



User Manual

# Lucid485 AO4/AO8

4/8 Channel Analog Output Serial Module

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## 1 Introduction

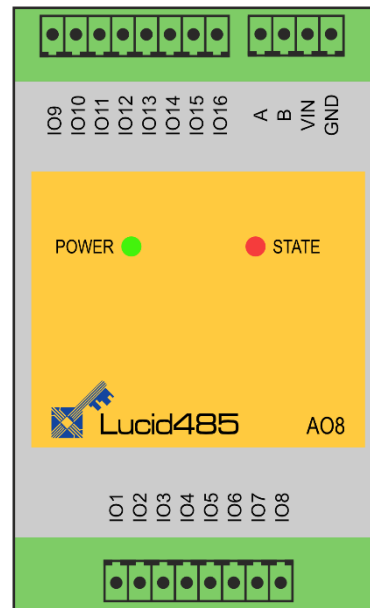
This document describes the functionality of the Lucid485 AO4/AO8 serial IO module generating 4/8 analog voltages or currents controllable by RS-485 bus.

A basic description of the Lucid485 product family can be found in the general Lucid485 User Manual.

## 2 Setup and Installation



**Fig. 1 Lucid485 AO4 Module**



**Fig. 2 Lucid485 AO8 Module**

Fig. 1 and Fig. 2 show drawings of the AO4 and AO8 analog output modules with 4/8 voltage or current output channels (AO0 – AO3 and AO4 – AO7).

The IO signals are connected to the lower (IO1 - IO8) and the upper (IO9 - IO16) IO terminals.

The upper IO terminal connector is present at the AO8 module only.

## 2.1 Safety Information

Lucid485 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 RS-485 bus and Power Connection

Please see the general *Lucid485 User Manual*.

## 2.3 LucidIoCtrl Command Line Tool

The LucidIoCtrl command line tool gives full access to all Lucid485 modules operating with Frame Protocol enabled. Executables for different architectures and can be downloaded from our website:

<https://www.lucid-control.com/downloads>

After downloading the program can be stored in a folder of choice.

Please see the general *Lucid485 User Manual* for more information.

### 2.3.1 First Steps

When the module is powered, the green power LED is switched on, signaling that the module is ready.

The following examples show the general usage of the LucidIoCtrl command line tool. It is assumed that the module is configured with default address 11, 9600 baud, 8N1. The serial to RS-485 adapter is connected to COM1 of the host.

#### 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 -drs485:COM1:11 -tV -c0,1,2,3 -w5.000,2.500,1.250,0.625
```

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 -drs485:COM1:11 -tC -c0,1,2,3 -w5.000,2.500,1.250,0.625
```

#### 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 -drs485:/dev/ttyACM0:11 -tV -c0,1,2,3 -w5.000,2.500,1.250,0.625
```

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 -drs485:/dev/ttyACM0:11 -tC -c0,1,2,3 -w5.000,2.500,1.250,0.625
```

## 2.4 IO Configurations

The AO4/AO8 module is available in different configurations, which are explained in this section.

Function Class	Value	Channels
AO4	0x9100	4
AO8	0x9110	8

**Tab. 1 Analog Output Function Classes**

Function Class Type	Value	Output Type
5	0x1000	0-5 V
10	0x1001	0-10 V
24	0x1005	0-24 V
20M0	0x1100	0-20 mA <sup>1)</sup>
20M4	0x1101	4-20 mA

**Tab. 2 Analog Output Function Class Types**

Note:

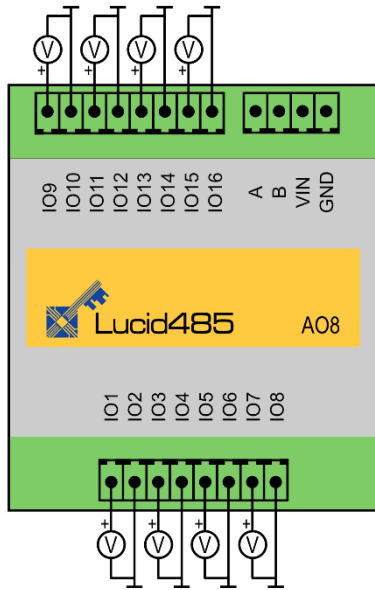
- 1) A minimum saturation current remains on the output. See  $I_{ChMin}$  in specification.

Tab. 1 and Tab. 2 list the Function Classes and their types.

The output signal range of the Function Class Types is shown in Tab. 2.

## 2.4.1 IO Connection

### 2.4.1.1 Voltage Outputs



**Fig. 3 AO8 IO Connection (Voltage)**



**Fig. 4 AO Voltage Signal**

Fig. 3 shows 8 voltmeters connected to the IO terminals of channels 0 - 7 of the AO8 module.

Fig. 4 shows the meter connected to the IO terminals IO1 and IO2 (output channel 0).

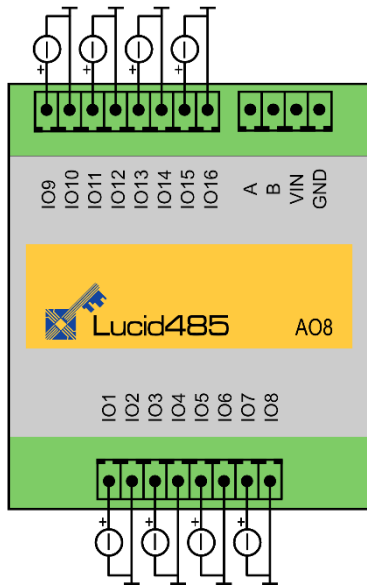
IO Terminal	Signal	IO Channel Number
1	AO0 +	0
2	GND	
3	AO1 +	1
4	GND	
5	AO2 +	2
6	GND	
7	AO3 +	3
8	GND	
9	AO4 +	4
10	GND	
11	AO5 +	5
12	GND	
13	AO6 +	6
14	GND	
15	AO7 +	7
16	GND	

**Tab. 3 AO4 / AO8 IO Terminal Connector**

Tab. 3 lists the IO terminals and voltage output signals.

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

### 2.4.1.2 Current Outputs



**Fig. 5 AO8-I IO Connection (Current)**

Fig. 5 shows 8 current meters connected to the IO terminals of channels 0 to 7 of the AO8-I module.



**Fig. 6 AO-I Current Signal**

Fig. 6 shows the meter connected to the IO terminals IO1 and IO2 (output channel 0).

Tab. 3 lists the IO terminals and current output signals

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



## 3 Module Operation

The Lucid485 AO4/AO8 Analog Output Module generates 4/8 independent output voltage or current signals.

### 3.1 Operation Modes

#### 3.1.1 Inactive Mode

Inactive mode disables processing of the output and sets the output to minimum value (e.g. 0 V).

#### 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* (→ 3.4.3) is added to the output value.

### 3.3 Commands

Lucid485 IO Modules can be accessed by the Network Frame Protocol, which is documented in the general *Lucid485 User Manual*.

This section describes in detail the commands, which are supported by the AO4/AO8 modules.

#### 3.3.1 Setlo

This command sets one output value.

Command	Setlo	Access	Write
Opcode	0x40		
LucidIoCtrl Command Line Tool			
Call (-tV)	LucidIoCtrl -drs485:[COMx:addr] -c[Channel] -tV -w[Voltage]		
Call (-tC)	LucidIoCtrl -drs485:[COMx:addr] -c[Channel] -tC -w[Current]		

Tab. 4 Setlo Command

#### LucidIoCtrl Command Line Tool Example

Set output channel 0 to 2.540 V:

```
LucidIoCtrl -drs485:COM4:11 -c0 -tV -w2.540
```

Set output channel 0 to 10 mA:

```
LucidIoCtrl -drs485:COM4:11 -c0 -tC -w10
```

#### Request Frame

DST	SRC	OPC	P1	P2	LEN	Data Field	CRC
DST	SRC	0x40	Channel	Value Type	Length	Value	CRC-16

Tab. 5 Setlo Network Request Frame

Value	Description												
Channel	Number of input or output channel (Range: 0 to 7)												
Value Type	Supported Value Types <table border="1" style="margin-left: 20px;"> <thead> <tr> <th>Value Type</th> <th>Value Range</th> <th>Length</th> </tr> </thead> <tbody> <tr> <td>Signed Voltage Resolution 1 <math>\mu</math>V (0x1D)</td> <td>-100,000,000 <math>\mu</math>V ~ 100,000,000 <math>\mu</math>V (-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 $\mu$ V (0x1D)	-100,000,000 $\mu$ V ~ 100,000,000 $\mu$ 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												

**Tab. 6 Setlo Request**

Response Frame

DST	SRC	Status	LEN	CRC-16
DST	SRC	Status	0	CRC

**Tab. 7 Setlo Network Response Frame**

Returns Execution Status Code, documented in the general *Lucid485 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		
<b>LucidIoCtrl Command Line Tool</b>			
	<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 (-tV)	LucidIoCtrl -drs485:[COMx:addr] -c[Channels] -tV -w[Voltages]		
Call (-tC)	LucidIoCtrl -drs485:[COMx:addr] -c[Channels] -tC -w[Currents]		

**Tab. 8 SetloGroup Command**

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 -drs485:COM4:11 -c0,2,3 -tV -w1.25,2.5,7.5
```

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

```
LucidIoCtrl -drs485:COM4:11 -c0,2,3 -tC -w5,15.5,20
```

Request Frame:

DST	SRC	OPC	P1	P2	LEN	Data Field	CRC
DST	SRC	0x42	Channel Mask	Value Type	Length	Value(s)	CRC-16

**Tab. 9 SetIoGroup Network Request Frame**

Values in channel number ascending order.

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																									
	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																										
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)																												
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 <math>\mu</math>V (0x1D)</td> <td>-100,000,000 <math>\mu</math>V ~ 100,000,000 <math>\mu</math>V (-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 $\mu$ V (0x1D)	-100,000,000 $\mu$ V ~ 100,000,000 $\mu$ 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 (One Value for each channel)																											
Values	One or more values to set in ascending channel order																											

Tab. 10 SetloGroup Request

Response Frame

DST	SRC	Status	LEN	CRC
DST	SRC	Status	0	CRC-16

**Tab. 11 SetloGroup Network Response Frame**

Returns Execution Status Code, documented in the general *Lucid485 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

DST	SRC	OPC	P1	P2	LEN	Data Field		CRC
0x11	0x10	0x42	0x03	0x1D	0x08	CH 0	CH 1	???
						...	...	

**Tab. 12 SetloGroup Network Request Example**

CH 0				CH 1			
0	1	2	3	4	5	6	7
0xD0	0x12	0x13	0x00	0xA0	0x25	0x26	0x00

**Tab. 13 SetloGroup Example Channel Values**

Channel Mask for Param1:

0x01 OR 0x02 = 0x03

Output Values in Data Field are sorted:

Channel 0, Channel 1

Response Frame:

DST	SRC	Status	LEN	CRC
0x10	0x11	0x00	0x00	CRC

**Tab. 14 SetloGroup Network Response Example**

### 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 -drs485:[COMx:addr] -c[Channel] -tV -r		
Call (-tC)	LucidIoCtrl -drs485:[COMx:addr] -c[Channel] -tC -r		
Return	CHn:VV		
	n	Output Channel	
	VV	Output Value	

**Tab. 15 Getlo Command**

## LucidIoCtrl Command Line Tool Example

### Read voltage of output channel 0

```
LucidIoCtrl -drs485:COM4:11 -c0 -tV -r
-> CH0:5.00000
```

### Read current of output channel 0

```
LucidIoCtrl -drs485:COM4:11 -c0 -tC -r
-> CH0:5.00000
```

## Request Frame

DST	SRC	OPC	P1	P2	LEN	CRC
DST	SRC	0x46	Channel	Value Type	0	CRC-16

**Tab. 16 GetIo Network Request Frame**

Value	Description												
Channel	Number of input or output channel (Range: 0 to 7)												
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 <math>\mu</math>V (0x1D)</td> <td>-100,000,000 <math>\mu</math>V ~ 100,000,000 <math>\mu</math>V (-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 $\mu$ V (0x1D)	-100,000,000 $\mu$ V ~ 100,000,000 $\mu$ 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											

**Tab. 17 GetIo Request**

## Response Frame:

DST	SRC	Status	LEN	Data Field	CRC
DST	SRC	Status	Length	Value	CRC-16

**Tab. 18 GetIo Network Response Frame**

Returns Execution Status Code, documented in the general *Lucid485 User Manual*.

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

### 3.3.4 GetloGroup

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

<b>Command</b>	GetloGroup	<b>Access</b>	Read
<b>Opcode</b>	0x48		
<b>LucidIoCtrl Command Line Tool</b>			
<b>Call (-tV)</b>	LucidIoCtrl -drs485:[COMx:addr] -c[Channels] -tV -r		
	<u>Channels:</u> Comma separated list of channels e.g. -c0,1,3		
<b>Call (-tC)</b>	LucidIoCtrl -drs485:[COMx:addr] -c[Channels] -tC -r		
	<u>Channels:</u> Comma separated list of channels e.g. -c0,1,3		
<b>Return</b>	List of values sorted from lower to higher channels		
	CHn:VV		
	n	Input Channel	
	VV	Output Value	

**Tab. 19 GetloGroup Command**

#### LucidIoCtrl Command Line Tool Example

Read output voltages of channel 0, 1 and 3:

```
LucidIoCtrl -drs485:COM4:11 -c0,1,3 -tV -r
-> CH0:1.25000 CH1:2.50000 CH3:5.00000
```

Read output currents of channel 0, 1 and 3:

```
LucidIoCtrl -drs485:COM4:11 -c0,1,3 -tC -r
-> CH0:1.25000 CH1:2.50000 CH3:5.00000
```

#### Request Frame

DST	SRC	OPC	P1	P2	LEN	CRC
DST	SRC	0x48	Channel Mask	Value Type	0	CRC-16

**Tab. 20 GetloGroup Network Request Frame**



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																										
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Signed Current Resolution 1nA (0x23)	-1,000,000,000 nA ~ 1,000,000,000 nA (-1 A ~ 1A)	4 Bytes																										

Tab. 21 GetloGroup Command

Response Frame:

DST	SRC	Status	LEN	Data Field	CRC
DST	SRC	Status	Length	Value(s)	CRC-16

Tab. 22 GetloGroup Network Response Frame

Returns Execution Status Code, documented in the general *Lucid485 User Manual*.  
 In case of successful execution, the command returns the read values of the channels specified in the Channel Mask in channel number ascending order.

Example of GetloGroup Request:

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

DST	SRC	OPC	P1	P2	LEN	CRC
0x11	0x10	0x48	0x03	0x1D	0x00	CRC

**Tab. 23 GetloGroup Network Request Example**

Channel Mask (P1):  $0x01 \text{ OR } 0x02 = 0x03$

Response Frame:

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

DST	SRC	Satus	LEN	Data Field	CRC				
0x10	0x11	0x00	0x08	<table border="1"> <tr> <td>CH 0</td> <td>CH 1</td> </tr> <tr> <td>...</td> <td>...</td> </tr> </table>	CH 0	CH 1	...	...	CRC
CH 0	CH 1								
...	...								

**Tab. 24 GetloGroup Network Response Example**

CH 0				CH1			
0	1	2	3	4	5	6	7
0xD0	0x12	0x13	0x00	0xA0	0x25	0x26	0x00

**Tab. 25 GetloGroup Example Channel Values**

### 3.4 IO Configuration Parameters

Lucid485 modules are configured by a set of System Configuration Parameters and IO Configuration Parameters.

The parameters are accessible by the SetParam and GetParam commands, which are described in the general *Lucid485 User Manual*.

Parameter values can be made persistent in the non-volatile memory of the microcontroller e.g., by adding the `-p` argument to `LucidIoCtrl` or by setting the persistent parameter in the API function to true. Values of persistent parameters are restored when Lucid485 is powered on.

The number of write cycles to the non-volatile memory is limited. Write operations wear out the non-volatile memory and periodical updates of persistent parameters should be avoided in order not to destroy the device over time.

#### 3.4.1 outAnValue

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

<b>Parameter</b>	<i>outAnValue</i>	<b>Access</b>	Read / Write
<b>Address</b>	0x1000		
<b>Values</b>	Voltage in 1 $\mu$ V, Current in 1nA resolution		
<b>Default Value</b>	0	<b>Parameter Type</b>	4 bytes signed
<b>LucidIoCtrl Command Line Tool</b>			
<b>Parameter Name</b>	<i>outAnValue</i>	<b>Parameter Values</b>	-100,000,000 $\mu$ V ~ 100,000,000 $\mu$ V or -1,000,000 $\mu$ A ~ 1,000,000 $\mu$ A
<b>Call (Set)</b>	LucidIoCtrl -drs485:[COMx:addr] -c[Channel] -soutAnValue[=Value] {-p} {--default}		
<b>Call (Get)</b>	LucidIoCtrl -drs485:[COMx:addr] -c[Channel] -goutAnValue		

**Tab. 26 IO Configuration Parameter outAnValue**

#### LucidIoCtrl Command Line Tool Example

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

```
LucidIoCtrl -drs485:COM4:11 -c0 -soutAnValue=5000000 -p
```

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

```
LucidIoCtrl -drs485:COM4:11 -c0 -goutAnValue  
-> outAnValue=5000000
```

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

### 3.4.2 outAnMode

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

<b>Parameter</b>	<i>outAnMode</i>	<b>Access</b>	Read / Write
<b>Address</b>	0x1100		
<b>Values</b>	Output Mode		
	<b>Byte</b>	<b>Mode</b>	
	0x00	inactive	
	0x01	standard	
<b>Default Value</b>	standard	<b>Parameter Type</b>	1 Byte unsigned
<b>LucidIoCtrl Command Line Tool</b>			
<b>Parameter Name</b>	<i>outAnMode</i>	<b>Parameter Values</b>	inactive / standard
<b>Call (Set)</b>	LucidIoCtrl -drs485:[COMx:addr] -c[Channel] -soutAnMode[=Mode] {-p} {--default}		
<b>Call (Get)</b>	LucidIoCtrl -drs485:[COMx:addr] -c[Channel] -goutAnMode		

**Tab. 27 IO Configuration Parameter outAnMode**

#### LucidIoCtrl Command Line Tool Example

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

```
LucidIoCtrl -drs485:COM4:11 -c0 -soutAnMode=standard -p
```

Read the operation mode of input channel 0.

```
LucidIoCtrl -drs485:COM4:11 -c0 -goutAnMode  
-> outAnMode=standard
```

### 3.4.3 outAnOffset

This IO Configuration Parameter configures the output offset compensation value (→ 3.2).

<b>Parameter</b>	<i>outAnOffset</i>	<b>Access</b>	Read / Write
<b>Address</b>	0x1120		
<b>Values</b>	Offset Compensation in 1 mV steps (-3 V ~ 3 V) Offset Compensation in 1µA steps (-3mA ~ 3mA)		
<b>Default Value</b>	0	<b>Parameter Type</b>	2 bytes signed
<b>LucidloCtrl Command Line Tool</b>			
<b>Parameter Name</b>	<i>outAnOffset</i>	<b>Parameter Values</b>	Voltage [1 mV] Current [1 µA]
<b>Call (Set)</b>	LucidIoCtrl -drs485:[COMx:addr] -c[Channel] -soutAnOffset[=Value] {-p} {--default}		
<b>Call (Get)</b>	LucidIoCtrl -drs485:[COMx:addr] -c[Channel] -goutAnOffset		

**Tab. 28 IO Configuration Parameter outAnOffset**

#### LucidloCtrl Command Line Tool Example

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

```
LucidIoCtrl -drs485:COM4:11 -c0 -soutAnOffset=-5 -p
```

Read Offset Compensation value.

```
LucidIoCtrl -drs485:COM4:11 -c0 -goutAnOffset  
-> outAnOffset=-5
```

## 4 Modbus RTU Protocol

The IO values can be accessed by Modbus holding registers listed in Tab. 29.

IO Channel Values contain the Voltage in mV (signed) or Currents in  $\mu\text{A}$  (signed).

Address	Type	Width	Description
0x2000	Holding	16	IO Channel Number 0 Value (AO0)
0x2001	Holding	16	IO Channel Number 1 Value (AO1)
0x2002	Holding	16	IO Channel Number 2 Value (AO2)
0x2003	Holding	16	IO Channel Number 3 Value (AO3)
0x2004	Holding	16	IO Channel Number 4 Value (AO4)
0x2005	Holding	16	IO Channel Number 5 Value (AO5)
0x2006	Holding	16	IO Channel Number 6 Value (AO6)
0x2007	Holding	16	IO Channel Number 7 Value (AO7)

**Tab. 29 Modbus RTU Registers**

## 5 Specification

Parameter		Condition	Value	
<b>Outputs</b>				
	No of Output Channels		4/8	
<b>Module - Electrical Characteristics</b>				
	Supply Voltage		7-24 V	
	Max. Supply Current		100 mA	
<b>Output - Electrical Characteristics</b>				
	Output Function		Digital to Analog Conversion	
	Resolution		12 bit	
	Base Accuracy		typ. $\pm 0.25\%$ of full scale range	
	Max. Output Current	AOn-24	I <sub>TotalMax</sub>	40 mA
		Others		160 mA
<b>Output – Electrical Characteristics of Current Outputs</b>				
	Max. Output Voltage		U <sub>ChMax</sub>	10 V
	Min. Output Current <sup>4)</sup>	AOn-20M4	I <sub>ChMin</sub>	4 mA
		AOn-20M0		typ. 0.25 mA
	Output Current Dependence <sup>3)</sup>		R <sub>L</sub> not 500 $\Omega$	$\pm 0.5\%$
<b>Output – Electrical Characteristics of Voltage Outputs</b>				
	Max. Output Current per Channel	AOn-24	I <sub>ChMax</sub>	10 mA <sup>1)</sup>
		Others		40 mA
	Min. Output Voltage <sup>2)</sup>	AOn-24	U <sub>ChMin</sub>	50 mV
		Others		See Note <sup>2)</sup>
<b>Output – Timing Characteristic</b>				
	Setup Time for stable output		T <sub>Stable</sub>	typ. 1 ms
	DAC Conversion Time		T <sub>Conv</sub>	typ. 1 ms
<b>Module – Communication</b>				
	Baudrate		1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 bps	
	Parity		NONE, EVEN, ODD	
	Stopbits		1 or 2	
	Databits		8	
	Bus Termination (If enabled)		120 $\Omega$	
<b>Module – Environment</b>				
	Temperature	Storage	-20 °C ... +70 °C	
		Operation	0 °C ... +55 °C	
	Humidity		< 85 % RH, non-condensing	
<b>Module – Housing</b>				
	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

**Tab. 30 AO4/AO8 Device 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.

Module is specified at environmental temperature of 25°C.



## 6 Order Information

Order Code	Product
L485-AO4-5	Lucid485 Analog Output Serial Module with 4 channels 0 ~ 5 V
L485-AO4-10	Lucid485 Analog Output Serial Module with 4 channels 0 ~ 10 V
L485-AO4-24	Lucid485 Analog Output Serial Module with 4 channels 0 ~ 24 V
L485-AO4-20M0	Lucid485 Analog Output Serial Module with 4 channels 0 ~ 20 mA
L485-AO4-20M4	Lucid485 Analog Input Serial Module with 4 channels 4 ~ 20 mA.
L485-AO8-5	Lucid485 Analog Output Serial Module with 8 channels 0 ~ 5 V
L485-AO8-10	Lucid485 Analog Output Serial Module with 8 channels 0 ~ 10 V
L485-AO8-24	Lucid485 Analog Output Serial Module with 8 channels 0 ~ 24 V
L485-AO8-20M0	Lucid485 Analog Output Serial Module with 8 channels 0 ~ 20 mA
L485-AO8-20M4	Lucid485 Analog Input Serial Module with 8 channels 4 ~ 20 mA.

**Tab. 31 Order Information**

## 7 Document Revision

Date	Rev.	
2024/10/08	1.0	Initial document

Tab. 32 Document Revision



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