

1. DATA EXCHANGE

According to DIN EN 60929 standard, each DALI frame consists of address and command (2 bytes in total). In the module sending data to DALI network is being done with writing needed DALI parcel (2 bytes) to the special register (0x01) of the module with standard Modbus RTU command. Meanwhile DALI network is permanently scanned by the module and each new command (frame) coming through the DALI network is read and stored to another special register (0x02) of the module. Each new command (frame) read from the DALI line replaces the previously stored message in that register so it's crucial to read the value of that register soon after request if the data from a DALI device as being awaited. The register 0x04 can be read to analyze if the DALI line is powered on.

The gateway functions can be called with standard software or with any Modbus RTU compatible PLC/software using the data and examples below:

Register address	Command/Parameter	Value
0x01	Write to DALI (write only)	2 bytes (standard DALI command)
0x02	Read from DALI (read only)	1 last byte read from the DALI line
0x03	Double write to DALI (write only)	2 bytes (standard DALI command); sends DALI command twice with 15 ms pause between frames
0x04	DALI line state (read only)	0xFFFF – line is powered on; 0x0000 – line is damaged or not powered

1.1. DIRECT AND INDIRECT DALI COMMANDS

According to DALI standard, a parcel transmitted via DALI line includes address, command and in general consists of 2 bytes of data in form:

YAAAAAAS XXXXXXXX,

where each symbol stands for one bit of information:

Y - type of address (0 – short address, 1 - group address or collective call);

AAAAAA – DALI address (0 to 63);

S - selection bit, which specifies the value of following eight bits (0 - direct control of the lamp power, 1 - command number);

XXXXXXX - lamp power or command number.

Direct control commands of the lamp power, accordingly have form:

YAAAAAA0 XXXXXXXX,

where data byte XXXXXXXX may take special meanings 0x00 (the DALI device dims using the current fade time down to the set MIN value, and then switches off), 0xFF (no change: this value is ignored and not loaded into memory), or a value in range from 0x01 to 0xFE representing the demanded lamp power.

Some examples of direct commands are present below:

Example 2.1.1: Dim all lamps to level 127 (collective call/broadcast)

Module address	Modbus function	Register address		DALI byte 1	DALI byte 2	MODBUS CRC-16	
0x01	0x06	0x00	0x01	0xFE	0x7F	0xD9	0x8A

Answer:

Module address	Modbus function	Register address		DALI byte 1	DALI byte 2	MODBUS CRC-16	
0x01	0x06	0x00	0x01	0xFE	0x7F	0xD9	0x8A

Example 2.1.2: Dim all lamps with the current fade time down to the set MIN value, and then switch off (collective call/broadcast)

Module address	Modbus function	Register address		DALI byte 1	DALI byte 2	MODBUS CRC-16	
0x01	0x06	0x00	0x01	0xFE	0x00	0x98	0x6A

Answer:

<i>Module address</i>	<i>Modbus function</i>	<i>Register address</i>		<i>DALI byte 1</i>	<i>DALI byte 2</i>	<i>MODBUS CRC-16</i>	
0x01	0x06	0x00	0x01	0xFE	0x00	0x98	0x6A

Example 2.1.3: Extinguish (turn off) all lamps (collective call/broadcast)

<i>Module address</i>	<i>Modbus function</i>	<i>Register address</i>		<i>DALI byte 1</i>	<i>DALI byte 2</i>	<i>MODBUS CRC-16</i>	
0x01	0x06	0x00	0x01	0xFF	0x00	0x99	0xFA

Answer:

<i>Module address</i>	<i>Modbus function</i>	<i>Register address</i>		<i>DALI byte 1</i>	<i>DALI byte 2</i>	<i>MODBUS CRC-16</i>	
0x01	0x06	0x00	0x01	0xFF	0x00	0x99	0xFA

Example 2.1.4: Set actual power level to the maximum value (addressed call/broadcast)

<i>Module address</i>	<i>Modbus function</i>	<i>Register address</i>		<i>DALI byte 1</i>	<i>DALI byte 2</i>	<i>MODBUS CRC-16</i>	
0x01	0x06	0x00	0x01	0xFF	0x05	0x59	0xF9

Answer:

<i>Module address</i>	<i>Modbus function</i>	<i>Register address</i>		<i>DALI byte 1</i>	<i>DALI byte 2</i>	<i>MODBUS CRC-16</i>	
0x01	0x06	0x00	0x01	0xFF	0x05	0x59	0xF9

Example 2.1.5: Dim the lamp with address 2 to the level 18 (addressed call)

<i>Module address</i>	<i>Modbus function</i>	<i>Register address</i>		<i>DALI byte 1</i>	<i>DALI byte 2</i>	<i>MODBUS CRC-16</i>	
0x01	0x06	0x00	0x01	0x04	0x18	0xDA	0xC0

Answer:

<i>Module address</i>	<i>Modbus function</i>	<i>Register address</i>		<i>DALI byte 1</i>	<i>DALI byte 2</i>	<i>MODBUS CRC-16</i>	
0x01	0x06	0x00	0x01	0x04	0x18	0xDA	0xC0

Indirect DALI commands for lamp power have form:

YAAAAAA1 XXXXXXXX

and listed in the table below:

DALI Command (HEX)	Description
0x00	Extinguish the lamp (without fading)
0x01	Dim up 200 ms using the selected fade rate
0x02	Dim down 200 ms using the selected fade rate
0x03	Set the actual arc power level one step higher without fading. If the lamp is off, it will be not ignited
0x04	Set the actual arc power level one step lower without fading. If the lamp has already it's minimum value, it is not switched off
0x05	Set the actual arc power level to the maximum value. If the lamp is off, it will be ignited
0x06	Set the actual arc power level to the minimum value. If the lamp is off, it will be ignited
0x07	Set the actual arc power level one step lower without fading. If the lamp has already it's minimum value, it is switched off
0x08	Set the actual arc power level one step higher without fading. If the lamp is off, it will be ignited

0x09 ... 0x0F	reserved
0x1N	Set the light level to the value stored for the selected scene (N)
0x20	Reset the parameters to default settings
0x21	Store the current light level in the DTR (Data Transfer Register)
0x22 ... 0x29	reserved
0x2A	Store the value in the DTR as the maximum level
0x2B	Store the value in the DTR as the minimum level
0x2C	Store the value in the DTR as the system failure level
0x2D	Store the value in the DTR as the power on level
0x2E	Store the value in the DTR as the fade time
0x2F	Store the value in the DTR as the fade rate
0x30 ... 0x3F	reserved
0x4N	Store the value in the DTR as the selected scene (N)
0x5N	Remove the selected scene (N) from the DALI slave
0x6N	Add the DALI slave unit to the selected group (N)
0x7N	Remove the DALI slave unit from the selected group (N)
0x80	Store the value in the DTR as a short address
0x81 ... 0x8F	reserved
0x90	Returns the status (XX) of the DALI slave
0x91	Check if the DALI slave is working
0x92	Check if there is a lamp failure
0x93	Check if the lamp is operating
0x94	Check if the slave has received a level out of limit
0x95	Check if the DALI slave is in reset state
0x96	Check if the DALI slave is missing a short address
0x97	Returns the version number as XX
0x98	Returns the content of the DTR as XX
0x99	Returns the device type as XX
0x9A	Returns the physical minimum level as XX
0x9B	Check if the DALI slave is in power failure mode
0x9C ... 0x9F	reserved
0xA0	Returns the current light level as XX
0xA1	Returns the maximum allowed light level as XX
0xA2	Returns the minimum allowed light level as XX
0xA3	Return the power up level as XX
0xA4	Returns the system failure level as XX
0xA5	Returns the fade time as X and the fade rate as Y
0xA6 ... 0xAF	reserved
0xBN	Returns the light level XX for the selected scene (N)

0xC0	Returns a bit pattern XX indicating which group (0-7) the DALI slave belongs to
0xC1	Returns a bit pattern XX indicating which group (8-15) the DALI slave belongs to
0xC2	Returns the high bits of the random address as HH
0xC3	Return the middle bit of the random address as MM
0xC4	Returns the lower bits of the random address as LL
0xC5 ... 0xDF	reserved
0xE0 ... 0xFF	Returns application specific extension commands

Some DALI commands (special commands and changing settings), to be executed, have to be sent twice during period of less than 100 ms. As soon as it can be complicated in cases of low baud rate Modbus, special Modbus register (0x03) of the gateway is used for those commands.

Example 2.1.6: Reset parameters and set maximum allowed light level in ballast memory

Step 1: Reset the parameters to ballast default settings (ballast address 2, DALI command 0x20, double write)							
Module address	Modbus function	Register address		DALI byte 1	DALI byte 2	MODBUS CRC-16	
0x01	0x06	0x00	0x03	0x05	0x20	0x7B	0x42
Answer							
0x01	0x06	0x00	0x03	0x05	0x20	0x7B	0x42
Step 2: Set current level to needed maximum allowed level (light level 163, ballast address 2)							
0x01	0x06	0x00	0x01	0x04	0xA3	0x9A	0xB3
Answer							
0x01	0x06	0x00	0x01	0x04	0xA3	0x9A	0xB3
Step 3: Store the current light level to Data Transfer Register (DALI command 0x21, double write)							
0x01	0x06	0x00	0x03	0x05	0x21	0xBA	0x82
Answer							
0x01	0x06	0x00	0x03	0x05	0x21	0xBA	0x82
Step 4: Store the value from DTR as maximum allowed level (DALI command 0x2A, double write)							
0x01	0x06	0x00	0x03	0x05	0x2A	0xFB	0x45
Answer							
0x01	0x06	0x00	0x03	0x05	0x2A	0xFB	0x45
Step 5: Request for reading maximum allowed light level from ballast memory (DALI command 0x2A)							
0x01	0x06	0x00	0x01	0x05	0xA1	0x1A	0xE2
Answer							
0x01	0x06	0x00	0x01	0x05	0xA1	0x1A	0xE2
Step 6: Reading gateway "Read DALI" register ()							
Module address	Modbus function	Starting register address		Quantity of registers to be read		MODBUS CRC-16	
0x01	0x03	0x00	0x02	0x00	0x01	0x25	0xCA
Answer							
Module address	Modbus function	Quantity of bytes in the answer		-	DALI read value	MODBUS CRC-16	
0x01	0x03	0x02		0x00	0xA3	0xF8	0x3D

1.2. READ DALI LINE

"Read from DALI" register of the gateway (0x02) contains the last message/frame come through the DALI line. As long as the length of the message can vary (a command from DALI master consists of 2 bytes while answers from DALI slaves consists of 1 byte only) and in some cases it may be needed not only to read answers from slaves but to monitor the line with other masters (beside gateway), that register may contain 1 or 2 bytes of data depending on what was the last frame in the line. In the case of monitoring data from DALI master the data in the register will be presented with 2 bytes exactly as they come through

DALI line: 2 consequent bytes. Meanwhile the data read from the slave (1 byte) will be presented as 0x00 value in high register byte and meaningful (sent by DALI slave) data in low byte of the register.

Example 2.2.1: Read DALI (there is only 1 byte in buffer come from DALI slave)

Module address	Modbus function	Starting register address		Quantity of registers to be read		MODBUS CRC-16	
0x01	0x03	0x00	0x02	0x00	0x01	0x25	0xCA

Answer:

Module address	Modbus function	Quantity of bytes in the answer	DALI READ	DALI READ	MODBUS CRC-16	
0x01	0x03	0x02	0x00	0xFE	0x39	0xC4

Example 2.2.1: Read DALI (there are 2 bytes in buffer come from DALI master)

Module address	Modbus function	Starting register address		Quantity of registers to be read		MODBUS CRC-16	
0x01	0x03	0x00	0x02	0x00	0x01	0x25	0xCA

Answer:

Module address	Modbus function	Quantity of bytes in the answer	DALI READ	DALI READ	MODBUS CRC-16	
0x01	0x03	0x02	0x04	0x6E	0x3B	0x68

1.3. CHECK DALI LINE

The current state of DALI line (“POWERED ON” or “NOT POWERED”) can be checked by reading register 0x04.

Example 2.3.1: DALI line check

Module address	Modbus function	Starting register address		Quantity of registers to be read		MODBUS CRC-16	
0x01	0x03	0x00	0x04	0x00	0x01	0xC5	0xCB

Answer:

Module address	Modbus function	Quantity of bytes in the answer	Line state (powered on)		MODBUS CRC-16	
0x01	0x03	0x02	0xFF	0xFF	0xB9	0xF4

Example 2.3.2: DALI line check

Module address	Modbus function	Starting register address		Quantity of registers to be read		MODBUS CRC-16	
0x01	0x03	0x00	0x04	0x00	0x01	0xC5	0xCB

Answer:

Module address	Modbus function	Quantity of bytes in the answer	Line state (no power or damaged)		MODBUS CRC-16	
0x01	0x03	0x02	0x00	0x00	0xB8	0x44

1.4. SPECIAL DALI COMMANDS

New DALI devices don’t have individual short addresses so they cannot respond to addressed messages unless they are initialized (got personal addresses) via special commands. Special commands are coded with bits inside the first data byte in DALI frame and listed in the table below:

Special DALI command (BIN)	Description
1010 0001 0000 0000	TERMINATE
1010 0011 XXXX XXXX	DATA TRANSFER REGISTER (DTR)
1010 0101 XXXX XXXX	INITIALISE
1010 0111 0000 0000	RANDOMISE
1010 1001 0000 0000	COMPARE

1010 1011 0000 0000	WITHDRAW
1010 1101 0000 0000	RESERVED
1010 1111 0000 0000	RESERVED
1011 0001 HHHH HHHH	SEARCHADDRH
1011 0011 MMMM MMMM	SEARCHADDRM
1011 0101 LLLL LLLL	SEARCHADDRL
1011 0111 OAAA AAA1	PROGRAM SHORT ADDRESS
1011 1001 OAAA AAA1	VERIFY SHORT ADDRESS
1011 1011 0000 0000	QUERY SHORT ADDRESS
1011 1101 0000 0000	PHYSICAL SELECTION
1011 1111 XXXX XXXX	RESERVED
1100 0001 XXXX XXXX	ENABLE DEVICE TYPE X
110X XXX1 XXXX XXXX	RESERVED

In order to use some special commands “Initialize” command must be called twice during 100 ms time period.

Example 2.4.1: Search for DALI devices and program short addresses (global readdressing)

Step 1: Initialize (broadcast, DALI special command, double write)							
Module address	Modbus function	Register address		DALI byte 1	DALI byte 2	MODBUS CRC-16	
0x01	0x06	0x00	0x03	0xA5	0x00	0x02	0x9A
Answer							
0x01	0x06	0x00	0x03	0xA5	0x00	0x02	0x9A
Step 2: Randomize (broadcast, DALI special command, double write)							
0x01	0x06	0x00	0x03	0xA7	0x00	0x03	0xFA
Answer							
0x01	0x06	0x00	0x03	0xA7	0x00	0x03	0xFA
Step 3.1: Search address, high byte (broadcast address 0x000001)							
0x01	0x06	0x00	0x01	0xB1	0x00	0xAC	0x5A
Answer							
0x01	0x06	0x00	0x01	0xB1	0x00	0xAC	0x5A
Step 3.2: Search address, middle byte (broadcast address 0x000001)							
0x01	0x06	0x00	0x01	0xB3	0x00	0xAD	0x3A
Answer							
0x01	0x06	0x00	0x01	0xB3	0x00	0xAD	0x3A
Step 3.3: Search address, low byte (broadcast address 0x000001)							
0x01	0x06	0x00	0x01	0xB5	0x01	0x6F	0x5A
Answer							
0x01	0x06	0x00	0x01	0xB5	0x01	0x6F	0x5A
Step 4: Compare (broadcast, DALI special command)							
0x01	0x06	0x00	0x01	0xA9	0x00	0xA6	0x5A
Answer							
0x01	0x06	0x00	0x01	0xA9	0x00	0xA6	0x5A
Step 5: Reading gateway “Read DALI” register – comparison is not approved							
Module address	Modbus function	Starting register address		Quantity of registers to be read		MODBUS CRC-16	
0x01	0x03	0x00	0x02	0x00	0x01	0x25	0xCA
Answer							
Module address	Modbus function	Quantity of bytes in the answer		DALI read value		MODBUS CRC-16	

0x01	0x03	0x02		0xA9	0x00	0xC6	0x14
<i>*From the answer in step 5 we see that the last DALI frame read from the DALI line was 0xA900 (“compare” command) so we conclude that no device answered “compare” command. After that we increase the searching address by one (to 0x000002) and repeat steps 3.1-5 looking for answer again and so on till the moment we receive the answer (step 6)</i>							
Step 6: Reading gateway “Read DALI” register - comparison is approved							
Module address	Modbus function	Starting register address		Quantity of registers to be read		MODBUS CRC-16	
0x01	0x03	0x00	0x02	0x00	0x01	0x25	0xCA
Answer:							
Module address	Modbus function	Quantity of bytes in the answer		DALI read value		MODBUS CRC-16	
0x01	0x03	0x02		0x00	0xFF	0xF8	0x04
<i>*0x00FF read from DALI line after “compare” command indicates that there is device on line with requested number and short address can be programmed to it</i>							
Step 7: Program short address (the device with address asked in steps 3.1-3.3 , DALI special command, short address - 01)							
0x01	0x06	0x00	0x01	0xB7	0x03	0xEF	0xFB
Answer							
0x01	0x06	0x00	0x01	0xB7	0x03	0xEF	0xFB
Step 8: Withdraw (the device with address asked in steps 3.1-3.3 , DALI special command)							
0x01	0x06	0x00	0x01	0xAB	0x00	0xA7	0x3A
Answer							
0x01	0x06	0x00	0x01	0xAB	0x00	0xA7	0x3A
<i>*After step 7 the found device was given a short address 01 and after step 7 it was excluded from the further search so the process of search can be continued in the loop of steps 3.1-5 (increasing search address again) and repeating steps 7-8 (increasing short addresses) after finding new ballasts</i>							
Step 9: Terminate (finish the process of search and addressing)							
0x01	0x06	0x00	0x01	0xA1	0x00	0xA1	0x9A
Answer							
0x01	0x06	0x00	0x01	0xA1	0x00	0xA1	0x9A

*For more detailed information of DALI commands usage look DIN EN 60929 standard