IB IL DALI/MM-PAC

1-channel DALI master; multi-master-capable; with integrated DALI power supply unit; safe electrical isolation

Data sheet
105846_en_00

1 Description

The terminal is designed for use within an Inline station.

It is a multi-master-capable DALI master and is used to control lights with DALI ballasts according to IEC 62386 (formerly IEC 60929).

Furthermore, the terminal supports multi-master operation for communication with Tridonic MSensors.

For integrated DALI bus supply, the terminal requires a 24 V DC supply, which can be implemented automatically via potential jumper U_M or alternatively via connector plug 1.

Features

- DALI master with integrated DALI bus supply
- Sends and receives 2 and 3-byte DALI commands
- DALI supply can be switched off
- Suitable for both single and multi-master operation
- Safe electrical isolation of the DALI bus
- DALI bus protected against unintentional connection of mains voltage (up to 250 V AC)
- Communication via process data
- Diagnostic and status indicators

The IB IL DALI/MM-PAC DALI master cannot be used to supply the IB IL DALI-PAC Inline DALI terminals.

This data sheet is only valid in association with the IL SYS INST UM E user manual.

Make sure you always use the latest documentation.
It can be downloaded from the product at phoenixcontact.net/products.

2 Table of contents

3 Ordering data

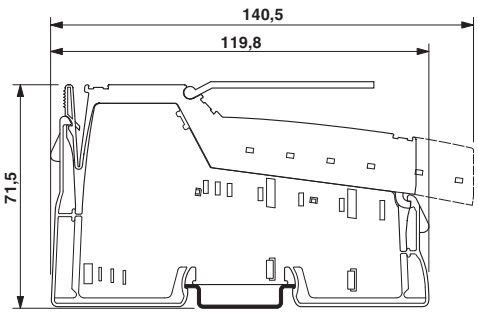
Description	Type	Order No.	Pcs. / Pkt.
1-channel DALI master; multi-master-capable; with integrated DALI power supply unit; safe electrical isolation	IB IL DALI/MM-PAC	2700605	1

Accessories	Type	Order No.	Pcs. / Pkt.
Labeling field, width: 12.2 mm (Marking)	IB IL FIELD 2	2727501	10
Labeling field, width: 48.8 mm (Marking)	IB IL FIELD 8	2727515	10
Insert strip, Sheet, white, Unlabeled, can be labeled with: Office printing systems, Plotter: Laser printer, Mounting type: Insert, Lettering field: 62 x 10 mm (Marking)	ESL 62X10	0809492	1
Insert strip, Sheet, white, Unlabeled, can be labeled with: Office printing systems, Plotter: Laser printer, Mounting type: Insert, Lettering field: 62 x 46 mm (Marking)	ESL 62X46	0809502	5

Documentation	Type	Order No.	Pcs. / Pkt.
User manual, English, Automation terminals of the Inline product range	IL SYS INST UM E	-	-

4 Technical data

Dimensions (nominal sizes in mm)



Width	48.8 mm
Height	119.8 mm
Depth	71.5 mm
Note on dimensions	Housing dimensions

General data

Weight	180 g (with connectors)
Ambient temperature (operation)	-25 °C ... 55 °C
Ambient temperature (storage/transport)	-25 °C ... 85 °C
Permissible humidity (operation)	10 % ... 95 % (according to DIN EN 61131-2)
Permissible humidity (storage/transport)	10 % ... 95 % (according to DIN EN 61131-2)
Air pressure (operation)	80 kPa ... 106 kPa (up to 2000 m above sea level)
Air pressure (storage/transport)	70 kPa ... 106 kPa (up to 3000 m above sea level)
Degree of protection	IP20
Protection class	III, IEC 61140, EN 61140, VDE 0140-1

Connection data	
Designation	Inline connector
Connection method	Spring-cage connection
Conductor cross section solid / stranded	0.2 mm² ... 1.5 mm² / 0.08 mm² ... 1.5 mm²
Conductor cross section [AWG]	24 ... 16

Interface Inline local bus	
Connection method	Inline data jumper
Transmission speed	500 kBit/s

Interface DALI	
Connection method	Inline connector
Supply voltage	typ. 15 V DC (Bus voltage)
Output current with short-circuit	max. 250 mA
Current carrying capacity	max. 220 mA (Bus load)
Transmission speed	1200 bps
Bus protected up to 250 V AC, maximum	Yes

Power consumption	
Main circuit supply U_M	24 V DC
Current consumption from U_M	max. 230 mA
Communications power U_L	7.5 V
Current consumption from U_L	max. 75 mA
Power consumption	3.5 W (The amount of power dissipation is heavily dependent on the bus activity, which is only influenced by the terminal itself to a limited extent. The maximum power dissipation is reached when other devices occupy the DALI bus with minimum pauses and the terminal itself does not transmit, and at the same time the DALI current of 220 mA is used in full.)

Programming Data	
ID code (hex)	BF
ID code (dec.)	191
Length code (hex)	04
Length code (dec.)	04
Process data channel	64 Bit
Input address area	8 Byte
Output address area	8 Byte
Parameter channel (PCP)	0 Byte
Register length (bus)	64 Bit

Error messages to the higher level control or computer system	
Yes	No I/O error; DALI-specific error at application level

Protective circuit	
Surge protection on DALI bus	275 V varistor
Short-circuit protection, overload protection on DALI bus	Electronic fuse, no time limit

Electrical isolation/isolation of the voltage areas	
Test section	**Test voltage**
7.5 V supply (bus logic)/24 V supply (I/O) and functional earth ground (FE)	500 V AC, 50 Hz, 1 min
7.5 V supply (bus logic)/DALI bus	2500 V AC, 50 Hz, 1 min

Electrical isolation/isolation of the voltage areas	
Test section	**Test voltage**
7.5 V supply (bus logic)/DALI bus (routine test)	1200 V AC, 50 Hz, 1 min
24 V supply (I/O)/DALI bus	2500 V AC, 50 Hz, 1 min
24 V supply (I/O)/DALI bus (routine test)	1200 V AC, 50 Hz, 1 min

Approvals

For the latest approvals, please visit phoenixcontact.net/products.

5 Internal basic circuit diagram

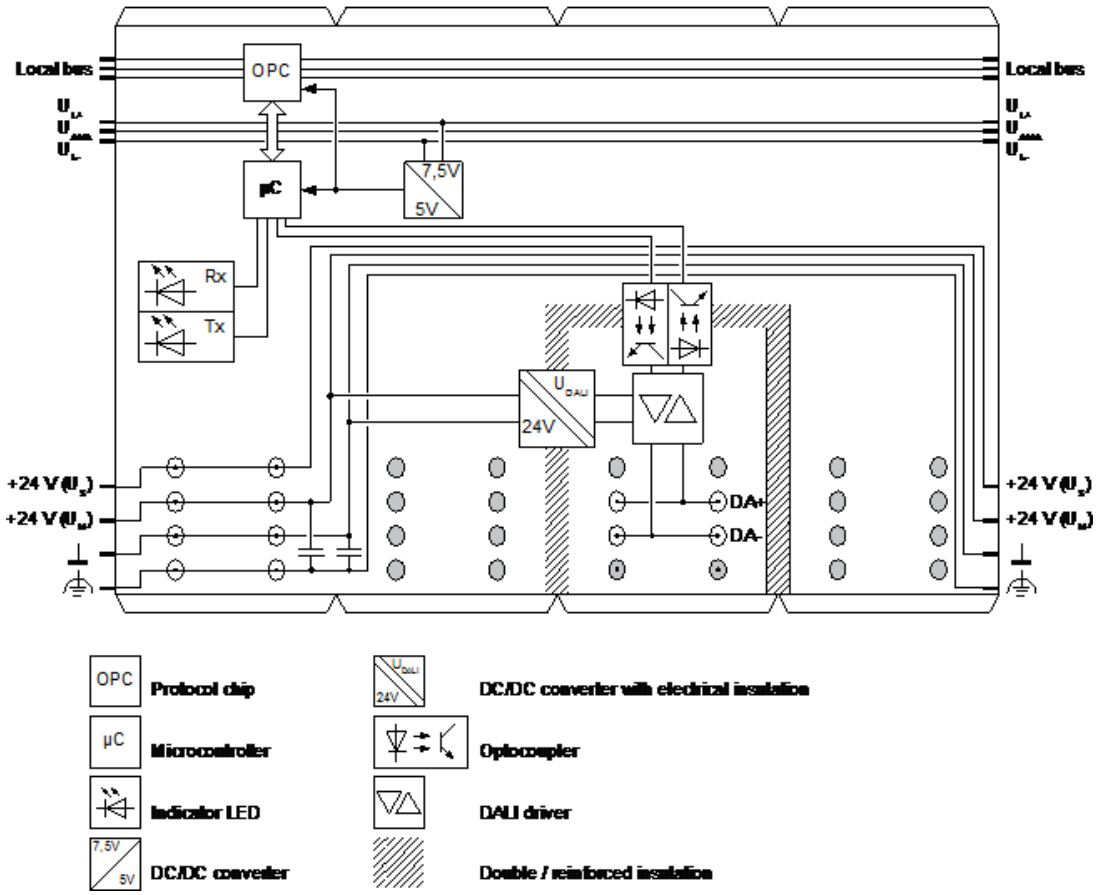


Figure 1 Internal wiring of the terminal points

Other symbols used are explained in the IL SYS INST UM E user manual.

6 Terminal point assignment

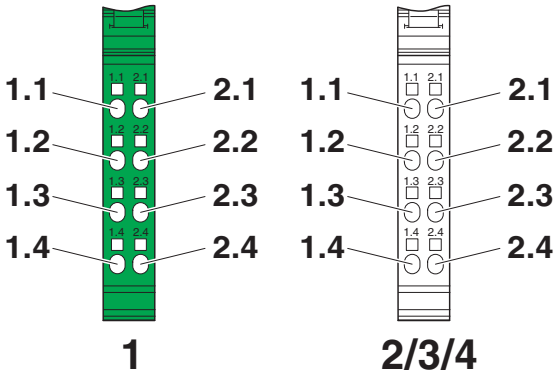


Figure 2 Terminal point assignment

Terminal point	Signal	Assignment
Plug 1		
1.1, 2.1	U_S	+24 V segment voltage, connected to potential jumper U_S
1.2, 2.2	U_M	+24 V main voltage, connected to potential jumper U_M Alternative: terminal supply 1)
1.3, 2.3	GND	Ground of 24 V voltage level 1)
1.4, 2.4	FE	Functional earth ground, internally connected to potential jumper FE
Plug 2		
Not used		
Plug 3		
1.2, 2.2	DA+	DALI bus (positive)
1.3, 2.3	DA-	DALI bus (negative)
Plug 4		
Not used		
1) If the terminal is not adjacent to a 24 V segment, the 24 V supply can be boosted here		

NOTE:
Terminal points not used by the terminal must not be wired.

7 Local status and diagnostics indicators

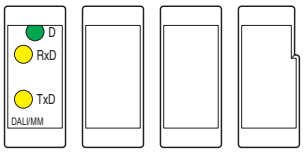


Figure 3 Local status and diagnostics indicators

Designation	Color	Meaning
D	Green	Bus diagnostics
RxD	Yellow	Terminal is receiving data from the DALI bus
TxD	Yellow	Terminal is transmitting data to the DALI bus

8 Connection notes

The voltage drop between the transmitter and receiver on the DALI bus cable must not exceed 2 V at 250 mA. The table below contains recommended values for wiring. The maximum cable length between two bus devices should not exceed 300 m.

Minimum cross sections of the DALI bus cabling:

Cable length	Minimum cross section
< 100 m	0.5 mm²
100 m to 150 m	0.75 mm²
> 150 m to 300 m	1.5 mm²

Special bus cables (twisted or shielded) are not required. Serial and star network topologies or a combination of both can be used. Ring structures should be avoided.

DALI interface insulation in the ballasts of lights only meets the requirements of basic insulation. SELV (safety extra-low voltage) is therefore not ensured on the DALI bus.

NOTE: Bus device overload/malfunction

External supply of the DALI bus is supported. In this case, the built-in DALI supply must not be activated to ensure that the maximum permissible short-circuit current of 250 mA is not exceeded. Otherwise bus devices could be overloaded or damaged.

9 Connection example

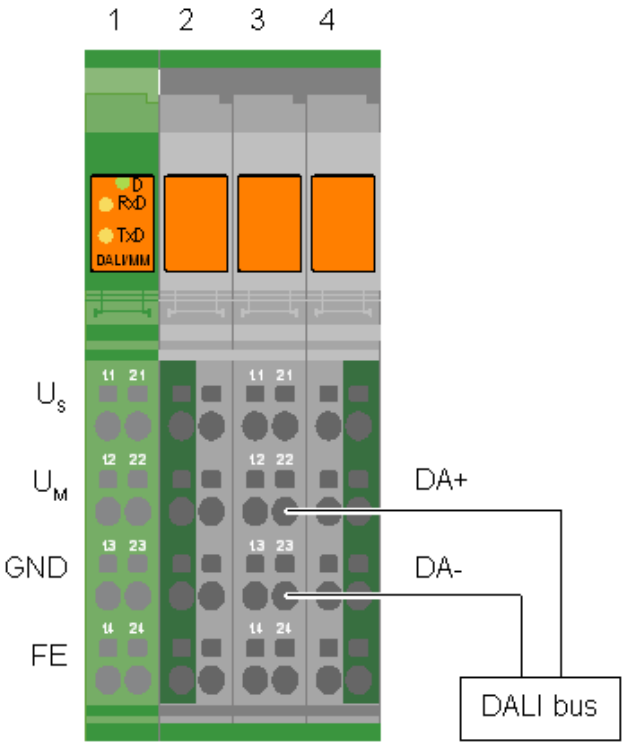


Figure 4 Connection example

As long as the terminal is connected to a previous 24 V segment, it gets its supply from U_M itself via the internal potential routing. Otherwise, it is possible to provide a boost at the terminal points of the first plug 1.2 (U_M) and 1.3 (GND) (see „Terminal point assignment“ auf Seite 6).

10 Typical station structure

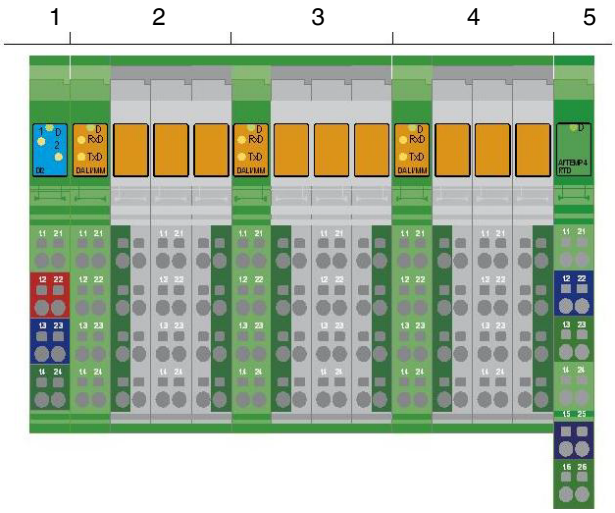


Figure 5 Typical station structure with several DALI terminals

The IB IL DALI/MM-PAC terminal does not interrupt the Inline potential jumpers (U_M, U_S, U_{ANA}, U_L, and FE) and provides an intermediate, non-touch-proof segment (marked in gray). Additional end terminals or disconnect terminals are not necessary. Since the 24 V segment to the left of the terminal continues seamlessly to the right of the terminal, sections 1 to 5 in Figure 5 are all in the same segment. Ideally, the DALI terminals should be positioned at the end of an Inline station but before the analog terminals, in order to minimize the power dissipation that occurs in the terminals due to the load from U_M and U_S.

11 Communication and structure of process data

After a reset, the terminal is unconfigured at first and reports this to the controller (CF bit = 0). The bus supply is switched off in the unconfigured state. The master must first set DALI mode for the terminal.

The command set can be divided into basic commands (CMD = 0 ... 7) and DALI commands (CMD = 8 ... 15).

The IN process data contains 4 bits in IN1, which always have the same function regardless of the mode (CTA, CF, PWR, TYP). The use of other bits differs for basic commands and DALI commands. The TYP bit indicates the type of IN process data.

In general, the terminal only evaluates commands if the OUT1 process data word has changed. The CT toggle bit should therefore also be changed on every new command. This bit is returned by the terminal in the CTA bit of IN1 and confirms receipt of the command.

All reserved or unused bits should be set to zero.

11.1 OUT process data OUT1

OUT1															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
CT	0			PAR		0					CMD				

Bit	Name	Description
15	CT	Command toggle – toggle bit to indicate a new command, should be set to 1 on the first command (since the terminal initially returns a 0) and then changed on each new command
14-12		Reserved
11-10	PAR	Parameter - depends on CMD
		For CMD = 2 (configure terminal) 0 DALI mode 1-3 Reserved
9-6		Reserved
4-0	CMD	Command
		Basic commands 0 No command 1 Read configuration 2 Configure terminal 3 Read firmware version 4 Switch bus supply on 5 Switch bus supply off 6, 7 Reserved
		DALI commands (only in DALI mode) 8 No command (read only) 9 Send DALI packet 10 Force end of INITIALISE state 11 Clear receive buffer 12 Clear transmit buffer 13-15 Reserved
		16-31 Reserved

11.2 IN process data IN1

IN1 (basic commands)															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
CTA	CF	PWR	0	PARA		0					CMDA				

IN1 (DALI commands)															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
CTA	CF	PWR	1	TF	RF	INI	FD	RL		SS	RP			AW	

Bit	Name	Description
Bits valid for all commands		
15	CTA	Command toggle acknowledge – toggle bit for confirmation, after reset 0
14	CF	Configured - terminal mode was configured, after reset 0
13	PWR	Power on - bus voltage present
12	TYP	Input data type 0 Answer to basic commands 1 DALI packet
TYP = 0: specific bits for basic commands		
11-10	PARA	Output parameter
9-5		Reserved
4-0	CMDA	Mirroring of command
TYP = 1: specific bits for DALI mode		
11	TF	Transmit buffer full - when the transmit buffer is full (TF == 1) and a transmit command is issued, the previous command may be lost (although not necessarily) Note: if the bit is still 0 on transmission, it can only be evaluated in the next bus cycle (if CTA also matches CT)
10	RF	Receive buffer full - if this bit is 1, no further outputs to the DALI bus are permitted
9	INI	Initialised - terminal is in INITIALISED mode, at first it cannot send packets for 15 minutes; all transmit buffers are cleared, new transmit commands are rejected
8	FD	Frame dropped - loss of packets: before this packet, one or more packets were lost (buffer overrun)
7-6	RL	Length - DALI packet length: 0 No packet 1 Frame error (no length assigned) 2 2-byte packet 3 3-byte packet

Bit	Name	Description
5	SS	Self sent - message sent by the terminal itself
4-2	RP	Receive priority - priority of the packet 0 Priority 0: 12 ms (> 11.5 ms to 12.5 ms) 1 Priority 1: 13 ms (> 12.5 ms to 13.5 ms) 2 Priority 2: 14 ms (> 13.5 ms to 14.5 ms) 3 Priority 3: 15 ms (>14.5 ms to 15.5 ms) 4 Priority 4: 16 ms (> 15.5 ms) 7 Invalid priority (≤ 11.5 ms)
1-0	AW	Answer - answer included in data 0 No answer 1 Valid answer included 2 Invalid answer 3 Only answer, no request ("orphaned"), RL = 1

11.3 Basic commands

The basic commands are CMD = 0 ... 7 and are mirrored in IN1 in CMDA. The CF and PWR status bits are also displayed.

Reading the configuration provides the current state in PARA, with the same bit assignment as for writing the configuration in PAR. The configuration request is only valid if the terminal has already been configured (CF = 1). For all other basic commands, PARA is set to zero.

Process data output words OUT2, OUT3, and OUT4 are not required for the basic commands and should be set to zero.

Process data input words IN2, IN3, and IN4 are set to zero for all basic commands apart from reading the firmware version. The firmware version is returned in IN2.

11.4 DALI commands

Use of process data output words OUT2 ... OUT4 for DALI commands:

OUT2 ... OUT4 in DALI mode with TYP = 1				
CMD	**Command**	**OUT2**	**OUT3**	**OUT4**
8	No command (receive only)	Acknowledgment RX packet	0	0
9	Send DALI command		Data bytes 1, 2	Data byte 3, controller
10	Exit Initialise state		0	0
11	Clear all receive buffers		0	0
12	Clear all transmit buffers		0	0

Structure of process data output word OUT2 in DALI mode:

OUT2															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Time stamp for the packet in ms														Index	

Structure of process data output words OUT3 and OUT4 for CMD = 9:

OUT3															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Data byte 2 (TD2)								Data byte 1 (TD1)							

OUT4															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
D	B	L	0		Priority TP			For L = 1: data byte 3 (TD3) For L = 0: 0							

Typical use of fields in OUT4 (0: set to zero, X: used):

DALI system		Field				
		D	B	L	TP	TD3
Single master	Normal operation	0	0	0	0	0
	Configuration	X	0	0	0	0
Multi-master	Normal operation	0	0	X	X	X
	Configuration	X	X	X	X	X

When **bit D** (duplicate) is set, the DALI packet is sent twice by the terminal. The first packet is always sent with priority TP, the second with priority 0 (highest priority).

Bit B (buffer) is used in DALI multi-master systems to send two messages as an associated sequence, where normally B = 0.
Certain command sequences must be sent without being interrupted by other devices. To ensure this happens, bit B = 1 is set for the first message. The terminal does not send this message to the DALI bus immediately, it is buffered first. The second message of the sequence is sent to the terminal as usual with B = 0. The second message always has the highest priority, field TP is ignored. As soon as the terminal receives this message, it begins by outputting the stored message, followed by the second message that it has just received.

If a new message with B = 0 is sent to the terminal before the first part has been output to the DALI bus, both of the individual messages available at the terminal are deleted and overwritten by the new message. It may be that the first part of the message is still output (if the output was already started).

If several messages with B = 1 are sent to the terminal, they overwrite each other and there is no output to the DALI bus until a message with B = 0 is sent to the terminal.

Bit L (length) indicates the length of the packet to be sent:

L = 0 2-byte DALI packet
L = 1 3-byte DALI packet

Field TP (transmit priority) specifies the priority with which the DALI packet is sent. In DALI single master systems, this field is not relevant and can always be set to zero. Valid values are 0 (highest priority) to 4 (lowest priority). The priority determines the minimum bus idle time, after which the packet may be sent to the DALI bus (for times, see field RP in „IN process data IN1“ auf Seite 9). Part 1 of standard NEMA 243-2004 includes specifications for the use of the individual priorities.

In the event of a high DALI bus load due to other DALI masters, the terminal may not be able to send DALI packets itself. According to the DALI multi-master access rules, this applies in particular to packets with low priority. In this case, the terminal rejects the packet to be output after 200 ms, and there is no need for explicit deletion by the controller.

Process data output word OUT2 acts as a mirror for IN2 for confirming the packets received by the terminal. The confirmation process is described in the following section. In the event of explicit deletion of the receive buffer, OUT2 should be left at the last confirmed value.

Structure of process data input words in DALI mode

IN2															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Time stamp for the packet in ms														Index	

IN3															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
DALI data byte 2 (RD2)								DALI data byte 1 (RD1)							

IN4															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
If AW = 1: DALI answer (RDA) otherwise 0								If LEN = 3: DALI data byte 3 (RD3) otherwise 0							

Process data word IN2 is used to secure the transmission of DALI packets from the terminal to the controller. After a reset, the terminal uses IDX = 1 for the first packet. After a reset, the controller first transmits a 0 in OUT2 to prevent confirmation errors.

In the process data words in IN3 and if necessary IN4 (for AW = 1 or LEN = 3), the packets received at the DALI bus are transmitted to the controller.

11.5 Transmission of DALI packets from the terminal to the controller

The terminal receives all the packets transmitted to the DALI bus (including self-sent packets) and transmits them to the controller. A special read command is not required. Typically, the controller only needs the send command including toggle bit in order to control a DALI network. The command is not mirrored (apart from bit CTA), the confirmation for DALI packets to be output must be sent via the read back DALI packets. Bit SS in IN1 is used to detect self-sent DALI packets.

Process data words OUT2 and IN2 are used to control the transfer of DALI packets from the terminal to the controller. The terminal internally assigns each packet a time stamp and a consecutive index from 0 to 3. The time stamp refers to the packet start time. According to the resolution of 1 ms, the time base overruns after approximately 16 s and begins again at 0. A change at IN2 indicates a new packet.

The terminal sends DALI packets with consecutive index to the controller one after another as long as they are available. The packets are stored temporarily in a four-stage extra buffer in the terminal. A packet confirmed by the controller is removed from the buffer when it is the oldest unconfirmed packet in the buffer. If the terminal detects that a packet has been lost (the terminal receives confirmation for a packet which is not the oldest), it begins sending again from the oldest unconfirmed packet and sends consecutive packets without waiting for immediate confirmation. If no further packets are available, i.e., all packets have been confirmed by the controller, the terminal will still output the last confirmed packet.

A DALI packet is confirmed by the controller by mirroring IN2 in OUT2. In DALI mode (i.e., TYP = 1), this confirmation is completely independent of the other process data output words. This means, for example, that on a change in OUT2 an existing send command is not output again.

On receipt of DALI packets, the controller therefore has the following tasks:

a) Confirmation of incoming packets (for the terminal)

b) Suppression of duplicate packets (for the controller application)

To complete task a), the controller in DALI mode (i.e., TYP = 1) copies IN2 to OUT2.

To complete task b), the controller rejects all DALI packets that do not have consecutive indices; only packets with index + 1 are accepted as new packets.

11.6 Example control

Initial state	OUT1 – OUT4 = 0
Activate DALI mode	OUT1 = 8002_{hex}
Switch on bus supply	OUT1 = 0004_{hex}
Send first DALI packet	OUT1 = 8009_{hex}, OUT3 DALI packet
Waiting for real output	IN3 == OUT3? or timeout
Send another packet	OUT1 = 0009_{hex}, OUT3 DALI packet

(confirmation and de-duplication not specified explicitly)