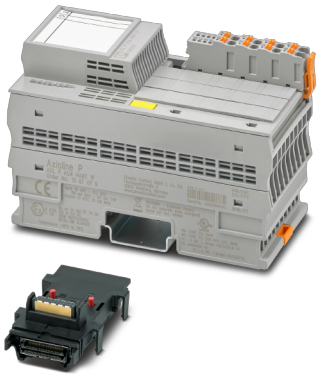
AXL P AO4 HART 1F



**Axioline F analog output module,
HART functionality, 4 outputs,
2-conductor connection technology**

Data sheet
110387_en_00

1 Description

The module is an Axioline P I/O module for use in the Axioline P modular I/O system.
The module is a modular I/O device that can be affixed to the Axioline P local bus, to communicate I/O data up to the Axioline P bus coupler, which forms the head of the station.
The module is fully hot-swappable on the Axioline P local bus, which also provides power to the module.
The module allows the connection of up to four HART devices.
The analog output I/O module with HART capabilities manages analog output and HART data to and from the field I/O terminals and makes this information available to the bus coupler through the Axioline P local bus.

Features

- 4 analog output-powered control signals for HART
- Current range: 4 mA ... 20 mA and 0 mA...20 mA
- Cyclic access to PV, SV, TV, QV, and Loop Current
- Temperature range: -40 °C ... +70 °C
- Hot-swappable

This data sheet is only valid in association with the UM EN AXL P SYSTEM user manual.

Make sure you always use the latest documentation.
It can be downloaded at: phoenixcontact.net/product/1087079

2 Table of contents

3 Ordering data

Description	Type	Item no.	Pcs./Pkt.
Axioline P, Analog output module, Analog outputs: 4 (HART), 0 mA ... 20 mA, 4 mA ... 20 mA, connection technology: 2-conductor, transmission speed in the local bus: 100 Mbps, HART functionality, degree of protection: IP20, including bus base module and connectors	AXL P AO4 HART 1F	1087079	1

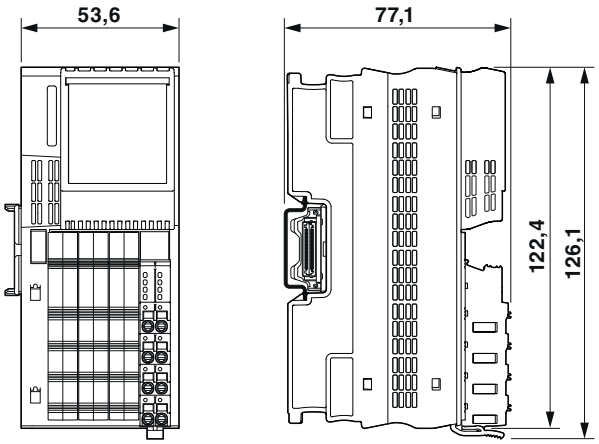
Accessories	Type	Item no.	Pcs./Pkt.
Axioline P bus base module for housing type F2	AXL P BS F2	1052428	1
Axioline shield connection set (contains 2 shield bus holders and 2 SK 5 shield connection clamps)	AXL SHIELD SET	2700518	1
Zack marker strip for Axioline F (device labeling), in 2 x 20.3 mm pitch, unprinted, 25-section, for individual labeling with B-STIFT 0.8, X-PEN, or CMS-P1-PLOTTER (Marking)	ZB 20,3 AXL UNPRINTED	0829579	25
Axioline P terminator pair	AXL P TERM PAIR	2316402	1

Replacement part	Type	Item no.	Pcs./Pkt.
Axioline P bus base module for housing type F2	AXL P BS F2	1052428	1

Optional accessories	Type	Item No.	Pcs./Pkt.
Axioline P terminator pair	AXL P TERM PAIR	2316402	1

4 Technical data

Dimensions (nominal sizes in mm)	



Width	53.6 mm
Height	126.1 mm
Depth	77.14 mm
Note on dimensions	The depth is valid when a TH 35-7,5 DIN rail is used (according to EN 60715).

General data	
Color	traffic grey A RAL 7042
Ambient temperature (operation)	-40 °C ... 70 °C (Standard)
Ambient temperature (storage/transport)	-40 °C ... 85 °C
Permissible humidity (operation)	5 % ... 95 % (non-condensing)
Permissible humidity (storage/transport)	5 % ... 95 % (non-condensing)
Air pressure (operation)	70 kPa ... 106 kPa (up to 2000 m above sea level)
Air pressure (storage/transport)	70 kPa ... 106 kPa (up to 2000 m above sea level)
Degree of protection	IP20
Protection class	III (IEC 61140, EN 61140, VDE 0140-1)
Overvoltage category	II
Degree of pollution	2
Mounting type	DIN rail
Mounting position	any (no temperature derating)
Maximum altitude	2000 m

Connection data: Axioline P connector	
Connection method	Push-in connection
Conductor cross section, rigid	0.2 mm² ... 1.5 mm²
Conductor cross section, flexible	0.2 mm² ... 1.5 mm²

Connection data: Axioline P connector	
Conductor cross section [AWG]	24 ... 16
Stripping length	8 mm

Please observe the information provided on conductor cross sections in the “Axioline P: system and installation” user manual.

Interface: Axioline P local bus	
Connection method	Bus base module
Transmission speed	100 Mbps

Supply of the logic voltage U_L	
Supply voltage range	19.2 V DC ... 30 V DC (via bus base module (U_L) at AXL P BK...)

Supply of the Axioline P local bus U_{Bus}	
Supply voltage	5 V DC (via bus base module)
Current consumption	max. 135 mA

Axioline P extension module supply voltage	
Supply voltage	U_L (via bus base module)
Current consumption	max. 160 mA (via bus base module)

Electrical isolation/isolation of the voltage areas	
Test section	**Test voltage**
5 V supply of the local bus (U_{Bus}) / functional ground	500 V AC, 62 Hz, 1 min.
24 V supply (I/O) / functional ground	500 V AC, 62 Hz, 1 min.
Field to functional earth	500 V AC, 62 Hz, 1 min.
Field to 5 V and 24 V supplies	1500 V AC, 62 Hz, 1 min.

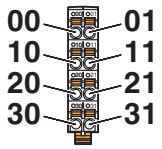
Mechanical tests	
Vibration resistance in acc. with EN 60068-2-6/ IEC 60068-2-6	5g
Shock in acc. with EN 60068-2-27/IEC 60068-2-27	30g
Continuous shock according to EN 60068-2-27/ IEC 60068-2-27	10g

Approvals

For the latest approvals, please visit phoenixcontact.net/products.

5 Terminal point assignment

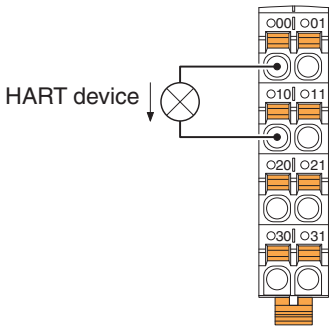
Figure 1 Terminal point assignment



Terminal point	Color	Assignment	
Analog outputs			
00 ... 01	Orange	I01+ ... I02+	Positive current connection for channel 1 ... 2
10 ... 11	Orange	I01- ... I02-	Negative current connection for channel 1 ... 2
20 ... 21	Orange	I03+ ... I04+	Positive current connection for channels 3 ... 4
30 ... 31	Orange	I03- ... I04-	Negative current connection for channels 3 ... 4

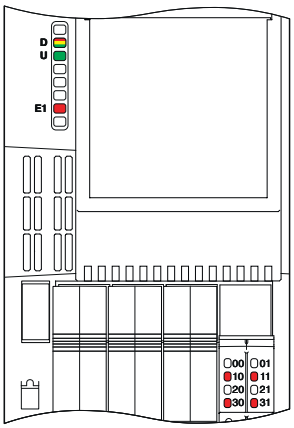
6 Connection examples

Figure 2 Connection for HART devices



7 Local diagnostic and status indicators

Figure 3 Local diagnostic and status indicators



Channel errors are errors that can be associated with a channel.
I/O errors are errors that affect the entire module.

Designation	Color	Meaning	State	Description
D	Red/ yellow/ green	Diagnostics of local bus communication		
		Run	Green on	The device is ready for operation, communication within the station is OK. All data is valid. An error has not occurred.
		Active	Flashing green	The device is ready to operate, communication within the station is OK. The data is **not** valid. The controller or superordinate network is not delivering valid data. There is no error on the module.
		Device application not active	Flashing green/yellow	The device is ready for operation, communication within the station is OK. Output data **cannot** be outputted and/or input data **cannot** be read. There is a fault on the periphery side of the module..
		Ready	Yellow on	The device is ready for operation but did not detect a valid cycle after power-up.
		Connected	Flashing yellow	The device is not (yet) part of the active configuration.
		Reset	Red on	The device is ready for operation but has lost the connection to the bus head.
		Not connected	Flashing red	The device is ready for operation but there is no connection to the previously existing device.
		Power down	Off	Device is in (power) reset.
U	Green	U_{Output}	On	Supply for analog output modules present.
			Off	Supply for analog output modules is not present.
E1	Red	I/O error	On	Breakdown or overload/short-circuit of an output.
			Off	No I/O error.
10, 11, 30, 31	Red	Channel error	On	Wire break/short circuit/overload of the output.
			Off	No error

8 Process data

The module uses 32 HART input process data bytes and 8 analog output process data bytes.

The 32 input bytes are used among 8 HART channels with 4 bytes per channel.

The 8 output bytes are used among 4 analog output channels with 2 bytes per channel.

Output words OUT01 to OUT04

The analog output measured values are transmitted to the bus coupler or controller by means of the output process data word values.

The measured values are depicted in IB IL, S7-compatible or standard format. In all cases, the measured value is displayed in 16 bit format. The data type is Integer 16 from a technical programming point of view.

INx															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Analog value															

In the IB IL format a diagnostic code is mapped to the input data in the event of an error.

Code (hex)	Cause
8001	Measuring range exceeded (overrange)
8002	Wire break
8004	Measured value invalid or no valid measured value available
8040	Device faulty / disabled
8080	Below measuring range (underrange)

Input floating-point HART_IN01 to HART_IN08

The HART process values are transmitted to the bus coupler or controller by means of the input process data floating-point values.

Channel 1 ... channel 4 measured value

Element	Data type	Length in bytes	Meaning
1	FLOAT32	4	Measured value in float format according to IEEE 754

Structure of the float format according to IEEE 754 in the bit representation:

VEEE EEEE	EMMM MMMM	MMMM MMMM	MMMM MMMM

V 1 sign bit, 0: positive, 1: negative

E 8 bits exponent with offset $7F_{hex}$

M 23 bits mantissa

Some example values for conversion from floating point to hexadecimal representation:

Floating point	Hexadecimal representation
1.0	3F 80 00 00
10.0	41 20 00 00
1.03965528	3F 85 13 6D
- 1.0	BF 80 00 00

9 Parameter, diagnostics and information (PDI)

Parameter and diagnostic data as well as other information is transmitted as objects via the PDI channel of the Axioline F station.

The standard and application objects stored in the module are described in the following section.

You will find an explanation of the data types in the user manual UM EN AXL P SYSTEM.

The following applies to all tables below:

Abbreviation	Meaning
A	Number of elements
L	Length of the elements in bytes
R	Read
W	Write

You will find detailed information on the PDI objects in the user manual UM EN AXL P SYSTEM.

10 Standard objects

10.1 Objects for identification (device rating plate)

Index (hex)	Object name	Data type	A	L	Rights	Meaning	Contents
Manufacturer							
0001	VendorName	Visible String	1	32	R	Vendor name	Phoenix Contact
0002	VendorID	Visible String	1	7	R	Vendor ID	00A045
0003	VendorText	Visible String	1	58	R	Vendor text	Components and systems for industrial automation
0012	VendorURL	Visible String	1	58	R	Vendor URL	http://www.phoenixcontact.com
Module - general							
0004	DeviceFamily	Visible String	1	Max. 58	R	Device family	I/O analog OUT
0006	ProductFamily	Visible String	1	32	R	Product family	AXL P
000E	CommProfile	Visible String	1	max. 4 + 1	R	Communication profile	633
000F	DeviceProfile	Visible String	1	max. 4 + 1	R	Device profile	0010
0011	ProfileVersion	Record of Visible Strings	2	Max. 51	R	Profile version	2011-12-07; Basic - Profile V2.0
0017	Language	Array of Records	2	Max. 56	R	Language	en-us; English
Module - special							
0005	Capabilities	Array of Octet Strings	8	N x 8	R	Capabilities	44 77 55 70 64 74 5F 30
0007	ProductName	Visible String	1	32	R	Product name	AXL P AO4 HART 1F
0008	SerialNo	Visible String	1	22	R	Serial number	e. g., 1234512345
0009	ProductText	Visible String	1	58	R	Product text	4 analog outputs with HART
000A	OrderNumber	Visible String	1	32	R	Item No.	1087079
000B	HardwareVersion	Record of Visible Strings	2	11	R	Hardware version	e. g., 2010-06-21; 01
000C	FlexwareVersion	Record of Visible Strings	2	11	R	Firmware version	e. g., 2010-06-21; V1.10
000D	PChVersion	Record of Visible Strings	2	Max. 51	R	PDI version	2016-12-01; PDI V1.10
0037	DeviceType	Octet string	8	8	R	Device type	04 12 04 20 00 0B 0C $A2_{hex}$
003A	VersionCount	Array of UINT16	4	8	R	Version counter	e. g., 0007 0001 0001 0001_{hex}
Use of the device							
0014	Location	Visible String	1	58	R/W	Location	Can be completed by the user.
0015	EquipmentIdent	Visible String	1	58	R/W	Equipment identifier	Can be completed by the user.
0016	ApplDeviceAddr	UINT16	1	2	R/W	Application-specific device address	Can be completed by the user.

10.2 Miscellaneous standard objects

Index (hex)	Object name	Data type	A	L	Rights	Meaning/contents	
Diagnostics objects							
0018	DiagState	Record	10	Max. 207	R	Diagnostic state	*
0019	ResetDiag	UINT8	1	1	R/W	Handling diagnostic messages	*
Objects for process data management							
0024	ResetCode	Array of UINT16	8	16	R/W	Substitute value behavior during bus reset (PDOUT)	*
0025	PDIN	Array of Records	1	48	R	Input process data	*
0026	PDOUT	UINT16	1	2	R/W	Output process data	*
003B	PDIN_Descr	Array of Records	3	12	R	Description of the IN process data	
003C	PDOUT_Descr	Array of Records	3	12	R	Description of the output process data	
Objects for device management							
001D	Password	Octet string	1	Max. 40	W	Password	*
002D	ResetParam	UINT8	1	1	R/W	Reset parameterization	*

The objects identified with * in the last column are described in more detail in the following sections.

The description of the other objects is to be found in the user manual UM EN AXL P SYSTEM.

The objects $003B_{hex}$ and $003C_{hex}$ are only applicable to tools.

10.3 Diagnostics objects

10.3.1 Diagnostics state (0018_{hex}: DiagState)

This object is used for a structured message of an error.

0018_{hex}: Diagnostics state (read)					
Subindex	**Data type**	**Length in bytes**	**Meaning**	**Contents**	
0	Record	21	Diagnostic state	Complete diagnostics information	
1	UINT16	2	Error number	0 ... 65535_{dec}	
2	UINT8	1	Priority	00_{hex}	No error
				01_{hex}	Error
				02_{hex}	Warning
				81_{hex}	Error removed
				82_{hex}	Warning eliminated
3	UINT8	1	Channel/group/module	00_{hex}	No error
				01_{hex}	Channel 1
				:	:
				04_{hex}	Channel 4
				FF_{hex}	Entire device
4	UINT16	2	Error code	See table below	
5	UINT8	1	More follows	00_{hex}	
6	Visible String	14	Text	See table below	

The message with priority 81_{hex} or 82_{hex} is a one-off, internal message to the bus coupler. The bus coupler transfers this error message to the error mechanisms of the higher-level system.

Error and status of the local diagnostics and status indicators

Subindex	2	3	4	6					
Error	**Priority**	**Channel/ group/ module**	**Error code**	**Text**	**Process data**	**LED**			
	hex	**hex**	**hex**			**D**	**U**	**E1**	**CH**
No error	00	00	0000	Status OK	xxxx	◐	●	○	○
Faulty supply voltage	01	FF	5160	Supply fail	0000	☼	○	●	◑
Device error	01	FF	6301	CS FLASH	0000	◐	●	●	◑
7620									
Wire break	01	01 ... 04	7710	Open circuit	8002	◐	●	○	◑
No HART subdevice present	01	01 ... 04	A001	Device missing	-	◐	●	○	○
HART subdevice replaced	02	01 ... 04	A003	Dev replaced	Channel value	◐	●	○	○
HART communication error	01	01 ... 04	A020	Comm error	Last channel value	◐	●	○	◑
HART Timeout	01	01 ... 04	A021	Timeout	Last channel value	◐	●	○	◑

○ Off ◐ Green on ◑ Red on
● On ☼ Flashing green/yellow CH Channel LED

10.3.2 Handling diagnostic messages (0019_{hex}: ResetDiag)

You can use this object to specify how the module should handle diagnostic messages.

0019_{hex}: Handling diagnostic messages (read, write)				
Subindex	**Data type**	**Length in bytes**	**Code (hex)**	**Meaning**
0	UINT8	1	00	Permit all diagnostic messages
			02	Delete and acknowledge all diagnostic messages and do not permit new diagnostic messages
			06	Delete and acknowledge all diagnostic messages and do not permit new diagnostic messages
			Other	Reserved

10.4 Objects for process data management

10.4.1 Substitute value behavior during bus reset (PDOUT) (0024_{hex}: ResetCode)

With this object, you parameterize the behavior of the module in the event that process data is missing.

0024_{hex}: substitute value behavior during bus reset (PDOUT) (read, write)			
Subindex	**Data type**	**Length in bytes**	**Meaning/contents**
0	Array	8 * 2	Substitute value behavior during bus reset (PDOUT)

Element	Data type	Length in bytes	Meaning	Contents	Default value
1	UINT16	2	Substitute value behavior channel 1	0000 ... 0003_{hex}	0002_{hex}
:	:	:	:	:	:
4	UINT16	2	Substitute value behavior channel 4	0000 ... 0003_{hex}	0002_{hex}

Value range:

Code (hex)	Behavior
0000	Output of zero value (0 mA / 4 mA) at output
0001	Output of final value (20 mA) at output
0002	Hold last value
0003	Substitute value (PDOUT): Copy the substitute value from the “Substitute value for the output process data” object ($002F_{hex}$)

Behavior of the outputs when the supply voltage fails

U_A	U_{Bus}	Behavior of the outputs
Available	Available	Nominal operation or see object 0024_{hex}
Missing	Available	Outputs to 0 V/0 mA
Available	Missing	Hold the last values (as with object 0024_{hex}, code 0002)

Special features

– You can only access this object via subindex 0, i. e., you access the entire object.
– Write access with 2 bytes is permissible. In this case, the parameterized value applies to all channels.
– In the case of valid parameters, the object is stored permanently.

OUT process data (0026_{hex}: PDOUT)

You can read the OUT process data of the module with this object.

The structure corresponds to the representation in the "Process data" section.

0026_{hex}: OUT process data (read)			
Subindex	**Data type**	**Length in bytes**	**Meaning**
0	Octet string	4	Output process data

10.5 Objects for device management

10.5.1 Password ($001D_{hex}$: Password)

By entering the "Superuser" password you permit writing to the "Exclusiv right received" object. These rights are required to transmit process data over the PDI channel.

$001D_{hex}$: Password (Write)			
Subindex	Data type	Length in bytes	Meaning/contents
0	Simple variable	9	Password

10.5.2 Reset parameterization ($002D_{hex}$: ResetParam)

This object is used to reset the module to the default settings.

To reset the parameters, value 01_{hex} must be transferred during write access. All other values are invalid and will be acknowledged with an error.

Then the default settings of the channels are loaded and all the user-set parameters are reset.

11 Analog output objects

Index	Subindex	Object name	Data type	L	Rights	Meaning	Contents	
0100	FF	AO_DataFormat	UINT8	1	R/W	Data format	00_{hex} (Default)	Inline
							02_{hex}	S7-compatible
							06_{hex}	Standard PD format
0200	Per channel: 00, 01 ... 04, FF	AO_OutputRange	UINT8	8 1	R/W	Output range	04_{hex}	0 ... 20 mA
							06_{hex}	4 ... 20 mA
							FF_{hex} (Default)	Channel disabled

12 HART objects

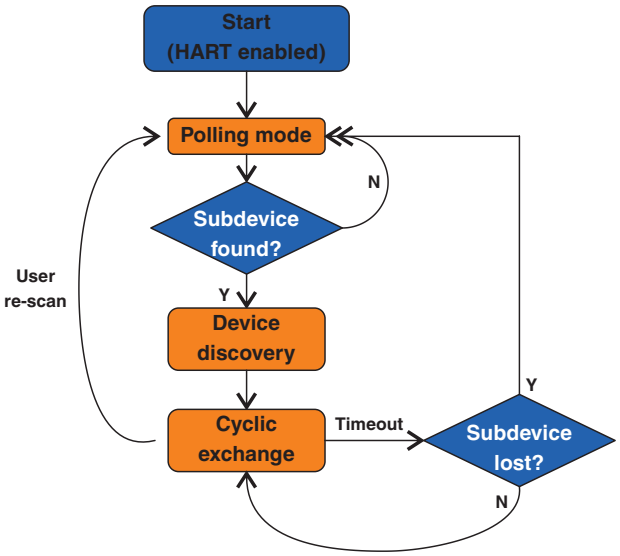
Index	Subindex	Object name	Data type	L	Rights	Meaning	Contents	
07A0	Per channel: 00, 01 ... 04, FF	HART_Scan SubDevices	UINT8	1	R/W	Scan subdevices	00_{hex} (Default)	Disabled
							01_{hex}	Enabled
07A1	Per channel: 00, 01 ... 04, FF	HART_ ChannelEnable	UINT8	1	R/W	HART channel enable	00_{hex}	Disabled
							01_{hex}	Enabled
							02_{hex}	Enabled, no alarms
07A2	Per channel: 00, 01 ... 04, FF	HART_High Priority_Polling	UINT8	1	R/W	HART high priority polling	00_{hex} (Default)	Off
							01_{hex}	On
07A3	Per channel: 00, 01 ... 04, FF	HART_ Channel	UINT8	1	R/W	HART channel	00_{hex}	Disabled
							01_{hex} ... 04_{hex}	Channel 1 ... channel 4
07A4	Per channel: 00, 01 ... 04, FF	HART_Variable	UINT8	1	R/W	HART variable	00_{hex}	Loop current
							01_{hex} (default)	PV
							02_{hex}	SV
							03_{hex}	TV
							04_{hex}	QV
07A5	Per channel: 00, 01 ... 04, FF	HART_Diag Value	UINT8	1	R/W	HART diagnostic value	01_{hex}	Clear HART status byte
07A6	Per channel: 00, 01 ... 04	HART_Sub DeviceInfo	Record	10	R	HART subdevice information		
	01	SubDevice Address	UINT8	1	R	Subdevice address		
	02	SubDevice Type	ENUM	2	R	Subdevice type		
	03	SubDeviceId	Octet string	3	R	Subdevice ID		
	04	SubDevice HartRevision	UINT8	1	R	Subdevice HART revision		
	05	SubDevice Manufacturer	ENUM	2	R	Subdevice manufacturer		
	06	SubDevice Status	UINT8	1	R	Subdevice status		

Index	Subindex	Object name	Data type	L	Rights	Meaning	Contents	
07A7	Per channel: 01 ... 04	HART_Sub DeviceTag	STRING	33	R	HART subdevice tag		
07A8	Per channel: 00, 01 ... 04	HART_Sub DevicePV	32-bit FLOAT	4	R	HART subdevice PV		
07A9	Per channel: 00, 01 ... 04	HART_ ChannelState	ENUM	1	R	HART channel state	00_{hex}	Idle
							01_{hex}	Starting
							02_{hex}	Polling
							03_{hex}	Getting name
							04_{hex}	Bursting
							05_{hex}	External command
							FF_{hex}	Error state
07AA	Per channel: 01 ... 04	HART_ External Command	Domain variable	Dy-namic	R/W	HART external command		

13 HART Functions of the Terminal

The module allows an easy-to-setup connection to HART devices. While this module does not support multi-drop, there are two HART modems embedded in the module that connect up to 4 HART devices. Once added to the Axioline F local bus, this module will start its HART loop scan until a device is found. The following diagram shows how the module polls for HART devices.

Figure 4 Polling HART devices



Configure the module so channels 1 to 4 are enabled or disabled, as well as high-priority selection. Within each HART group you have the ability to set a high priority flag for each channel, causing the polling of high priority channels to be more frequent than others.

Select the cyclic process data for each of the 4 channels in the module. Available HART data includes Loop Current, PV, SV, TV, and QV. The process data for the analog input values and HART process values is given in the following data block structure.

Figure 5 Data block structure of process data

AO4 process data block	
[0]	[7]

HART process data block	
[0]	[31]

The HART process data block provides all HART data from the module through 8 slots. Select Loop Current, PV, SV, TV or QV from the HART values of the field device to populate each of the 8 slots. Each of these 5 HART values will occupy just 1 slot. This allows a modular and customer specific configuration approach.

As an example, a HART device is connected to any one channel of the module. It is desired to receive the Loop Current, PV, and SV from the device. In this scenario, these 3 HART variables would take up 3 of the 8 available HART slots. These 3 HART variables may be placed anywhere in the 8 slots. The module can configure HART devices to poll at different priorities, by enabling priority polling on the desired channel of the module.

As a second example, 4 different HART devices could be connected to all 4 channels of the module. In this case, it is desired to receive 2 HART variables from each device. These 8 HART variables in total can be mapped to the 8 slots of HART process data in any order and polling priority desired.