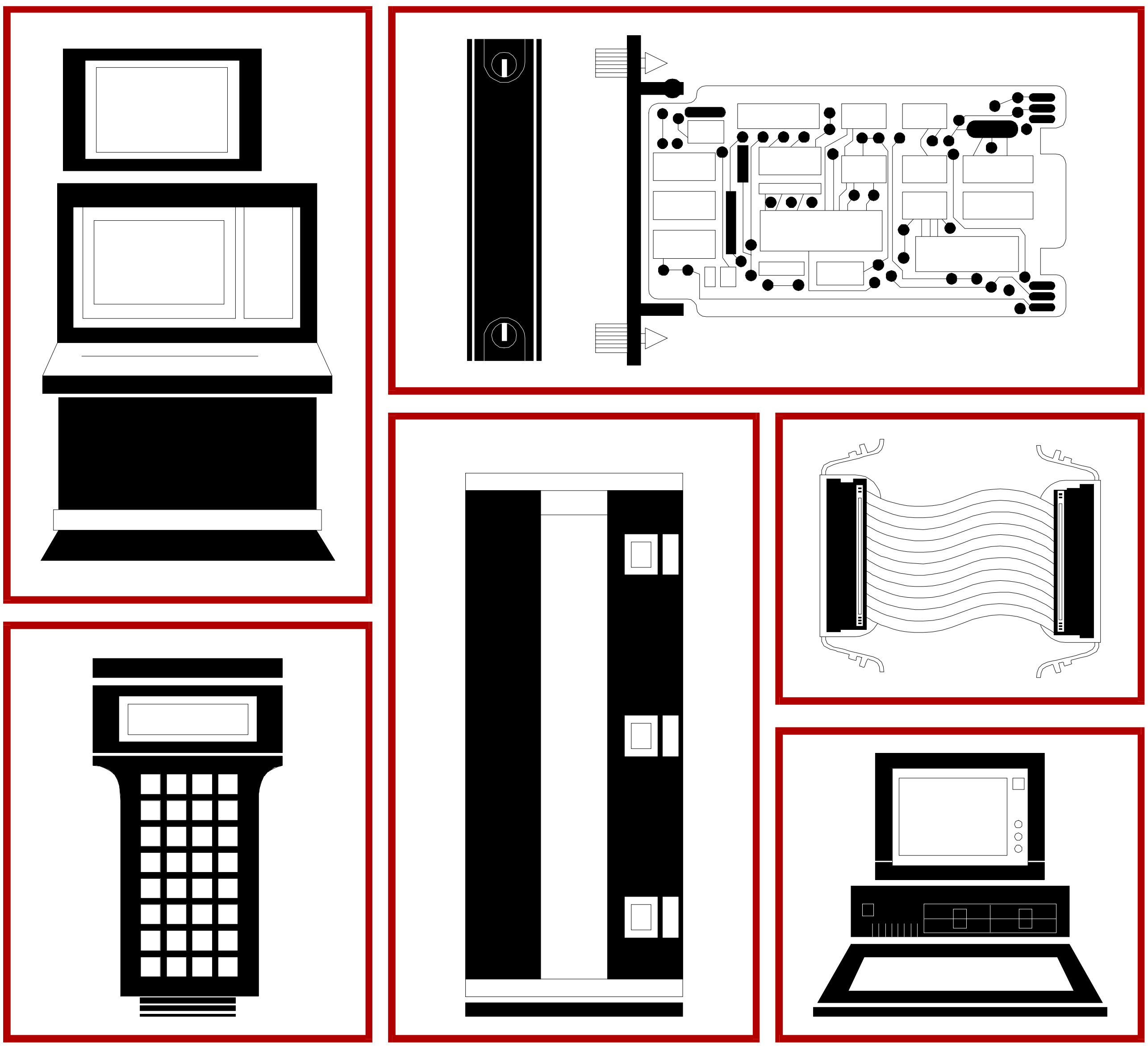
Bailey infi 90

E96-301

Instruction

Universal Analog Input Slave Module

(IMASI03)



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

POSSIBLE PROCESS UPSETS

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

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L’ENTRETIEN DOIT ÊTRE ASSURÉ PAR UNE PERSONNE QUALIFIÉE EN CONSIDÉRANT L’ASPECT SÉCURITAIRE DES ÉQUIPEMENTS CONTRÔLÉS PAR CE PRODUIT. L’AJUSTEMENT ET/OU L’EXTRACTION DE CE PRODUIT PEUT OCCASIONNER DES À-COUPS AU PROCÉDÉ CONTRÔLE LORSQU’IL EST INSÉRÉ DANS UNE SYSTÈME ACTIF. CES À-COUPS PEUVENT ÉGALEMENT OCCASIONNER DES BLESSURES OU DES DOMMAGES MATÉREILS.

NOTICE

Preface

The Universal Analog Input Slave Module (IMASI03) interfaces field inputs to the multi-function processor module. The IMASI03 supplies 16 separate process field signals into the INFI 90® Process Management System. These analog inputs are used by the Multi-Function Processor Module (MFP) to monitor and control a process.

Universal analog input slave modules provide an isolated thermocouple, millivolt, RTD, and high level analog signal interface for the Multi-Function Processor Module with variable analog-to-digital conversion resolution up to a maximum of 24 bits.

This instruction explains the slave module features, specifications and operation. It details the procedures to set up and install an IMASI03 module, and explains status indicators that help in system test and diagnosis.

System engineers or technicians using the IMASI03 should read and understand this instruction before installing and operating the slave module. In addition, a complete understanding of the INFI 90 system is beneficial to the user.

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List of Effective Pages

Total number of pages in this instruction is 102, consisting of the following:

Page No.	Change Date
Preface	15 December 1994
List of Effective Pages	15 December 1994
iii	Original
iv	15 December 1994
v through viii	Original
1-1 through 1-11	Original
2-1 through 2-11	Original
3-1 through 3-7	Original
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9-1	Original
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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	**Equipment Environment** All components, whether in transportation, operation or storage, must be in a noncorrosive environment. **Electrical Shock Hazard During Maintenance** Disconnect power or take precautions to insure that contact with energized parts is avoided when servicing. **Special Handling** This module uses Electrostatic Sensitive Devices (ESD).

SPECIFIC WARNINGS	Disconnect power before installing dipshunts for slave modules on the MMU backplane (slave expander bus). Failure to do so couls result in severe or fatal shock. (p. 3-5)

Sommaire de Sécurité

AVERTISSEMENTS D'ORDRE GÉNÉRAL	**Environnement de l'équipement** Ne pas soumettre les composants à une atmosphère corrosive lors du transport, de l'entreposage ou l'utilisation. **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. **Precautions de Manutention** Ce module contient des composantes sensibles aux decharges electro-statiques.

AVERTISSEMENTS D'ORDRE SPÉCIFIQUE	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 moretlles. (p. 3-5)

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SECTION 1 - INTRODUCTION

OVERVIEW

The Universal Analog Input Slave Module (IMASI03) performs analog input signal processing for up to 16 input channels and sends this information to a Multi-Function Processor (IMMFP01/02/03) in the INFI 90® System.

This manual explains the purpose, operation, maintenance, handling precautions and installation procedures of the slave module.

INTENDED USER

System engineers and technicians should read this manual before installing the IMASI03 module. Put the module into operation only after reading and understanding the information in this manual. Refer to the ***Table of Contents*** to find specific information. Refer to the ***HOW TO USE THIS MANUAL*** entry in this section to get started.

MODULE DESCRIPTION

The IMASI03 is a single printed circuit board that occupies one slot in an INFI 90 Module Mounting Unit (MMU). Two captive latches on the module faceplate secure it to the MMU. The slave module has three card edge connectors for external signals and power: P1, P2 and P3. P1 connects to the supply voltages. P2 connects the IMASI03 to the slave expander bus, over which it communicates with the MFP.

Connector P3 carries the inputs from the input cable plugged into the termination unit (TU) or termination modules (TM). The terminal blocks for field wiring are on the TU/TM.

The single dipswitch on the IMASI03 module sets the address for the slave or selects on-board tests. Refer to Section 3 for the steps to set the module address. Refer to Section 6 for the on-board tests. Be sure to check the switch setting before putting the module into the MMU.

Jumpers configure the type of analog input signals. Refer to Section 3 for the correct setting of these jumpers.

Figure 1-1 shows the INFI 90 communication levels.

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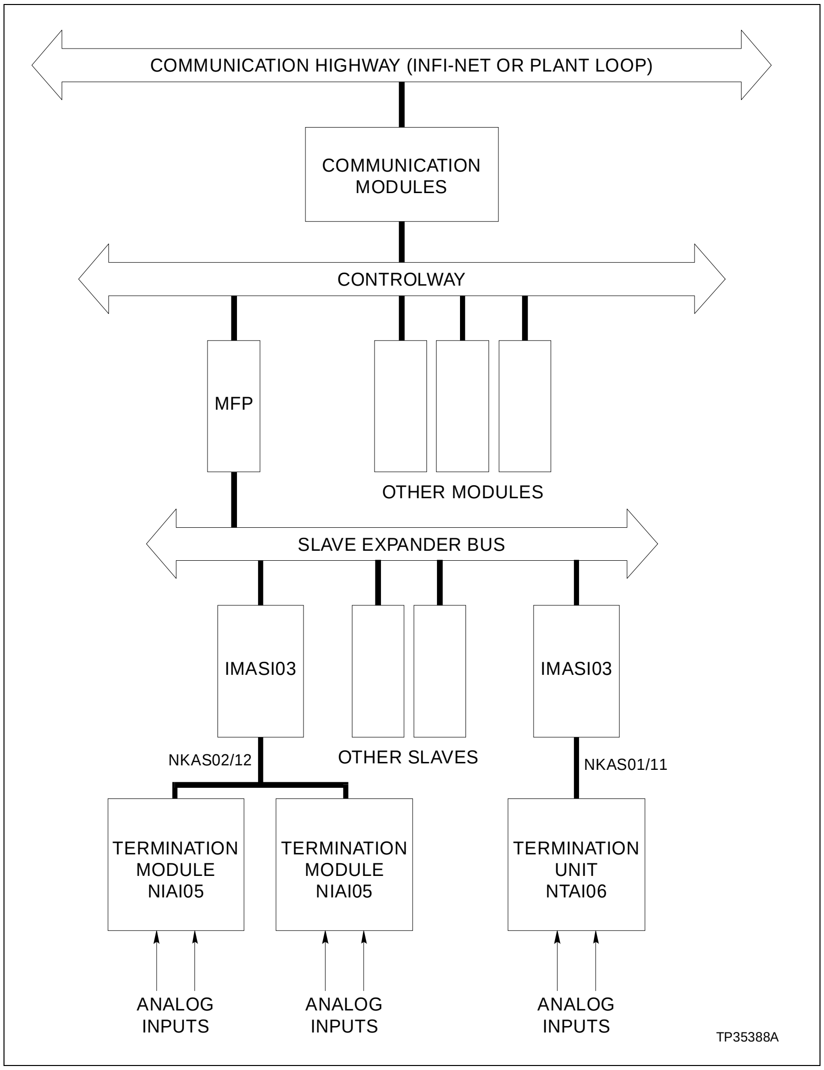


Figure 1-1. INFI 90 Communication Levels

FEATURES

The design of the IMASI03 module, as with all INFI 90 modules, allows for flexibility in creating a process management system. Refer to the ***NOMENCLATURE*** entry of this section to see the list of devices that can be used with the slave module in an INFI 90 system.

- The IMASI03 conditions (filters, amplifies and isolates) up to 16 analog input signals.
- The IMASI03 converts analog signals to digital values, adds compensation and corrections as needed, and provides digital values to the MFP through the slave expander bus.

- Each channel is individually programmable for these input types:

  E, J, K, L, N (14 AWG), N (28 AWG), R, S, T, U thermocouples.
  Chinese type E and Chinese type S thermocouples.
  Millivolt (-100 to +100 mV).
  3-wire RTDs (10, 100 U.S., 100 European, 120 and Chinese 53 Ohm).
  High level (-10 to +10 V).
  Current (4-20 mA).

- Resolution of the analog-to-digital conversion process is programmable over a range from 16 to 24 bits.

- Input type and channel resolution may be selected independently for each channel, permitting any mix of inputs on a single IMASI03 module.

- Channel isolation and open input detection are provided for each channel.

- Input circuit offset, gain and nonlinearity errors are recorded during a one time factory calibration procedure. These measurements provide error compensation during normal operation. The slave does automatic recalibration during normal operation to compensate for component aging and temperature drift. No user calibration is ever required.

- Engineering units conversion to degrees C or F is automatically calculated on all input signals that are thermocouple or RTD types. These conversions correct for nonlinearities in the conversion to temperature units using industry standard linearization tables.

- The slave scales the block output value to engineering units for low and high level voltage inputs. Input type and zero and span values are specified in function code 216.

- Thermocouple inputs have cold junction compensation. Each termination device has a built-in cold junction reference. The cold junction reference applied to thermocouple inputs may be this built-in reference or it may be a remote reference read from another input from this or another slave.

- The slave compensates for lead wire resistance in the connection between the thermocouple, RTD or low level voltage input signals.

- The IMASI03 can be removed or installed without turning off power to the system.

INSTRUCTION CONTENT

This manual has nine sections and three appendices.

Introduction Is an overview of the IMASI03 module: features, description and specifications.

Description and Operation Explains the module operation and input circuits.

Installation Contains the cautions to observe when handling IMASI03 modules. It shows the steps to install and connect the module before applying power. This section also covers switch and jumper settings.

Configuration and Calibration Presents steps to configure slave inputs for specific input types and how to field calibrate an input channel for a specific input type.

Operating Procedures Explains the operator interface to the IMASI03.

Troubleshooting Describes the IMASI03 error codes and explains how to test the IMASI03.

Maintenance Has a schedule for taking care of the IMASI03. This schedule can be used for all the modules in the MMU.

Repair/Replacement Procedures Contains the cautions and steps for removing and replacing modules from the MMU.

Support Services Provides a list of information to present when ordering parts from the local Bailey Controls sales office. It explains other areas of support that Bailey Controls provides.

Appendix A Shows the jumper settings, terminal wiring for the NIAI05 termination module and the cabling needed for the IMASI03.

Appendix B Shows the jumper settings, terminal wiring for the NTAI06 termination unit and the cabling needed for the IMASI03.

Appendix C Describes the applications, specifications and block outputs for function codes 215, 216 and 217.

HOW TO USE THIS MANUAL

Read this manual before handling the IMASI03 module. Refer to the sections in this list as needed for more information.

1. Read Section 5 before connecting the IMASI03.

2. Read Section 2.

3. Read and follow the steps in Section 3.

4. Read and follow the configuration steps in Section 4.

5. Refer to Section 6 for what to do if a problem occurs.

6. Refer to Section 7 for the scheduled steps needed to maintain the IMASI03.

7. Refer to Section 8 for steps to replace a module.

8. Use Section 9 to order parts. This section also explains some of the many services Bailey offers.

GLOSSARY OF TERMS AND ABBREVIATIONS

Term	Definition
A/D Conversion	Analog-to-digital conversion; process of generating a digital, (numeric) value representing the magnitude of an analog signal.
Analog Signal	A variable input signal that may be any value within a given range.
Cold Junction Reference	The ambient temperature at the bimetal junction of terminated thermocouple wires.
Common Mode Isolation	Indicates the ability to isolate common mode voltages between inputs and outputs and protect a measurement circuit from damage up to a maximum specified voltage level. Also indicates the ability to reject the common mode voltage by a specified amount (in units of dB at a specific frequency, such as 60 Hz).
Configuration	A control strategy with function blocks.
Controlway	A redundant peer-to-peer communication path for point data transfer between intelligent modules within a process control unit.
Digital Signal	A discrete input signal having only ON and OFF states.
Digital Value	The representation of a value by some number of digital bits that is capable of being read by a microprocessor.
Dipshunt	Dual in-line package with shorting bars.
Dipswitch	A dual in-line package that contains single pole switches.
Dual Port RAM (DPRAM)	SRAM shared by two devices. Either device can write or read to the SRAM simultaneously through separate address and data ports.
EWS	Engineering Work Station; an integrated hardware and software personal computer system for configuring and monitoring INFI 90 modules and systems.
Function Code (FC)	An algorithm that defines specific functions. These functions link together to form the control strategy.
FTP	Field Termination Panel.

GLOSSARY OF TERMS AND ABBREVIATIONS *(continued)*

Term	Definition
High Level Voltage	For IMASI03 applications, high level voltage inputs are values between -10 and +10 Volts.
INFI-NET	Advanced data communication highway for the INFI 90 system having 250 node capacity.
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.
Low Level Voltage	For IMASI03 applications, low level voltage inputs are values between -100 millivolts and +100 millivolts.
Master Module	One of a series of controller modules designed to interface with field processes through a slave module. The Multi-Function Processor is an example.
MFP	Multi-Function Processor Module; a multiple-loop controller with data acquisition and information processing capabilities.
MMU	Module Mounting Unit; a card cage that provides electrical and communication support for INFI 90 modules.
MSB	Most Significant Bit; the bit of a binary number that carries the most numerical weight.
Normal Mode Rejection	Indicates the ability to reject normal mode voltage (differential + to - Voltage) by a specified amount (in units of dB at a specified frequency, such as 60 Hz).
NVRAM	Nonvolatile random access memory; memory whose data does not change 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, tuning and monitoring.
PCU	Process Control Unit; rack type industrial cabinet that contains master, slave and communication modules, their communication paths and power supplies.
PROM	Programmable read only memory.
RAM	Random Access Memory.
RTD	Resistance Temperature Detector. A sensing device that changes resistance based on changes of ambient temperature.
SRAM	Static Random Access Memory.
Slave Expander Bus	A parallel address/data bus used for communication between the master module and the slave.
Thermocouple	A bimetal sensor used for temperature measurements.

GLOSSARY OF TERMS AND ABBREVIATIONS *(continued)*

Term	Definition
TM	Termination Module; provides input/output connection between plant equipment and the INFI 90 process modules. The termination module slides into the Termination Mounting Unit (TMU).
TMU	Termination Mounting Unit.
TU	Termination Unit; provides input/output connection between plant equipment and the INFI 90 process modules. The termination unit is mounted flat on a Field Termination Panel (FTP).

REFERENCE DOCUMENTS

Number	Description
I-E93-900-20	Function Code Application Manual
I-E93-916	Engineering Work Station (EWS)
I-E96-110	Operator Interface Station (IIOIS20)
I-E96-201	Multi-Function Processor (IMMFP01)
I-E96-202	Multi-Function Processor (IMMFP02)
I-E96-203	Multi-Function Processor (IMMFP03)
I-E96-440	Termination Unit Manual (NTAI06)
I-E96-441	Termination Module Manual (NIAI05)

NOMENCLATURE

The following modules and equipment can be used with the IMASI03 module:

Number	Description
IMMFP01/02/03	Multi-Function Processor Module
NIAI05	Termination Module
NKAS02/12	Cables, Termination Module
NTAI06	Termination Unit
NKAS01/11	Cables, Termination Unit

SPECIFICATIONS

Power Consumption	
	+ 5 VDC typical 300 mA, maximum 450 mA + 15 VDC typical 130 mA, maximum 150 mA - 15 VDC typical 35 mA, maximum 50 mA
Analog Input Types	
Analog Input Channels	16 independently configured channels
Thermocouples	Type E, J, K, L, N (14 AWG), N (28 AWG), R, S, T, U Chinese type E and Chinese type S
3-Wire RTD	100 Ohm platinum: U.S. Lab. Standard 100 Ohm platinum: U.S. Industry Standard 100 Ohm platinum: European Standard 120 Ohm nickel 10 Ohm copper Chinese 53 Ohm copper
Millivolt	-100 mV to +100 mV, o to 100 mV
High Level	1-5 VDC, 0-5 VDC, 0-10 VDC -10 VDC to +10 VDC, or user specified range within -10 VDC and +10 VDC
Current	4-20 mA, system or external powered.
High Level Voltage Analog Accuracy	
4-20 mA Current Inputs	Add 0.025% to high level voltage analog error values
25^{o} C Ambient Operating Temperature Power Supplies at Nominal Values Zero Lead Wire Resistance Full Scale Range (FSR) = 20.0 V	

Resolution	**Error (Two Standard Deviations From Mean)**		**Typical Noise (Reading Stability)**	
Bits	**± Percent FSR**	**± Millivolts**	**± Percent FSR**	**± Millivolts**
16	0.05	10	0.02	4
18	0.04	8	0.015	3
20	0.03	6	0.0125	2.5
22	0.02	4	0.005	1
24	0.015	3	0.0025	0.5

SPECIFICATIONS *(continued)*

Low Level Voltage Analog Accuracy

25^{o} C Ambient Operating Temperature
Power Supplies at Nominal Values
Zero Lead Wire Resistance
Full Scale Range (FSR) = 200.0 mV

Resolution	Error (Two Standard Deviations From Mean)		Typical Noise (Reading Stability)	
Bits	**± Percent FSR**	**± Millivolts**	**± Percent FSR**	**± Millivolts**
16	0.05	100	0.03	60
18	0.03	60	0.025	50
20	0.025	50	0.02	40
22	0.025	50	0.015	30
24	0.025	50	0.01	20

Resistance Analog Accuracy

25^{o} C Ambient Operating Temperature
Power Supplies at Nominal Values
Zero Lead Wire Resistance
Full Scale Range (FSR) = 500 Ohms

Resolution	Error (Two Standard Deviations From Mean)		Typical Noise (Reading Stability)	
Bits	**± Percent FSR**	**± Ohms**	**± Percent FSR**	**± Ohms**
16	0.1	0.5	0.06	0.3
18	0.075	0.375	0.06	0.3
20	0.07	0.35	0.03	0.3
22	0.06	0.3	0.03	0.15
24	0.05	0.25	0.03	0.15

Cold Junction Reference Accuracy	± 0.5° C
Software Temperature Linearization Accuracy	± 0.1° C

SPECIFICATIONS (continued)

Maximum Lead Wire Resistance Effect	
Voltage Input	
Uncompensated	1 microvolt of error per Ohm of lead wire resistance
Compensated	0.1 microvolt of error per Ohm of lead wire resistance
3-Wire Resistance Inputs	
Uncompensated	0.020 Ohms of error per Ohm of lead wire resistance
Compensated	0.008 Ohms of error per Ohm of lead wire resistance
Resolution	Programmable, 16 to 24 bits, in steps of two over full scale resolution

Resolution (Bits of A/D)	Resolution (Percent of A/D Span)	Typical A/D Conversion Times Per Channel
16	0.0015	30 ms
18	0.00038	175 ms
20	0.000095	175 ms
22	0.000024	450 ms
24	0.000006	2000 ms

Temperature Effect	
(0 - 70° C)	± 0.003% of full scale range per degree C maximum
Power Supply Effect	
Over Operating Range (± 15 Volt Supplies)	± 0.003% of full scale range per Volt maximum
Input Setting	
Time	0.5 seconds to within 1% after full scale step change
Input Impedance	10 MOhm minimum
Common Mode Isolation	
Continuous AC Voltage (Absolute Maximum)	250 VRMS
Channel/Channel (Absolute Maximum)	250 VRMS
50/60 Hz Rejection (Minimum)	-110 dB

SPECIFICATIONS *(continued)*

Normal Mode Rejection	
Peak or Continuous Voltage (Absolute Maximum)	± 15 VDC
50/60 Hz AC Rejection (Minimum)	-80 dB
Environment	
Electromagnetic	No values available at this time.
Radio Frequency Interference	Keep cabinet doors closed. Do not use communication equipment closer than 2 meters from the cabinet.
Ambient Temperature	0 to 70° C (32 to 158° F)
Relative Humidity	5% to 95% up to 55° C (131° F) (noncondensing) 5% to 45% at 70° C (158° F) (noncondensing)
Atmospheric Pressure	Sea level to 3 km (1.86 miles) (86 kPa to 108 kPa)
Air Quality	Noncorrosive
Mounting	Occupies a single slot in a standard INFI 90 Module Mounting Unit (MMU).
Shipping Weight	1.146 kg (2.5 lb)
Container Size	27.94 cm x 35.56 cm x 5.54 cm (11 in. x 14 in. x 3 in.)
Certification	CSA certified for use as process control equipment in an ordinary (nonhazardous) location.
	Complies with IEEE-472 Surge withstand test.

NOTE: Absolute maximum ratings indicate limits beyond which damage to the device may occur and device operation is not guaranteed.

Specifications are subject to change without notice.

SECTION 2 - DESCRIPTION AND OPERATION

INTRODUCTION

This section explains the inputs, control logic, communication and connections for the Universal Analog Input Slave Module (IMASI03). The analog slave interfaces 16 analog inputs to the Multi-Function Processor (MFP). The information in this section will answer most questions about how the IMASI03 works. Read this section and Section 3 before installing the IMASI03 slave.

FUNCTIONAL OPERATION

The IMASI03 is an intelligent INFI 90 slave module with an on-board microcontroller and memory. It interfaces to INFI 90 master modules over the slave expander bus. An on-board microcontroller allows the IMASI03 to do the input channel processing. This allows the master module to do other tasks. Input processing tasks include error compensation, adjustments and conversion to engineering units.

BLOCK DIAGRAM

Each input channel has an isolation amplifier used to isolate, filter and amplify the analog input signals. This isolation amplifier also contains references used for on-line calibration. Each channel accepts voltage and resistance inputs. Resistance measurements are made by digitizing the voltage drop created across the input resistance source. A precision constant current source supplies the current used to measure the input.

Each channel provides under-range, over-range and open input detection. On-board circuitry detects either open field wires or a disconnected termination device cable. Open input detection is provided for all input types and can detect any combination of open input wires.

The IMASI03 has a single, software programmable, high resolution analog-to-digital converter that digitizes channel signals and references. A very low drift system voltage reference allows continuous software calibration of the A/D Converter. A system reference also provides the source for the cold junction input that allows the slave to compensate for cold junction errors introduced when connecting thermocouple signals.

The IMASI03 communicates with the MFP through a shared memory interface connected to the slave expander bus. The IMASI03 constantly updates the shared memory device (Dual

Port RAM) with the current values of the inputs. The MFP can read these values at any time, even if the IMASI03 is simultaneously writing to the dual port RAM.

Figure 2-1 shows a block diagram of the complete IMASI03 module.

Isolation Amplifier

Each of the 16 user-configurable input channels on the IMASI03 consists of an isolation amplifier which is shown in the slave block diagram, (Figure 2-1). This isolation amplifier contains:

- Filtering stage.
- Low drift channel voltage reference.
- Programmable gain amplifier.
- Signal isolation barrier.
- Open input detection circuitry.

Input Multiplexer (MUX)

Once amplified, isolated, buffered and scaled, the input signal is ready to be digitized. All the inputs, including the references and cold junction input, are multiplexed through the same analog to digital converter, as shown in Figure 2-1.

Analog to Digital Conversion

Each input is multiplexed to the charge balanced analog to digital converter which converts the analog inputs to digital signals for the MFP. The A/D is software programmable for 16 to 24 bit resolution.

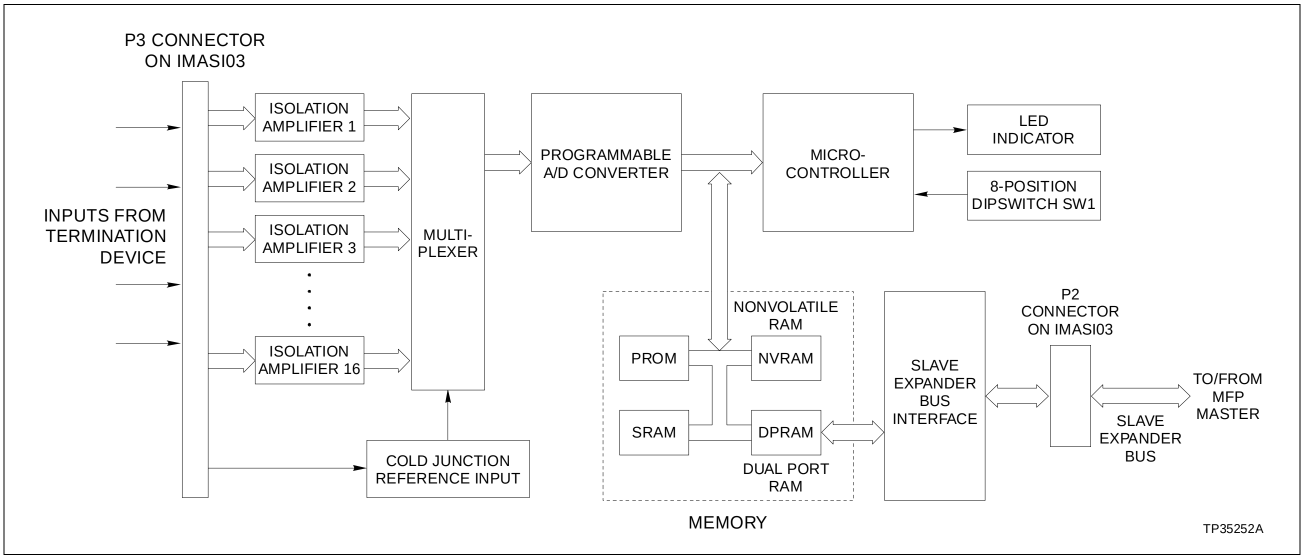


Figure 2-1. IMASI03 Functional Block Diagram

Each input channel can be independently configured for resolution through individual function code 216 blocks. The resolution and approximate conversion speed are shown in Appendix C function code 216.

Microcontroller and Memory

The on-board microcontroller coordinates IMASI03 functions. The main functions are:

- Calibrating the A/D converter.
- Isolation amplifier input reference switching.
- Channel and cold junction reference switching.
- Programming A/D resolution.
- Reading the A/D and applying all necessary correction factors.
- Interfacing to switch and LED (used for diagnostic mode).
- Background integrity checks.
- Reads and writes of expander bus data through dual port RAM (DPRAM).

Cold Junction Reference

The IMASI03 measures the cold junction RTDs on the slave's termination device. This results in an accurate reading of the ambient temperature at the field wire termination area. This value can be used by the slave to compensate for voltages generated from the bimetal connections made by terminating the field wires (thermocouple wires) onto the terminal blocks of the termination device.

The block address of the cold junction reference used by thermocouple inputs on the slave is contained in function code 215 specification 3.

Each slave configured for a thermocouple input requires a cold junction reference. Each slave can only have one reference which can be used by up to 16 thermocouple inputs. The exception to this is when one of the inputs is used as a remote cold junction reference.

Refer to Section 4 for more information.

Switch Settings

The IMASI03 has one 8-position DIP switch to select the slave address for the slave expander bus. This switch also selects built-in diagnostics for a stand-alone test.

On-Board Indicators

The IMASI03 has one red/green LED indicator which shows the operating status. The LED will:

- Flash red on power-up.
- Remain off after passing on board diagnostics until the IMASI03 is configured by the MFP.
- Show solid green after the master MFP downloads configuration data.
- Show solid green during normal running.
- Blink green when the MFP which configured the IMASI03 enters configure mode from execute mode.
- Blink green if slave expander bus communication is lost (if the MFP is removed).
- Show solid red if a fatal failure of the IMASI03 module occurs. For example, if power up diagnostics fail.
- Show solid red for a power fail interrupt (PFI).
- Show pass/fail of diagnostic routines when in diagnostic mode (refer to Section 6).

SLAVE EXPANDER BUS

The INFI 90 slave expander bus is a high speed synchronous parallel bus. It provides a path between MFP master modules and slave modules. The master module sends control functions to the IMASI03, and the IMASI03 provides input data to the master module. The P2 card edge of the IMASI03 and master module connect to the bus.

The slave expander bus is 12 parallel signal lines located on the module mounting unit (MMU) backplane. A 12-position dipshunt placed in a socket on the MMU backplane connects the bus between the master and slave modules. Cable assemblies can extend the bus to eight MMUs.

A master module and its slaves form a 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.

Slave Expander Bus Interface

The IMASI03 uses a custom gate array for the slave expander bus interface. An integrated circuit holds all the control logic and communication protocol. This integrated circuit provides these functions:

- Address comparison and detection.
- Message decoding and translation.
- Data line filtering of bus signals.
- On-board bus drivers.
- Expander bus watchdog.

A dual port RAM (DPRAM) stores data that can be accessed at the same time by the MFP and the slave's microcontroller.

Data Values

For all inputs, channel values are adjusted based on the factory calibration and drift correction data. Thermocouple inputs receive cold junction reference compensation. Nonlinearity and lead wire resistance adjustments are performed when necessary. The IMASI03 slave provides drift-corrected values to the MFP master over the slave expander bus. These values are in engineering units.

The slave sends a status indication to the MFP master for each input channel. This status indicates any hardware errors and channel configuration errors detected by the slave.

Termination Units

The IMASI03 uses one NTAI06 termination unit or two NIAI05 termination modules to connect to field signals. An NKAS01/11 cable connects the termination unit to the slave through the P3 connector. An NKAS02/12 cable connects the termination module to the slave through the P3 connector. The termination devices contain RTDs used for cold junction compensation of thermocouple inputs. They also contain the circuitry needed to convert 4-20 mA field signals into the 1-5 V needed to input to the slave. The system power supply is protected from short circuits by current limiting resistors on the NIAI05 (hardware revision A) and by fuses on the NTAI06 and NIAI05 (hardware revision B).

Function Codes

Function codes 215 and 216 in the master MFP configure the IMASI03 and identify the active analog inputs. One function code 215 is required for each IMASI03 slave. One function code 216 is required for each input channel used on the slave. These function codes specify the slave expander bus address of the

IMASI03 module and the channel number on the slave module connected to an analog input signal.

The type of the input, and the zero and span in engineering units, must also be specified to ensure proper scaling and corrections for calibration, cold junction compensation and nonlinearity correction.

Add function code 215 and 216 to the master MFP to configure the IMASI03. Set function code 217 in the master MFP to calibrate the IMASI03 or to set the user gain and offset values. Refer to the ***Function Code Application Manual I-E93-900-20*** for more information.

AUTOMATIC ADJUSTMENTS AND CORRECTIONS

Input Processing

The IMASI03 slave scans all active inputs at a rate determined by the requested input channel resolution. A preset conversion time is determined for the A/D converter depending upon the configured input resolution. Conversion time specifies the length of time required for a single conversion. The input scans from one active channel to the next, as fast as the conversion time allows.

In addition to the active input channels, the built-in cold junction reference, and the reference values for drift correction are digitized during normal input scanning.

Point Value Calculation

The slave maintains a set of adjustment values for each input channel. These values correct for offset, gain and nonlinearity errors in the input channel. The raw analog-to-digital converter count value is first adjusted for any drift in the accuracy of the input channel components. The resulting value is then converted to an actual input signal value using the calibration data which also adjusts for any nonlinearity in the input channel circuitry. The lead wire resistance is then taken into account and the required adjustment is made.

For thermocouple inputs, an adjustment is made for the cold junction temperature of the thermocouple. An additional, user-specified adjustment is then applied, if one has been defined with function code 217. The final corrected input reading is then converted to engineering units using either thermocouple or RTD conversion tables, or the engineering unit zero and span values specified for the input.

The following sections describe the various types of input value adjustments.

Input Calibration

Each input channel is calibrated at the factory. During the calibration procedure, any offset, gain and nonlinearity errors are identified and required correction factors are calculated and stored in the slave's nonvolatile memory.

These factors are used when the input channel is scanned to correct the reading. A calibration adjustment is applied to active channels and the cold junction reference input.

Periodic reference readings are taken to provide a correction for drift of input channel components. This drift calibration is performed automatically and continually while normal input processing is maintained.

Lead Wire Resistance Adjustment

All but high level inputs are adjusted for lead wire resistance coming into the termination device (The effect of lead wire resistance on high level inputs is negligible). This value is supplied through a function code specification and is used by the slave module in its input value calculation. The adjustment for lead wire resistance depends upon the input channel circuitry used for a particular input signal type. For millivolt and thermocouple inputs, lead wire resistance is equal to the series resistance of the + and - leads. For 3-wire RTD inputs, the lead wire resistance specified in function code 216 specification 10 is equal to the resistance of any ONE of the three leads. All three resistances must be equal for accurate lead wire resistance compensation.

The resistance of the cable from the termination module to the slave module is also taken into account when making this adjustment.

Cold Junction Compensation

Thermocouple input channels are adjusted for cold junction temperature. The cold junction reference may be the built-in reference available on the slave's termination device, or may be a value originating from any other function code block output anywhere in the INFI 90 system. The cold junction reference supplied by the MFP is assumed to be in degrees C. The slave converts this value to millivolts and adds it to the value from the analog-to-digital converter.

Thermocouple channels identified to be cold junction reference inputs (function code 216 specification 4) use the built-in cold junction reference on the termination device for their cold junction compensation.

User Gain and Offset Adjustment

A user-specified linear adjustment may be applied to the input signal before it is converted to engineering units. This gain and offset is applied to the value obtained after all compensation and correction operations are performed.

User offset and gain compensates input signals for user corrections. For example, if a 0 to 10 Volt analog input is 0.1 Volts too high, the slave can compensate for this offset by adding an offset value of -0.1 for this channel and input type.

User gain value is multiplied times Volts for high level inputs, times millivolts for low level inputs and thermocouple inputs, and times Ohms for RTD inputs. The default user gain is a value of one.

User offset is added to the input signal. Units of offset are specified as Volts for high level inputs, millivolts for low level inputs and Ohms for RTD inputs. The default user offset is a value of zero. Separate user gain and offset values can be specified for each input channel and each input type. The user gain and offset values can be set and reset using function code 217. Once defined, user gain and offset values remain in NVRAM and are not lost when module power is interrupted. For more information refer to function code 217 in Appendix C.

Engineering Units Conversion

Thermocouple and RTD inputs are converted to the temperature units specified in function code 216, either degrees C or F. Conversion tables representing the voltage (or resistance) to temperature relationship are used for this conversion. The table used in performing the conversion depends upon the input signal type specified.

If the input is identified as either millivolt or high level, then the specified engineering unit zero and span values are used to convert the input reading to a scaled engineering unit value. If special calculations need to be performed prior to conversion to engineering units (external to function code 215/216 blocks), then the zero and span values specified in the function code should be set to represent a standard voltage span for the input. The slave function code 216 would then output a corrected voltage input reading which may be processed in the MFP through a square root, polynomial, or other function block followed by a scaling function to provide the value in engineering units.

Automatic Calibration

Compensation for drift of input channel circuitry is done by periodic automatic calibration of each channel using on-board precision low-drift references. This function is transparent to normal input channel processing.

Field Calibration

Field calibration is not necessary in normal situations. It is possible to perform calibration procedures in the field if ultra stable, known, precision references are available. Field calibration data is stored in NVRAM. The complete field calibration instruction is in Section 4.

Factory calibration data is stored in a unique NVRAM area. If field calibration does not provide the desired results, the factory calibration data can be restored.

Using Function code 217 to change the gain or offset values per channel and type can compensate for differences in input signal readings. Tuning these parameters can take the place of a field calibration. Refer to function code 217 specification 1.

INPUT CALIBRATION

Data from the factory calibration is stored on the slave in nonvolatile memory. No customer calibration is necessary. If field calibration is desired, use the procedure in Section 4.

SECURITY AND INTEGRITY CHECKS

Diagnostics Run on Reset

The IMASI03 performs built-in tests on power-up and on reset to check the operation of the module. These tests include:

- PROM checksum verification.
- NVRAM checksum verification.
- DPRAM/SRAM verification.
- Processor instruction set tests.
- Timer test.

Diagnostics Run in Diagnostic Mode

The IMASI03 performs built-in tests in diagnostic mode to check the operation of the module. These tests include:

- Sixteen channel reference checks.
- A/D internal reference checks.
- Switch test.
- Watchdog timer test.
- CPU test.
- Timer test.
- ROM test.
- DPRAM test.
- NVRAM test.
- SRAM test.
- System reference checks.
- Configured channel reference checks.
- Unconfigured channel reference checks.

Diagnostics Run During Normal Operation

During normal operation, the IMASI03 verifies the checksum of the PROM and nonvolatile RAM. Watchdog timers safeguard against an A/D converter failure which would halt input scanning. Input circuits are monitored for open circuits. Any errors are reported to the master MFP through the slave module status. Certain failures detected by these diagnostics may result in halting the slave.

Expander Bus Communication Security

Expander bus message integrity is maintained by checksum calculations on each transmitted and received message or data set.

Open Input Detection

The IMASI03 recognizes and reports any open inputs on active channels by indicating bad quality on these channels.

Alarm and Exception Reporting

No alarm or exception reports are generated by the function codes associated with the IMASI03. The values input from the IMASI03 must be fed to a standard exception reporting block. Refer to Section 6 for more information.

ON-LINE CONFIGURATION

All specifications in function codes 215, 216 and 217 associated with the IMASI03 may be changed during on-line configuration. When changes are made to the input channel parameters (function code 216), the channel will hold the last value for a short period, the status remains unchanged during this period. This hold time is based on the number of channels that were changed during on-line configuration, as well as the resolution specified in the function code 216 blocks for that channel. Plan on a hold time of four seconds (worst case) for each function code 216 changed during on-line configuration.

LOGIC POWER

The IMASI03 receives its power (+5 V, ±15 V) from the MMU backplane. Power connects through the top 12-pin card edge connector (P1) at the back of the IMASI03.

SECTION 3 - INSTALLATION

INTRODUCTION

This section explains what to do before putting the Universal Analog Input Slave Module (IMASI03) into operation. *DO NOT PROCEED* with the installation and operation until you read, understand and do the steps in the order in which they appear.

Refer to Appendix A and Appendix B for termination device wiring instructions. Refer to Section 4 to configure the IMASI03.

SPECIAL HANDLING

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

This device uses metal oxide semiconductor (MOS) devices that require special precautions during shipping and handling. Static discharge, improper grounding, and careless handling can damage these devices. To help reduce the chance of damage, follow these procedures:

1. Keep the module in its special antistatic bag until ready to install it. Save the antistatic bag for future use.

2. Ground the antistatic bag before opening it.

3. Make sure all devices to which the module connects are properly grounded before connection.

4. Avoid touching the circuitry when handling the module.

NOTE: Wear the grounding strap from the field static kit when removing or installing the module to change switch settings.

UNPACKING AND INSPECTION

These are steps to follow for general handling:

1. Examine the module to make sure that no damage has occurred in transit.

2. Notify the nearest Bailey Controls sales/service office of any damage.

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

4. Use the original packing material or container to store the module.

5. Store the module in a place with clean air; free of extremes of temperature and humidity.

SETUP/INSTALLATION

Before applying power to the IMASI03, make these checks:

1. Check that the module address is set correctly.

2. Check that the jumpers on the module are set correctly.

3. Be sure the dipshunts in the MMU's slave expander bus are installed correctly.

4. Check that the jumpers on the termination devices are set correctly.

5. Verify I/O cabling connections.

6. Verify there is sufficient logic and field power for the modules in the MMU.

Address Selection Switch (SW1)

The IMASI03 must have an address to communicate with the MFP. The IMASI03 can have one of 64 addresses (address 0 to 63) on the slave expander bus. This address identifies the slave to the master module and must be the same as the address set in the master module configuration data (function code 215 and 216 specification 1).

Set the address with the eight position address dipswitch (SW1), shown in Figure 3-1. The six right switch positions (3

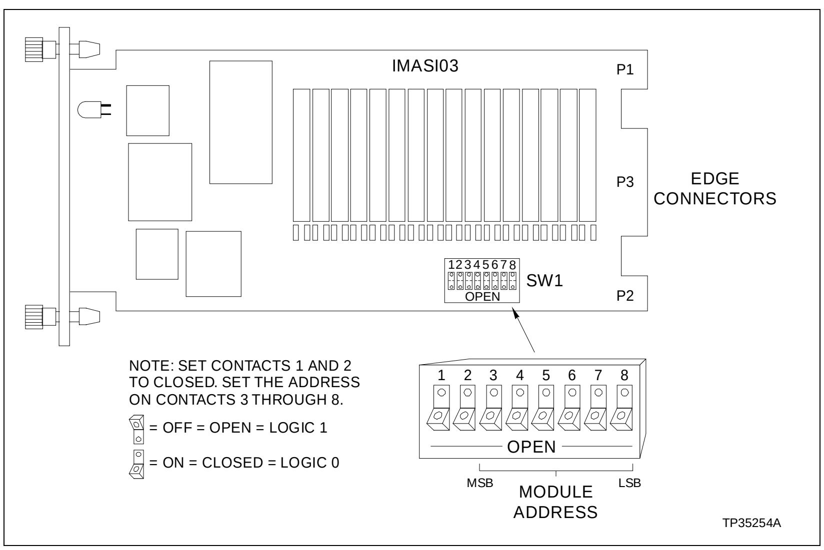


Figure 3-1. Address Select Switch (SW1)

through 8) of SW1 set the six bit address. Positions 1 and 2 must remain closed (set to zero) for normal operation.

Table 3-1 lists the binary addresses for setting SW1. Refer to Section 6 for the diagnostic settings for SW1.

Table 3-1. Address Switch Settings (S1)

	MSB					LSB		MSB					LSB
Addr	**3**	**4**	**5**	**6**	**7**	**8**	**Addr**	**3**	**4**	**5**	**6**	**7**	**8**
0	0	0	0	0	0	0	32	1	0	0	0	0	0
1	0	0	0	0	0	1	33	1	0	0	0	0	1
2	0	0	0	0	1	0	34	1	0	0	0	1	0
3	0	0	0	0	1	1	35	1	0	0	0	1	1
4	0	0	0	1	0	0	36	1	0	0	1	0	0
5	0	0	0	1	0	1	37	1	0	0	1	0	1
6	0	0	0	1	1	0	38	1	0	0	1	1	0
7	0	0	0	1	1	1	39	1	0	0	1	1	1
8	0	0	1	0	0	0	40	1	0	1	0	0	0
9	0	0	1	0	0	1	41	1	0	1	0	0	1
10	0	0	1	0	1	0	42	1	0	1	0	1	0
11	0	0	1	0	1	1	43	1	0	1	0	1	1
12	0	0	1	1	0	0	44	1	0	1	1	0	0
13	0	0	1	1	0	1	45	1	0	1	1	0	1
14	0	0	1	1	1	0	46	1	0	1	1	1	0
15	0	0	1	1	1	1	47	1	0	1	1	1	1
16	0	1	0	0	0	0	48	1	1	0	0	0	0
17	0	1	0	0	0	1	49	1	1	0	0	0	1
18	0	1	0	0	1	0	50	1	1	0	0	1	0
19	0	1	0	0	1	1	51	1	1	0	0	1	1
20	0	1	0	1	0	0	52	1	1	0	1	0	0
21	0	1	0	1	0	1	53	1	1	0	1	0	1
22	0	1	0	1	1	0	54	1	1	0	1	1	0
23	0	1	0	1	1	1	55	1	1	0	1	1	1
24	0	1	1	0	0	0	56	1	1	1	0	0	0
25	0	1	1	0	0	1	57	1	1	1	0	0	1
26	0	1	1	0	1	0	58	1	1	1	0	1	0
27	0	1	1	0	1	1	59	1	1	1	0	1	1
28	0	1	1	1	0	0	60	1	1	1	1	0	0
29	0	1	1	1	0	1	61	1	1	1	1	0	1
30	0	1	1	1	1	0	62	1	1	1	1	1	0
31	0	1	1	1	1	1	63	1	1	1	1	1	1

Configuring Inputs

Configure the IMASI03 by setting the specifications in function code 215 and 216 in the master MFP and setting the input jumpers on both the IMASI03 slave and the termination device. Refer to Section 4 for more information on configuration and calibration. Refer to Appendix C for more information on function code 215 and 216.

Each Input on the IMASI03 has two jumpers. Set both jumpers on each input to pins 2 and 3 for a resistance (3-wire RTD) input. Set both jumpers on each input to pins 1 and 2 for a voltage or current input. Each channel can be configured independently. The IMASI03 can have any number of inputs configured as resistance, low level voltage or high level voltage.

Table 3-2 lists the jumper configurations for the IMASI03. Table 3-3 lists the jumpers set to configure each channel on the IMASI03. Figure 3-2 shows the jumper locations on the IMASI03.

Table 3-2. IMASI03 Jumper Configurations

Analog Input Type	Jumper Position	Jumper Number
Current Thermocouples Low Level Voltage High Level Voltage	1 - 2	J1 - J32 (Analog Input 1 through Analog Input 16)
3 Wire RTD	2 - 3	J1 - J32 (Analog Input 1 through Analog Input 16)

Table 3-3. IMASI03 Jumpers Used for Each Channel

Channel Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Jumper Number	J1 J2	J3 J4	J5 J6	J7 J8	J9 J10	J11 J12	J13 J14	J15 J16	J17 J18	J19 J20	J21 J22	J23 J24	J25 J26	J27 J28	J29 J30	J31 J32

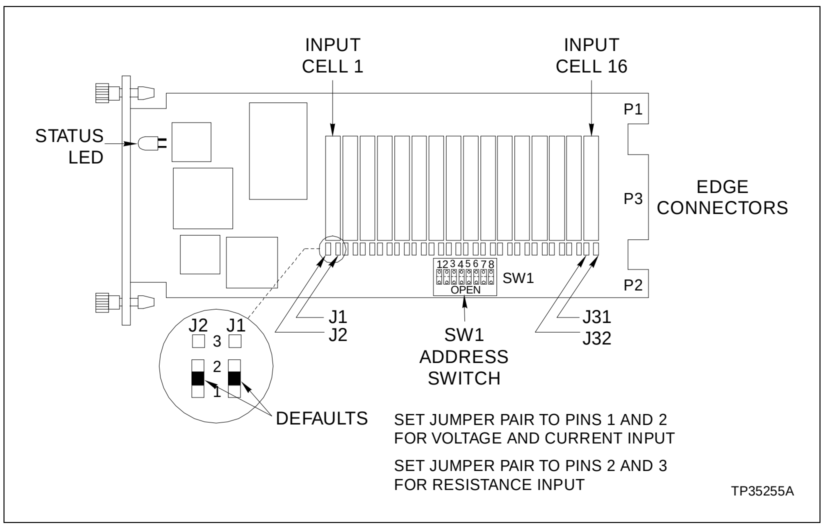


Figure 3-2. IMASI03 Jumper Locations

Termination Module/Unit Configuration

Two NIAI05 termination modules or one NTAI06 termination unit connects the field device wiring to the INFI 90 system. The terminal blocks are located on the termination device.

Set up the termination device to accept the analog field inputs sent to the IMASI03 module. Refer to Appendix A or Appendix B for the termination device for your application.

Physical Installation

NOTE: Section 3 provides data on the physical installation of the slave only. For complete cable and termination module information, refer to Appendix A and Appendix B.

The IMASI03 module occupies one slot in a standard INFI 90 Module Mounting Unit (MMU). To install the module:

1. Verify the slot placement of the module.

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 moretlles.**

2. Verify that a dipshunt is in the slave expander bus socket on the MMU backplane between the slave and master module.

3. Connect the hooded end of the cable from the termination module/unit to the MMU backplane. To do this, insert the connector into the backplane slot in the same slot as the one assigned to the slave module. The latches should snap securely into place.

4. Align the module with the guide rails in the MMU. Carefully 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 latches on the module faceplate one half turn to the latched position. It is latched when the slots on the latches are vertical and the open ends face the center of the module.

WIRING CONNECTIONS AND CABLING

The IMASI03 has three card edge connectors to supply power (P1), connect slave expander bus communication (P2), and provide analog inputs (P3).

Wiring

Install the module in the MMU to connect the slave module to the voltages (+5, ± 15 VDC), needed to power the circuits. The MMU also connects P2 to the slave expander bus for communication with the master module. P1 and P2 connection require no additional wiring or cabling.

NOTE: A dipshunt on the backplane of the MMU connects the slave expander bus between the slave module and master module. Locate the module so the bus can connect to them or they will not communicate.

Cable Connections

The IMASI03 uses two NIAI05 termination modules or one NTAI06 termination unit for termination.

A single NKAS02 or NKAS12 is used to connect the IMASI03 to two NIAI05 termination modules. The NTAI06 requires an NKAS01 or NKAS11 to connect to the IMASI03.

The cables have a Y configuration with two connectors on one end. Note the labeling of J2 and J3 to insure proper connection of the input signals.

Figure 3-3 shows cable connections to the NIAI05 termination module. Figure 3-4 shows cable connections to the NTAI06 termination unit.

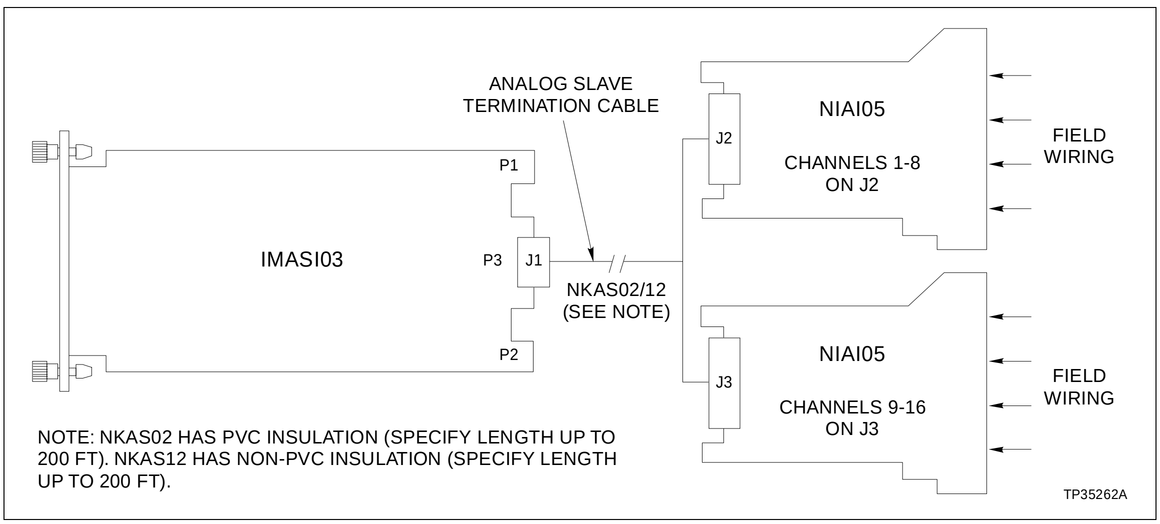


Figure 3-3. NIAI05 to IMASI03 Cable Connections

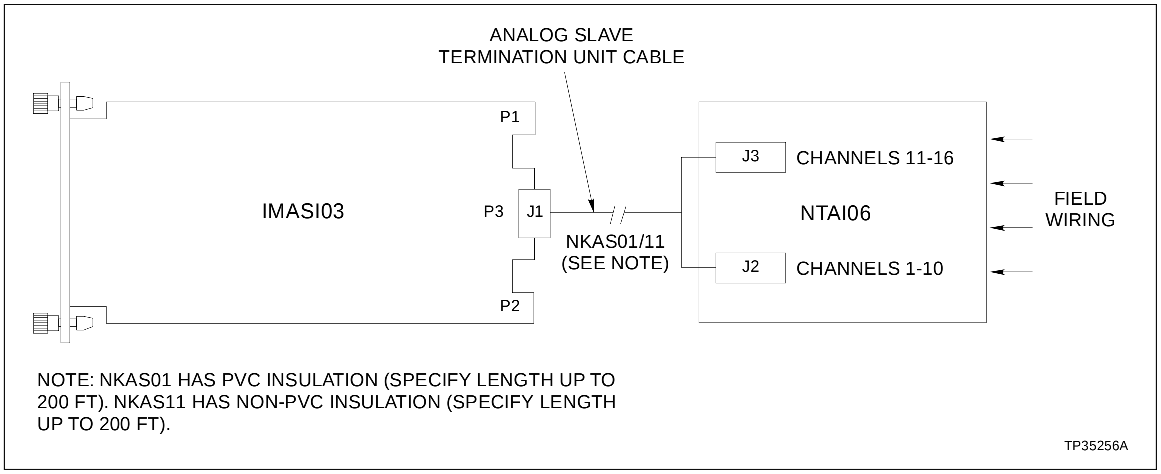


Figure 3-4. NTAI06 to IMASI03 Cable Connections

SECTION 4 - CONFIGURATION AND CALIBRATION

INTRODUCTION

This section explains the configuration and optional field calibration for the field inputs of the Universal Analog Input Slave Module (IMASI03).

Function codes in the master MFP configure the IMASI03 and identify the active analog inputs. These function codes specify the slave expander bus address of the IMASI03 module and the number of active channels on the slave module. The type of input, and the zero and span in engineering units, is also specified by the user with a function code. Set function code 215 and 216 in the master MFP to configure the slave. Refer to Appendix C for descriptions of function code 215, 216 and 217.

Module calibration is performed during module assembly at the factory. Circuitry and software in the module make automatic adjustments to compensate for application variations, component drift and cold junction errors. The slave does provide for field calibration although it should not be required.

CONFIGURING INPUTS

Configure the IMASI03 by setting the specifications in function code 215 and 216 in the master MFP. One function code 215 is required for each slave and one function code 216 is required for each channel used on the slave. Refer to Appendix A for more information on the termination module NIAI05 and Appendix B for more information on the termination unit NTAI06.

CONFIGURING FUNCTION CODES

The MFP initializes the IMASI03 slave module with the configuration data specified in function codes 215 and 216. The MFP sends a command to the IMASI03 whenever new configuration data is entered in the MFP. This command causes the slave to read the configuration data and initialize its input processing, conversion, and compensation calculations.

Refer to Appendix C or the ***Function Code Application Manual***, I-E96-200, for more information on function codes 215 and 216.

Function codes 215 and 216 are entered in the master MFP to configure the IMASI03 and identify the active analog inputs. These function codes specify the slave expander bus address of the IMASI03 module as well as the channel number on the slave module connected to an analog input signal. The type of the input, as well as the zero and span in engineering units, must also be specified to ensure proper scaling and corrections for field calibration, cold junction compensation or nonlinearity correction. Function code specifications also contain the A/D resolution, lead wire resistance (if such a correction is desired), and primary frequency of the noise to be rejected by each input.

For cold junction compensation, the block which represents the cold junction input must also be specified. To use the slave's on board cold junction reference, set specification 3 in function code 215 to the block address of function code 215. Any channel can be used as a remote cold junction reference (in function code 216 specification 4, enter 1xx).

When an input channel is selected as a remote cold junction reference, software smoothing of the input reading takes place. This smoothing allows the temperature response of the remote cold junction reference to closely match the temperature response of the remote terminal blocks.

Each slave configured for a thermocouple input requires a cold junction reference. Each slave can only have one cold junction reference for up to 16 thermocouple inputs. The exception to this is when one of the thermocouple inputs is used as a remote cold junction reference.

Install one function code 217 block in the MFP configuration in case slave tuning or field calibration operations are needed later.

CALIBRATING INPUTS

Calibration is done at the factory and the calibration data is stored on the slave in nonvolatile memory. ***No calibration is necessary.*** If, however, field calibration is desired, use the procedure described in the field calibration instructions.

Field calibrate the IMASI03 slave with the MFP by tuning function code 217 which is described in Appendix C. It is necessary to install function code 215 and one function code 216 for each input channel in a configuration to field calibrate a slave. In addition, when field calibrating a slave, the calibration type defined in S4 of function code 217 must be consistent with the input signal type defined in S4 of function code 216. Consider the following examples.

Example 1 If calibrating a channel for millivolts or thermocouples, then S4 of function code 217 must be set to zero and S4 of function code 216 must be set to any one of the millivolt or thermocouple input types. In this case, S4 of function code 216 must be within the following:

x01 ≤ S4 < x20
or
x60 ≤ S4 < x99

Example 2 If calibrating a channel for high level voltage, then S4 of function code 217 must be set to one and S4 of function code 216 must be set to one of the high level voltage ranges (four to 20 milliamps is considered high level input type). In this case, function code 216 should be within the following:

x40 ≤ S4 < x60
or
S4 = x99

Example 3 If calibrating a channel for RTD mode, then S4 of function code 217 must be set to two and S4 of function code 216 must set to any one of the RTD types. In this case, S4 of function code 216 should be within the following range:

x20 ≤ S4 < x40

The operator starts, guides, and ends the field calibration with function code 217. Commands are initiated by tuning this block. The command errors are provided as an output (N+4) of this function block. It reflects the status of the most recently issued calibration command.

The status of a channel field calibration is also reported as an output (N+1) of this function block. This output shows the status for the channel referenced in the most recent field calibration command. Refer to Appendix C for more information about function code 217.

FIELD CALIBRATION

Field calibration is not necessary in normal situations. It is possible to perform calibration procedures in the field if ultra stable, known, precision references are available. Field calibration data is stored in NVRAM.

Factory calibration data is stored in a unique NVRAM area. If a field calibration does not provide the desired results, the factory calibration data can be restored. Do this by tuning specification 1 of function code 217 to an 11.

A user can compensate signal readings by changing the gain or offset of the point signal. In most cases changing these values will take the place of a field calibration. Refer to function code 217 specification 5.

This is an example of a set user gain and offset operation:

Function	FC 217 Specifications					
	S1	S2	S3	S4	S5	S6[1]
Tune channel 1 offset and gain correction	5	100	1	0	gain value	offset value
Tune channel 2 offset and gain correction	5	100	2	0		

NOTE: 1. S7 and S8 are not used.

In this example the specifications have these functions:

- S1 selects the field calibration operation (5). The value of 5 is the set user gain and offset command.
- S2 is the block address of the FC215 which corresponds to the IMASI03.
- S3 calls up the channel to be tuned (channel 1).
- S4 sets the input type (0 = millivolt).
- S5 sets the amount of gain. Set S5 to the gain value.
- S6 sets the offset value. Set S6 to the offset value.

Check block N+2 or block N+3 to see if the set user gain and offset command is processed correctly, and is incorporated into slave input reading of that channel and type.

Field calibrating all 16 channels for all three input types on a slave is a lengthy procedure that may require up to four hours to complete when done properly.

A channel can be disabled and field calibrated separately from the rest of the active channels on the slave. Each channel can be calibrated for any of the three input ranges:

- Individual Channel Low Level Voltage Range (-100 mV to +100 mV).
- Individual Channel High Level Voltage Range (-10V to +10V).
- Individual Channel 3-Wire Resistance Range (5 Ohms to 500 Ohms).

To field calibrate each of the three ranges:

1. Configure the point in the system.
2. Disable the point from the system.

3. Calibrate the point with the new value (2 to 11 calibration points per channel and input type).

4. Enable the point to the system.

Before beginning calibration, each channel must be configured with one function code 216, and the calibration type defined in S4 of function code 217 must be consistent with the input signal defined in S4 of function code 216.

The input channel being field calibrated must be disabled before any calibration commands are accepted. Disabling the input channel removes the channel from the normal input scan processing. The point shows bad quality while it is disabled. The value of the input is undefined while the channel is disabled. All other channels are not affected and continue processing input data according to the configuration data.

Before performing a point field calibration, ultra stable, known, precise values are connected to the input channel. During point calibration, the slave reads the input and stores its digitized value. A user must perform at least two point calibrations and can perform up to 11 point calibrations within an input range. All these adjustment factors are calculated and stored in the slave's NVRAM when the point is enabled.

Up to 11 calibration points may be identified to adjust for nonlinear components in the input circuitry. Precision voltage values are required for low level, thermocouple and high level input field calibration. For RTD input calibration, precision resistance values are used. Function code 217 and the same procedure is used for all three field calibrations.

Each input channel must be enabled before normal input scan processing is resumed. The enable command indicates to the slave that the calibration process is completed. At that time the slave stores the field calibration values in NVRAM. The slave uses these values during input scan processing to calculate the correction factors for the calibrated channel.

If no field calibration is performed, or if the escape command was issued to cancel the calibration, the new calibration correction values are not computed and the previous correction factors will continue to be used. There is no change to the calibration of the point. The quality of the input point remains bad after an enable command until a successful input scan is performed for that point. If either the master or the slave is stopped, or placed into CONFIGURE mode while a field calibration sequence is in progress (before an enable is issued), the field calibration sequence is aborted and must be restarted.

Once the slave module is calibrated, no further manual calibration is necessary. On-board, low-drift references maintain the accuracy of the calibration.

Field Calibration Instruction

The original slave calibration is done in the factory in a controlled, stable environment. Ambient temperature must remain constant at 25 (±1.0) degrees C. The field calibration location must be free from drafts.

After each slave is powered-up in its calibration location, allow some warmup time before calibration for the most accurate results. This warmup time should be at least 15 minutes.

There are three types of inputs on the slave:

- Low Level Voltage Range (-100 mV to +100 mV).
- High Level Voltage Range (-10V to +10V).
- 3-Wire Resistance Range (5 Ohms to 500 Ohms).

Each of the 16 inputs can be used as a high level, a low level or a 3-wire RTD input.

The high level, low level and 3-wire RTD inputs can be field calibrated with this procedure.

We recommend checking the accuracy of the channel within each of the specified ranges after calibrating each channel.

Test Equipment Required

The devices required to perform the field calibration are:

- One powered MMU slot per slave (+5V, ±15V, with power fail interrupt).
- One MFP with slave expander bus dipshunts.
- An MFP interface device, such as a computer interface unit or an engineering work station or configuration and tuning module.
- An NKAS01 cable and its termination device (NTAI06), or an NKAS02 cable and its termination devices (two NIAI05s).

Each input type to be field calibrated requires ultra-stable, known precision sources.

Low-Level Voltage Source

- -100 mV to +100 mV range with an accuracy of ±10 microvolts (or ±0.005 percent of this range).
- DC output resistance of less than 2.0 Ohms.

High-Level Voltage Source

- -10 V to +10 V range with an accuracy of ±1.0 millivolt (or ±0.005 percent of this range).

- DC output resistance of less than 5.0 Ohms.

Resistance Source

- 5.0 Ohms to 500 Ohms range with an accuracy of ±25 milliohms (or ±0.005 percent of specified range).

Individual Channel Calibration

This section provides field calibration instructions for low level, high level and resistance inputs. To calibrate each channel in the module:

1. Configure the point in the system.

2. Disable the channel.

3. Calibrate the channel with 2 to 11 calibration points.

4. Enable the channel.

This example shows the values to tune the function code 217 specifications for a low level voltage range calibration for channel one on the IMASI03 referenced by the function code 215 at block address 100. S4 of function code 216 must also be set to any of the thermocouple or millivolt types.

Function	FC 217 Specifications					
	S1	S2	S3	S4	S5	S6
Disable point	1	100	1	x[2]	x[2]	x[2]
Point calibration[1]	2	100	1	0	value	x[2]
Enable point	3	100	1	x[2]	x[2]	x[2]

NOTES:
1. Repeat this entry at least 2 times making specification 5 equal to the low voltage value applied to the input terminals. For maximum accuracy, repeat 11 times of the range to be used.
2. x is a do not care value.

This example shows the values to tune the specifications to, in order to reset the channel field calibration data to the original factory settings for an IMASI03 at address one. This is needed only if the field calibration is unsuccessful.

Function	FC 217 Specifications					
	S1	S2	S3	S4	S5	S6
Reset factory calibration	11	100	x[1]	x[1]	x[1]	x[1]

NOTE:
1. x is a do not care value. It may be left at the previous value.

The following steps field calibrate channel 1 for the low-level voltage range of -100 mV to +100 mV. Change specification 4 and use these steps to configure high level or resistance inputs. Also S4 of function code 216 must be consistent with the type of calibration being performed.

1. Locate the block address in the MFP of the Enhanced Function Code (FC 217).

2. Verify that the slave expander bus dipshunts are in place to allow slave bus communications.

3. On the IMASI03, for each input channel, place the jumper connector pairs (J1-J32) in position 1-2 for low or high voltage inputs (position 2-3 is for RTD inputs).

4. Set S2 of FC 217 to the block address of the function code 215 which references the IMASI03.

5. Insert the slave into a powered slot. The LED will change to solid green because the slave is linked to a function code 215 in the configuration.

6. Allow the slave to warm up for at least 15 minutes.

7. Put the MFP in execute mode.

8. Set the FC 217 block for the required specifications. After each calibration command is issued by performing a tune operation, monitor the calibration command status to determine if any errors have occurred during the field calibration.

This example calibrates channel one on the slave which is referenced by the function code 215 at block address 100. For low level voltage, disable the desired channel by tuning these values into the specifications.

a.	disable point	S1 = 1
b.	the slave referenced by FC 215 at block address 100	S2 = 100
c.	slave channel 1	S3 = 1

9. Verify that the low-level voltage source is connected to channel 1 of the slave to be calibrated and the source voltage is set to the first desired value (this example calls for -100 mV).

NOTE: Each time the source voltage is changed, at least 15 seconds settling time is required before the point field calibration takes place. If the source itself has a measurable settling time, add this to the 15 second requirement.

10. Tune the FC 217 block specification 5 to the input voltage or resistance value. For this example, tune these specifications:

a.	perform point calibration	S1 = 2
b.	the slave referenced by FC 215 at block address 100	S2 = 100
c.	slave channel 1	S3 = 1
d.	calibration type 0 (low level)	S4 = 0
e.	calibration parameter 1 - 100 (millivolts)	S5 = -100

Successful field calibration operations can be verified by checking for a zero value in FC 217 blocks N+1 and N+4. If the point calibration was unsuccessful, an error code will appear in the FC 217 blocks N+1 and N+4 which can aid in troubleshooting.

11. Change the calibration voltage (source output) to the next desired value (this example calls for -80 mV) and wait the 15 second settling time.

12. Tune the FC 217 block to the next higher value in the calibration range. In this example, tune specification 5 to:

a.	perform point calibration	S1 = 2
b.	the slave referenced by FC 215 at block address 100	S2 = 100
c.	slave channel 1	S3 = 1
d.	calibration type 0 (low level)	S4 = 0
e.	calibration parameter 1 - 80 (millivolts)	S5 = -80

13. Successful field calibration operations can be verified by checking for a zero value in FC 217 blocks N+1 and N+4 for a zero value. If the point calibration was unsuccessful, an error code will appear in the FC 217 blocks N+1 and N+4 which can aid in troubleshooting.

At this step two points have been field calibrated and the enable calibration command can be executed. For greater channel nonlinearity, calibrate additional points by repeating Steps 7 through 12 for each additional point. A maximum of 11 points can be specified for a given input range on each channel. The three input ranges are low level, high level, or RTD.

If desired, repeat Steps 7 through 12 for channels 2 through 16 to calibrate all 16 channels on the slave.

14. Enable the point. Tune the FC 217 block specification 1 to enable the channel. For this example, tune these specifications:

a.	enable the channel	S1 = 3
b.	the slave referenced by FC 215 at block address 100	S2 = 100
c.	slave channel 1	S3 = 1
d.	calibration type x	S4 = x[1]
e.	calibration parameter x	S5 = x

A successful enable operation can be verified by checking FC 217 blocks N+1 and N+4 for a zero value. If the enable was unsuccessful, an error code will appear in the FC 217 blocks N+1 and N+4 which can aid in troubleshooting.

A channel can be calibrated over the range used, even if it is only part of the total range of the sensing device. For example, If the range of channel 1 was -100 mV to 0.0 mV enter -100 mV, -90 mV, -80 mV (10 mV increments) up to 0.0 mV. Or if the range of channel 1 is -100 mV to -90 mV enter -100 mV, -99 mV, -98 mV, (1 mV increments) up to -90 mV.

This provides very accurate values from the slave to the MFP for the range of the sensing device used (-100 mV to 0.0 mV, -100 mV to -90 mV).

1. x is a do not care value.

SECTION 5 - OPERATING PROCEDURES

INTRODUCTION

This section explains the start-up and operation for the Universal Analog Input Slave Module (IMASI03).

START-UP

Communication between the IMASI03 slave and MFP master starts when the two modules are configured correctly (refer to Section 4). The slave address in Function Code 215 and 216 must be the same as the address set on the address dipswitch.

Upon start-up, when power is applied to the IMASI03 and the MFP is put into execute mode, all channels are initially marked bad quality until the MFP downloads the configuration data and the slave digitizes a valid input signal.

OPERATION

The MFP sends an interrupt command to the IMASI03 whenever the MFP sends new configuration data. This interrupt causes the slave to read the configuration data and initialize its input handling, conversion, and compensation calculations. Once configured by the master, the IMASI03 slave scans its inputs and makes corrected values available to the master over the slave expander bus. The master reads the values from the slave during its normal segment cycle operations. Refer to Section 2 for more information about IMASI03 theory of operation.

ON-BOARD INDICATORS

The IMASI03 has one red/green LED indicator which shows the operating status. The LED will:

- Flash red on power-up.
- Remain off after passing on board diagnostics until the IMASI03 is configured by the MFP.
- Show solid green after the master MFP downloads configuration data.
- Show solid green during normal running.
- Blink green when the MFP which configured the IMASI03 enters configure mode from execute mode.

- Blink green if slave expander bus communication is lost (if the MFP is removed).
- Show solid red if a fatal failure of the IMASI03 module occurs. For example, if power up diagnostics fail.
- Show solid red for a power fail interrupt (PFI).
- Show pass/fail of diagnostic routines when in diagnostic mode (refer to Section 6).

SECTION 6 - TROUBLESHOOTING

INTRODUCTION

This section explains the error signs and corrective actions for the Universal Analog Input Slave Module (IMASI03).

ON-BOARD INDICATORS

The IMASI03 has one red/green LED indicator which shows the operating status. The LED will:

- Flash red on power-up.
- Remain off after passing on board diagnostics until the IMASI03 is configured by the MFP.
- Show solid green after the master MFP downloads configuration data.
- Show solid green during normal running.
- Blink green when the MFP which configured the IMASI03 enters configure mode from execute mode.
- Blink green if slave expander bus communication is lost (if the MFP is removed).
- Show solid red if a fatal failure of the IMASI03 module occurs. For example, if power up diagnostics fail.
- Show solid red for a power fail interrupt (PFI).
- Show pass/fail of diagnostic routines when in diagnostic mode.

ALARM AND EXCEPTION REPORTING

No alarm or exception reports are generated directly by the function codes associated with the IMASI03. The values from the IMASI03 must be sent to a standard exception reporting block if exception reporting is required. Refer to the instruction manual for the operator interface being used for more information.

PROBLEM REPORTS

Problem reports generated by the IMASI03 function codes (215 and 216) are I/O slave error reports (Report Type 12).

Function codes 215 and 216 generate five kinds of error messages.

- No response/wrong type (error type 1).
- Calibration error (error type 2).
- Channel failure/out of range (error type 3).
- Calibration (error type 14).
- Configuration mismatch (error type 7).

Problem reports are generated in response to three types of errors detected by the function codes.

- For a communication failure, if any message read by the MFP from the IMASI03 fails.
- If the detailed module status read from the IMASI03 by the MFP indicates any error conditions.
- If the channel status for any configured channel indicates an error.

Table 6-1 contains the error types generated for each error.

Table 6-1. IMASI03 Error Types

Module Problem Report Type 12			
Error Type	**Error Description**	**Slave Error**	**Corrective Actions**
14	Calibration (0EH) problem report (from FC 216)	Channel 1-16 Disabled	Remove IMASI03 and insert. If error recurs, replace the IMASI03.
14	Calibration (0EH) problem report (from FC 215)	Cold Junction Disabled	
14	Calibration (0EH) problem report (from FC 216)	Channel 1-16 Not Calibrated	
14	Calibration (0EH) problem report (from FC 215)	Cold Junction Not Calibrated	
7[1]	Configuration Mismatch problem report (from FC 216)	Channel Not Configured	Verify that Specs 3 through 9 of the indicated FC 216 are correct.
3	Channel Failure/Out of Range (03H) problem report (from FC 216)	Channel 1-16 Out Of Range Error	Possible open input or signal is out of range. Verify field wiring, connections, sensor and module seating.
3	Channel Failure/Out of Range (03H) problem report (from FC 215)	Cold Junction Out of Range Error	

Table 6-1. IMASI03 Error Types (continued)

Module Problem Report Type 12			
Error Type	**Error Description**	**Slave Error**	**Corrective Actions**
3	Channel Failure/Out of Range (03H) problem report (from FC 216)	External Cold Junction Reference Error	Verify quality of block defined for Spec 3.
3	Channel Failure/Out of Range (03H) problem report (from FC 216)	Channel 1-16 A/D Conversion Error	Remove IMASI03 and insert. If error recurs, replace the IMASI03.
3	Channel Failure/Out of Range (03H) problem report (from FC 215)	Cold Junction A/D Conversion Error	
2	Calibration (02H) problem report (from FC 215)	Unconfigured Reference Error	Cold junction reference is not zero and has bad quality. Unconfigured channel reference error (unused channel not functioning properly). The slave and all configured channels will continue to function properly.
2	Calibration Error (02H) problem report (from FC 215)	Cold Junction Reference Error	
2	Calibration Error (02H) problem report (from FC 216)	Channel 1-16 Reference Error	Remove IMASI03 and insert. If error recurs, replace the IMASI03.
1	No Response/Wrong Type (01H) problem report (from FC 215)	Any Communication Failure. Any Command or Data Failure	
1	No Response/Wrong Type (01H) problem report (from FC 215)	NVRAM Error	
1	No Response/Wrong Type (01H) problem report (from FC 215)	Slave A/D Reference Error	
1	Calibration Error (01H) problem report (from FC 215)	Slave Not Calibrated	
1	No Response/Wrong Type (01H) problem report (from FC 216)	Channel 1-16 Slave Expander Bus Error	
1	No Response/Wrong Type (01H) problem report (from FC 215)	Cold Junction Slave Expander Bus Error	

ERROR MESSAGES AND CORRECTIVE ACTIONS

Input Channel Status

The slave maintains a fixed area in the dual port RAM to store the current value and status of each channel. The master MFP reads the data and status for each channel individually.

To view the status of the IMASI03, read it's block output N+1 of function code 215. Check the input status on each point individually by looking at the corresponding function code 216 block output quality. Use any INFI 90 operator interface, such as an Operator Interface Station (OIS) or Engineering Work Station (EWS).

Slave Errors

Slave errors are reported to the MFP through function codes 215 for the slave and 216 for the active input channels. The MFP indicates slave errors through module status when in the execute mode. Byte 1 of the module status will indicate an error and byte 2 of the module status will indicate LIO (local I/O) when there is an IMASI03 error.

When specification 4 in function code 215 is set to 1, the MFP will continue to execute if function code 215 detects an error. A module problem report can be requested in order to get specific information about any slave error indicated in module status. When specification 4 in function code 215 is set to 0, the MFP goes into error mode if function code 215 detects an error. If an error occurs, module status byte 1 will indicate an error, byte 2 will indicate LIO and byte 3 will indicate the specific error. Refer to Table 6-2. For example, Analog Input Reference Error is indicated by a 2 and Missing I/O is indicated by a 3 in byte 3.

Table 6-2. Module Status (Byte 3) Error Codes

Error Code	Error Message	Description	Corrective Actions
2	*AI Reference Error*	The indicated FC 215 block failed due to an IMASI03 A/D system reference error.	Remove IMASI03 and insert. If error recurs, replace the IMASI03.
3	*Missing I/O*	The indicated FC 215 block failed due to a communication error with the IMASI03.	Remove IMASI03, verify expander bus dip shunt, verify IMASI03 slave address is same as FC 215 Spec 1. Insert IMASI03 and verify proper seating. If error recurs, call Bailey field service.
		The indicated FC 215 block detected an IMASI03 error. (IMASI03 slave firmware has reported an error.)	

Table 6-2. Module Status (Byte 3) Error Codes (continued)

Error Code	Error Message	Description	Corrective Actions
5	*Configuration Error - Undefined Input*	The indicated FC 215 or FC 216 detected a function code channel link error: • Too many FC 216 blocks in link (greater than 16 channels defined for IMASI03). • A circular link, an FC 216 block appears more than once in the channel link list[1]. • An FC 216 block in the channel link list has a different slave address than the linked FC 215 block. • An incorrect block number is in the channel link list[1]. • IMASI03 channel number defined more than once (two FC 216 blocks with the same channel number).	Verify FC 215 spec values and all linked FC 216s are correct.
		The indicated FC 215 has an incorrect CJR block number.	Verify FC 215 Spec 3 points to the correct block.

NOTE:
1. Link list is a chained series of function code blocks. Function code 215 is the first block in the series. Function code 215 links to the first of up to 16 function code 216 blocks.

When the MFP goes from configure mode to execute mode and there is a configuration error, the MFP will go into error mode and byte 3 of the module status will be 5 (Configuration Error - Undefined Input).

If the MFP goes into error mode, module status byte 3 may contain a 2, 3 or 5. A 2 = AI Reference Error, a 3 = Missing I/O and a 5 = Configuration Error - Undefined Input.

If the MFP goes into error mode and module status byte 3 contains a 2, 3 or 5, look at module status bytes 4 and 5 for the block number of the function code detecting the error. Block 4 contains the two most significant digits and block 5 contains the two least significant digits of the error block. For example, if byte 4 contains 10 and byte 5 contains 42, then block 1042 contains the error.

For more information on module status, refer to the Multi-Function Processor product instruction manual.

Error Example

Function code 215 for the slave and 216 for the active channel need the same address. Check that the address on IMASI03 switch SW1, the address in function code 215 specification 1 and function code 216 specification 1 are the same.

If function code 216 slave address is not the same as function code 215 the MFP will go into error mode when put into execute mode. The error will indicate 5, (byte 3 of module status/error message = 05) Configuration Error - Undefined Input.

Modify the address in function code 215 and the associated 216 blocks. The IMASI03 address value set in function code 215 specification 1 and function code 216 specification 1 should match the slave address set on SW1 on the IMASI03 module.

Use an INFI 90 operator interface to change the configuration data. For procedures on how to change a function code specification, refer to the product instruction manual for the operator interface being used.

The master module generates a local I/O error in the module status if the slave expander bus is not connected between the slave module and the master module. Verify that the bus is connected on the MMU backplane.

> **NOTE:** Setting FC 215 specification 4 to 0 will cause the master module to ***trip*** when the IMASI03 module fails. Changing specification 4 to a 1 causes the master module to ***continue*** to operate if the IMASI03 fails or is missing.

If both the 215 and 216 blocks have the wrong address, the MFP status will indicate a local I/O error. To correct this:

> Remove the slave module and change the setting of SW1 on the IMASI03 to match the module configuration settings. Refer to Section 3 for information on setting an address and installing a slave module.

MODULE FUNCTIONAL TESTS

There are two sections in the slave functional test. Self-contained, dipswitch configurable diagnostics. Slave expander bus interface testing (requires an MFP).

Test Equipment Requirements

To perform the functional testing, a single powered MMU slot (+5 V, ± 15 V, and power fail interrupt - PFI) is required. Slave expander bus testing requires a powered MMU slot, an MFP, an MFP interface device, and slave expander bus dipshunts.

Switch SW1 Settings

Table 6-3 lists the switch settings used in both parts of the functional test.

Table 6-3. Switch SW1 Settings, Operating Modes and Error Messages

SW1 Settings	Operating Mode	Error Code[1]
00000000 00000001	Initial switch setting Module address = 1	
00000001 00000010 00000100 00001000 00010000 00100000	1 Module addresses 2 for the slave 4 expander bus test 8 16 32	
10000000 1x2000001	Dipswitch test Watchdog timer test	
1x[2]000100 1x[2]000101 1x[2]000110 1x[2]000111	CPU test Timer test ROM test All tests (this group)	10 11 12 13
1x[2]001000 1x[2]001001 1x[2]001010 1x[2]001011	Dual-port RAM test NVRAM test SRAM test All tests (this group)	20 21 22 23
1x[2]001100 1x[2]001101 1x[2]001110 1x[2]001111	16 channel low level reference test A/D reference test 16 channel high level reference test All tests (this group)	30[1] 31 40[1] 33
1x[2]011111	All tests (10, 11, 12, 20, 21, 22, 30, 31)	

NOTES: 0 = ON = CLOSED; 1 = OFF = OPEN

1. An error code of 30 or 40 will be followed by an error code indicating which input channel is not functional. For example, an error code of 30 followed by an error code of 7 indicates that channel 7 is not functional. In this example, the LED will continue to display 30 and 7. The LED error sequence repeats every 6 seconds.

2. x = 0 Continue looping on tests. Do not display error.
x = 1 Halt on test failure. Display error code.

HALT - DISPLAY ERROR

SW1 pole position 2 is the error halt/continue bit. A one in this position when in diagnostics mode instructs the slave to stop testing when an error is detected. The slave will loop on displaying the error code of the failed test.

If the test or group of tests passes, the LED will turn off momentarily at the start of the test and display solid green during the test (or tests).

If halt on error with display is selected and a specific test fails, an error code will be displayed by the status LED and repeated every six seconds. Refer to Table 6-3 for all of the error codes.

Example:

Error Code[1]	Green LED Blink Sequence	
10	1 long blink (1 sec.)	0 short blinks (1/3 sec.)
11	1 long blink (1 sec.)	1 short blink (1/3 sec.)
12	1 long blink (1 sec.)	2 short blinks (1/3 sec.)

NOTE:
1. An error code of 30 will be followed by an error code indicating which input channel is not functional. For example, an error code of 30 followed by an error code of 7 indicates that channel 7 is not functional.

CONTINUE - DO NOT DISPLAY ERROR

When SW1 pole position 2 is set to a zero during diagnostics mode, the slave will loop on running the selected tests. Looping continues even if an error occurs. This mode is used to loop on a particular component in the event of a suspected failure.

If the continue - do not display error mode is selected, the LED will show solid green during the first iteration of the selected tests. During the second test iteration, the LED will be off. The LED will blink at a rate determined by the selected tests. For example, if all tests are selected, the LED will repeat a sequence of being on for ten seconds and off for ten seconds.

Dipswitch Configurable Diagnostics

The diagnostic tests check these slave components:

- Slave Bus Address Switch
- Watchdog Timer
- Microprocessor
- ROM
- Static RAM
- Dual-Port RAM (Slave read/write accesses)
- Nonvolatile RAM
- Individual Channel Voltage References
- A/D Internal Voltage References

Test Procedure

DIPSWITCH TEST

1. Unplug the slave, set SW1 to the Dipswitch Test Mode as shown in Table 6-3, and insert the slave into the powered MMU slot. The status LED should immediately turn GREEN and stay GREEN.

2. With the slave still plugged into the powered MMU slot, toggle each dipswitch position of SW1 individually. As each dipswitch position is toggled (from 0 to 1, and back to 0) individually, the status LED should change from GREEN to OFF, and back to GREEN again. Test all 8 dipswitch positions of SW1.

ALL TESTS MODE

1. Unplug the slave and set SW1 to the All Tests Mode, Halt-Display Error, as shown in Table 6-3 (SW1 = 11011111).

2. Insert the slave into the powered MMU slot.

If the slave is passing the All Tests Mode diagnostics, the status LED will turn GREEN after 1 second and stay GREEN for about 12 seconds. The status LED will then blink OFF and back to solid GREEN again within 1 second. The status LED will again stay green for about 12 seconds. Allow this cycle to repeat at least one additional time. If the All Tests Mode is successful, go to the Universal Slave Bus Test.

If the slave is failing the All Tests Mode and the halt/display on error bit is set, the status LED will begin blinking an error code. The blinking LED represents a 2 digit error code. Find the number by counting the number of times the status LED blinks GREEN for long and short time periods. The two digit number can then be found in Table 6-3 (under Error Codes), and the problem can be identified.

Slave Expander Bus Interface Test

The following tests check for proper operation of these slave expander bus interface components.

- Slave Expander Bus interface chip.
- Dual-Port Static RAM (slave read/writes and MFP read/writes).
- MFP/IMASI03 slave handshaking.

Test Procedure

These two steps check for proper operation of the slave bus interface:

1. Tune specification one of function code 217 to ten indicating slave expander bus test. Also, tune specification two to the block address of the slave's function code 215 block. Set all other specifications to the default value and send this block.

2. Monitor the function code 217, block number N+4 to determine the status of the slave expander bus.

If block N+4 = 0000, the test is successful.

If block N+4 = 2000, the test has failed (data passed back was incorrect).

For more information on function code 217 errors, refer to Table C-10 in Appendix C. The functional test is complete. If the IMASI03 does not function properly, return it for repair. Refer to Section 7 and Section 8.

MODULE PIN CONNECTIONS

This section shows the pin connections for the IMASI03. Check the signals on the pins and compare them to the tables. The slave module has three connection points for external signals and power (P1, P2 and P3). Table 6-4 shows the pin connections for P1. Table 6-5 shows the pin connections for P2. Table 6-6 shows the pin connections for P3.

Table 6-4. P1 Power Pin Connections

Pin (P1)	Connection	Pin (P1)	Connection
1	+5 VDC	7	+15 VDC
2	+5 VDC	8	-15 VDC
3	Not Used	9	Power Fail Interrupt
4	Not Used	10	Not Used
5	Common	11	Not Used
6	Common	12	Not Used

Table 6-5. P2 Expander Bus Connections

Pin (P2)	Signal	Pin (P2)	Signal
1	Data 1	7	Data 7
2	Data 0	8	Data 6
3	Data 3	9	Clock
4	Data 2	10	Sync
5	Data 5	11	Not Used
6	Data 4	12	Not Used

Table 6-6. P3 Input Signal Pin Connections

Pin	Signal	Pin	Signal
1	RTD-	26	RTD+
2	IN1+	27	IN1-
3	COM1	28	COM2
4	IN2-	29	IN2+
5	IN3+	30	IN3-
6	COM3	31	COM4
7	IN4-	32	IN4+
8	IN5+	33	IN5-
9	COM5	34	COM6
10	IN6-	35	IN6+
11	IN7+	36	IN7-
12	COM7	37	COM8
13	IN8-	38	IN8+
14	IN9+	39	IN9-
15	COM9	40	COM10
16	IN10-	41	IN10+
17	IN11+	42	IN11-
18	COM11	43	COM12
19	IN12-	44	IN12+
20	IN13+	45	IN13-
21	COM13	46	COM14
22	IN14-	47	IN14+
23	IN15+	48	IN15-
24	COM15	49	COM16
25	IN16-	50	IN16+

SECTION 7 - MAINTENANCE

INTRODUCTION

The Universal Analog Input Slave Module (IMASI03) needs little maintenance. Repair procedures are limited to module replacement. If the IMASI03 fails, remove and replace it with another. Verify that the switch settings on the replacement module are the same as the failed module. This section contains a schedule to help take care of the system hardware. Refer questions to your local Bailey Controls service office.

MAINTENANCE SCHEDULE

Do the tasks in Table 7-1 at the times shown.

Table 7-1. Maintenance Schedule

Task	Interval
Clean and tighten each power and ground connection.	Every 6 months or at plant shutdown, whichever occurs first.
Use static safe vacuum cleaner to remove dust from: Modules Module Mounting Unit Fan Assembly Power Entry Panel	

SECTION 8 - REPAIR/REPLACEMENT PROCEDURES

INTRODUCTION

This section explains the replacement steps for a Universal Analog Input Slave Module (IMASI03). There are no special tools required to replace an IMASI03 module.

MODULE REPAIR/REPLACEMENT

If the IMASI03 is faulty, replace it with a new one. ***DO NOT*** try to repair the module; replacing components may affect the module performance. Modules can be removed while system power is supplied. To replace a module:

1. Push and turn the two front panel captive latches one half turn to unlatch the module. It is unlatched when the slots on the latches are vertical and the open end of the slots face away from the center of 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 latches on the module faceplate one half turn to the latched position. It is latched when the slots on the latches are vertical and the open ends face the center of the module.

6. Return to normal operation.

SECTION 9 - SUPPORT SERVICES

INTRODUCTION

Bailey Controls is ready to help you use, apply and repair its products. Contact the nearest sales office to request services for sales, repair and maintenance contracts. The sales office can answer your questions on how to apply and install the Bailey Controls INFI 90 system. They can help apply and install devices onto your system if it needs to be updated or expanded.

REPLACEMENT PARTS AND ORDERING INFORMATION

When making repairs, be sure to order parts from a Bailey Controls sales office. If you provide this information when ordering, it helps us to deliver the correct parts. Have this list ready when calling in to order parts:

1. Part description, part number and quantity.

2. Model and serial numbers.

3. Bailey instruction manual number, page number and figure that describe the part.

When ordering standard parts from Bailey Controls, use part numbers and descriptions from the Recommended Spare Parts Lists. Order parts without commercial descriptions from the nearest Bailey Controls sales office.

TRAINING

Bailey Controls has a modern training complex that provides service and repair instruction. Service and repair training courses can be held in your plant to train service personnel. Contact a Bailey Controls sales office for more information and to schedule training.

TECHNICAL DOCUMENTATION

Additional copies of this manual are available from the nearest Bailey Controls sales office at a moderate charge. The current manuals for all products being offered can be ordered.

APPENDIX A - NIAI05 TERMINATION MODULE CONFIGURATION

INTRODUCTION

The Universal Analog Input Slave Module (IMASI03) uses two NIAI05 termination modules to connect field wiring (eight inputs each). Jumpers on each NIAI05 configure each of the eight analog inputs for either system powered 4-20 mA, external powered 4-20 mA, 3-wire RTD, differential or single ended voltage.

IMASI03 termination modules with both revision A and revision B hardware are in service. This section contains information on revision A and B termination modules. See Figure A-1 for the revision A module and Figure A-2 for the revision B module.

Setup

The two NIAI05 termination modules should be installed next to each other in the same termination module unit (TMU) or directly above and below each other in two separate TMUs. The distance between termination modules is limited by the distance between J2 and J3 on the NKAS02 (or NKAS12) connector cable.

Channel designation labels are provided with each NIAI05. This allows the user to configure one NIAI05 as the J2 termination module for channels 1 through 8 and configure a second NIAI05 as the J3 termination module for channels 9 through 16. The J2 termination module connects to the NKAS02 (or NKAS12) connector labeled J2. The J3 termination module connects to the NKAS02 (or NKAS12) J3 connector.

The NKAS02 connector cable has PVC insulation and is rated for 80° C (0 to 176° F) at 300 V (UL rated type CL2). The NKAS12 connector cable has non-PVC insulation and is rated for 90° C (0 to 194° F) at 300 V (UL rated type PLTC).

Cold Junction Reference Input

Each NIAI05 termination module (two are required, even if only 8 inputs or less are used) has an RTD which measures the temperature of the termination module. This temperature is used to compensate for the cold junction effect on thermocouple inputs.

When using the built-in cold junction reference, the termination module front cover should be in place. The cover encloses both the terminal blocks and the RTD. It helps maintain the same temperature around the terminal blocks and the RTD. Maintaining both at the same temperature allows maximum accuracy for thermocouple inputs.

To apply the built-in cold junction reference for thermocouple inputs, refer to function code 215 specifications and block outputs in Appendix C.

Configuring Inputs

Jumpers on each termination module configure the eight analog inputs. Table A-1 lists the inputs that the NIAI05 accepts. Table A-2 lists the jumper configurations for the NIAI05. Table A-3 describes the NIAI05 input types.

Table A-1. NIAI05 Input Types

Input Type	Signal Type
Thermocouple	E, J, K, L, N (14 AWG) N (28 AWG), R, S, T, U Chinese E, Chinese S.
Millivolt	-100 to +100 mV
High Level	-10 V to +10 V
Current	4 to 20 mA, external or system powered.
3 Wire RTD	Resistance Range: 0 to 500 Ohms RTDs: 10, 100, 120 Ohms Chinese 53 Ohms (3-wire)

Table A-2. NIAI05 Jumper Configurations

Input Type	Jumper Number		
	J1 - J16	J17 - J24	J25 - J32
Single Ended Voltage	1 - 2	1 - 2	2 - 3
Differential Voltage	1 - 2	1 - 2	1 - 2
System Powered 4-20 mA	2 - 3	2 - 3	2 - 3
External Powered 4-20 mA	1 - 2	2 - 3	1 - 2
3-Wire RTD	1 - 2	1 - 2	1 - 2

NOTE: Jumpers used by each input channel are listed with the terminal assignments in Figures A-3 and A-4.

Table A-3. NIAI05 Input Type Descriptions

Input Type	Input Description
Single Ended Voltage	This jumper configuration connects the minus (-) input terminal to I/O COM on the NIAI05. The IMASI03 measures the voltage at the plus (+) input terminal with respect to the I/O COM terminal. No connection to the C terminal is necessary.
Differential Voltage	This jumper configuration connects the plus (+) and minus (-) inputs directly to IMASI03 differential input. Channel to channel and channel to system signal isolation is achieved for all voltage input types, including high level voltage, millivolts and thermocouples. No connection to the C terminal is necessary.
System Powered 4-20 mA	This jumper configuration connects the plus (+) input terminal to system +24 VDC through a current limiting resistor on NIAI05 modules with revision A hardware (revision B hardware replaces the resistor with a fuse). The minus (-) input terminal connects to a precision resistor that generates a single ended voltage (1 to 5 V) for the IMASI03 to measure. No connection to the C terminal is necessary. The INFI 90 system must have +24 volts (system power) installed.
External Powered 4-20 mA	This jumper configuration connects the plus (+) input terminal to one end of a precision resistor and the minus (-) input to the other end of the same precision resistor in the NIAI05. An isolated 1 to 5 Volts is generated for the IMASI03 to measure. No connection to the C terminal is necessary.
3-Wire Resistance	This jumper configuration connects the plus (+) and minus (-) inputs and the C input directly to IMASI03 three-wire input. Channel to channel and channel to system signal isolation is maintained. The two common leads of the RTD element should be connected across the plus (+) and common (C) terminals, and the third lead should be connected to the minus (-) terminal.

CONFIGURING INPUTS

This section contains figures of revision A and revision B IMASI03 termination modules.

- Figure A-1 shows the jumper locations on a module with revision A hardware. Check jumpers before installing the NIAI05. Figure A-2 shows the jumper locations on a module with revision B hardware. Check jumpers before installing the NIAI05.

- Figure A-3 shows the revision A hardware terminal assignments and the jumpers used for each input. Figure A-4 shows the revision B hardware terminal assignments and the jumpers used for each input.

- Figure A-5 shows a typical input circuit for the revision A hardware NIAI05. Figure A-6 shows a typical input circuit for the revision B hardware NIAI05.

- Figure A-7 shows revision A hardware field input termination examples. Figure A-8 shows revision B hardware field input termination examples.

- Figure A-9 shows revision A hardware IMASI03 input examples. Figure A-10 shows revision B hardware IMASI03 input examples.

- Figure A-11 shows the cabling for the NIAI05 with revision A or B hardware to the IMASI03. The NKAS02 (or NKAS12) cable connects the termination module to the IMASI03. The NKAS02 cable has PVC insulation and is rated for 80^{o} C (0 to 176^{o} F) at 300 volts (UL rated type CL2). The NKAS12 cable has non-PVC insulation and is rated for 90^{o} C (0 to 194^{o} F at 300 volts (UL rated type PLTC).

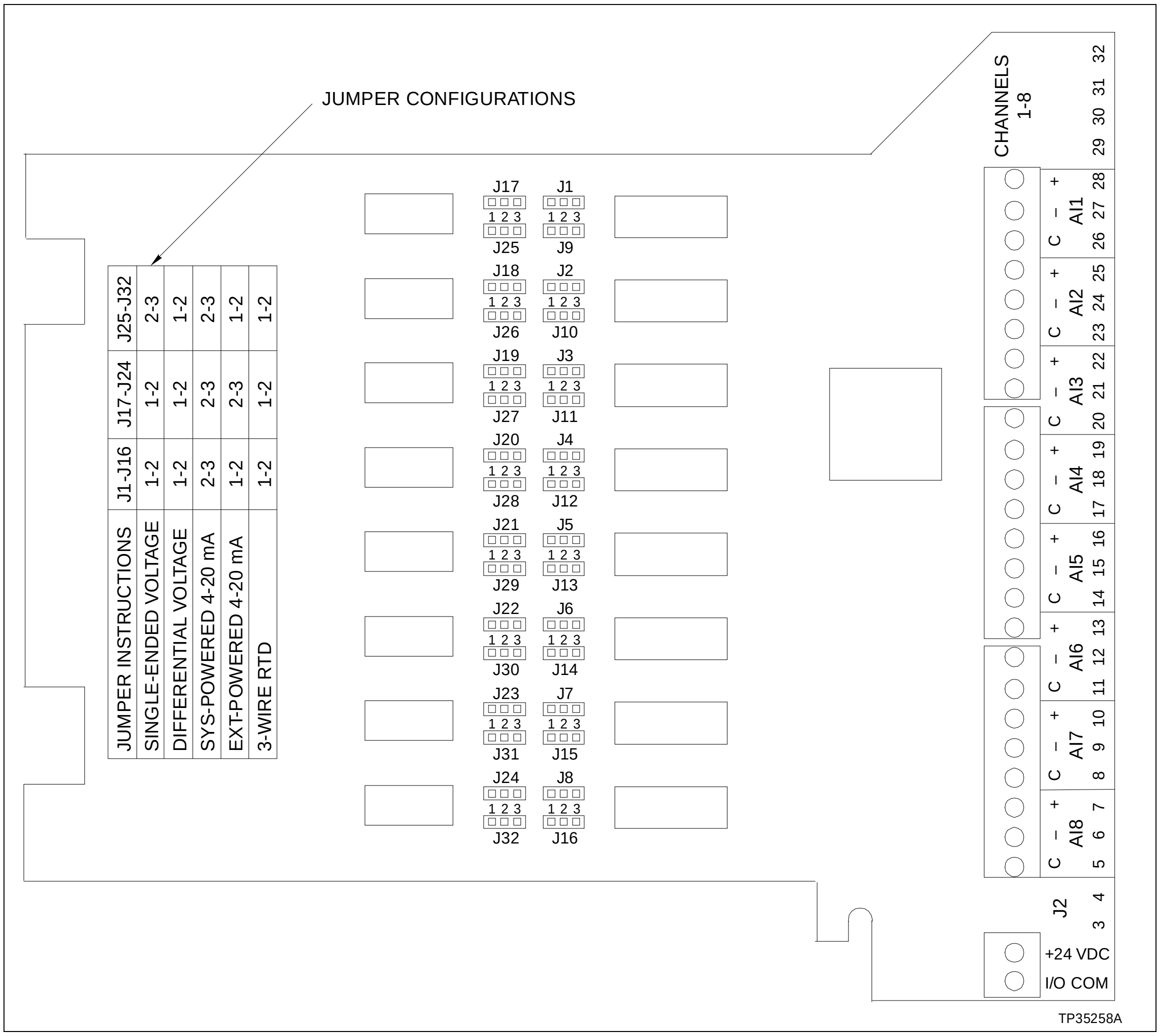


Figure A-1. Jumper Locations for Revision A Hardware NIAI05

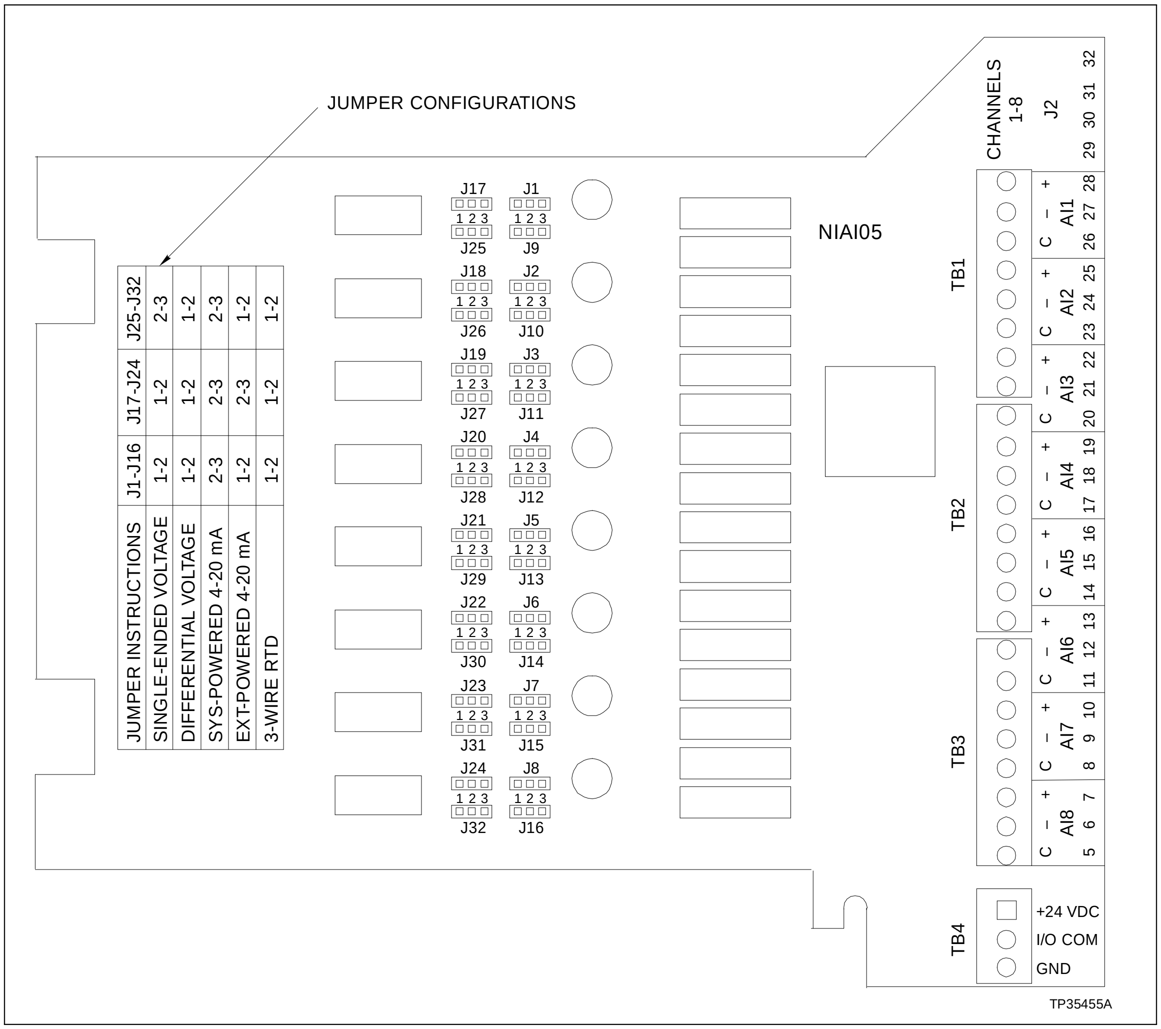


Figure A-2. Jumper Locations for Revision B Hardware NIAI05

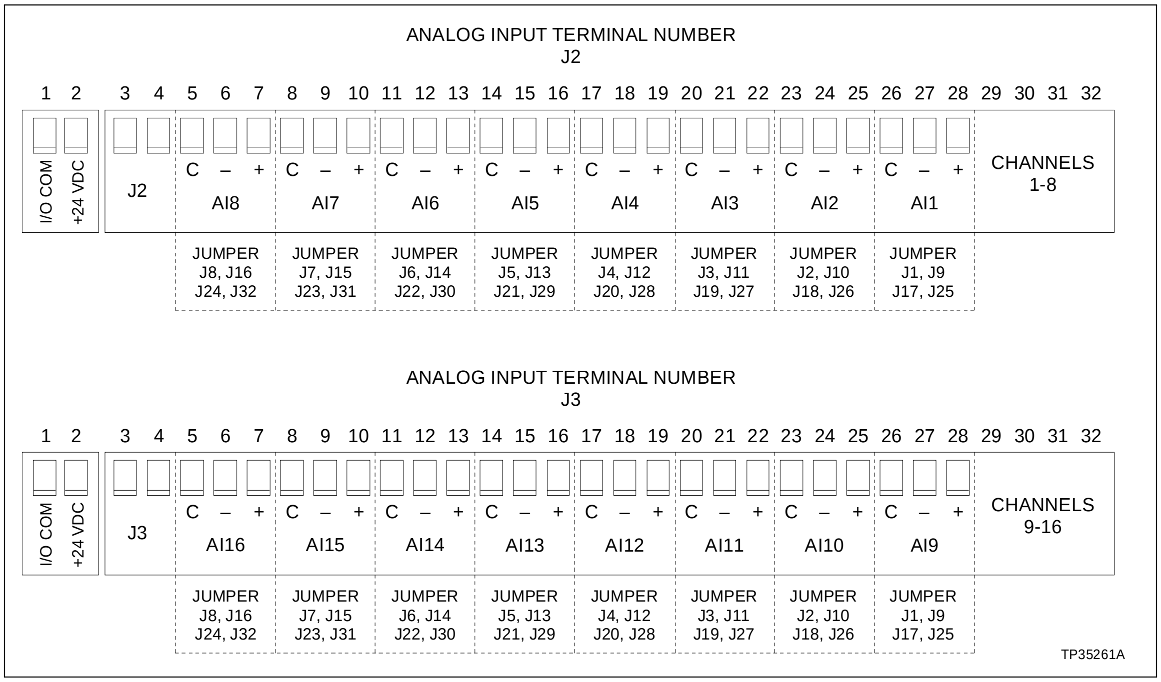


Figure A-3. Terminal Assignments for Revision A Hardware NIAI05

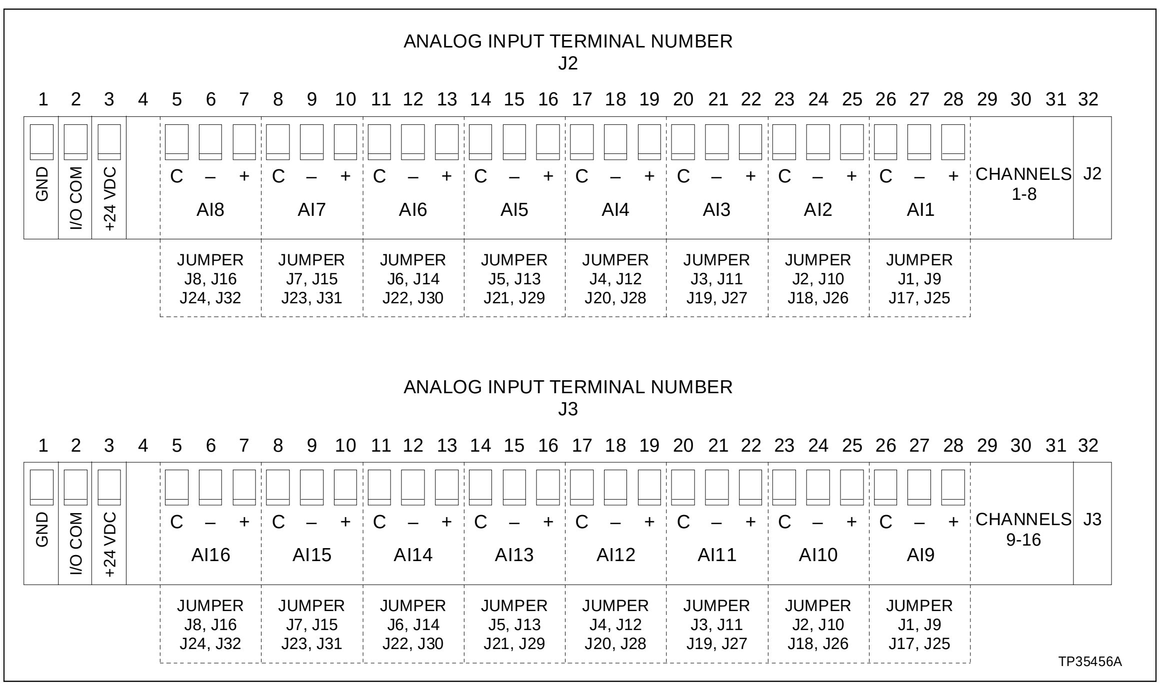
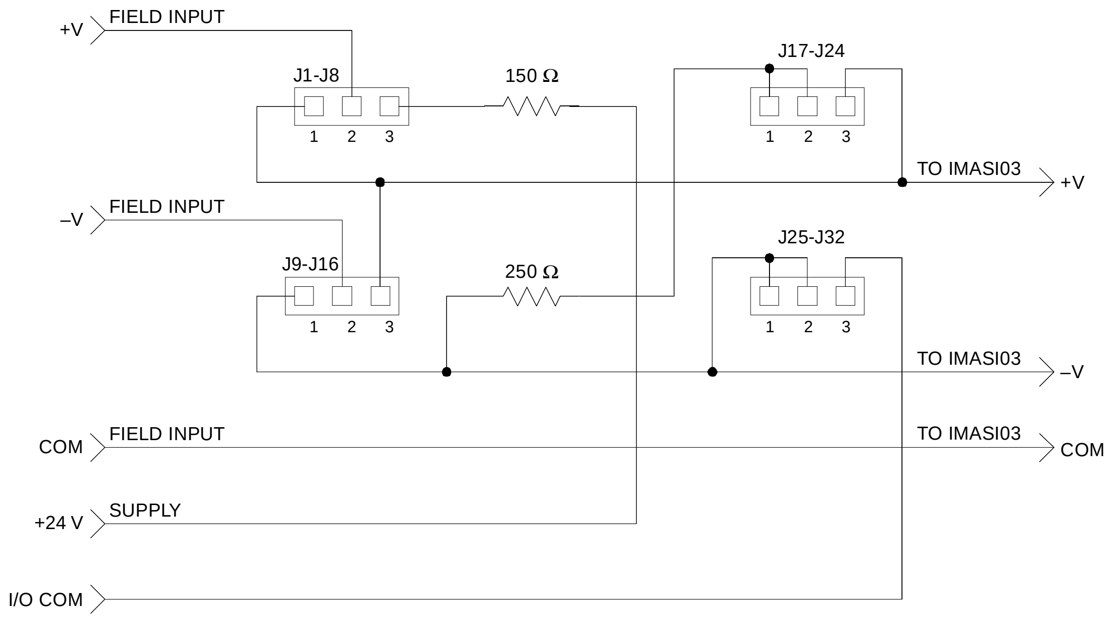


Figure A-4. Terminal Assignments for Revision B Hardware NIAI05



	INPUT CHANNEL 1	INPUT CHANNEL 2	INPUT CHANNEL 3	INPUT CHANNEL 4	INPUT CHANNEL 5	INPUT CHANNEL 6	INPUT CHANNEL 7	INPUT CHANNEL 8
J2 MODULE JUMPERS	J1, J9, J17, J25	J2, J10, J18, J26	J3, J11, J19, J27	J4, J12, J20, J28	J5, J13, J21, J29	J6, J14, J22, J30	J7, J15 J23, J31	J8, J16, J24, J32

	INPUT CHANNEL 9	INPUT CHANNEL 10	INPUT CHANNEL 11	INPUT CHANNEL 12	INPUT CHANNEL 13	INPUT CHANNEL 14	INPUT CHANNEL 15	INPUT CHANNEL 16
J3 MODULE JUMPERS	J1, J9, J17, J25	J2, J10, J18, J26	J3, J11, J19, J27	J4, J12, J20, J28	J5, J13, J21, J29	J6, J14, J22, J30	J7, J15 J23, J31	J8, J16, J24, J32

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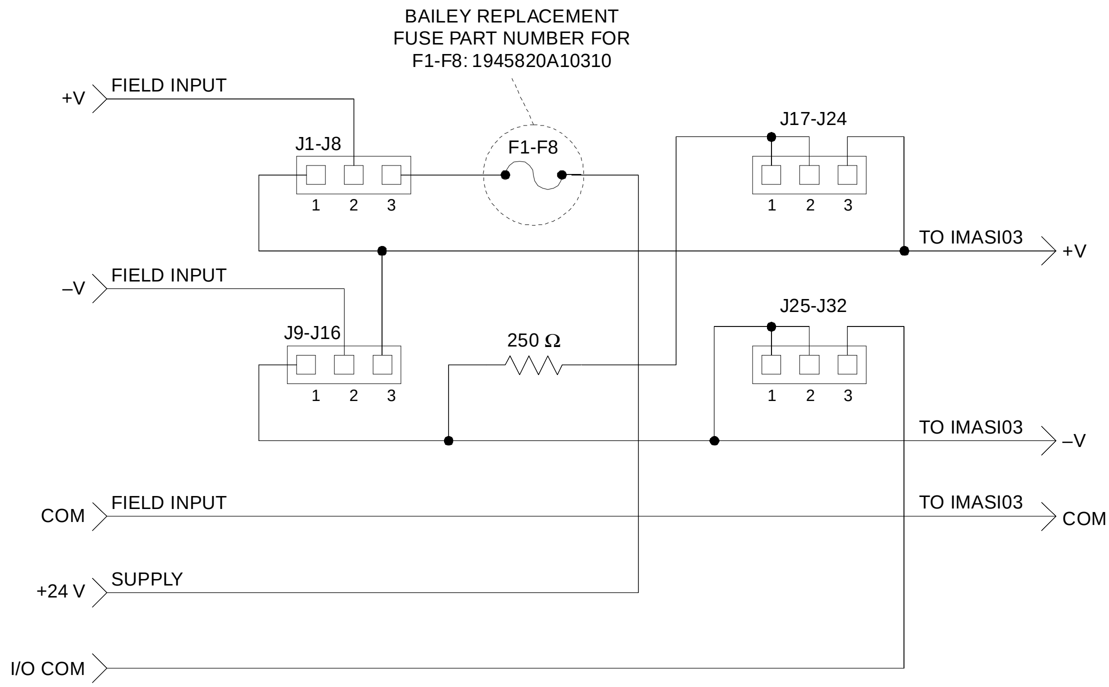
Figure A-5. Typical Input Circuit for Revision A Hardware



	INPUT CHANNEL 1	INPUT CHANNEL 2	INPUT CHANNEL 3	INPUT CHANNEL 4	INPUT CHANNEL 5	INPUT CHANNEL 6	INPUT CHANNEL 7	INPUT CHANNEL 8
J2 MODULE JUMPERS	J1, J9, J17, J25	J2, J10, J18, J26	J3, J11, J19, J27	J4, J12, J20, J28	J5, J13, J21, J29	J6, J14, J22, J30	J7, J15 J23, J31	J8, J16, J24, J32

	INPUT CHANNEL 9	INPUT CHANNEL 10	INPUT CHANNEL 11	INPUT CHANNEL 12	INPUT CHANNEL 13	INPUT CHANNEL 14	INPUT CHANNEL 15	INPUT CHANNEL 16
J3 MODULE JUMPERS	J1, J9, J17, J25	J2, J10, J18, J26	J3, J11, J19, J27	J4, J12, J20, J28	J5, J13, J21, J29	J6, J14, J22, J30	J7, J15 J23, J31	J8, J16, J24, J32

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Figure A-6. Typical Input Circuit for Revision B Hardware

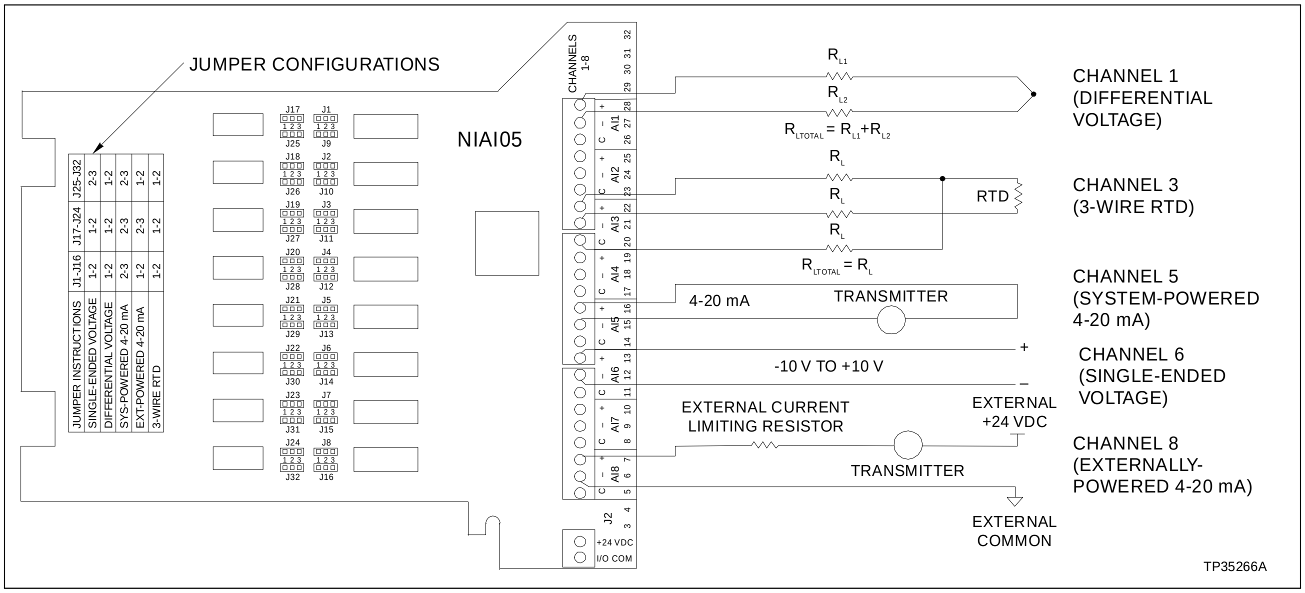


Figure A-7. Field Input Termination Examples for Revision A Hardware NIAI05

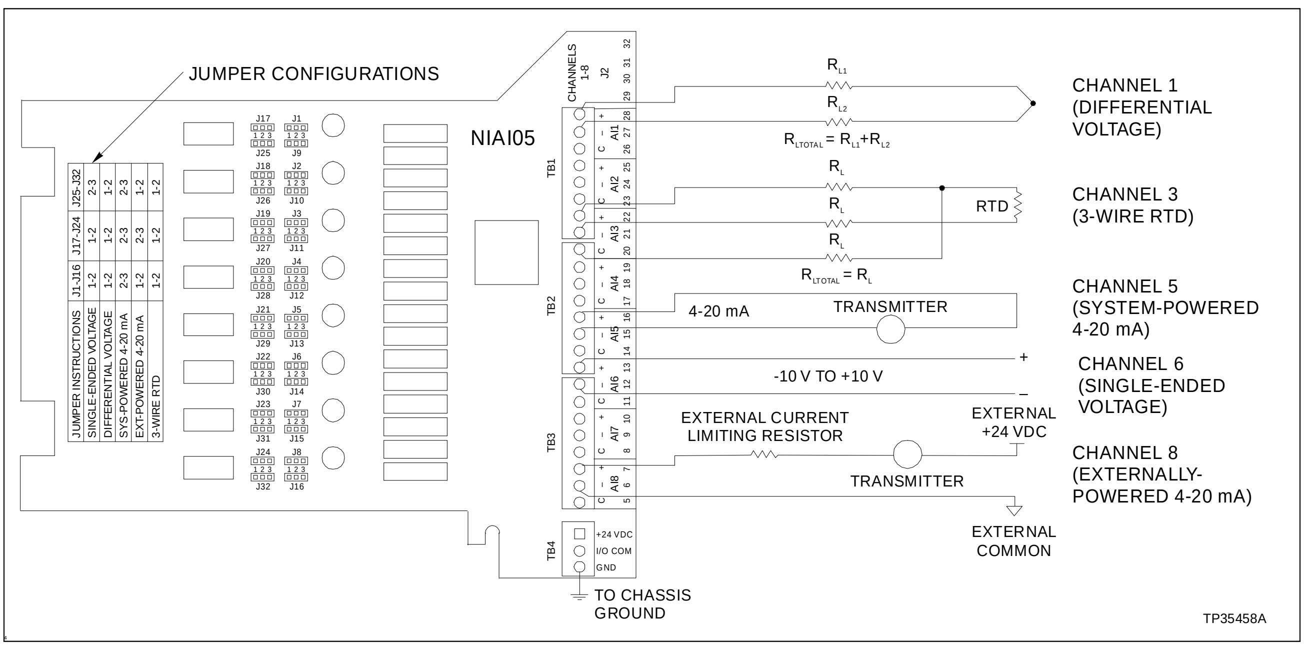


Figure A-8. Field Input Termination Examples for Revision B Hardware NIAI05

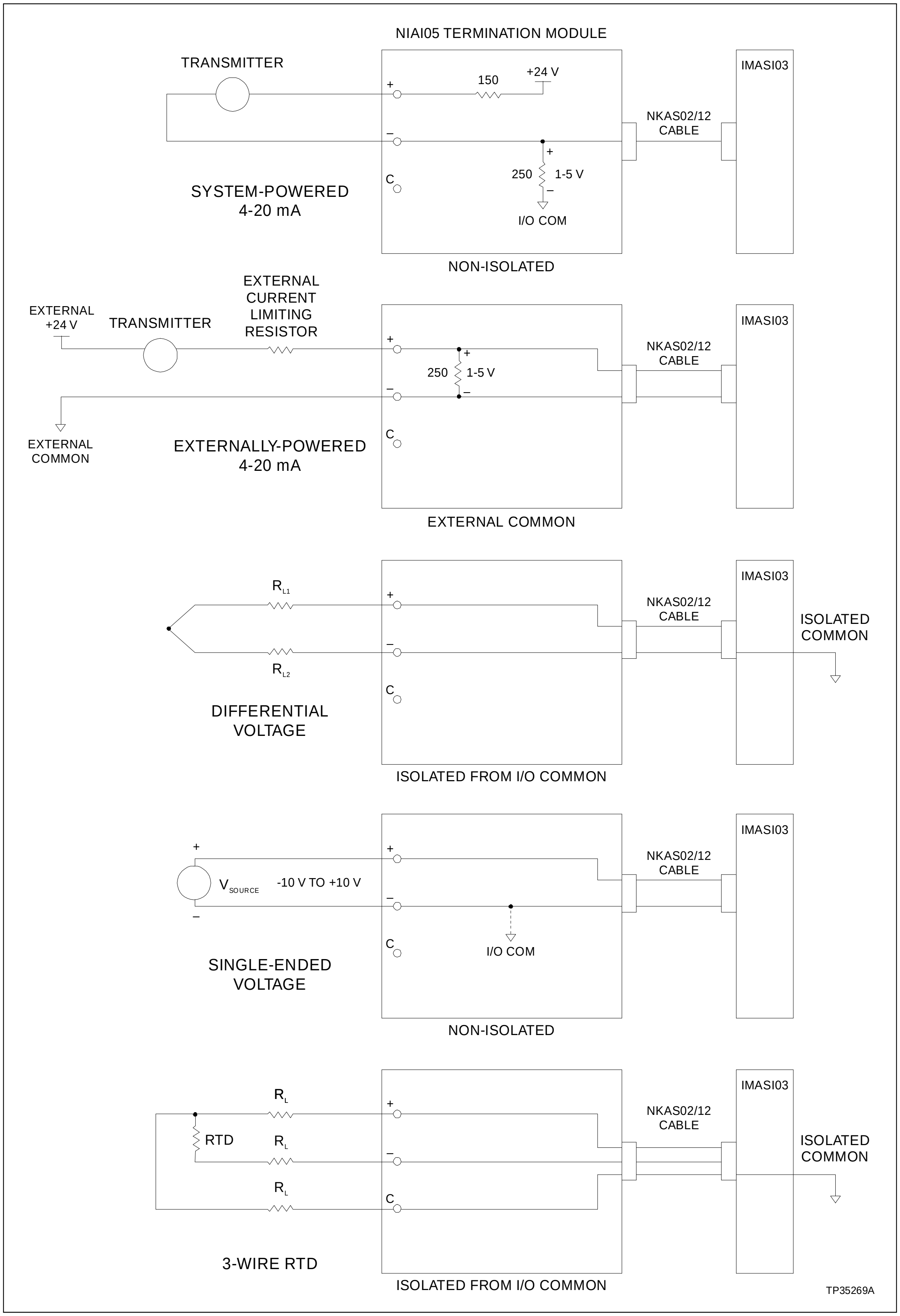


Figure A-9. Revision A Hardware IMASI03 Input Examples

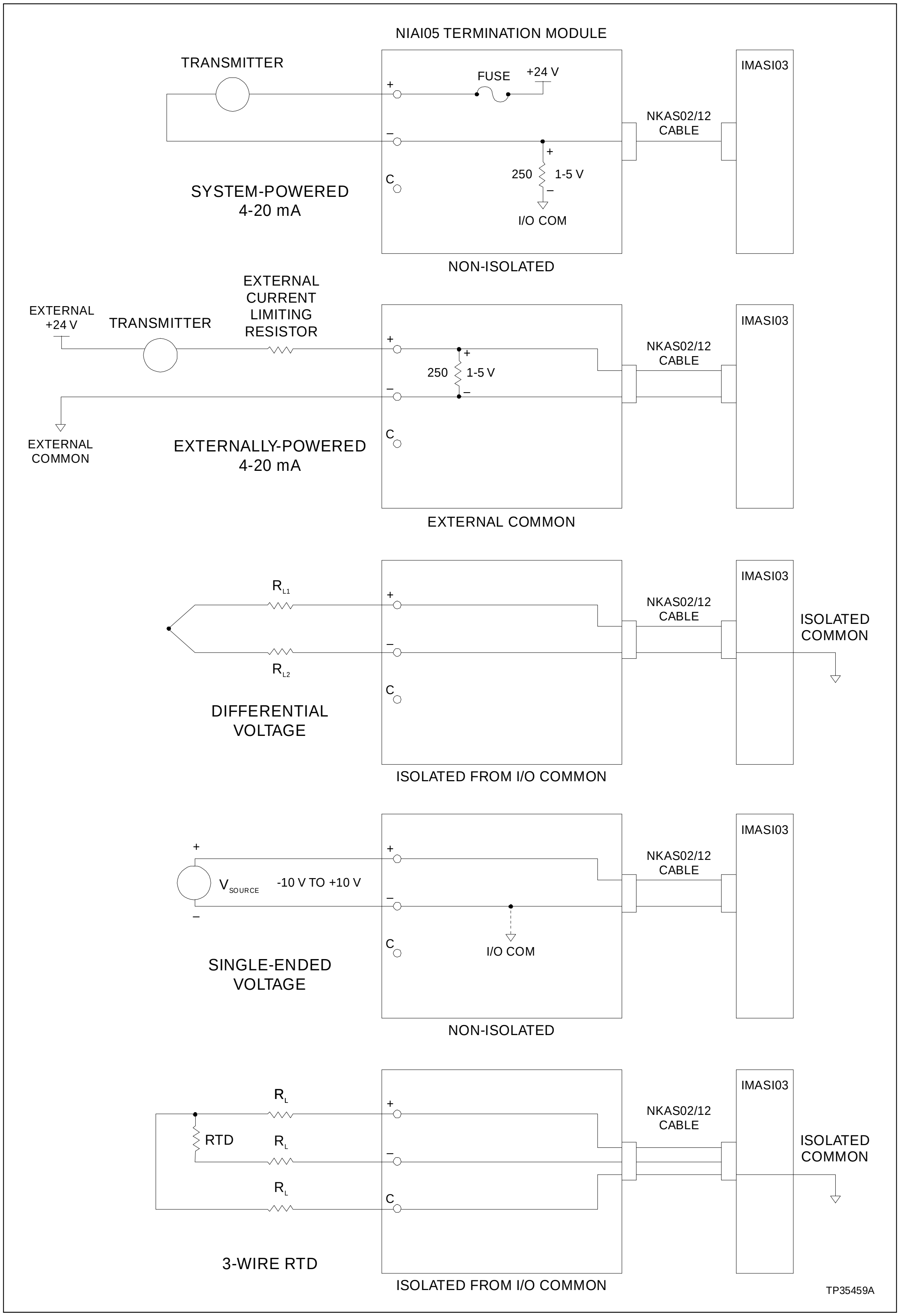


Figure A-10. Revision B Hardware IMASI03 Input Examples

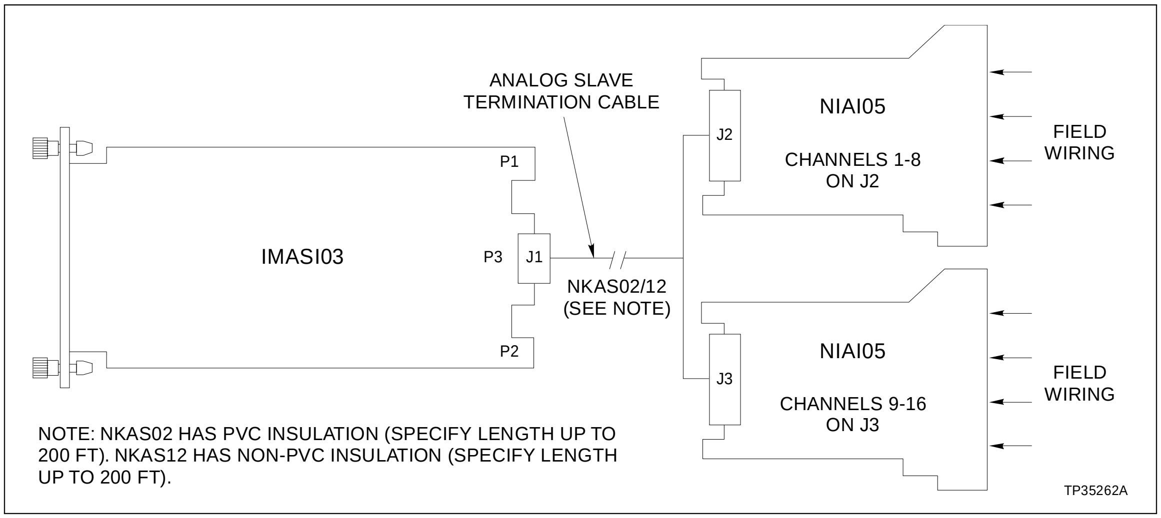


Figure A-11. Cable Connections for Revision A and B Hardware NIAI05

APPENDIX B - NTAI06 TERMINATION UNIT CONFIGURATION

INTRODUCTION

The Universal Analog Slave Input Module (IMASI03) uses one NTAI06 Termination Unit for termination. Jumpers on the NTAI06 configure each of the 16 analog inputs for either system powered 4-20 mA, external powered 4-20 mA, 3-wire RTD, differential or single ended voltage.

IMASI03 termination units with both revision A and revision B hardware are in service. This section contains information on revision A and B units (see Figure B-1).

Cold Junction Reference Input

Each NTAI06 termination unit has a pair of RTDs which measure the temperature of the termination unit. This temperature is used to compensate for the cold junction effect on thermocouple inputs.

When using the built-in cold junction reference, the termination unit covers should be in place. The cover encloses both the terminal blocks and the RTD. It helps maintain the same temperature around the terminal blocks and the RTD. Maintaining both at the same temperature allows maximum accuracy for thermocouple inputs.

To apply the built-in cold junction reference for thermocouple inputs, refer to function code 215 specifications and block outputs in Appendix C.

Configuring Inputs

Jumpers on the termination unit configure the 16 analog inputs. Table B-1 lists the inputs that the NTAI06 accepts. Table B-2 lists the jumper configurations for the NTAI06. Table B-3 describes the NTAI06 input types.

Table B-1. NTAI06 Input Types

Input Type	Signal Type
Thermocouple	E, J, K, L, N (14 AWG) N (28 AWG), R, S, T, U Chinese E, Chinese S.
Millivolt	-100 to +100 mV
High Level	-10 V to +10 V
Current	4 to 20 mA, external or system powered.
3-Wire RTD	Resistance Range: 0 to 500 Ohms RTDs: 10, 100, 120 Ohms Chinese 53 Ohms (3-wire)

Table B-2. NTAI06 Jumper Configurations

Input Type	Jumper Number		
	J1 - J32	J33 - J48	J49 - J64
Single Ended Voltage	1 - 2	1 - 2	2 - 3
Differential Voltage	1 - 2	1 - 2	1 - 2
System Powered 4-20 mA	2 - 3	2 - 3	2 - 3
External Powered 4-20 mA	1 - 2	2 - 3	1 - 2
3-Wire RTD	1 - 2	1 - 2	1 - 2

NOTE: Jumpers used by each input channel are listed with the terminal assignments in Figure B-3.

Table B-3. NTAI06 Input Type Descriptions

Input Type	Input Description
Single Ended Voltage	This jumper configuration connects the minus (-) input terminal to I/O COM on the NTAI06. The IMASI03 measures the voltage at the plus (+) input terminal with respect to the C terminal. No connection to the C terminal is necessary.
Differential Voltage	This jumper configuration connects the plus (+) and minus (-) inputs directly to IMASI03 differential input. Channel to channel and channel to system signal isolation is achieved for all voltage input types, including high level voltage, millivolts and thermocouples. No connection to the C terminal is necessary.
System Powered 4-20 mA	This jumper configuration connects the plus (+) input terminal to system +24 VDC through a fuse on the NTAI06. The minus (-) input terminal connects to a precision resistor that generates a single ended voltage (1 to 5 V) for the IMASI03 to measure. No connection to the C terminal is necessary. INFI 90 must have +24 Volts (system power) installed.
External Powered 4-20 mA	This jumper configuration connects the plus (+) input terminal to one end of a precision resistor and the minus (-) input to the other end of the same precision resistor in the NTAI06. An isolated 1 to 5 Volts is generated for the IMASI03 to measure. No connection to the C terminal is necessary.
3-Wire Resistance	This jumper configuration connects the plus (+) and minus (-) inputs and the COM input directly to IMASI03 three-wire input. Channel to channel and channel to system signal isolation is maintained. The two common leads of the RTD element should be connected across the plus (+) and common (C) terminals, and the third lead should be connected to the minus (-) terminal.

CONFIGURING INPUTS

This section contains figures of revision A and revision B IMASI03 termination units.

- Figure B-1 shows the jumper locations and terminal assignments for revision A hardware. Check jumpers before installing the NTAI06. Figure B-2 shows the jumper locations and terminal assignments for revision B hardware. Check jumpers before installing the NTAI06.

- Figure B-3 shows a typical input circuit and the jumpers used for each input.

- Figure B-4 shows field input termination examples for revision A and B hardware.

- Figure B-5 shows IMASI03 input examples.

- Figure B-6 shows the cabling for the IMASI03. The NKAS01 (or NKAS11) cable connects the termination unit to the IMASI03. The NKAS01 cable has PVC insulation and is rated for 80^{o} C (0 to 176^{o} F) at 300 V (UL rated type CL2). The NKAS11 cable has non-PVC insulation and is rated for 90^{o} C (0 to 194^{o} F) at 300 V (UL rated type PLTC).

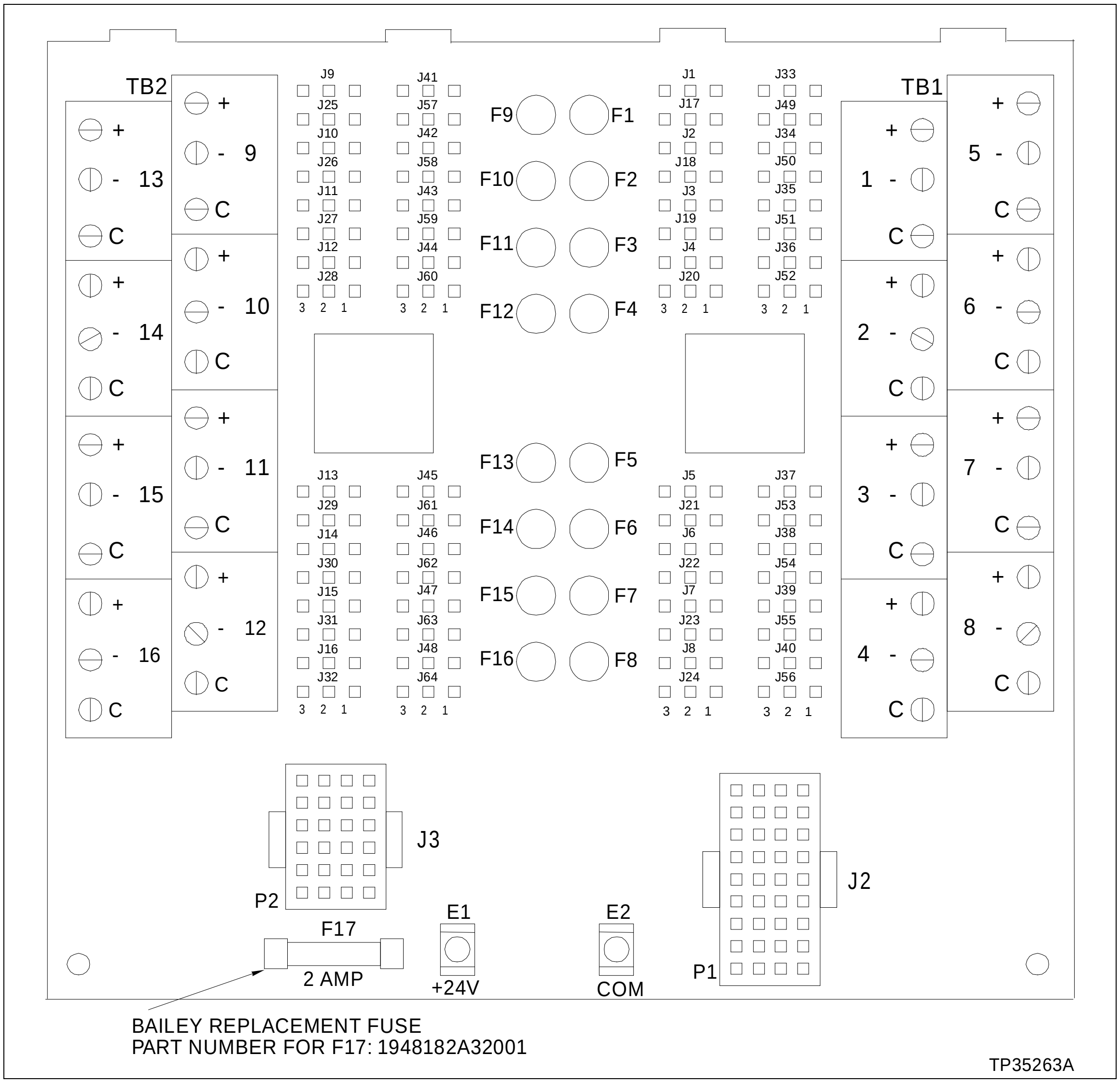


Figure B-1. Jumper locations and Terminal Assignments for Revision A Hardware NTAI06

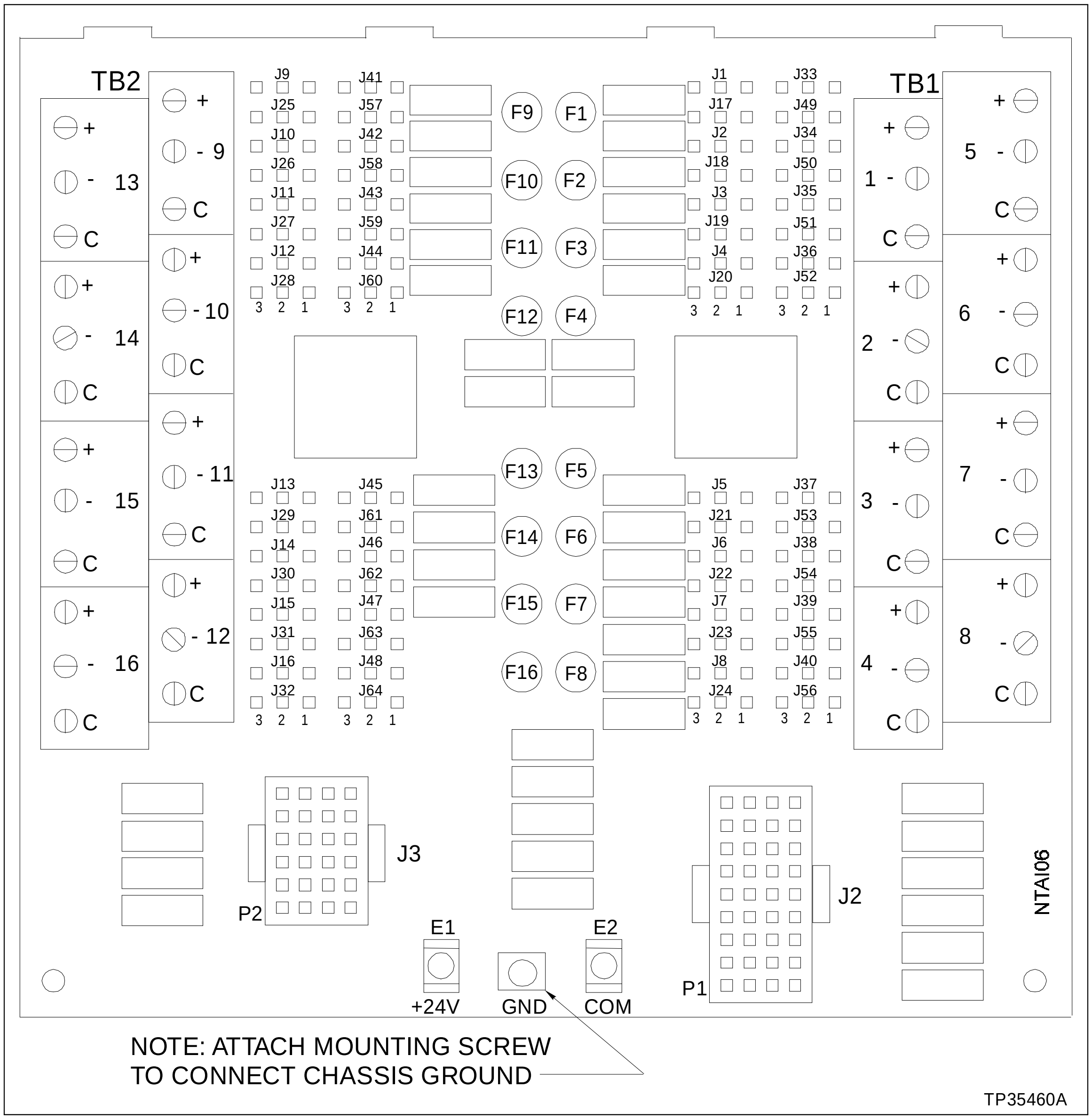
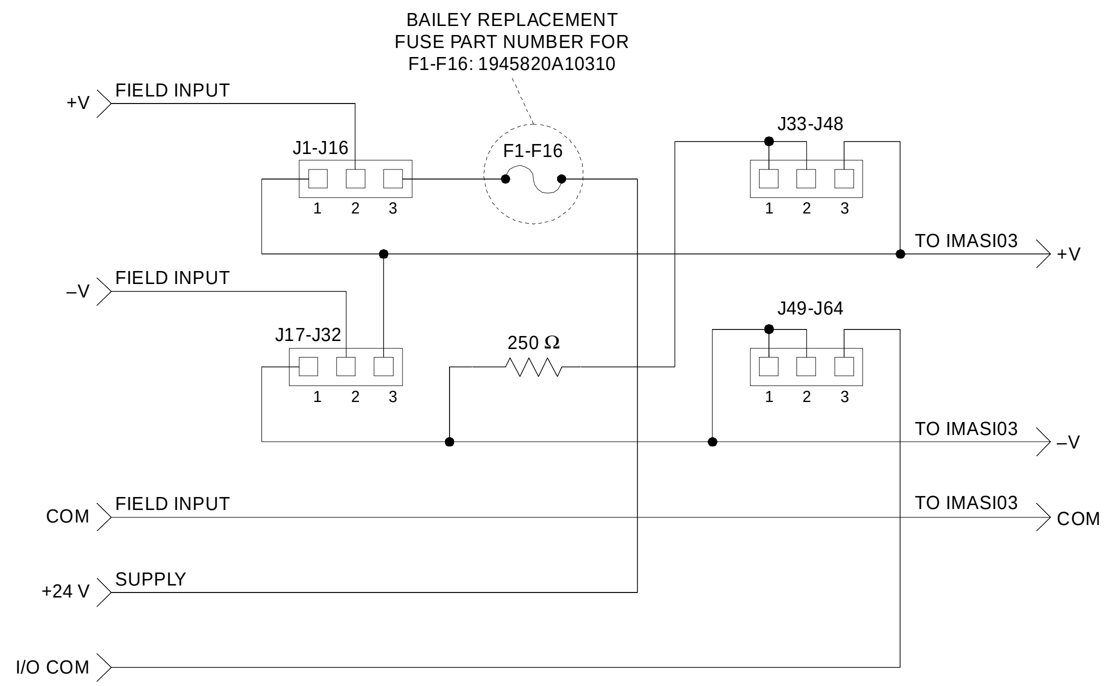


Figure B-2. Jumper Locations and Terminal Assignments for Revision B Hardware NTAI06



INPUT CHANNEL 1	INPUT CHANNEL 2	INPUT CHANNEL 3	INPUT CHANNEL 4	INPUT CHANNEL 5	INPUT CHANNEL 6	INPUT CHANNEL 7	INPUT CHANNEL 8
J1, J17, J33, J49	J2, J18, J34, J50	J3, J19, J35, J51	J4, J20, J36, J52	J5, J21, J37, J53	J6, J22, J38, J54	J7, J23 J39, J55	J8, J24, J40, J56

INPUT CHANNEL 9	INPUT CHANNEL 10	INPUT CHANNEL 11	INPUT CHANNEL 12	INPUT CHANNEL 13	INPUT CHANNEL 14	INPUT CHANNEL 15	INPUT CHANNEL 16
J9, J25, J41, J57	J10, J26, J42, J58	J11, J27, J43, J59	J12, J28, J44, J60	J13, J29, J45, J61	J14, J30, J46, J62	J15, J31 J47, J63	J16, J32, J48, J64

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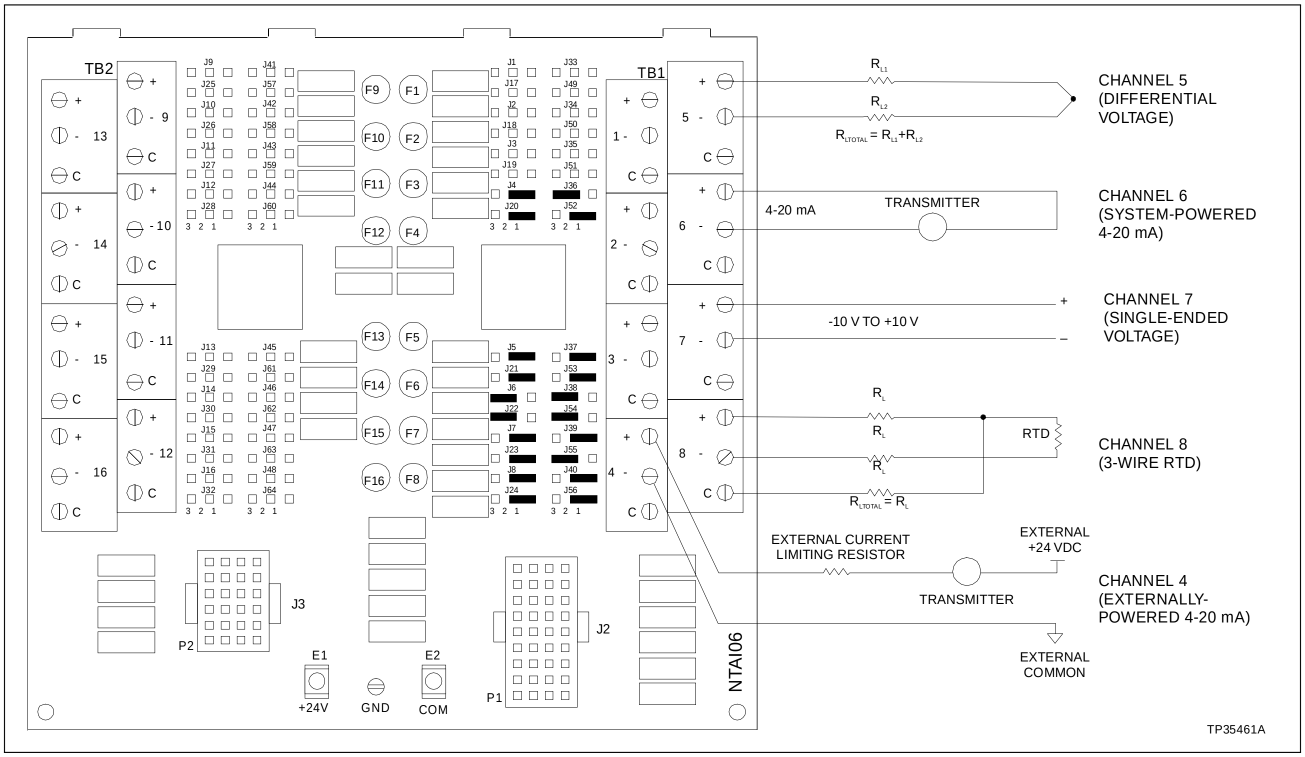
Figure B-3. Typical Input Circuit for NTAI06



NOTE: Example is NTAI06 termination unit with revision B hardware.

Figure B-4. Field Input Termination Examples for Revision A and B Hardware NTAI06

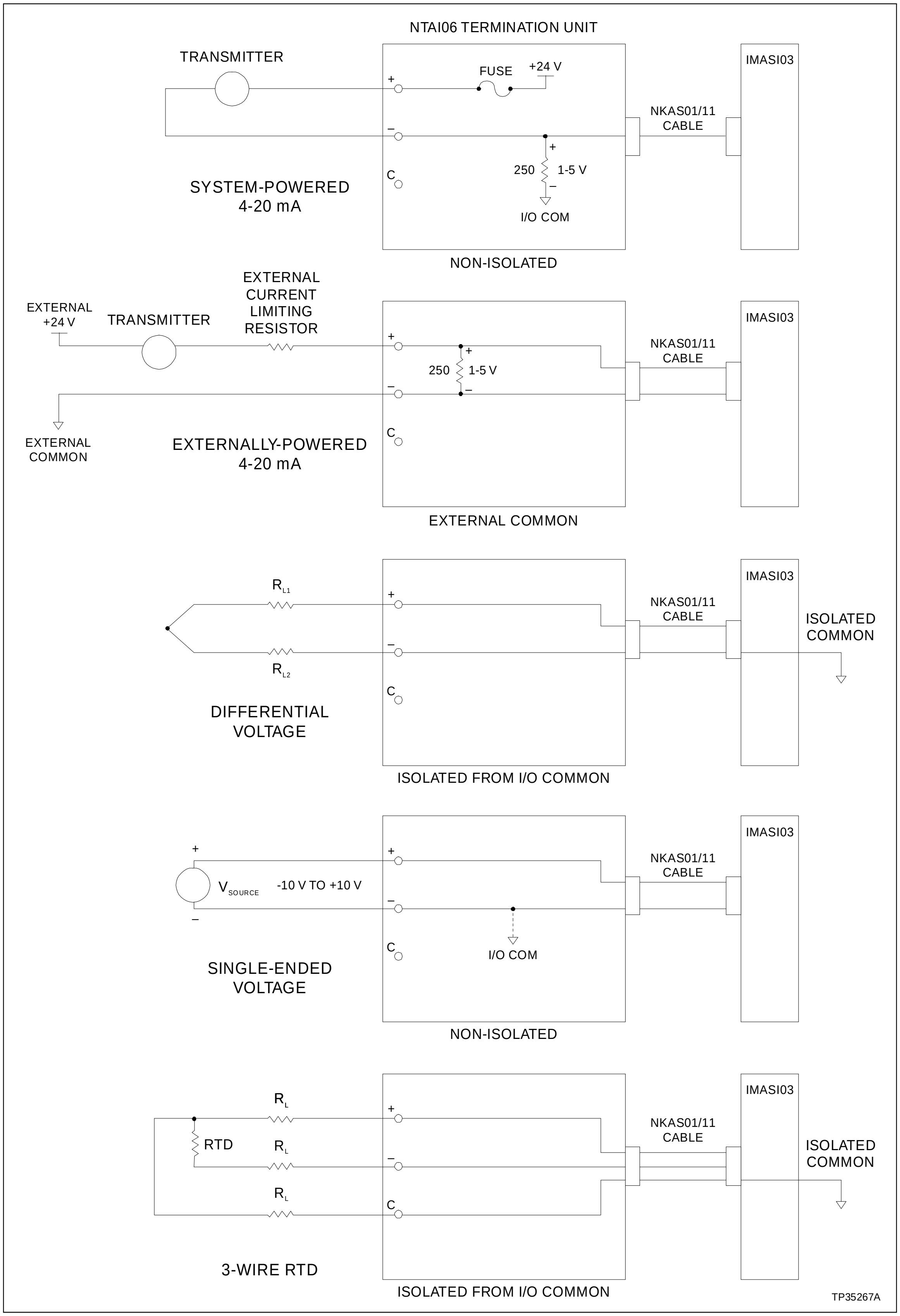


Figure B-5. IMASI03 Input Examples

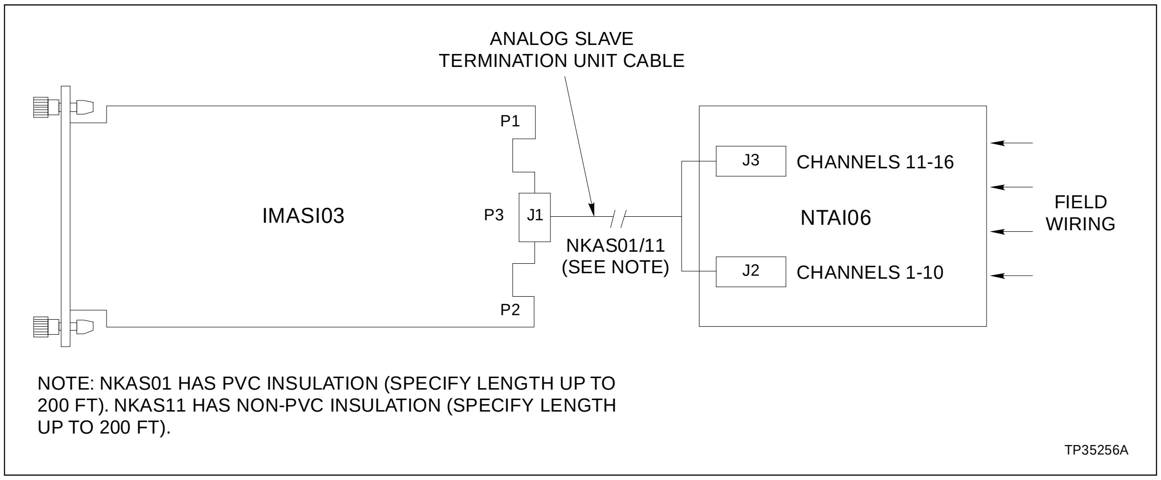


Figure B-6. Cable Connections for NTAI06

APPENDIX C - FUNCTION CODE DEFINITIONS

INTRODUCTION

The IMASI03 Universal Analog Input Slave Module is configured and controlled through function blocks configured on the master MFP. This section describes the three function codes that support the IMASI03. They are FC 215, FC 216 and FC 217.

All specifications in function codes 215, 216 and 217 associated with the IMASI03 may be changed during on-line configuration. When changes are made to the input channel parameters (FC 216), the channel will hold the last value with status unchanged for a short period. This hold time is based on the number of channels that were changed during on-line configuration, as well as the resolution specified in the function code 216 blocks for that channel. Plan on a hold time of four seconds (worst case) for each function code 216 changed during on-line configuration.

The function code information in this appendix is for reference only. Refer to the ***Function Code Application Manual, I-E93-900-20*** for current information on the function codes.

ENHANCED ANALOG SLAVE DEFINITION FUNCTION CODE (FC 215)

This function code is used to define an analog slave module to the MFP.

The Enhanced Analog Slave Definition Function Code (FC215) defines the common specifications for the IMASI03 module. Individual input function code 216 blocks are linked to this block to define the channels available on an IMASI03. Function code 215 uses 30 bytes of NVRAM and 206 bytes of RAM memory in the MFP module.

This function block has three outputs. The first represents the cold-junction reference input in degrees C from the analog slave input module termination device. The second output is a Boolean value representing the overall status of the slave module. The third output gives the actual scan cycle time in seconds for all of the active inputs on the slave.

Table C-1 lists the outputs of function code 215. Table C-2 lists the output descriptions of function code 215. Table C-3 lists the specifications of function code 215.

Table C-1. FC 215 Outputs

Block No.	Data Type	Description
N	REAL	Cold Junction Reference Temperature (degrees C)
N+1	BOOLEAN	Slave Status: 0 = GOOD; 1 = BAD
N+2	REAL	Input scan cycle time (seconds)

Table C-2. FC 215 Output Descriptions

Block No.	Description
N	Temperature of the cold junction for reference inputs as measured by the built-in RTDs on the termination device of the IMASI03.
N+1	Indicates BAD if a failure of the slave is detected.
N+2	Represents the amount of time between successive updates of an individual channel's input value and quality.

Table C-3. FC 215 Specifications

Spec No.	Tune	Default Value	Data Type	Range Min. Max	Description
S1	No	0	INT(2)	0 to 63	Slave Address
S2	No	2	INT(2)	0 to 9998	Block Address of first Enhanced Analog Input Definition (FC216)
S3	No	5	INT(2)	0 to 9998	Block Address of Cold Junction Reference Input (degrees C)
S4	No	0	INT(2)	0 to 1	Failure Action 0 = Trip MFP 1 = Continue
S5	No	0	INT(2)	0 to 1	Normal Mode Rejection Type 0 = 60 Hz. 1 = 50 Hz.
S6	No	0	REAL(3)	Full	Termination Device Cable (feet)
S7	No	0	INT(2)	Full	Spare parameter
S8	No	0	INT(2)	Full	Spare parameter
S9	No	0	REAL(3)	Full	Spare parameter
S10	No	0	REAL(3)	Full	Spare parameter

S1 Specification S1 is the analog slave expander bus address of the Universal Analog Input Slave Module (IMASI03).

S2 This specification contains the block address of the first Enhanced Analog Input Definition (Function Code 216) function block describing one of the channels on the slave module.

S3 This specification contains the block address of the cold junction reference temperature used for compensation of thermocouple inputs. S3 should refer to the function code 215 output block if the built-in cold junction reference is used (see Figure C-1). The value of the function code 215 output block is in degrees C.

If a remote cold junction reference is needed, refer to function code 216 specification 4 and Note 3 in Table C-7. Figure C-2 shows an example of remote cold junction reference.

Select the cold junction reference input by configuring specification 3 of function code 215 with the block output of the cold junction reference for the slave addressed in specification 1 of function code 215.

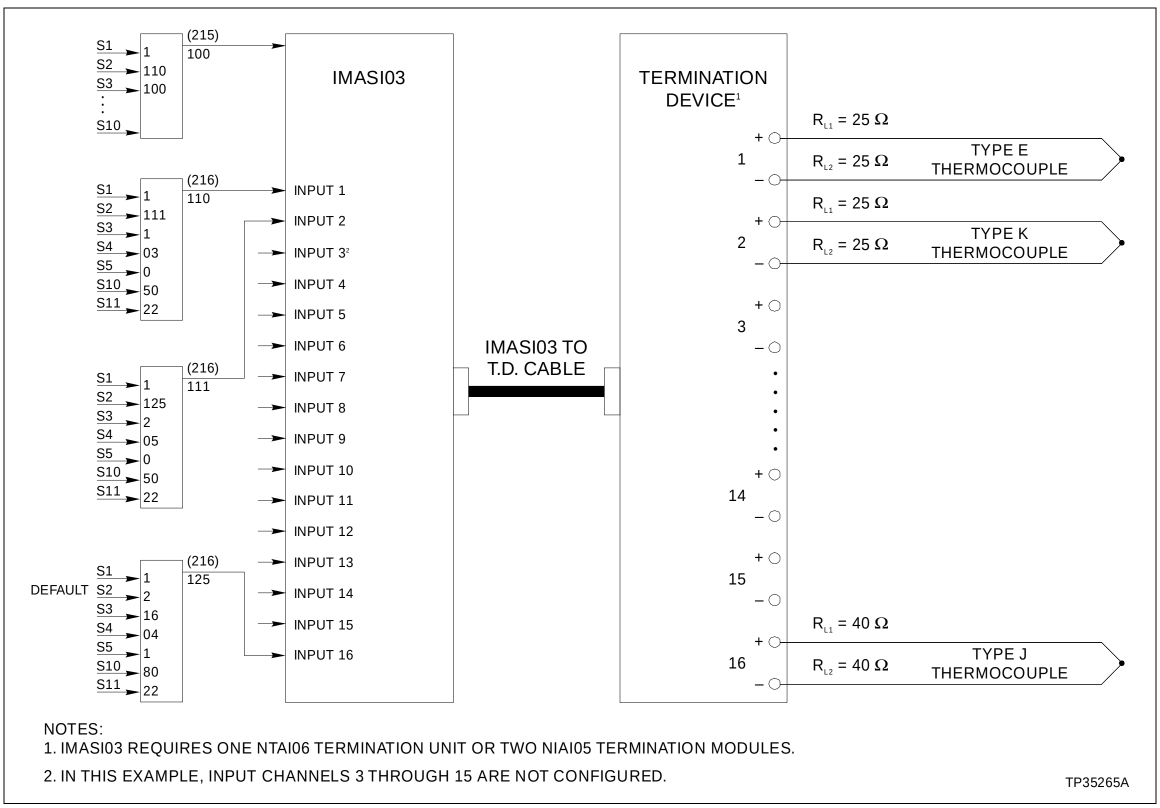
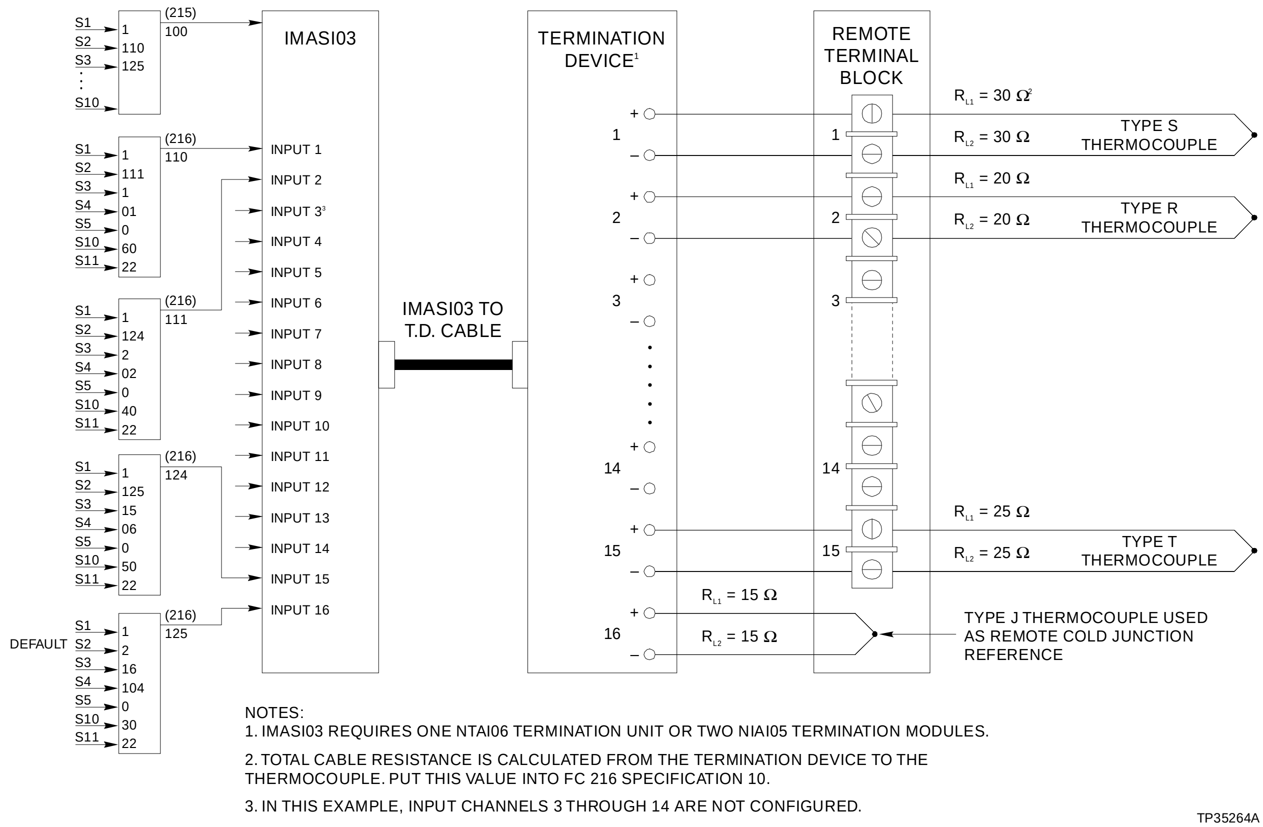


Figure C-1. Local Cold Junction Compensation



NOTES:
1. IMASI03 REQUIRES ONE NTAI06 TERMINATION UNIT OR TWO NIAI05 TERMINATION MODULES.
2. TOTAL CABLE RESISTANCE IS CALCULATED FROM THE TERMINATION DEVICE TO THE THERMOCOUPLE. PUT THIS VALUE INTO FC 216 SPECIFICATION 10.
3. IN THIS EXAMPLE, INPUT CHANNELS 3 THROUGH 14 ARE NOT CONFIGURED.

Figure C-2. Remote Cold Junction Compensation

S4 This specification identifies the action to be taken in the event of a failure of the slave module (such as NVRAM, A/D reference, or ROM checksum errors). A zero indicates that the MFP should cease operation while a one indicates the MFP should continue operation.

S5 This specification identifies the dominant noise frequency to be rejected during the analog-to-digital conversion operation (50 or 60 Hertz).

S6 This specification gives the length of the cable between the termination device and the slave module. This is used by the slave to compensate the measured input value for effects of resistance in the cable. This adjustment is similar to that for lead wire resistance of the field input lead wires.

S7-S10 Spare parameters.

ENHANCED ANALOG INPUT DEFINITION FUNCTION CODE (FC 216)

This function code is used to specify an input to an analog slave module. This must be configured in the same segment as the Enhanced Analog Slave Definition Function Block 215 which references it.

The enhanced analog input definition function code reads a single analog input from a Universal Analog Input Slave Module (IMASI03). Any number of these blocks, up to a maximum of 16, may be configured to use all channels on an IMASI03. Function code 216 uses 42 bytes of NVRAM and 114 bytes of RAM memory in the MFP module.

This function block has one output which represents the quality and value in engineering units of the input from the IMASI03. Table C-4 lists the outputs of function code 216. Table C-5 lists the output descriptions of function code 216. Table C-6 lists the specifications of function code 216.

Table C-4. FC 216 Outputs

Block No.	Data Type	Description
N	REAL	Analog input value and quality in specified engineering units (EU)

Table C-5. FC 216 Output Descriptions

Block No.	Description
N	Analog Input Value: • High Level Input: Input reading in engineering units based on S6 and S7 adjusted for drift, and input channel nonlinearities • RTD Input: Input reading in degrees as specified in S5 adjusted for drift, lead wire resistance and input channel nonlinearities • Thermocouple Input: Input reading in degrees as specified in S5 adjusted for drift, lead wire resistance, cold junction temperature and input channel nonlinearities • Millivolt Input: Input reading in engineering units based on S6 and S7 adjusted for drift, lead wire resistance and input channel nonlinearities
Quality	Bad if input reading is unreliable, the input channel has not been calibrated, the input channel is disabled, or the input channel has not been properly configured. Otherwise, good.

Table C-6. FC 216 Specifications

Spec No.	Tune	Default Value	Data Type	Range Min. Max	Description
S1	No	0	INT(2)	0 to 63	Slave Address
S2	No	2	INT(2)	0 to 9998	Block Address of next enhanced Analog Input Definition (FC216)
S3	No	1	INT(2)	Full	Slave Input Channel Number
S4	No	1	INT(1)	Full	Input Signal Type
S5	No	0	INT(1)	0 to 1	EU Conversion Type: 0 = Degrees C 1 = Degrees F
S6	Yes	0.0	REAL(3)	Full	EU Zero of input
S7	Yes	0.0	REAL(3)	Full	EU Span of input
S8	No	0.0	REAL(3)	Full	Input Signal Range Low Limit
S9	No	0.0	REAL(3)	Full	Input Signal Range High Limit
S10	No	0.0	REAL(3)	Full	Lead wire resistance (Ohms)
S11	No	16	INT(1)	16 - 24	A/D Conversion Resolution (Number of bits)
S12	No	0	INT(2)	Full	Spare parameter
S13	No	0	INT(2)	Full	Spare parameter
S14	No	0.0	REAL(3)	Full	Spare parameter
S15	No	0.0	REAL(3)	Full	Spare parameter

S1 This specification contains the expander bus address of the analog slave input module (IMASI03).

S2 This specification contains the block address of the next enhanced analog input definition (function code 216) function block describing one of the channels on the slave module. A value of 2 in this specification indicates that this block is at the end of the linked list.

S3 This specification contains the number of the input channel on the slave described by this function block.

S4 This specification defines the input signal type of the input from the IMASI03. Table C-7 lists the type codes for the various recognized input types.

For input signals which specify a defined range (for example +1 to +5 V) any signals detected to fall five percent outside of that range will be marked as bad quality with a status indication of out-of-range.

Table C-7. FC 216 Input Signal Types

S4 Value	Definition
0	Undefined. Do not use.
x01	Type S thermocouple
x02	Type R thermocouple
x03	Type E thermocouple
x04	Type J thermocouple
x05	Type K thermocouple
x06	Type T thermocouple
x07	Chinese Type E thermocouple
x08	Chinese Type S thermocouple
x09	Type L thermocouple
x10	Type U thermocouple
x11	Type N (14 AWG) thermocouple
x12	Type N (28 AWG) thermocouple
x20	U.S. Lab. Standard 100 Ohm Platinum RTD (TCR = 0.003926)
x21	U.S. Ind. Standard 100 Ohm Platinum RTD (TCR = 0.003911)
x22	European Standard 100 Ohm Platinum RTD (TCR = 0.003850)
x23	120 Ohm Chemically pure Nickel RTD (TCR = 0.00672)
x24	10 Ohm Copper RTD (TCR = 0.00427)
x25	Chinese 53 Ohm Copper RTD
x40	+1 to +5 V. 4-20 mA.
x41	-10 to +10 V.
x42	0 to +10 V.
x43	0 to +5 V.
x60	-100 to +100 mV.
x61	0 to +100 mV.
x99	User-specified Voltage Range (min. -10 V., max. +10 V.)

NOTES:

1. Any S4 value not listed is undefined and should not be used.
2. x = 0 Normally used for thermocouple inputs. S3 of FC 215 will be used as the cold junction reference.
3. x = 1 For any input used as a remote cold junction reference. This input may be used as the cold junction reference for other thermocouple inputs. If x=1, the channel output value is digitally filtered to emulate the temperature coefficient of the terminal block. If x=1 and the input type is a thermocouple, S3 of FC 215 is ignored and this input automatically uses the onboard cold junction reference for compensation.

S5 This specification defines the temperature units displayed (degrees Celsius or Fahrenheit) if S4 indicates other than a thermocouple or RTD type. Specification 5 is the type of engineering unit conversion to be performed on the input signal. If S4 indicates a thermocouple or RTD type, then S5 is ignored and S6/S7 are used to convert the input signal to engineering units.

S6 This specification defines the low limit of the input in engineering units (EU). This value corresponds to the low end of the input signal range as identified in S4. This specification is ignored if the input type (S4) is a thermocouple or RTD.

S7 This specification defines the range of the input in engineering units. This value corresponds to the input signal range as identified in S4. This specification is ignored if the input type (S4) is a thermocouple or RTD.

S8 This specification is ignored unless the input signal type (S4) indicates a user-specified voltage range. In that case, this specification defines the lower limit of the range, in Volts.

S9 This specification is ignored unless the input signal type (S4) indicates a user-specified voltage range. In that case, this specification defines the upper limit of the range, in Volts.

S10 This specification gives the resistance (in Ohms) of the field input lead wire for this input coming into the termination device. This value is used to correct the value of the input signal. For millivolt and thermocouple inputs, lead wire resistance is the sum of the resistance in both the plus and minus leads. For three-wire RTD inputs, lead wire resistance is the resistance in any one of the three leads (the resistance of each wire must be equal for accurate three-wire resistance measurements). This value is not used for high-level input types.

S11 The resolution of the analog-to-digital conversion may be specified for each channel independently. This specification specifies the resolution as the number of bits in the binary representation of the raw input value when it is scanned by the slave module. A higher value for the resolution requires a longer conversion time and a correspondingly slower scanning rate for the inputs. Table C-8 lists the approximate resolution and scan time relationship.

Table C-8. FC 216 Resolution and Scan Time

Resolution (Bits of A/D)	Resolution (Percent of A/D Span)	Typical A/D Conversion Times Per Channel
16	0.0015	30 ms
18	0.00038	175 ms
20	0.000095	175 ms
22	0.000024	450 ms
24	0.000006	2000 ms

Table C-8 gives approximate typical channel A/D conversion rates for each channel. These rates will vary from scan to scan. This time can be used to determine an approximate slave scan rate.

For example, if the IMASI03 has six channel configured with:

2 channels configured at 16 bits
2 channels configured at 20 bits
1 channel configured at 22 bits
1 channel configured at 24 bits

An approximate slave scan time can be found by adding the A/D conversion times beside the resolution values in Table C-8.

2 at 30 ms
2 at 175 ms
1 at 450 ms
1 at 2000 ms

The approximate scan rate total is 2.655 seconds for 6 channels.

ENHANCED CALIBRATION COMMAND FUNCTION CODE (FC 217)

This function code is used to calibrate the IMASI03 Slave Input Module.

The operator initiates, guides, and terminates a calibration sequence with this enhanced calibration command function code. Commands are entered by tuning this block. The status of the command may be determined by examining S1 after the TUNE operation is completed.

This specification will be set to indicate if any errors occurred during the processing of the command. A detailed description of any command errors is provided as an output (N + 4) to this function block. This output will reflect the status of the most recently issued calibration command.

Errors encountered during calibration of a particular channel are also reported as an output (N + 1) to this function block. This output will reflect the status for the channel referenced in the most recent calibration command.

Function code 217 uses 24 bytes of NVRAM and 156 bytes of RAM memory in the MFP module.

Function code 217 has five output values:

- The first represents the value of the input signal, uncorrected for any errors or nonlinearities. This output value spans a range of -100 to +100 for the full range of an input channel and represents an ideal conversion of the A/D count value for the channel to this range.
- The second output gives the calibration status for the last calibration operation performed on the referenced channel.
- The third and fourth outputs give the user-specified gain and offset adjustment values for the referenced channel. These will be initially 1.0 and 0.0, respectively, until changed by the user.
- The fifth output gives the detailed status of the most recently issued calibration command. The block output values will be updated only when a calibration command is issued.

Table C-9 lists the outputs of function code 217.

Table C-9. FC 217 Outputs

Block No.	Data Type	Description
N	REAL	Uncorrected value of input signal.
N+1	REAL	Channel calibration status.
N+2	REAL	User gain adjustment.
N+3	REAL	User offset adjustment.
N+4	REAL	Calibration command status.

The following block outputs are updated each time a calibration command is issued. The values reflect the slave channel specified with the calibration command. Table C-10 describes the outputs of function code 217. Table C-11 lists the specifications of function code 217.

Table C-10. FC 217 Output Descriptions

Block No.	Description
N	Uncorrected value of input signal. This output gives the value of the input signal without any of the calibration, drift, lead wire, or cold junction compensations applied. The input value is converted to a range of -100 to +100 using an ideal conversion from the digitized value.
N+1	Channel calibration status. This output gives the detailed status of the last calibration operation performed on the specified channel. 0 - Channel calibration command was successful. 1 - Channel reference error. 2 - Out of range error. 3 - Channel NOT calibrated error. (Applies if user attempts a Set/Reset user parameters command to an uncalibrated channel type). 4 - NVRAM error. 5 - A/D converter error. 6 - Point NOT on curve error. (Measured values read during calibration do NOT correspond linearly to the input values specified by S5).
N+2	User gain adjustment. This output gives the value of the user specified gain adjustment. If none has been specified, this value will be 1.
N+3	User offset adjustment. This output gives the value of the user specified offset adjustment. If none has been specified, this value will be 0. The units for this value are Ohms for an RTD input or Volts otherwise.
N+4	This output represents the status of the most recently issued calibration command. Output information is organized in the format shown. Each decimal digit represents one type of status. 0 - Command parameters were specified correctly. 1 - S1, Command code, not valid. 2 - S2, Does not reference a valid IMASI03 function code 215 block. 3 - S3, Channel number, not valid. 4 - S4, Calibration type, calibration type invalid or not same as type already in progress. 5 - S5, Calibration point, not valid for type of input. 10 - Point not disabled. 20 - Point already disabled. 30 - Calibration point count error - must be more than one, less than maximum allowed. 40 - Factory calibration data is lost. Cannot process enable command. 50 - Restore operation failed. Data was not successfully written into field calibration data area. 100 - Error occurred during channel calibration. Refer to N+1. 0000 - Slave responding normally, no errors. 1000 - Slave not responding. 2000 - Expander bus test failed. 9999 - Calibration command processing.

Table C-11. FC 217 Specifications

Spec No.	Tune	Default Value	Data Type	Range Min. Max	Description
S1	Yes	0	INT(1)	0 to 255	Calibration operation code
S2	Yes	0	INT(2)	0 to 9998	Block Address of FC 215 used to configure the slave.
S3	Yes	0	INT(2)	Full	Slave channel number
S4	Yes	0	INT(1)	0 to 2	Calibration type
S5	Yes	0	REAL(3)	Full	Calibration parameter 1
S6	Yes	0	REAL(3)	Full	Calibration parameter 2
S7	No	0	INT(2)	Full	Spare
S8	No	0	REAL(3)	Full	Spare

S1 This specification is tuned to the proper command code for the calibration operation to be performed. S1 is returned as a zero in the event of a calibration command error, and must be changed before sending another calibration command to the slave. S1 is unchanged if calibration command processing is successful. The defined operations and their codes are described here.

1 - Disable point. Removes a channel from normal input scan processing. A point must be disabled before any calibration can begin to prevent calibration related data from being interpreted as process data by the rest of the system. Calibration should only be performed using precision voltage or resistance sources applied at the terminal blocks.

2 - Perform point calibration using external reference.

3 - Enable point. A point must be enabled before normal input processing can occur. This action terminates the field calibration sequence for a point. User gain and offset values will be reset to 1.0 and 0.0, respectively, if a successful calibration has been performed.

4 - Point Escape. The Point Escape command is used to reset (clear) calibration point information for a particular channel in the middle of a calibration sequence. It clears only the point data. This allows the user to restart a calibration procedure for the channel specified. The Point Escape command does not enable the channel.

5 - Set user gain and offset adjustment. This command allows the user to enter a linear adjustment factor which will be applied to the input signal after all drift and nonlinearity corrections, but before conversion to engineering units. This value can be applied to low-level, high-level and resistance values.

6 - Reset user gain and offset adjustment. This command cancels any previously entered user gain and offset adjustment for the specified channel.

7 - Display uncorrected point data (percent of positive full scale). This command performs no operation other than to update the uncorrected output data value for the specified input channel (block output N of function code 217).

8 - Update point data. This command causes a new scan of the specified input channel to be performed and the output data value of the block to be updated with the new uncorrected value.

9 - Slave escape command. Performs Point Escape command to all 16 channels and cold junction reference on the IMASI03 slave module.

10 - Expander bus test command. Performs single test of expander bus between MFP and slave. The test verifies transmission, reception and data integrity of messages passed between these modules. (Intended as an additional diagnostic for the slave interface. It requires an MFP.)

11 - Restore factory calibration command. This command overwrites the field calibration data in NVRAM with the original factory calibration parameters. This command resets the values entered in the set user gain and offset command.

S2 This specification identifies the block address of the enhanced analog slave definition (function code 215) function block identifying the slave module to which the command specified in S1 is to be applied.

> **NOTE:** For MFP01/02 firmware releases prior to C_0, S2 identifies the ***expander bus address*** of the slave module to which the command specified in S1 is to be applied.

S3 This specification identifies the slave input channel number to which the command specified in S1 is to be applied.

S4 This specification identifies which type of calibration is to be performed.

0 = Low-level (millivolt, thermocouple)
1 = High-level
2 = RTD

S5 This specification is used for channel calibration and changing the user gain and offset value. Calibration parameter 1 provides a real value dependent upon the type of command specified in S1.

For command code 2, point calibration, this parameter specifies the true value of the signal applied to the input channel during the calibration operation. Enter S5 for each calibration point (twice if two points on a channel are calibrated). Up to 11 points may be identified for adjustment of input channel nonlinearities, resulting in 10 linear segments for correction. These calibration points may be applied in any order. The units for the point value are determined by the type of calibration operation specified in S4.

For user gain and offset applications, S5 specifies the gain and S6 specifies the offset. When the IMASI03 is shipped, the default value for gain is set to one and the default value for offset is set to zero. This command sets both the gain and offset parameters simultaneously each time it is entered.

Example:

Low-level	=	millivolts (-100.0 to +100.0)
High-level	=	Volts (-10.0 to +10.0)
RTD	=	Ohms (5.0 to 500)

For command code 5, user gain and offset adjustment, this parameter specifies the gain, or slope, of the linear correction to be applied. Both user gain and offset adjustment can be changed at one time.

S6 Calibration parameter 2 provides a real value dependent upon the type of command specified in S1.

For command code 5, user gain and offset adjustment, this parameter specifies the offset, or intercept, of the linear correction to be applied. The units for the offset value are determined by the type of calibration operation specified in S4.

Example:

Low-level	=	millivolts (-100.0 to +100.0)
High-level	=	Volts (-10.0 to +10.0)
RTD	=	Ohms (5.0 to 500)

S7-S8 Spare parameters.

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