X20CS1013

1 General information

The module is a DALI control device with an integrated power supply. Up to 64 operating devices can be connected.

DALI stands for Digital Addressable Lighting Interface and enables easy and safe control of light fixtures using a standardized digital operating device interface. The DALI bus conforms with EN 62386 series of standards and is now supported by many electronic ballast manufacturers.

- Integrated power supply
- Up to 64 operating devices (individual addresses)
- Up to 16 groups (group addresses)
- Up to 16 scenes (scene lighting values)

1.1 Other applicable documents

For additional and supplementary information, see the following documents.

Other applicable documents

Document name	Title
MAX20	X20 system user's manual
MAEMV	Installation / EMC guide

2 Order data

Order number	Short description	Figure
	X20 electronics module communication	
X20CS1013	X20 interface module, 1 DALI master interface	
	Required accessories	
	Bus modules	
X20BM11	X20 bus module, 24 VDC keyed, internal I/O power supply connected through	
X20BM15	X20 bus module, with node number switch, 24 VDC keyed, internal I/O power supply connected through	
	Terminal blocks	
X20TB06	X20 terminal block, 6-pin, 24 VDC keyed	
X20TB12	X20 terminal block, 12-pin, 24 VDC keyed	

Table 1: X20CS1013 - Order data

3 Technical description

3.1 Technical data

Order number	X20CS1013
Short description	
Communication module	DALI master
General information	
B&R ID code	0xDE85
Diagnostics	
Module status	Yes, using LED status indicator and software
Bus status	Yes, using LED status indicator and software
Power consumption	
Bus	0.2 W
Internal I/O	0.4 W
Additional power dissipation caused by actuators (resistive) [W]	4 W
Insulation voltages	
Channel - Bus	510 VAC / 1 minute
Certifications	
CE	Yes
ATEX	Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X
UL	cULus E115267 Industrial control equipment
HazLoc	cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5
EAC	Yes
DALI bus	
Insulation system	Basic insulation
Open-circuit voltage	16.5 V ±5%
Short-circuit proof	Yes (current limiting)
Signal voltage	
Low	-6.5 V to 6.5 V (typically 0 V)
High	11.5 V to 20.5 V (typically 16 V)
Signal current	
Low	≤250 mA (internally limited)
High	≤130 mA at voltage ≥11.5 V
Transfer rate	1200 baud
Maximum number of slaves	64
Data signal slew rate (Manchester bi-phase)	
Falling edge	10 µs ≤ t_{fall} ≤ 100 µs
Rising edge	10 µs ≤ t_{rise} ≤ 100 µs
Electrical properties	
Electrical isolation	Channel isolated from bus
Operating conditions	
Mounting orientation	
Horizontal	Yes
Vertical	Yes
Installation elevation above sea level	
0 to 2000 m	No limitation
>2000 m	Reduction of ambient temperature by 0.5°C per 100 m
Degree of protection per EN 60529	IP20
Ambient conditions	
Temperature	
Operation	
Horizontal mounting orientation	-25 to 60°C
Vertical mounting orientation	-25 to 50°C
Derating	-
Storage	-40 to 85°C
Transport	-40 to 85°C
Relative humidity	
Operation	5 to 95%, non-condensing
Storage	5 to 95%, non-condensing
Transport	5 to 95%, non-condensing
Mechanical properties	
Note	Order 1x terminal block X20TB06 or X20TB12 separately. Order 1x bus module X20BM11 separately.
Pitch	$12.5^{+0.2}$ mm

Table 2: X20CS1013 - Technical data

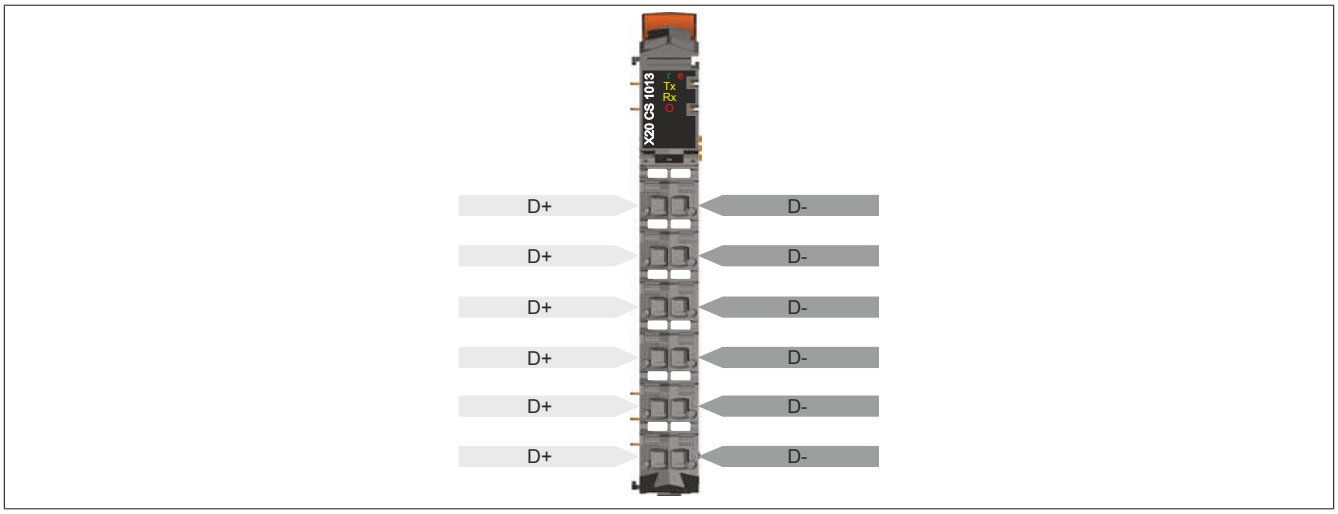
3.2 LED status indicators

For a description of the various operating modes, see section "Additional information - Diagnostic LEDs" in the X20 system user's manual.

Figure	LED	Color	Status	Description
	r	Green	Off	No power to module
			On	RUN mode
			Double flash	BOOT mode (during firmware update)[1)]
	e	Red	Off	No power to module or everything OK
			On	Error status
	Tx	Yellow		Control device (master) transmitting
	Rx	Yellow		Operating device (slave) responding
	O	Red		Error status: Overload or short circuit

1) Depending on the configuration, a firmware update can take up to several minutes.

3.3 Pinout



3.4 Using an external power supply

Since the internal DALI power supply provides sufficient power for a configuration with up to 64 slaves, the module is not designed for an external power supply.

Warning!

Using an additional DALI power supply may result in damage to the module.

4 Register description

4.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "Additional information - General data points" in the X20 system user's manual.

4.2 Function model 0 - default

Register	Name	Data type	Read		Write	
			Cyclic	Acyclic	Cyclic	Acyclic
258	Dali_State	UINT	•			
263	Dali_RequestCounter	USINT	•			
261	Dali_AnswerCounter	USINT	•			
265	Dali_Answer	USINT	•			
257	Dali_Enable	USINT			•	
262	Dali_Control	UINT			•	
265	Dali_Address	USINT			•	
267	Dali_Command	USINT			•	

4.3 Function model 254 - Bus controller

Register	Offset[1)]	Name	Data type	Read		Write	
				Cyclic	Acyclic	Cyclic	Acyclic
258	0	Dali_State	UINT	•			
263	3	Dali_RequestCounter	USINT	•			
261	2	Dali_AnswerCounter	USINT	•			
265	4	Dali_Answer	USINT	•			
257	0	Dali_Enable	USINT			•	
262	2	Dali_Control	UINT			•	
265	4	Dali_Address	USINT			•	
267	5	Dali_Command	USINT			•	

1) The offset specifies the position of the register within the CAN object.

4.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see section "Additional information - Using I/O modules on the bus controller" in the X20 user's manual (version 3.50 or later).

4.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

4.4 General information

DALI stands for Digital Addressable Lighting Interface and is mainly used to control lighting systems. The communication standard is intended for building automation systems and described in the EN 62386 series of standards.

4.4.1 The DALI protocol

The DALI standard specifies bidirectional communication based on the "request and answer" principle. A DALI network may contain multiple masters. The serial asynchronous interface transmits voltage signals at a transfer rate of 1200 bits/s.
According to the DALI standard, up to 64 individual addresses can be assigned on the network. In addition, all of the slaves in the network can be addressed via broadcast and group addresses. 16 different group addresses can be assigned independently of the individual slave addresses. This makes it possible to send a command to multiple slaves at the same time.

4.5 DALI - Communication

The module provides the user with a channel for communicating with and controlling DALI slaves in a DALI network.

The multi-master mode described in the DALI standard is accepted by the module but not actively supported.

4.5.1 Communication in the DALI network

The module supports all commands defined in the DALI standard.

Communication in the DALI network takes place using the 2 bytes of the following registers:

- "Address of the DALI slave" on page 5
- "Direct or indirect command for receiver" on page 5

Some commands are described in the DALI specification with the structure "YAAA AAAS XXXX XXXX". In order to translate this representation to the B&R interface, the two registers "DALI_Address" and "DALI_Command" must be viewed with "Byte" as the unit.

Dali_Address								Dali_Command							
MSB	6	5	4	3	2	1	0	LSB	6	5	4	3	2	1	0
↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
Y	A	A	A	A	A	A	S	X	X	X	X	X	X	X	X

Key

Y	Address type
A	Address
S	Command type
X	Command

4.5.1.1 Address of the DALI slave

Name:
Dali_Address

This register provides the module with the address of the DALI slave being addressed. It also defines the address type (single or group address) and command type (direct or indirect command).

Data type	Value	
USINT	0 to 159	Single or group address for direct or indirect command
	254	Broadcast address for direct DALI command
	255	Broadcast address for indirect DALI command

Bit structure:

Bit	Name	Value	Information
0	Type of the subsequent command	0	Direct DALI command
		1	Indirect DALI command
1 - 6	Address	0 to 63	Address of an individual slave
		0 to 15	Address of a group of slaves
7	Type of the subsequent address	0	Addressing of an individual slave
		1	Addressing of a group of slaves

4.5.1.2 Direct or indirect command for receiver

Name:
Dali_Command

This register provides the module with the direct or indirect command for the receiver in the DALI network.

Data type	Value	Information
USINT	0 to 255	DALI or slave-specific command

4.5.2 Status in the DALI network

Name:
Dali_State

This register is used to indicate the current status of the DALI network.

Data type	Value
UINT	See bit structure.

Bit structure:

Bit	Name	Value	Information
0	Enables/Disables the level converter	0	Communication off
		1	Communication on
1	Status of the last request	0	Valid request not yet sent
		1	Transmit procedure successful
2	Status of the last response	0	No response since the last request
		1	Receive procedure successful
3	Collision (multi-master)	0	No collision
		1	Collision in the DALI network
4 - 7	Reserved	-	
8	Transmit error	0	No error
		1	Transmit procedure failed
9	Receive error	0	No error
		1	Invalid response received
10	TX busy	0	No transmission activity
		1	Transmission taking place
11	RX busy	0	No receiving activity
		1	Receiving taking place
12 - 15	Reserved	-	

4.5.3 Transmission counter

Name:
Dali_RequestCounter

This register provides the user with information about how many DALI messages have already been sent by the module.

Data type	Value
USINT	0 to 255

4.5.4 Response counter

Name:
Dali_AnswerCounter

This register provides the user with information about how many DALI messages have already been received by the module.

Data type	Value
USINT	0 to 255

4.5.5 Response from DALI network

Name:
Dali_Answer

This register provides the user with access to the last valid response from the downstream DALI network.

Data type	Value
USINT	0 to 255

4.5.6 Enabling the communication channel

Name:
Dali_Enable

This register is used to enable or disable the communication channel.

Data type	Value
USINT	See bit structure.

Bit structure:

Bit	Name	Value	Information
0	Turn communication on/off (via software)	0	Turn communication channel off
		1	Turn communication channel on
1	Turn power saving mode on/off	0	Supply DALI network
		1	Turn internal power supply for the module off
2 - 7	Reserved	-	

Information:

for communication in the DALI network, the internal power supply in the module must be turned on.

4.5.7 Controlling the DALI module

Name:
Dali_Control

This register is used to control the module. The respective command is transported via X2X Link and then executed by the module. The register is edge-triggered (i.e. this type of command is only triggered if the state of the respective bit changes).

Data type	Value
UINT	See bit structure.

Bit structure:

Bit	Name	Value	Information
0	Requests command (pos. edge)	0	No action
		1	Transmits request in the DALI network
1	Reserved	-	
2	Acknowledges the status byte (pos. edge)	0	No action
		1	Resets the status byte
3	Acknowledges the transmission counter (pos. edge)	0	No action
		1	Resets the transmission counter
4	Acknowledges the response counter (pos. edge)	0	No action
		1	Resets the response counter
5 - 15	Reserved	-	

4.6 Excerpt from the DALI specification

4.6.1 General

The DALI standard involves 2 different command types. Direct commands control the brightness of the lights on the DALI slave being addressed. This type of communication runs only from the master to the slave.

Setting the LSB in the address register will use the included command for independent digital communication. The commands are also transferred from the master to the slave. Some requests require a response from the slave. In this case, communication from the slave to the master must also be possible.

4.6.2 Direct DALI commands (ARC)

These commands can be used to directly set the brightness of each DALI slave. The statements 1 to 254 correspond to a brightness of the connected DALI slave based on the following formula:

$$P = 10^{\frac{Value - 1}{253 / 3}} * \frac{P_{max}}{1000}$$

Command 0 can also be transmitted to switch off a DALI slave. In this case, the brightness decreases slowly at first and then shuts off when a critical power level is crossed.

Command 255 serves as an internal mask value. It is not applied by the DALI slave, which means it has no effect on its behavior.

4.6.3 Indirect DALI commands for lamp wattage

Indirect commands make digital communication possible on the DALI network. In addition to the commands defined in the DALI standard, some manufacturers of DALI slaves also define their own commands.

Selected standardized DALI commands

Source: EN 62386-102:2009

Code (dec.)	Function
Indirect control commands	
0	Switches off the light immediately – No smooth transition
1	200 ms dimming up – Possible to configure the dimming speed separately – No further change once maximum is reached – Command ignored when light is off
2	200 ms dimming down – Possible to configure the dimming speed separately – No further change once minimum is reached – Command does not turn light off
3	Increases the brightness by one step – No smooth transition – No further change once maximum is reached – Command ignored when light is off
4	Decreases the brightness by one step – No smooth transition – No further change once minimum is reached – Command does not turn light off
5	Maximum brightness – No smooth transition – Turns the light on
6	Minimum brightness – No smooth transition – Turns the light on
7	Decrease brightness by one step (including switching off) – No smooth transition – Command can turn light off
8	Increase brightness by one step (including switching on) – No smooth transition – Switches on a switched-off light
9	Commence DACP sequence – Starts direct power control – Dimming speed adjusted dynamically by the control device – DACP sequence required at the end
10 - 15	Reserved
16 - 31	Enables scene 0 to 15 – Power regulated to the level stored in the scene

4.6.4 Indirect DALI commands for configuration

Indirect commands make digital communication possible on the DALI network. In addition to the commands defined in the DALI standard, some manufacturers of DALI slaves also define their own commands.

Information:

Some indirect DALI commands must be repeated within 100 ms. The module does not evaluate specified addresses and commands, which means this repetition must be ensured by the application.

Selected standardized DALI commands

Source: EN 62386-102:2009

Code (dec.)	Function	Response
Configuration commands[1)]		
32	Resets nonvolatile memory – DALI slave requires up to 300 ms for execution	
33	Reads out the current power level – Stores the current power value in the DTR – Command code 152 required	
34 - 41	Reserved	
Save DTR value[1)]		
42	Save as maximum power value	
43	Save as minimum power value	
44	Save power value as value for event of error	
45	Save power value as switch-on value	
46	Save value as dimming time	
47	Save value as dimming speed	
48 - 63	Reserved	
Used for setting system parameters[1)]		
64 - 79	Save DTR value as selected scene 0 to 15 – Scene number = Command number - 64	
80 - 95	Removes DALI slave from scene 0 to 15 – Scene number = Command number - 80	
96 - 111	Adds DALI slave to group 0 to 15 – Group number = Command number - 96	
112 - 127	Removes DALI slave from group 0 to 15 – Group number = Command number - 112	
128	Save DTR value as short address	
129 - 143	Reserved	
Request commands		
144	Checks the general status	**Bit / Value / Function** 0 / 0 / DALI slave status OK 0 / 1 / DALI slave status not OK 1 / 0 / Light status OK 1 / 1 / Light status not OK 2 / 0 / Light off 2 / 1 / Light on 3 / 0 / Last requested power level permissible 3 / 1 / Last requested power level not permissible 4 / 0 / Last dimming procedure complete 4 / 1 / Dimming procedure not yet complete 5 / 0 / DALI slave not in reset state 5 / 1 / DALI slave in reset state 6 / 0 / DALI slave has short address 6 / 1 / DALI slave has no short address 7 / 0 / Reset or control command not yet received by DALI slave 7 / 1 / Reset or control command received by DALI slave
145	Checks communication readiness	Yes/No
146	Checks for light failure	Yes/No
147	Checks whether the light is currently switched on	Yes/No
148	Checks whether the last requested power value was applied	Yes/No
149	Checks whether the DALI slave is in reset state	Yes/No
150	Checks whether the DALI slave has a short address	Yes/No
151	Checks whether the DALI slave has a version number	The response depends on the DALI slave: • Yes/No (DALI slave has a version number or not) • Version number
152	Checks the DTR value	DTR value
153	Checks the device type	DALI-specific code for categorizing DALI slaves
154	Checks the physical minimum level (greater than 0)	Value of physical minimum level
155	Checks for power failure	Yes/No

<table>
<tr><th>Code (dec.)</th><th>Function</th><th>Response</th></tr>
<tr><td>156 - 159</td><td>Reserved</td><td></td></tr>
<tr><td>160</td><td>Checks the current power level</td><td>Current power level or 255 if the light is being warmed up</td></tr>
<tr><td>161</td><td>Checks the maximum value</td><td>Maximum value</td></tr>
<tr><td>162</td><td>Checks the minimum value</td><td>Minimum value</td></tr>
<tr><td>163</td><td>Checks the switch-on power level</td><td>Switch-on power level</td></tr>
<tr><td>164</td><td>Checks the power level in the event of error</td><td>Power level in the event of error</td></tr>
<tr><td>165</td><td>Checks the dimming time and dimming speed</td><td><table><tr><th>Bit</th><th>Function</th></tr><tr><td>0 - 3</td><td>Dimming speed</td></tr><tr><td>4 - 7</td><td>Dimming time</td></tr></table></td></tr>
<tr><td>166 - 175</td><td>Reserved</td><td></td></tr>
<tr><td>176 - 191</td><td>Checks the light level for scene 0 to 15</td><td></td></tr>
<tr><td>192</td><td>Checks whether the DALI slave member is part of group 0 to 7</td><td><table><tr><th>Bit</th><th>Value</th><th>Function</th></tr><tr><td rowspan="2">0</td><td>0</td><td>Slave not in group 0</td></tr><tr><td>1</td><td>Slave in group 0</td></tr><tr><td>...</td><td></td><td></td></tr><tr><td rowspan="2">7</td><td>0</td><td>Slave not in group 7</td></tr><tr><td>1</td><td>Slave in group 7</td></tr></table></td></tr>
<tr><td>193</td><td>Checks whether the DALI slave member is part of group 8 to 15</td><td><table><tr><th>Bit</th><th>Value</th><th>Function</th></tr><tr><td rowspan="2">0</td><td>0</td><td>Slave not in group 8</td></tr><tr><td>1</td><td>Slave in group 8</td></tr><tr><td>...</td><td></td><td></td></tr><tr><td rowspan="2">7</td><td>0</td><td>Slave not in group 15</td></tr><tr><td>1</td><td>Slave in group 15</td></tr></table></td></tr>
<tr><td>194</td><td>Checks a 24-bit random address (H)</td><td>Random address (higher 8 bits)</td></tr>
<tr><td>195</td><td>Checks a 24-bit random address (M)</td><td>Random address (middle 8 bits)</td></tr>
<tr><td>196</td><td>Checks a 24-bit random address (L)</td><td>Random address (lower 8 bits)</td></tr>
<tr><td>197 - 223</td><td>Reserved</td><td></td></tr>
<tr><td>224 - 255</td><td>Checks application-specific defined commands</td><td></td></tr>
</table>

1) Any command in the range 32 to 129 must be repeated within the next 100 ms. No other commands can be transmitted to the DALI slave being addressed during this time.

4.6.5 DALI special commands

In the DALI standard, special commands are described as a bit structure represented by the arrangement YAAAAAAS XXXXXXXX (see also "Communication in the DALI network" on page 5). This section contains information about he most important special commands from the DALI specification.

Leave special modes

TERMINATE

YAAAAAAS XXXXXXXX 10100001 00000000

Switches all DALI slaves on the bus in normal mode

Write DTR

DATA TRANSFER REGISTER (DTR)

YAAAAAAS XXXXXXXX 10100011 xxxxxxxx

Writes the bit pattern xxxxxxxx to the Data Transfer Register (DTR)

Special addressing for address assignment

INITIALISE

YAAAAAAS XXXXXXXX 10100101 xxxxxxxx

Allows commands for special addressing within the next 15 minutes.

Information:

- **The command must be sent twice within 100 ms.**
- **"TERMINATE" can be used to exit initialization early.**
  Reinitializing (before the 15 minutes is completed) extends initialization by a further 15 minutes.

RANDOMISE

YAAAAAAS XXXXXXXX 10100111 00000000

Information:

The command must be sent twice within 100 ms.

SEARCHADDRH
SEARCHADDRM
SEARCHADDRL

YAAAAAAS XXXXXXXX 10110001 hhhhhhhh
10110011 mmmmmmmm
10110101 llllllll

"hhhhhhhh", "mmmmmmmm" and "llllllll" represent the currently "selected" 24-bit address in the DALI network.

COMPARE

YAAAAAAS XXXXXXXX 10101001 00000000

All slaves in the DALI network with a 24-bit address less than or equal to hhhhhhhh mmmmmmmm llllllll respond with YES. By repeatedly assigning new search addresses and using "COMPARE", it is possible to select the currently initialized slave with the smallest 24-bit address.

PROGRAM SHORT ADDRESS

YAAAAAAS XXXXXXXX 10110111 0aaaaaa1

The selected slave takes on the short address assigned to aaaaaa.

QUERY SHORT ADDRESS

YAAAAAAS XXXXXXXX = 10111011 00000000

The selected slave responds with its current short address. If no short address has been assigned, it responds with 255. This can be used to check the possible success of address assignment.

VERIFY SHORT ADDRESS

YAAAAAAS XXXXXXXX 10111001 0aaaaaa1

The selected slave responds with YES if the value specified on aaaaaa corresponds to its short address. This can be used to check the possible success of address assignment.

WITHDRAW

YAAAAAAS XXXXXXXX 10101011 00000000

The selected slave is excluded from the subsequent search with "COMPARE" statements but remains initialized and can be selected.

PHYSICAL SELECTION

YAAAAAAS XXXXXXXX = 10111101 00000000

The selected slave is excluded from the subsequent search with "COMPARE" statements, no longer initialized and can no longer be selected.

Additional special commands

Additional special commands can be found in the DALI standard.

4.7 Minimum cycle time

The minimum cycle time specifies how far the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

Minimum cycle time
100 µs

4.8 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

Minimum I/O update time
30 ms