Data Sheet

Control^{IT} Harmony Analog I/O

TC00892A

Description

The Harmony Input/Output (I/O) System utilizes a variety of input and output blocks to interface process signals to the Symphony™ Enterprise Management and Control System. Analog input (AIN) blocks interface field inputs such as pressure and flow transmitter signals, thermocouple (TC) inputs, and resistive temperature device (RTD) inputs. Analog output (AOT) blocks provide output signals to adjust final control elements such as control valves, pumps, positioners, actuators, etc. These analog blocks along with other types of blocks for digital and control I/O interface and remote I/O communication combine to create a complete I/O system (Fig. 1). Refer to the ***Harmony Input/Output System*** overview for a complete system description.

Operation

Each analog I/O block has an onboard microprocessor which controls and performs the following functions for the block:

- Hnet communication.
- Analog input/output processing.
- Redundancy link communication.
- Block diagnostics.
- Status reporting.

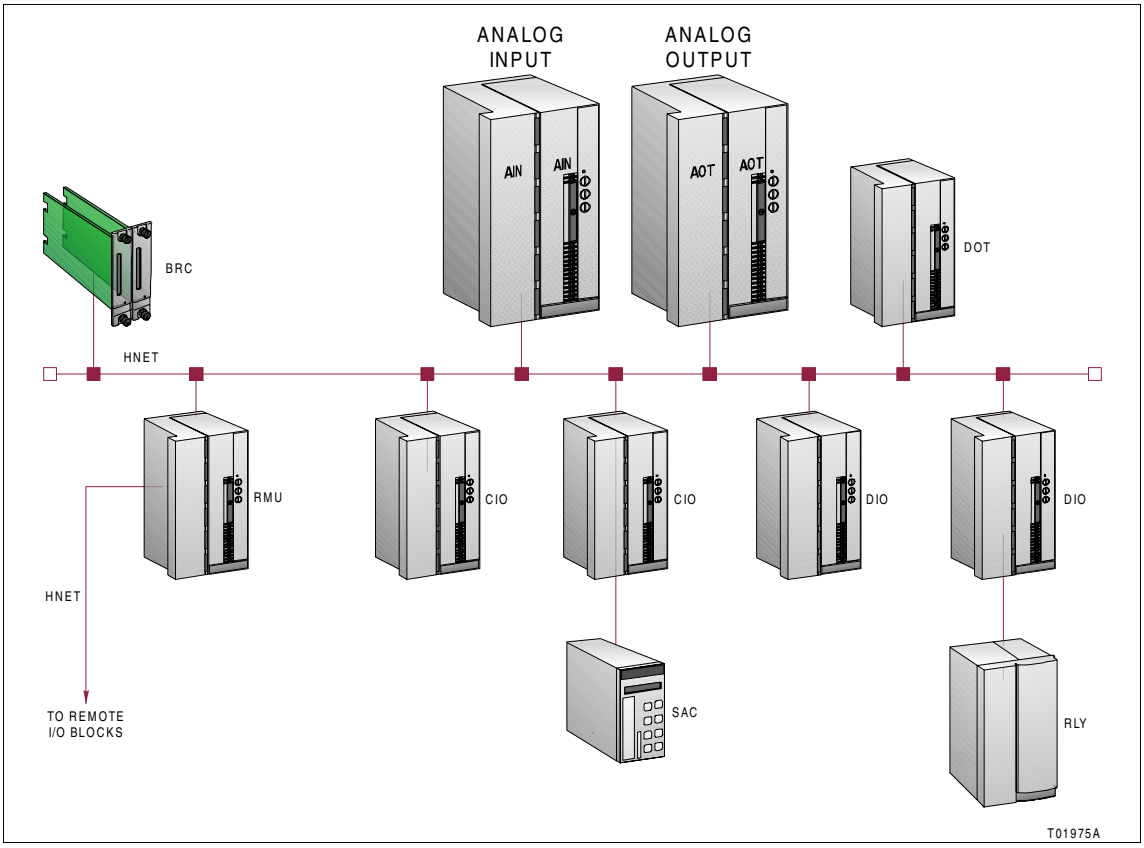

Figure 1. Harmony I/O System

Along with these functions, the microprocessor is also responsible for executing the I/O block portion of the control configuration. The complete control configuration made up of linked function codes resides and is retained in the Harmony controller at all times. The controller only off loads a portion of the configuration to be executed by the individual I/O blocks.

Function codes are predefined, fixed function algorithms. When interfacing analog I/O blocks, the controller utilizes the following function codes:

- I/O device definition (FC 221).
- Analog input/channel (FC 222).
- Analog output/channel (FC 223).

Specifications are set on a per channel basis rather than on an I/O group basis. The function codes provide addressing, and start-up, execute (i.e., run time), override, simulation, and failure mode operation specifications. The I/O channel function codes are exception reporting function codes.

Analog Input

The Harmony I/O System supports four to 20 milliampere, high level –10 to +10 VDC, low level -100 to +100 millivolt (DC), thermocouple (TC), and resistive temperature device (RTD) inputs through AIN blocks:

- AIN-120 - High level voltage, current in.
- AIN-200 - Isolated TC, high level voltage, low level voltage in.

- AIN-220 - Isolated TC, high level voltage, low level voltage, current in.
- AIN-300 - Isolated RTD in.

Data Conversion

An AIN block reads currents or voltages at its input channels, scales and converts the inputs to real values in engineering units, then reports the input values to the controller. The block provides channel status information along with each reported input.

High and low level inputs are converted to the proper engineering units based on input type and engineering unit high and low value specifications. Thermocouple and RTD inputs are converted to the proper engineering units (degrees C or degrees F) using predefined conversion tables for each type of thermocouple and RTD supported.

The AIN-120 block uses a single successive approximation analog-to-digital converter through which all channels are multiplexed. This type of A/D conversion method is fast (ten microseconds per conversion), which allows multiple channels to be sequentially multiplexed through one converter. Redundancy provides a backup analog-to-digital conversion.

The AIN-200, AIN-220, and AIN-300 blocks have dedicated Delta-Sigma analog-to-digital converters on each channel. These converters are slower (50 milliseconds per conversion); however, no multiplexing is required since each channel performs independent conversions. The converters also have built-in digital signal processing which provides low pass filtering. The AIN-200, AIN-220, and AIN-300 blocks have optically isolated input channels.

Digital Signal Processing

The AIN-120 block uses a floating point digital signal processor (DSP) to achieve low pass filtering. The advantage to using a DSP device for this function is that significant noise rejection can be achieved (better than 70 dB) while maintaining fast settling time to an input step response (75 milliseconds). As stated previously, the Delta-Sigma analog-to-digital converters used in the AIN-200, AIN-220, and AIN-300 blocks have built-in digital signal processing which provides low pass filtering.

Calibrations

No field calibrations are required. The electronics automatically perform the following adjustments to the raw analog inputs depending on input type:

- Drift correction using onboard zero and span reference voltages.
- Lead wire resistance adjustment for low level, thermocouple, and RTD inputs.
- Cold junction temperature compensation for thermocouple inputs using either an internal or external cold junction reference.

Current Limiting

The analog input channels provide onboard current limiting for short circuit protection. The current limiting prevents circuit damage that can result from excessive current levels at an input channel caused by field input faults. Specifically, the four to 20 milliampere input channels are protected against shorts across the transmitter, across positive and negative terminals, from the positive terminal to ground, and from the negative terminal to ground. A channel will recover to full function after correcting the fault condition.

Analog Output

The Harmony I/O System supports four to 20 milliampere outputs through an AOT-150 block. This block receives output demand values in engineering units from the controller, scales the demand values to percentages of output, and converts them to analog voltages or currents at the output channels. User selectable default states of zero percent, 100 percent, or hold output are provided.

Calibrations

The electronics automatically adjust analog outputs to compensate for supply voltage variations. Field calibration of analog outputs is not required.

Readback

Each analog output channel is monitored on the block. This readback function serves two purposes:

- Provides high accuracy (0.1 percent) by using a software compensation algorithm in combination with the analog output readback value.
- The integrity of the hardware and field wiring is constantly monitored by way of checking the readback value.

The block also reports the readback values to the controller. It automatically scales the values to their proper engineering units before reporting them. The readback values are converted to the proper engineering units based on engineering unit high and low value specifications.

Analog Input Blocks

The AIN block interfaces various analog inputs: Current, voltage, thermocouple, and RTD. An AIN block that supports thermocouple inputs includes cold junction compensation for the TC inputs and can detect open thermocouples. The AIN block supports redundant I/O electronics. An AIN block can be ordered with either a screw terminal (S type) or cable/clamp terminal (C type) base.

AIN-120

Current, High Level Voltage In

The AIN-120 block supports the following inputs:

- 4 to 20 milliampere.
- –10 to +10 VDC differential.
- –10 to +10 VDC single-ended.

The block provides 16 nonisolated input channels that are individually hardware configurable for either voltage or current mode and software configurable for voltage range.

AIN-200

Isolated High Level Voltage, Low Level Voltage, Thermocouple In

The AIN-200 block supports the following inputs:

- –10 to +10 VDC differential.
- –100 to +100 millivolt (DC) differential.
- Thermocouple (refer to the analog input specifications table for types).

The block provides 16 isolated input channels that operate in voltage mode only. Each input channel is individually software configurable for voltage range or thermocouple type.

AIN-220

Isolated Current, High Level Voltage, Low Level Voltage, Thermocouple In

The AIN-220 block supports the following inputs:

- 4 to 20 milliampere.
- –10 to +10 VDC differential.
- –10 to +10 VDC single-ended.
- –100 to +100 millivolt (DC) differential.
- –100 to +100 millivolt (DC) single-ended.
- Thermocouple (refer to the analog input specifications table for types).

The block provides 16 isolated input channels that are individually hardware configurable for either voltage or current mode and software configurable for voltage range or thermocouple type.

AIN-300

Isolated RTD In

The AIN-300 block supports three-wire RTD inputs. It provides 16 isolated input channels individually software configurable for RTD type (refer to the analog input specifications for types).

Analog Output Blocks

AOT-150

Current Out

The AOT-150 block interfaces high level analog output signals. It supports 16 nonisolated output channels that operate in current mode (four to 20 milliamperes). Special output circuitry allows this block to support redundant I/O electronics. An AOT block can be ordered with either a screw terminal (S type) or cable/clamp terminal (C type) base.

Power Options

The AIN and AOT blocks use two types of power:

- 24 VDC block logic power.
- 24 VDC field power.

Each I/O block develops its own operating voltages from redundant 24 VDC block logic power (BLP). The 24 VDC field power operates field devices and some I/O channel circuitry depending on the block type. Both internally powered (i.e., I/O system powered) and externally powered field devices are supported (Figs. 2 and 3).

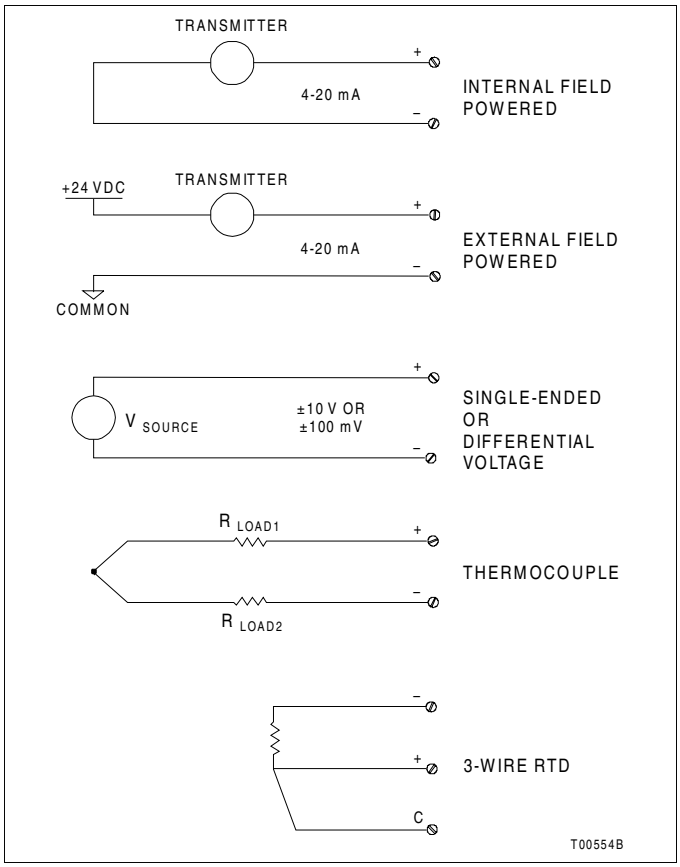

Figure 2. Analog Input

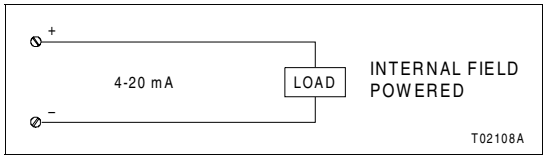

Figure 3. Analog Output

The field power can be supplied in three different forms: internal field power (IFP), external local field power (LFP), and external remote field power (RFP). IFP power is distributed to the I/O blocks through the block mounting columns, LFP power is wired to each I/O block, and RFP power is wired to individual I/O channels.

The choice of using IFP or LFP power is jumper selectable for each I/O block. This selection affects all I/O channels of a block. The IFP/LFP field power select jumpers are located on the back of the I/O module.

The choice of using IFP/LFP power or RFP power is selectable on a per channel basis where appropriate. For analog blocks, the location of these channel field power select jumpers varies depending on the block type. In most cases the jumpers are located inside the I/O module; in some cases they are located on the base.

Table 1 summarizes the AIN and AOT blocks field power options.

Table 1. Field Power Options Summary

Block	I/O Type	Field Power		
		IFP	LFP	RFP
AIN-120	4 to 20 mA	•	•	•
	–10 to +10 VDC			•
AIN-200	–10 to +10 VDC			•
	–100 to +100 mVDC			•
	Thermocouple			
AIN-220	4 to 20 mA	•	•	•
	–10 to +10 VDC			•
	–100 to +100 mVDC			•
	Thermocouple			
AIN-300	RTD			
AOT-150	4 to 20 mA	•	•	

Redundancy

Redundancy allows backup electronics to read analog inputs and to drive analog outputs in the event of a primary failure. As a background diagnostic task, the backup is continuously monitoring its ability to read field inputs and to drive field outputs. Redundancy requires a redundant base and two I/O modules. The input channels are connected in parallel. Special output circuitry allows the analog output channels to operate redundantly.

Related Documents

Number	Document Title
WBPEEUD240002??	Harmony Digital Input/Output, Data Sheet
WBPEEUD240003??	Harmony Control Input/Output, Data Sheet
WBPEEUD240004??	Harmony Input/Output System, Data Sheet
WBPEEUS240008??	Harmony Input/Output System, Overview

I/O Specifications

<table>
<tr><th>Property</th><th>Characteristic/Value[1]</th></tr>
<tr><td>I/O blocks
AIN-120
AIN-200
AIN-220
AIN-300
AOT-150</td><td>
High level voltage, current in
Isolated TC, high level voltage, low level voltage in
Isolated TC, high level voltage, low level voltage, current in
Isolated RTD in
Current out</td></tr>
<tr><td>Microprocessor</td><td>16-bit processor running at 16 MHz</td></tr>
<tr><td>Memory</td><td>64 kb SRAM
512 kb Flash RAM</td></tr>
<tr><td>Redundancy link data rate</td><td>1 Mbaud</td></tr>
<tr><td>Block logic power (BLP) - refer to Power Requirements</td><td>21.6 VDC minimum
24.0 VDC nominal
28.0 VDC maximum</td></tr>
<tr><td>Field power (IFP/LFP) - refer to Power Requirements</td><td>24.0 VDC nominal</td></tr>
<tr><td>Common mode isolation[2]
Tested</td><td>300 VDC/V_{RMS} at 60 Hz
1,400 V_{RMS} at 60 Hz for 2 sec</td></tr>
<tr><td>Differential voltage without damage</td><td>±15 VDC/V_{RMS} continuous</td></tr>
<tr><td>Common mode voltage</td><td>±5 VDC/V_{RMS} continuous</td></tr>
<tr><td>Input/output protection</td><td>Continuous short to ground</td></tr>
<tr><td>Dimensions</td><td>
<table>
<tr><th rowspan="2">Type</th><th colspan="2">Height</th><th colspan="2">Width</th><th colspan="2">Depth</th></tr>
<tr><th>mm</th><th>in.</th><th>mm</th><th>in.</th><th>mm</th><th>in.</th></tr>
<tr><td>I/O module</td><td>266</td><td>10.5</td><td>76</td><td>3.0</td><td>162</td><td>6.4</td></tr>
<tr><td>Nonredundant base</td><td>267</td><td>10.5</td><td>138</td><td>5.4</td><td>169</td><td>6.7</td></tr>
<tr><td>Redundant base</td><td>267</td><td>10.5</td><td>217</td><td>8.5</td><td>169</td><td>6.7</td></tr>
</table>
</td></tr>
<tr><td>Overvoltage (installation) category[2]</td><td>ANSI/ISA-S82.01-1994 and IEC 1010-1
I for circuits above 150 V
II for circuits below 150 V</td></tr>
<tr><td>Environmental</td><td rowspan="2">Refer to the Harmony I/O System data sheet for environmental specifications and design standards including certification and CE mark directives.</td></tr>
<tr><td>Design standards</td></tr>
</table>

NOTES:
1. All specification values are maximums unless stated otherwise.
2. AIN-200, AIN-220, and AIN-300 blocks only.

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

Power Requirements

Property[1]		AIN-120	AIN-200	AIN-220	AIN-300	AOT-150
24 VDC BLP current	Typ	315 mA	520 mA	520 mA	520 mA	780 mA
	Max	350 mA	570 mA	570 mA	570 mA	860 mA
24 VDC IFP/LFP current	Typ[2]	215 mA	215 mA	215 mA	—	215 mA
	Max[3]	320 mA	320 mA	320 mA	—	320 mA
	Fault[4]	355 mA	355 mA	355 mA	—	245 mA
Heat dissipation[5]	Typ	8.3 W	13.5 W	13.3 W	13.3 W	21.4 W
	Max	10.9 W	16.5 W	14.6 W	14.6 W	28.1 W

NOTES:
1. For redundant AIN blocks (i.e., redundant base and two I/O modules), calculate power requirements as 2 × BLP and 1 × IFP/LFP. For a redundant AOT block, calculate power requirements as 2 × BLP and 2 × IFP/LFP.
2. 66 percent channel activity with no faults.
3. All channels active with no faults.
4. 66 percent channel activity, one channel faulted. AIN block - one channel 160 mA fault; AOT block - one channel 50 mA fault.
5. Heat dissipation values include both BLP and IFP/LFP power and include the base and one I/O module.

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

Input Specifications

Property[1]	AIN-120	AIN-200	AIN-220	AIN-300
4 to 20 mA in	Yes	No	Yes	No
−10 to +10 VDC in	Yes	Yes	Yes	No
−100 to +100 mVDC in	No	Yes	Yes	No
Thermocouple in: B, E, J, K, L, N (14 AWG), N (28 AWG), R, S, T, U Chinese E, S	No	Yes	Yes	No
3-wire RTD in: 10 Ω copper 100 Ω platinum: U.S. Lab. Standard 100 Ω platinum: U.S. Industry Standard 100 Ω platinum: European Standard 120 Ω nickel Chinese 53 Ω copper	No	No	No	Yes
Channels	16	16	16	16
Isolation	Nonisolated	Isolated	Isolated	Isolated
Full scale range Voltage Resistance	 20 V —	 20 V or 200 mV —	 20 V or 200 mV —	 — 500 Ω
Maximum error (% of full scale range) Current Voltage Resistance	 ±0.06% ±0.05% —	 — ±0.05% —	 ±0.06% ±0.05% —	 — — ±0.10%
Response time per channel – 0 to 95% of final value (100% step change)	75 msec	170 msec	170 msec	170 msec
Fastest update rate[2] – per second (all channels)	40	18	18	18
Rejection (50-60 Hz) Normal mode Common mode	 –70 dB –90 dB	 –70 dB –120 dB	 –70 dB –120 dB	 –70 dB –120 dB
Number of A-to-D converters	1	16 + 1 for cold junction	16 + 1 for cold junction	16

Property[1] *(continued)*	AIN-120	AIN-200	AIN-220	AIN-300
Full scale resolution	16 bit[4]	18 bit[5]	18 bit[5]	18 bit
Channel fault currents (nominal)[3] – current mode				
Shorted transmitter:				
IFP/LFP	60 mA	—	60 mA	—
RFP	100 mA	—	100 mA	—
Shorted positive to ground:				
IFP/LFP	160 mA	—	160 mA	—
Supports redundant I/O electronics	Yes	Yes	Yes	Yes

NOTES:
1. All specification values are maximums unless stated otherwise.
2. This is the rate at which the block reads and updates values. The rate at which the values are actually read and become available to the system depends on the scan cycle of the controller.
3. Remote field powered I/O may need external protection.
4. 16 bit resolution for –10 to +10 VDC range.
5. 18 bit resolution for –10 to +10 VDC range or –100 to +100 mVDC range.

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

Output Specifications

Property[1]	AOT-150
4 to 20 mA out	Yes
Channels	16
Isolation	Nonisolated
Full scale range	18 mA
Maximum error (% of full scale range)	±0.15%
Fastest update rate[2] – per second (all channels)	16
Response time per channel (0 to 95% step change)	50 µsec (resistive load)
Number of D-to-A converters	1
D-to-A resolution	12 bit
Number of A-to-D converters	1 (readback)
A-to-D resolution	16 bit (readback)
Load compliance	
Resistive	0 to 750 Ω
Inductive	600 mH
Supports redundant I/O electronics	Yes

NOTES:
1. All specification values are maximums unless stated otherwise.
2. This is the rate at which the block reads and updates values. The rate at which the values are actually read and become available to the system depends on the scan cycle of the controller.

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

Fuse Specifications

Fuse[1]	Rating	Part Number	Description
Block power (A and B)	1.6 A, 250 V	1949438A1601	5 x 20 mm, fast-acting, low break capacity (IEC 127-2/II)
Field power	3.15 A, 250 V	1949532A3151	5 x 20 mm, time-lag, medium break capacity (IEC 127-2/VI)

NOTE:
1. All AIN and AOT blocks.

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

For more information on the Control IT *suite of products , contact us at ControlIT@us.abb.com*
For the latest information on ABB visit us on the World Wide Web at http://www.abb.com

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