswitch positions. During normal operation, positions 1 thru 3 (bits 6 thru 8) determine the AMM operating state, and positions 4 thru 8 (bits 1 thru 5) set the AMM address. The address can be one of 32 addresses (0 to 31). The three LSB define:

- Normal (or secondary AMM) mode.
- Configuration lock.
- Initialize NVRAM.
- Inhibit checksums.
- Primary AMM mode.
- Diagnostics mode.

Refer to Section 3 for S2 switch settings.

I/O LOGIC

The I/O logic circuits use data from the microprocessor to enable and select ASM inputs, and control serial links, interface circuits and output circuitry.

Input Select

The input select block consists of a latch register and two analog multiplexers. The data received and latched by the data latch register specifies which input the multiplexers select. It also enables the calibration output and lights the four front panel module status LEDs. The processor support circuit controls this data latch. Inputs selected by the multiplexers are either an analog signal from an ASM or calibration signals. Refer to Section 5 and Section 6 for an explanation of the LED states.

An AMM analog input is one of 64 possible addressable field inputs from its slave modules. An ASM conditions field inputs, and interfaces an input when the AMM addresses it. Depending on the ASM used, it converts millivolt, thermocouple and RTD inputs to high level signals. Once addressed, an ASM sends an input signal over an analog bus.

The analog bus is two lines of the slave expander bus dedicated for routing selected analog input signals to the input select block. Only one input signal can be sent on this bus at a time.

Calibration signals are:

- Four RTD cold junction signals from a thermocouple TU/TM.
- Calibration output feedback.
- +10 VDC reference (generated on board AMM).
- 0 VDC reference.

RTD Inputs

The RTD inputs are thermocouple slave cold junction compensation signals from RTD pairs mounted on a TU/TM. The CPU uses these signals to compensate for temperature variations at the cold junctions (TU/TM).

Calibration Output Feedback

The multiplexer selects the calibration output feedback signal to verify the calibration signal being sent to a Thermocouple Slave Module (IMASM02); refer to ***Calibration Output*** in this section.

+10 VDC/0 VDC Reference

The reference block generates an accurate +10 VDC signal. An AMM can select this voltage and the 0 VDC input to verify A/D converter circuits, and to perform internal calibrations. The AMM will go to error mode if the reference is out of tolerance.

Output Control

The output control block is a latch register that provides several enable signals to different functions of the AMM. From data received, it enables:

- 1.56 kHZ slave expander bus clock output.
- Digital output.
- Master status serial link output.
- Indicator station serial link output.
- Green module mode LED.

It also provides control signals to address NVRAM memory locations and enable writing data to NVRAM.

Slave Expander Bus Control

The slave expander bus control block consists of a latch register, PAL and bus clock driver circuits. A latch register latches signals to the bus to enable the slave modules, and to select a slave module and one of its input channels.

Six binary address bits are latched to the bus. The first three bits are the input channel number (1 to 8), the second three are the slave address (1 to 8). A slave module sends an acknowledge signal after it decodes an address. The AMM uses this signal to verify that a slave module exists on the slave expander bus with the latched address.

The module bus interface circuit generates a 1.56 KHZ, open collector clock. A bus clock driver circuit drives this clock to synchronize slave modules (IMASM02/03/04) connected to the bus.

A PAL provides the bus clock control functions. It enables or disables the bus clock and checks the clock status. In redundant mode, the primary AMM generates the bus clock. If an INFI 90 system contains more than one AMM in the same cabinet, the system must be configured so only one AMM drives the bus clock for all ASMs in the cabinet. This synchronizes the ASMs to prevent drift resulting from cross talk. Once the system is configured, a PAL circuit on each AMM tests a clock status signal to determine which module will drive the clock. The clock master is automatically identified at system start-up. An AMM with the highest address will take control of the clock causing the other modules to disable their clocks.

NOTE: If an AMM that is driving the bus fails, the AMM with the next highest address provides the clock.

A *time out* will cause the PAL to disable the clock. The output control block provides the clock enable signal to the PAL. Refer to ***Machine Fault Timer*** in this section for an explanation of *time out*.

INPUT CIRCUITS

The A/D converter block consists of input buffer and amplifier circuits, and a Digital to Analog (D/A) converter, preamplifier and comparator. These circuits are capable of converting a -10 VDC to +10 VDC input signal from an ASM.

Buffer circuits convert a differential input voltage from the input select block to a single ended voltage. An amplifier then inverts and amplifies the voltage, which is sent to the D/A converter.

The AMM uses a 16 bit successive approximation technique to determine the digital value of the input voltage. To do this, it sends a digital value to the D/A converter, which it converts to a current output. A preamplifier sums this D/A current output and the selected input signal. The summed signal is sent to a comparator. The CPU reads the comparator output through a buffer to determine if the D/A output signal is less than or greater than the analog input. The CPU sends a new digital value, and repeats this operation until it zeros in on the actual input signal value, providing 15 bit guaranteed linearity.

COMMUNICATION SERIAL LINK DRIVER CIRCUITS

An AMM communicates with other modules on a serial module bus. It can also communicate with indicator stations and a redundant AMM over dedicated communication links. Driver circuits drive these serial links.

Module Bus Driver

The module bus driver block consists of driver and buffer circuits. These circuits receive and transmit serial module bus data messages. They provide an interface between the module bus and module bus interface circuits. These circuits buffer and drive any data entering or leaving the AMM on the module bus. The AMM receives commands in messages and responds to them, but does not initiate messages. Refer to ***MODULE BUS*** in this section for an explanation of the module bus.

Indicator Station Driver

An AMM sends data serially to an Indicator Station (NDIS01) over a 5 kbaud serial link. It uses an RS-422 transmitter in the indicator station driver block to send data to a station. Up to four stations, each displaying up to three values, can be daisy chained from this serial link. Each station can be up to 400 feet from the AMM. Refer to Product Instruction I-E93-904-2A for further information on the indicator station.

Redundant Serial Link Driver

A 31.25 kbaud serial redundancy link connects a primary AMM and a secondary (redundant) AMM. During normal operation, the primary AMM controls all analog input operations.

The redundant serial link driver block consists of a RS-422 driver and receiver. The RS-422 driver transmits serial data from the CPU on the serial link, and a RS-422 receiver receives and directs data to the CPU.

OUTPUT CIRCUITS

The AMM generates two outputs. A single digital output for cold junction RTD signal routing and a calibration output.

Digital Output

An AMM provides one 250 mA, optically isolated, open collector digital output. This output enables a relay on a NTAM01 to direct the cold junction RTD inputs from a thermocouple slave TU to the primary AMM in a redundant pair. The primary AMM energizes this output.

> **NOTE:** A dipswitch on an NIAM02 determines the cold junction RTD signal routing when using termination modules.

Calibration Output

The calibration output block generates a 0 mA or 10 mA current to calibrate a thermocouple slave module. Resistors on a thermocouple TU/TM develop a 0 mV or 100 mV internal calibration voltage using this output. An external source can be used in place of the internal calibration voltage. Refer to Section 4 in this manual for internal and external calibration procedures.

MACHINE FAULT TIMER BLOCK

A Machine Fault Timer (MFT) generated on board the AMM is a security feature common to all microprocessor based INFI 90 modules. The MFT is a one-shot timer that is reset periodically by the CPU. A *time out*:

- Clears the output control register.
- Disables the slave expander bus clock.
- Resets the processor support circuit.
- Resets the module bus interface circuit.
- Resets the microprocessor.

NOTE: A *time out* does not affect a configuration stored in NVRAM.

Refer to ***Machine Fault Timer*** in this section for further explanation.

Redundant Operation

Each module in a redundant pair generates a Master Status Out (MSO) and receives it as a Master Status In (MSI). An AMM tests the quality of this signal to determine its operating role (i.e., primary or secondary) in a redundant pair. If the role cannot be established from the master status message, the configuration switch (S2) setting is a final test to determine whether an AMM will operate as a primary or secondary AMM. The address set on S2 must be the same for both modules in the pair.

After the primary initializes, it attempts to establish communication with a secondary AMM. Once established, the primary sends data to the secondary to set its operating mode (e.g., EXECUTE or CONFIGURE) to match the primary. In CONFIGURE or ERROR mode, the primary sends a status check message every second to keep the secondary on-line. In EXECUTE, the primary copies its configuration to the secondary; it also sends the current trend data and cold junction data. Once the primary has verified the data in the secondary, the secondary is ready to takeover using current process data if the primary fails. Refer to Section 5 for an explanation of the different operating modes.

If a primary AMM fails, the secondary will not receive MSI, and will attempt to establish communication with the primary. If communication cannot be established within a set time, the secondary assumes the primary control.

The group of four status LEDs on the module face plate indicate the primary and secondary AMM status. Refer to Section 5 to determine the indications.

NOTE: A primary and redundant AMM must be the same firmware revision.

Module Bus Data

An AMM receives messages from several different INFI 90 devices: Master modules, operator interfaces or communication modules. These messages, sent to an AMM, are data requests and configuration information. During normal operation, the AMM responds to four types of messages:

- Data transfer.
- Module status.
- Exception report.
- Configuration and tuning.

These messages allow other INFI 90 devices to access AMM data and functions.

Data transfer messages trigger point (input) data and trend data reply messages from an AMM. A status message triggers status data replies. The AMM generates exception reports to provide point data to other nodes on the INFI 90 communication loop. Configuration and tuning messages provide the ability to manipulate AMM configurations. Function codes can be configured in a master module to access an analog input.

Configuration and tuning messages manipulate AMM configurations. Blocks within a configuration can be added, modified, tuned, monitored or deleted. A configuration and tuning message can also be used to initialize the AMM NVRAM prior to downloading a configuration. Refer to the Function Code Manual I-E93-900-20 for more information on function codes and configurations.

The AMM receives commands and responds to messages but does not initiate them. Before executing a command, the AMM performs consistency checks to determine if a message is valid. The type of message and number of bytes must conform to standard transaction formats.

The AMM also responds to other messages including:

- System troubleshooting messages.
- DEBUG messages.

POINT DATA

Point (input) data values can be read from an AMM using a master module or operator interface (e.g., Configuration and Tuning Terminal (CTT)). When a point value is requested, the AMM sends a three byte point report. This report contains the point type, status and value.

The point type designates it as an analog point. A point status byte contains:

- Point quality (good or bad).
- Alarm state (normal, low or high).
- Deviation alarm state (normal, low or high deviation).
- Calibration quality flag (normal or correction values out of range).
- Point disabled flag (normal or point being serviced.
- Point tracking (normal or tracking).

The AMM sends a REAL-2 (1.0 E-03 to 4.0 E 06) or REAL-3 value (2.7 E -20 to 9.2 E 18) for the requested input point.

STATUS DATA

Status data can be read to determine the current operating status of an AMM. After receiving a status request, the AMM responds with five bytes of status information. Refer to Section 6 for a definition of these bytes.

Circuit Connections

An AMM has three card edge connectors that provide external signal connection points (P1, P2 and P3). Figure 2-1 shows the location of these connectors.

P1 P1 is a 12 pin edge connector that connects logic power (+5 VDC and ±15 VDC) from the module bus to drive the AMM logic circuits. It also connects the module bus interface circuits to the module bus.

NOTE: P1 also connects the system Power Fail Interrupt (PFI).

P2 P2 is a 12 pin edge connector that connects the slave expander bus interface circuits to the slave expander bus. This routes the bus clock, address and enable signals to ASMs, and a clock status signal from the bus. It also connects the input select circuits to the analog bus to provide an analog input signal path.

P3 P3 is a 30 pin edge connector that connects the redundancy link interface circuits directly to a redundant AMM, or to an analog master TU/TM to route:

- Four cold junction RTD inputs.
- Calibration output signals.
- Digital output signals.
- Indicator station serial link.
- Master status signals and data.

Cables connect an AMM to a redundant AMM or analog master TU/TM. Refer to Appendix A for cable connections.

Machine Fault Timer

The MFT is an AMM security feature that shuts the module down if an error condition exists. The MFT is a one-shot timer that is periodically reset by the microprocessor. This reset prevents the timer from timing out. If an AMM error condition exists that causes the microprocessor to fail or operate incorrectly, the MFT will not be reset and will time out to shut the module down (*time out*). If it is not a hardware failure, it can be reset on power up or by the manual reset switch accessed through the module faceplate.

The AMM performs a series of on-line tests to verify module circuit integrity. If any of these tests fail, a *time out* occurs. The microprocessor can detect certain conditions that cause a *time out*:

- Configuration error (undefined reference or data type conflict).
- Power failure or reset during an NVRAM write.
- Excessive analog input gain or offset error.

If a *time out* occurs, the AMM will not respond over the module bus and the front panel module status LED lights red.

> **NOTE:** If a *time out* occurs, the configuration in NVRAM will not be affected. Any configuration loaded before the *time out* will be saved in memory.

On-line Tests

When the AMM is first installed or after a reset, it conducts on-line self tests to verify that its logic circuitry is operating properly.

RAM Test A RAM test is run that consists of writing data to RAM, and then comparing the data in RAM to the data that was written. If this test fails, the microprocessor stops resetting the MFT causing a *time out*.

PROM Test A PROM test computes a checksum of PROM memory locations. It then compares this checksum with a known checksum. If they do not match, the microprocessor stops resetting the MFT until a *time out* occurs.

If all tests pass, the AMM initializes all RAM memory locations.

> **NOTE:** The configuration switch (S2) can be set to inhibit a *time out* caused by a PROM checksum error. The AMM will continue to operate even if a checksum error occurs. This is set for troubleshooting purposes ONLY.

Status LED Indicators

A single front panel module status LED indicator shows the current operating mode of the AMM. A group of four status LEDs indicate error conditions and redundant AMM operation. Figure 2-1 shows the location of these LEDs. Circuits on the AMM determine the module status and light the LEDs accordingly. Section 5 explains the indications and Section 6 explains corrective actions to take.

ANALOG SLAVE MODULE

Analog Slave Modules (ASM) condition and interface process analog input signals for an AMM. There are four versions to provide the AMM with the variety of analog inputs it is capable of processing: IMASM01, IMASM02, IMASM03 and IMASM04. Each provides a different input capability.

Module Functions

An AMM communicates with an ASM over the slave expander bus. To select an input, an AMM latches a slave enable signal and a six bit address to the bus. Three bits of the address are the group number (module address), and the remaining three are the input point number. An AMM can address up to eight groups (addresses 0 thru 7), and up to eight points per group giving an input capability of up to 64 signals. An IMASM01 provides two groups of inputs (16 inputs), and the IMASM02/03/04 each provide one group (eight inputs).

After receiving an enable and decoding an address, an ASM replies with an acknowledge and multiplexes the requested, conditioned analog signal to the analog bus. Refer to ***SLAVE EXPANDER BUS*** in this section for an explanation of the analog bus. An AMM uses the acknowledge to verify that an ASM exists with the latched address.

A 1.56 kHZ clock, enabled by the AMM, synchronizes ASMs (IMASM02/03/04 only) connected to the slave expander bus. An AMM *time out* disables this clock, and disables the slave module inputs.

An ASM (except IMASM01) converts a low level (i.e., millivolt, thermocouple or RTD) input to a high level (-10 VDC to +10 VDC) signal: IMASM02 converts a millivolt or thermocouple input, an IMASM03 and IMASM04 convert a RTD input. This is required to change the input signal levels to levels the AMM can process. Low level slaves require calibration; refer to Section 4.

High Level Analog Slave Module Block Diagram

An IMASM01 interfaces up to 16 high level, analog input signals. A high level input is 0 to 5 VDC, 1 to 5 VDC, 0 to 10 VDC or -10 VDC to +10 VDC. All inputs within these signal ranges can be interfaced directly to an AMM, and do not require conditioning by the ASM. This module provides the input selection capability to the AMM. It does not require calibration.

Two separate sets of input circuits, each with its own address, allow the ASM to input two groups of eight signals. Each set of input circuits has its own address switch to set its group address. Each set also has a jumper to enable or disable the input group. Up to four IMASM01 modules can be used with a single AMM.

Figure 2-2 is a block diagram of the IMASM01.

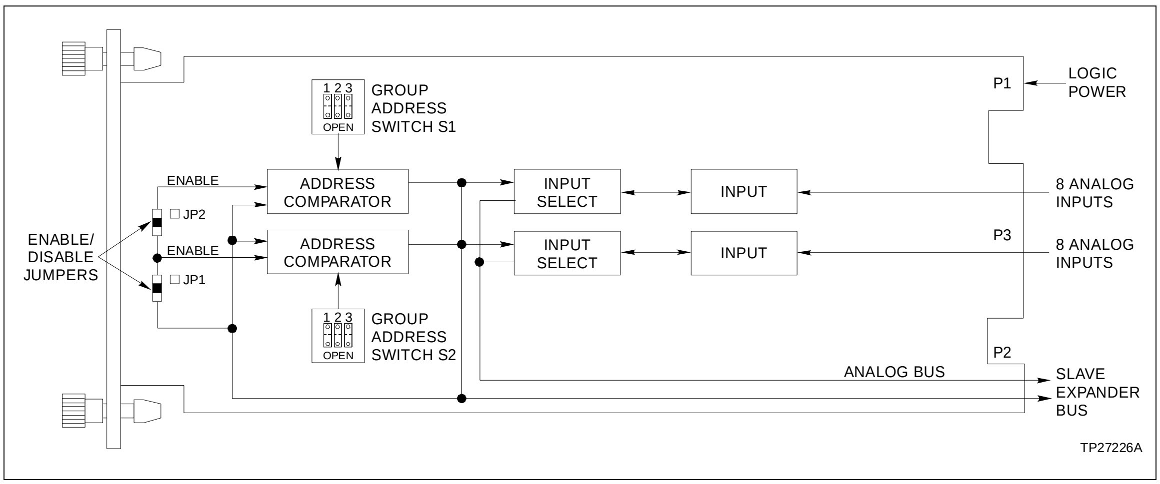


Figure 2-2. IMASM01 Block Diagram

ADDRESS COMPARATOR

The comparator block receives the three bit group address latched by the AMM from the slave expander bus. After latching the address, the AMM sends an enable signal to enable all slaves (i.e., comparators). A bit comparator in the address comparator block receives the latched address, and compares it to the address set on the group address switch (S1 or S2). If there is a match, the comparator sends an enable signal to the input select block. An AMM also receives this signal to acknowledge that an ASM exists with the latched address. If the address from the AMM does not match, the slave ignores the address.

Two separate addresses can be set on this ASM. If one of the groups has no inputs, the jumper for that input group should be configured to disable the group. In the disable position, connection between the enable signal from the bus and the comparator is open to disable address comparison. This prevents possible dual address problems.

INPUT SELECT

The input select block receives the three bit point address latched by the AMM from the bus. After an enable from the comparator, an analog multiplexer in the input select block decodes the point address to select one of eight inputs. The multiplexer then outputs the selected analog signal on the analog bus.

INPUT

The input block consists of eight sets of input filtering circuits. An associated TU/TM directs the process field signals to each of the input channels through cables.

Filtering circuits reduce input signal noise. They provide 60 db of normal mode rejection, and 50 db of common mode rejection.

Low Level Analog Slave Block Diagram

An IMASM02/03/04 interfaces up to eight low level, analog input signals. Low level inputs are:

- -100 to +100 mV, 0 to 100 mV or thermocouple (IMASM02).
- 3-wire 100 ohm RTD (IMASM03).
- 3-wire 10 ohm copper RTD (IMASM04).

The different types of input capabilities of each of these ASMs results from differences in the input and amplifier circuits. Each of these modules is functionally the same. The address comparator and input select blocks function exactly the same as the IMASM01.

Calibrations must be performed when using IMASM02/03/04 slave modules. An AMM compensates for ASM initial offset and gain errors by using values derived during calibration procedures. These modules also provide the input selection capability to the AMM.

Each of these slave modules can input eight signals (one group). An address switch (S1) sets the address for the input group. A single AMM supports up to eight IMASM02/03/04 modules.

Figure 2-3 is a block diagram of the IMASM02/03/04.

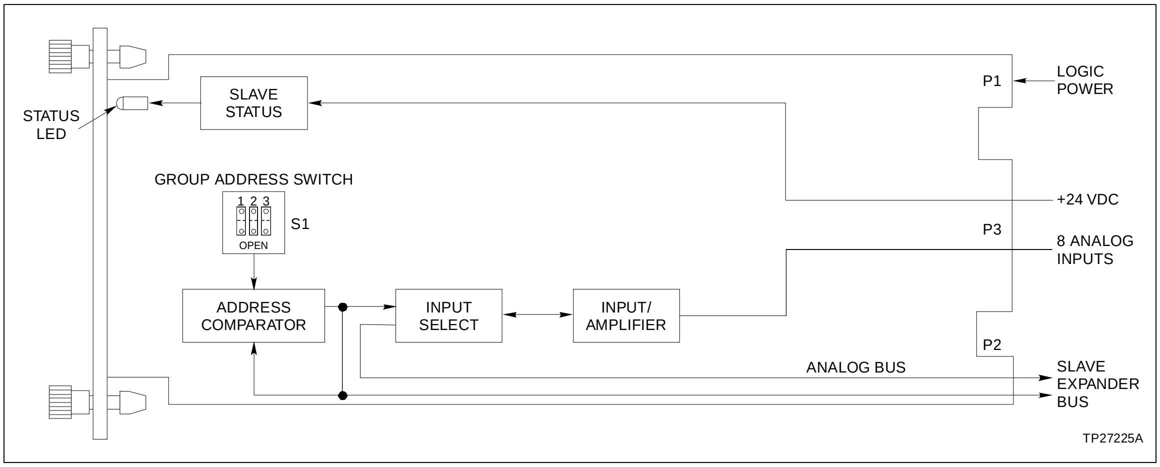


Figure 2-3. IMASM02/03/04 Block Diagram

INPUT/AMPLIFIER

The input/amplifier block is eight separate sets of isolated input, driver, and demodulator and amplifier circuits. Transformers between the different circuits isolate each input channel from other channels and system power.

The input circuits filter and chop an input so it can be sent to the demodulator and amplifier circuits through a transformer. These circuits provide 80 db of normal mode rejection and 120 db of common mode rejection to reduce input signal noise.

The RTD slave modules use a resistance bridge network to detect small changes in temperature. The input circuits filter and chop the output of this bridge. Three wire connection provides cancellation of most of the cable resistance error caused by remote RTD locations. Using cable length to the TU/TM and lead wire resistance entered into the module configuration corrects for the remaining error.

The driver circuits provide operating power to the input circuits. This power is taken though a transformer to isolate the inputs from the INFI 90 system. These circuits use the 1.56 kHZ clock and a regulated voltage to enable and drive the input circuits.

The demodulator converts a chopped signal to a DC voltage. This voltage is amplified and directed to the analog multiplexer. If selected, it is output to the analog bus.

SLAVE STATUS

The slave status block uses +24 VDC from a TU/TM to determine the state of the red/green slave status LED. When the termination cable is connected to the normal operating socket on a TU or the ASM is in its normal operating slot when using TMs, +24 VDC connects to the status circuitry to light the front panel LED green. When this cable is connected to the calibration socket or is disconnected, +24 VDC connection is open causing the status circuits to light the LED red.

Circuit Connections

An ASM has three card edge connectors that provide external signal connection points (P1, P2 and P3). Figures 2-2 and 2-3 show the location of these connectors.

P1 P1 is a 12 pin edge connector that connects logic power (+5 VDC and ±15 VDC) to drive the ASM circuits.

P2 P2 is a 12 pin edge connector that connects to the slave expander bus. This routes the bus clock, address and enable signals from an AMM. It also connects the input select circuits to the analog bus to provide an analog input signal path.

P3 P3 is a 30 pin edge connector that connects the ASM input circuits to a TU/TM. A cable routes the field input signals from a TU/TM to this connector. It also routes +24 VDC to an IMASM02/03/04.

MODULE BUS

The INFI 90 module bus is a high speed (83.3 kbaud), peer-to-peer, serial bus. It provides a communication path between modules connected to it. An AMM performs the analog signal input functions for a master module or operator interface. The P1 card edge connector of the AMM connects to the bus.

The module bus signal lines are located on the Module Mounting Unit (MMU) backplane. It provides a communication connection point for up to 32 separate modules, each with a unique address (0 to 31).

SLAVE EXPANDER BUS

The INFI 90 slave expander bus is twelve parallel signal lines located on the Module Mounting Unit (MMU) backplane. It provides a communication path between master modules and slave modules. The master module provides the control functions and the slave module provides the I/O functions. When an AMM and ASMs are connected, two lines of this bus are a dedicated analog bus to provide a signal path for analog input signals. The P2 card edge connector of the slave and master module connect to the bus.

A 12-position dipshunt placed in a connection socket on the MMU backplane connects the bus between the master and slave modules. Cable assemblies can extend the bus to up to six MMUs.

A master module and its slaves form an individual subsystem within a Process Control Unit (PCU). The slave expander bus between master/slave subsystems must be separated. Leaving a dipshunt socket empty or not connecting the MMUs with cables separates them.

CONFIGURATION

A configuration must be defined to determine the operations an AMM performs on its input signals. This section explains the Function Codes (FC) that can be used with an AMM.

Function codes are software algorithms that can be configured to define specific tasks. In an AMM, the function codes are preassigned in available AMM blocks (i.e., function blocks). A function block in memory has a reference number (i.e., block address) that can be used as an input reference by other function blocks. The AMM processes defined function blocks in ascending order. There are three types of function blocks available in an AMM:

Executive Block The executive block contains parameters that affect the overall operation of the module.

Data Block Data blocks contain often used data values (e.g., calibration data).

Input/Output Block The I/O blocks correspond to module I/O.

NOTE: This instruction contains function codes specific to the IMAMM03 only. The function codes defined in this section reflect the function codes that were available at the time the instruction was created. Refer to the latest Function Code Application Manual for additional function codes.

Function Blocks

NOTE: Refer to the Function Code Application Manual I-E93-900-20 for the specifications and outputs of the AMM function codes.

All AMM function blocks have preassigned function codes located at fixed memory blocks. These blocks define the parameters that affect the 64 possible inputs. They also determine values sent to indicator stations, conduct calibration functions, determine module operating parameters and define calculations to be performed on the inputs. Table 2-1 lists the AMM function blocks and their associated function codes. Additional function codes must be configured in other modules to access the AMM inputs.

Table 2-1. IMAMM03 Function Blocks

Block Number	Definition	Function Code
1 to 64	Inputs 1 through 64	158
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	TU Temperature Blocks	76
94	Local Time - Hours	
95	Local time - Minutes	
96	Local Time - Seconds	
97	Revision Level	
98	Cycle Time	
101 to 164	Calibration Data Blocks for inputs 1 through 64	73
165 to 196	Polynomial Adjustment	159

NOTE: FC 74, FC 75, FC 73 and FC 76 are calibration specific function codes, and are explained in Section 4.

ENHANCED ANALOG POINT DEFINITION (FUNCTION CODE 158)

An AMM requires an Enhanced Analog Point Definition (EAPD) FC to perform analog input and analog adjustments, and to alternate cold junction referencing, specify exception reporting and set alarm functions. This FC is available in function blocks 1 through 64 to define inputs 1 through 64 respectively. The block parameters must be defined to input an analog signal.

INDICATOR STATION (FUNCTION CODE 20)

A FC 20 must be configured in the AMM to transmit up to three real values to an INFI 90 Indicator Station (NDIS01). Up to four indicator stations can be daisy chained from the AMM indicator station serial link. An FC 20 must be configured for each of the stations. The address of the station must be entered to direct the values to the appropriate station.

EXECUTIVE BLOCK (FUNCTION CODE 71)

The AMM executive block defines a number of variables that affect the overall module operations. This block is always in fixed block 75. The executive block specifies the AMM configuration lock, hi/low alarm deadband value, cable length to a thermocouple termination unit or module, and minimum and maximum exception reporting times for groups of eight inputs.

ANALOG SLAVE DEFINITION (FUNCTION CODE 72)

The analog slave definition FC is used in conjunction with FC 71. It defines the slave type and slave terminations for each of the eight input groups. The FC is always in fixed block 76; it produces no usable outputs.

In order for the AMM to read inputs accurately, slave type and termination connection must be specified. FC 72 identifies the slave type for each input group.

FC 72 also defines thermocouple slave addresses so that a correction for ambient temperature can be made for thermocouple inputs. Figure 2-4 shows the daisy chain arrangement for thermocouple slave TUs. This FC directs the TU/TM RTD pair (i.e., pair A, B, C or D) temperature value used in cold junction compensation to the correct ASM (i.e., slave position). The position is always the same, but the address for each slave can be different (i.e., the slave at position 1 can have slave address 6). High level, millivolt and RTD inputs do not require temperature correction.

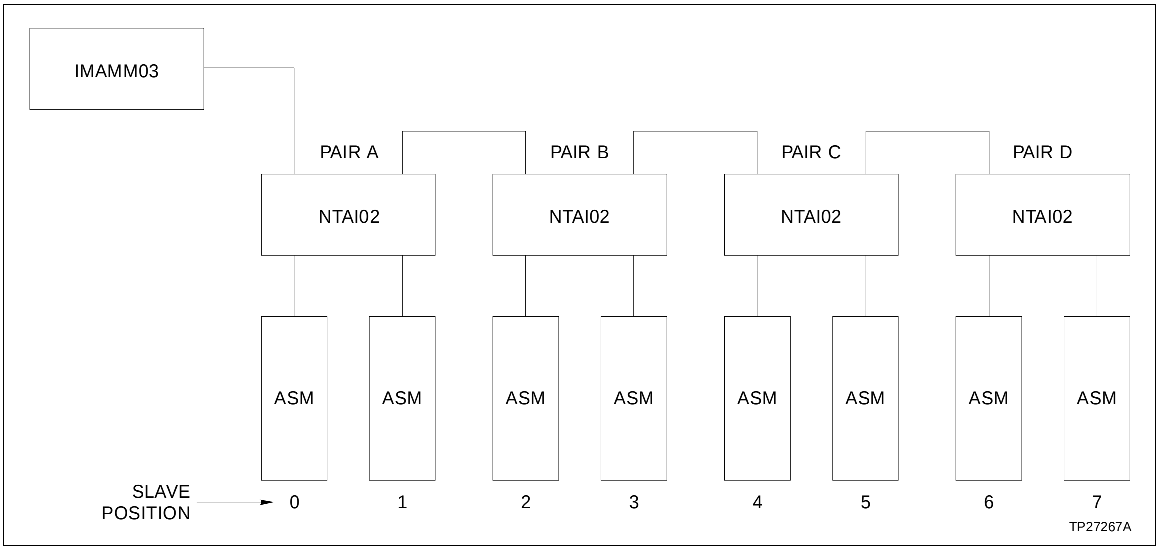


Figure 2-4. Daisy Chain Arrangement of Termination Units

TREND DEFINITION (FUNCTION CODE 78)

The trend definition FC defines the trend type for each of the 64 AMM inputs. This FC is always in fixed block 77.

The trend resolution and mode can be defined for each analog input point. Two trend resolution choices are available: Normal or fast trending. Normal trending saves 30 data values at one minute intervals. Fast trending saves the same 30 values plus 120 values at 15 second intervals.

Five trending modes are available:

- Sample - current point value saved every 15 or 60 seconds.
- Mean - mean value of all values over the trending interval.
- Minimum - minimum point value over trending interval.
- Maximum - maximum point value over trending interval.
- Sum - sum of all values collected over trending interval.

POLYNOMIAL ADJUSTMENT (FUNCTION CODE 159)

The polynomial adjustment FC defines a fifth order polynomial equation of the type:

$$Y = Ax^5 + Bx^4 + Cx^3 + Dx^2 + Ex + F$$

A maximum of 32 polynomial adjustment calculations can be defined in fixed blocks 165 to 196. These FCs can be linked to EAPD blocks (FC 158). The EAPD block performs the defined polynomial adjustment on the engineering unit value, and outputs a new calculated value. Multiple EAPD blocks can use the same polynomial calculation. A coefficient mantissa of 0.0 effectively removes that term from the equation.

ANALOG INPUT FUNCTION CODES

The function codes defined previously are strictly to perform AMM functions. To access and use the final AMM product (i.e., AMM input values after performing its conversions and calculations), additional function codes can be defined in other master module configurations. These include:

- Analog Input/Bus (FC 25).
- Analog Input/Loop (FC 26).
- Analog Input List (FC 63).
- Analog Input/Superloop (FC 121).

SECTION 3 - INSTALLATION

INTRODUCTION

This section explains what you must do before you put the Analog Master Module (AMM) and Analog Slave Module (ASM) into operation. ***DO NOT*** proceed with operation until you read, understand and do the steps in the order in which they appear.

SPECIAL HANDLING

NOTE: Always use Bailey's Field Static Kit (P/N 1948385A2 - consists of wrist strap, ground cord assembly, alligator clip) when working with modules. The kit is designed to connect a technician and the static dissipative work surface to the same ground point to prevent damage to the modules by electrostatic discharge.

The AMM and ASM use electrostatic sensitive devices. Follow Steps 1 through 4 when handling:

1. Keep the module in its 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 the circuitry when handling the module.

UNPACKING AND INSPECTION

1. Examine the hardware immediately to verify 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 container to store the hardware.

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

SETUP/PHYSICAL INSTALLATION

NOTE: The Installation section provides instructions pertaining to the installation of the AMM and ASMs only. For complete TU/TM installation, wiring and cable information, refer to the Termination Unit Manual I-E93-911.

This section explains the procedures to set switches and jumpers, and install both the AMM and its associated ASMs. After installing these modules, a configuration must be created to define the functions an AMM will perform.

NOTE: The slave expander bus must be connected between the AMM and ASM before they can communicate; refer to ***Slave Expander Bus Connection*** in this section.

Analog Master Module Installation

A few steps must be performed ***BEFORE*** operating an IMAMM03. These include:

1. Setting the address and hardware operating mode on the hardware configuration switch (S2).

2. Connecting cables.

3. Installing the module.

Figure 3-1 shows the location of the hardware configuration switch and edge connectors.

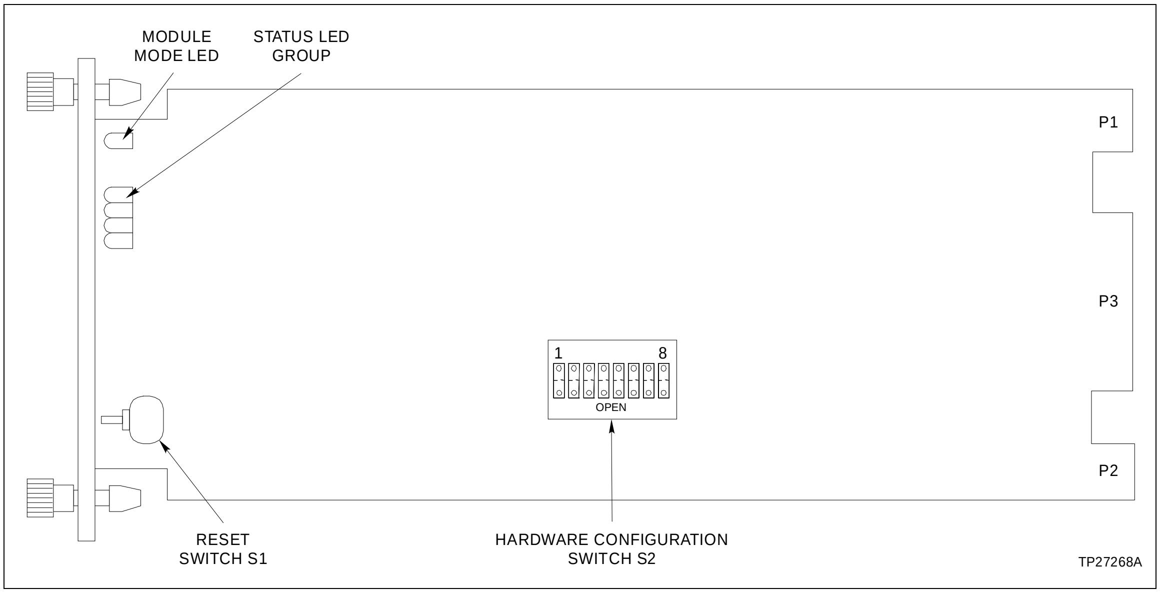


Figure 3-1. Analog Master Module

HARDWARE CONFIGURATION SWITCH (S2) SETTINGS

The hardware configuration switch (S2) sets the hardware operating states (run modes or diagnostic modes) and module address of the AMM. Figure 3-1 shows the location of S2.

During normal operation, dipswitch positions 1 thru 3 set the run mode and positions 4 thru 8 set the module address as shown in Figure 3-2. Refer to Section 6 for the diagnostics settings.

NOTE: For INFI 90 dipswitches, OPEN or OFF have the same meaning.

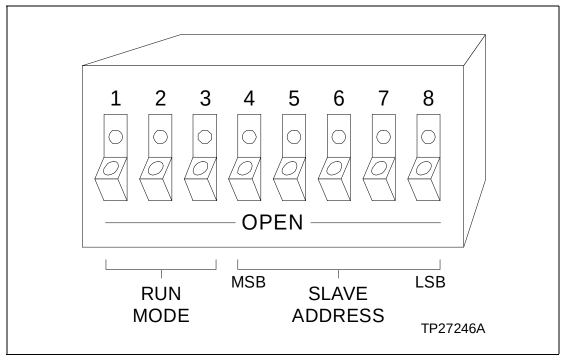


Figure 3-2. Hardware Configuration Switch (S2)

Run Mode Setting

Table 3-1 shows the run modes that can be set with dipswitch positions 1 thru 3. Determine the requirements for your application and set the switches accordingly.

Table 3-1. Run Mode Settings (S2)

Positions			Mode
1	2	3	
0	0	0	Normal or backup
0	0	1	Configuration lock
0	1	0	Initialize NVRAM
0	1	1	Inhibit checksums
1	0	0	Primary
1	0	1	Primary and configuration lock
1	1	0	Unused
1	1	1	Unused run mode (sets diagnostic mode)

NOTE: 1=OPEN (OFF); 0=CLOSED (ON)

The run modes are:

Normal or Backup When set on an AMM that is NOT part of a redundant pair, normal mode designates normal operation. When in a redundant pair, this designates the AMM as a secondary AMM (backup).

Configuration Lock Configuration lock is set to prevent the module from being changed to CONFIGURE mode. The module must be removed and the switch set to its opposite position (configuration unlock) to enter CONFIGURE mode.

Initialize NVRAM Initialize NVRAM is set to clear any existing configuration from non-volatile memory (NVRAM). This initializes the NVRAM prior to entering a configuration, and should be done before loading a new configuration. The AMM mode LED will blink green to indicate that initialization is complete.

NOTE: Calibrations must be performed after initialization. Initializing clears previously stored calibration data. Refer to Section 4 for procedures.

Inhibit Checksums Inhibit checksums prevents a ROM checksum error from halting the module. Refer to ***On-line Tests*** in Section 2 for further explanation of ROM test.

NOTE: This setting is for troubleshooting purposes ONLY. The switch should NOT be set to this position during normal operation.

Primary The primary setting is a final test by a redundant AMM pair on power-up. It determines which module operates as the primary in case a conflict occurs in which both modules have a primary configuration still in memory (i.e., both had been operating as a primary in another system).

Primary and Configuration Lock This designates a primary AMM, but also enables configuration lock.

Address Setting

An AMM can have one of 32 addresses (0 to 31) on the module bus. This address uniquely identifies the AMM to other INFI 90 devices. Determine the address for the AMM, and set S2 dipswitches (4 thru 8) to the corresponding positions shown in Table 3-2.

NOTES:

1. The address must be a unique address within a PCU. Normally, addresses 0 and 1 are not used for an AMM since these are reserved for communication modules.

2. The address must be set the same for both AMMs operating in a redundant pair.

Table 3-2. Module Address Settings (S2)

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

NOTE: 1 = Switch open or off; 0 = Switch closed or on.

PHYSICAL INSTALLATION

The AMM inserts into a standard INFI 90 Module Mounting Unit (MMU) and occupies one slot. To install:

NOTE: Set the AMM configuration switch BEFORE installing.

1. Verify the slot assignment of the module.

2. Connect the hooded end of a termination cable (NKTU01/02 or NKTM01) or redundancy cable (NKMP01) to the MMU backplane. To do this, insert the connector into the backplane slot in the same slot as the one assigned to the AMM. The latches should snap securely into place. Refer to ***Cable Connections*** in this section.

3. Align the module with the guide rails in the MMU; gently slide the module in until the front panel is flush with the top and bottom of the MMU frame.

4. Push and turn the two captive retaining screws on the module faceplate one half turn to the latched position. It is latched when the slots on the screws are vertical and the open ends face the center of the module. (To remove the module, turn the module retaining screws to the unlatched position and gently slide it out).

Analog Slave Module Installation

Several steps must be performed ***BEFORE*** operating an IMASM01/02/03/04. These include:

1. Setting the group address on the address dipswitch (S1 and S2 for a IMASM01, S1 for all others).

2. Installing jumpers (IMASM01 only)

3. Connecting cables.

4. Installing the module.

5. Configuring the slaves respective Termination Unit (TU) or Termination Module (TM).

Figure 3-3 and 3-4 show the location of the ASM components that require configuring and the edge connectors.

WARNING	**Input terminals and circuits of the IMASM02/03/04, NTAI02/03/04, NTTA01 and NIAI02/03 may be at 250 volts.**
AVERTISSEMENT	**La tension aux bornes et circuits d'entrees d'un IMASM02/03/04, NTAI02/03/04, NTTA01 et NIAI02/03 puet etre de 250 V.**

SETTING GROUP ADDRESS

One of eight addresses (0 to 7) can be set on the ASM group address switch. Each ASM must have a unique address. It identifies the input group to the AMM, which it uses to enable an input from an ASM.

NOTE: The IMASM01 has two groups of eight inputs each identified by its group address switch. S1 sets the address for inputs 9 thru 16, and S2 sets the address for inputs 1 thru 8.

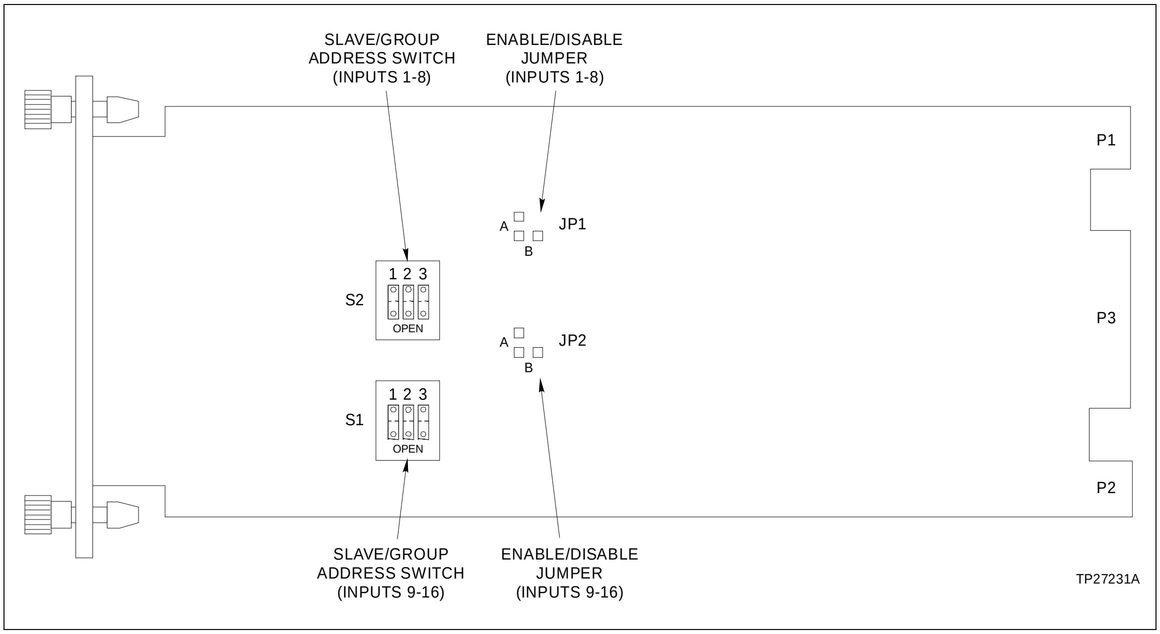


Figure 3-3. IMASM01 Component Locations

Figure 3-4. IMASM02/03/04 Component Locations

Determine the address for the input group, and set the dipswitches (1 thru 3) to the corresponding positions shown in Table 3-3.

Table 3-3. Group Address Settings

Addr.	MSB 1	2	LSB 3	Addr.	MSB 1	2	LSB 3
0	0	0	0	4	1	0	0
1	0	0	1	5	1	0	1
2	0	1	0	6	1	1	0
3	0	1	1	7	1	1	1

NOTE: 1=Open (Off); 0=Closed (On)

INSTALLING JUMPERS

Jumpers on the IMASM01 provide the ability to enable and disable each of its two input groups. JP1 controls inputs 1 thru 8 (S2), and JP2 controls inputs 9 thru 16 (S1). To enable a group, install a jumper in the B position. If an input group is not being used, install a jumper in the A position to disable the group.

PHYSICAL INSTALLATION

An ASM inserts into a standard INFI 90 Module Mounting Unit (MMU) and occupies one slot. To install:

NOTE: Configure the ASM BEFORE installing.

1. Verify the slot assignment of the module. It must be located to connect to the slave expander bus driven by its AMM.

2. Verify that a dipshunt is in the slave expander bus socket on the MMU backplane between the slave and master module. If not, refer to ***Slave Expander Bus Connection*** in this section.

3. Connect the hooded end of a termination cable (NKTU01/02 or NKTM01) to the MMU backplane. To do this, insert the connector into the backplane slot in the same slot as the one assigned to the AMM. The latches should snap securely into place. Refer to ***Cable Connections*** in this section.

4. Align the module with the guide rails in the MMU; gently slide the module in until the front panel is flush with the top and bottom of the MMU frame.

5. Push and turn the two captive retaining screws on the module faceplate one half turn to the latched position. It is latched when the slots on the screws are vertical and the open ends face the center of the module. (To remove the module, turn the module retaining screws to the unlatched position and gently slide it out).

Termination Unit/Module Configuration

Several different TU/TMs connect process field device wiring to the INFI 90 system. The terminal blocks (connection points) are located on the TU/TM. TU/TMs also provide operating voltages (+24 VDC), thermocouple slave module cold junction RTD references and calibration references. Some TU/TMs require configuration to input process field device and calibration signals. Refer to Appendix B or Appendix C to determine the configuration for your application. The TU/TMs that can be used with an AMM and ASMs are:

Analog Master Termination

An NTAM01/NIAM02 must be used to connect:

- Redundant AMM pair using an IMASM02 (routes RTD cold junction signals).
- Indicator stations (up to four daisy chained NDIS01) for a redundant or non-redundant AMM.
- An additional calibration TM (NIAC02) used in calibrating an IMASM02.

High Level ASM Termination

An NTAI05/NIAI04 terminates high level signals for the IMASM01.

Thermocouple ASM Termination

An NTAI02/NIAI02 terminates thermocouple inputs for the IMASM02. The NTAI02 provides selection and routing of an IMASM02 calibration signal. An on board switch selects either a signal generated internally by an AMM or connected externally to the TU/TM.

An NTTA01 (Translator TU) can be used to interface high level signals to an IMASM02 for enhanced common mode rejection.

100 Ohm RTD ASM Termination

An NTAI03/NTAI04/NIAI03 terminates 100 ohm RTD inputs for the IMASM03. The NTAI03 provides switch selectable references, and the NTAI04 provides jumper selectable references for calibrating an IMASM03.

10 Ohm RTD ASM Termination

An NTAI04/NIAI03 terminates 10 ohm RTD inputs for the IMASM04. The NTAI04 provides jumper selectable references for calibrating an IMASM04.

Calibration Termination

An NIAC02 provides on board references for calibrating an IMASM02. It provides selection and routing of the IMASM02 calibration signal. An on board switch selects either a signal generated internally by an AMM or connected externally to the TU.

An NIAC03 provides jumper selectable references for calibrating an IMASM03.

An NIAC04 provides jumper selectable references for calibrating an IMASM04.

Refer to ***Cable Connections*** in this section and Appendix A to determine required cables, and slave and termination combinations.

Slave Expander Bus Connection

An AMM and its ASMs make up a master/slave subsystem within a Process Control Unit (PCU). The slave expander bus, located on the MMU backplane, must be connected to provide a communication path between an AMM and its slaves connected to the bus. The modules must be installed in adjacent slots to provide the connection capability.

WARNING	**Disconnect power before installing dipshunts for slave modules on the MMU backplane (slave expander bus). Failure to do so could result in severe or fatal shock.**
AVERTISSEMENT	**Couper l'alimentation avant d'installer les dipshunts sur la plaque arriere du chassis de montage de modules (MMU). Toute negligence a cet egard constitue un risque de choc pouvant entrainer des blessures graves, voire moretiles.**

To connect the slave expander bus, insert a twelve strap dipshunt (all straps intact) into the MMU backplane socket (XU1 thru XU11) between each slave, and the slaves and master module. The sockets on either side of the AMM and ASM group should not have dipshunts; this separates the master/slave subsystems. An AMM can support up to eight slaves. For further information on the MMU, refer to Module Mounting Unit Product Instruction I-E93-910-4.

Slave Expander Bus Clock

An AMM generates the slave expander bus clock used by the slaves to enable their input functions. To prevent ASM cross talk or drift when more than one AMM/ASM group is in an INFI 90 cabinet, a single AMM must drive the clock for all ASMs in a cabinet. This includes slave modules mounted in other MMUs within the cabinet.

To configure the slave expander bus to provide this single clock, insert a twelve pin dipshunt with all straps except 11 and 12 broken between each AMM/ASM subsystem. Attach a slave expander bus extender cable (P/N 1948502A0340) to the surface contact bus connector on the MMU backplane to connect the slave expander bus to other MMUs. The individual AMMs will determine which module will drive the clock based on the AMM address.

NOTES:

1. When connecting the slave expander bus to provide the clock signal to all AMM/ASM subsystems in a cabinet, do NOT place an AMM or ASM in the last MMU slot nearest the cable connections. A dipshunt with straps 11 and 12 intact must be placed in the slave expander bus socket next to these vacant slots.

2. The AMM with the highest module address provides the bus clock. If this AMM fails, the AMM with the next highest module address provides the clock.

Figure 3-5 shows an example of the slave expander bus dipshunt configurations required to:

- Communicate within an AMM/ASM subsystem (i.e., all dipshunt strap positions intact).
- Separate the AMM/ASM subsytem from other master/slave subsystems (i.e., dipshunt socket empty).
- Provide clock signals to all ASMs within a cabinet (i.e., dipshunt straps 11 and 12 intact).

NOTE: The top row of modules in Figure 3-5 show an IMAMM03 with the maximum number of slave inputs. AMM/ASM modules can be arranged in any order or any slots in an MMU as long as they can connect with dipshunts.

WIRING CONNECTIONS AND CABLING

An AMM and ASM has three card edge connectors (P1, P2 and P3) to provide power, establish communication and connect external signals. Cables connect the external signals to the modules.

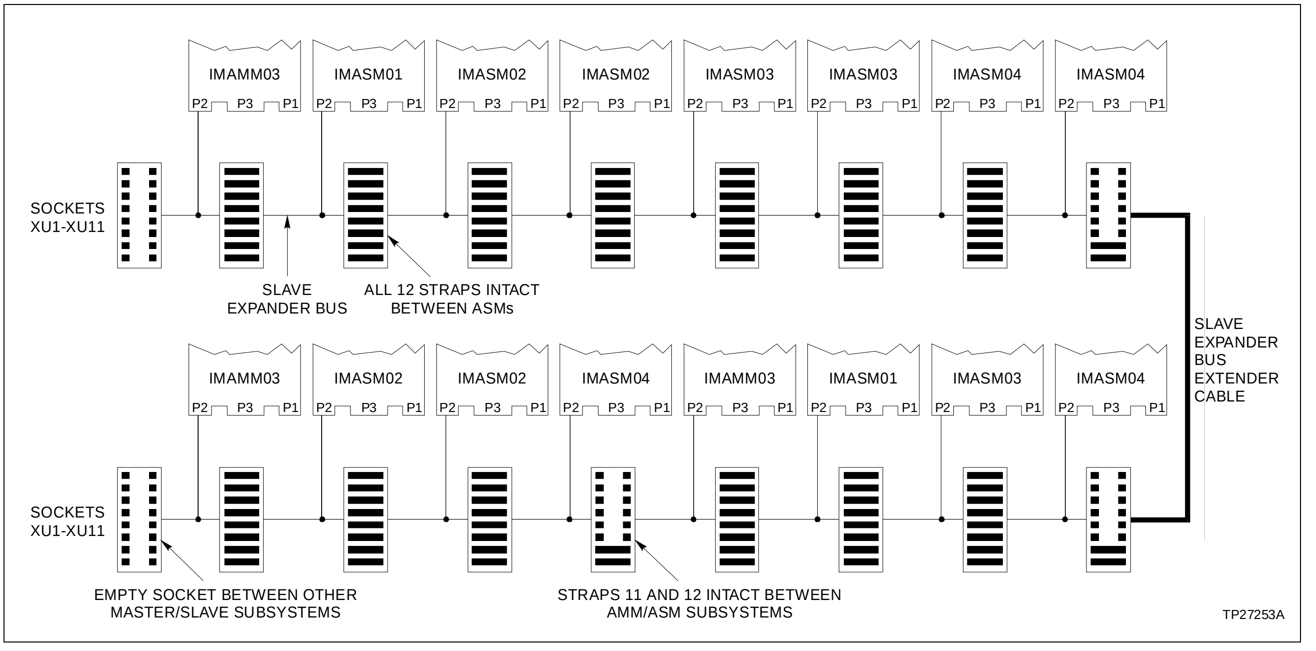


Figure 3-5. Slave Expander Bus Dipshunt Configuration

Wiring

Installing an AMM or ASM in the MMU connects P1 of the module to logic power (+5 VDC and ±15 VDC) necessary to operate the logic circuitry, and P2 to the slave expander bus. P1 also connects the AMM to the module bus for communication with other modules. P1 and P2 connection require no additional wiring or cabling.

Cable Connections

A variety of cables connect the I/O for the IMAMM03 and IMASM01/02/03/04. These connections are dependent on the associated hardware being used to provide support for the AMM functions.

Cables route:

- Analog inputs from a TU/TM to an ASM.
- Serial data from an AMM to an Indicator Station (NDIS01).
- Operating and status data between a redundant AMM pair.
- Calibration references.

Refer to Appendix A to determine the cabling for your application.

FUSING

The AMM and ASMs do not have any on board fusing requirements.

PRE-OPERATING ADJUSTMENTS

There are no physical adjustments to be performed prior to operating an AMM or ASM.

NOTE: Calibration procedures must be performed if using an IMASM02/03/04; refer to Section 4.

CONFIGURATION AND CALIBRATION

Once the AMM and ASMs are installed, a configuration must be defined to determine the operations an AMM performs on its input signals. If using an IMASM02/03/04, calibrations must be performed to determine correction factors for errors caused by minor variations in hardware, time and temperature. Section 2 explains the function codes available to configure an Analog Master Module (AMM). For further explanation of these function codes and their specifications, or further explanation of function blocks and configurations, refer to the Function Code Application Manual I-E93-900-20. Section 4 outlines the procedures for calibrating the different ASMs.

Use an operator interface to enter a configuration into module memory. The module must be placed in CONFIGURE mode to enter values into function code specifications. After entering all values, change the mode to EXECUTE. If any errors exist in the configuration, the module will not go into EXECUTE. Instead, the mode LED will continue to blink green and the operator interface will indicate ERROR mode. The cause of the configuration error can be determined by reading status information from the AMM. Refer to the product instruction for the operator interface you are using for procedures to change mode, configure a module and view status messages.

NOTE: The NVRAM should be initialized BEFORE entering a configuration into the module. This can be done using the operator interface or the hardware configuration switch (S2).

Nonstandard Transducers

When using a nonstandard millivolt or high level transducer, values must be calculated for zero, span and significant change percent to allow proper conversion to engineering units, and exception reporting. These calculated values must be entered in the Enhanced Analog Point Definition (FC 158) specifications.

Formula Variables:	AS	=	Actual Span (specification 5).
	AZ	=	Actual Zero (specification 4).
	ASC%	=	Actual Significant Change, Percent Span (specification 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)

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

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

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

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

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

Type 61

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

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

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

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

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

High Level Transducer Formulas

Type 40

$$AS = \frac{(FULL - ZERO) \times 4}{FV - ZV} = \frac{SPAN \times 4}{HISPAN}$$

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

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

Type 41

$$AS = \frac{(FULL - ZERO) \times 20}{FV - ZV} = \frac{SPAN \times 20}{HISPAN}$$

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

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

Type 42

$$AS = \frac{(FULL - ZERO) \times 10}{FV - ZV} = \frac{SPAN \times 10}{HISPAN}$$

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

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

Type 43

$$AS = \frac{(FULL - ZERO) \times 5}{FV - ZV} = \frac{SPAN \times 5}{HISPAN}$$

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

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

SECTION 4 - CALIBRATION

INTRODUCTION

This section describes the procedures for calibrating Analog Slave Modules (ASM) used with an Analog Master Module (AMM). It discusses general calibration information, calibration function codes and examples of calibrations specific to an analog slave/termination combination.

The calibrations determine correction factors for errors caused by minor variations in hardware, time and temperature. The AMM combines these correction factors with lead wire resistance factors to correct for errors caused by thermocouple and RTD field wiring. High level slaves do not need to be calibrated.

NOTE: Refer to the Function Code Application Manual I-E93-900-20 for individual function code specifications.

WHEN TO CALIBRATE

Inputs must be calibrated:

- For each newly configured Enhanced Analog Point Definition (EAPD).
- After initial installation of the master and slave modules.
- After replacing an AMM (not a redundant AMM).
- After replacing a slave module.
- After a slave address has been changed, which changes the address in the blocks referring to it.
- After initializing nonvolatile memory (NVRAM).
- When a change is made to the lead wire resistance parameter in an EAPD block (FC 158).
- When the cable length between the slave and termination unit is changed.
- Periodically to adjust for component aging.

CALIBRATION STRATEGIES

Several strategies are available for calibration. For thermocouple slaves:

1. 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 (NTAI02) or calibration termination module (NIAC02) hardware.

2. 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.

For RTD slave modules, the RTD points are calibrated one at a time:

1. Each point can be calibrated without disturbing the data collection of any other slave point by attaching a precision resistor to the input terminal blocks.

2. Each point can be calibrated using hardware supplied on the termination unit (NTAI03/04) or calibration termination module (NIAC03/04). In this case, the slave must be removed from service during calibration.

For either type of slave, calibration data can be manually entered into the AMM.

CALIBRATION SPECIFIC BLOCKS

All calibrations must be done with the AMM in EXECUTE mode since calibration is a tuning operation. When calibrating, the operator interacts with the AMM through six function codes in fixed AMM function blocks:

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

Through these function codes, a calibration sequence is initiated, performed and terminated. These blocks are read, modified or monitored over the module bus. A Configuration and Tuning Terminal (CTT), Operator Interface Station (OIS), Management Command System (MCS), Engineering Work Station

(EWS) or other INFI 90 operator interfaces can be used to configure the function blocks.

Calibration Command Block (Function Code 74)

The operator initiates, performs and terminates a calibration sequence through the Calibration Command Block (CCB), which is in fixed block 80. Commands are entered by tuning this block. A command (1 to 12) and point number (1 to 64) must be specified.

If, for example, after tuning the CCB block a CTT responds with a *GOOD* message, the operation was successful. If the response is *CAL ERROR*, the operation failed and the Calibration Status Block (Function Code 75, block 71) must be read to determine the cause. At an operator interface console, a command success or failure is indicated by the command field value of the CCB (specification 1); a value of *0* indicates an error condition. Refer to the product instruction for the operator interface you are using for specific error code definitions.

The CCB commands fall into four groups: Disable commands, slave calibration commands, point calibration commands and enable commands. The calibration commands are:

1 - Disable point.

2 - Disable slave.

3 - Perform complete thermocouple slave calibration automatically using internal references.

4 - Perform thermocouple slave calibration using external 0 millivolt source.

5 - Perform thermocouple slave calibration using external 100 millivolt source.

6 - Perform thermocouple point calibration using external 0 millivolt source.

7 - Perform thermocouple point calibration using external 100 millivolt source.

8 - Perform RTD point ZERO calibration.

9 - Perform RTD point SPAN calibration.

10 - Enable point.

11 - Enable slave.

12 - Escape.

NOTE: The escape command (i.e., command 12) allows the calibration of a point or slave to be stopped after the zero scale measurement has been completed. Specifying any other action besides an escape or full scale measurement on the same point causes a command sequence error.

DISABLE OPERATION

A point must be disabled before calibration can begin. This prevents calibration related data from being interpreted by the INFI 90 system as process data.

A single point can be disabled using the disable point command (i.e., command 1) when a calibration reference is connected at the terminal block.

All points of a slave can be disabled at once by using the disable slave command (i.e., command 2). This is done when using the calibration hardware on a termination unit or calibration termination module.

SLAVE CALIBRATION COMMANDS

Slave calibration commands refer to all points on a thermocouple slave. Two methods can be used to simultaneously calibrate all input points on a thermocouple slave:

1. Automatic calibration using internal references generated by the AMM (i.e., command 3).

2. Calibration using an external millivolt source connected at the terminal block (i.e., command 4 and 5).

When using commands 4 and 5 (external mode), the zero and full scale calibration steps must be performed explicitly, and in that order. Regardless of which slave calibration method is used, every point on the slave must be disabled prior to entering the command. Any point number on the slave can be used to define the point specification when using a slave calibration command.

The new calibration factors are not saved to NVRAM until the entire calibration sequence is complete (i.e., after the full scale measurement has been taken).

POINT CALIBRATION COMMANDS

The point commands (i.e., commands 6 thru 9) define the calibration to be performed for both thermocouple and RTD input types. These commands can be entered when using an external source, or when using the calibration socket or calibration termination module. 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 full scale measurement must be complete before the calibration factors are saved.

ENABLE OPERATION

A point or slave must be enabled using the enable point or enable slave command (i.e., command 10 or 11) before normal input processing can occur. Using the enable point command terminates the calibration sequence for a particular point. All slave points can be enabled at once using the slave enable command. The slave enable can be used even if the points were disabled individually.

Calibration Status Block (Function Code 75)

The Calibration Status Block is in fixed block 81, and contains the results from the most recently performed calibration command. The specifications in this block can be monitored to determine the success or failure of the calibration command. Its specifications can be read, but not modified.

When the most recent calibration command was a slave command, the block holds the status for eight points. If the most recent command was a point calibration, the calibration status block holds the results for a single point. Refer to the Function Code Application Manual for a definition of the status information.

Calibration Data Block (Function Code 73)

The correction factors computed during calibration are stored in NVRAM, and can be viewed by monitoring the calibration data blocks. These blocks are in fixed blocks 101 to 164, and correspond to inputs 1 through 64 respectively (e.g., calibration data block 121 corresponds to input 21). The data is stored in function blocks to facilitate restoring an AMM after an NVRAM failure. Calibration values (i.e., offset and gain) can be entered through an operator interface.

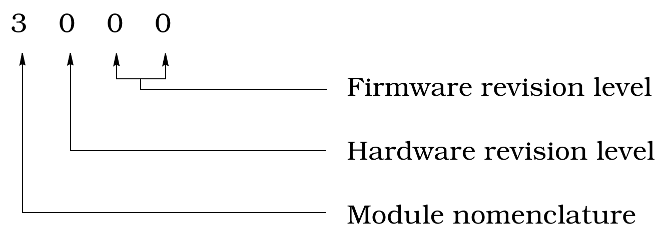
The data contained in a particular calibration data block pertains to a point defined by an EAPD block (FC 158) (i.e., calibration data block 121 corresponds to EAPD block 21). The block is undefined if the associated point is not configured.

Offset and gain values can be modified in CONFIGURE mode. Entered correction data is checked against predefined limits for the input type. If the correction factors are not within the limits (i.e., out of range), the calibration quality flag is set in an exception report record to indicate bad quality. This information can be observed by tuning to the calibration data block that corresponds to the point in question (i.e., EAPD block of the input + 100).

NOTE: Monitoring the calibration blocks gives the raw AMM input value in millivolts without the calibration correction factors for slave modules. It does reflect corrections for master induced errors.

Thermocouple Temperature Block (Function Code 76)

The thermocouple temperature block (FC 76) is in fixed function blocks 90 through 98. Blocks 90 through 93 allow monitoring of cold junction RTD temperatures at the thermocouple TU/TM. Additionally, block 94 through 96 provide system trend times (hours, minutes and seconds respectively), block 97 holds module software and firmware revision levels, and block 98 holds the AMM cycle time. The cycle time is the amount of time (in seconds) required for the AMM to make one scan of its inputs. The module revision level is expressed as:



These blocks can only be accessed by a READ POINT or READ BLOCK module bus message (i.e., monitor function on a CTT).

Thermocouple temperatures are measured at the TU/TM to ensure accurate reporting of field thermocouple temperatures. Since connection to the TU/TM terminal block creates a junction of dissimilar metals, an additional voltage is created. This voltage subtracts from the one produced by the thermocouple, which leads to an inaccurate thermocouple temperature value. The AMM takes the termination thermocouple temperature provided by this FC, internally converts it to a voltage signal, and adds it to the initial voltage signal to correct the value. The value is then converted to a temperature and output from the module.

The AMM accepts inputs from eight slaves. Each TU/TM can accommodate two thermocouple slaves. A signal to the AMM from an RTD pair measures the ambient temperature of the air surrounding the TU/TM. These RTD pairs are used for the temperature correction of the thermocouple inputs. TU/TMs are usually daisy chained together. Each NTAI02 has two RTDs, while each NIAI02 has one RTD. If a slave is not associated with an RTD pair, then the corresponding block number (i.e., 90 thru 93) is undefined. All temperatures are given in degrees centigrade (°C). Bad quality is associated with an RTD pair when the calculated temperature is not within the allowable range of 0 to 70°C, or when an open input is detected. The high/low alarm status available during block monitoring indicates whether the temperature is above or below the allowable temperature range.

NTAI02 Cold Junction RTD Pairs

Table 4-1 shows the relationship between block numbers and NTAI02 RTD pairs.

Table 4-1. NTAI02 Cold Junction RTD Pairs

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

NOTE: 2nd, 3rd and 4th TU daisy chained from the 1st TU.

NIAI02 Cold Junction RTD Pairs

Each NIAI02 has only one RTD. 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. An eight position dipswitch on the NIAM02 allows this RTD to be switched in or out.

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 can be obtained by monitoring block 90 (RTD pair A). The temperature of the third NIAI02 is averaged with the temperature at the NIAM02 and can be obtained by monitoring block 91 (RTD pair B).

Up to four NIAI02s should be daisy chained from the NIAM02 J1 socket before connecting any additional NIAI02s (up to four) to socket J2.

Enhanced Analog Point Definition (Function Code 158)

The AMM accepts up to 64 inputs. FC 158 in fixed blocks 1 to 64 define each input. This FC defines parameters for analog inputs including alarm detection and exception reporting.

These blocks can be monitored after performing a calibration to determine the quality of each input. If the input is present and calibrated correctly, a point value will display. If the calibration is not correct or the input value cannot be read, a status code will display.

The point status will show either:

- Point status good.
- Point status bad.
- High alarm.
- Low alarm.

Refer to the product instruction for the operator interface you are using for procedures to sequence through the status codes, and to interpret the bad quality indications.

CALIBRATION EXAMPLES

This section provides calibration examples for each hardware combination and calibration option available. Commands are entered using the CCB (FC 74) from any operator interface.

> **NOTE:** After initiating a calibration command, a response from the operator interface may take up to one minute.

The calibration examples given do not consider various error possibilities. If any calibration command fails, monitor the Calibration Status Block (FC 75) to determine the exact cause.

The examples show the specific FC specification values to enter when calibrating. For example:

<1> = 11

indicates to enter 11 into specification 1.

When using a station to calibrate, a *0* displayed in CCB specification 1 (FC 74) indicates an abnormal condition was detected during calibration.

External references can be used to calibrate thermocouple and RTD input points. Figure 4-1 shows the connections for both input types when calibrating a single point with an external reference.

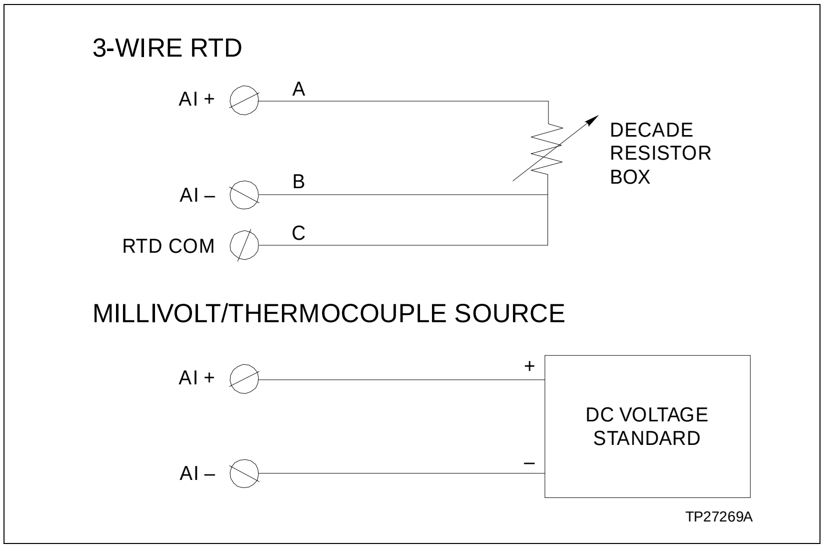


Figure 4-1. External Reference Calibration Connections

Refer to the product instruction for the operator interface you are using for procedures to manipulate configuration function blocks (e.g., tune, monitor, delete or add).

Thermocouple Slave Module (IMASM02) Calibration

The IMASM02 can be calibrated in four different ways:

- All points using internal reference.
- All points using external reference.
- Single point using internal reference.
- Single point using external reference.

Calibrating all points requires the thermocouple slave module be taken out of operation. This is required since the termination cable must be moved to the calibration socket (P3) on an NTAI02. And if using termination modules, the IMASM02 must be physically moved to an MMU slot containing the calibration module (NIAC02). Figure 4-2 shows the cable connections when using an NTAI02.

NOTE: When performing a thermocouple slave calibration (all eight points at once), all slave points must be configured in EAPD blocks (FC 158) or a calibration error will occur. It is recommended that all thermocouple slave points be defined as thermocouple or millivolt inputs before calibrating the slave. If any error occurs during calibration, the Calibration Status Block (FC 75) shows the points that are in error, and the specific problem.

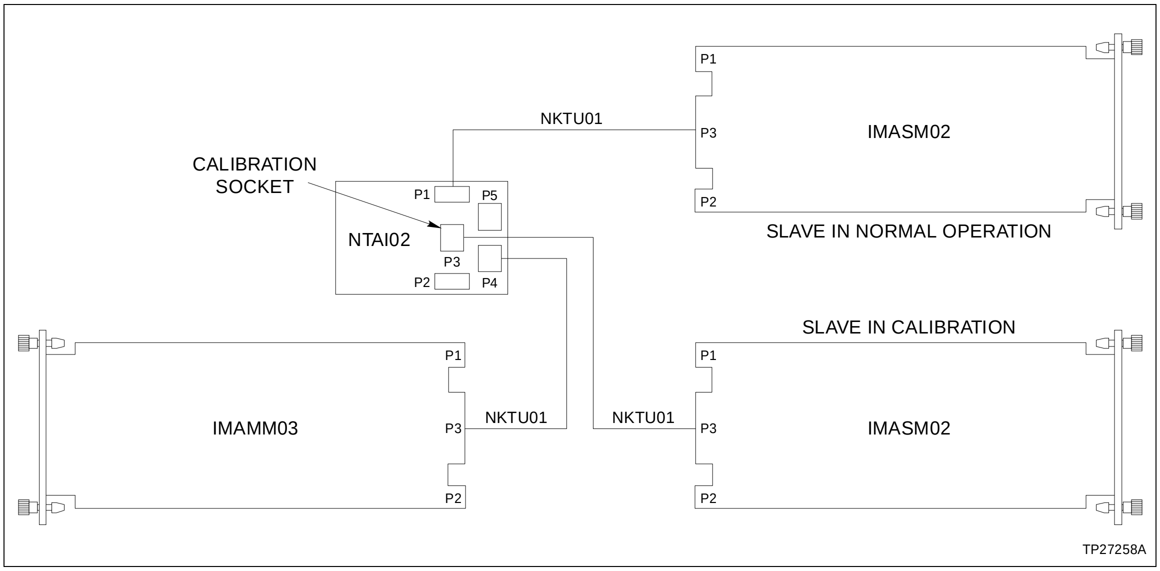


Figure 4-2. IMASM02 Cable Connections to Calibration Socket (P3)

CALIBRATION EQUIPMENT (EXTERNAL)

When calibrating the IMASM02, the best accuracy can be attained by performing an external calibration with quality equipment. The required equipment is:

- 5-1/2 digit multimeter.
- Millivolt source with precise control.

CALIBRATING ALL SLAVE POINTS USING NTAI02

External Calibration

This example shows how to calibrate all points of a thermocouple slave at once using a precision millivolt source. To calibrate:

1. Disable the slave module by tuning the CCB:

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

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

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

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

5. Adjust the source for a 0 millivolt reading on the multimeter, and tune the CCB to perform a 0 millivolt calibration:

<S1> = 4

6. Adjust the source to read 100 millivolts on the multimeter, and tune the CCB to perform a 100 millivolt calibration.

<S1> = 5

7. Move the NTAI02 input cable from the calibration socket (P3) to its original input socket P1 or P2. Red/green LED on affected slave should turn solid green.

8. Enable the slave module by tuning the CCB:

<S1> = 11

Internal (Auto) Calibration

This example demonstrates the operations necessary to automatically calibrate all points of a thermocouple slave at once using internal references.

1. Disable the slave module by tuning the CCB:

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

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

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

4. Tune the CCB to perform a slave calibration:

<S1> = 3

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

6. Enable the slave module by tuning the CCB:

<S1> = 11

CALIBRATING ALL SLAVE POINTS USING NIAI02/NIAM02/NIAC02

When using high density termination modules, the NIAC02 is used to provide calibration references. This module is located in its own slot in the MMU.

External Calibration

This procedure calibrates all eight slave points at once.

1. Disable the slave module by tuning the CCB:

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

2. Remove the IMASM02 from its MMU operating slot and insert it into the calibration slot. This is the MMU slot cabled to the NIAC02. Red/green LED on the affected slave should turn solid red.

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

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

5. Adjust the source to read 0 millivolts on the multimeter, and tune the CCB to perform the 0 millivolt calibration:

   <S1> = 4

6. Adjust the source to read 100 millivolts on the multimeter, and tune the CCB to perform the 100 millivolt calibration:

   <S1> = 5

7. Return the IMASM02 to its normal MMU slot. The slave red/green LED should indicate solid green.

8. Enable the slave module by tuning the CCB:

   <S1> = 11

Internal (Auto) Calibration

This procedure demonstrates how to calibrate all points of a thermocouple slave module at once using references developed on the NIAC02.

1. Disable the slave module by tuning the CCB:

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

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

3. Remove the IMASM02 from its MMU operating slot and insert it into the calibration slot. This is the MMU slot cabled to the NIAC02. Red/green LED on the affected slave should turn solid red.

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

5. Tune the CCB for slave calibration:

<S1> = 3

6. Return the IMASM02 to its normal MMU slot. Slave status LED should turn solid green.

7. Enable the slave module by tuning the CCB:

<S1> = 11

SINGLE POINT CALIBRATION USING NTAI02

Internal/External Calibration

This example demonstrates how to calibrate a single thermocouple input without disturbing the data collection of any other point on the slave.

1. Disable the slave point by tuning the CCB:

<S1> = 1
<S2> = point to calibrate

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

3. If an external source is used, adjust it to read 0 millivolts on the multimeter. If the internal source is used, the IMAMM03 sets the 0 millivolt level automatically when the CCB is tuned.

4. Tune the CCB to perform 0 millivolt calibration:

<S1> = 6

5. If an external source is used, adjust it to read 100 millivolts on the multimeter. Again, if the internal source is used, the IMAMM03 sets the 100 millivolt level automatically when the CCB is tuned.

6. Tune the CCB to perform 100 millivolt calibration:

<S1> = 7

7. Disconnect the calibration source and re-attach the field wiring.

8. Tune the CCB to enable the point:

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

SINGLE POINT CALIBRATION USING NIAI02

External Calibration

The calibration procedure is the same for single point calibration when using the NIAI02 instead of the NTAI02. Perform the procedure for ***SINGLE POINT CALIBRATION USING NTAI02***, except when an external calibration source is used, attach the millivolt source and multimeter to the NIAI02 terminal blocks in place of the field wiring for the point being calibrated.

RTD Slave Module (IMASM03/04) Calibration

The IMASM03/04 uses either an external resistance source, resistances on board the NTAI03/04 or resistances on board the NIAI03/04 to calibrate its input point zero and span. The external sources provide the ability to calibrate an RTD point without affecting the data collection of any other point on the slave. Using the TU/TM references requires the RTD slave module to be taken out of operation since the termination cable must be moved to the calibration socket (P3) when using an NTAI03/04. And if using termination modules, the IMASM03/04 must be physically moved to an MMU slot containing the calibration module (NIAC03/04). Figure 4-3 shows the cable connections when using a NTAI03/04. The procedures to perform each of the three methods follows.

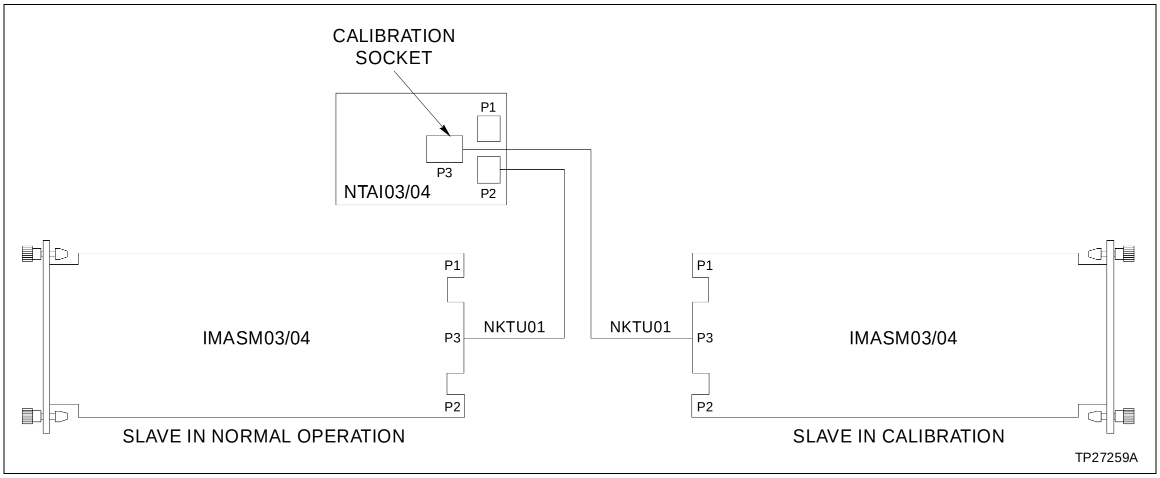


Figure 4-3. IMASM03/04 Cable Connections to Calibration Socket (P3)

EXTERNAL CALIBRATION RESISTANCES

The IMASM03/04 can be calibrated using external resistors connected to the NTAI03/04 terminal blocks. Using external references allows a single point to be calibrated without affecting other points. The required precision resistors (0.02 percent tolerance) are:

100 ohm (IMASM03 zero)
400 ohm (IMASM03 span)
7.35 ohm (IMASM04 zero)
14.7 ohm (IMASM04 span)

NOTE: All resistors should be 0.1 percent tolerance or better

SINGLE RTD POINT CALIBRATION USING EXTERNAL REFERENCES

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

100 Ohm RTD

This procedure is for calibrating an IMASM03 using an NTAI03/04 or NIAI03 for termination.

1. Disable the point to be calibrated by tuning the CCB:

   <S1> = 1
   <S2> = point to calibrate

2. Attach a 100 ohm, 0.02% precision resistor to the TU/TM terminal blocks in place of the field wiring for the point being calibrated 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 a 100 ohm (ZERO) calibration:

   <S1> = 8

4. Replace the 100 ohm precision resistor at the point termination blocks with a 400 ohm, 0.02% 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 the CCB to perform a 400 ohm (SPAN) calibration:

   <S1> = 9

6. Remove the resistor and attach the field wiring.

7. Enable the point by tuning the CCB:

   <S1> = 10

10 Ohm RTD

The procedure for calibrating an IMASM04 using an NTAI04 or NIAI03 for termination is the same as for calibrating the 100 ohm RTD. Perform the same procedures outlined for a 100 ohm RTD, except substitute a 7.35 ohm resistor (or two 14.7 ohm resistors in parallel) for the 100 ohm resistor and a 14.7 ohm resistor for the 400 ohm resistor.

CALIBRATING RTD POINTS USING TERMINATION UNIT REFERENCES

These examples demonstrate how to calibrate an RTD input using the jumpers and precision resistors provided on the NTAI03/04.

NTAI03 (100 Ohm RTD)

1. Disable the slave module by tuning the CCB:

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

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

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

4. Select a 100 ohm (ZERO) resistance with the NTAI03 toggle switch (S1).

5. Tune CCB to perform ZERO calibration:

   <S1> = 8
   <S2> = point to calibrate

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

6. Select a 400 ohm resistance (SPAN) with the NTAI03 toggle switch (S1).

7. Tune the CCB to perform a SPAN calibration:

   <S1> = 9

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

9. Move the NTAI03 input cable from the calibration socket (P3) to its original input socket (P1 or P2). Red/green LED on the affected slave should turn green.

10. Enable the slave module by tuning the CCB:

<S1> = 11

NTAI04 (10 or 100 Ohm RTD)

1. Disable the slave module by tuning the CCB:

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

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

3. Select the slave point to be calibrated using jumpers (CH1 through CH8) on the NTAI04.

4. For a 100 ohm RTD (IMASM03), select a 100 OHM ZERO resistance with the jumper. For a 10 ohm RTD (IMASM04), select a 10 OHM ZERO with the jumpers.

5. Tune the CCB to perform a ZERO calibration:

<S1> = 8
<S2> = point to calibrate

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

6. For a 100 ohm RTD, select a 100 OHM SPAN with the jumpers. For a 10 ohm RTD, select a 10 OHM SPAN with jumper.

7. Tune the CCB to perform a RTD SPAN calibration:

<S1> =9

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

9. Move the NTAI04 input cable from the calibration socket (P3) to its original input socket (P1 or P2). The slave status LED should turn solid green.

10. Enable the slave module by tuning the CCB:

<S1> = 11

CALIBRATING RTD POINTS USING TERMINATION MODULE REFERENCES

These examples demonstrate how to calibrate an RTD input using the jumpers and precision resistors provided on the NIAC03 and NIAC04.

NIAC03 (100 Ohm RTD)

1. Disable the IMASM03 by tuning the CCB:

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

2. Move the slave module from its normal MMU slot to the calibration slot. This is the slot cabled to the NIAC03. LED on affected slave should turn red.

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

4. Tune the CCB to perform a ZERO calibration:

   <S1> = 8
   <S2> = point to calibrate

5. Set the NIAC03 jumper to the SPAN setting for the point being calibrated.

6. Tune the CCB to perform a SPAN calibration:

   <S1> = 9
   <S2> = point to calibrate

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

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

9. Enable the slave module by tuning the CCB:

   <S1> = 11

NIAC04 (10 Ohm RTD)

The NIAC04 is used to calibrate the IMASM04. The procedures for calibrating the IMASM04 using an NIAC04 are the same as for calibrating an IMASM03 using an NIAC03.

MONITORING INPUT VALUES

The actual input value, in millivolts, for each slave input channel can be monitored. This value is a raw value corrected only for master induced errors; no slave offset or gain correction is performed. It is the actual value of the input signal that the ASM sends on the slave expander bus. To view the raw value in millivolts, monitor the Calibration Data Block (FC 73) corresponding to the desired input block with an operator interface. To determine the calibrated value use the formula:

Calibrated value = (Raw millivolt value - Offset) x Gain

where:

Raw millivolt value	Output of calibration block (101 to 164)
Offset	Value in specification 1 (S1)
Gain	Value in specification 2 (S2)

The raw input value is not available on the first poll of the particular block. That first message informs the IMAMM03 which raw value should be saved on its next pass through the input list. Consequently, the bad quality indication can be seen initially. Subsequent polls will have the true millivolt reading. The bad quality flag remains set if the value is unreadable (i.e., slave not present or the value is out of range).

MANUAL CALIBRATION DATA WRITE

The gain and offset correction factors for any slave input can be manually entered into the Calibration Data Block (FC 73) for that input. The values can be entered in CONFIGURE mode only using the modify block command.

Regardless of how the correction values are ascertained, either from the IMAMM03 through calibration or through manual entry, the values are compared against set limits, with the calibration quality set accordingly. The quality of the input correction values can be monitored only in EXECUTE mode by monitoring the EAPD block for the desired point.

SECTION 5 - OPERATING PROCEDURES

INTRODUCTION

This section explains the modes of operation, front panel indicators and start-up procedures for the Analog Master Module (IMAMM03). It also explains the front panel indicators for the Analog Slave Modules (IMASM02/03/04).

MODES OF OPERATION

The Analog Master Module (AMM) has three modes of operation: EXECUTE, CONFIGURE, and ERROR mode. The mode can be changed using an operator interface. A description of each mode follows.

Configure Mode

When in CONFIGURE mode, an AMM configuration can be modified by adding, changing, or deleting function blocks (e.g., Enhanced Analog Point Definition blocks (FC 158)). Specification parameters can also be adjusted. In CONFIGURE mode, the module does not scan the inputs or perform any point calculations. The front panel module mode LED flashes green to indicate that the module is in CONFIGURE mode.

Execute Mode

EXECUTE mode is the normal operating mode. The AMM scans the inputs, and performs its configured digital conversions on the inputs. The ASM conditions a selected input which the AMM converts to a digital value available to requesting INFI 90 devices, and for indicator station display. The AMM also performs self diagnostic routines. The configuration cannot be changed, but certain parameters can be tuned and output blocks monitored. In EXECUTE mode the mode LED is solid green.

Error Modes

Configuration Error A flashing green mode LED indicates a configuration error. If the AMM detects a configuration error when attempting to go to EXECUTE mode, the module enters this ERROR mode. If a NVRAM error occurs in EXECUTE mode, the LED flashes green and the module continues to operate. If a reset or mode change occurs during this error, the module loses its configuration. These are nonfatal configuration (software) related errors. Refer to Section 6 for corrective actions.

Time Out Error

Certain error conditions cause the module to halt all operations (*time out*). If this occurs the mode LED lights solid red.

When reset, the module error mode depends on the type of error detected. For example, a reference error forces a configuration ERROR mode (i.e., flashing green) on reset. Refer to Section 6 for corrective actions.

LED INDICATORS

Front panel module status indicators on the AMM and ASM modules (IMASM02/03/04 only) provide a visual indication of module operation.

NOTE: The IMASM01 does not have a front panel status indicator since it does not require calibration.

Analog Master Module Indicators

The AMM has a single mode LED indicator and a group of four status indicators. The status LED group consists of four red LEDs. These indicators show either normal operating conditions or error conditions. Figure 5-1 shows the location of the mode and status LEDs.

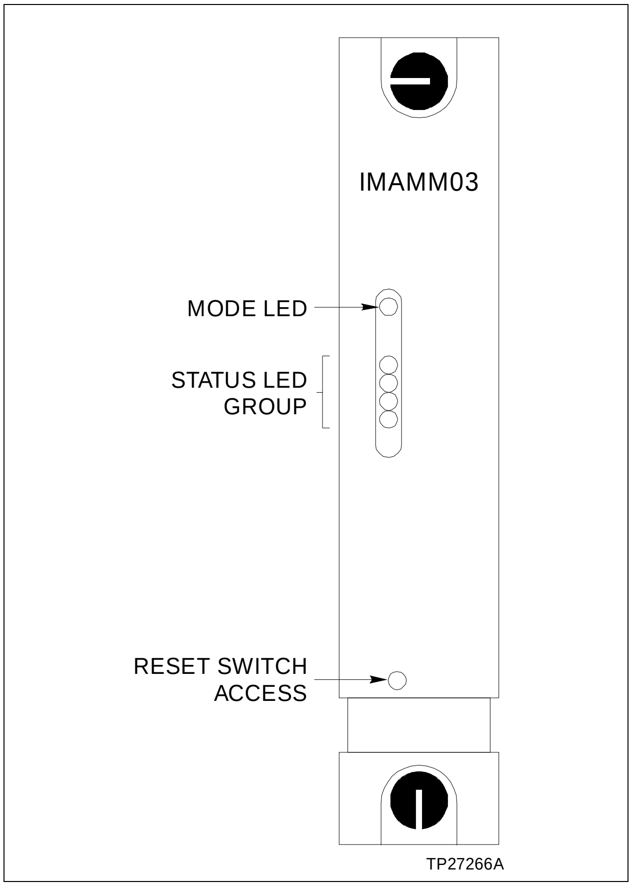


Figure 5-1. AMM Front Panel

Table 5-1 summarizes the mode LED states. Refer to ***MODES OF OPERATION*** in this section for an explanation of the indicated modes. Table 5-2 shows the status LED indications during normal operating conditions (i.e., no errors). Refer to Section 6 for an explanation of status LED error indications.

Table 5-1. IMAMM03 Mode LED Indicator

LED	Mode
Solid Green	EXECUTE
Blinking Green	CONFIGURE or ERROR (configuration error)
Red	ERROR (*time out*)
Off	No power to module

Table 5-2. Normal Operation Status LED States

LED				Description
1	2	3	4	
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 = Off; 1 = On

Analog Slave Module Indicators

The IMASM02/03/04 has a single front panel status indicator to show either normal or calibration connection. Figure 5-2 shows the location of the status LED. Table 5-3 explains the three states of the LED.

MODULE RESET

To reset the AMM, momentarily press the reset pushbutton located near the bottom of the AMM front plate.

START-UP PROCEDURES

NOTE: The Analog Slave Modules (ASM) are ready for operation after being configured, and as soon as they are installed. The front panel module status indicator for the IMASM02/03/04 will indicate operating conditions. The IMASM01 does not have a front panel indicator.

Start-up of the AMM is fully automatic. Its address dipswitch must be configured before installing the module. If the mode and status LEDs do not light after installation, refer to Section 6 for corrective actions.

The AMM performs self tests during start-up to verify circuit integrity. Once the AMM is on-line, a configuration must be loaded to initiate AMM functions.

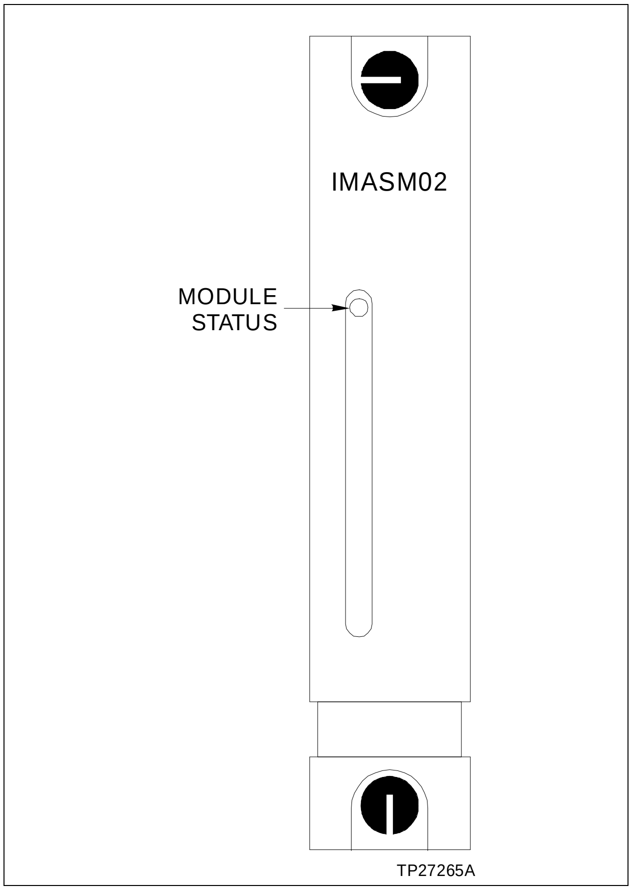


Figure 5-2. ASM Front Panel

Table 5-3. IMASM02/03/04 Status LED Indicator

LED	Indication
Green	Termination cable connected to normal operation TU socket (P1 or P2) if using termination units.
	ASM is in its normal operating MMU slot if using termination modules.
Red	Termination cable connected to TU calibration socket (P3) if using termination units.
	ASM is in its MMU calibration slot if using termination modules.
Off	No power to module.

SECTION 6 - TROUBLESHOOTING

INTRODUCTION

This section explains the error indications and corrective actions for the Analog Master Module (AMM) and Analog Slave Modules (ASM).

NOTE: If the corrective actions in this section do not correct a problem with these modules, replace the module or contact your nearest Bailey Controls representative. Refer to Section 8 for procedures to replace an AMM and ASM.

ERROR INDICATIONS AND CORRECTIVE ACTION

The status of the AMM can be obtained through an operator interface or the front panel LED indicators. An operator interface can also be used to verify the input values sent to the AMM from an ASM (i.e., monitor FC 73). Refer to ***MONITORING INPUT VALUES*** in Section 4. Operator interfaces include the Configuration and Tuning Terminal (CTT), Operator Interface Station (OIS), Management Command System (MCS) or Engineering Work Station (EWS).

Analog Master Module Indicators

The AMM has a single mode LED indicator and a group of four status indicators. These indicators show either normal operating conditions or error conditions.

MODE LED

The mode LED indicates both normal and error conditions for the AMM. Table 6-1 summarizes the LED states, probable causes and corrective actions to take for the different indications. An explanation of the error indications follows. Refer to Section 5 for the normal indications.

Solid Red A solid red LED indicates a module hardware failure (*time out*). During this type of error, the module halts all operation and does not communicate over the module bus. Without communication over the module bus, the module status bytes cannot be accessed. The conditions that cause a *time out* are:

- Configuration error (undefined reference or data type conflict).
- Power fail or reset during a NVRAM write.
- On-line self test failure during start-up (RAM or ROM failure).
- Excessive analog input gain or offset error.

Table 6-1. AMM Module Mode LED Indications and Corrective Actions

LED State	Indication	Probable Cause	Corrective Action
Solid Green	Module in EXECUTE mode. No errors exist.	Normal operation.	No corrective action required.
Blinking Green	AMM in CONFIGURE mode.	Normal operation.	No correctiveaction required.
	Configuration error; module in ERROR mode. Operator interface indicates ERROR mode.	Configuration error detected when attempting to go from CONFIGURE to EXECUTE mode.	Return to CONFIGURE mode. Read module status to determine error.
	NVRAM error while in EXECUTE mode. Module continues to operateusing its current configuration. Configuration cannot be tuned.	NVRAMfailure.	Replace module or contact nearest Bailey Controls representative. Reset or mode change causes the module to lose its configuration.
Red	Machine fault timer error (*time out*); module in ERROR mode. AMM does not communicate with modules on module bus. Status bytes cannot be read.	Microprocessor or related hardware failure.	Press reset switch to attempt to clear the error. If this does not reset the error, replace module or contact nearest Bailey Controls representative.
Off	No power to AMM.	Module not completely inserted in MMU.	Verify module is completely inserted in MMU: faceplate flush with MMU and captive retaining screws latched.
	+5 VDC logic power failure (on board AMM). LED or LED driver circuit failure.	AMM circuit failure.	Replace module or contact nearest Bailey Controls representative.

NOTE: Refer to the ***Machine Fault Timer*** in Section 2 for an explanation of the Machine Fault Timer.

When a *time out* error exists, a few steps can be performed to try to clear the error:

1. Reset the module to bring it back on-line.

2. If the module will not reset, try to reinitialize it by removing the module, setting the hardware configuration switch to initialize and reinserting the module.

    NOTE: The mode LED will blink green when initialization is complete.

3. Set the hardware configuration switch to its normal operating condition, download the AMM configuration and attempt to place the module in EXECUTE mode.

If this does not clear the error, refer to ***DIAGNOSTICS*** in this section to try to localize the error.

Blinking Green

The LED blinking green indicates that the module has detected an error in configuration when attempting to go from CONFIGURE to EXECUTE mode. The module status bytes can be monitored to identify the configuration error (refer to Table 6-2).

The AMM also enters this ERROR mode 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. The module uses its current configuration to maintain operation; the configuration cannot be modified (i.e., tuned) in this mode. If a reset or mode change occurs during this error, the module loses its configuration.

STATUS LEDS

Table 6-2 interprets the error indications presented by the status LEDs.

Table 6-2. AMM Status LED Error Indications

1	2	3	4	Description
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.
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 VDC 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.

NOTE: 0 = LED OFF; 1 = ON

Analog Slave Module Indicator

An IMASM02/03/04 has a single LED indicator. This indicator is mainly to indicate whether the ASM is cable connected to the Termination Unit (TU) calibration socket, or its normal operating socket. It also indicates whether the ASM is in its normal operating MMU slot or in its calibration slot when using Termination Modules (TM). After installing the ASM, if this LED does not light either red or green, it may indicate an ASM hardware failure.

STATUS BYTES

The AMM status bytes provide information concerning the primary and backup AMM, slave modules and AMM inputs. The status bytes display as hexadecimal values on the CTT, and are available by displaying the module address and pressing the NEXT key. On the OIS, MCS or EWS, the status bytes can be accessed by displaying the module status screen. Table 6-3 interprets the bits presented in the module status bytes.

DIAGNOSTICS

NOTE: Entering diagnostic mode takes the AMM off-line.

AMM on board diagnostics can be run to verify circuit operation. Setting the hardware configuration dipswitch (S2) to the various diagnostic option positions and installing the AMM in the MMU initiates the tests. Table 6-4 shows the dipswitch positions required to initiate a diagnostic test. The procedures to run the individual tests follow. A failure of any of these diagnostic tests indicates a hardware failure. Replace the module or contact your nearest Bailey Controls representative.

NOTE: For INFI 90 dipswitches, OPEN and OFF have the same meaning.

Table 6-3. Module Status Bytes

Byte	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
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							

Table 6-3. Module Status Bytes (continued)

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 <197> 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	
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 6-4. AMM Configuration Switch Diagnostics Settings

Diagnostic Mode								
Switch								Description
MSB							LSB	
1	2	3	4	5	6	7	8	
1	1	1						**Diagnostic Mode**
								Halt Select
			0					Continue on fail
			1					Halt on fail
								Diagnostic Select
				0	0	0	0	Switches and LEDs
				0	0	0	1	ROM
				0	0	1	0	RAM
				0	0	1	1	Timer
				0	1	0	0	DIS
				0	1	0	1	Redundancy link
				0	1	1	0	DO and master status
				0	1	1	1	MFT
				1	1	1	1	ROM, RAM, and timer as group

NOTES: (1 = Switch open or off; 0 = Switch closed or on.)
1. Running the diagnostics with *halt on fail* set causes the mode LED to turn red if an error is encountered during the diagnostic test. The following procedures indicate test results when the *halt on fail* is not set.
2. S2 dipswitch positions 1 thru 3 must be in the OPEN position to enter diagnostics mode.

The diagnostic tests can be performed with the AMM in any MMU slot that provides power to the AMM. For some tests, the AMM must be placed in a slot where the hardware configuration switch can be accessed.

Test 0

The switch and LED test verifies that the microprocessor can read each dipswitch position, and verifies that the mode LED and each status LED functions. To run the test:

1. Set the hardware configuration dipswitches to the Test 0 positions (refer to Table 6-4).

2. Insert the module into an MMU slot. It must be placed in a slot that allows access to the configuration switch.

3. Set ALL dipswitch positions to the CLOSED (ON) position.

4. Toggle dipswitch position 1 to the OPEN position. The mode LED should change from green to off, and one of the red status LEDs should turn on.

5. Return the switch to the CLOSED position. The LEDs should return to their opposite states.

6. Repeat Steps 3 and 4 for each of the remaining dipswitch positions (i.e., 2 thru 8).

7. Return to operation or continue to next test.

Test 1 The ROM test initiates a ROM checksum test. To run the test:

1. Set the hardware configuration dipswitches to the Test 1 positions (refer to Table 6-4).

2. Insert the module into a MMU slot. The mode LED will blink green if the test passes. If the test fails, the mode LED turns red.

3. Return to operation or continue to next test.

Test 2 The RAM test initiates a read and write sequence for the RAM. To run the test:

1. Set the hardware configuration dipswitches to the Test 2 positions (refer to Table 6-4).

2. Insert the module into a MMU slot with power. The mode LED will blink green if the test passes. If the test fails, the mode LED will be off.

3. Return to operation or continue to next test.

Test 3 The timer test verifies the AMM internal timers. To run the test:

1. Set the hardware configuration dipswitches to the Test 3 positions (refer to Table 6-4).

2. Insert the module into a MMU slot. The mode LED will blink green if the test passes. If the test fails, the mode LED will turn solid green.

3. Return to operation or continue to next test.

Test 4 The DIS test verifies that the AMM can communicate properly with a NDIS01. A NDIS01 must be connected for the AMM to run this test. To run the test:

1. Set the hardware configuration dipswitches to the Test 4 positions (refer to Table 6-4).

2. Insert the module into a MMU slot. If the test runs properly, the display on the station will indicate a 0 percent, then 50 percent, 75 percent, 25 percent and back to 0 percent.

3. Return to operation or continue to next test.

NOTE: This verifies the indicator station serial link and cable connections.

Test 5 The redundancy link test verifies that redundant AMMs (i.e., primary and secondary) can communicate properly. This test checks AMM hardware and also the cables that connect the pair. To run the test:

1. Set the hardware configuration switch on BOTH AMMs to the Test 5 positions (refer to Table 6-4).

2. Insert the modules into the MMU.

NOTE: The module that is reset last becomes the primary and its mode LED will blink green. The mode LED on the other module will remain solid green.

3. After receiving the proper indications, set S2 position 4 on the primary AMM to the OPEN position (halt on fail). Let the modules run for a few minutes. If the AMMs are not synchronized, reset one of the modules.

4. Push and hold the reset switch on the module with the solid green mode LED (i.e., secondary). The primary module should recognize the error and its mode LED should turn red (i.e., halt on fail).

5. Return the switches to their original positions and return to operation, or continue to next test.

Test 6 The Digital Output (DO) and master status test verifies that the interrupt circuitry that signals failure of a primary AMM to a redundant AMM works properly. It also verifies that the DO signal that enables a relay on an NTAM01 is working.

NOTE: If an NTAM01 is not used with the redundant pair, the DO signal is not tested.

To run the test:

1. Set the hardware configuration switch on BOTH AMMs to the Test 6 positions (refer to Table 6-4).

2. Reset each AMM. If the test is working properly, the mode LED will blink green and be synchronized on each AMM. If a NTAM01 is used, the relay on the NTAM01 will make a periodic buzzing sound.

NOTE: If the LEDs do not synchronize, immediately reset one of the modules. If after a few attempts the AMMs do not synchronize, there is a problem with one of the AMMs or the cable connections.

3. After receiving the proper indications, set S2 position 4 on the primary AMM to the OPEN position (halt on fail). Let the modules run for a few minutes. If the AMMs are not synchronized, reset one of the modules.

4. Push and hold the reset switch on the secondary module. The primary module should recognize the error and its mode LED should turn red (i.e., halt on error).

5. Return the switches to their original positions and return to operation, or continue to next test.

Test 7 The Machine Fault Timer (MFT) test verifies that the MFT works properly, and disables the AMM after timing out.

1. Set the hardware configuration dipswitches to the Test 7 positions (refer to Table 6-4).

2. Insert the module into a MMU slot with power. The mode LED should turn green and then turn red after a few moments to indicate a *time out*.

3. Return to operation or continue to next test.

Test 15 This test runs the RAM, ROM and TIMER test as a group.

1. Set the hardware configuration dipswitches to the Test 15 positions (refer to Table 6-4).

2. Insert the module into a MMU slot. The mode LED will blink green if the test passes. If the test fails, the mode LED turns red for a ROM failure, off for a RAM failure or solid green for a timer failure.

3. Return to operation or continue to next test.

CONNECTOR PINOUTS

Tables 6-5 through 6-12 show the pinouts for the AMM and ASM edge connectors.

Analog Master Module

Table 6-5. P1 Pinout

Pin	Signal	Pin	Signal
1	+5 VDC	2	+5 VDC
3	NC	4	NC
5	COMMON	6	COMMON
7	+15 VDC	8	-15 VDC
9	PFI	10	NC
11	Module Bus	12	NC

NOTE: NC = Not Connected, PFI = Power Fail Interrupt

Table 6-6. P2 Pinout

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

NOTE: A = Address bit

Table 6-7. P3 Pinout

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

NOTES:

1. Drives a relay on the NTAM01 to switch cold junction RTD inputs between primary and secondary AMM.
2. Indicates primary or secondary AMM to the other AMM in a redundant pair configuration.

Analog Slave Module

Table 6-8. P1 Pinout (All ASMs)

Pin	Signal	Pin	Signal
1	+5 VDC	2	+5 VDC
3	NC	4	NC
5	COMMON	6	COMMON
7	+15 VDC	8	-15 VDC
9	NC	10	NC
11	NC	12	NC

NOTE: NC = Not Connected

Table 6-9. P2 Pinout (All ASMs)

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

NOTE: A = Address Bit, NC = Not Connected

Table 6-10. P3 Pinout (IMASM01)

Pin	Signal	Pin	Signal
1	AI1 (-)	A	AI1 (+)
2	AI2 (-)	B	AI2 (+)
3	AI3 (-)	C	AI3 (+)
4	AI4 (-)	D	AI4 (+)
5	AI5 (-)	E	AI5 (+)
6	AI6 (-)	F	AI6 (+)
7	AI7 (-)	H	AI7 (+)
8	AI8 (-)	J	AI8 (+)
9	AI9 (-)	K	AI9 (+)
10	AI10 (-)	L	AI10 (+)
11	AI11 (-)	M	AI11 (+)
12	AI12 (-)	N	AI12 (+)
13	AI15 (+)	P	AI13 (+)
14	AI16 (+)	R	AI14 (+)
15	AI13/14/15 (-)	S	NC

NOTE: AI = Analog input, NC = Not connected

Table 6-11. P3 Pinout (IMASM02)

Pin	Signal	Pin	Signal
1	AI1 (+)	A	AI1 (-)
2	NC	B	NC
3	AI2 (+)	C	AI2 (-)
4	NC	D	NC
5	AI3 (+)	E	AI3 (-)
6	NC	F	NC
7	AI4 (+)	H	AI4 (-)
8	NC	J	NC
9	AI5 (+)	K	AI5 (-)
10	NC	L	NC
11	AI6 (+)	M	AI6 (-)
12	+24 VDC[1]	N	COMMON (TU)

Table 6-11. P3 Pinout (IMASM02) (continued)

Pin	Signal	Pin	Signal
13	AI7 (+)	P	AI7 (-)
14	COMMON	R	NC
15	AI8 (+)	S	AI8 (-)

NOTES: AI = Analog input, NC = Not connected

1. The +24 VDC is used to indicate the status, calibration or normal operation, of the IMASM02. 24 VDC is connected when the IMASM02 is in its normal operating slot or when its termination cable is connected to the normal operation connector (P1 or P2) on a NTAI02.

Table 6-12. P3 Pinout (IMASM03/04)

Pin	Signal	Pin	Signal
1	RTD 1 (B)	A	RTD 1 (A)
2	RTD 1 (C)	B	NC
3	RTD 2 (B)	C	RTD 2 (A)
4	RTD 2 (C)	D	NC
5	RTD 3 (B)	E	RTD 3 (A)
6	RTD 3 (C)	F	NC
7	RTD 4 (B)	H	RTD 4 (A)
8	RTD 4 (C)	J	NC
9	RTD 5 (B)	K	RTD 5 (A)
10	RTD 5 (C)	L	+24 VDC[1]
11	RTD 6 (B)	M	RTD 6 (A)
12	RTD 6 (C)	N	COMMON
13	RTD 7 (B)	P	RTD 7 (A)
14	RTD 7 (C)	R	RTD 8 (C)
15	RTD 8 (A)	S	RTD 8 (B)

NOTES: NC = Not connected

1. The +24 VDC is used to indicate the status, calibration or normal operation, of the IMASM03/04. 24 VDC is connected when the IMASM03/04 is in its normal operating slot or when its termination cable is connected to the normal operation connector (P1 or P2) on a NTAI03/04.

SECTION 7 - MAINTENANCE

INTRODUCTION

The Analog Master Module (AMM) and Analog Slave Modules (ASM) require limited maintenance. This section contains a maintenance schedule.

MAINTENANCE SCHEDULE

Perform the tasks in Table 7-1 at the specified intervals.

Table 7-1. Maintenance Schedule

Task	Interval
Perform calibrations to adjust for component aging.	Every 6 months or during plant shutdown, whichever occurs first (refer to Section 4).
Clean and tighten all power and grounding connections.	Every 6 months or during plant shutdown, whichever occurs first.
Use a static safe vacuum cleaner to remove dust from: Modules Module Mounting Unit Fan Assembly Power Entry Panel Termination Units/Modules	Every 6 months or during plant shutdown, whichever occurs first.

SECTION 8 - REPAIR/REPLACEMENT PROCEDURES

INTRODUCTION

This section explains the replacement procedures for an Analog Master Module (AMM) and Analog Slave Module (ASM). There are no special tools required to replace these modules.

MODULE REPAIR/REPLACEMENT PROCEDURES

If you determine an AMM or ASM is faulty, replace it with a new one. ***DO NOT*** try to repair the module; replacing components may affect the module performance.

The module can be removed while system power is supplied. To replace a module:

1. Push and turn the two front panel captive retaining screws one half turn to unlatch the module. It is unlatched when the slots on the screws are vertical and the open end of the slots face away from the module.

2. Gently slide the module out of the MMU.

3. Configure the replacement module switch and jumper settings. Ensure they are set the same as the original module.

4. In the same slot assignment as the original module, align the replacement module with the guide rails in the MMU; gently slide it in until the front panel is flush with the top and bottom of the MMU frame.

5. Push and turn the two captive retaining screws on the module faceplate one half turn to the latched position. It is latched when the slots on the screws are vertical and the open ends face the center of the module.

6. Return to normal operation.

NOTE: If replacing an AMM, a new configuration must be loaded into the module.

SECTION 9 - SUPPORT SERVICES

INTRODUCTION

Bailey Controls is ready to help in the use, application and repair of its products. Contact your nearest sales office to make requests for sales, applications, installation, repair, overhaul and maintenance contract services.

REPLACEMENT PARTS AND ORDERING INFORMATION

When making repairs at your facility, order replacement parts from a Bailey Controls sales office. Provide this information:

1. Part description, part number and quantity.

2. Model and serial numbers (if applicable).

3. Bailey instruction instruction number, page number and reference figure that identifies the part.

Order parts without commercial descriptions from the nearest Bailey Controls sales office.

Table 9-1. Spare Parts List

Description	Part No.
IMASM01 Jumper	1946984A1

TRAINING

Bailey Controls has a modern training facility that provides service and repair instruction. This facility is available for in-plant training of your personnel. Contact a Bailey Controls sales office for specific information and scheduling.

TECHNICAL DOCUMENTATION

Additional copies of this instruction, or other Bailey Controls instructions, can be obtained from the nearest Bailey Controls sales office at a reasonable charge.

APPENDIX A - CABLE CONNECTIONS

INTRODUCTION

Cable connections for an IMAMM03 and IMASM01/02/03/04 vary depending on the master/slave combination and termination being used. Using an Indicator Station (NDIS01) with the IMAMM03 also adds to the cable requirements. Refer to Figures A-1 through A-10 to determine the cable requirements and connections for your application.

NOTE: For complete termination unit or module installation, cabling and terminal block wiring information refer to Termination Unit Manual I-E93-911.

IMAMM03

NOTE: In a single IMAMM03 configuration (without stations or IMASM02), the IMAMM03 communicates with its slave module over the slave expander bus and does not require additional cable connections. Refer to Figure A-2 for cable connections when operating with a station, and Figures A-3 through A-7 when operating with an IMASM02.

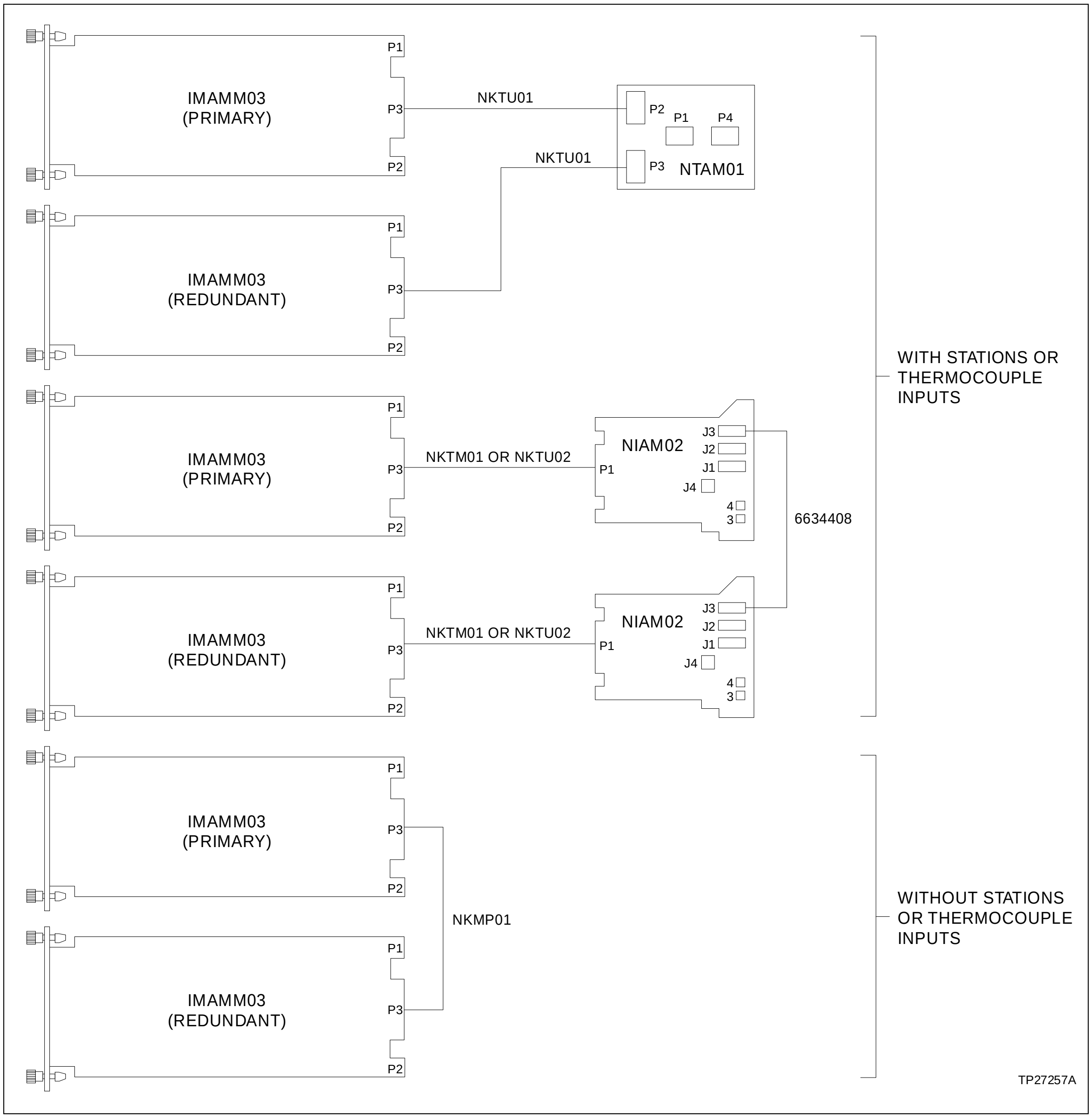
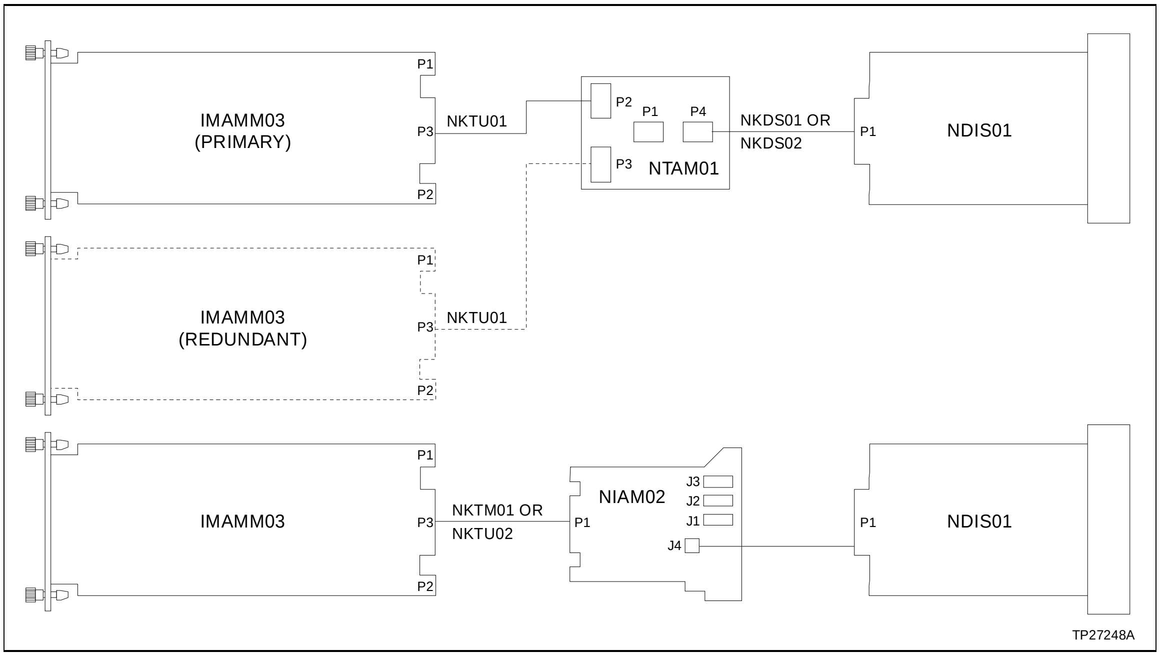


Figure A-1. Redundant IMAMM03 Cable Connections



NOTE: Up to four Indicator Stations (NDIS01) can be daisy chained from one NTAM01 or NIAM02 per IMAMM03.

Figure A-2. IMAMM03 with Indicator Station (NDIS01) Cable Connections

IMASM01

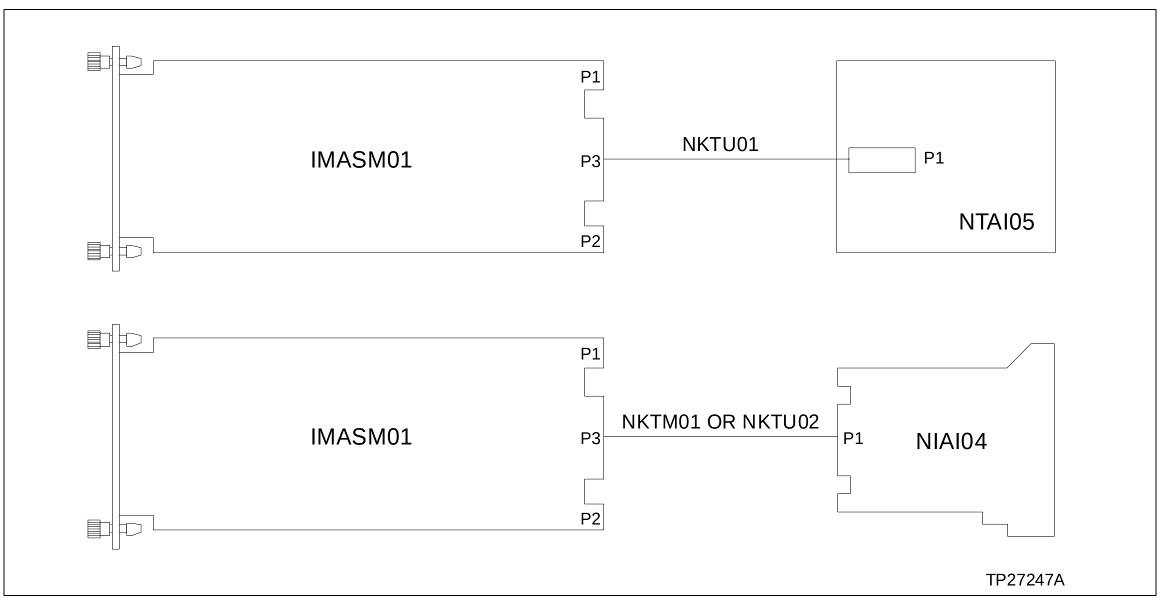


Figure A-3. IMASM01 Cable Connections

IMASM02

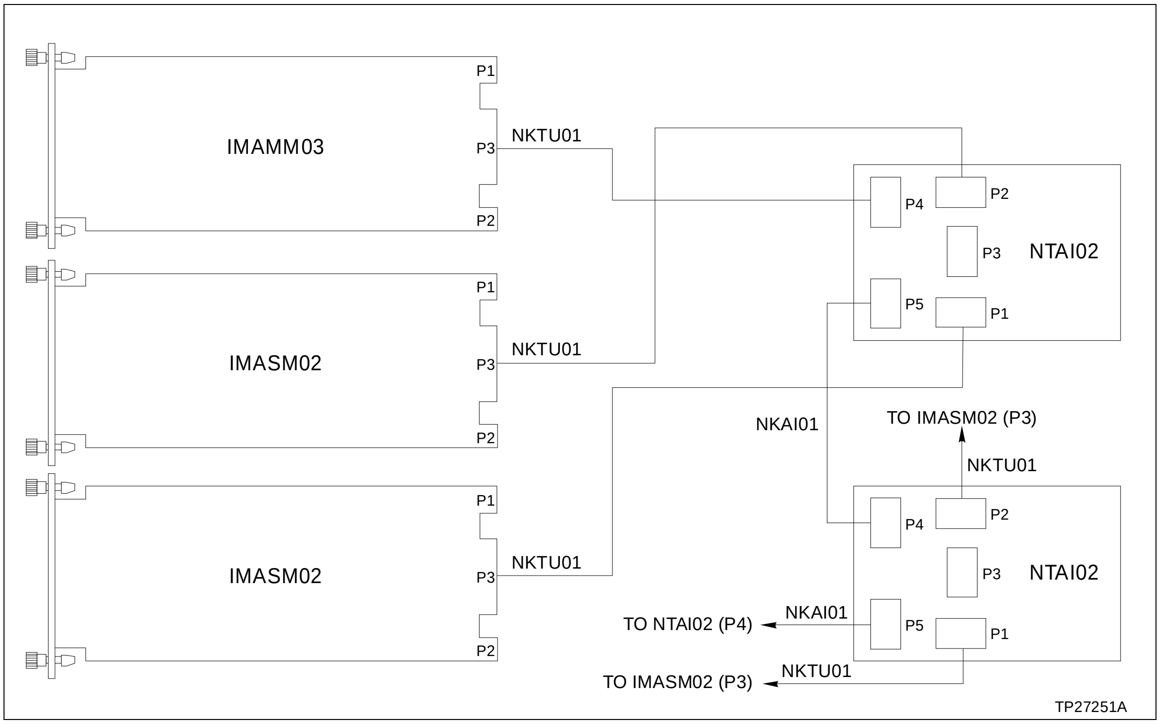


Figure A-4. Single IMAMM03 with IMASM02 Cable Connections (NTAI02)

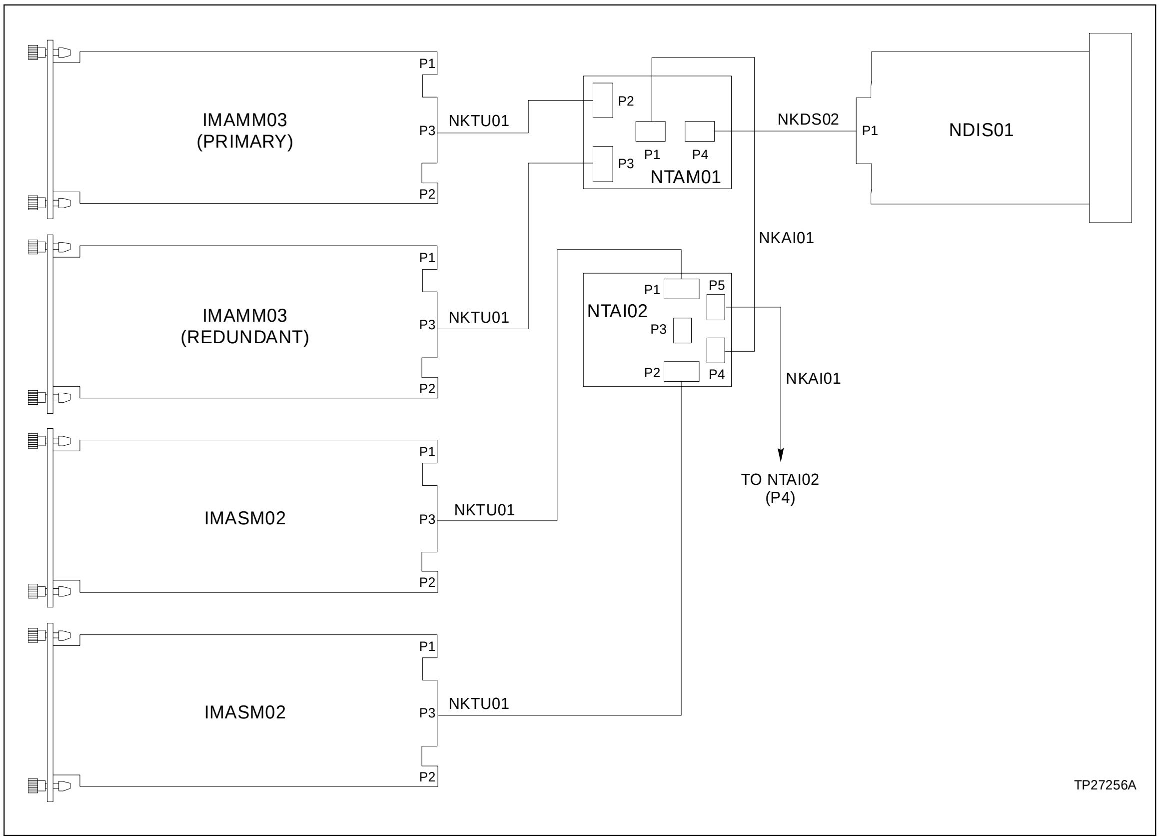


Figure A-5. Redundant IMAMM03 with IMASM02 Cable Connections (NTAI02)

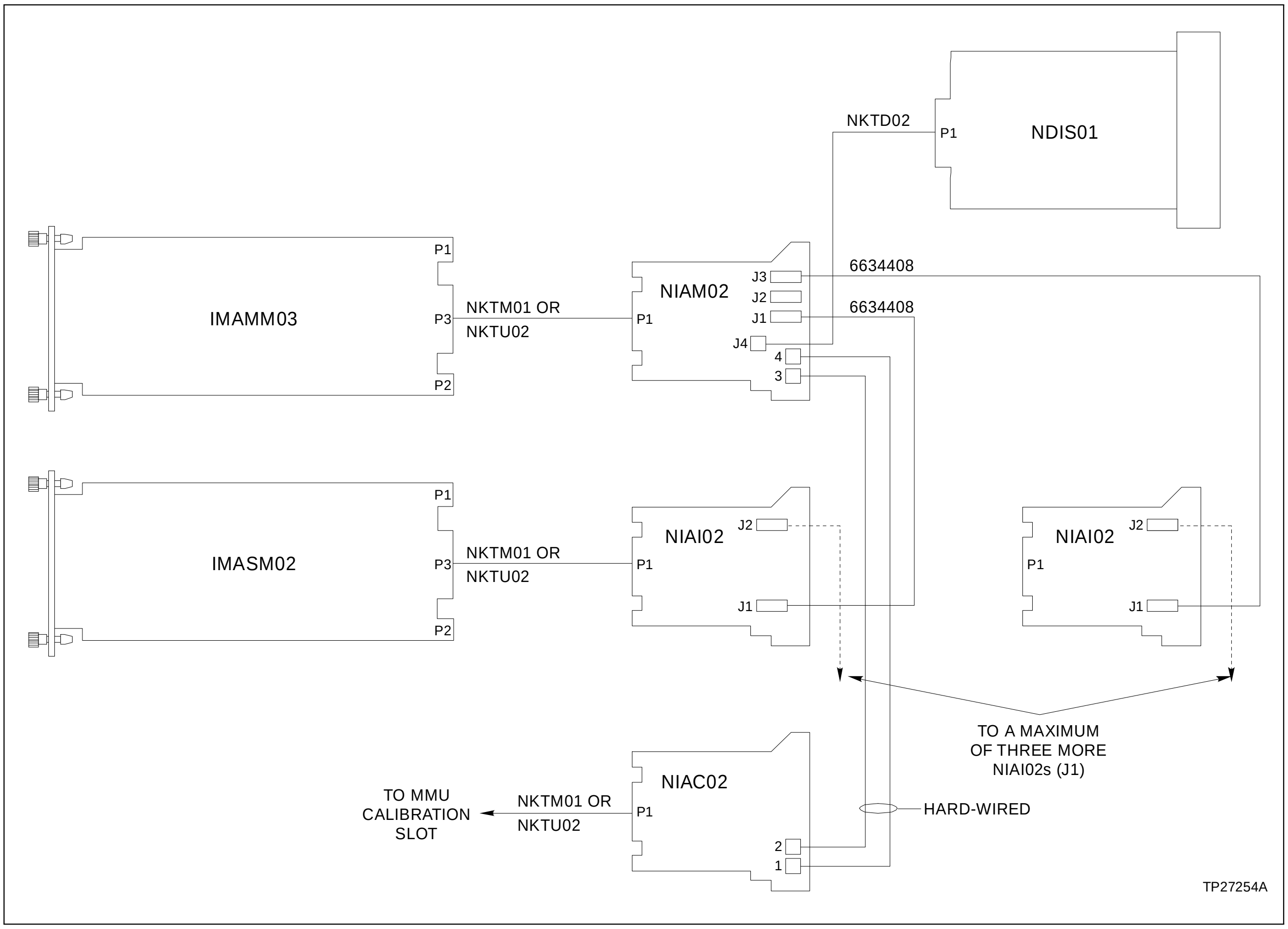


Figure A-6. Single IMAMM03 with IMASM02 Cable Connections (NIAI02)

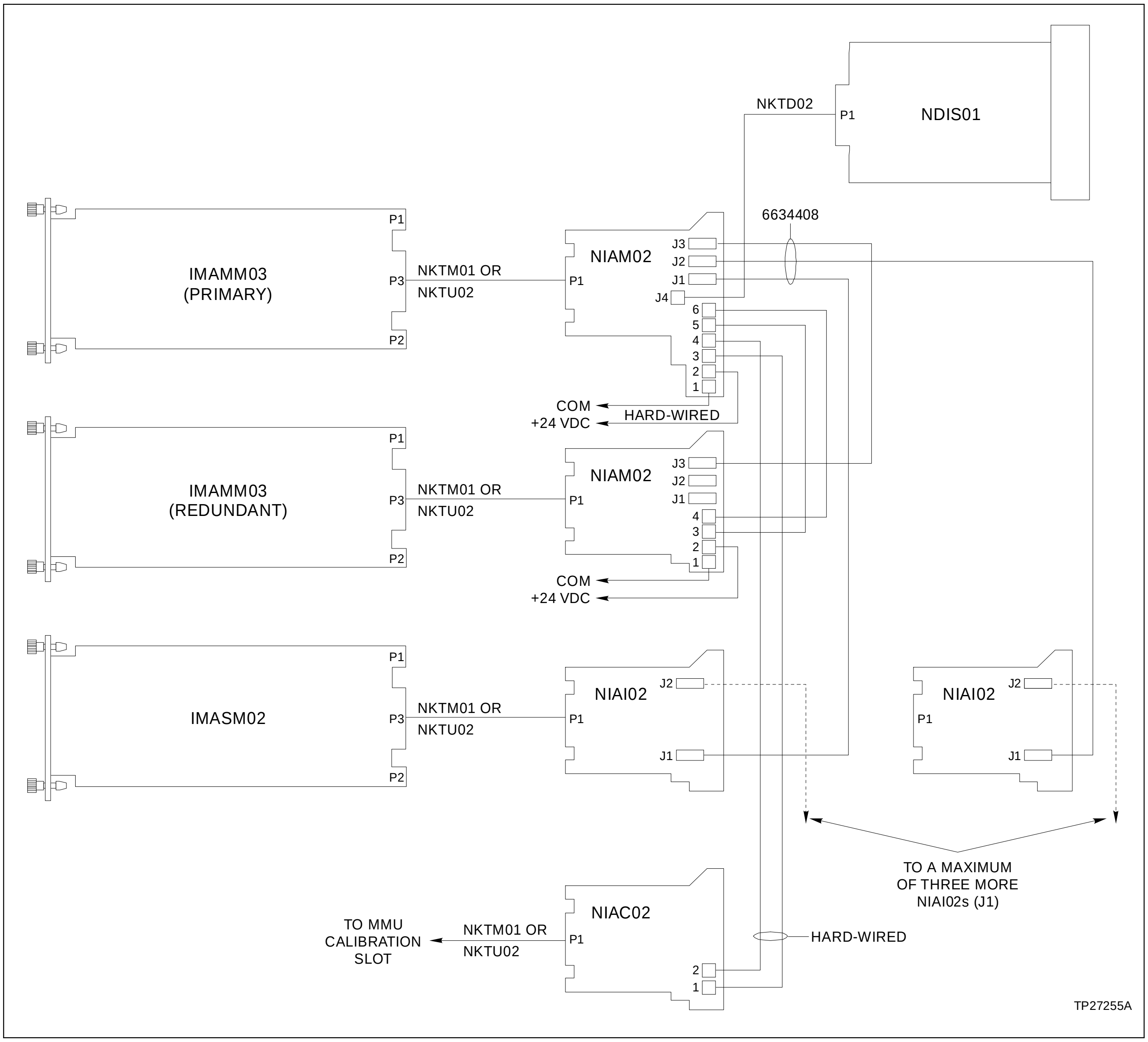


Figure A-7. Redundant IMAMM03 with IMASM02 Cable Connections (NIAI02)

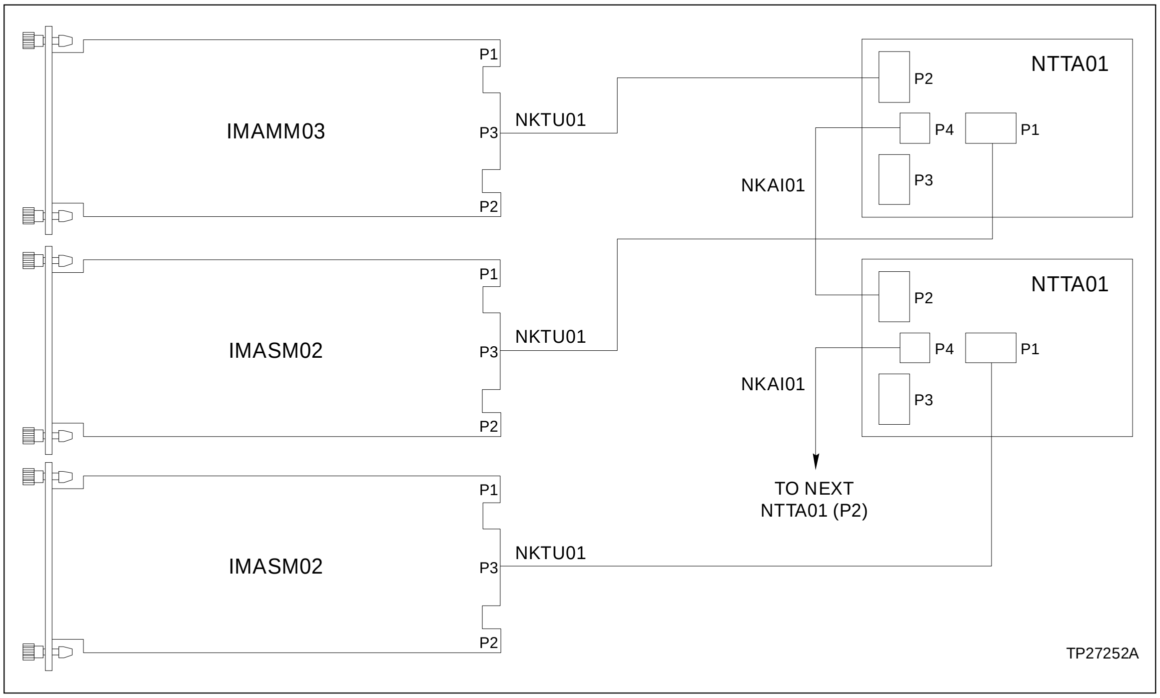


Figure A-8. IMASM02 with NTTA01 Cable Connections

IMASM03

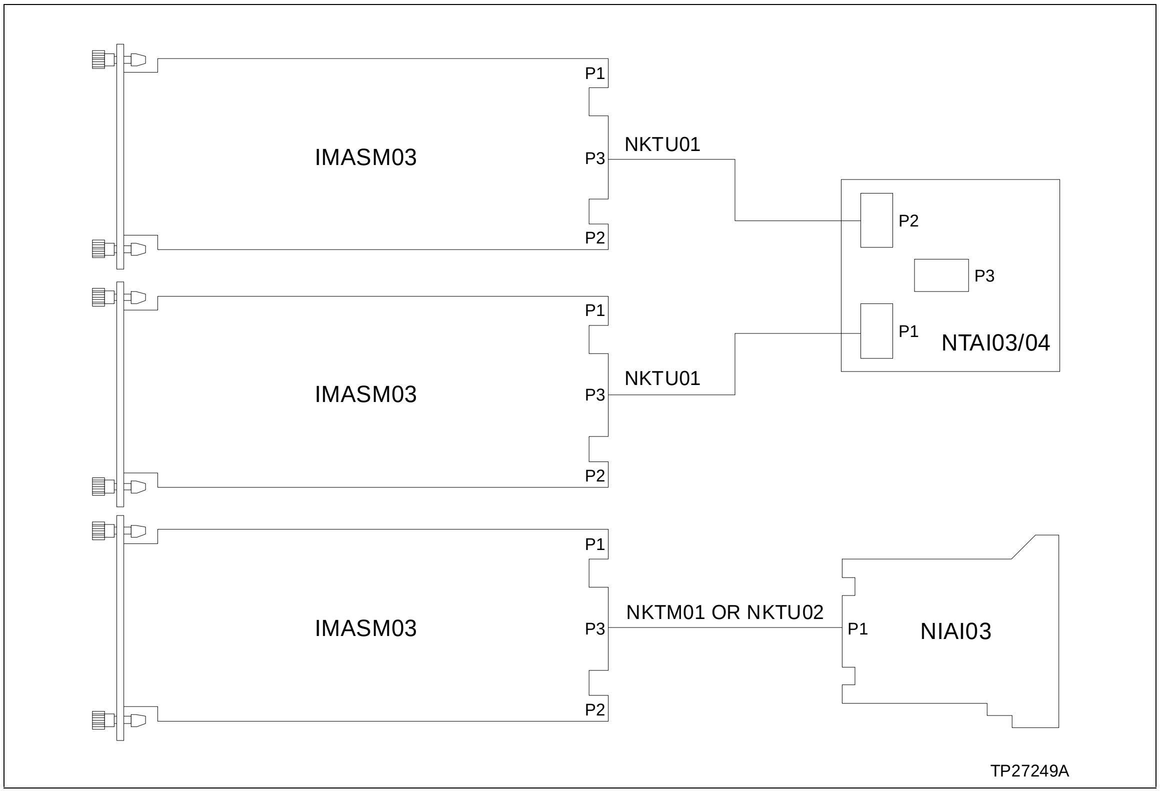


Figure A-9. IMASM03 Cable Connections

IMASM04

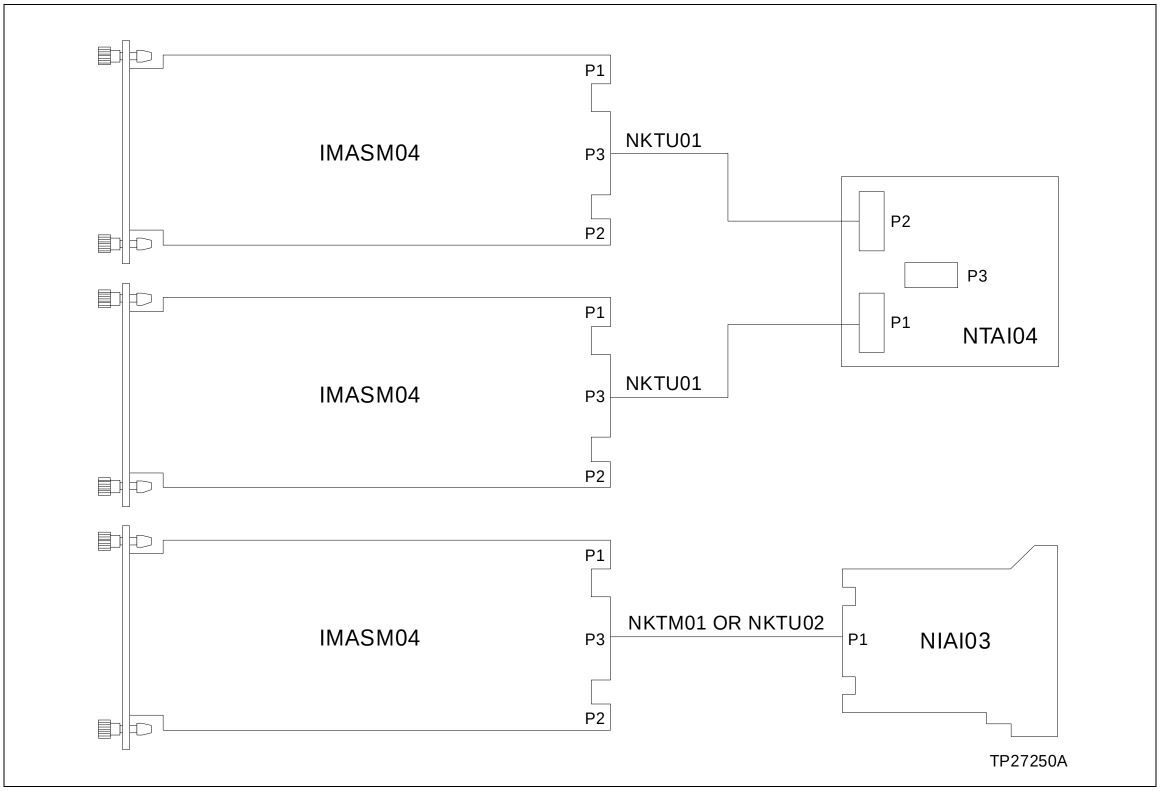


Figure A-10. IMASM04 Cable Connections

APPENDIX B - TERMINATION UNIT CONFIGURATION

INTRODUCTION

This appendix defines the hardware settings required to configure Termination Units (TU) that provide support for an Analog Master Module (AMM) and Analog Slave Modules (ASM). It also contains the terminal block assignments for field wiring.

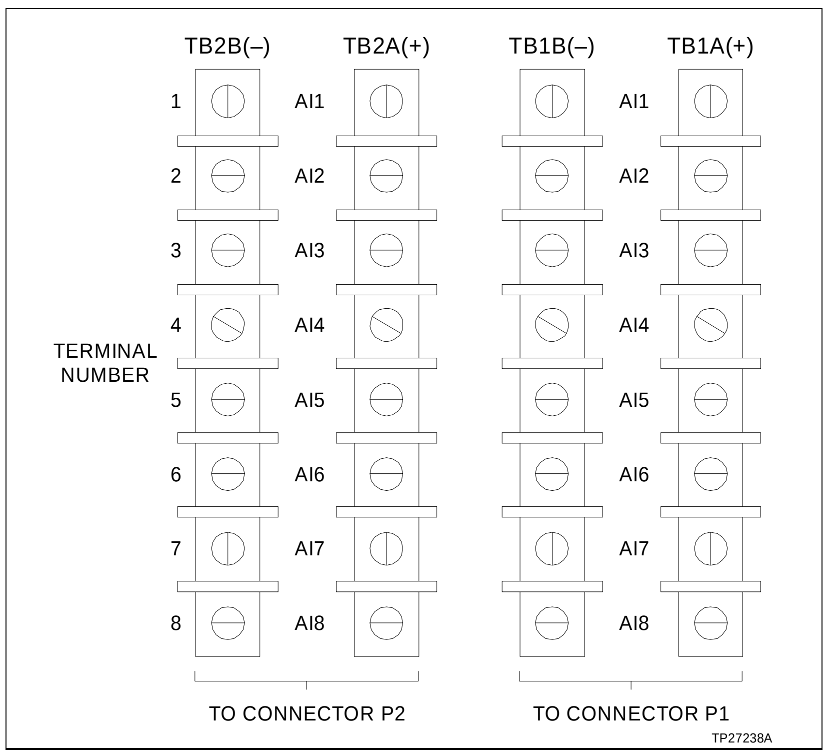
Refer to the Terminal Block Assignment Figures when connecting field wiring to the termination units.

NOTES:
1. Refer to Section 3 and Appendix A for cable connections.

2. The IMAMM03 uses a NTAM01 when it is operating in a redundant AMM configuration, with Indicator Stations (NDIS01) or with an IMASM02. The NTAM01 does not require hardware configuration.

NTAI02

NOTE: The NTAI02 does not require hardware configuration.



NOTE: AI = Analog Input

Figure B-1. NTAI02 Terminal Block Assignments

NTAI03/04

NOTE: The NTAI03 and NTAI04 do not require hardware configuration.

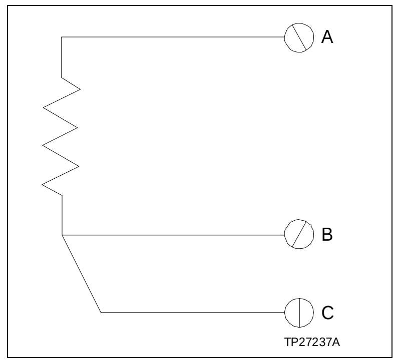


Figure B-2. Typical RTD Connections

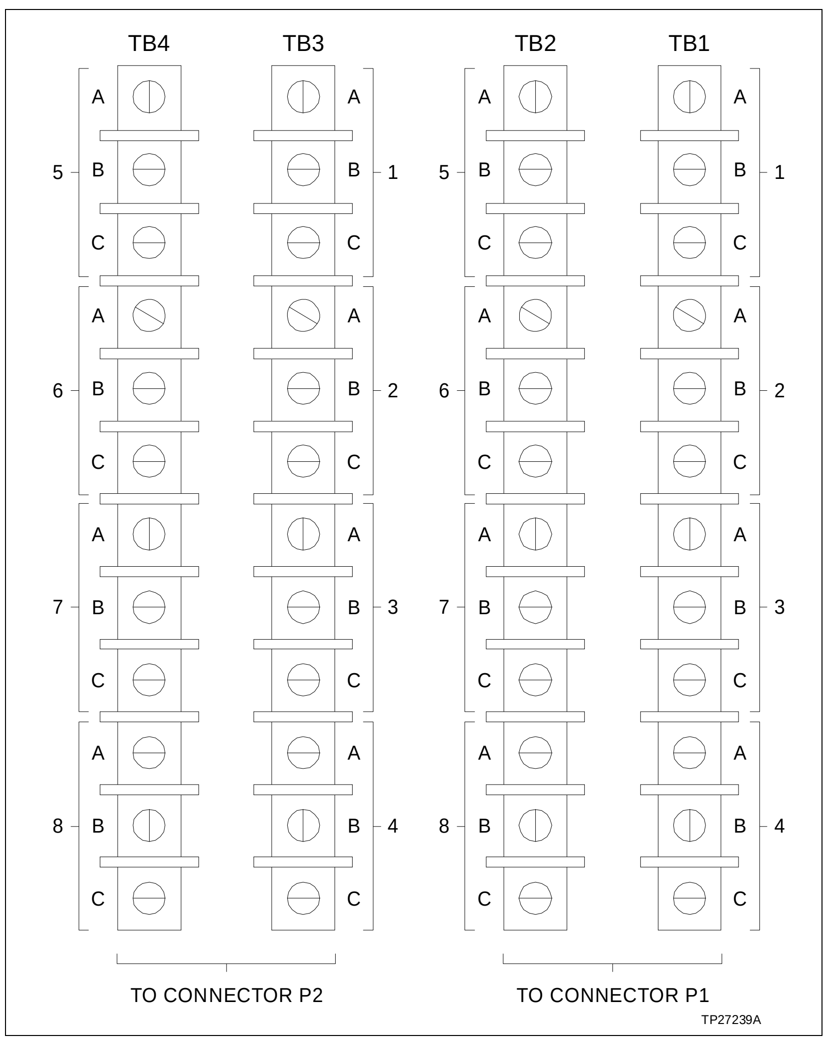


Figure B-3. NTAI03/04 Terminal Block Assignments

NTAI05

Dipshunts on the Thermocouple Termination Unit (NTAI05) configure field analog inputs sent to an IMASM01. The Analog Slave Module (ASM) can input signals of 4 to 20 mA, 1 to 5 VDC, 0 to 5 VDC, 0 to 10 VDC or -10 to +10 VDC. The dipshunts determine the input capability.

Figure B-4 shows the NTAI05 dipshunt socket and the analog signal path from the field device to the AMM/ASM. Refer to Table B-1 to determine the dipshunt strapping for your application.

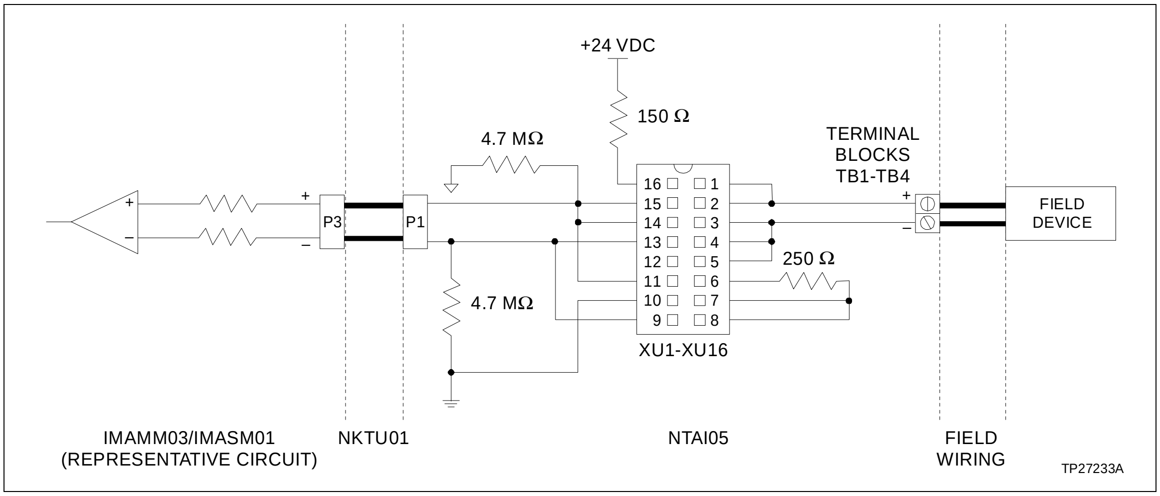
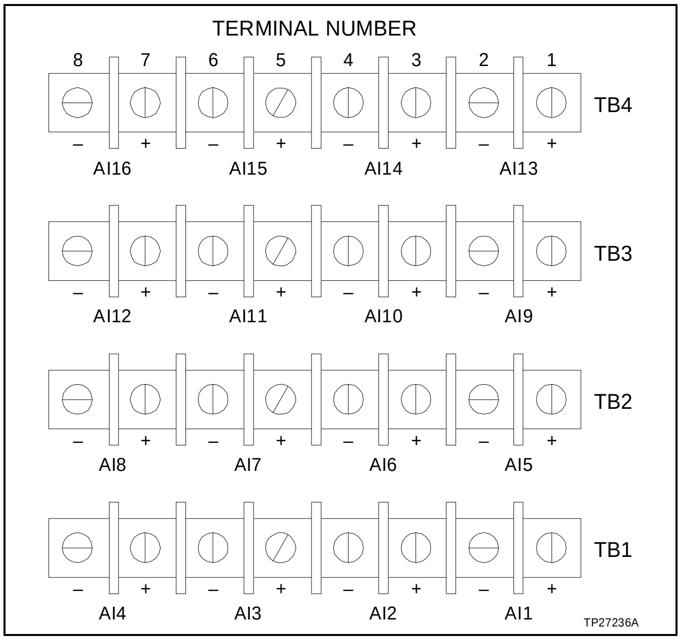


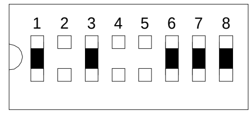
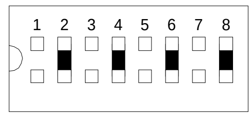
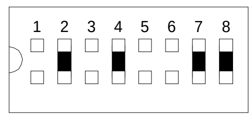
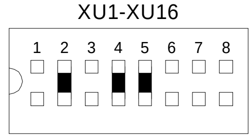
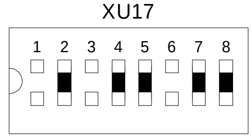
Figure B-4. NTAI05 to IMAMM03/IMASM01 Diagram



NOTE: AI = Analog Input

Figure B-5. NTAI05 Terminal Block Assignments

Table B-1. NTAI05 Dipshunt Configuration

Application/Signal Type	Dipshunt Configuration
System Powered 4 - 20 mA	XU1-XU16 
Externally Powered 4 - 20 mA	XU1-XU16 
Single Ended Voltage	XU1-XU16 
Differential Voltage	XU1-XU16 
All Applications	XU17  TP27260A

NTTA01

The Translator Termination Unit (NTTA01) converts high level inputs (4 to 20 mA and 1 to 5 VDC) to low level signals. Dipshunts on the TU configure field analog inputs that are sent to an IMASM02; the ASM can input low level signals. The dipshunts determine the input capability.

Figure B-6 shows the NTTA01 dipshunt socket and the analog signal path from the field device to the ASM. Refer to Table B-2 to determine the dipshunt strapping for your application.

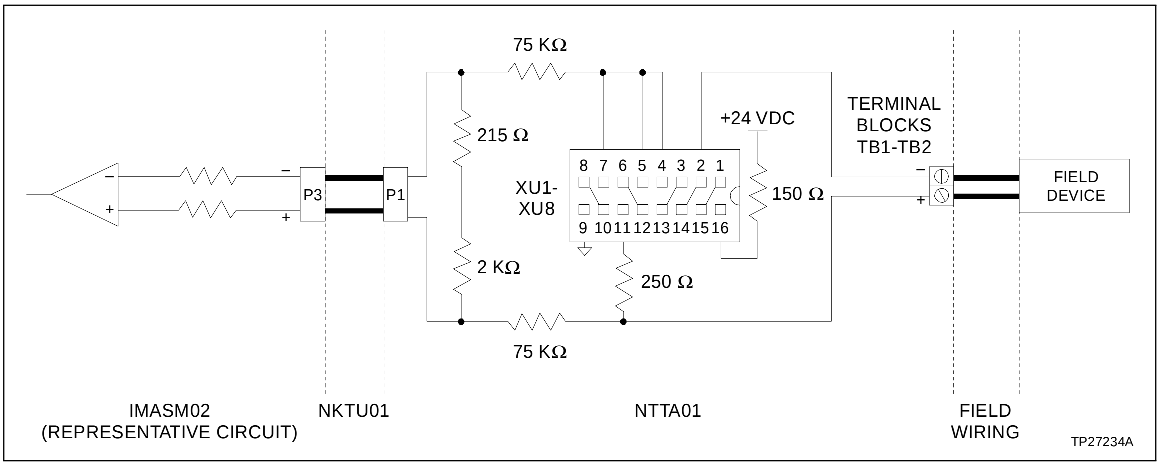
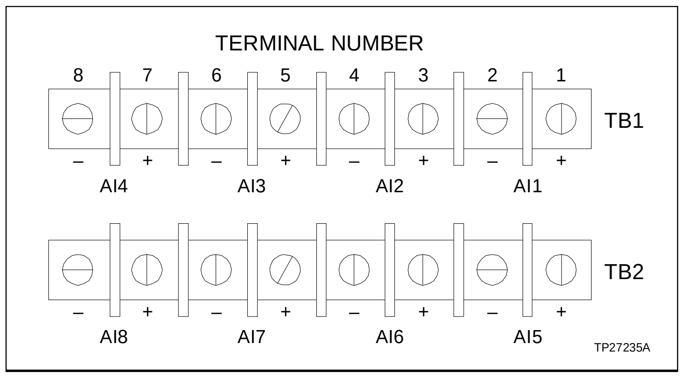


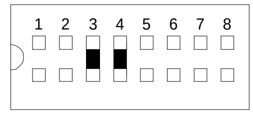
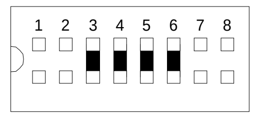
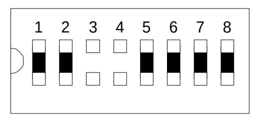
Figure B-6. NTTA01 to IMASM02



NOTE: AI = Analog Input

Figure B-7. NTTA01 Terminal Block Assignments

Table B-2. NTTA01 Dipshunt Configuration

Application/Signal Type	Dipshunt XU1 - XU8
1 - 5 VDC	
Externally Powered 4 - 20 mA	
System Powered 4 - 20 mA	 TP27261A

APPENDIX C - TERMINATION MODULE CONFIGURATION

INTRODUCTION

This appendix defines the hardware settings required to configure Termination Modules (TM) that provide support for an Analog Master Module (AMM) and Analog Slave Modules (ASM). It also contains the terminal block assignments for field wiring.

Refer to the Terminal Block Assignment Figures when connecting field wiring to the termination modules.

NOTE: Refer to the Section 3 and Appendix A for cable connections.

NIAM02

The IMAMM03 uses a NIAM02 when operating in a redundant pair, with Indicator Stations (NDIS01) or with an IMASM02 for thermocouple inputs. The NIAM02 has four eight position dipswitches (S1, S2, S3 and S4).

When operating with an IMASM02, an AMM reads RTD elements on the NIAI02 for thermocouple cold junction compensation. An NIAI02 has only one RTD. The AMM reads a pair of RTDs and averages there values to determine the compensation factor. If there is an odd number of NIAI02s connected to the NIAM02, the AMM averages the value of the odd NIAI02 with an RTD on board the NIAM02.

S1 selects the NIAM02 cold junction RTD element. The assignment of this RTD element depends on which RTD pair contains a single slave. Refer to Table C-1 for the switch settings.

S2, S3 and S4 are used only when two NIAM02s operate with a redundant AMM pair. These switches allow proper communication between the primary and redundant AMM. Refer to Table C-2 for the switch settings.

Table C-1. S1 Dipswitch Settings

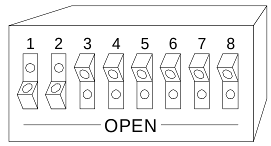
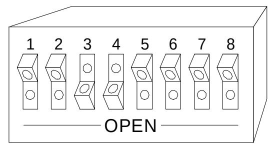
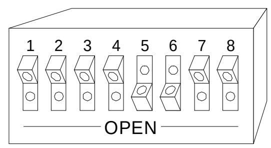
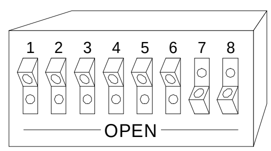
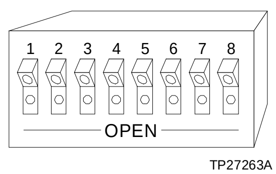
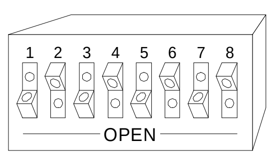
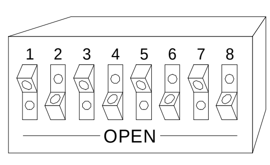
Number of TMs	RTD Pair	Switch S1
1	A	
3	B	
5	C	
7	D	
2/4/6/8	A/B/C/D	

Table C-2. S2, S3 and S4 Dipswitch Settings

TM	Switch S1
Primary NIAM02	
Secondary NIAM02	

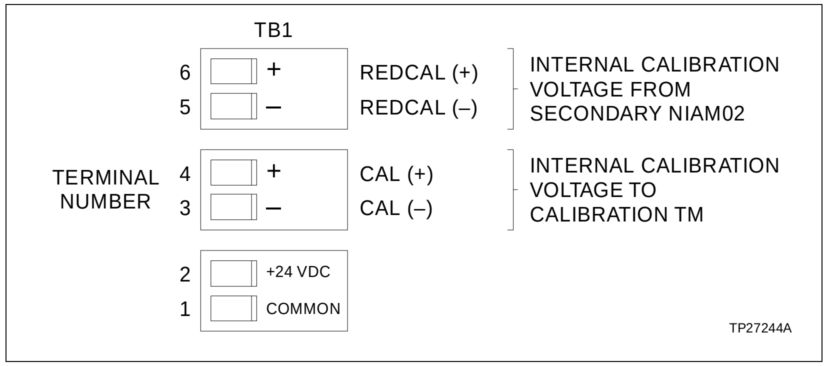


Figure C-1. NIAM02 Terminal Assignments

NIAI02

NOTE: The NIAI02 does not require hardware configuration.

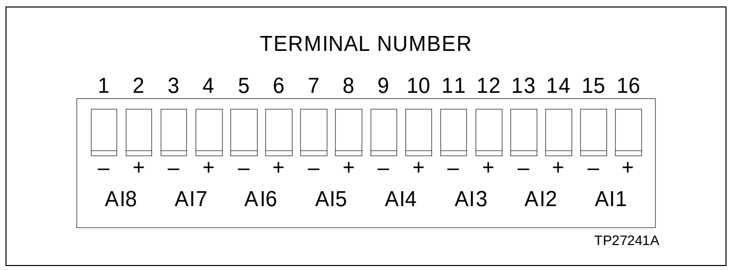


Figure C-2. NIAI02 Terminal Block Assignments

NIAI03

NOTE: The NIAI03 does not require hardware configuration.

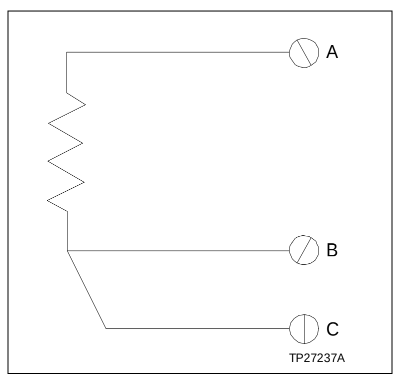


Figure C-3. Typical RTD Connections

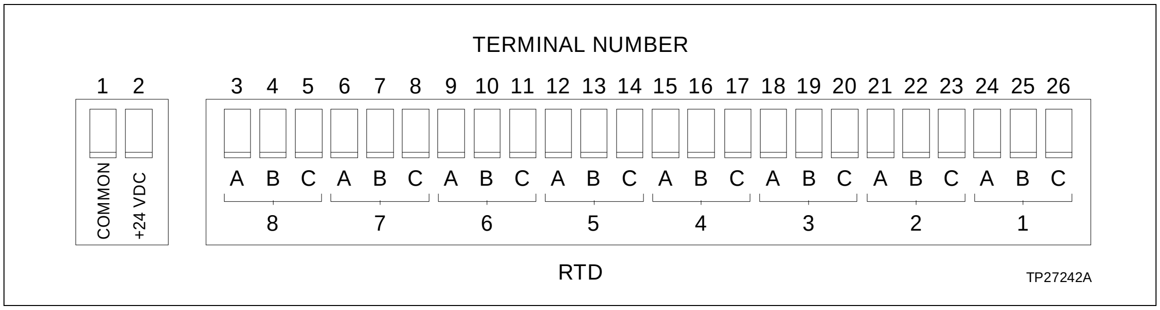


Figure C-4. NIAI03 Terminal Block Assignments

NIAI04

Dipswitches on the High Level Termination Module (NIAI04) configure field analog inputs sent to an IMASM01. The Analog Slave Module (ASM) can input signals of 4 to 20 mA, 1 to 5 VDC, 0 to 5 VDC, 0 to 10 VDC or -10 to +10 VDC. The dipswitches determine the input capability.

Figure C-5 shows the NIAI04 dipswitch and the analog signal path from the field device to the AMM/ASM. Refer to Table C-3 to determine the dipswitch settings for your application.

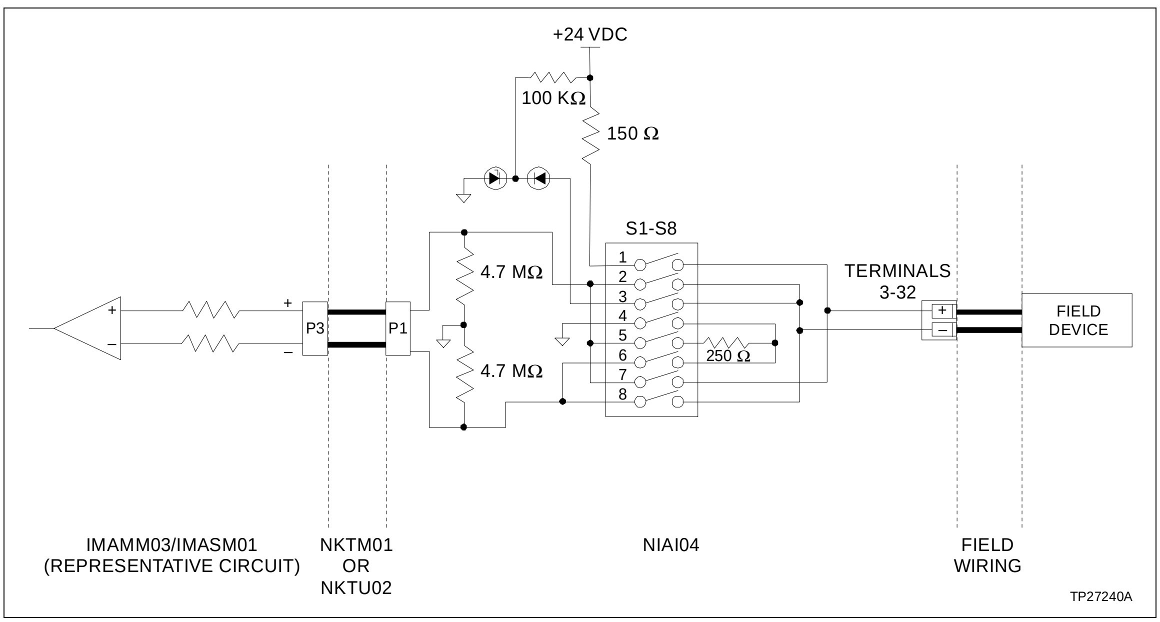
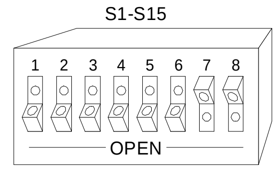
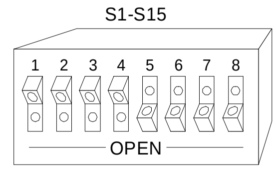
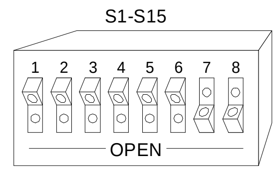
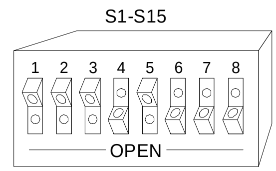
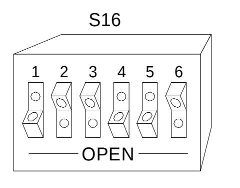
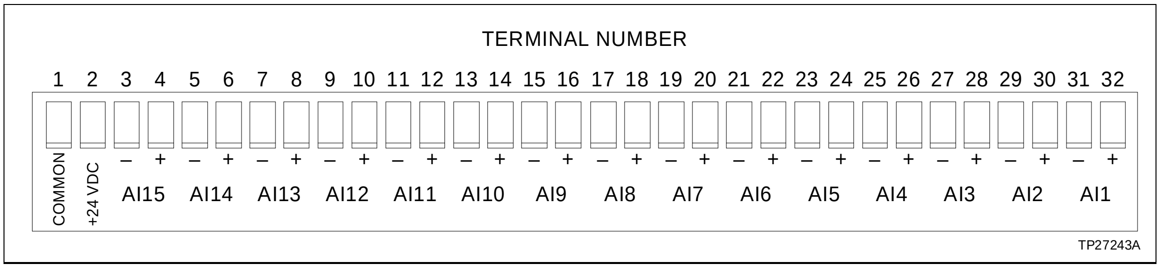


Figure C-5. NIAI04 to IMAMM03/IMASM01 Diagram

Table C-3. NIAI04 Dipswitch Configuration

Application/Signal Type	Dipswitch Configuration
System Powered 4 - 20 mA	
Externally Powered 4 - 20 mA	
Differential Voltage	
Single Ended Voltage	
All Applications	



NOTE: AI = Analog Input

Figure C-6. NIAI04 Terminal Block Assignments

NIAC02

NOTE: The NIAC02 does not require hardware configuration.

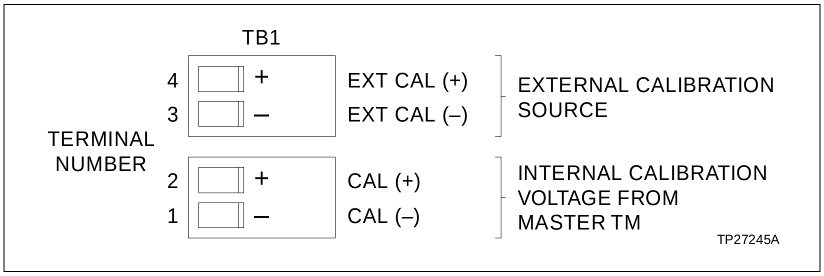


Figure C-7. NIAC02 Terminal Block Assignments

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Index (continued)

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