



User Manual

LucidControl AO4/AO8

4/8 Channel Analog Output USB Module

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1 Introduction

This document describes the functionality of the LucidControl AO4/AO8 USB module generating 4/8 analog voltages or currents controllable via Universal Serial Bus.

This document explains functions which are specific to the AO4/AO8 module.

2 Setup and Installation

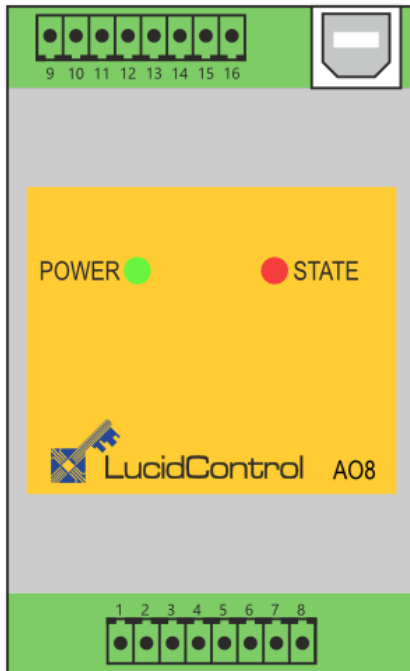


Fig. 1 Analog Output Module AO8

Fig. 1 shows the sketch of the Analog Output AO8 module with 8 analog voltage or current outputs.

Each IO connector has 8 terminals, one positive and one negative pin.

The lower IO connector is used for channels 0 to 3.

The upper IO connector available on the AO8 analog input module only. It is used for the channels 4 to 7.

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



For the analog output module it is explicitly stated that no potential of any external power source must be applied to any connector of the module. The modules must only be used within the specified conditions.

2.2 Configurations

Module Type	Type Number	Output Voltage Range	
		V _{Min}	V _{Max}
Voltage Outputs	LCTR-AOn-5	0 V	5 V
	LCTR-AOn-10	0 V	10 V
	LCTR-AOn-24	0 V	24 V

Tab. 1 Output Voltage Range

Module Type	Type Number	Output Voltage Range	
		I _{Min}	I _{Max}
Current Outputs	LCTR-AOn-20M0	0 mA ¹⁾	20 mA
	LCTR-AOn-20M4	4 mA	20 mA

Tab. 2 Output Current Range

Note:

- 1) A minimum saturation current remains on the output. See I_{ChMin} in specification.

Tab. 1 and Tab. 2 list the available output types and their value ranges.

2.3 Interface and Interconnection

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.

LucidControl AO4/AO8 module is rated with a maximum current of 250 mA.

2.3.2 IO Connection

2.3.2.1 Voltage Outputs

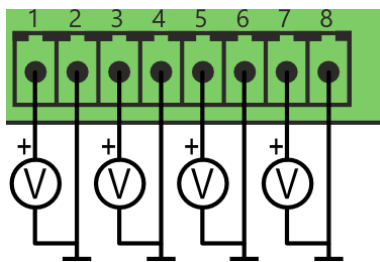


Fig. 2 shows the connection of 4 voltmeters connected to the IO terminals of channels 0 to 3 of the AO4/AO8 module.

Fig. 2 AO4/AO8 Voltage Outputs

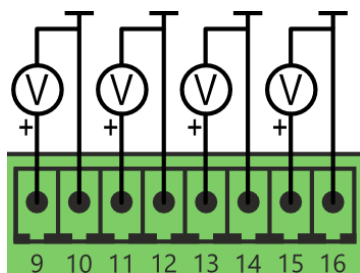


Fig. 3 shows the connection of 4 voltmeters connected to the IO terminals of channels 4 to 7 of the AO8 module.

Fig. 3 AO8 Voltage Outputs

Uneven IO terminal numbers are connected with the positive voltage output signal, even IO terminal numbers are connected to ground signal.

2.3.2.2 Current Outputs

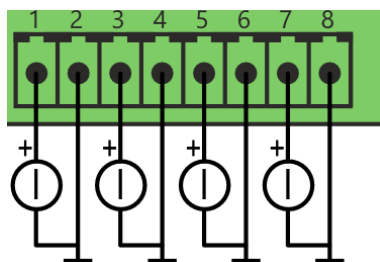


Fig. 4 shows 4 currentmeters connected to the IO terminals of channels 0 to 3 of the AO4-I/AO8-I module.

Fig. 4 AO4-I/AO8-I Current Outputs

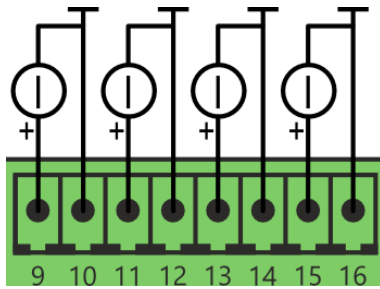


Fig. 5 shows 4 current meters connected to the IO terminals of channels 4 to 7 of the AO8-I module.

Fig. 5 AO8-I Current Outputs

Uneven IO terminal numbers are connected with the positive current output signal, even IO terminal numbers are connected to ground signal.

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/ttyACMn` 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/ttyACMn` device.

2.4.3 LucidloCtrl Command Line Tool

The LucidloCtrl 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:

For all examples it is assumed that the module is connected to COM1.

Set the values of all 4 voltage output channels. Value of CH0 = 5.000 V, CH1 = 2.500 V, CH2 = 1.250 V, CH3 = 0.625 V

```
LucidIoCtrl -dCOM1 -tV -c0,1,2,3 -w5.000,2.500,1.250,0.625 [ENTER]
```

Set the values of all 4 current output channels. Value of CH0 = 5.000 mA, CH1 = 2.500 mA, CH2 = 1.250 mA, CH3 = 0.625 mA

```
LucidIoCtrl -dCOM1 -tC -c0,1,2,3 -w5.000,2.500,1.250,0.625 [ENTER]
```

Linux Examples:

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

Set the values of all 4 output channels. Value of CH0 = 5.000 V, CH1 = 2.500 V, CH2 = 1.250 V, CH3 = 0.625 V

```
LucidIoCtrl -d/dev/ttyACM0 -tV -c0,1,2,3 -w5.000,2.500,1.250,0.625 [ENTER]
```

Set the values of all 4 current output channels. Value of CH0 = 5.000 mA, CH1 = 2.500 mA, CH2 = 1.250 mA, CH3 = 0.625 mA

```
LucidIoCtrl -d/dev/ttyACM0 -tC -c0,1,2,3 -w5.000,2.500,1.250,0.625 [ENTER]
```

3 Module Operation

The LucidControl AO4/AO8 Analog Output Module generates 4/8 independent output voltage or current signals.

3.1 Operation Modes

3.1.1 Inactive Mode

Setting an output to inactive mode disables processing of the output and sets the output voltage to minimum value (e.g. 0 V).

Setting an output to Inactive Mode does not suspend the output processing and refreshing but forces the output voltage to minimum value.

3.1.2 Standard Mode

In standard mode the processing of the analog output is executed.

3.2 Offset Compensation

The value of the IO Configuration Parameter *outAnOffset* (see 3.4.4) is added to the output value.

3.3 Commands

3.3.1 Setlo

This command sets the output signal of one output channel.

Command	Setlo	Access	Write
Opcode	0x40		
LucidIoCtrl Command Line Tool			
Call (-tV)	LucidIoCtrl -d[COMx] -c[Channel] -tV -w[Voltage]		
Call (-tC)	LucidIoCtrl -d[COMx] -c[Channel] -tC -w[Current]		

LucidIoCtrl Command Line Tool Example

Set output channel 0 to 2.540 V:

```
LucidIoCtrl -dCOM4 -c0 -tV -w2.540 [ENTER]
```

Set output channel 0 to 10 mA:

```
LucidIoCtrl -dCOM4 -c0 -tC -w10 [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: 0 to 7)												
Value Type	Value Type Supported Value Types												
	<table border="1"> <thead> <tr> <th>Value Type</th> <th>Value Range</th> <th>Length</th> </tr> </thead> <tbody> <tr> <td>Signed Voltage Resolution 1 μV (0x1D)</td> <td>-100,000,000 μV ~ 100,000,000 μV (-100 V ~ 100 V)</td> <td>4 Bytes</td> </tr> <tr> <td>Signed Voltage Resolution 1 mV (0x1C)</td> <td>-30,000 mV ~ 30,000 mV (-30 V ~ 30 V)</td> <td>2 Bytes</td> </tr> <tr> <td>Signed Current Resolution 1nA (0x23)</td> <td>-1,000,000,000 nA ~ 1,000,000,000 nA (-1 A ~ 1A)</td> <td>4 Bytes</td> </tr> </tbody> </table>	Value Type	Value Range	Length	Signed Voltage Resolution 1 μ V (0x1D)	-100,000,000 μ V ~ 100,000,000 μ V (-100 V ~ 100 V)	4 Bytes	Signed Voltage Resolution 1 mV (0x1C)	-30,000 mV ~ 30,000 mV (-30 V ~ 30 V)	2 Bytes	Signed Current Resolution 1nA (0x23)	-1,000,000,000 nA ~ 1,000,000,000 nA (-1 A ~ 1A)	4 Bytes
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Signed Current Resolution 1nA (0x23)	-1,000,000,000 nA ~ 1,000,000,000 nA (-1 A ~ 1A)	4 Bytes											
Length	Length of the Values in the Data Field												
Value	Values accordingly to the Value Type												

Response Frame

Status	Length
Status	0

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

3.3.2 SetloGroup

This command sets the voltage or current of a group of output channels of the same Value Type.

Command	SetloGroup	Access	Write
Opcode	0x42		
LucidIoCtrl Command Line Tool			
Call (-tV)	LucidIoCtrl -d[COMx] -c[Channels] -tV -w[Voltages] <u>Channels:</u> Comma separated list of channels e.g. -c0,2,3 <u>Values:</u> Comma separated list of voltages or currents to set e.g. -w1.25,2.5,7.5		
Call (-tC)	LucidIoCtrl -d[COMx] -c[Channels] -tC -w[Currents]		

LucidIoCtrl Command Line Tool Example

Set output channel 0 to 1.25 V, output channel 2 to 2.50 V and output channel 3 to 7.50:

```
LucidIoCtrl -dCOM4 -c0,2,3 -tV -w1.25,2.5,7.5 [ENTER]
```

Set output channel 0 to 5 mA, output channel 2 to 15.5 mA and output channel 3 to 20:

```
LucidIoCtrl -dCOM4 -c0,2,3 -tC -w5,15.5,20 [ENTER]
```

Request Frame:

OPC	P1	P2	LEN	Data Field
0x40	Channel Mask	Value Type	Length	Value(s)

Value	Description																											
Channel Mask	<p>Channel Mask Specifies the output channels to access</p> <table border="1"> <thead> <tr> <th>Channel</th> <th>Bit Position</th> <th>Value</th> </tr> </thead> <tbody> <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> </tbody> </table> <p>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.</p> <p><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)</p>	Channel	Bit Position	Value	0	0	0x01	1	1	0x02	2	2	0x04	3	3	0x08	4	4	0x10	5	5	0x20	6	6	0x40	7	P1A 0	P1=0x80 P1A = 0x01
	Channel	Bit Position	Value																									
0	0	0x01																										
1	1	0x02																										
2	2	0x04																										
3	3	0x08																										
4	4	0x10																										
5	5	0x20																										
6	6	0x40																										
7	P1A 0	P1=0x80 P1A = 0x01																										
Value Type	<p>Value Type Supported Value Types</p> <table border="1"> <thead> <tr> <th>Value Type</th> <th>Value Range</th> <th>Length</th> </tr> </thead> <tbody> <tr> <td>Signed Voltage Resolution 1 μV (0x1D)</td> <td>-100,000,000 μV ~ 100,000,000 μV (-100 V ~ 100 V)</td> <td>4 Bytes</td> </tr> <tr> <td>Signed Voltage Resolution 1 mV (0x1C)</td> <td>-30,000 mV ~ 30,000 mV (-30 V ~ 30 V)</td> <td>2 Bytes</td> </tr> <tr> <td>Signed Current Resolution 1nA (0x23)</td> <td>-1,000,000,000 nA ~ 1,000,000,000 nA (-1 A ~ 1A)</td> <td>4 Bytes</td> </tr> </tbody> </table>	Value Type	Value Range	Length	Signed Voltage Resolution 1 μ V (0x1D)	-100,000,000 μ V ~ 100,000,000 μ V (-100 V ~ 100 V)	4 Bytes	Signed Voltage Resolution 1 mV (0x1C)	-30,000 mV ~ 30,000 mV (-30 V ~ 30 V)	2 Bytes	Signed Current Resolution 1nA (0x23)	-1,000,000,000 nA ~ 1,000,000,000 nA (-1 A ~ 1A)	4 Bytes															
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	Signed Voltage Resolution 1 mV (0x1C)	-30,000 mV ~ 30,000 mV (-30 V ~ 30 V)	2 Bytes																									
Signed Current Resolution 1nA (0x23)	-1,000,000,000 nA ~ 1,000,000,000 nA (-1 A ~ 1A)	4 Bytes																										
Length	Length of the Values in the Data Field (One Value for each channel)																											
Values	One or more values to set in ascending channel order																											

Response Frame

Status	Length
Status	0

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

Example of SetloGroup

The following request frame sets outputs 0 to 1.25 V and output 1 to 2.5 V.

Request Frame

OPC	P1	P2	LEN	Data Field							
0x42	0x03	0x1D	0x08	Byte							
				Value Output 0				Value Output 1			
				0	1	2	3	4	5	6	7
				0xD0	0x12	0x13	0x00	0xA0	0x25	0x26	0x00

Channel Mask for Param1: 0x01 OR 0x02 = 0x03
 Output Values in Data Field are sorted: Channel 0, Channel 1

Response Frame:

Status	Length
0x00	0x00

3.3.3 Getlo

This command reads the voltage or current of the analog output.

Command	Getlo	Access	Read				
Opcode	0x46						
LucidIoCtrl Command Line Tool							
Call (-tL)	LucidIoCtrl -d[COMx] -c[Channel] -tV -r LucidIoCtrl -d[COMx] -c[Channel] -tC -r						
Return	CHn:VV <table border="1" style="margin-left: 20px;"> <tr> <td>n</td> <td>Output Channel</td> </tr> <tr> <td>VV</td> <td>Output Value</td> </tr> </table>			n	Output Channel	VV	Output Value
n	Output Channel						
VV	Output Value						

LucidIoCtrl Command Line Tool Example

Read voltage of output channel 0

```
LucidIoCtrl -dCOM4 -c0 -tV -r [ENTER]
-> CH0:5.00000
```

Read current of output channel 0

```
LucidIoCtrl -dCOM4 -c0 -tC -r [ENTER]
-> CH0:5.00000
```

Request Frame

OPC	P1	P2	LEN
0x46	Channel	Value Type	0

Value	Description												
Channel	Number of input or output channel (Range: 0 ~ 3)												
Value Type	Supported Value Types <table border="1"> <thead> <tr> <th>Value Type</th> <th>Value Range</th> <th>Length</th> </tr> </thead> <tbody> <tr> <td>Signed Voltage Resolution 1 μV (0x1D)</td> <td>-100,000,000 μV ~ 100,000,000 μV (-100 V ~ 100 V)</td> <td>4 Bytes</td> </tr> <tr> <td>Signed Voltage Resolution 1 mV (0x1C)</td> <td>-30,000 mV ~ 30,000 mV (-30 V ~ 30 V)</td> <td>2 Bytes</td> </tr> <tr> <td>Signed Current Resolution 1nA (0x23)</td> <td>-1,000,000,000 nA ~ 1,000,000,000 nA (-1 A ~ 1A)</td> <td>4 Bytes</td> </tr> </tbody> </table>	Value Type	Value Range	Length	Signed Voltage Resolution 1 μ V (0x1D)	-100,000,000 μ V ~ 100,000,000 μ V (-100 V ~ 100 V)	4 Bytes	Signed Voltage Resolution 1 mV (0x1C)	-30,000 mV ~ 30,000 mV (-30 V ~ 30 V)	2 Bytes	Signed Current Resolution 1nA (0x23)	-1,000,000,000 nA ~ 1,000,000,000 nA (-1 A ~ 1A)	4 Bytes
Value Type	Value Range	Length											
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Signed Voltage Resolution 1 mV (0x1C)	-30,000 mV ~ 30,000 mV (-30 V ~ 30 V)	2 Bytes											
Signed Current Resolution 1nA (0x23)	-1,000,000,000 nA ~ 1,000,000,000 nA (-1 A ~ 1A)	4 Bytes											

Tab. 3 Getlo Request

Response Frame:

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

Status	LEN	Data Field
Status	Length	Value

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

3.3.4 GetloGroup

This command reads the voltage or currents of a group of analog outputs of the same Value Type.

Command	GetIoGroup	Access	Read				
Opcode	0x48						
LucidIoCtrl Command Line Tool							
Call (-tV)	LucidIoCtrl -d[COMx] -c[Channels] -tV -r LucidIoCtrl -d[COMx] -c[Channels] -tC -r <u>Channels:</u> Comma separated list of channels e.g. -c0,1,3						
Return	List of values sorted from lower to higher channels CHn:VV <table border="1"> <tr> <td>n</td> <td>Input Channel</td> </tr> <tr> <td>VV</td> <td>Output Value</td> </tr> </table>			n	Input Channel	VV	Output Value
n	Input Channel						
VV	Output Value						

LucidIoCtrl Command Line Tool Example

Read output voltages of channel 0, 1 and 3:

```
LucidIoCtrl -dCOM4 -c0,1,3 -tV -r [ENTER]
-> CH0:1.25000 CH1:2.50000 CH3:5.00000
```

Read output currents of channel 0, 1 and 3:

```
LucidIoCtrl -dCOM4 -c0,1,3 -tC -r [ENTER]
-> CH0:1.25000 CH1:2.50000 CH3:5.00000
```

Request Frame

OPC	P1	P2	LEN
0x48	Channel Mask	Value Type	0

Value	Description																											
Channel Mask	Channel Mask Specifies the output channels to access																											
	<table border="1"> <thead> <tr> <th>Channel</th> <th>Bit Position</th> <th>Value</th> </tr> </thead> <tbody> <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> </tbody> </table>	Channel	Bit Position	Value	0	0	0x01	1	1	0x02	2	2	0x04	3	3	0x08	4	4	0x10	5	5	0x20	6	6	0x40	7	P1A 0	P1=0x80 P1A = 0x01
	Channel	Bit Position	Value																									
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	3	3	0x08																									
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	5	5	0x20																									
	6	6	0x40																									
7	P1A 0	P1=0x80 P1A = 0x01																										
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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)																												
Value Type	Supported Value Types																											
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Response Frame:

In case of successful execution the command returns the read values of the channels specified in the Channel Mask.

Status	LEN	Data Field
Status	Length	Value(s)

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

Example of GetloGroup Request:

The following request frame reads outputs 0 and 1. It returns the output voltages as signed 4 byte result.

Opcode	P1	P2	Length
0x48	0x03	0x1D	0x00

Channel Mask (P1): 0x01 OR 0x02 = 0x03

Response Frame:

Output 0 = 1.25 V, output 1 = 2.50 V. Values in Data Field are in ascending channel order.

Header Field		Data Field							
Status	LEN	Bytes							
0x00	0x08	Value 0				Value 1			
		0	1	2	3	4	5	6	7
		0xD0	0x12	0x13	0x00	0xA0	0x25	0x25	0x00

3.4 IO Configuration 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*.

3.4.1 outAnValue

This IO Configuration Parameter represents the voltage or current value of the analog output.

Parameter	<i>outAnValue</i>	Access	Read / Write
Address	0x1000		
Values	Voltage in 1 μ V resolution		
Default Value	0	Parameter Type	4 bytes signed
LucidloCtrl Command Line Tool			
Parameter Name	outAnValue	Parameter Values	-100,000,000 μ V ~

			100,000,000 μ V or -1,000,000 μ A ~ 1,000,000 μ A
Call (Set)	LucidIoCtrl -d[COMx] -c[Channel] -soutAnValue[=Value] {-p} {--default}		
Call (Get)	LucidIoCtrl -d[COMx] -c[Channel] -goutAnValue		

LucidIoCtrl Command Line Tool Example

Set output voltage of channel 0 to 5 V and make the setting persistent.

```
LucidIoCtrl -dCOM4 -c0 -soutAnValue=5000000 -p [ENTER]
```

Read output voltage of channel 0 (value is 5 V).

```
LucidIoCtrl -dCOM4 -c0 -goutAnValue [ENTER]
```

```
-> outAnValue=5000000
```

By using outAnValue an output value can be made persistent. In this case the stored voltage or current level is restored after a restart of the module.

Note:

For normal operation it is recommended to use the functions SetIo (see 3.3.1) and GetIo (3.3.3) in order to access the output channel value.

3.4.2 outAnMode

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

Parameter	<i>outAnMode</i>	Access	Read / Write
Address	0x1100		
Values	Output Mode		
	Byte	Mode	
	0x00	inactive	
0x01	standard		
Default Value	standard	Parameter Type	1 byte unsigned
LucidIoCtrl Command Line Tool			
Parameter Name	outAnMode	Parameter Values	inactive / standard
Call (Set)	LucidIoCtrl -d[COMx] -c[Channel] -soutAnMode[=Mode] {-p} {--default}		
Call (Get)	LucidIoCtrl -d[COMx] -c[Channel] -goutAnMode		

LucidIoCtrl Command Line Tool Example

Set operation mode of output channel 0 to Standard Mode and make the setting persistent.

```
LucidIoCtrl -dCOM4 -c0 -soutAnMode=standard -p [ENTER]
```

Read the operation mode of input channel 0.

```
LucidIoCtrl -dCOM4 -c0 -goutAnMode [ENTER]
-> outAnMode=standard
```

3.4.3 outAnRefreshTime

This IO Configuration Parameter configures the output refresh time $T_{Refresh}$

Parameter	<i>outAnRefreshTime</i>	Access	Read / Write
Address	0x1113		
Values	$T_{Refresh}$ in μ s (micro seconds) $0.1 \text{ ms} \leq T_{Refresh} \leq 10 \text{ ms}$		
Default Value	1 ms	Parameter Type	4 bytes unsigned
LucidIoCtrl Command Line Tool			
Parameter Name	<i>outAnRefreshTime</i>	Parameter Values	Time [μ s]
Call (Set)	LucidIoCtrl -d[COMx] -c[Channel] -soutAnRefreshTime[=Value] {-p} {--default}		
Call (Get)	LucidIoCtrl -d[COMx] -c[Channel] -goutAnRefreshTime		

LucidIoCtrl Command Line Tool Example

Set $T_{Refresh}$ of output channel 0 to 5 ms and make the setting persistent.

```
LucidIoCtrl -dCOM4 -c0 -soutAnRefreshTime=5000 -p [ENTER]
```

Read $T_{Refresh}$ parameter of input channel 0

```
LucidIoCtrl -dCOM4 -c0 -goutAnRefreshTime [ENTER]
-> outAnRefreshTime=5000
```

3.4.4 outAnOffset

This IO Configuration Parameter configures the output offset compensation value which is described in section 3.2.

Parameter	<i>outAnOffset</i>	Access	Read / Write
Address	0x1120		
Values	Offset Compensation in 1 mV steps (-3 V ~ 3 V) Offset Compensation in 1 μ A steps (-3mA ~ 3mA)		
Default Value	0	Parameter Type	2 bytes signed
LucidIoCtrl Command Line Tool			
Parameter Name	outAnOffset	Parameter Values	Voltage [1 mV] Current [1 μ A]
Call (Set)	LucidIoCtrl -d[COMx] -c[Channel] -soutAnOffset[=Value] {-p} {--default}		
Call (Get)	LucidIoCtrl -d[COMx] -c[Channel] -goutAnOffset		

LucidIoCtrl Command Line Tool Example

Set output offset compensation value of output channel 0 to -5 mV and make the setting persistent.

```
LucidIoCtrl -dCOM4 -c0 -soutAnOffset=-5 -p [ENTER]
```

Read Offset Compensation value.

```
LucidIoCtrl -dCOM4 -c0 -goutAnOffset [ENTER]
```

```
-> outAnOffset=-5
```

4 Specification

Parameter		Condition	Value	
Outputs				
	No of Output Channels		4/8	
Output - Electrical Characteristics				
	Output Function	Digital to Analog Conversion		
	Resolution	12 bit		
	Base Accuracy	typ. $\pm 0.25\%$ of full scale range		
	Max. Output Current	AOn-24	ITotalMax	40 mA
		Others		160 mA
Output – Electrical Characteristics of Current Outputs				
	Max. Output Voltage		UCChMax	10 V
	Min. Output Current ⁴⁾	AOn-20M4	IChMin	4 mA
		AOn-20M0		typ. 0.25 mA
	Output Current Dependence ³⁾		RL not 500 Ω	$\pm 0.5\%$
Output – Electrical Characteristics of Voltage Outputs				
	Max. Output Current per Channel	AOn-24	IChMax	10 mA ¹⁾
		Others		40 mA
	Min. Output Voltage ²⁾	AOn-24	UChMin	50 mV
		Others		See Note ²⁾
Output – Timing Characteristic				
	Setup Time for stable output		TStable	typ. 1 ms
	DAC Conversion Time		TConv	typ. 1 ms
Module – Communication				
	USB		2.0 Full Speed CDC Profil	
Module – Electrical Characteristics				
	Power Supply	USB Bus Powered with +5V No additional Power Supply needed.		
	Maximum Rated Supply Current	250 mA		
Module – Environment				
	Temperature	Storage	-20 °C ... +70 °C	
		Operation	0 °C ... +55 °C	
	Humidity	< 85 % RH, non-condensing		
Module – Housing				
	Dimension 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		
	<ul style="list-style-type: none"> • Operation and Error Indicator • Communication Indicator 	
Software		
	Supported Operating Systems	Windows® XP, Windows® Vista, Windows® 7, Ubuntu, Debian, Raspbian
	Application Programming Interface (API)	Console / Terminal Application, Java and Python

Tab. 4 AO4/AO8 Specification**Notes:**

- 1) For currents > 2 mA an additional tolerance of max. 50 mV must be considered.
- 2) If not further specified, the modules are able to drive the minimum output value within the specified tolerances.
The minimum value is 0V for non -S voltage modules.
- 3) Outputs are calibrated to a base accuracy with 500Ω output resistors. For output resistances other than 500Ω, the Output Current Dependence applies.
- 4) For AOn-20M0, a minimum saturation current must be considered.

5 Order Information

Order Code	Product
LCTR-AO4-5	LucidControl Analog Output USB Module with 4 channels 0 ~ 5 V
LCTR-AO4-10	LucidControl Analog Output USB Module with 4 channels 0 ~ 10 V
LCTR-AO4-24	LucidControl Analog Output USB Module with 4 channels 0 ~ 24 V
LCTR-AO4-20M0	LucidControl Analog Output USB Module with 4 channels 0 ~ 20 mA
LCTR-AO4-20M4	LucidControl Analog Input USB Module with 4 channels 4 ~ 20 mA.
LCTR-AO8-5	LucidControl Analog Output USB Module with 8 channels 0 ~ 5 V
LCTR-AO8-10	LucidControl Analog Output USB Module with 8 channels 0 ~ 10 V
LCTR-AO8-24	LucidControl Analog Output USB Module with 8 channels 0 ~ 24 V
LCTR-AO8-20M0	LucidControl Analog Output USB Module with 8 channels 0 ~ 20 mA
LCTR-AO8-20M4	LucidControl Analog Input USB Module with 8 channels 4 ~ 20 mA.

Tab. 5 Order Information

6 Document Revision

Date	Rev.	
2019/09/16	1.4	Added documentation of USB Isolation
2023/04/06	1.5	AO8 Support

Tab. 6 Document Revision



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