		Description
R-ORG	**A5**	4BS Telegram
FUNC	**20**	HVAC Components
TYPE	**06**	Harvesting-powered actuator with local temperature offset control (BI-DIR)

Submitter:

Submitting EnOcean Alliance Member: EH4 GmbH (Micropelt)
Membership Level: Participant

Contact Information
Contact Person: Martin Schmidt
E-Mail Address: martin.schmidt@micropelt.com
Telephone Number: +49 7665 932183-0

Date of Submission: 2018-01-09
Start of TWG Review: YYYY-MM-DD
Date of Approval: YYYY-MM-DD

EEP Version: 0.6
Last Change: 2018-02-28
Status: DRAFT

Change History :

Date	Version	Author	Description
2017-12-01	0.1	Volkert	Initial draft version
2017-12-19	0.2	Schmidt	Draft version, major doc structure changes
2017-12-22	0.3	Schmidt	Wrong reference to TSL fixed
			Insufficient resolution of DIR-2 TMP doubled (0…80 -> 0…160), 0 and 0xFF defined as "no temp. value available"
2018-01-09	0.4	Schmidt	DIR-2 SB: Removed confusing reference to 10 min radio duty cycle. It works from any setting of RFC.
			DIR-2 SBY: Improved wording to make it clear that motor does not engage in temperature control except for anti-freeze
			Description, line 3: Corrected "(LOC)" to "(LO)"
2018-01-30	0.5	Schmidt	Marked unused values as "reserved"
			Eliminated indication of "enum" types

			Redefined LO to 7 bit signed integer
			Cleaned up description of various bits
			Added detailed description to some of the parameters (Appendix)
			Added reference to 4BS teach-in
			Renamed RQL to RSS and set the decision level to -80 dBm
			Added chapter on the interaction of SPS, LOM, LO (Appendix)
2018-02-28	0.6	Schmidt	Fine-tuned RSS decision level to -77 dBm

EEP Submission

R-ORG	**A5**	4BS Telegram
FUNC	**20**	HVAC Components
TYPE	**06**	Harvesting-powered actuator with local temperature offset control (BI-DIR)

Description:
A5-20-06 is defined for use with bi-directional, harvesting-powered valve actuators supporting either "Valve position" or "Temperature set point". This EEP supports local offset control (LO), in other words, the actuator features user controls to increase or decrease the target temperature within a range of +/- 5°C in steps of 1°C.

Local offset control with "Temperature Set Point"-mode (SPS = 1):
Local changes have an immediate effect on the target temperature of the actuator's internal temperature control loop. The resulting new target temperature is instantly communicated to the room control unit (RCU) to be the new temperature set point.

* Local target temperature offset is added to or subtracted from the RCU transmitted temperature, resulting in an immediate change of the actuator's temperature setpoint.
* Local offset changes initiate an instant radio telegram transmission
* The new setpoint (previous setpoint +/- offset) is transmitted as an absolute temperature value to the RCU.
* The local offset is discarded upon receiving the next set point from the RCU.

This way, the user is presented with a fast response of the actuator while the RCU maintains full control over the effect of local changes.

Local offset control with "Valve Position"-mode (SPS = 0):
Local changes are transmitted as offset values to the RCU without changing actuator-internal settings.

* Input of a local offset initiates an instant radio transmission
* The RCU's temperature controller may use the transmitted value to adjust its target temperature according to the user request

* The local offset is discarded after its transmission to the RCU, allowing the RCU to master local changes (accept, ignore, overwrite, scale).

On top of the local offset control, A5-20-06 provides actuator feedback on Radio Communication Errors (RCE) and Radio Signal Strength (RSS). Other features of this protocol are flexible radio communication interval (RFC), read-out of feed temperature (TSL/TMP) and Standby (SBY).

Telegram Definition:

DIRECTION-1 = Transmit mode: Message from the actuator (ACT) to the controller (RCU)
DIRECTION-2 = Receive mode: Commands from the controller (RCU) to the actuator (ACT): Maximum response time must be less than 1 second.

DIRECTION-1: TRANSMIT DATA - FROM ACT to RCU

Offset	Size	Bit-range	Data	Short-Cut	Description	Valid Range	Scale	Unit
0	8	DB3.7... DB3.0	Current value	CV	Current Valve position	0…100dec	0…100	%
						101…255 (0x65…0xFF) reserved		
8	1	DB2.7	Local Offset Mode	LOM	Local Offset Mode defines the format of LO	0 = LO is relative (temperature offset) 1 = LO is absolute (temperature with offset)		
9	7	DB2.6 … DB2.0	Local Offset	LO	LOM =1, use with temperature setpoint mode (DIR-2, DB1.2, SPS = 1)			
					Current temperature set-point plus / minus local offset are communicated as an absolute temp-erature value [°C]	Temperature setpoint °C +/- local offset °C		
						0…80dec	0…+40	ºC
						81…255 (0x51…0xFF) reserved		
					LOM = 0, use with valve position mode (DIR-2, DB1.2, SPS = 0)			
					Local offset setting is communicated directly	0x0: 0 °C (Default) 0x1: 1 °C 0x2: 2 °C 0x3: 3 °C 0x4: 4 °C 0x5: 5 °C 0x7B: -5 °C 0x7C: -4 °C 0x7D: -3 °C 0x7E: -2 °C 0x7F: -1 °C 7 bit signed integer 0x06…0x7A (6…122) reserved		
16	8	DB1.7… DB1.0	Temperature	TMP	Local Ambient or Feed temperature (Selected by Direction 2, DB1.1)	Local ambient temperature:		
						0…80dec	0…+40	°C
						81…254 (0x51…0xFE) reserved		
						Feed temperature:		
						0…160dec	0…+80	°C
						161…254 (0xA1…0xFE) reserved		
						0xFF = Sensor failure or out of range (either ambient or feed or both of them)		

24	1	DB0.7	Temperature Selection	TSL	Indicates which sensor is used for TMP	0: Ambient sensor temp 1: Feed sensor temperature
25	1	DB0.6	Energy Input Enabled	ENIE	Harvesting status	0: Not harvesting 1: Harvesting active
26	1	DB0.5	Energy Storage	ES	Charge level of energy storage	0: Low, almost discharged 1: Sufficiently charged
27	1	DB0.4	Window open detection	DWO	Window open detection	0: No open window detected 1: Open window detected
28	1	DB0.3	LRN Bit	LRNB	Telegram type	0: Teach-in telegram 1: Data telegram
29	1	DB0.2	Radio Com Error	RCE	Indicates radio communication errors	0: Radio communication is stable 1: Six or more consecutive radio communication errors have occurred
30	1	DB0.1	Radio Signal Strength	RSS	Weak radio signal warning	0: Radio signal is strong 1: Radio signal is weak (-77 dBm or less)
31	1	DB0.0	Actuator obstructed	ACO	Reports blocked actuator (motor)	0: Actuator working correctly 1: Actuator is blocked

DIRECTION-2 RECEIVE DATA - FROM RCU TO ACT

Offset	Size	Bit-range	Data	Short-Cut	Description	Valid Range	Scale	Unit
0	8	DB3.7…DB3.0	Valve position or Temperature Setpoint	SP	Valve Position or Temperature Setpoint Selection with DB1.2	0..100dec	0…100	%
						101…255 (0x65…0xFF) reserved		
						Or		
						0…80dec	0…+40	°C
						81…255 (0x51…0xFF) reserved		
8	8	DB2.7…DB2.0	Temperature from RCU	TMP	Room temperature from room control unit (RCU)	0..160dec	0…+40	°C
						161…254 (0xA1…0xFE) reserved Special values 0 and 0xFF: IF SPS=1, use actuator-internal temperature sensor.		
16	1	DB1.7	Reference Run	REF	Execute reference-run	0: Normal operation 1: Reference-run		
17	3	DB1.6…DB1.4	RF Communication interval	RFC	Radio duty cycle selection. Find additional information in the Appendix	0b000: AUTO (default) 2, 5 or 10 minutes 0b001: 2 minutes 0b010: 5 minutes 0b011: 10 minutes 0b100: 20 minutes 0b101: 30 minutes 0b110: 60 minutes 0b111: 120 minutes		
20	1	DB1.3	Summer Bit	SB	Initiate summer mode (reduced communication)	0: Normal operation 1: Summer mode with 8h radio duty cycle		
21	1	DB1.2	Set Point Selection	SPS	Setpoint selection for DB3	0: Valve position mode (0…100%) 1: Temperature setpoint (0…40°C), actuator-internal temperature controller is used		
22	1	DB1.1	Temperature Selection	TSL	Temperature requested from the actuator (DB1.7…DB1.0, DIR-1, TMP)	0: Request ambient temperature 1: Request feed temperature		
23	1	DB1.0	Standby	SBY	Enter standby mode, refer to Appendix	0: Normal operation 1: Standby		
24	4	DB0.7…DB0.4	Not used			Set to 0		
28	1	DB0.3	LRN Bit	LRNB	LRN Bit	0: Teach-in telegram 1: Data telegram		
29	3	DB0.2…DB0.0	Not used			Set to 0		

Appendix:

DIR-1, DIR-2, TSL, Temperature Selection

The TSL-bit exists in both directions, DIR-1 and DIR-2.
In DIR-1, it indicates the mode of DIR-1 TMP (ambient or feed temperature), in DIR-2 it selects the mode of DIR-1 TMP.
This is how TSL is used:
The actuator contacts the controller and receives TSL from the controller.
During the next communication, the actuator communicates a temperature DIR-1 TMP as selected by the previously-received TSL (if TSL = 0, TMP = ambient temperature).
If for some reason the actuator has never received TSL, it assumes TSL = 0.
Whenever the actuator communicates with the controller, it sets TSL according to the TMP that is being transmitted.
The controller trusts the actuator that TSL and TMP match.

DIR-1, DIR-2, TMP, Temperature

TMP exists in both directions, DIR-1 and DIR-2. Note that each direction has its own resolution and valid range, they are not the same.

In DIR-1, TMP communicates the temperature of the actuator's temperature sensors to the controller. The actuator features two temperature sensors, they are ambient and feed. Bit TSL selects which one is communicated.

In DIR-2, TMP communicates the room temperature from the controller to the actuator. This room temperature is typically taken from a room sensor, linked to or integrated in the controller. It is meant to work with the actuator's temperature control loop. If DIR-2 TMP is either 0x00 or 0xFF, the actuator's temperature control loop uses its integrated ambient sensor.

DIR-2, REF, Reference-Run

When REF = 1 is sent, the actuator re-calibrates its zero-position, then resumes normal operation.

DIR-2, RFC, RF Communication Interval

The default setting for the radio communication interval is "AUTO", selecting between 2, 5, and 10 minutes.
The selection is based on the actuator's energy budget. With more energy available, a shorter communication interval is applied.

Priorities: Summer mode overrides the AUTO/manual setting.

DIR-2, SBY, Standby

SBY initiates a mode of low power consumption. There is no motor movement, except for the purpose of freeze protection. The radio is permanently off, while any local user interaction will wake-up the actuator into normal operation.

SBY is intended to minimize power consumption of actuators that are rarely used or have not been used for a long time (and consequently don't get much chance to harvest any energy).

Teach-In Procedure

Teach-in is accomplished by the 4BS, Variation 3 procedure. This is described in EnOcean's EEP 2.6.7 Specification, Chapter 3.3.

Teach-in is initiated by a transmission of the actuator (device A, DIR-1, LRNB = 0) while the controller (device B) is set to learn mode. The controller saves sender ID, EEP and manufacturer ID of the actuator, then confirms the teach-in request to the actuator (DIR-2, LRNB = 0). Upon receiving the confirmation, the actuator saves the sender ID, EEP and manufacturer ID of the controller. The teach-in process is completed by the controller exiting learn-mode.

In case this procedure is not completed (typically due to loss of radio communication), the teach-in has failed and there will not be communication between the actuator and the controller. The teach-in may be repeated.

Interaction of SetPoint Selection (SPS), Local Offset Mode (LOM) and Local Offset (LO)

The controller decides if it wants to operate the actuator in valve position mode (0…100%, SPS = 0) or in temperature setpoint mode (0…40ºC, SPS = 1).

Valve Position Mode:
Upon being contacted by the actuator, the controller communicates SPS = 0 and SP between 0 and 100%.
The actuator receives SPS = 0 and the SP % value from the controller. It then sets the valve to SP %.

When SPS = 0, the actuator will always use LOM = 0.

The user may select a temperature offset through local controls. Immediately after registering a temperature offset input by the user, the actuator contacts the controller with LOM = 0 and LO n ºC. The controller processes it accordingly and derives a new valve position. The new position is communicated back to the actuator. The actuator then discards the user offset.

A user offset input initiates an *immediate* radio transmission by the actuator. Without user action, the actuator and controller communicate periodically as defined by RFC. In this case there is no user input, so no offset is communicated (LO = 0 ºC).

If the user attempts setting an offset but the resulting radio communication fails (actuator receives no response from controller), the offset is discarded and normal operation resumes. The user may repeat his action.

! Note that the actuator is not allowed to transmit LOM = 1 after having received SPS = 0 !
However, the controller shall trust the value of LOM and shall process LO accordingly.

Temperature Setpoint Mode:
Upon being contacted by the actuator, the controller communicates SPS = 1 and SP between 0 and 40ºC.
The actuator receives SPS = 1 and the SP ºC value from the controller. It then sets its internal temperature control loop to SP ºC.

When SPS = 1, the actuator will always use LOM = 1.

Immediately after the user selects a temperature offset, the resulting new temperature setpoint (= old setpoint + user offset) is applied to the temperature control loop.
Only then, the actuator contacts the controller with LOM = 1 and LO = user-modified setpoint (0...40ºC). The controller processes it accordingly and derives its own temperature setpoint SP ºC. This is communicated back to the actuator, overriding its user-modified temperature setpoint and setting LO = SP.

If the user attempts setting an offset but the ensuing radio communication fails (actuator receives no response from controller), the user-modified setpoint is maintained in the control loop and transmitted to the controller with every communication attempt. When communication is restored and a SP from the controller is taken in, the actuator sets LO = SP.

! Note that the actuator is not allowed to transmit LOM = 0 after having received SPS = 1 !
However, the controller shall trust the value of LOM received and shall process LO accordingly.

Neither Valve Position nor Temperature Setpoint Mode:
While the actuator has not yet received a data transmission from the controller, it doesn't know if it will be working in valve position or temperature setpoint mode. Consequently, it doesn't know which local offset mode to use. In this situation, it ignores any temperature offset input by the user. For radio communication, LO = LOM = 0.

How the controller processes the user-requested temperature offset:
The user may request a temperature offset, but it's the controller that decides what to do with the request. It may accept, modify, filter or ignore it. The controller may also decide that the request shall affect more actuators than only the one that has sent the request (e.g. all actuators in one room).