User Manual

LucidControl DI4DO4

USB Module with 4 Digital Input and 4 Digital Output Channels

Table of Content

1 Introduction

This document describes the functionality of the LucidControl DI4DO4 USB IO module with 4 digital input and 4 digital output channels controllable by the Universal Serial Bus.

A basic description of the LucidControl product family can be found in the general *LucidControl User Manual*.

This document focuses on functions which are specific for the DI4DO4 USB IO module.

2 Setup and Installation

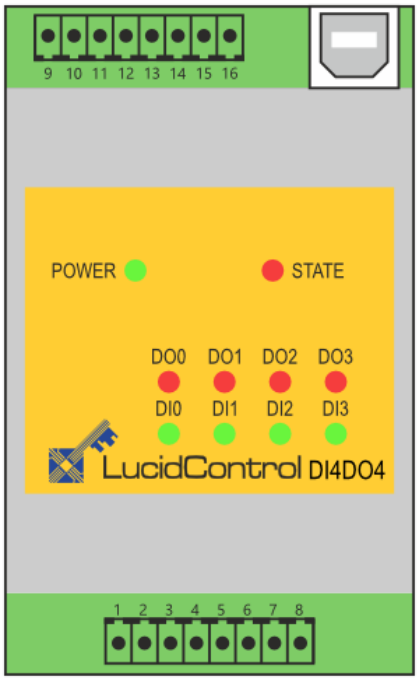


Fig. 1 Digital IO Module DI4DO4

Fig. 1 shows the sketch of the Digital DI4DO4 module with 4 digital input (DI0 to DI3) and 4 digital output (DO0 to DO3) channels.

The lower IO connector (IO1 to IO8) provides the terminals for the digital input channels DI0 to DI3. The input state of a channel is indicated by its related green LED.

The upper IO connector (IO9 to IO16) provides the terminals for the digital output channels DO0 to DO3. The output state of each channel is indicated by the related red LED.

2.1 Safety Information

LucidControl complies with regulations and industrial standards active in the EU. To keep the device functional, the following safety and maintenance information must be adhered.

The device must only be used for the intended purpose.

The device must not be used under the following conditions:

- It is obviously damaged
- An error was detected
- Outside humidity and temperature limits
- Unauthorized personnel

Never apply voltages higher than 30V (or lower than -30V) to any IO terminal. This would damage the device.

2.2 Configurations

The digital output channels of the DI4DO4 are consist of solid-state relays.

The digital input channels are available for different threshold levels:

Threshold Level	V_{LowMax}	$V_{HighMin}$	$V_{HighMax}$
5 V	2.5 V	3.5 V	7.5V
10 V	6.0 V	8.5V	15V
24 V	16.0 V	21.0 V	30V

Tab. 1 Digtal Input Threshold Level

Tab. 1 shows the characteristic voltages for the different threshold levels. Voltages below V_{LowMax} result in a LOW value, voltage higher than $V_{HighMin}$ in a HIGH value. Because of the input hysteresis, voltages between V_{LowMax} and $V_{HighMin}$ do not change the logic value.

In order to prevent excessive stress on the digital inputs, the maximum applied voltage must not exceed $V_{HighMax}$.

Example
When interfacing a 24 V signal, the applied voltage of a HIGH state must be higher than 21.0 V. The voltage of a low state needs to be lower than 16.0 V. For the voltages between, the last detected stable value remains.

2.3 Interface and Connection

2.3.1 USB Connection

LucidControl USB modules are connected to the computer by using a USB 2.0 cable which must not extend a length of 5 m. They are bus powered what means that the host computer supplies the module with power.

The LucidControl DI4DO4 module is rated with a maximum current of 40 mA.

2.3.2 IO Connection

2.3.2.1 Digital Input Channels

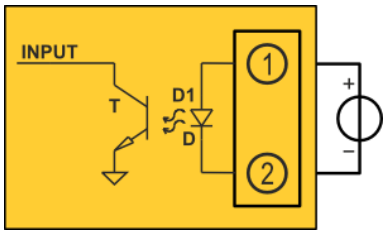


Fig. 2 illustrates how the digital input works. The signal is applied to the IO terminals 1 and 2. It powers the opto-coupler, which insulates the input signal and the acquisition hardware.

Fig. 2 Isolated Digital Input

All input channels work independently and are potentially isolated. They do not share any common contacts (e.g. ground line).

Applying a voltage above $V_{HighMin}$ between the input terminals 1 (resp. 3, 5, 7) and 2 (resp. 4, 6, 8) powers the LED of the opto-coupler and makes the transistor conductive resulting in a digital HIGH state level. If the voltage is below V_{LowMax} is applied this results in a LOW state level.

All digital inputs are protected against overvoltage. Applying a voltage higher than V_{InMax} = 30 V or lower than $-V_{InMax}$ = -30V may damage the input.

Digital Input Channel	IO Terminals Pins
DI0	1 / 2
DI1	3 / 4
DI2	5 / 6
DI3	7 / 8

Tab. 2 Digital Input Channel IO Terminals

Tab. 2 lists the digital input channels and their corresponding IO terminal pins.

2.3.2.2 Digital Output Channels

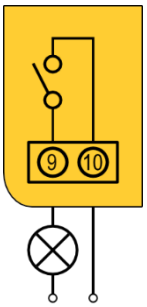


Fig. 3 SSR Output

Fig. 3 shows the connection of the first digital output channel.

When the output is activated, the SSR connects terminal 9 with terminal 10, closing the circuit and switching on the lamp in the shown application.

The polarity of the signal is not relevant. The positive or negative potential can be connected to any terminal.

SSR outputs are opto-insulated, protecting the hardware behind the SSR (e.g. the host computer).

The outputs are potential-free and do not share any common contacts e.g. ground line.

Digital Output Channel	IO Terminals Pins
DO0	9 / 10
DO1	11 / 12
DO2	13 / 14
DO3	15 / 16

Tab. 3 Digital Output Channel IO Terminals

Tab. 3 lists the digital output channels and their IO terminal pins

The SSR outputs are not protected against overcurrent and overvoltage. U_{SSRMax} and I_{SSRMax} limits must be considered. Otherwise, the output may be damaged.

If inductive loads are controlled, additional protection might be necessary in order to protect the SSR from high voltage.

The digital output channels support Reflect Mode, Duty-Cycle Mode and On-Off Mode.

For Duty-Cycle and On-Off Modes the minimum on and off times are limited to T_{SSRMin}.

2.4 Setup of Hard- and Software

Setting up LucidControl hardware is straight forward:

1. Ensure that no signal is applied to the IO Connector
2. Connect LucidControl via USB with the computer
3. Applies for Microsoft Windows older than Windows 10 only: The system asks for an installation file. This is not a driver but only an information file (INF). The file can be downloaded from our website www.lucid-control.com/downloads
4. LucidControl switches the green power LED on. The module can be used.

2.4.1 Windows

After the installation has finished, the Windows Device Manager lists a new serial port (COM). The module can be accessed by using this port.

If more than one module is connected to a computer, the operating system ensures that the same serial port number is assigned to the module(s) after restart.

2.4.2 Linux

The module is immediately installed as /dev/ttyACM**n** device where n is a number referring to the index of the device.

Note
If more than one module is connected to a computer, Linux does by default not ensure that a module is permanently linked to the same /dev/ttyACM**n** device.

2.4.3 LucidIoCtrl Command Line Tool

The LucidIoCtrl command line tool can be downloaded from our website:

www.lucid-control.com/downloads

This page provides the command line tool LucidIoCtrl for different architectures.

Please see the section 3 of the general *LucidControl User Manual* for more information about LucidIoCtrl.

2.4.4 First Steps

After the module was successfully installed, the green Power LED is switched on signaling that the module is ready for use.

The following examples demonstrate the functionality of the module by using the LucidIoCtrl command line tool.

Windows Examples

Setting output channel number 4 to “1”. The module is connected to COM1

```
LucidIoCtrl -dCOM1 -tL -c4 -w1 [ENTER]
```

Windows requires a different argument for comport numbers >= 10.

```
LucidIoCtrl –d\\.\COM10 –tL –c4 –w1 [ENTER]
```

Reading the states of all digital inputs and outputs

```
LucidIoCtrl –dCOM1 –tL -c0,1,2,3,4,5,6,7 –r [ENTER]
CH0:00  CH1:00  CH2:00  CH3:00  CH4:00  CH5:00  CH6:00  CH7:00
```

Linux Examples

For all examples it is assumed that the module is connected to /dev/ttyACM0.

Setting output channel number 4 to “1”

```
./LucidIoCtrl –d/dev/ttyACM0 –tL –c4 –w1 [ENTER]
```

Resetting output channel number 4 to “0”

```
./LucidIoCtrl –d/dev/ttyACM0 –tL –c4 –w0 [ENTER]
```

Reading the states of all digital inputs and outputs

```
./LucidIoCtrl –d/dev/ttyACM0 –tL –c0,1,2,3,4,5,6,7 –r [ENTER]
CH0:00  CH1:00  CH2:00  CH3:00  CH4:00  CH5:00  CH6:00  CH7:00
```

3 Module Operation

3.1 Digital Input Channel Processing

3.1.1 Real-time Considerations

Operating systems for personal computers are not made for deterministic real-time operation. Because of multitasking it cannot be ensured that a task will continue to run within a specified interval.

USB is also no real-time bus and limits the timing.

Assuming that short pulses (e.g., shorter than 10 ms) should be detected the computer has to read the input value at least 100 times per second what is not realistic. It is possible that a pulse is located between two readings and the pulse would be missed.

Edge detection and count modes improve the real-time characteristics.

3.1.2 Input Signal Value Inversion

Digital input channels have an input signal value and a logical input value. The input signal value is represented by the voltage applied to the input channel. The logical value is evaluated by the input processing.

In case of inversion is disabled, the input signal values and logical values are identical.

In case of input inversion is enabled by configuration parameter *inDi0Inverted* set to "on" the logical value is the inverted input signal value. This means that a voltage higher than $V_{HighMin}$ results in a HIGH input signal value but a LOW logical input value.

All input modes support input signal value inversion.

3.1.3 Operation Modes

This section explains the operation modes of the input channels and gives examples how to configure and to use them.

Digital input channels can operate in one of the modes:

- Reflect Mode
- Rising Edge Mode
- Falling Edge Mode
- Count Mode

In all modes the input values are captured and evaluated after a stable signal has been detected.

3.1.3.1 Reflect Mode

The reflect mode acquires the logical input value.

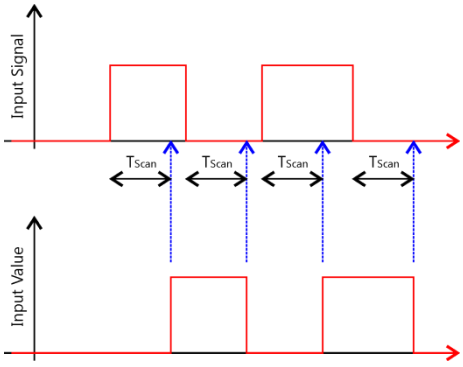
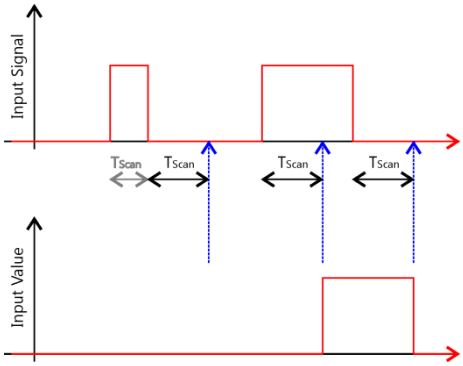


Fig. 4 illustrates the processing of the digital input channels in reflect mode.

After the rising edge of the input signal was detected and it remained stable for the interval T_{Scan} the input value is updated.

Fig. 4 Digital Input Channel Processing in Reflect Mode



In the case that a pulse of the input signal is shorter than T_{Scan}, it is ignored and the input value does not change. Fig. 5 shows this at the first pulse. The rising edge of the input signal starts the scan timer and the falling edge stops it (indicated by the gray T_{Scan} interval).

The second pulse is longer than T_{Scan} and considered valid. The input value is updated.

Fig. 5 Reflect Mode Pulse Width

Filtering digital signals can be used in order to surpress instable signals (debouncing). It makes the detection of digital input signals more relyable.

The scan interval T_{Scan} is configured by the parameter *inDi0ScanTime* (→ 0).

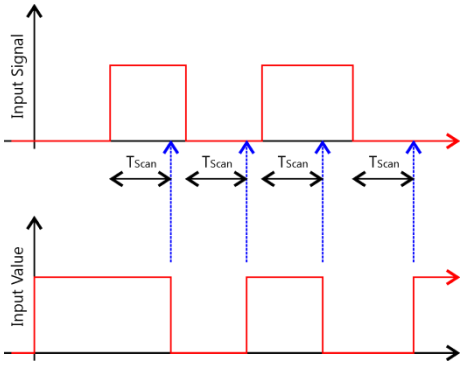


Fig. 6 illustrates the digital input signal and the inverted input value with configuration parameter *inDi0Inverted* set to "on".

Fig. 6 Inverted Reflect Mode

LucidIoCtrl Command Line Tool Example
Set digital input channel 0 to Reflect Mode

```
LucidIoCtrl –dCOM4 –c0 –sinDi0Mode=reflect [ENTER]
```

3.1.3.2 Edge Detection

Digital input channels can operate in edge detection modes. In rising edge mode, the channel is sensitive for low-to-high transitions, in falling edge mode it recognizes high-to-low transitions.

Edge detection modes improve the real-time processing of input signal transitions without the host computer being involved.

Operating systems for personal computers are not made for deterministic real-time behavior. Because of multitasking it cannot be ensured that a task will continue to run within a specified interval.

USB is also no real-time bus and limits the timing.

The following example explains how the edge detection mode can improve timing behavior. If a short pulse of 10 ms length should be detected, the host computer would need to poll with a rate of 200 times per second. This is beyond the capabilities of the operating system and USB.

Digital input channels in edge detection mode remembers a fast signal change and the host computer can poll at a lower rate in order to detect if a transition happened.

LucidIoCtrl Command Line Tool Example
Configure input channel 0 for rising edge detection mode

```
LucidIoCtrl –dCOM4 –c0 –sinDi0Mode=risingEdge [ENTER]
```

Set T_{Scan} to 90 µs

```
LucidIoCtrl –dCOM4 –c0 –sinDi0ScanTime=90000 [ENTER]
```

Read input channel 0

```
LucidIoCtrl –dCOM4 –c0 –tL -r [ENTER]
CH0:01
```

3.1.3.2.1 Rising Edge Detection Mode

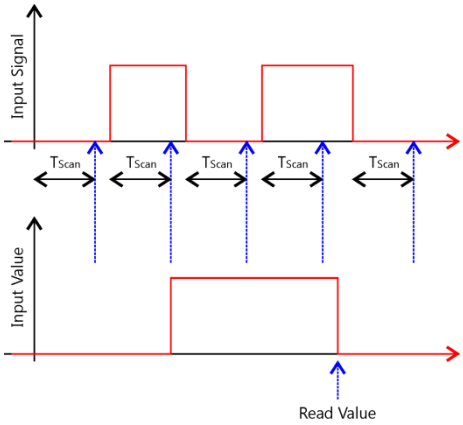
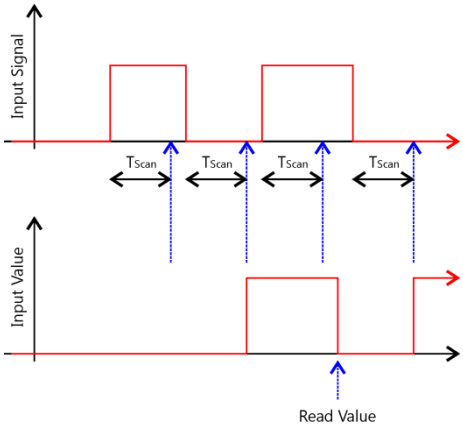


Fig. 7 shows a digital input signal and the corresponding input value in rising edge detection mode. After the HIGH input signal was detected as being valid, the input value remains pending until it was read by the host computer.

The rising edge detection mode allows detecting low-to-high transitions of the input signal without the host computer being involved.

Fig. 7 Rising Edge Detection Mode

3.1.3.2.2 Falling Edge Detection Mode



The falling edge detection mode (Fig. 8) operates similar to the rising edge detection mode but triggers at high-to-low transition of the input signal.

In falling edge detection mode, a high-to-low transition of the input signal sets the input value to “1”.

Fig. 8 Falling Edge Detection Mode

3.1.3.3 Count Mode

The count mode accumulates valid pulses of the input signal within a count interval specified by T_{Count}.

The counter is 16 bit wide. When 65535 is reached it rolls over to 0 with the next increment.

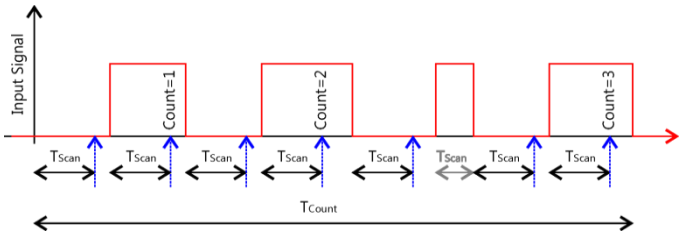


Fig. 9 illustrates a typical periodical input signal. In count mode all valid pulses are accumulated until the counting interval T_{Count} finishes.

Fig. 9 Count Mode

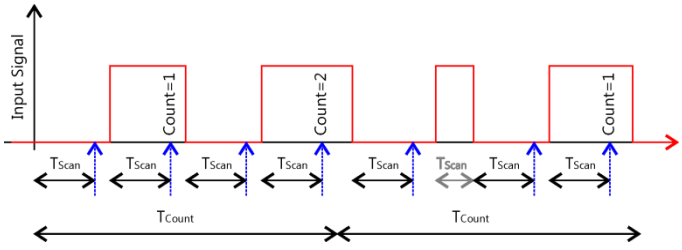


Fig. 10 shows the same input signal, but with a shorter count interval.

After count interval T_{Count} has passed, the count value is accessible and a new measurement cycle starts.

Fig. 10 Count Mode Interval

The input signal is considered as valid after it was stable for at least the scan time T_{Scan}. Only valid pulses are accumulated (see the gray interrupted pulse).

T_{Scan} time starts when the rising edge of the input signal was detected. In the case that the parameter *inDi0Inverted* is set to "on", T_{Scan} time starts when the falling edge of the input signal is detected.

Reading the input value in count mode returns the count value of the last finished count interval cycle.

LucidIoCtrl Command Line Tool Example

Configure input channel 0 for Count Mode

```
LucidIoCtrl -dCOM4 -c0 -sinDi0Mode=count [ENTER]
```

Set Scan Time T_{Scan} to 1ms

```
LucidIoCtrl -dCOM4 -c0 -sinDi0ScanTime=1000 [ENTER]
```

Set Count Time T_{Count} to 1s

```
LucidIoCtrl -dCOM4 -c0 -sinDi0CountTime=1000000 [ENTER]
```

Read count value (number of pulses)

```
LucidIoCtrl -dCOM4 -c0 -tN -r [ENTER]
CH0:0x0064 (100)
```

In this example 100 pulses of at least 1 millisecond length have been acquired within a count interval of 1 second.

Since the input value is updated after count interval has passed it takes 1 second to update the value. Decreasing the count interval results in a faster update of the input value.

In Count Mode the value type N is supported. The count value is returned in hexadecimal and decimal format.

3.1.3.3.1 Count Mode Options

The functionality of the count mode can be controlled by the parameters *inDi0AddCounts* and *inDi0ResetCountsOnRead*.

The number of counted pulses becomes valid after count interval has passed.

The number counted pulses becomes valid after count interval T_{Count} has passed:

- In the case that *inDi0AddCounter* is set to “off”, the current counter value is overwritten by the new counter value and previous counter value might be lost.
- In the case that *inDi0AddCounter* is set to “on”, the new counter value is added to the current counter value.

When the count number is read by the host:

- If *inDi0ResetCounterOnRead is set to* "*off*", reading the counter value does not affect the counter value.
- If *inDi0ResetCounterOnRead* is set to “on”, the counter value is reset after reading it.

The parameter *inDi0ResetCounterOnRead* has only an effect when *inDi0AddCounter* set to “on”.

In order to avoid counter overflows parameter *inDi0AddCounter* ”on” should be combined with *inDi0ResetCounterOnRead* "on" parameter.

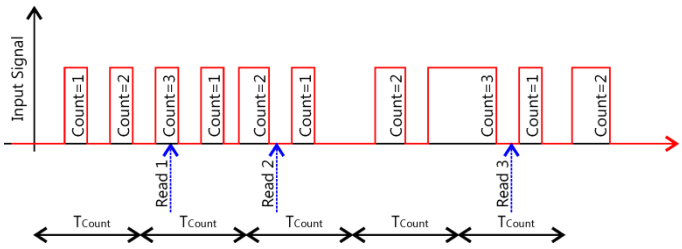


Fig. 11 shows a non-periodic input signal with 10 pulses in total. The counter value is read at 3 times. In the following it is explained how the options affect the count value.

Fig. 11 Count Value Add Mode

The value "Count" in the diagram refers to the internal counter, which is accumulated during count interval T_{Count}.

Mode	Value Read 1	Value Read 2	Value Read 3
inDi0AddCounter = "on" *inDi0ResetCounterOnRead* = "on"	2	3	3
inDi0AddCounter = "on" *inDi0ResetCounterOnRead* = "off"	2	5	8
inDi0AddCounter = "off" *inDi0ResetCounterOnRead* = "off" (Default)	2	3	2

Tab. 4 Count Mode Options Value Read Results

Tab. 4 lists the count values at the 3 reading positions for the *inDi0AddCounter* and *inDi0ResetCounterOnRead* options.

The options *inDi0AddCounter* and *inDi0ResetCounterOnRead* are set to "on" which is the most useful combination. (→ Tab. 4, first row)

On Read 1 the returned counter value is 2 since the internal counter value when T_{Count} ended was 2. The counter value is reset on reading and 1 pulse is carried over to the next T_{Count} inverval.

On Read 2 the returned counter value is 3 because of the internal counter value 2 plus the carried over counter 1 from the last count interval. The counter value is reset on read.

At the reading 3 the read value is 3. The counter value is reset on read.

Count mode with *inDi0AddCounter* = "on"

In the case that *inDi0AddCounter* is "on" and *inDi0ResetCounterOnRead* is "off" the pulses are accumulated but the counter is not reset on reading the value. This causes the counter value will be updated when count interval has finished and the current counter is added to the last counter value. This may result in an overflow when the counter value rolls over its maximum value of 65535.

3.2 Digital Output Channel Processing

3.2.1 Output Signal Value Inversion

Digital output channels have an output signal value and a logical output value. The logical output value is the current state of the output which can be “0” (cleared) or “1” (set). The output signal value is calculated by the output handling.

Read and write commands give access to the logical output value.

In the case that *outDi1Inverted* is set to “off”, output signal value inversion is disabled and the output signal values and logical output values are identical.

In the case that inversion is enabled by setting *outDi1Inverted* to “on” the output signal value is the inverted logical value. Writing “1” to the output channel value clears the output.

All output modes support output signal value inversion.

3.2.2 Timing Limits

The output timing resolution specifies the minimum interval for an on-phase or off-phase. If an on-time or off-time is lower than t_{Res} the phase is skipped.

3.2.3 Operation Modes

This section describes the operation of the different output modes and gives examples how the outputs can be controlled.

Each of the outputs of the module can work in one of the following modes:

- Reflect Mode
- Duty-Cycle Mode
- On-Off Mode

3.2.3.1 Reflect Mode

Reflect Mode gives direct access to the logical output value of the output channel.

Writing "1" to the output causes the output being set immediately.

Writing "0" to the output causes the output being cleared immediately.

By setting and clearing outputs in Reflect Mode any pattern of the output signal can be generated, but the timing is limited by the communication protocol and the host computer.

This means e.g., that switching an output on and off every 1ms would need 1000 commands per second. This is not realistic because common operating systems and USB latency do not allow such a fast and deterministic timing.

Duty-Cycle Mode and On-Off Mode improves this by handling the critical timing in the module.

LucidIoCtrl Command Line Tool Example
Configure output channel 4 for Reflect Mode

```
LucidIoCtrl –dCOM4 –c4 –soutDi1Mode=reflect [ENTER]
```

Set output channel 0 to "1"

```
LucidIoCtrl –dCOM4 –c4 –tL –w1 [ENTER]
```

Set the channel 0 back to "0"

```
LucidIoCtrl –dCOM4 –c4 –tL –w0 [ENTER]
```

3.2.3.2 Duty-Cycle Mode and PWM

In Duty-Cycle Mode the module switches outputs on and off in a periodical PWM (pulse-width-modulation) sequence.

By switching an output periodically on and off it is e.g., possible to control the power consumed by a device and can be used for controlling the power of a pump or a heating element.

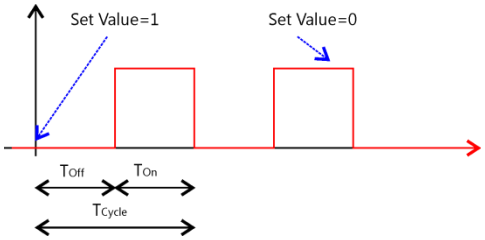


Fig. 12 Duty-Cycle Mode

Fig. 12 shows a periodical signal generated in Duty-Cycle Mode.

Setting the logical output value to "1" starts processing until it is set back to "0".

If the logical output value is set to "0" in off-phase, processing is stopped.

If the value of the output is set to "0" in on-phase, behavior depends on IO Configuration Parameter *outDi1CanCancel*.

The timing of the generated signal is configured by two parameters:

- T_{Cycle} defines the cycle time (period) of the signal and can be configured by the IO Configuration Parameter *outDi1CycleTime*.
- The IO Configuration Parameter *outDi1DutyCycle* defines the relation of the on-time T_{On} and the off-time T_{Off}
  - On-time equals to $T_{On} = \frac{T_{Cycle}}{1000} * DutyCycle$
  - Off-time equals to $T_{Off} = T_{Cycle} - \frac{T_{Cycle}}{1000} * DutyCycle$

The resolution of the generated signal is $\frac{T_{Cycle}}{1000}$ which means that on-time and off-time have a resolution of 1 ‰.

Changing the Configuration Parameters *outDi1CycleTime* or *outDi1DutyCylce* while processing of the Duty-Cycle outputs is running updates the values immediately.

The calculated values of T_{on} and T_{off} must be in the limits of t_{Res}. Values outside the limits result in permanent off or on state.

Output Signal Value Inversion

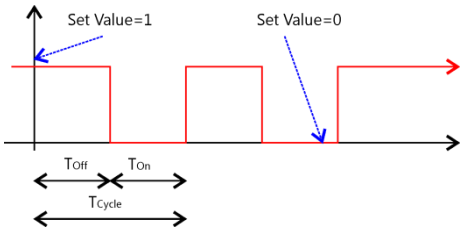


Fig. 13 Duty-Cycle Mode Output Inversion

Fig. 13 shows the output signal value in the case that output signal value inversion is enabled (*outDi1Inverted* is "on").

Cancelation of On-Phase

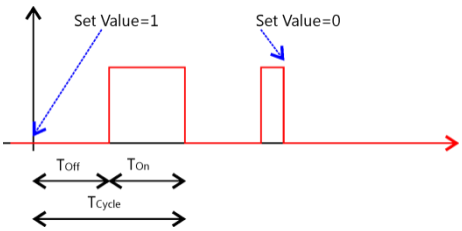


Fig. 14 Duty-Cycle Mode Cancel On-Phase

If output processing is stopped while the output is in on-phase (T_{on}), IO Configuration Parameter *outDi1CanCancel* specifies the behavior of stopping

If *outDi1CanCancel* is set to "off" the sequence completes as shown in Fig. 12.

If *outDi1CanCancel* is set to "on" the on-phase is interrupted immediately when the output value is set to "0" as shown in Fig. 14.

Updating Parameters

If output processing is running, updates of the IO Configuration Parameters *outDi1CycleTime* and *outDi1DutyCycle* are applied immediately.

LucidIoCtrl Command Line Tool Example

Configure output channel 4 for Duty-Cycle mode

```
LucidIoCtrl -dCOM4 -c4 -soutDi1Mode=dutyCycle [ENTER]
```

Start processing of PWM signal for output channel 4

```
LucidIoCtrl -dCOM4 -c4 -tL -w1 [ENTER]
```

By default, the module is configured with T_{Cycle} = 1 s and DutyCycle = 50%. The output channel is switched 500 ms to “1” and 500 ms to “0”.

Changing T_{Cycle} to 2 s

```
LucidIoCtrl -dCOM4 -c4 -soutDi1CycleTime=2000000 [ENTER]
```

The output is now 1 s switched on and 1 s switched of

Change DutyCycle to 75%

```
LucidIoCtrl -dCOM4 -c4 -soutDi1DutyCycle=750 [ENTER]
```

Disable processing of output channel 4

```
LucidIoCtrl -dCOM4 -c4 -tT -w0 [ENTER]
```

3.2.3.3 On-Off Mode

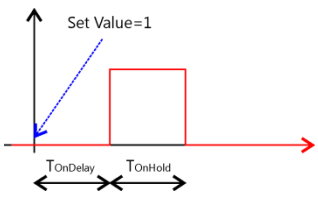


Fig. 15 On-Off Mode

In On-Off Mode the output channel generates a one-time sequence pattern shown in Fig. 15.

By using On-Off Mode time-controlled switching functions (e.g. used in timing relays) can be realized.

Setting the output value to "1" starts processing of the output handling by starting the $T_{OnDelay}$ interval (off-phase). After $T_{OnDelay}$ has passed the output changes to on-phase and T_{OnHold} interval starts. After T_{OnHold} time has passed output changes back to off-phase and the sequence finishes.

Writing "0" to the logical output value while being in off-phase stops the sequence in any case, preventing the output entering on-phase.

If the output value is set to "0" in on-phase, behavior depends on IO Configuration Parameter *outDi1CanCancel*.

In On-Off Mode the following two IO Configuration Parameters are relevant for timing configuration:

- Time $T_{OnDelay}$ is specified by the parameter *outDi1OnDelay*
- Time T_{OnHold} is specified by the parameter *outDi1OnHold*

Output Signal Value Inversion

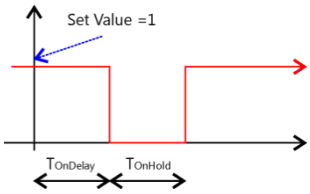


Fig. 16 On-Off Mode Output Inversion

Fig. 16 shows the output signal in case that the output signal inversion is enabled for the output channel (*outDi1Inverted* set to "on").

Cancelation of On-Phase

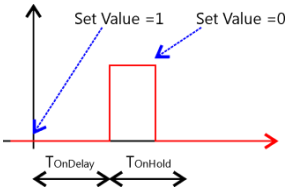


Fig. 17 On-Off Mode Cancel On Phase

f the IO Configuration Parameter *outDi1CanCancel* is set to "on", output processing can be stopped by writing "0" to the output channel value. This is shown in Fig. 17 where the on-phase is immediately interrupted before T_{OnHold} has passed.

Writing "0" to the logical output value while being in on on-phase is ignored if *outDi1CanCancel* is set to "off".

Retrigger of On-Phase

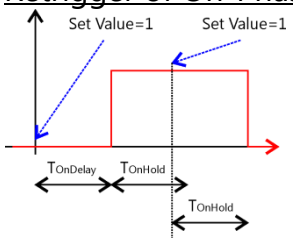


Fig. 18 On-Off Mode Retrigger

Fig. 18 shows the output timing sequence with IO Configuration Parameter *outDi1CanRetrigger* set to "on".

This setting allows retriggering the on-phase before the logical output returns to initial "0" value.

Setting the logical output value to "1" before T_{OnHold} has passed

restarts the T_{OnHold} interval.

LucidIoCtrl Command Line Tool Example

Configure output channel 4 for On-Off mode

```
LucidIoCtrl –dCOM4 –c4 –soutDi1Mode=onOff [ENTER]
```

By default, $T_{OnDelay}$ and T_{OnHold} are set to 1s.
After writing a "1" to the output value of channel 0 the output will be set after 1s to "1" returning to "0" after 1s more.

Start processing of output channel 4

```
LucidIoCtrl –dCOM4 –c4 –tL –w1 [ENTER]
```

3.3 Commands

LucidControl IO Modules can be accessed by a protocol which is fully documented in the general LucidControl manual.

This section describes in detail the commands, which are supported by the DI4DO4 module.

Digital IO Channel	Channel Number
DI0	0
DI1	1
DI2	2
DI3	3
DO0	4
DO1	5
DO2	6
DO3	7

Tab. 5 IO Connections and Channel Numbers

Tab. 5 lists the digital IO channels (→ Tab. 2, Tab. 3) and their channel numbers.

3.3.1 SetIo

This command sets one output value.

Mode	Value
Reflect	Value reflects the logic state to the output
Duty-Cycle	**Value** / 0: Processing disabled / 1: Processing enabled
On-Off	**Value** / 0: Processing disabled / 1: Processing enabled, triggered

Tab. 6 Value of Digtal Output Channel

Tab. 6 lists the digital output channel modes and how the IO value is interpreted.

Command	SetIo	**Access**	Write
Opcode	0x40		
LucidIoCtrl Command Line Tool			
Call (-tL)	`LucidIoCtrl –d[COMx] –c[Channel] –tL –w[Value]`		

LucidIoCtrl Command Line Tool Example

Set output channel 4 to "1"

```
LucidIoCtrl –dCOM4 –c4 –tL –w1 [ENTER]
```

Request Frame

OPC	**P1**	**P2**	**LEN**	**Data Field**
0x40	Channel	Value Type	Length	Value

Value	**Description**
Channel	Number of input or output channel (Range: 3 to 7)
Value Type	Value Type Supported Value Types **Value Type** / **Value Range** / **Length** Digital Logic Value (0x00) / 0 / 1 / 1 Byte
Length	Length of the Values in the Data Field
Value	Values accordingly to the Value Type

Tab. 7 SetIo Request

Response Frame

Status	**Length**
Status	0

Returns Execution Status Code documented in the general *LucidControl User Manual*.

3.3.2 SetIoGroup

This command sets the output values of a group of outputs.

Tab. 6 lists the digital output channel modes and how the IO value is interpreted.

Command	SetIoGroup	**Access**	Write
Opcode	0x42		
LucidIoCtrl Command Line Tool			
Call (-tL)	`LucidIoCtrl –d[COMx] –c[Channels] –tL –w[Values]` Channels Comma separated list of channels e.g. –c4,5,6 Values Comma separated list of values to set e.g. -w1,1,0		

LucidIoCtrl Command Line Tool Example

Set output channel 4 to "1", output channel 5 to "1" and output channel 6 to "0"

```
LucidIoCtrl –dCOM4 –c4,5,6 –tL –w1,1,0 [ENTER]
```

Request Frame

OPC	P1	P2	LEN	Data Field
0x40	Channel Mask	Value Type	Length	Values

<table>
<tr><th>Value</th><th>Description</th></tr>
<tr><td>Channel Mask</td><td>Channel Mask
Specifies the output channels to access
<table>
<tr><th>Channel</th><th>Bit Position</th><th>Value</th></tr>
<tr><td>4</td><td>4</td><td>0x10</td></tr>
<tr><td>5</td><td>5</td><td>0x20</td></tr>
<tr><td>6</td><td>6</td><td>0x40</td></tr>
<tr><td>7</td><td>P1A 0</td><td>P1=0x80
P1A = 0x01</td></tr>
</table>
Values are bitwise or combined
Size of P1 is 1 or 2 bytes. If Bit 7 of P1 is set, a subsequent P1A is expected.

<u>Examples</u>
Accessing channel numbers:
4, 5 and 7 Value P1 = 0x10 OR 0x20 OR 0x80= 0xB0
Value P1A = 0x01 (for channel 7)</td></tr>
<tr><td>Value Type</td><td>Value Type
Supported Value Types
<table>
<tr><th>Value Type</th><th>Value Range</th><th>Length</th></tr>
<tr><td>Digital Logic Value (0x00)</td><td>0x00 oder 0x01</td><td>1 Byte</td></tr>
</table></td></tr>
<tr><td>Length</td><td>Length of the Values in the Data Field (One Value for each channel)</td></tr>
<tr><td>Values</td><td>One or more values to set in ascending channel order</td></tr>
</table>

<u>Response Frame</u>

Status	Length
Status	0

Returns Execution Status Code documented in the general *LucidControl User Manual*.

<u>Example of SetIoGroup</u>

The following request frame sets:

- outputs 4 to “1”; output 5 to “1” and output 6 to “0”

<u>Request Frame</u>

OPC	P1	P1A	P2	LEN	Data Field
0x42	0xB0	0x01	0x00	0x03	Byte: 0 = 0x01, 1 = 0x01, 2 = 0x00

Values in Data Field are sorted in ascending channel order.

Response Frame

Status	Length
0x00	0x00

In case of an error, the command returns the Execution Status Code documented in the general *LucidControl User Manual*.

3.3.3 GetIo

This command reads the value or state of an input or output channel.

Input Mode	Value
Reflect	Logic input value 0 or 1
Edge Detection	Pending edge event detected value 0 or 1
Count	Counter value 0 to 65535

Tab. 8 Value of Digital Input Channel

Tab. 6 lists the digital output channel modes and how the IO value is interpreted.
Tab. 8 lists the digital input channel modes and how the IO value is interpreted.

Command	GetIo	**Access**	Read
Opcode	0x46		
LucidIoCtrl Command Line Tool			
Call (-tL)	`LucidIoCtrl -d[COMx] -c[Channel] -tL -r`		
Return	CHn:L n: Channel L: Digital Value		
Call (-tN)	`LucidIoCtrl -d[COMx] -c[Channel] -tN -r`		
Return	CHn:V n: Input Channel V: Input Count Value		

LucidIoCtrl Command Line Tool Example

Read back state of output channel 4

```
LucidIoCtrl -dCOM4 -c4 -tL -r [ENTER]
CH0:01
```

Read input channel 0 operating in Count Mode

```
LucidIoCtrl -dCOM4 -c0 -tN -r [ENTER]
CH0:0x0064 (100)
```

Request Frame

OPC	P1	P2	LEN
0x46	Channel	Value Type	0

<table>
<tr><th>Value</th><th>Description</th></tr>
<tr><td>Channel</td><td>Number of input or output channel (Range: 0 to 3)</td></tr>
<tr><td>Value Type</td><td>Supported Value Types
<table>
<tr><th>Value Type</th><th>Value Range</th><th>Response Len</th></tr>
<tr><td>Digital Logic Value (0x00)</td><td>0 / 1</td><td>1 Byte</td></tr>
<tr><td>Digital Counter Value (0x0A)</td><td>0 ~ 65,535</td><td>2 Bytes</td></tr>
</table></td></tr>
</table>

Response Frame

Status	LEN	Data Field
Status	Length	Value

In case of successful execution, the command returns the value of the specified channel number.

In case of an error, the command returns the Execution Status Code documented in the general *LucidControl User Manual*.

3.3.4 GetIoGroup

This command reads the input or output values of a group of IO of the same Value Type.

Tab. 6 lists the digital output channel modes and how the IO value is interpreted.
Tab. 8 lists the digital input channel modes and how the IO value is interpreted.

<table>
<tr><td>Command</td><td>GetIoGroup</td><td>Access</td><td>Read</td></tr>
<tr><td>Opcode</td><td>0x48</td><td></td><td></td></tr>
<tr><td colspan="4">LucidIoCtrl Command Line Tool</td></tr>
<tr><td>Call (-tL)</td><td colspan="3"><code>LucidIoCtrl –d[COMx] –c[Channels] –tL –r</code>

<u>Channels</u>
Comma separated list of channels e.g. –c0,1,7</td></tr>
<tr><td>Return</td><td colspan="3">List of values sorted from lower to higher channels
CHn:L
<table><tr><td>n</td><td>Channel</td></tr><tr><td>L</td><td>Digital Value</td></tr></table></td></tr>
<tr><td>Call (-tN)</td><td colspan="3"><code>LucidIoCtrl –d[COMx] –c[Channels] –tN –r</code></td></tr>
<tr><td>Return</td><td colspan="3">CHn:V
<table><tr><td>n</td><td>Input Channel</td></tr><tr><td>V</td><td>Input Count Value</td></tr></table></td></tr>
</table>

<u>LucidIoCtrl Command Line Tool Example</u>

Read digital input channels 0, 1 and digital output channel 7.

```
LucidIoCtrl –dCOM4 –c0,1,7 –tL –r [ENTER]
CH0:00  CH1:01  CH7:01
```

<u>Request Frame</u>

OPC	P1	P2	LEN
0x48	Channel Mask	Value Type	0

<table>
<tr><th>Value</th><th>Description</th></tr>
<tr><td>Channel Mask</td><td>
Channel Mask
Specifies the IO channels to access
<table>
<tr><th>Channel</th><th>Bit Position</th><th>Value</th></tr>
<tr><td>0</td><td>0</td><td>0x01</td></tr>
<tr><td>1</td><td>1</td><td>0x02</td></tr>
<tr><td>2</td><td>2</td><td>0x04</td></tr>
<tr><td>3</td><td>3</td><td>0x08</td></tr>
<tr><td>4</td><td>4</td><td>0x10</td></tr>
<tr><td>5</td><td>5</td><td>0x20</td></tr>
<tr><td>6</td><td>6</td><td>0x40</td></tr>
<tr><td>7</td><td>P1A 0</td><td>P1=0x80
P1A = 0x01</td></tr>
</table>
Values are bitwise or combined
Size of P1 is 1 or 2 bytes. If Bit 7 of P1 is set, a subsequent P1A is expected.

<u>Examples</u>
Accessing channel numbers:
0 and 3 Value = 0x01 OR 0x08 = 0x09
1 and 2 Value = 0x02 OR 0x04 = 0x06
1, 2 and 7 Value P1 = 0x02 OR 0x04 = 0x86
Value P1A = 0x01 (for channel 7)
</td></tr>
<tr><td>Value Type</td><td>
Supported Value Types
<table>
<tr><th>Value Type</th><th>Value Range</th><th>Response Len</th></tr>
<tr><td>Digital Logic Value (0x00)</td><td>0 / 1</td><td>1 Byte</td></tr>
</table>
</td></tr>
</table>

<u>Response Frame</u>

Status	LEN	Data Field
Status	Length	Value(s)

In case of successful execution, the command returns the read values of the channels specified in the Channel Mask in channel number ascending order.

In case of an error, the command returns the Execution Status Code documented in the general *LucidControl User Manual*.

Example of GetIoGroup Request
Request frame reads input channels 0, 1 and output channel 7

Opcode	P1	P1A	P2	Length
0x48	0x83	0x01	0x00	0x00

Response Frame
Channel 0 = "0", channel 1 = "1", channel 7 = "1"

Header Field		Data Field		
Status	LEN	Value Channel 0	Value Channel 1	Value Channel 7
0x00	0x03	0x00	0x01	0x01

3.4 Parameters

LucidControl modules are configured by a set of System Configuration Parameters and IO Configuration Parameters.

The parameters are accessible by the SetParam and GetParam command which are described in the general *LucidControl User Manual*.

The DI4DO4 modules mixes input and output channels what made it necessary to rename parameter names and change parameter addresses.

3.4.1 Digital Input Channels

3.4.1.1 inDi0Value

This IO Configuration Parameter reflects the value of the input channel.

In Reflect Mode and Edge Detection Mode the parameter contains the input value as it can also be read by GetIo or GetIoGroup command.

If the input is configured in Count Mode this parameter is "0".

Parameter	*inDi0Value*	**Access**	Read
Address	0x1400		
Values	Input Value		
Default Value	0x00	**Parameter Type**	1 Byte unsigned
LucidIoCtrl Command Line Tool			
Parameter Name	*inDi0Value*	**Parameter Values**	0 / 1
Call (Get)	`LucidIoCtrl -d[COMx] -c[Channel] -ginDi0Value`		

LucidIoCtrl Command Line Tool Example
Read value of input channel 0.

```
LucidIoCtrl –dCOM4 –c0 –ginDi0Value [ENTER]
inDi0Value=0
```

3.4.1.2 inDi0Mode

This IO Configuration parameter configures the operation mode of the input.

Parameter	*inDi0Mode*	**Access**	Read / Write
Address	0x1500		
Values	Input Mode **Byte** / **Mode** 0x00 inactive 0x01 reflect 0x10 risingEdge 0x11 fallingEdge 0x20 count		
Default Value	0x00	**Parameter Type**	1 Byte unsigned
LucidIoCtrl Command Line Tool			
Parameter Name	*inDi0Mode*	**Parameter Values**	Mode
Call (Set)	`LucidIoCtrl –d[COMx] –c[Channel] –sinDi0Mode=[Mode] {-p} {--default}`		
Call (Get)	`LucidIoCtrl –d[COMx] –c[Channel] –ginDi0Mode`		

LucidIoCtrl Command Line Tool Example

Set operation mode of input channel 0 to Count Mode and make the setting persistent.

```
LucidIoCtrl –dCOM4 –c0 –sinDi0Mode=count –p [ENTER]
```

Read the operation mode of input channel 0

```
LucidIoCtrl –dCOM4 –c0 –ginDi0Mode [ENTER]
inDi0Mode=count
```

3.4.1.3 inDi0Flags

This IO Configuration Parameter groups configuration settings which are represented by one bit.

Parameter	*inDi0Flags*	**Access**	Read / Write
Address	0x1501		
Values	Bit Parameters **Bit Parameter** / **Bit Postion** *inDi0AddCounter* Bit 0 *inDi0ResetCounterOnRead* Bit 1 *inDi0Inverted* Bit 2		
Default Value	0x00	**Parameter Type**	1 Byte unsigned

The parameter *inDi0Flags* cannot be accessed directly by using the Command Line Tool. The Bit Parameters can be used instead.

If *inDi0Flags* is changed by the SetParam command this must be done in a read-modify-write sequence in order to prevent overwriting other bit parameters.

3.4.1.3.1 inDi0Inverted

This Bit Parameter configures the input signal value inversion.

Parameter	*inDi0Flags*	**Access**	Read / Write
Address	0x1501	Parameter bit *inDi0Flags*	
Values	**Bit Parameter**: *inDi0Inverted* — **Bit Postion**: Bit 2		
Default Value	Off	**Parameter Type**	1 Bit
LucidIoCtrl Command Line Tool			
Parameter Name	*inDi0Inverted*	**Parameter Values**	on / off
Call (Set)	`LucidIoCtrl –d[COMx] –c[Channel] –sinDi0Inverted=[Value] {-p} {--default}`		
Call (Get)	`LucidIoCtrl –d[COMx] –c[Channel] –ginDi0Inverted`		

LucidIoCtrl Command Line Tool Example

Enable input signal value inversion of input channel 0 and make the setting persistent.

```
LucidIoCtrl –dCOM4 –c0 –sinDi0Inverted=on –p [ENTER]
```

Read input signal value inversion flag of input channel 0

```
LucidIoCtrl –dCOM4 –c0 –ginDi0Inverted [ENTER]
inDi0Inverted=on
```

3.4.1.3.2 inDi0AddCounter

This Bit Parameter controls how the counter value is updated after count interval time T_{Count} has finished. It is relevant in Count Mode only.

Parameter	*inDi0Flags*	**Access**	Read / Write
Address	0x1501	Parameter bit *inDi0Flags*	
Values	**Bit Parameter**: *inDi0AddCounter* — **Bit Postion**: Bit 0		
Default Value	Off	**Parameter Type**	1 Bit
LucidIoCtrl Command Line Tool			
Parameter Name	*inDi0AddCounter*	**Parameter Values**	on / off
Call (Set)	`LucidIoCtrl –d[COMx] –c[Channel] –sinDi0AddCounter=[Value] {-p} {--default}`		
Call (Get)	`LucidIoCtrl –d[COMx] –c[Channel] –ginDi0AddCounter`		

LucidIoCtrl Command Line Tool Example

Enable counter add on update for input channel 0 and make the setting persistent.

```
LucidIoCtrl –dCOM4 –c0 –sinDi0AddCounter=on –p [ENTER]
```

Read counter add setting of input channel 0

```
LucidIoCtrl –dCOM4 –c0 –ginDi0AddCounter [ENTER]
inDi0AddCounter=on
```

3.4.1.3.3 inDi0ResetCounterOnRead

This Bit Parameter controls how to update the counter value after it was read. It is relevant in Count Mode only.

Parameter	*inDi0Flags*	**Access**	Read / Write
Address	0x1501	Parameter bit *inDi0Flags*	
Values	**Bit Parameter** / **Bit Postion**: *inDi0ResetCounterOnRead* / Bit 1		
Default Value	Off	**Parameter Type**	1 Bit
LucidIoCtrl Command Line Tool			
Parameter Name	*inDi0ResetCounterOnRead*	**Parameter Values**	on / off
Call (Set)	`LucidIoCtrl –d[COMx] –c[Channel] –sinDi0ResetCounterOnRead=[Value] {-p} {--default}`		
Call (Get)	`LucidIoCtrl –d[COMx] –c[Channel] –ginDi0ResetCounterOnRead`		

LucidIoCtrl Command Line Tool Example

Enable counter reset on read for input channel 0 and make the setting persistent.

```
LucidIoCtrl –dCOM4 –c0 –sinDi0ResetCounterOnRead=on –p [ENTER]
```

Read counter reset setting of input channel 0

```
LucidIoCtrl –dCOM4 –c0 –ginDi0ResetCounterOnRead [ENTER]
inDi0ResetCounterOnRead=on
```

3.4.1.4 inDi0ScanTime

This IO Configuration Parameter specifies the scan time T_{Scan} of the digital input.

T_{Scan} defines the scan time interval within the input signal must be stable in order to detect it as valid.

Parameter	*inDi0ScanTime*	**Access**	Read / Write
Address	0x1511		
Values	T_{Scan} in µs (micro seconds) 80 µs ≤ T_{Scan} ≤ 1 s		
Default Value	50,000 (50 ms)	**Parameter Type**	4 Bytes unsigned
LucidIoCtrl Command Line Tool			
Parameter Name	*inDi0ScanTime*	**Parameter Values**	Time [µs]
Call (Set)	`LucidIoCtrl –d[COMx] –c[Channel] –sinDi0ScanTime=[Time] {-p} {--default}`		
Call (Get)	`LucidIoCtrl –d[COMx] –c[Channel] –ginDi0ScanTime`		

LucidIoCtrl Command Line Tool Example

Set T_{Scan} of input channel 0 to 1.5 s and make the setting persistent.

```
LucidIoCtrl –dCOM4 –c0 –sinDi0ScanTime=1500000 –p [ENTER]
```

Read T_{Scan} parameter of input channel 0

```
LucidIoCtrl –dCOM4 –c0 –ginDi0ScanTime [ENTER]
inDi0ScanTime=1500000
```

3.4.1.5 inDi0CountTime

This IO Configuration Parameter specifies the count time T_{Count} of the digital input in Count Mode.

The count interval specifies the time during which pulses of the input signal are accumulated.

Parameter	*inDi0CountTime*	**Access**	Read / Write
Address	0x1512		
Values	T_{Count} in µs (micro seconds) 1 ms ≤ T_{Count} ≤ 1 h		
Default Value	5,000,000 (5 s)	**Parameter Type**	4 Bytes unsigned
LucidIoCtrl Command Line Tool			
Parameter Name	*inDi0CountTime*	**Parameter Values**	Time [µs]
Call (Set)	`LucidIoCtrl –d[COMx] –c[Channel] –sinDi0CountTime=[Time] {-p} {--default}`		
Call (Get)	`LucidIoCtrl –d[COMx] –c[Channel] –ginDi0CountTime`		

LucidIoCtrl Command Line Tool Example

Set T_{Count} of input channel 0 to 10 s and make the setting persistent.

```
LucidIoCtrl –dCOM4 –c0 –sinDi0CountTime=10000000 –p [ENTER]
```

Read T_{Count} parameter of input channel 0

```
LucidIoCtrl –dCOM4 –c0 –ginDi0CountTime [ENTER]
inDi0CountTime=10000000
```

3.4.2 Digital Output Channels

3.4.2.1 outDi1Value

This IO Configuration Parameter reflects the value or the state of the output (see Tab. 6).

In the case the output is in Reflect mode the *outDi1Value* contains the logic value of the output.

In the case that the output is in Duty-Cycle or On-Off mode *outDi1Value* contains "1" in the case that the output processing is running and "0" in the case that the output processing is stopped.

Parameter	*outDi1Value*	**Access**	Read / Write
Address	0x1800		
Values	Output Value		
Default Value	0x00	**Parameter Type**	1 Byte unsigned
LucidIoCtrl Command Line Tool			
Parameter Name	*outDi1Value*	**Parameter Values**	0 / 1
Call (Set)	`LucidIoCtrl –d[COMx] –c[Channel] –soutDi1Value=[Value] {-p} {--default}`		
Call (Get)	`LucidIoCtrl –d[COMx] –c[Channel] –goutDi1Value`		

LucidIoCtrl Command Line Tool Example

Set value of output channel 4 to "1" and make the setting persistent.

```
LucidIoCtrl –dCOM4 –c4 –soutDi1Value=1 –p [ENTER]
```

Read value or state of output channel 0.

```
LucidIoCtrl –dCOM4 –c4 –goutDi1Value [ENTER]
outDi1Value=0
```

Setting *outDi1Value* allows to assign a persistent value by means that the output value is restored after the module is restarted.

3.4.2.2 outDi1Mode

This IO Configuration parameter configures the operation mode of the output.

<table>
<tr><td>Parameter</td><td>outDi1Mode</td><td>Access</td><td>Read / Write</td></tr>
<tr><td>Address</td><td>0x1900</td><td colspan="2"></td></tr>
<tr><td>Values</td><td colspan="3">Output Mode<table><tr><th>Byte</th><th>Mode</th></tr><tr><td>0x00</td><td>Inactive</td></tr><tr><td>0x01</td><td>Reflect</td></tr><tr><td>0x08</td><td>On-Off</td></tr><tr><td>0x0A</td><td>Duty-Cycle</td></tr></table></td></tr>
<tr><td>Default Value</td><td>0x01</td><td>Parameter Type</td><td>1 Byte unsigned</td></tr>
<tr><td colspan="4">LucidIoCtrl Command Line Tool</td></tr>
<tr><td>Parameter Name</td><td>outDi1Mode</td><td>Parameter Values</td><td>incactive / reflect / onOff / dutyCycle</td></tr>
<tr><td>Call (Set)</td><td colspan="3"><code>LucidIoCtrl -d[COMx] -c[Channel] -soutDi1Mode=[Value] {-p} {--default}</code></td></tr>
<tr><td>Call (Get)</td><td colspan="3"><code>LucidIoCtrl -d[COMx] -c[Channel] -goutDi1Mode</code></td></tr>
</table>

LucidIoCtrl Command Line Tool Example

Set operation mode of channel 4 to Duty-Cycle Mode and make the setting persistent.

```
LucidIoCtrl -dCOM4 -c4 -soutDi1Mode=dutyCycle -p [ENTER]
```

Read the operation mode of channel 4

```
LucidIoCtrl -dCOM4 -c4 -goutDi1Mode [ENTER]
outDi1Mode=dutyCycle
```

3.4.2.3 Bit Parameter outDi1Flags

This IO Configuration Parameter groups configuration settings which are represented by one bit.

Parameter	*outDi1Flags*	**Access**	Read / Write
Address	0x1901		
Values	The "bit container" consists of the following parameters. **Bit Parameter** / **Bit Postion** *outDi1CanRetrigger* / Bit 0 *outDi1CanCancel* / Bit 1 *outDi1Inverted* / Bit 2		
Default Value	0x00	**Parameter Type**	1 Byte unsigned

The parameter *outDi1Flags* cannot be accessed directly by using the Command Line Tool. The Bit Parameters can be used instead.

If *outDi1Flags* is changed by the SetParam command this must be done in a read-modify-write sequence in order to prevent overwriting other bit parameters.

3.4.2.3.1 outDi1Inverted

This Bit Parameter configures the output signal value inversion.

Parameter	*outDi1Flags*	**Access**	Read / Write
Address	0x1901	Bit Parameter *outDi1Flags*	
Values	**Bit Parameter** / **Bit Postion** *outDi1Inverted* / Bit 2		
Default Value	Off	**Parameter Type**	1 Bit
LucidIoCtrl Command Line Tool			
Parameter Name	*outDi1Inverted*	**Parameter Values**	on / off
Call (Set)	`LucidIoCtrl –d[COMx] –c[Channel] –soutDi1Inverted=[Value] {-p} {--default}`		
Call (Get)	`LucidIoCtrl –d[COMx] –c[Channel] –goutDi1Inverted`		

LucidIoCtrl Command Line Tool Example

Enable output signal value inversion of output channel 4 and make the setting persistent.

```
LucidIoCtrl –dCOM4 –c4 –soutDi1Inverted=on –p [ENTER]
```

Read output signal value inversion flag of output channel 4.

```
LucidIoCtrl –dCOM4 –c4 –goutDi1Inverted [ENTER]
outDi1Inverted=on
```

3.4.2.3.2 outDi1CanCancel

This Bit Parameter configures the output on-phase cancelation.

Parameter	*outDi1Flags*	**Access**	Read / Write
Address	0x1901	Bit Parameter *outDi1Flags*	
Values	**Bit Parameter** / **Bit Postion**: *outDi1CanCancel* / Bit 1		
Default Value	Off	**Parameter Type**	1 Bit
LucidIoCtrl Command Line Tool			
Parameter Name	*outDi1CanCancel*	**Parameter Values**	on / off
Call (Set)	`LucidIoCtrl –d[COMx] –c[Channel] –soutDi1CanCancel=[Value] {-p} {--default}`		
Call (Get)	`LucidIoCtrl –d[COMx] –c[Channel] –goutDi1CanCancel`		

LucidIoCtrl Command Line Tool Example

Enable output cancelation flag for output channel 4 and make the setting persistent.

```
LucidIoCtrl –dCOM4 –c4 –soutDi1CanCancel=on –p [ENTER]
```

Read output configuration cancelation flag of output channel 4

```
LucidIoCtrl –dCOM4 –c4 –goutDi1CanCancel [ENTER]
outDi1CanCancel=on
```

3.4.2.3.3 outDi1CanRetrigger

This Bit Parameter configures the on-phase retrigger function of the output.

See the output modes descriptions in section 3.2.2 for more information.

Parameter	*outDi1Flags*	**Access**	Read / Write
Address	0x1901	Bit Parameter *outDi1Flags*	
Values	**Bit Parameter** / **Bit Postion**: *outDi1CanRetrigger* / Bit 0		
Default Value	Off	**Parameter Type**	1 Bit
LucidIoCtrl Command Line Tool			
Parameter Name	*outDi1CanRetrigger*	**Parameter Values**	on / off
Call (Set)	`LucidIoCtrl –d[COMx] –c[Channel] –soutDi1CanRetrigger=[Value] {-p} {--default}`		
Call (Get)	`LucidIoCtrl –d[COMx] –c[Channel] –goutDi1CanRetrigger`		

LucidIoCtrl Command Line Tool Example

Enable output retrigger of channel 4 and make the setting persistent.

```
LucidIoCtrl –dCOM4 –c4 –soutDi1CanRetrigger=on –p [ENTER]
```

Read output retrigger configuration of output channel 4

```
LucidIoCtrl –dCOM4 –c4 –goutDi1CanRetrigger [ENTER]
outDi1CanRetrigger=on
```

3.4.2.4 outDi1CycleTime

This IO Configuration Parameter specifies the cycle time T_{Cycle} of an output in Duty-Cycle Mode.

Parameter	*outDi1CycleTime*	**Access**	Read / Write
Address	0x1910		
Values	T_{Cycle} in µs (micro seconds) $T_{Res} \leq T_{Cycle} \leq 1$ h		
Default Value	1,000,000 (1 s)	**Parameter Type**	4 Bytes unsigned
LucidIoCtrl Command Line Tool			
Parameter Name	*outDi1CycleTime*	**Parameter Values**	Time [µs]
Call (Set)	`LucidIoCtrl –d[COMx] –c[Channel] –soutDi1CycleTime=[Time] {-p} {--default}`		
Call (Get)	`LucidIoCtrl –d[COMx] –c[Channel] –goutDi1CycleTime`		

LucidIoCtrl Command Line Tool Example

Set T_{Cycle} of output channel 4 to 1.5 s and make the setting persistent.

```
LucidIoCtrl –dCOM4 –c4 –soutDi1CycleTime=1500000 –p [ENTER]
```

Read T_{Cycle} parameter of output channel 4

```
LucidIoCtrl –dCOM4 –c4 –goutDi1CycleTime [ENTER]
outDi1CycleTime=1500000
```

Note

Timing limits for T_{Res} (see 3.2.2) have to be considered.

3.4.2.5 outDi1DutyCycle

This IO Configuration Parameter specifies the Duty-Cycle of an output in Duty-Cycle mode.

Parameter	*outDi1DutyCycle*	**Access**	Read / Write
Address	0x1911		
Values	Duty Cycle in ‰ (1 / 1000)		
Default Value	500 (50%)	**Parameter Type**	2 Bytes unsigned
LucidIoCtrl Command Line Tool			
Parameter Name	*outDi1DutyCycle*	**Parameter Values**	Duty Cycle [‰]
Call (Set)	`LucidIoCtrl –d[COMx] –c[Channel] –soutDi1DutyCycle=[Value] {-p} {--default}`		
Call (Get)	`LucidIoCtrl –d[COMx] –c[Channel] –goutDi1DutyCylce`		

LucidIoCtrl Command Line Tool Example

Set Duty Cycle of output channel 4 to 20% and make the setting persistent.

```
LucidIoCtrl –dCOM4 –c4 –soutDi1DutyCycle=200 –p [ENTER]
```

Read Duty Cycle setting for output channel 0

```
LucidIoCtrl –dCOM4 –c4 –goutDi1DutyCycle [ENTER]
outDi1DutyCycle=200
```

Note

Timing limits (see 3.2.2) have to be considered.

3.4.2.6 outDi1OnDelay

This IO Configuration Parameter specifies the on-delay time $T_{OnDelay}$ of an output in On-Off Mode.

Parameter	*outDi1OnDelay*	**Access**	Read / Write
Address	0x1912		
Values	$T_{OnDelay}$ in µs (micro seconds) $T_{Res} \leq T_{OnDelay} \leq 1$ h		
Default Value	1,000,000 (1 s)	**Parameter Type**	4 Bytes unsigned
LucidIoCtrl Command Line Tool			
Parameter Name	*outDi1OnDelay*	**Parameter Values**	Time [µs]
Call (Set)	`LucidIoCtrl –d[COMx] –c[Channel] –soutDi1OnDelay=[Time] {-p} {--default}`		
Call (Get)	`LucidIoCtrl –d[COMx] –c[Channel] –goutDi1OnDelay`		

LucidIoCtrl Command Line Tool Example

Set $T_{OnDelay}$ of output channel 4 to 520 ms and make the setting persistent.

```
LucidIoCtrl –dCOM4 –c4 –soutDi1OnDelay=520000 –p [ENTER]
```

Read $T_{OnDelay}$ setting for output channel 0

```
LucidIoCtrl –dCOM4 –c4 –goutD1iOnDelay [ENTER]
outDi1OnDelay=520000
```

Note

Timing limits (see 3.2.2) have to be considered.

3.4.2.7 outDi1OnHold

This IO Configuration Parameter specifies the on-hold time T_{OnHold} of an output in On-Off Mode.

Parameter	*outDi1OnHold*	**Access**	Read / Write
Address	0x1913		
Values	T_{OnHold} in µs (micro seconds) $T_{Res} \leq T_{OnHold} \leq 1$ h		
Default Value	1,000,000 (1 s)	**Parameter Type**	4 Bytes unsigned
LucidIoCtrl Command Line Tool			
Parameter Name	*outDi1OnHold*	**Parameter Values**	Time [µs]
Call (Set)	`LucidIoCtrl –d[COMx] –c[Channel] –soutDi1OnHold=[Time] {-p} {--default}`		
Call (Get)	`LucidIoCtrl –d[COMx] –c[Channel] –goutDi1OnHold`		

LucidIoCtrl Command Line Tool Example

Set T_{OnHold} of output channel 4 to 1200 ms and make the setting persistent.

```
LucidIoCtrl –dCOM4 –c4 –soutDi1OnHold=1200000 –p [ENTER]
```

Read T_{OnHold} setting of output channel 4

```
LucidIoCtrl –dCOM4 –c4 –goutDi1OnHold [ENTER]
outDi1OnHold=1200000
```

Note
Timing limits (see 3.2.2) have to be considered.

4 Specification

Parameter		Condition	Value	
Inputs				
	No of Input Channels		4	
Inputs - Electrical Characteristics				
	Input Signal Maximum Low Level	5V	$U_{05MaxLow}$	2.5 V
		10V	$U_{10MaxLow}$	6.0 V
		24V	$U_{24MaxLow}$	16.0 V
	Input Signal Minimum High Level	5V	$U_{05MinHigh}$	3.5 V
		10V	$U_{10MinHigh}$	8.5 V
		24V	$U_{24MinHigh}$	21.0 V
	Input Signal Maximum Voltage Note1	5V	U_{5Max}	7.5 V
		10V	U_{10Max}	15 V
		24V	U_{24Max}	30 V
	Input Impedance		R_{In}	> 1 kΩ
Inputs – Timing Characteristic				
	T_{Scan}		$t_{Min} < T_{Scan} < 1$ s	
	T_{Count}		1 ms < T_{Count} < 1 h	
	Minimum pulse length		t_{Min}	100 µs
	Maximum Frequency of Input Signal in Count Mode	DC 50 %	2,000 Hz	
		20% > DC < 80%	500 Hz	
Outputs				
	No of Output Channels		4	
Outputs - Electrical Characteristics				
	Maximum Rated Load Current Note2		I_{SSRMax}	750 mA
	Maximum Rated Load Voltage		U_{SSRMax}	24 V
	Maximum On Resistance		R_{SSR}	0.25 Ω
Outputs – Timing Characteristic				
	Minimum Resolution t_{Res}		10 ms	
	T_{Cycle}, $T_{OnDelay}$, T_{OnHold}		$t_{Res} < T < 3600$ s	
Module – Communication				
	USB		2.0 Full Speed CDC Profile	
Module – Electrical Characteristics				
	Power Supply		USB power supplied	
	Maximum Rated Supply Current			40 mA
Module – Environment				

	Temperature	Storage	-20 °C … +70 °C
		Operation	0 °C … +55 °C
	Humidity		< 85 % RH, non-condensing
Module – Housing			
	Dimensions L x W x H		90 x 54 x 62 mm
	Weight (in total)		120 g
	Assembly		Rail-Mount (EN 50022, TS35)
	Protection Class (DIN 40050)		IP20
Module - Indicators			
	• Operation and Error Indicator • Communication Indicator • Indicator Input Output State (Enabled / Disabled)		

Tab. 9 Technical Specification

Note1 Maximum forward and reverse voltage

Note2 Output channels are able to control resistive loads only. For inductive loads additional protection is necessary.

5 Order Information

Format of order code: LCTR-DI4-*voltage*-DO4-I

Order Code	Product
LCTR-DI4-5-DO4-I	LucidControl USB IO Module with 4 insulated 5V Input Channels and 4 Solid State Relay (SSR) Output Channels
LCTR-DI4-10-DO4-I	LucidControl USB IO Module with 4 insulated 10V Input Channels and 4 Solid State Relay (SSR) Output Channels
LCTR-DI4-24-DO4-I	LucidControl USB IO Module with 4 insulated 24V Input Channels and 4 Solid State Relay (SSR) Output Channels

Tab. 10 Order Information

6 Document Revision

Date	Rev.	
2022/02/03	1.0	Initial documentation

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