Appendix B: HART Revision 5

UNIVERSAL COMMANDS IN HART REVISION 5

Command		Data in Command			Data in Reply		
#	Function	Byte	Data	Type	Byte	Data	Type
0	Read unique identifier		None		0	"254" (expansion)	
					1	Manufacturer identification code	
					2	Manufacturer device type code	
					3	Number of preambles required	
					4	Universal command revision	
					5	Device-specific command revision	
					6	Software revision	
					7	Hardware revision	
					8	Device function flags*	(H)
					9–11	Device ID number	(B)
						* Bit 0 = multisensor device; Bit 1 = EEPROM control required; Bit 2 = protocol bridge device	
1	Read primary variable		None		0	PV units code	
					1–4	Primary variable	(F)
2	Read current and percent of range		None		0–3	Current (mA)	(F)
					4–7	Percent of range	(F)
3	Read current and four (predefined) dynamic variables		None		0–3	Current (mA)	(F)
					4	PV units code	
					5–8	Primary variable	(F)
					9	SV units code	
					10–13	Secondary variable	(F)
					14	TV units code	
					15–18	Third variable	(F)
					19	FV units code	
					20–23	Fourth variable	(F)
						(truncated after last supported variable)	
6	Write polling address	0	Polling address			As in command	
11	Read unique identifier associated with tag	0–5	Tag	(A)	0–11	As Command 0	
12	Read message		None		0–23	Message (32 characters)	(A)
13	Read tag, descriptor, date		None		0–5	Tag (8 characters)	(A)
					6–17	Descriptor (16 characters)	(A)
					18–20	Date	(D)
14	Read PV sensor information		None		0–2	Sensor serial number	
					3	Units code for sensor limits and minimum span	
					4–7	Upper sensor limit	(F)
					8–11	Lower sensor limit	(F)
					12–15	Minimum span	(F)

Appendix B: HART Revision 5

Command		Data in Command			Data in Reply		
#	Function	Byte	Data	Type	Byte	Data	Type
15	Read output information		None		0 1 2 3–6 7–10 11–14 15 16	Alarm select code Transfer function code PV/range units code Upper-range value Lower-range value Damping value (seconds) Write-protect code Private-label distributor code	 (F) (F) (F)
16	Read final assembly number		None		0–2	Final assembly number	
17	Write message	0–23	Message (32 characters)	(A)		As in command	
18	Write tag, descriptor, date	0–5 6–17 18–20	Tag (8 characters) Descriptor (16 characters) Date	(A) (A) (D)		As in command	
19	Write final assembly number	0–2	Final assembly number			As in command	

Appendix C: HART Revisions 2, 3, and 4

UNIVERSAL COMMANDS IN HART REVISIONS 2, 3, AND 4 (DIFFERENCES FROM REVISION 5)

Command		Data in Command			Data in Reply		
#	Function	Byte	Data	Type	Byte	Data	Type
0	Read unique identifier		None		0 1 2 3 4 5 6 7–9	Transmitter type code* Number of preambles Universal command revision Device-specific command revision Software revision Hardware revision Device function flags Final assembly number	 (H) (B)
					* Revision 4 introduced the expanded device type as an option (see Rev. 5, Table 4-4), with the remaining bytes moved up by two positions.		
4	Read common static data (block 0): Read message	0	Block number ("0")		0 1–24	Block number ("0") Message	 (A)
4	Read common static data (block 1): Read tag, descriptor, date	0	Block number ("1")		0 1–6 7–18 19–21 22–24	Block number ("1") Tag Descriptor Date "250"	 (A) (A) (D)
4	Read common static data (block 2): Read sensor information	0	Block number ("2")		0 1–3 4 5–8 9–12 13–16 17–24	Block number ("2") Sensor serial number Units code for sensor limits and minimum span Upper-sensor limit Lower-sensor limit Minimum span "250"	 (F) (F) (F)
4	Read common static data (block 3): Read output information	0	Block number ("3")		0 1 2 3 4–7 8–11 12–15 16 17 18–24	Block number ("3") Alarm select code Transfer function code PV/range units code Upper-range value Lower-range value Damping value (seconds) Write-protect code ("1" = protected)* Private-label distributor code** "250"	 (F) (F) (F)
					* "250" or "251" in Revisions 2 and 3 ** "250" in Revisions 2 and 3		
5	Write common static data (block 0): Write message	0 1–24	Block number ("0") Message	 (A)		As in command	

Appendix C: HART Revisions 2, 3, and 4

Command		Data In Command			Data in Reply		
#	**Function**	**Byte**	**Data**	**Type**	**Byte**	**Data**	**Type**
5	Write common static data (block 1): Write tag, descriptor, date	0 1–6 7–18 19–21 22–24	Block number ("1") Tag Descriptor Date "250"	 (A) (A) (D)		As in command	
5	Write common static data (block 4): Write final assembly number	0 1–3 4–24	Block number ("4") Final assembly number "250"			As in command	
11–19		*These commands did not exist before Revision 5.0.*					

Appendix D: Common Practice Commands

COMMON PRACTICE COMMANDS

Command		Data In Command			Data in Reply		
#	Function	Byte	Data	Type	Byte	Data	Type
33	Read transmitter variables	0 1 2 3 (truncated after last requested code)	Transmitter variable code for slot 0 Transmitter variable code for slot 1 Transmitter variable code for slot 2 Transmitter variable code for slot 3		0 1 2–5 6 7 8–11 12 13 14–17 18 19 20–23 (truncated after last requested variable)	Transmitter variable code for slot 0 Units code for slot 0 Variable for slot 0 Transmitter variable code for slot 1 Units code for slot 1 Variable for slot 1 Transmitter variable code for slot 2 Units code for slot 2 Variable for slot 2 Transmitter variable code for slot 3 Units code for slot 3 Variable for slot 3	(F) (F) (F) (F)
34	Write damping value	0–3	Damping value (seconds)	(F)		As in command	
35	Write range values	0 1–4 5–8	Range units code Upper-range value Lower-range value	 (F) (F)		As in command	
36	Set upper-range value (= push SPAN button)		None			None	
37	Set lower-range value (= push ZERO button)		None			None	
38	Reset "configuration changed" flag		None			None	
39	EEPROM control	0 *0 = burn EEPROM; 1 = copy EEPROM to RAM	EEPROM control code*			As in command	
40	Enter/exit fixed current mode	0–3 *0 = exit fixed current mode	Current (mA)*	(F)		As in command	
41	Perform device self-test		None			None	
42	Perform master reset		None			None	
43	Set (trim) PV zero		None			None	
44	Write PV units	0	PV units code			As in command	
44	Write PV units	0	PV units code			As in command	
45	Trim DAC zero	0–3	Measured current (mA)	(F)		As in command	

Appendix D: Common Practice Commands

#	Function	Byte	Data	Type	Byte	Data	Type
46	Trim DAC gain	0–3	Measured current (mA)	(F)		As in command	
47	Write transfer function	0	Transfer function code			As in command	
48	Read additional device status		None		0–5 6–7 8–10 11–13 14–24	Device-specific status Operational modes Analog outputs saturated* Analog outputs fixed* Device-specific status *24 bits each: LSB ... MSB refers to AO #1 ... #24.	(B) (B) (B) (B)
49	Write PV sensor serial number	0–2	Sensor serial number			As in command	
50	Read dynamic variable assignments		None		0 1 2 3	PV transmitter variable code SV transmitter variable code TV transmitter variable code FV transmitter variable code	
51	Write dynamic variable assignments	0 1 2 3	PV transmitter variable code SV transmitter variable code TV transmitter variable code FV transmitter variable code			As in command	
52	Set transmitter variable zero	0	Transmitter variable code			As in command	
53	Write transmitter variable units	0 1	Transmitter variable code Transmitter variable units code			As in command	
54	Read transmitter variable information	0	Transmitter variable code		0 1–3 4 5–8 9–12 13–16 17–20	Transmitter variable code Transmitter variable sensor serial number Transmitter variable limits units code Transmitter variable upper limit Transmitter variable lower limit Transmitter variable damping value (seconds) Transmitter variable minimum span	 (F) (F) (F) (F)
55	Write transmitter variable damping value	0 1–4	Transmitter variable code Transmitter variable damping value (seconds)	 (F)		As in command	

Appendix D: Common Practice Commands

#	Function	Byte	Data	Type	Byte	Data	Type
	Command		**Data in Command**			**Data in Reply**	
56	Write transmitter variable sensor serial number	0 1–3	Transmitter variable code Transmitter variable sensor serial number			As in command	
57	Read unit tag, descriptor, date		None		0–5 6–17 18–20	Unit tag (8 characters) Unit descriptor (16 characters) Unit date	(A) (A) (D)
58	Write unit tag, descriptor, date	0–5 6–17 18–20	Unit tag (8 characters) Unit descriptor (16 characters) Unit date	(A) (A) (D)		As in command	
59	Write number of response preambles	0	Number of response preambles			As in command	
60	Read analog output and percent of range	0	Analog output number code		0 1 2–5 6–9	Analog output number code Analog output units code Analog output level Analog output percent of range	 (F) (F)
61	Read dynamic variables and PV analog output		None		0 1–4 5 6–9 10 11–14 15 16–19 20 21–24	PV analog output units code PV analog output level PV units code Primary variable SV units code Secondary variable TV units code Tertiary variable FV units code Fourth variable	 (F) (F) (F) (F) (F)
62	Read analog outputs	0 1 2 3 (truncated after last requested code)	Analog output number; code for slot 0 Analog output number; code for slot 1 Analog output number; code for slot 2 Analog output number; code for slot 3		0 1 2–5 6 7 8–11 12 13 14–17 18 19 20–23 (truncated after last requested level)	Slot 0 analog output number code Slot 0 units code Slot 0 level Slot 1 analog output number code Slot 1 units code Slot 1 level Slot 2 analog output number code Slot 2 units code Slot 2 level Slot 3 analog output number code Slot 3 units code Slot 3 level	 (F) (F) (F) (F)

Appendix D: Common Practice Commands

	Command		Data in Command			Data in Reply	
#	**Function**	**Byte**	**Data**	**Type**	**Byte**	**Data**	**Type**
63	Read analog output information	0	Analog output number code		0 1 2 3 4–7 8–11 12–15	Analog output number code Analog output alarm select code Analog output transfer function code Analog output range units code Analog output upper-range value Analog output lower-range value Analog output additional damping value (sec)	 (F) (F) (F)
64	Write analog output additional damping value	0 1–4	Analog output number code Analog output additional damping value (sec)	 (F)		As in command	
65	Write analog output range value	0 1 2–5 6–9	Analog output number code Analog output range units code Analog output upper-range value Analog output lower-range value	 (F) (F)		As in command	
66	Enter/exit fixed analog output mode	0 1 2–5	Analog output number code Analog output units code Analog output level* * "not a number" exits fixed output mode	 (F)		As in command	
67	Trim analog output zero	0 1 2–5	Analog output number code Analog output units code Externally measured analog output level	 (F)		As in command	
68	Trim analog output gain	0 1 2–5	Analog output number code Analog output units code Externally measured analog output level	 (F)		As in command	
69	Write analog output transfer function	0 1	Analog output number code Analog output transfer function code			As in command	

Appendix D: Common Practice Commands

Command		Data in Command			Data in Reply		
#	Function	Byte	Data	Type	Byte	Data	Type
70	Read analog output endpoint values	0	Analog output number code		0 1 2–5 6–9	Analog output number code Analog output endpoint units code Analog output upper endpoint value Analog output lower endpoint value	(F) (F)
107	Write burst mode transmitter variables (for Command #33)	0 1 2 3	Transmitter variable code for slot 0 Transmitter variable code for slot 1 Transmitter variable code for slot 2 Transmitter variable code for slot 3			As in command	
108	Write burst mode command number	0	Burst mode command number			As in command	
109	Burst mode control	0	Burst mode control code (0 = exit, 1 = enter)			As in command	
110	Read all dynamic variables		None		0 1–4 5 6–9 10 11–14 15 16–19	PV units code PV value SV units code SV value TV units code TV value FV units code FV value	(F) (F) (F) (F)

Appendix E: Response Codes

STATUS

Two bytes of *status*, also called the *response code*, are included in every reply message from a field or slave device. These two bytes convey three types of information:

❏ Communication errors
❏ Command response problems
❏ Field device status

If an error is detected in the outgoing communication, the most significant bit (bit 7) of the first byte is set to 1 and the details of the error are reported in the rest of that byte. The second byte is then all zeros.

If no error is detected in the outgoing communication, bit 7 of the first byte is 0 and the remainder of the byte contains the command response, which indicates any problem with the received command. The second byte contains status information pertaining to the operational state of the field or slave device.

Communication errors are typically those that would be detected by a UART (i.e., parity overrun and framing errors). The field device also reports overflow of its receive buffer and any discrepancy between the message content and the checksum received.

RESPONSE CODES

First Byte

Bit 7 = 1: Communication Error			OR	Bit 7 = 0: Command response
				Bits 6 to 0 (decoded as an integer, not bit-mapped):
Bit 6	hex C0	Parity error		0 No command-specific error
Bit 5	hex A0	Overrun error		1 (Undefined)
Bit 4	hex 90	Framing error		2 Invalid selection
Bit 3	hex 88	Checksum error		3 Passed parameter too large
Bit 2	hex 84	0 (reserved)		4 Passed parameter too small
Bit 1	hex 82	Rx buffer overflow		5 Too few data bytes received
Bit 0	hex 81	Overflow (undefined)		6 Device-specific command error (rarely used)
				7 In write-protect mode
				8–15 Multiple meanings (see Table 4-9 in *A Technical Overview*)
				16 Access restricted
				28 Multiple meanings (see Table 4-9 in *A Technical Overview*)
				32 Device is busy
				64 Command not implemented

Appendix E: Response Codes

Second Byte

(Not Used)			OR	Field Device Status		
Bit 7				Bit 7	(hex 80)	Field device malfunction
Bit 6				Bit 6	(hex 40)	Configuration changed
Bit 5	All bits 0			Bit 5	(hex 20)	Cold start
Bit 4	(when a			Bit 4	(hex 10)	More status available
Bit 3	communication error is			Bit 3	(hex 08)	Analog output current fixed
Bit 2	reported in the first			Bit 2	(hex 04)	Analog output saturated
Bit 1	byte)			Bit 1	(hex 02)	Nonprimary variable out of limits
Bit 0				Bit 0	(hex 01)	Primary variable out of limits

Note: Hexadecimal equivalents are quoted assuming only a single bit is set. In reality, several bits may be set simultaneously, and the hex digits can be or'ed together.