Series 3730/3731
Type 3730-3, Type 3730-6 and Type 3731-3 (Ex d) Electropneumatic Positioners

HART® Communication
Supplementary Configuration Instructions

Configuration Manual

KH 8384-3 EN

Edition February 2015

Definition of the signal words used in these mounting and operating instructions

⚠ *DANGER!*
indicates a hazardous situation which, if not avoided, will result in death or serious injury.

⚠ *WARNING!*
indicates a hazardous situation which, if not avoided, could result in death or serious injury.

❗ *NOTICE*
indicates a property damage message.

ⓘ *Note:*
Supplementary explanations, information and tips

1 General

This Manual (KH 8384-3 EN) supplements the standard instructions for Types 3730-3, 3730-6 and 3731-3 Positioners and the associated diagnostics instructions.

Table 1: *Associated documentation*

Positioner	Standard instructions	Diagnostics instructions
Type 3730-3	▶ EB 8384-3 EN	▶ EB 8389 EN
Type 3730-6	▶ EB 8384-6 EN	▶ EB 8389-1 EN
Type 3731-3	▶ EB 8387-3 EN	▶ EB 8389 EN

These instructions describe the most important HART® commands used together with the above listed SAMSON positioners.

1.1 HART® revisions

Type 3730-3 and Type 3731-3

HART® revision 5 is used in these positioners by default. Switchover to HART® revision 6 is possible using the operator interface.

Type 3730-6

HART® revision 5 is used in this positioner by default. Switchover to HART® revision 6 is not possible.

2 Device status and response code

The device response consists of 2 bytes. The first byte represents either the communication status or the response code. If the most significant bit (0x80) of the first byte is set, this byte represents the communication status. If the bit is not set, the first byte represents the response code according to Table 3.

2.1 Communication status

A communication status is indicated by the response code when a communication error occurs.

Table 2: *Communication status*

Bit	Definition
0x80	This bit must be set to 1 to show a communication error.
0x40	*Vertical Parity Error* – The parity of one or more of the bytes received by the device was not uneven.
0x20	*Overrun Error* – At least one byte of data in the receive buffer of the UART was overwritten before it was read (i.e. the slave did not process the incoming byte fast enough).
0x10	*Framing Error* – The stop bit of one or more bytes received by the device was not detected by the UART (i.e. a marking or 1 was not detected if a stop bit should have occurred).
0x08	*Longitudinal Parity Error* – The Longitudinal Parity calculated by the device did not match the Longitudinal Parity byte at the end of the message.
0x04	Reserved – set to zero.
0x02	*Buffer Overflow* – The message was too long for the receive buffer of the device.
0x01	Reserved – set to zero.

If a communication error has not occurred, the response code contains a zero in the highest valued bit and the code represents the following described code (0 to 127). The response code is transferred in the first byte of the data field and indicates the status of the command. A zero value indicates that the command is OK. A value unequal to zero means that there is an error (see section 2.2 Response code on page 6).

2.2   Response code

Table 3: *Response codes*

Value	Definition
0	Success
2	Invalid selection
3	Passed parameter too large
4	Passed parameter too small
5	Too few data bytes received
6	Device-specific command error
7	In write protect mode
9	Invalid date code detected
10	Lower range value too low
11	Upper range value too high
12	Upper range value too low
16	Access restricted
18	Invalid units code
17	Invalid device variable index
20	Invalid extended command number
29	Invalid span
32	Busy

2.3   Device status

This byte indicates the current status of the field device.

Table 4: *Device status*

Bit	Definition
0x80	The device has detected a serious error. This error endangers the functioning of the device.
0x40	*Configuration Changed* – The device configuration has been changed. It can have been changed by HART®, TROVIS-VIEW or using the local operation.
0x20	*Cold Start* – The device has been restarted.
0x10	*More Status Available* – Further status information is available in **Code 48**, *Read Additional Status Information*.
0x08	*Loop Current Fixed* – The loop current is kept at a fixed value and does not respond anymore to the process variables.
0x04	*Loop Current Saturated* – The loop current has reached its top (or bottom) limit and cannot rise (or fall) any further.
0x02	*Non-Primary Variable Out of Limits* – A device variable, other than that of the Primary Variable, is beyond the operating limits of the device.
0x01	*Primary Variable Out of Limits* – The Primary Variable PV is beyond the operating limits of the device.

3 Universal commands

3.1 Command 0 (*Read Unique Identifier*)

Table 5: *Command 0*

Byte	Definition
Byte 0	254
Byte 1	Manufacturer identification code (66 stands for SAMSON)
Byte 2	Device type (373x-3: 239, 3730-6: 238)
Byte 3	Minimum number of preambles (master to slave): 5
Byte 4	HART® revision number: 5
Byte 5	Device revision number: 1
Byte 6	Software version number: 1
Byte 7	Hardware version number: 8 (does not exist)
Byte 8	Flags: 0
Byte 9 to 11	Serial number of the device
Byte 12	Minimum number of preambles (slave to master)
Byte 13	Maximum number of device variables: 12
Byte 14 and 15	Counter for configuration change
Byte 16	Maintenance indicator (total valve travel exceeded)

3.2 Command 1 (*Read Primary Variable*)

Command 1 indicates the percent of the Primary Variable. The Primary Variable corresponds to the reference variable in the default setting.

Table 6: *Command 1*

Byte	Definition
Byte 0	Unit of the Primary Variable
Byte 1 to 4	Value of the Primary Variable

3.3   Command 3 (*Read Dynamic Variables and Loop Current*)

Command 3 reads the values of the four Dynamic Variables.

The assignment between the four Dynamic Variables and the selection from the twelve device variables is made by command 51. Table 7 shows the currently available device variables.

In Type 373x-3, the reference variable is fixed as the first Dynamic Variable and cannot be changed.

In Type 3730-6, the first Dynamic Variable can be selected as required.

– Value 0 corresponds to the control value.
– Value 1 corresponds to the valve set point.
– Value 2 corresponds to the target position.
– Value 3 corresponds to the valve position.
– Value 4 corresponds to the error e.
– Value 5 corresponds to the total valve travel.
– Value 6 corresponds to the state of the binary input.
– Value 7 corresponds to the status of the internal solenoid valve/forced venting.
– Value 8 corresponds to the NAMUR condensed status.
– Value 9 corresponds to the current temperature.
– Value 10 corresponds to the sound level value (leakage sensor).
– Value 11 corresponds to the differential pressure.

Table 7: *Command 3*

Byte	Definition
Byte 0 to 3	Reference variable in mA
Byte 4	Unit of the Primary Variable
Byte 5 to 8	Value of the Primary Variable
Byte 9	Unit of the Secondary Variable
Byte 10 to 13	Value of the Secondary Variable
Byte 14	Unit of the Tertiary Variable
Byte 15 to 18	Value of the Tertiary Variable
Byte 19	Unit of the Fourth Variable
Byte 20 to 23	Value of the Fourth Variable

3.4 Command 33 (*Read Device Variables*)

Command 33 allows a maximum of four of the device variables listed below to be read. The indices of the variables to be read are specified in the readout.

Table 8: *Command 33*

Value	Definition
Value 0	Control value
Value 1	Valve set point
Value 2	Target position
Value 3	Valve position
Value 4	Error e
Value 5	Total valve travel
Value 6	State of the binary input (optional)
Value 7	Status of the internal solenoid valve/forced venting (optional)
Value 8	NAMUR condensed status
Value 9	Current temperature
Value 10	Sound level value (leakage sensor)
Value 11	Differential pressure (Type 3730-6)

3.5 Command 38 (*Reset Configuration Change Flag*)

Command 38 resets the configuration change flag. This flag is always reset when a value is written to the EEPROM.

3.6   Command 48 *(Read Additional Status)*

3.6.1   Type 3730-3 and Type 3731-3

The command 48 reads the additional device status. Four internal error bytes are returned which, for example, contain error messages for the closed-loop operation (control loop error etc.).

Table 9: *Command 48 for Type 3730-3 and Type 3731-3*

Byte	Definition
Byte 0 to 3 [1]	4 internal error bytes
Byte 4	Cold start flag
Byte 5	Positioner initialized flag
	Bit 0: Positioner initialized flag (0/1)
	Bit 1: Positioner initialized in Sub mode (0/1)
Byte 6	Extended device status (0/1)
Byte 7	Device operating mode (= 0)
Byte 8 to 10	Analog channel saturated (= 0)
Byte 11 to 13	Analog channel fixed (= 0)
Byte 14	Device family status 0
Byte 15	Device family status 1
Byte 16	Device family status 2
Byte 17 [2]	NAMUR status
Byte 18 to 30 [2]	NAMUR status messages of the extended diagnostics

[1]   Concerning bytes 0 to 3: These bytes contain four error bytes of the positioner. The bytes then have the following meaning:

Byte	Bit	Error description	Display menu item
0	0	x > range	50
	1	Delta x < range	51
	2	Attachment (mechanic/pneumatic unit)	52
	3	Initialization time exceeded	53
	4	Initialization/internal solenoid valve/forced venting	54

Byte	Bit	Error description	Display menu item
0	5	Transit time too short	55
	6	Pin position missing	56
	7	Control loop error	57
1	0	Zero point	58
	1	Autocorrection	59
	2	Fatal error	60
	3	–	–
	4	x signal	62
	5	w too small	63
	6	i/p converter	64
	7	Hardware	65
2	0	Data memory	66
	1	Test calculation	67
	2	Control parameter	68
	3	Potentiometer parameter	69
	4	Calibration parameter	70
	5	General parameters	71
	6	–	–
	7	Internal device error	73
3	0	HART® parameter	74
	1	Info parameters	75
	2	No emergency mode	76
	3	Program loading error	77
	4	Options parameter	78
	5	–	–
	6	Diagnostic parameter	80
	7	–	–

[2] Concerning bytes 17 to 30: NAMUR status messages of extended diagnostics

Byte	Bit	Message description
17	Bit 0	No message
	Bit 1	Maintenance required
	Bit 2	Maintenance demanded
	Bit 3	Maintenance alarm
	Bit 7	Function check
18	Bit 0	Supply pressure – OK
	Bit 1	Supply pressure – Perhaps modified (TEST)
	Bit 2	Supply pressure – Perhaps not enough (TEST)
	Bit 3	Supply pressure – Perhaps not enough
	Bit 4	Supply pressure – Working at full capacity
	Bit 5	Supply pressure – Working at full capacity (TEST)
	Bit 6	Supply pressure – Perhaps modified
19	Bit 0	Actuator springs – OK
	Bit 1	Actuator springs – Perhaps spring stiffness reduced (spring failure) (TEST)
	Bit 2	Actuator springs – Perhaps bias reduced (TEST)
	Bit 3	Actuator springs – Perhaps bias increased (TEST)
	Bit 4	Working at full capacity
	Bit 5	Working at full capacity (TEST)
20	Bit 0	Shifting working range – OK
	Bit 1	Shifting working range – Shifting working range to closing position
	Bit 2	Shifting working range – Shifting working range to max. opening position
21	Bit 0	Friction – OK
	Bit 1	Friction – Much higher over whole range
	Bit 2	Friction – Much lower over whole range
	Bit 3	Friction – Much higher over section
	Bit 4	Friction – Much lower over section
	Bit 5	Friction – Much higher over whole range (TEST)
	Bit 6	Friction – Much lower over whole range (TEST)
	Bit 7	Friction – Much higher over section (TEST)
	Bit 8	Friction – Much lower over section (TEST)

Byte	Bit	Message description
22	Bit 0	Leakage in the pneumatics – OK
	Bit 1	Leakage in the pneumatics – Perhaps existing (TEST)
	Bit 2	Leakage in the pneumatics – Perhaps existing
	Bit 3	Leakage in the pneumatics – Perhaps too large (TEST)
	Bit 4	Leakage in the pneumatics – Perhaps too large
23	Bit 0	Limit working range – OK
	Bit 1	Limit working range – Down
	Bit 2	Limit working range – Up
	Bit 3	Limit working range – Modification impossible (seizure)
24		Dynamic stress factor [%]
25	Bit 0	Inner leakage – OK
	Bit 1	Inner leakage – Perhaps larger than origin
	Bit 2	Inner leakage – Perhaps larger than origin (TEST)
	Bit 3	Inner leakage – Perhaps existing
26	Bit 0	External leakage – OK
	Bit 1	External leakage – Perhaps soon expected
	Bit 2	External leakage – Perhaps expected
27	Bit 0	Observing end position – OK
	Bit 1	Observing end position – Zero point shift monotone down, average above reference
	Bit 2	Observing end position – Zero point shift monotone up, average above reference
	Bit 3	Observing end position – Zero point alternates, average above reference
	Bit 4	Observing end position – Zero point shift monotone down, average below reference
	Bit 5	Observing end position – Zero point shift monotone up, average below reference
	Bit 6	Observing end position – Zero point alternates, average below reference

Byte	Bit	Message description
28	Bit 0	Positioner/valve mechanical connection – OK
	Bit 1	Positioner/valve mechanical connection – No optimum travel transmission (TEST)
	Bit 2	Positioner/valve mechanical connection – Perhaps loose
	Bit 3	Positioner/valve mechanical connection – Perhaps range limit
	Bit 4	Positioner/valve mechanical connection – Perhaps loose (TEST)
29	Bit 0	Working range – OK
	Bit 1	Working range – Mostly near closing position
	Bit 2	Working range – Mostly near max. opening
	Bit 3	Working range – Mostly closing position
	Bit 4	Working range – Mostly max. opening
30	Bit 0	Partial stroke test (PST) – OK
	Bit 1	Partial stroke test (PST) – Not OK
		Note: The exact cause of failure must read out using CMD 161 Refer to section 3.7 on page 21.

3.6.2   Type 3730-6

The command 48 reads the extended device status. Six internal error bytes are returned which, for example, contain error messages for the closed-loop operation (control loop error etc.).

Table 10: *Command 48 for Type 3730-6*

Byte	Definition
Byte 0 to 5 [1]	Internal error bytes
Byte 6	Extended device status (0/1)
Byte 7	Device operating mode (= 0)
Byte 8 to 10	Analog channel saturated (= 0)
Byte 11 to 13	Analog channel fixed (= 0)
Byte 14	Device family status 0
Byte 15	Device family status 1
Byte 16	Device family status 2
Byte 17 [2]	NAMUR status

Byte 18 to 29 [2)]	NAMUR status messages of the extended diagnostics
Byte 30 to 31 [2)]	PST: Results of current test
Byte 32 to 33 [2)]	FST: Results of current test
Byte 34	On/off (0 = no error/1 = an error has occurred)
Byte 35	Temperature monitoring

[1)] Concerning bytes 0 to 5: these bytes contain six error bytes of the positioner. The bytes then have the following meaning:

Byte	Bit	Message description	Local operation
0	Bit 0	x > range	Code 50
	Bit 1	Delta x < range	Code 51
	Bit 2	Attachment	Code 52
	Bit 3	Initialization time exceeded	Code 53
	Bit 4	Internal solenoid valve/forced venting/supply pressure	Code 54
	Bit 5	Transit time too short	Code 55
0	Bit 6	Pin position/switch position	Code 56
	Bit 7	Control loop	Code 57
1	Bit 0	Zero point	Code 58
	Bit 1	Inconsistent data memory	Code 59
	Bit 2	Internal device error	Code 60
	Bit 3	KP too small	Code 61
	Bit 4	x signal	Code 62
	Bit 5	SIL shutdown/w too small	Code 63
	Bit 6	i/p converter	Code 64
	Bit 7	Hardware	Code 65

Byte	Bit	Message description	Local operation
2	Bit 0	Test calculation	Code 67
	Bit 1	Pressure sensor	Code 72
	Bit 2	No emergency mode	Code 76
	Bit 3	Valve signature canceled	Code 81
	Bit 4	PST/FST status	Code 84
	Bit 5	On/off error	Code 85
	Bit 6	SIL tests	Code 86
	Bit 7	–	–
3	Bit 0	Set point outside range	–
	Bit 1	Binary input error status	–
	Bit 2	Total valve travel exceeded	–
	Bit 3	Operating mode not equal to Auto	–
	Bit 4	Cold start	–
	Bit 5	Positioner not initialized	–
	Bit 6	Positioner initialized in Sub mode	–
	Bit 7	–	–

From this point onwards, the extended error messages are summarized in groups and sent as bits.

Byte	Bit	Message description	Local operation
4	Bit 0	Supply pressure	–
	Bit 1	Defective actuator springs	–
	Bit 2	Shifting working range	–
	Bit 3	Friction change	–
	Bit 4	Pneumatic leakage	–
	Bit 5	Limit range	–
	Bit 6	Inner leakage	–
	Bit 7	External leakage	–

Byte	Bit	Message description	Local operation
5	Bit 0	Course of end position	–
	Bit 1	Positioner/valve mechanical connection	–
	Bit 2	Range	–
	Bit 3	Partial stroke test (PST)/full stroke test (FST)	–
	Bit 4	Temperature monitoring	–
	Bit 5	–	–
	Bit 6	–	–
	Bit 7	–	–

2) Concerning bytes 18 to 33: NAMUR status messages of the extended diagnostics

Byte	Bit	Message description
17	Bit 0	No message
	Bit 1	Maintenance required
	Bit 2	Maintenance demanded
	Bit 3	Maintenance alarm
	Bit 7	Function check
18	Bit 0	Supply pressure – OK
	Bit 1	Supply pressure – Perhaps modified (TEST)
	Bit 2	Supply pressure – Perhaps not enough (TEST)
	Bit 3	Supply pressure – Perhaps not enough
	Bit 4	Supply pressure – Working at full capacity
	Bit 5	Supply pressure – Working at full capacity (TEST)
	Bit 6	Supply pressure – Perhaps modified
19	Bit 0	Actuator springs – OK
	Bit 1	Actuator springs – Perhaps spring stiffness reduced (spring failure) (TEST)
	Bit 2	Actuator springs – Perhaps bias reduced (TEST)
	Bit 3	Actuator springs – Perhaps bias increased (TEST)
	Bit 4	Working at full capacity
	Bit 5	Working at full capacity (TEST)

Byte	Bit	Message description
20	Bit 0	Shifting working range – OK
	Bit 1	Shifting working range – Shifting working range to closing position
	Bit 2	Shifting working range – Shifting working range to max. opening position
21	Bit 0	Friction – OK
	Bit 1	Friction – Much higher over whole range
	Bit 2	Friction – Much lower over whole range
	Bit 3	Friction – Much higher over section
	Bit 4	Friction – Much lower over section
	Bit 5	Friction – Much higher over whole range (TEST)
	Bit 6	Friction – Much lower over whole range (TEST)
	Bit 7	Friction – Much higher over section (TEST)
	Bit 8	Friction – Much lower over section (TEST)
22	Bit 0	Leakage in the pneumatics – OK
	Bit 1	Leakage in the pneumatics – Perhaps existing (TEST)
	Bit 2	Leakage in the pneumatics – Perhaps existing
	Bit 3	Leakage in the pneumatics – Perhaps too large (TEST)
	Bit 4	Leakage in the pneumatics – Perhaps too large
23	Bit 0	Limit working range – OK
	Bit 1	Limit working range – Down
	Bit 2	Limit working range – Up
	Bit 3	Limit working range – Modification impossible (seizure)
24		Dynamic stress factor [%]
25	Bit 0	Inner leakage – OK
	Bit 1	Inner leakage – Perhaps larger than origin
	Bit 2	Inner leakage – Perhaps larger than origin (TEST)
	Bit 3	Inner leakage – Perhaps existing
26	Bit 0	External leakage – OK
	Bit 1	External leakage – Perhaps soon expected
	Bit 2	External leakage – Perhaps expected

Byte	Bit	Message description
27	Bit 0	Observing end position – OK
	Bit 1	Observing end position – Zero point shift monotone down, average above reference
	Bit 2	Observing end position – Zero point shift monotone up, average above reference
	Bit 3	Observing end position – Zero point alternates, average above reference
	Bit 4	Observing end position – Zero point shift monotone down, average below reference
	Bit 5	Observing end position – Zero point shift monotone up, average below reference
	Bit 6	Observing end position – Zero point alternates, average below reference
28	Bit 0	Positioner/valve mechanical connection – OK
	Bit 1	Positioner/valve mechanical connection – No optimum travel transmission (TEST)
	Bit 2	Positioner/valve mechanical connection – Perhaps loose
	Bit 3	Positioner/valve mechanical connection – Perhaps range limit
	Bit 4	Positioner/valve mechanical connection – Perhaps loose (TEST)
29	Bit 0	Working range – OK
	Bit 1	Working range – Mostly near closing position
	Bit 2	Working range – Mostly near max. opening
	Bit 3	Working range – Mostly closing position
	Bit 4	Working range – Mostly max. opening

Byte			Message description
30/31	00000000	00000001	No PST performed
	00000000	00000010	PST successful performed
	00000000	00000100	x cancelation
	00000000	00001000	Δp out cancelation
	00000000	00010000	Tolerance band exceeded

Byte			Message description
30/31	00000000	00100000	Max. test duration exceeded
	00000000	01000000	Test cancelled manually
	00000000	10000000	Measured data memory full
	00000001	00000000	Cancel internal solenoid valve/forced venting
	00000010	00000000	Cancelled by control loop error
	00000100	00000000	Set point start difference too high
	00001000	00000000	Set point change
	00010000	00000000	Current too low
	00100000	00000000	Max. breakaway time exceeded
	01000000	00000000	Perm. time until step end exceeded
	10000000	00000000	Supply pressure too low

3.7 Starting and assessing the partial stroke test (PST)

3.7.1 Type 3730-3 and Type 3731-3

	Send		Receive
	Byte 1	**Byte 2**	
Start PST Cmd 168	0x89	–	–
Stop PST Cmd 168	0x9D	–	–
PST Info Cmd 171	0x01	0x19	0/1: PST not activated/running
PST test status Cmd 161	0x00	0xD9	See Table 11

Current PST results

– Command 181 Subcommand 467
   Byte 0   –
   Byte 1 to 4:   Dead time (rising)

- Command 181 Subcommand 468
  Byte 0   –
  Byte 1 to 4:   T63 (rising)
- Command 181 Subcommand 469
  Byte 0   –
  Byte 1 to 4:   T98 (rising)
- Command 181 Subcommand 470
  Byte 0   –
  Byte 1 to 4:   Rise time step (rising)
- Command 181 Subcommand 471
  Byte 0   –
  Byte 1 to 4:   Settling time step (rising)
- Command 151 Subcommand 290 (float)
  Byte 0   –
  Byte 1 to 4:   Overshoot (rising)

- Command 181 Subcommand 472
  Byte 0   –
  Byte 1 to 4:   Dead time (falling)
- Command 181 Subcommand 473
  Byte 0   –
  Byte 1 to 4:   T63 (falling)
- Command 181 Subcommand 474
  Byte 0   –
  Byte 1 to 4:   T98 (falling)
- Command 181 Subcommand 475
  Byte 0   –
  Byte 5 to 8:   Rise time step (falling)
- Command 181 Subcommand 476
  Byte 0   –
  Byte 9 to 12:   Settling time step (falling)
- Command 151 Subcommand 296 (float)
  Byte 0   –
  Byte 1 to 4:   Overshoot (falling)

Table 11: *PST status (bit = 1 means that the description applies)*

Bit		Description
00000000	00000001	No PST performed
00000000	00000010	PST successful performed
00000000	00000100	x cancelation
00000000	00001000	y cancelation
00000000	00010000	Tolerance band exceeded
00000000	00100000	Max. test duration exceeded
00000000	01000000	Test cancelled manually
00000000	10000000	Measured data memory full
00000001	00000000	Cancel internal solenoid valve/forced venting
00000010	00000000	Canceled by control loop error
00000100	00000000	Set point start difference too high
00001000	00000000	Set point change
00010000	00000000	Current too low
00100000	00000000	Max. breakaway time exceeded
01000000	00000000	Perm. time until step end exceeded
10000000	00000000	Supply pressure too low

3.7.2   Type 3730-6

	Send		Receive
	Byte 1	**Byte 2**	
Start PST Cmd 168	0x89	–	–
Stop PST Cmd 168	0x9D	–	–
PST info Cmd 171	0x01	0x19	0/1: PST not activated/running
PST measurement results Cmd 157	0xA4	–	See Table 12
PST test status Cmd 161	0x00	0xD9	See page 21 onwards

Table 12: *PST measurement results*

Byte	Measurement results
Byte 0	–
Byte 1 to 4	Overshoot (rising) float
Byte 5 to 8	Dead time (rising)
Byte 9 to 12	–
Byte 13 to 16	T86 (rising)
Byte 17 to 20	Settling time (rising)
Byte 21 to 24	–
Byte 25 to 28	Overshoot (falling) float
Byte 29 to 32	Dead time (falling)
Byte 33 to 36	–
Byte 37 to 40	T86 (falling)
Byte 41 to 44	Settling time (falling)