Description and Operation

Section 2

Introduction

This section explains the inputs, control logic, communication, and connections for the IMASI23 module. The ASI module interfaces 16 analog inputs to a Harmony controller. The Harmony controller communicates with its I/O modules over the I/O expander bus (Fig. 1-1). Each I/O module on the bus has a unique address set by its address dipswitch (S1).

Module Description

The ASI module consists of a single printed circuit board that occupies one slot in a module mounting unit (MMU). Two captive latches on the module front panel secure it to the module mounting unit.

The ASI module has three card edge connectors for external signals and power: P1, P2 and P3. P1 connects to the supply voltages. P2 connects the module to the I/O expander bus, over which it communicates with the controller. Connector P3 carries the inputs from the termination cable plugged into the termination unit (TU). The terminal blocks for field wiring are on the termination unit.

A single dipswitch on the module sets its address or selects onboard tests. Jumpers configure the type of analog input signals.

Functional Operation

The ASI module is an intelligent module with an onboard microcontroller and memory. It interfaces to a controller over the I/O expander bus. An onboard microcontroller allows the ASI module to perform the input channel processing. This allows the controller to do other tasks. Input processing tasks include error compensation, adjustments, and conversion to engineering units.

Each channel provides underrange, overrange, and open input detection. Onboard circuitry detects either open field wires or a disconnected termination unit cable. Open input detection is provided for millivolt, thermocouple, RTD, 1 to 5 VDC, and 4 to 20 milliampere input types and can detect any combination of open input wires.

Figure 2-1 shows a block diagram of the IMASI23 module.

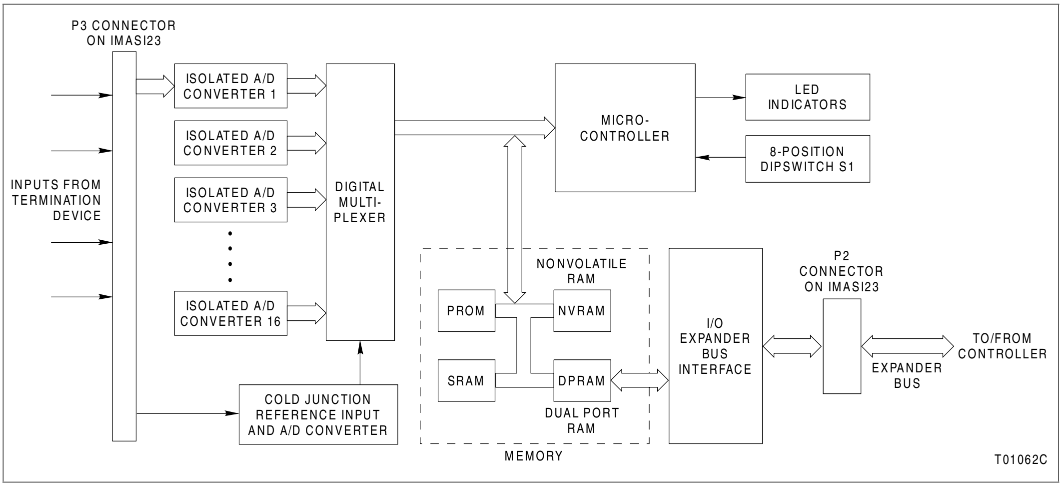

Figure 2-1. IMASI23 Functional Block Diagram

Isolated A/D Converter

Each input channel has an A/D converter (delta-sigma type). Isolation is done by DC/DC converters (one per channel) and optocouplers on the digital serial line of the A/D converter. 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.

Cold Junction Reference

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

The block address of the cold junction reference used by thermocouple inputs on the ASI module is contained in FC 215, specification S3.

Each analog input module configured for a thermocouple input requires a cold junction reference. Each analog input module 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.

Digital Input Multiplexer (MUX)

Once isolated, digitized, and buffered, the input signal is sent to the microcontroller by a digital multiplexer. All the inputs, including the references and cold junction input, are multiplexed as shown in Figure 2-1.

Microcontroller and Memory

The onboard microcontroller coordinates ASI functions. The main functions are:

- Channel and cold junction reference switching.
- Programming A/D converters.
- Reading the A/D converters and applying all necessary correction factors.
- Interfacing to switch and LEDs (used for diagnostic mode).
- Background integrity checking.
- Reading and writing expander bus data through dual port RAM (DPRAM).

Switch Settings

The ASI module has one eight-position dipswitch to select the I/O module address on the I/O expander bus. This switch also selects built-in diagnostics for stand alone testing.

LED Indicators

The ASI module has two LED indicators, one red and one green, which show the operating status. The LEDs will:

- Flash red on power-up.
- Remain off (both LEDs) after passing onboard diagnostics until the ASI module is configured by the controller.
- Show solid green after the controlling controller downloads configuration data.
- Show solid green during normal running.
- Blink green when the controller that configured the ASI module enters configure mode from execute mode.
- Blink green if I/O expander bus communication is lost (if the controller is removed).
- Show solid red if a fatal failure of the ASI module occurs. For example, if power up diagnostics fail.
- Show solid red for a power fail interrupt (PFI).

I/O Expander Bus

The I/O expander bus is a high-speed, synchronous, parallel bus. It provides a path between controllers and I/O modules. The controller sends control functions to the ASI module, and the ASI module provides input data to the controller. The P2 card edge of the ASI module and controller connect to the bus.

The I/O expander bus is parallel signal lines located on the module mounting unit backplane. A 12-position dipshunt placed in a socket on the MMU backplane connects the bus between the controller and I/O modules. Cable assemblies can extend the bus to eight module mounting units.

A controller and its I/O modules form a subsystem within a Harmony control unit (HCU). The I/O expander bus between control and I/O subsystems must be separated. Leaving a dipshunt socket empty or not connecting the module mounting units with cables separates them.

I/O Expander Bus Interface

The ASI module communicates with the controller through a shared memory interface connected to the I/O expander bus. The ASI module constantly updates the shared memory device (dual port RAM) with the current values of the inputs. The controller can read these values at any time, even if the ASI module is simultaneously writing to the dual port RAM.

The ASI module uses a custom gate array for the I/O 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.
- Onboard bus drivers.
- Expander bus watchdog.

A dual port RAM stores data that can be accessed at the same time by the controller and the I/O module's microcontroller.

Data Values

For all inputs, channel values are adjusted based on the factory calibration. Thermocouple inputs receive cold junction reference compensation. Lead wire resistance adjustments are performed when necessary (for cold junction reference only). The ASI module provides values to the controller over the I/O expander bus. These values are in engineering units.

The ASI module sends a status indication to the controller for each input channel. This status indicates any hardware errors and channel configuration errors detected by the ASI module.

Termination Units

The IMASI23 module uses one NTAI06 termination unit to connect to field signals. An NKAS01 or NKAS11 cable connects the termination unit to the ASI module through its P3 connector.

The termination unit contains RTDs used for cold junction compensation of thermocouple inputs. They also contain the circuitry needed to convert 4 to 20 milliampere field signals into the 1 to 5 VDC needed to input to the analog input module. The system power supply is protected from short circuits by fuses on the NTAI06 termination unit.

Function Codes

NOTE: Refer to Appendix C for function code specification changes required when replacing an IMASI03 module with an IMASI23 module.

FCs 215 and 216 in the controller configure the ASI module and identify the active analog inputs. One FC 215 is required for each ASI module. One FC 216 is required for each input channel used on the ASI module. These function codes specify the I/O expander bus address of the ASI module and the channel number on the module connected to a specific 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 FC 215 and 216 to the controller to configure the ASI module. Set FC 217 in the controller to calibrate the ASI module or to set the user gain and offset values. Refer to the ***Composer Function Code Application Manual*** for more information.

Automatic Adjustments and Corrections

Input processing, calibration, point value calculations, lead wire resistance adjustment, cold junction compensation, gain and offset adjustment, and engineering unit conversions are all automatically performed by the ASI module.

Input Processing

Each A/D converter samples the input signal continuously without need for a ***start convert*** command. The A/D output register is updated at a rate determined by the internal filter and can be ready at any time. The ASI module scans all A/D converter output registers at a rate of about 180 milliseconds including calibration and open circuit tests.

In addition to the input channels, the built-in cold junction reference is read during normal input scanning.

Point Value Calculation

The ASI module maintains a set of adjustment values for each input channel. These values correct for offset and gain errors in the input channel. The raw analog-to-digital converter count value is converted to an actual input signal value using the calibration data.

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 FC 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 and gain errors are identified and required correction factors are calculated and stored in the analog input module'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.

Cold Junction Compensation

Thermocouple input channels are adjusted for cold junction temperature. The cold junction reference can either be the built-in reference available on the I/O module's termination unit or a value originating from any other function code block output anywhere in the system. The cold junction reference supplied by the controller is assumed to be in degrees C. The ASI module 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 (FC 216, specification S4) use the built-in cold junction reference on the termination unit for their cold junction compensation.

User Gain and Offset Adjustment

A user-specified linear adjustment can 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 VDC analog input is 0.1 VDC too high, the ASI module can compensate for this offset by adding an offset value of -0.1 for this channel and input type.

User gain value is multiplied by volts for high level inputs, by millivolts for low level inputs and thermocouple inputs, and by 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 FC 217. Once defined, user gain and offset values remain in nonvolatile memory and are not lost when module power is interrupted. For more information refer to FC 217 in the ***Composer Function Code Application Manual***.

Engineering Units Conversion

Thermocouple and RTD inputs are converted to the temperature units specified in FC 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 voltage, 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 FC 215 and FC 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 I/O module FC 216 would then output a corrected voltage input reading which may be processed in the controller 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 A/D converter using an internal precision low-drift reference. 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 nonvolatile memory. The complete field calibration procedure is in Section 4.

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

Using FC 217 to change the gain or offset values per channel and type, it can compensate for differences in input signal readings. Tuning these parameters can take the place of a field calibration. Refer to FC 217, specification S1.

Diagnostic, Security, and Integrity Checks

The IMASI23 module performs built-in tests during power-up and on reset to check the operation and integrity of the module.

Diagnostics in Diagnostic Mode

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

- 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 During Normal Operation

During startup, the ASI module 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 controller through the I/O module status. Certain failures detected by these diagnostics may result in halting the I/O module.

Diagnostics on Reset

These tests include:

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

I/O 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 ASI module recognizes and reports any open inputs on active channels by indicating bad quality on these channels. The exception is for -10 to +10 VDC, 0 to 10 VDC, and 0 to 5 VDC inputs.

Alarm and Exception Reporting

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

Online Configuration

All specifications in FCs 215, 216, and 217 associated with the ASI module can be changed during online configuration. When changes are made to the input channel parameters (FC 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 online configuration.

NOTE: Plan on a hold time of four seconds (worst case) for each FC 216 changed during online configuration.

Logic Power

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

Mounting Hardware

Harmony rack I/O modules and termination units mount in standard ABB Automation enclosures (CAB-01, CAB-04, CAB-12). The number of modules that can be mounted in a single cabinet varies.

An IEMMU11, IEMMU12, IEMMU21, or IEMMU22 module mounting unit and an NFTP01 field termination panel (FTP) are used for module and termination unit mounting respectively (Fig. 2-2). The mounting unit and termination panel both attach to the side rails in standard 483-millimeter (19-inch) enclosures. Front mount and rear mount MMU versions are available to provide flexibility in enclosure mounting.

A module mounting unit is required to mount and provide power to rack-mounted modules. The unit is for mounting controllers, I/O modules, and communication interface modules. The MMU backplane connects and routes:

- Controlway.
- I/O expander bus.

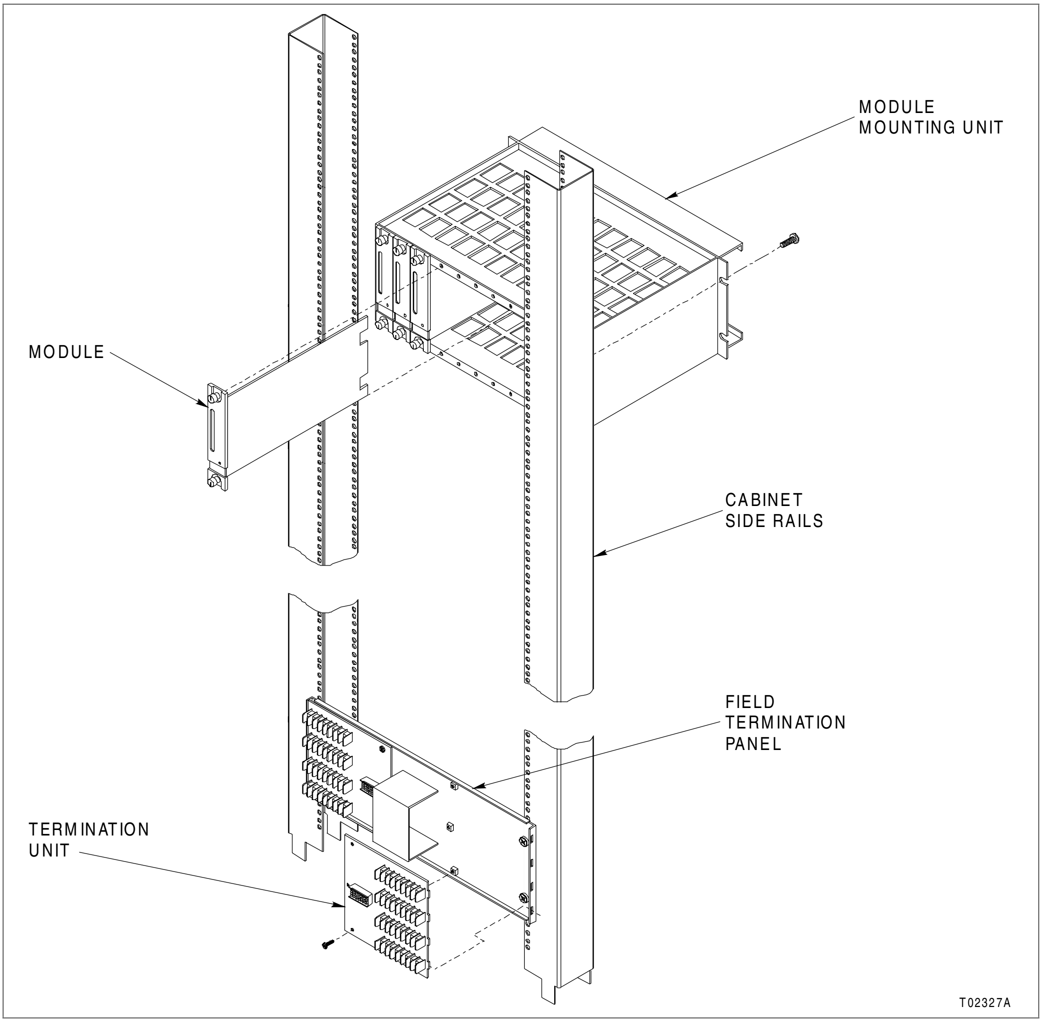

Figure 2-2. Mounting Hardware

- Logic power to control, I/O, and interface modules.

The Controlway and I/O expander bus are internal cabinet, communication buses. Communication between rack controllers and communication interface modules is over Controlway.