

WAGO → I/O → SYSTEM 750

**Fieldbus Independent
I/O Modules**

**DALI/DSI Master Module
750-641**



Manual

Version 1.2.0

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Every conceivable measure has been taken to ensure the correctness and completeness of this documentation. However, as errors can never be fully excluded, we would appreciate any information or ideas at any time.

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We wish to point out that the software and hardware terms as well as the trademarks of companies used and/or mentioned in the present manual are generally trademark or patent protected.

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1 Important Notes

This section includes an overall summary of the most important safety requirements and notes that are mentioned in each individual section. To protect your health and prevent damage to devices as well, it is imperative to read and carefully follow the safety guidelines.

1.1 Legal Bases

1.1.1 Copyright

This Manual, including all figures and illustrations, is copyright-protected. Any further use of this Manual by third parties that violate pertinent copyright provisions is prohibited. Reproduction, translation, electronic and phototechnical filing/archiving (e.g., photocopying) as well as any amendments require the written consent of WAGO Kontakttechnik GmbH & Co. KG, Minden, Germany. Non-observance will involve the right to assert damage claims.

WAGO Kontakttechnik GmbH & Co. KG reserves the right to provide for any alterations or modifications that serve to increase the efficiency of technical progress. WAGO Kontakttechnik GmbH & Co. KG owns all rights arising from the granting of patents or from the legal protection of utility patents. Third-party products are always mentioned without any reference to patent rights. Thus, the existence of such rights cannot be excluded.

1.1.2 Personnel Qualifications

The use of the product described in this Manual requires special personnel qualifications, as shown in the following table:

Activity	Electrical specialist	Instructed personnel*)	Specialists**) having qualifications in PLC programming
Assembly	X	X	
Commissioning	X		X
Programming			X
Maintenance	X	X	
Troubleshooting	X		
Disassembly	X	X	

*) Instructed persons have been trained by qualified personnel or electrical specialists.

**) A specialist is a person, who – thanks to technical training – has the qualification, knowledge and expertise to meet the required specifications of this work and to identify any potential hazardous situation in the above listed fields of activity.

All responsible persons have to familiarize themselves with the underlying legal standards to be applied. WAGO Kontakttechnik GmbH & Co. KG does not assume any liability whatsoever resulting from improper handling and damage incurred to both WAGO's own and third-party products by disregarding detailed information in this Manual.

1.1.3 Use of the 750 Series in Compliance with Underlying Provisions

Couplers, controllers and I/O modules found in the modular WAGO-I/O-SYSTEM 750 receive digital and analog signals from sensors and transmit them to the actuators or higher-level control systems. Using programmable controllers, the signals can also be (pre-)processed.

The components have been developed for use in an environment that meets the IP20 protection class criteria. Protection against finger injury and solid impurities up to 12.5 mm diameter is assured; protection against water damage is not ensured. Unless otherwise specified, operation of the components in wet and dusty environments is prohibited.

1.1.4 Technical Condition of Specified Devices

The components to be supplied Ex Works, are equipped with hardware and software configurations, which meet the individual application requirements. Changes in hardware, software and firmware are permitted exclusively within the framework of the various alternatives that are documented in the specific manuals. WAGO Kontakttechnik GmbH & Co. KG will be exempted from any liability in case of changes in hardware or software as well as to non-compliant usage of components.

Please send your request for modified and new hardware or software configurations directly to WAGO Kontakttechnik GmbH & Co. KG.

1.2 Standards and Guidelines for Operating the 750 Series

Please adhere to the standards and guidelines required for the use of your system:

- The data and power lines shall be connected and installed in compliance with the standards required to avoid failures on your system and to substantially minimize any imminently hazardous situations resulting in personal injury.
- For assembly, start-up, maintenance and troubleshooting, adhere to the specific accident prevention provisions which apply to your system (e.g. BGV A 3, "Electrical Installations and Equipment").
- Emergency stop functions and equipment shall not be made ineffective. See relevant standards (e.g. DIN EN 418).
- The equipment of your system shall conform to EMC guidelines so that any electromagnetic interferences will be eliminated.
- Operating 750 Series components in home applications without further measures is permitted only if they meet the emission limits (emissions of interference) in compliance with EN 61000-6-3. You will find the detailed information in section "WAGO-I/O-SYSTEM 750" → "System Description" → "Technical Data".
- Please observe the safety precautions against electrostatic discharge in accordance with DIN EN 61340-5-1/-3. When handling the modules, please ensure that environmental factors (persons, working place and packaging) are well grounded.
- The valid standards and guidelines applicable for the installation of switch cabinets shall be adhered to.

1.3 Symbols



Danger

Always observe this information to protect persons from injury.



Warning

Always observe this information to prevent damage to the device.



Attention

Marginal conditions that must always be observed to ensure smooth and efficient operation.



ESD (Electrostatic Discharge)

Warning of damage to the components through electrostatic discharge. Observe the precautionary measure for handling components at risk of electrostatic discharge.



Note

Make important notes that are to be complied with so that a trouble-free and efficient device operation can be guaranteed.



Additional Information

References to additional literature, manuals, data sheets and internet pages.

1.4 Safety Information

When connecting the device to your installation and during operation, the following safety notes must be observed:



Danger

The WAGO-I/O-SYSTEM 750 and its components are an open system. It must only be assembled in housings, cabinets or in electrical operation rooms. Access is only permitted via a key or tool to authorized qualified personnel.



Danger

All power sources to the device must always be switched off before carrying out any installation, repair or maintenance work.



Warning

Replace defective or damaged device/module (e.g. in the event of deformed contacts), as the functionality of field bus station in question can no longer be ensured on a long-term basis.



Warning

The components are not resistant against materials having seeping and insulating properties. Belonging to this group of materials is: e.g. aerosols, silicones, triglycerides (found in some hand creams). If it cannot be ruled out that these materials appear in the component environment, then the components must be installed in an enclosure that is resistant against the above mentioned materials. Clean tools and materials are generally required to operate the device/module.



Warning

Soiled contacts must be cleaned using oil-free compressed air or with ethyl alcohol and leather cloths.



Warning

Do not use contact sprays, which could possibly impair the functioning of the contact area.



Warning

Avoid reverse polarity of data and power lines, as this may damage the devices.



ESD (Electrostatic Discharge)

The devices are equipped with electronic components that may be destroyed by electrostatic discharge when touched.



Warning

For components with ETHERNET/RJ-45 connectors:
Only for use in LAN, not for connection to telecommunication circuits.

1.5 Font Conventions

- italic* Names of paths and data files are marked in italic-type.
e.g.: *C:\Programs\WAGO-IO-CHECK*
- italic* Menu items are marked in italic-type, bold letters.
e.g.: ***Save***
- \ A backslash between two names characterizes the selection of a menu point from a menu.
e.g.: ***File \ New***
- END** Pushbuttons are marked as bold with small capitals
e.g.: **ENTER**
- <>** Keys are marked bold within angle brackets
e.g.: **<F5>**
- Courier* The print font for program codes is Courier.
e.g.: `END_VAR`

1.6 Number Notation

Number code	Example	Note
Decimal	100	Normal notation
Hexadecimal	0x64	C notation
Binary	'100' '0110.0100'	In quotation marks, nibble separated with dots (.)

1.7 Scope

This manual describes the Specialty Module 750-641 DALI/DSI Master Module of the modular WAGO-I/O-SYSTEM 750.

Handling, assembly and start-up are described in the manual of the Fieldbus Coupler. Therefore this documentation is valid only in the connection with the appropriate manual.

2 I/O Modules

2.1 Special Modules

2.1.1 750-641 [DALI/DSI Master Module]

DALI/DSI Master Module



Attention

Accessories required: WAGO DC/DC converter, Item-No. 288-895

2.1.1.1 View

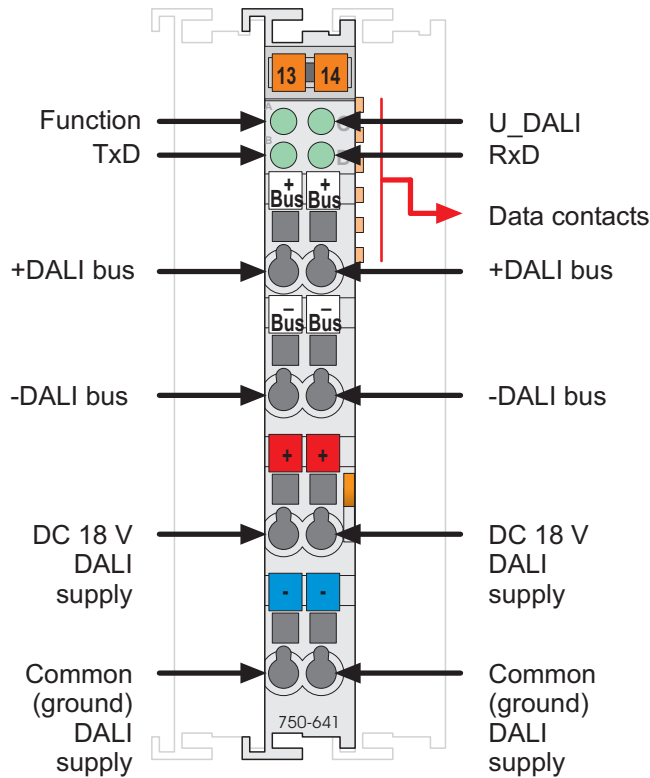


Fig. 2.1.1-1: View

g064100e

2.1.1.2 Description

The DALI/DSI Master Module 750-641 enables actuators used in lighting applications (e.g. electronic ballasts for the building automation) to be controlled digitally. This module is a substitute for an analog 1-10 V dimmer interface used currently.

DALI (Digital Adressable Lighting Interface) is a protocol used by manufacturers for standardized control of electronic ballasts in lighting applications (DIN IEC 60929). With DALI complex lighting scenes and group functionalities can be realized. Beyond that, using the DALI/DSI Master Module within the WAGO-I/O-SYSTEM allows for any combinations of DALI controls with other building services.

DSI (Digital Serial Interface) is a proprietary interface developed by the TRIDONIC ATCO company and as a 1-10 V dimmer interface in digitally function it is also used to control electronic ballasts.

However, compared to the DALI master, the slaves of the DSI module cannot be addressed individually and no feedback signals can be sent to the master. The module has two parallel connections each for the +DALI and the -DALI bus connection. These connections allow, for example, the wiring of up to 64 DALI slaves directly via one bus line or two parallel bus lines using 2-connectors. The module is supplied DC 18 V and common (ground) connections.



Warning

The WAGO DC/DC Converter, Item-No.: 288-895, must be used when providing the module with DALI and DSI compliant 18 V supply. The converter guarantees the electrical isolation between the DALI bus and the internal data bus, which is required when using 230V consumer loads.



Attention

The WAGO DC/DC Converter, Item-No.: 288-895, delivers up to 400mA and can supply three DALI modules in full extension, that means each module is wired with a maximum of 64 electronic ballasts à 2mA ≈ 130mA. As far as the wiring of the converter and the topology are concerned, please refer to the chapter “Installation Notes“.



Warning

The DALI/DSI Master Module 750-641 is not protected from arbitrary exchanging of the connecting cables.

Up to 64 DALI slaves can be installed. Each slave can be assigned to 16 individual groups or 16 individual scenes. Addressing, allocating and parameter changes to the slaves are done using an IEC 61131-3 application. This application accesses both the implemented DALI standard command sets according to DIN IEC 60929 and an extended command set (Extended Commands).

The IEC 61131-3 application can be implemented in the connected programmable fieldbus controller (PFC) of the fieldbus node using the

WAGO-I/O-PRO programming tool or in a higher-level control when a connected fieldbus coupler is used.

The data of the individual electronic ballasts or sensors are not mapped in the process image of the connected coupler/controller, but tunneled to the application programm so the data can be analysed and processed via the commands.

LEDs indicate the operating condition of the module and the trouble-free internal data bus communication as well as the state of both the signal transmission and the DALI bus.

Any Modules can be placed in any configuration when designing the fieldbus node. Grouping of module types is not necessary.



Attention

This module has no power contacts. For field supply to downstream I/O modules, a supply module will be needed.



Attention

The DALI/DSI Master Module cannot be used in the following combination: LonWorks® Fieldbus Coupler 750-319 together with the WAGO TOPLON® IF and PRIO Plug-Ins.

The module is directly supported by the controllers of the WAGO-I/O-SYSTEM 750.

A higher-level control must be used to control the module when a coupler is used.

This module can be used with all couplers/controllers (except for the economy variations 750-320, -323, -324 and -327) of the WAGO-I/O-SYSTEM 750.

2.1.1.3 Display Elements

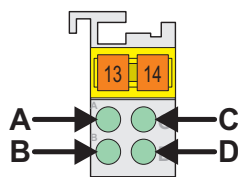


Fig. 2.1.1-2: Display elements g041402xx

LED	Designation	State	Function
A	Function	off	no operational readiness or the internal data bus communication is interrupted/disturbed
		green	operational readiness and trouble-free internal data bus communication
B	TxD	off	no TxD signal transmission or DSI mode
		green	signal transmission TxD available
		flashing	DALI mode (cyclical flashing, 1x per sec.)
C	U_DALI	off	no 18 V supply available or Dali bus cable break/short circuit or self-test failure
		green	18 V supply available and no DALI bus failure as well as trouble-free self-test
D	RxD	off	no RxD signal transmission
		green	RxD signal transmission available

2.1.1.4 Schematic Diagram

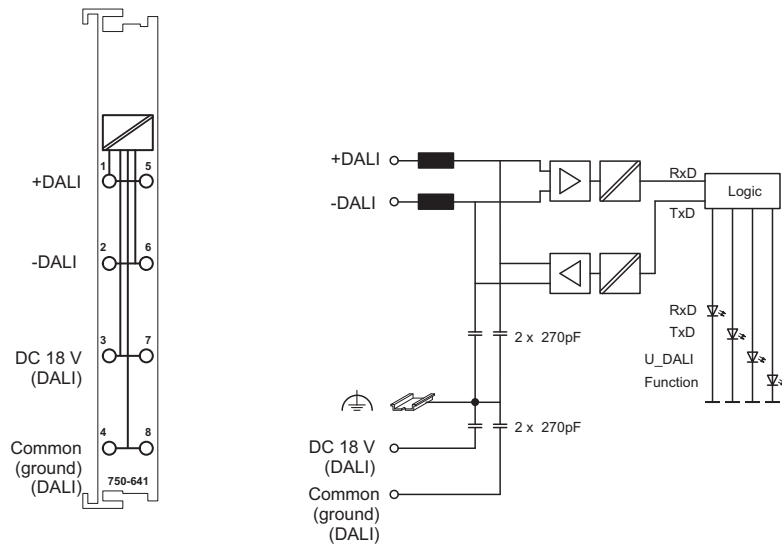


Fig. 2.1.1-3: Schematic Diagram

g064101e

2.1.1.5 Technical Data

Module Specific Data	
DALI Specification	DIN IEC 60929 (VDE 0712 part 23)
DSI Specification	TRIDONIC ATCO Specification 2.0
Number of Slaves (DALI)	64
Number of Slaves (DSI)	100
Current output _{max}	200 mA
Voltage supply (DALI/DSI)	18 V via DC/DC converter 288-895
Transmission channel	1
Current consumption (internal)	30 mA
Voltage supply	via system voltage
Isolation	DC 1500 V DALI bus/internal bus
Data width internal	1 x 40 bit in / out (5 bytes data) 1 x 8 bit control/ status
Dimensions (mm) W x H x L	12 x 64* x 100 * from upper edge of 35 DIN rail
Weight	ca. 60 g
Vibration and shock resistance	acc. to IEC 60068-2-6 acc. to 60068-2-27
Degree of protection	IP20

Standards and Regulations *) (See Chapter 2.2 of Coupler/Controller Manual)		
EMC Immunity to interference (CE)	acc. to EN 61000-6-2 (01)	
EMC Emission to interference (CE)	acc. to EN 61000-6-3 (01)	
EMC Immunity to interference (ship building)	acc. to Germanischer Lloyd (97)	
EMC Emission to interference (ship building)	acc. to Germanischer Lloyd (97)	
Approvals *) (See Chapter 2.2 of Coupler/Controller Manual)		
	cUL _{US} (UL508)	(requested)
	cUL _{US} (ANSI/ISA 12.12.01)	Class I Div2 ABCD T4
	DEMKO / IEC	I M2 / II 3 G/D Ex nA IIC T4
	Conformity Marking	

*)



Attention!

For the guarantee of the standards and approvals for ship employment, the DALI/DSI Master Module 750-641 must be used in bundle with the DC/DC converter 288-895!



More Information

Detailed references to the approvals are listed in the document "Overview Approvals WAGO-I/O-SYSTEM 750", which you can find on the CD ROM "AUTOMATION Tools and Docs" (Item-No.: 0888-0412) or in the internet under: <http://www.wago.com> → Documentation → WAGO-I/O-SYSTEM 750 → System Description

2.1.1.6 Process Data

Six data bytes are allocated in the process image of the coupler/controller by the DALI/DSI Master Module in the input and output area. The transfer of the data to be delivered and received takes place in 5 input and 5 output bytes. The additional control and status byte of the module is used to perform the data transfer on the internal data bus.

The data of the individual electronic ballasts or sensors are not mapped in the process image of the connected coupler/controller, but tunneled via the DALI commands to the application level to be analysed and processed.

Depending whether the module is operated in a fieldbus node using a PFC or a coupler with higher-level control, different detailed information will be required for accessing and analysing the process data.

2.1.1.6.1 Implementing a PFC (Programming Fieldbus Controller)

IEC 61131-3 function blocks for WAGO-I/O-PRO are available so that the process data can be read out using the controller.

These functions blocks allow for both the Dali commands specified in the standard DIN IEC 60929 and the extended commands to be transmitted and executed.



Further information

Preprogrammed function blocks can be downloaded free of charge from the Internet when implementing the DALI/DSI Master Module together with the IEC 61131-3 programming tool WAGO-I/O-PRO.

These can be found at: **www.wagotoplon.com**.

2.1.1.6.2 Implementing a Coupler with Higher-Level Control

By creating an IEC 61131-3 application for the higher-level control, detailed process image of the module and coding in bytes of the process data is only required when using a coupler.

Six data bytes are allocated in the process image of the coupler/controller by the DALI/DSI Master Module in the input and output area.

The transfer of the data to be delivered and received takes place in 5 input and 5 output bytes. One control byte and one status byte are used to control the data flow.



Further information

The individual commands and the corresponding codings in bytes are described in detail in the sections “Command Sets acc. to DIN IEC 60929“ and “Extended Commands“.

2.1.1.6.2.1 Input Data

Input data					
S	D0	D1	D2	D3	D4
Status byte	DALI response	DALI address	Message 3	Message 2	Message 1

The response of the Control Byte command is displayed in the Input Status byte.

2.1.1.6.2.2 Output Data

Output data					
C	D0	D1	D2	D3	D4
Control byte	DALI command, DSI dimming value	DALI address	Parameter 2	Parameter 1	Command extension

The Control Byte sends output data commands to the module to control functions.

Either a DALI individual address or a group address are recorded in byte D1 of the output data.

The requested command is determined in byte D0.

The selection of commands to be used is determined in byte D4.

If byte D4=0, the DALI standard commands will be used according to DIN IEC 60929. In this case, the parameter bytes D2 and D3 are also equal to 0.

If byte D4≠0, the extended commands which have been saved as macro in the DALI/DSI Master Module will be accessed. The parameter bytes D2 and D3 are used for further extended parameters.

2.1.1.6.2.3 Control and Status Byte

The control byte bitdata is transmitted to the module to perform the function required and the status byte returns the data from the module of the control function. Command requests performed by toggling a bit. An allocated bit in the status shows that the process is finished. This bit takes the value of the request bit.

Control byte							
Bit 0	Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7
TR Transmit Request	RA Receive Accepted	IR Init Request				DALI Active	always=0

Status byte							
Bit 0	Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7
TA Transmit Accepted	RR Receive Request	IA Init Accepted	Actor Error	Frame Error	Bus- Error	Gen. Error	always=0

Bit	Control byte	Status byte	Function
0	TR Transmit Request	TA Transmit Accepted	Data direction control => module (DALI control commands). Handshake for data transfer is completed via this bit. When the state of TR (TA≠TR) is changing, 5 data bytes are loaded from the internal data bus into the internal module buffer. When D4 = 0 (i.e. no command extension is available), the data bytes D0 and D1 are stored in the DALI transmit buffer. If D4 is unequal zero, the command interpreter will have to execute a macro inducing the communication via the DALI bus. This transmission (TA=TR) will be indicated by the module via TA.
1	RA Receive Accepted	RR Receive Request	Data direction module => control (DALI requests) Due to RR changing status (RA≠RR), the module will advise the control that it can provide 5 bytes for transmission. After the transfer of data in the control byte has been acknowledged by the control via RA (RA=RR), the new data can be transmitted or received by the module.
2	IR Init Request	IA=0 Init Accepted	Resetting the module into the default status. The initialization is accomplished only with a rising edge. The acknowledgement IA=1 persists so long, until a new regular command over TR/TA is requested.
3		Actor Error	Lamps or electronic ballasts' errors
4		Frame Error	The Tx/D / Rx/D framing error is set in the event of an error until the next error-free transmission.
5		Bus-Error	The DALI bus error (collision, short circuit or open circuit) may occur in a very short time. The consecutive error is often a frame error. When a short-circuit of duration > 500ms is detected by the module, the module sets the DALI voltage to zero over a period of 5 seconds. Subsequently, the state machine of the module will be set to an initial value.
6		Gen. Error	General module errors, e.g. POST of the internal flash memory, DALI bus error (lasting short-circuit or open circuit), however no electronic ballasts' errors.
	DALI Active		The module suppresses telegrams with the process value 0x00, even if at the same time thereby the bit DALI Active is reset of 1 to 0. For compatibility reasons however only the falling edge is used for suppression.
7			always = 0

2.1.1.6.2.4 DALI Addressing Scheme

Every DALI device (electronic ballast) is able to react to a short address, 16 group addresses and broadcast. Each type of addresses is coded in an address byte.

Address type	Address byte
Short or group address	YAAA AAAS
64 Short addresses	0AAA AAAS
16 Group addresses	100A AAAS
Collective address	111 111S

Y: Address type: Y='0' Short address,
Y='1' Group address or collective address

A: Significant address bit

S: Selection bit: S='0', Direct lamp power value is following
S='1', Command is following in the next byte

2.1.1.6.2.5 Command Sets acc. to DIN IEC 60929 (dated: Draft July 2001)

DALI Commands (Request)

Output Data						
No.	D0	D1	D2	D3	D4	Function
	Command Code	DALI Address	=0	=0	=0	
0	0000 0000	YAAA AAA1	0	0	0000 0000	Off
1	0000 0001	YAAA AAA1	0	0	0000 0000	Up
2	0000 0010	YAAA AAA1	0	0	0000 0000	Down
3	0000 0011	YAAA AAA1	0	0	0000 0000	Step up
4	0000 0100	YAAA AAA1	0	0	0000 0000	Step down
5	0000 0101	YAAA AAA1	0	0	0000 0000	Recall Max – Level
6	0000 0110	YAAA AAA1	0	0	0000 0000	Recall Min – Level
7	0000 0111	YAAA AAA1	0	0	0000 0000	Step down and off
8	0000 1000	YAAA AAA1	0	0	0000 0000	On and step up
9-15	0000 1XXX	YAAA AAA1	0	0	0000 0000	Reserved
16-31	0001 XXXX	YAAA AAA1	0	0	0000 0000	Go to scene 1 - 16
32 *)	0010 0000	YAAA AAA1	0	0	0000 0000	Reset
33 *)	0010 0001	YAAA AAA1	0	0	0000 0000	Store actual Level in the DTR **)
34-41 *)	0010 XXXX	YAAA AAA1	0	0	0000 0000	Reserved
42 *)	0010 1010	YAAA AAA1	0	0	0000 0000	Store the DTR **) as Max – Level
43 *)	0010 1011	YAAA AAA1	0	0	0000 0000	Store the DTR **) as Min – Level
44 *)	0010 1100	YAAA AAA1	0	0	0000 0000	Store the DTR **) as System Failure – Level
45 *)	0010 1101	YAAA AAA1	0	0	0000 0000	Store the DTR **) as Power On Level
46 *)	0010 1110	YAAA AAA1	0	0	0000 0000	Store the DTR **) as Fade Time
47 *)	0010 1111	YAAA AAA1	0	0	0000 0000	Store the DTR **) as Fade Rate
48-63 *)	0011 XXXX	YAAA AAA1	0	0	0000 0000	Reserved
64-79 *)	0100 XXXX	YAAA AAA1	0	0	0000 0000	Store the DTR **) as Scene1 -16
80-95 *)	0101 XXXX	YAAA AAA1	0	0	0000 0000	Remove from Scene 1 - 16
96-111 *)	0110 XXXX	YAAA AAA1	0	0	0000 0000	Add to Group 1 - 16
112 *)	0111 XXXX	YAAA AAA1	0	0	0000 0000	Remove from Group 1 -16
128 *)	1000 0000	YAAA AAA1	0	0	0000 0000	Store the DTR **) as Short Address
129-143	1000 XXXX	YAAA AAA1	0	0	0000 0000	Reserved
144	1001 0000	YAAA AAA1	0	0	0000 0000	Query Status
145	1001 0001	YAAA AAA1	0	0	0000 0000	Query Ballast
146	1001 0010	YAAA AAA1	0	0	0000 0000	Query Lamp Failure
147	1001 0011	YAAA AAA1	0	0	0000 0000	Query Lamp Power On
148	1001 0100	YAAA AAA1	0	0	0000 0000	Query Limit Error

Output Data						
No.	D0 Command Code	D1 DALI Address	D2 =0	D3 =0	D4 =0	Function
149	1001 0101	YAAA AAA1	0	0	0000 0000	Query Reset State
150	1001 0110	YAAA AAA1	0	0	0000 0000	Query Missing Short Address
151	1001 0111	YAAA AAA1	0	0	0000 0000	Query Version Number
152	1001 1000	YAAA AAA1	0	0	0000 0000	Query Content DTR (**)
153	1001 1001	YAAA AAA1	0	0	0000 0000	Query Device Type
154	1001 1010	YAAA AAA1	0	0	0000 0000	Query Physical Min – Level
155	1001 1011	YAAA AAA1	0	0	0000 0000	Query Power Failure
156– 159	1001 11XX	YAAA AAA1	0	0	0000 0000	Reserved
160	1010 0000	YAAA AAA1	0	0	0000 0000	Query Actual Level
161	1010 0001	YAAA AAA1	0	0	0000 0000	Query Max – Level
162	1010 0010	YAAA AAA1	0	0	0000 0000	Query Min – Level
163	1010 0011	YAAA AAA1	0	0	0000 0000	Query Power On – Level
164	1010 0100	YAAA AAA1	0	0	0000 0000	Query System Failure – Level
165	1010 0101	YAAA AAA1	0	0	0000 0000	Query Fade Time / Fade Rate
166– 175	1010 XXXX	YAAA AAA1	0	0	0000 0000	Reserved
176– 191	1011 XXXX	YAAA AAA1	0	0	0000 0000	Query Scene – Level (Scene 1 to 16)
192	1100 0000	YAAA AAA1	0	0	0000 0000	Query Groups 1 to 8
193	1100 0001	YAAA AAA1	0	0	0000 0000	Query Groups 9 to 16
194	1100 0010	YAAA AAA1	0	0	0000 0000	Query Random Address (H)
195	1100 0011	YAAA AAA1	0	0	0000 0000	Query Random Address (M)
196	1100 0100	YAAA AAA1	0	0	0000 0000	Query Random Address (L)
197– 223	110X XXXX	YAAA AAA1	0	0	0000 0000	Reserved
224– 255	11XX XXXX	YAAA AAA1	0	0	0000 0000	Query Application Extended Commands
999	XXXX XXXX	YAAA AAA0	0	0	0000 0000	WAGO specific: Direct Lamp Power Control

*)



Attention

The configuration commands No. 32 to No. 128 must be sent in each case a second time before the execution by the DALI master within the next 100 ms. Between the two commands no further command may be sent to the same addressed electronic ballast.

***) DTR: Data Transfer Register

Response

Response	DALI-Code
„Yes“	1111 1111
„No“	No Answer
8-Bit Information	XXXX XXXX

Input Data						
No.	D0	D1	D2	D3	D4	Function
	DALI Response	DALI Address	Mes- sage 3	Mes- sage 2	Mes- sage 1	
0	-	-	-	-	-	Off
1	-	-	-	-	-	Up
2	-	-	-	-	-	Down
3	-	-	-	-	-	Step up
4	-	-	-	-	-	Step down
5	-	-	-	-	-	Recall Max – Level
6	-	-	-	-	-	Recall Min – Level
7	-	-	-	-	-	Step down and off
8	-	-	-	-	-	On and step up
9-15	-	-	-	-	-	Reserved
16-31	-	-	-	-	-	Go to scene 1 - 16
32	-	-	-	-	-	Reset
33	-	-	-	-	-	Store actual Level in the DTR **)
34-41	-	-	-	-	-	Reserved
42	-	-	-	-	-	Store the DTR **) as Max – Level
43	-	-	-	-	-	Store the DTR **) as Min – Level
44	-	-	-	-	-	Store the DTR **) as System Failure – Level
45	-	-	-	-	-	Store the DTR **) as Power On Level
46	-	-	-	-	-	Store the DTR **) as Fade Time
47	-	-	-	-	-	Store the DTR **) as Fade Rate
48-63	-	-	-	-	-	Reserved
64-79	-	-	-	-	-	Store the DTR **) as Scene1 -16
80-95	-	-	-	-	-	Remove from Scene 1 - 16
96-111	-	-	-	-	-	Add to Group 1 - 16
112	-	-	-	-	-	Remove from Group 1 -16
128	-	-	-	-	-	Store the DTR **) as Short Address
129-143	-	-	-	-	-	Reserved
144	Bit 0=,0'=OK, Ballast Bit 1=,0'=OK, Lamp Failure Bit 2=,0'=Off, Lamp Power On Bit 3=,0'=Off, Limit Error Bit 4=,0'=Terminate Fading, Bit 5=,0'=No, Reset State Bit 6=,0'=No, Missing Short Address Bit 7=,0'=No, Power Failure	YAAA AAA1	-	-	-	Query Status
145	,Yes' or ,No'	YAAA AAA1	-	-	-	Query Ballast
146	,Yes' or ,No'	YAAA AAA1	-	-	-	Query Lamp Failure
147	,Yes' or ,No'	YAAA AAA1	-	-	-	Query Lamp Power On
148	,Yes' or ,No'	YAAA AAA1	-	-	-	Query Limit Error
149	,Yes' or ,No'	YAAA AAA1	-	-	-	Query Reset State
150	,Yes' or ,No'	YAAA AAA1	-	-	-	Query Missing Short Address
151	8-Bit Value; Bit 0-3= Major Version Bit 0-3= Minor Version	YAAA AAA1	-	-	-	Query Version Number
152	8-Bit Number	YAAA AAA1	-	-	-	Query Content DTR **)
153	8-Bit Number, X=0-255; Standard Type='0'	YAAA AAA1	-	-	-	Query Deviec Type
154	8-Bit Number	YAAA AAA1	-	-	-	Query Physical Min – Level
155	,Yes', if no reset command or if after last switching on	YAAA AAA1	-	-	-	Query Power Failure

Input Data						
No.	D0	D1	D2	D3	D4	Function
	DALI Response	DALI Address	Mes- sage 3	Mes- sage 2	Mes- sage 1	
	no certain Lamp Power On command was received.					
156–159	-	YAAA AAA1	-	-	-	Reserved
160	8-Bit Number	YAAA AAA1	-	-	-	Query Actual Level
161	8-Bit Number	YAAA AAA1	-	-	-	Query Max – Level
162	8-Bit Number	YAAA AAA1	-	-	-	Query Min – Level
163	8-Bit Number	YAAA AAA1	-	-	-	Query Power On – Level
164	8-Bit Number	YAAA AAA1	-	-	-	Query System Failure – Level
165	XXXX YYYY X= Number of command 46; Y= Number of command 47	YAAA AAA1	-	-	-	Query Fade Time / Fade Rate
166–175	-	YAAA AAA1	-	-	-	Reserved
176–191	Lamp Power Level of the Scene XXXX as 8-Bit Number	YAAA AAA1	-	-	-	Query Scene – Level (Scene 1 to 16)
192	One bit for each Group. LSB= Group 0 ,0'is not associated to the Group, ,1'is associated to the Group	YAAA AAA1	-	-	-	Query Groups 1 to 8
193	One bit for each Group. LSB= Group 9 ,0'is not associated to the Group, ,1'is associated to the Group	YAAA AAA1	-	-	-	Query Groups 9 to 16
194	The upper 8 bits of the Random Address	YAAA AAA1	-	-	-	Query Random Address (H)
195	The middle 8 bits of the Random Address	YAAA AAA1	-	-	-	Query Random Address (M)
196	The lowest 8 bits of the Random Address	YAAA AAA1	-	-	-	Query Random Address (L)
197–223	-	YAAA AAA1	-	-	-	Reserved
224–255	-	-	-	-	-	Query Application Extended Commands
999	-	-	-	-	-	WAGO specific: Direct Lamp Power Control

**) DTR: Data Transfer Register

2.1.1.6.2.6 Extended Commands

Commands (Request)

Output Data						
No.	D0	D1	D2	D3	D4	Function
	DALI Command, DSI Fade Value	DALI Address	Parameter 2	Parameter 1	Command Extension	
1		YAAA AAA1	0100 XXXX	Value	0x01	Store Scene/Parameter
1		1AAA AAA1	0110 XXXX - 0111 XXXX	-	0x01	Assign Group/Store
1	-	YAAA AAA1	0010 1110	Value	0x01	Store Fade Time
1	-	YAAA AAA1	0010 1111	Value	0x01	Store Fade Rate
1	-	YAAA AAA1	0010 1010	Value	0x01	Store Max Level
1	-	YAAA AAA1	0010 1011	Value	0x01	Store Min Level
1	-	YAAA AAA1	0010 1100	Value	0x01	Store System Failure Level
1	-	YAAA AAA1	0010 1101	Value	0x01	Store Power On Level
2	-	-	-	0	0x02	Complete New Addressing
2	-	-	-	Address	0x02	New Addressing Short Address
2	-	-	-	1111 1111	0x02	New Addressing extends
3	-	0AAA AAA1	-	-	0x03	Delete Short Address
4	-	1AAA AAA1 (old Address)	1AAA AAA1 (new Address)	-	0x04	Replace Short Address
5	-	YAAA AAA1	-	1-255	0x05	Blink Show Address [sec]
6	-	-	-	-	0x06	Query Short Address available [0-31]
7	-	-	-	-	0x07	Query Short Address available [32-63]
8	-	-	-	-	0x08	Query State Ballast [0-31]
9	-	-	-	-	0x09	Query State Ballast [32-63]
10	-	-	-	-	0x0A	Query Lamp Failure [0-31]
11	-	-	-	-	0x0B	Query Lamp Failure [32-63]
12	-	-	-	-	0x0C	Query Lamp Power On [0-31]
13	-	-	-	-	0x0D	Query Lamp Power On [32-63]
14	-	-	-	0x01(DALI) 0x02(DSI)	0x0E	Setting DALI/DSI Mode and Polling
15	-	-	-	-	0x0F	Reset
16	-	-	-	0x40 – 0x4F	0x10	Store Scene – Level
17	-	-	0xFF 0x03	0xFF 0xE8	0x11	Deactivate automatic polling Activate automatic polling
18	-	-	YYYYXXX X X = Device Type Y = repeat	DALI Command	0x12	Sending the DEVICE type specific DALI commands
19	-	-	-	-	0x13	Responds on QUERY ACTUAL LEVEL devices 56 to 59
20	-	-	-	-	0x14	Responds on QUERY ACTUAL LEVEL devices 60 to 63
21	-	-	Break between two QUERY commands * x 2 ms 0xFF = OFF	Number of short addresses (1 - 8)	0x15	Set the Level Polling Period
22	-	-	-	-	0x16	Request on the Level Polling Period
23	-	-	-	-	0x17	Request on the Hardware and Software version
36	-	-	-	-	0x24	Fast request on the network status

Response

Input data						
No.	D0 DALI Response	D1 DALI Address	D2 Message 3	D3 Message 2	D4 Message 1	Function
1	-	-	-	-	-	Store Scene/Parameter
1	-	-	-	-	-	Assign Group/Store
1	-	-	-	-	-	Store Fade Time
1	-	-	-	-	-	Store Fade Rate
1	-	-	-	-	-	Store Max Level
1	-	-	-	-	-	Store Min Level
1	-	-	-	-	-	Store System Failure Level
1	-	-	-	-	-	Store Power On Level
2	-	-	-	-	-	Complete New Addressing
2	-	-	-	-	-	New Addressing Short Address
2	-	-	-	-	-	New Addressing extends
3	-	-	-	-	-	Delete Short Address
4	-	-	-	0x01 OK 0xF1 Add. unknown 0xF2 Add. assign	-	Replace Short Address
5	-	-	-	-	-	Blink Show Address [sec]
6	Address 0-7	-	Address 8-15	Address 16-23	Address 24-31	Query Short Address available [0-31]
7	Address 32-39	-	Address 40-47	Address 48-55	Address 56-63	Query Short Address available [32-63]
8	Address 0-7	-	Address 8-15	Address 16-23	Address 24-31	Query State Ballast [0-31]
9	Address 32-39	-	Address 40-47	Address 48-55	Address 56-63	Query State Ballast [32-63]
10	Address 0-7	-	Address 8-15	Address 16-23	Address 24-31	Query Lamp Failure [0-31]
11	Address 32-39	-	Address 40-47	Address 48-55	Address 56-63	Query Lamp Failure [32-63]
12	Address 0-7	-	Address 8-15	Address 16-23	Address 24-31	Query Lamp Power On [0-31]
13	Address 32-39	-	Address 40-47	Address 48-55	Address 56-63	Query Lamp Power On [32-63]
14	-	-	-	-	-	Setting DALI/DSI Mode and Polling
15	-	-	-	-	-	Reset
16	-	-	-	-	-	Store Scene – Level
17	-	-	-	-	-	Store Polling Period
18	-	-	-	-	-	Send the requested DALI command
19	Address 57	-	Address 58	Address 59	Address 60	Response on QUERY ACTUAL LEVEL devices 56 to 59
20	Address 61	-	Address 62	Address 63	Address 64	Response on QUERY ACTUAL LEVEL devices 60 to 63
21	-	-	-	-	-	Setting Level Polling Period
22	-	-	Number of polled sensors	Sensor Polling time x * 2 ms	Number of found sensors	Request on the Level Polling Period
23	-	-	-	Software version	Hardware version	Request on the Hardware and Software version
36	-	-	-	-	-	Fast request on the network status

0=No/
1=Yes
0=No/
1= Yes
0=OK/
1=Error
0=OK/
1= Error
0=OK/
1= Error
0=Off/
1=On
0=Off/
1=On

2.1.1.6.2.7 Description of Extended Commands

- **0x01 Store Scene/Parameter (Set_Various_Level)**

This macro allows the DALI storage algorithms to be processed according to the following pattern: Load "Parameter 1" into DTR and store DTR as "Parameter 2", repeat storage command. For example, 'Parameter 2' may be 'MAX LEVEL' or 'FADE TIME'.

- **0x02 New Addressing (Generate_Short_Address)**

Automatic address allocation using the random electronic ballast long addresses. Algorithm according to DIN 60929 E.4.3.4. The macro is awaiting for a parameter 1 describing the type of initialisation (low byte of DALI command 258).

- 0x00 all lamps will be initialized
- 0Adr1 lamps with address 'Adr' will be initialized
- 0xff lamps without short address will be initialized

All search addresses used in the algorithm are sent back on the return channel (message 3 - 5). When a short address is allocated, the lamps assigned to this address are lighting. When performing a system extension (Parameter 1 = 0xff), it is necessary to check if the short address has already been allocated before assigning the short addresses by polling the slaves. Newly allocated short addresses will be immediately transferred to the present register. The macro stops when no long addresses can be found or when the slave address exceeds number 63.

Parameter 2 contains information about the behaviour of addressed electronic ballasts:

- Bit 0: 0 =electronic ballast is controlled brightly after the address assignment
 1 = electronic ballast remains unchanged after the address assignment
- Bit 1...7 reserved

- **0x03 Delete Short Address (Delete_Short_Address)**

Delete the short address (DALI addr.) of one single ballast or all ballasts (DALI address = 0xFF, broadcast). The present registers will be updated.

- **0x04 Replace Short Address (Replace_Short_Address)**

Replace the short address (DALI addr.) of the ballasts by a new short address which has not been allocated yet (Parameter 2). Responses to 'Message 4':

- 0xf1: old address not available
- 0xf2: new address already allocated
- 0x01: replacement was successful

- **0x05 Blink Show Address (Blink)**

Initiate cyclical blinking of the ballasts with the assigned address (individual ballast, group or all). If no further parameter is assigned, the ballasts are blinking 5 times.

With Parameter 1 the number of flashing sequences can be determined. With Parameter 2 the period duration is adjusted.

- D1 DALI Address
- D2 Parameter 2: Duration of one flashing period, resolution: ~600ms (300ms ON, 300ms OFF), 0x00 = 1 s (default), 0xFF = Switching on one time
- D3 Parameter 1: Number of flashing sequences (1...0xFF, 0x00 = 5 (default))
- D4 0x05 Blink

- **0x06 Query Short Address available [0-31] (Request_Present_Bit_Low)**

Requesting the low present register

- Return channel byte 1: Present bits of ballasts 1 up to 8
- Return channel byte 3: Present bits of ballasts 9 up to 16
- Return channel byte 4: Present bits of ballasts 17 up to 24
- Return channel byte 5: Present bits of ballasts 25 up to 32

- **0x07 Query Short Address available [32-63] (Request_Present_Bit_High)**

Requesting the high present register

- Return channel byte 1: Present bits of ballasts 33 up to 40
- Return channel byte 3: Present bits of ballasts 41 up to 48
- Return channel byte 4: Present bits of ballasts 49 up to 56
- Return channel byte 5: Present bits of ballasts 57 up to 64

- **0x08 Query State Ballast [0-31]**
(Request_Ballast_Status_Bit_Low)

Requesting the low ballast status register

- Return channel byte 1: Ballast error bits of ballasts 1 up to 8
- Return channel byte 3: Ballast error bits of ballasts 9 up to 16
- Return channel byte 4: Ballast error bits of ballasts 17 up to 24
- Return channel byte 5: Ballast error bits of ballasts 25 up to 32

- **0x09 Query State Ballast [32-63]**
(Request_Ballast_Status_Bit_High)

Requesting the high ballast status register

- Return channel byte 1: Ballast error bits of ballasts 33 up to 40
- Return channel byte 3: Ballast error bits of ballasts 41 up to 48
- Return channel byte 4: Ballast error bits of ballasts 49 up to 56
- Return channel byte 5: Ballast error bits of ballasts 57 up to 64

- **0x0A Query Lamp Failure [0-31]**
(Request_Lamp_Failure_Bit_Low)

Requesting the low lamp status register

- Return channel byte 1: Lamp error bits of ballasts 1 up to 8
- Return channel byte 3: Lamp error bits of ballasts 9 up to 16
- Return channel byte 4: Lamp error bits of ballasts 17 up to 24
- Return channel byte 5: Lamp error bits of ballasts 25 up to 32

- **0x0B Query Lamp Failure [32-63]**
(Request_Lamp_Failure_Bit_High)

Requesting the high lamp status register

- Return channel byte 1: Lamp error bits of ballasts 33 up to 40
- Return channel byte 3: Lamp error bits of ballasts 41 up to 48
- Return channel byte 4: Lamp error bits of ballasts 49 up to 56
- Return channel byte 5: Lamp error bits of ballasts 57 up to 64

- **0x0C Query Lamp Power On [0-31]
(Request_Lamp_ArcPowerOn_Bit_Low)**

Requesting the low lamp status register

- Return channel byte 1: PowerOn bits of ballasts 1 up to 8
- Return channel byte 3: PowerOn bits of ballasts 9 up to 16
- Return channel byte 4: PowerOn bits of ballasts 17 up to 24
- Return channel byte 5: PowerOn bits of ballasts 25 up to 32

- **0x0D Query Lamp Power On [32-63]
(Request_Lamp_ArcPowerOn_Bit_High)**

Requesting the high lamp status register

- Return channel byte 1: PowerOn bits of ballasts 33 up to 40
- Return channel byte 3: PowerOn bits of ballasts 41 up to 48
- Return channel byte 4: PowerOn bits of ballasts 49 up to 56
- Return channel byte 5: PowerOn bits of ballasts 57 up to 64

- **0x0E Setting DALI/DSI Mode and Polling (Set_Feature_Reg)**

Parameter 1 = 0x01: The DALI mode is activated,
polling period is set to default value.

Parameter 1 = 0x02: The DSI mode is activated,
polling is deactivated.

- **0x0F Reset (Reset)**

Double execution of the RESET command with subsequent waiting time (500ms).

- **0x10 Store Scene Level (Store_Actual_Level_As_Scene)**

Write the actual lamp value into the DTR and transfers this value as scene value with the scene number including command number into the variable ,Parameter 2'.

- **0x11 Store the Polling Period (Set_Polling_Period)**

Store the compound value from Parameter 1 = D3 = Highbyte and Parameter 2 = D2 = Lowbyte as ,Polling Period' in register 39.

- **0x12 Send the requested DALI command
(Exec_Device_Type_Dependent_Commands)**

This makro sends the DALI Command '1100 0001 0000 XXXX' and afterwards the requested DALI Command of Byte 3.

Parameter "Retry" indicates, how often the DALI Command is to be sent:

- D1 DALI Address
- D2 Parameter 2: e. g. DALI Command 224...255
- D3 Parameter 1: YYYYXXXX: Retry(Y), Device Type(X)
- D4 0x12 =Exec Device Type Dependent Commands

- **0x13 Response on QUERY ACTUAL LEVEL devices 56 to 59
(Request_Level_56_59)**

Responses on QUERY ACTUAL LEVEL of the devices 56 to 59

- Backward channel Byte 1: Level 56 (Init: 0xFF)
- Backward channel Byte 3: Level 57 (Init: 0xFF)
- Backward channel Byte 4: Level 58 (Init: 0xFF)
- Backward channel Byte 5: Level 59 (Init: 0xFF)

- **0x14 Response on QUERY ACTUAL LEVEL devices 60 to 63
(Request_Level_60_63)**

Responses on QUERY ACTUAL LEVEL of the devices 60 to 63

- Backward channel Byte 1: Level 60 (Init: 0xFF)
- Backward channel Byte 3: Level 61 (Init: 0xFF)
- Backward channel Byte 4: Level 62 (Init: 0xFF)
- Backward channel Byte 5: Level 63 (Init: 0xFF)

- **0x15 Setting Level Poll Period (Set_Level_Polling_Period)**

Inverse function to 0x16

Parameter 1 contains the Level Poll Period in ms * 2 (30ms ... 2540ms), 0xFF = Off/Default

Parameter 2 contains the number of devices polled with QUERY ACTUAL LEVEL. The address range is descending of address 63.

- D1 DALI Address
- D2 Parameter 2: Number of devices (1...8, backwards in the address range 63...56)
- D3 Parameter 1: Level Polling Period in msec * 2 (3...0xFF, 0xFF = Off/Default)
- D4 0x15 Set Level Polling Period

- **0x16 Request on the Level Poll Period (Request_Level_Polling_Period)**

Inverse function to 0x15

Backward channel Byte 4: contains the Level Poll Period in msec * 2 (30 ms ... 2540 ms), 0xFF = Off/Default

Backward channel Byte 3: contains the number of devices, polled with QUERY ACTUAL LEVEL. The address range is descending of address 63.

- D1 DALI Address
- D2 Backward channel Byte 3: Number of activated devices (1...8, backwards in the address range 63...56)
- D3 Backward channel Byte 4: Level Polling Period in msec * 2 (3...0xFF, 0xFF = Off/Default)

- **0x17 Request on the Hardware and Software version (Request_SW_HW_Version)**

Request on the software and hardware release of the I/O module

- Backward channel Byte 5: hardware version
- Backward channel Byte 4: software version

- **0x24 Fast request on the network status (Fast_Poll)**

Briefly accelerated request via QUERY STATUS for the fast determination of the status of the complete DALI network.

2.1.1.7 Installation Notes

2.1.1.7.1 Module Supply



Attention

The WAGO DC/DC Converter, Item-No.: 288-895, must be used when providing the module with DALI and DSI compliant 18 V supply. The converter guarantees the electrical isolation between the DALI bus and the internal data bus, which is required when using 230V consumer loads. The internal power supply unit of the DALI/DSI Master module cannot be decommissioned when using an external power supply unit.



Attention

In order to meet the EMC regulations, the DC/DC converter must be connected to ground using the appropriate FE- connection (S) on the rail.

The length of the power supply cable between the DC/DC converter and the module must not exceed 1 meter. Both devices must be installed in an enclosure.

Fig. 2.1.1-4 : Wiring diagram using three DALI/DSI Master modules

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2.1.1.7.2 Module Assembly

Depending on the program functionality up to five DALI/DSI Master modules can be connected in a fieldbus node.

Up to 400 mA can be delivered using a single DC/DC Converter 288-895. As a result, the converter can supply three DALI modules in full extension, that means each module is wired with a maximum of 64 electronic ballasts à 2mA ≈ 130mA.

An additional DC/DC Converter 288-895 is required to supply the other DALI/DSI Master modules within the fieldbus node.



Note

The DALI/DSI Master module has no power jumper contacts. The field supply potential of the adjacent I/O modules in the node will not be passed to the following modules. A supply module is therefore required to provide any additional I/O modules.



Danger

It is not allowed to remove a live module.

2.1.1.7.3 DALI Bus Line

The DALI bus control line consists of one pair of conductors which can be run together with the 230 V installation.

For example, a 5-conductor cable can be used combining both the voltage supply and the DALI control line.

The minimum cross section of the conductors depends on the cable length.

Cable length	Conductor cross section min.
< 100 m	0.5 mm ²
100 m - 150 m	0.75 mm ²
> 150 m	1.5 mm ²



Attention

The maximum voltage drop of the DALI line should not exceed 2 V. Therefore, the maximum cable length between the more distant components is limited to 300 m.

2.1.1.7.4 DALI Bus Topology

A DALI Master can control a line with a maximum of 64 slaves consuming 2 mA each. 16 separate groups and 16 separate scenes can be allocated to each slave.

The topology of the DALI bus is not defined. Line, tree, star or mixed structures are possible. However, ring structures should be avoided.

The same installation regulations apply for both lighting equipments and power supply cables.

This also applies to the installation of special rooms (“harmonized installation regulations“).

Fig. 2.1.1-5 : Example of DALI topology

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2.1.1.7.5 DALI Addressing

The DALI/DSI Master module is used as interface between DALI slaves and other components in building management applications.

The logical assignment between sensors, control elements and DALI devices is done by the fieldbus controller or the coupler's higher-level control.

The devices are controlled by individual addresses (short addresses) whereas individual groups are controlled by group addresses. Controlling all devices at the same time is made possible by broadcast addressing.

Using DALI, up to 64 short addresses, 16 group addresses and 16 scene light values can be defined.

Addresses assignment is done using the software so that the system configuration can be modified without changing the installation.

When activated by the PLC application, the electronic ballasts generate themselves an coincidental long address of 24 bit. The module searches the electronic ballast with the lowest long address in the network and assigns to this the first free short address. This procedure is repeated until all electronic ballasts are addressed. By the coincidental long addresses also the short addresses are arranged in coincidental order. Assignment is done using the addressing commands implemented in the module.

2.1.1.7.6 DALI Parameters

The settings and light values stored in an electronic ballast can be programmed using the DALI commands.

Parameters:
• Individual address
• Group assignment/s
• Operating margins of the lamp (e.g. minimum and maximum levels)
• Light scene values
• Fade rate
• System failure level
• Power on level

The electronic ballasts are provided with a logarithmic dimming curve so that adaptation to the eye sensitivity can be achieved.

Emergency operation settings will be automatic if the data line is interrupted.

Additionally the status inquiry and the error message of electronic ballasts are possible. This is very important for the building management, e.g. with LON, and can take place according to the addressing via DALI-commands, from individual electronic ballast, or via Extended Commands, by groups.



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