DALI LM Sensor 01

iLumTech

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Functionality

DALI LM Sensor 01 is a sensing and regulation device. It can sense the Lux level and movement. The values of Lux Level and movement detection status can be read by external application. However the sensor itself can be used for regulation and control of the luminaires.

Movement detection can control the luminaires with direct dimming level. When no movement is detected for period longer than Timeout the luminaires (defined by address value) are set to OFF level. Transition is done with corresponding fade time for OFF/ON transition. When the movement is detected the luminaires are set to ON level with corresponding fade time for ON/OFF transition. In case of Slave mode instead of direct dimming levels Movement notification extended commands are sent – these can be received by sensors in Master mode that will handle the regulation of the luminaires.

When Lux regulation is enabled only the sensor regulates the luminaire in order to keep lux level stored in ON level register (encoded). When Lux regulation is enabled together with movement detection then the sensor regulates the luminaires according to the actual movement detection state – ON and OFF lux levels (encoded).

Communication protocol

DALI LM Sensor 01 appear as standard DALI slave device with standard commissioning support according to the IEC 62386-102 standard. The reported device type is 129.
From standard commands DALI LM Sensor 01 supports Query status and Query Groups and as Add to Group / Remove from group commands. The commands connected with ambient light sensing and regulation are extended commands and Enable Device type 129 command must be used prior their usage. All extended commands **must be repeated within 100 ms** in order to be valid (the same behaviour as standard STORE DTR AS… commands). For transfer of values DTR (Data transfer register) and DTR 1 is used. DTR is used also for reading 16 bit values.

Extended commands for DALI LM Sensor 01:

Command number	**Command name**
216 (0xD8)	Query Control Register
217 (0xD9)	Query Address
218 (0xDA)	Query Fading
219 (0xDB)	Query On Level
220 (0xDC)	Query Off Level
221 (0xDD)	Query Lux Level
222 (0xDE)	Query Timeout
223 (0xDF)	Query Calibration
224 (0xE0)	Set Address
225 (0xE1)	Set Fading
226 (0xE2)	Set On Level
227 (0xE3)	Set Off Level
228 (0xE4)	Set Timeout

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229 (0xE5)	Set Calibration
230 (0xE6)	Set Control register
231 (0xE7) – 239 (0xEF)	Reserved
240 (0xF0)	Query Movement
241 (0xF1)	Movement Notification
242 (0xF2) – 255 (0xFF)	Reserved

Examples of abbreviations:
ENABLE DT 129: 193-129 (0xC1- 0x91)
DTR: 163- data (0xA3- data)
DTR1: 195- data (0xC3- data)
READ_DTR: address- 152 (address- 0x98)
READ_DTR1: address- 156 (address- 0x9C)

Note:
Address value contains shifted short (A5:A0) or group address (G3:G0). In case of group address MSB bit must be set. In this document the address value is always used for sending command so LSB bit must be always set:
Example for short address: 0 A5 A4 A3 A2 A1 A0 1 A range from 0 to 63
Example for group address: 1 0 0 G3 G2 G1 G0 1 G range from 0 to 15

The description of commands:

Query Control Register Command 216 (0xD8)

Response contains the status register of DALI LM Sensor 01. Each bit of the register works as flag:

Bit 0 (LSB): Lux regulation control. When set Lux regulation is active.
Bit 1: Movement detection control. When set movement detection is active.
Bit 2: Not used
Bit 3: Not used
Bit 4: Override control. When set sensor considers any dimming command as movement
Bit 5: Slave mode control. When set sensor is in slave mode.
Bit 6: Not used
Bit 7 (MSB): Identification control – when set sensor start flashing with LED indicator. After 5 seconds the bit is automatically reset.

Example:
ENABLE DT 129, address-216 (address-0xD8) -> response

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Query Address Command 217 (0xD9)
This command returns address which is used for regulation in active mode.
Example:
ENABLE DT 129, address-217 (address-0xD9) -> response

Query Fading Command 218 (0xDA)
This command returns fading time values for OFF/ON and ON/OFF transitions for active mode. Fading time values are defined in IEC:62386-102 standard.
Bit 0 (LSB) – Bit 3: Fade time for ON/OFF transition
Bit 4 – Bit 7 (MSB): Fade time for OFF/ON transition

Example:
ENABLE DT 129, address-218 (address-0xDA) -> response

Query ON Level Command 219 (0xDB)
This command returns ON Level value. ON Level value can be either direct dimming level (movement detection only) or lux level (lux regulation).

Example:
ENABLE DT 129, address-219 (address-0xDB) -> response

Query OFF Level Command 220 (0xDC)
This command returns OFF Level value. OFF Level value can be either direct dimming level (movement detection only) or lux level (lux regulation).

Example:
ENABLE DT 129, address-220 (address-0xDC) -> response

Query Lux Level Command 221 (0xDD)
This command returns measured Lux Level value. MSB bit of the returned value contains information about the movement detection. The other 7 bits encodes Lux level in following way:

```
uint8_t level = LUX_LEVEL & 0x7F;       // input value without MSB
uint16_t lux_value = 0;                  // result

switch((level>>5)&0x03)
{
   case 0: lux_value = ((level & 0x3F)<<2) + 0;
        break;
   case 1: lux_value = ((level & 0x1F)<<3) + 128;
        break;
   case 2: lux_value = ((level & 0x3F)<<2) + 256;
```

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```
        break;
    default: lux_value = ((level & 0x1F)<<4) + 512;
        break;
}
```

Bit 0(LSB) – Bit 6: Lux level value
Bit 7 (MSB): Movement detection: 1 – movement detected.

Example:
ENABLE DT 129, address-221 (address-0xDD) -> response

Query Timeout **Command 222 (0xDE)**
This command returns Timeout value. Timeout value is period during which no movement state must be detected in order to switch of OFF state.

Example:
ENABLE DT 129, address-222 (address-0xDE) -> response

Query Calibration **Command 223 (0xDF)**
This command returns calibration factors. Calibration factors are two numbers that have to be applied in order to get raw value from the lux sensor. First number is Reference lux level and second number is raw reference lux level measured during the calibration. By default the calibration factors are equal to 100 lx. Raw reference lux level is returned directly and Reference lux level is stored in DTR. Calibration values are encoded as lux levels.

Example:
ENABLE DT 129, address-223 (address-0xDF), < 100 ms, address-223 (address-0xDF),
-> response Higher byte
READ DTR -> response Lower Byte

Set Address **Command 224 (0xE0)**
When this command is sent (repeated) the value written in DTR is stored as address register which is used in active mode for control and regulation.

Example:
DTR (with data)
ENABLE DT 129, address-224 (address-0xE0), < 100 ms, address-224 (address-0xE0)

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Set Fading **Command 225 (0xE1)**

When this command is sent (repeated) the value written in DTR is stored as fading register which is used in active mode for control and regulation.

Example:
DTR (with data)
ENABLE DT 129, address-225 (address-0xE1), < 100 ms, address-225 (address-0xE1)

Set ON Level **Command 226 (0xE2)**

When this command is sent (repeated) the value written in DTR is stored as ON level which is used in active mode for control and regulation.

Example:
DTR (with data)
ENABLE DT 129, address-226 (address-0xE2), < 100 ms, address-226 (address-0xE2)

Set OFF Level **Command 227 (0xE3)**

When this command is sent (repeated) the value written in DTR is stored as OFF Level which is used in active mode for control and regulation.

Example:
DTR (with data)
ENABLE DT 129, address-227 (address-0xE3), < 100 ms, address-227 (address-0xE3)

Set Timeout **Command 228 (0xE4)**

When this command is sent (repeated) the value written in DTR is stored as timeout value which is used in active mode for control and regulation.

Example:
DTR (with data)
ENABLE DT 129, address-228 (address-0xE4), < 100 ms, address-228 (address-0xE4)

Set Calibration **Command 229 (0xE5)**

When this command is sent (repeated) the values written in DTR and DTR1 are stored as calibration factors. DTR contains reference measurement from external lux meter encoded as lux level. DTR_1 contains lux level measured by the sensor during the calibration encoded as lux level. Once correct calibration values are written, the output of the sensor is equal to the measurement of reference lux meter.

Example:
DTR (with data)
DTR_1 (with data)
ENABLE DT 129, address-229 (address-0xE5), < 100 ms, address-229 (address-0xE5)

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Set Control Register Command 230 (0xE6)

This command is used for main sensor control. Each bit controls a feature of sensor that can be activated or deactivated.

Example:
DTR (with data)
ENABLE DT 129, address-230 (address-0xE6), < 100 ms, address-230 (address-0xE6)

Query Movement Command 240(0xF0)

This command is sent by the sensor in Master mode to check whether other sensors from the same group still detects movement or not. Response to this command is not defined – can be multiresponse.

Movement Notification Command 241 (0xF1)

This command is sent by the sensor in Slave mode to notify the Master sensor about the movement detection. The regulation of luminaires is managed by the Master sensor.

Application examples:

Multiple movement sensors that controls the same group:

For this application the sensors must have the same regulation address, and as well the same group address. When movement is detected any of the sensors can set the luminaires to ON level. When one of the sensors stops detecting the movement before setting the luminaires to OFF level it sends Query Movement command. When a response is received it means that other sensors from the same group still detects the movement – therefore the sensor will not set the luminaires, but internally it goes to no movement state, in order to be able to detect the movement. When no response is received it means that no sensor in the group detects movement – therefore the sensor will set the luminaires to the OFF state.

Multiple movement sensors and single lux sensor that controls the same group:

Additionally to the previous application lux sensor has to be set to Master mode and all other movement sensor have to be set to Slave mode. In this case sensors in Slave mode will send Movement Notification commands when detecting the movement. The reception of this command internally triggers the lux sensor to the movement state and it starts to regulate the luminaire to ON level. Master lux sensor also manages the transition to the OFF state.

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Calibration example:

Calibration of the sensor requires external Luxmeter. Place the DALI LM Sensor 01 to the final position and the reference Luxmeter to the position for which the calibration is important (for example table). Read the data from sensor (encoded value) and from the reference Luxmeter (non- encoded value). Calculate encoded value for reference Luxmeter measurement. Write reference Luxmeter measurement (encoded value) to DTR_1 register and value from the sensor (encoded value) to DTR. Then send Set Calibration command. From this moment the value read from the sensor (decoded) will be the same as the value from the reference Luxmeter.

Calibration uses following formulas:

Final_lux = raw_lux * Reference_lux / (raw_lux_ref)

raw_lux -> raw output from the sensor
reference_lux -> lux value measured by reference lux meter
raw_ref_lux -> raw output from the sensor at the same conditions reference_lux was measured

Revision history:

V1.0	**12/06/2017**	Initial release