

# MIO

## Analog Output Extension Card with Digital I/O

**Z**AHNER

## 1 Introduction

The MIO card is a member of the extension card family available for the Zahner Zennium potentiostats. It allows for an output of up to four analog signals at 16-bit resolution and an output voltage range of  $\pm 10$  V. Additionally, the MIO provides four digital inputs and four isolated digital output channels.

Up to two MIO add-on cards can be addressed by the Thales software so that up to 8 analog output, 8 digital input, and 8 digital output channels can be handled.

## 2 Hardware

The MIO card features two BNC connectors and a D-SUB connector. The BNC connectors are assigned to the first two analog output channels.

The D-SUB port contains connectors for 4 analog outputs, 4 digital inputs and 4 isolated digital outputs.

The complete connection scheme of the D-SUB port is shown below.

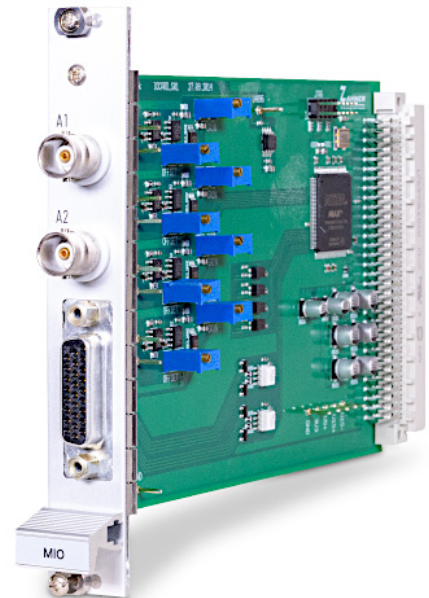
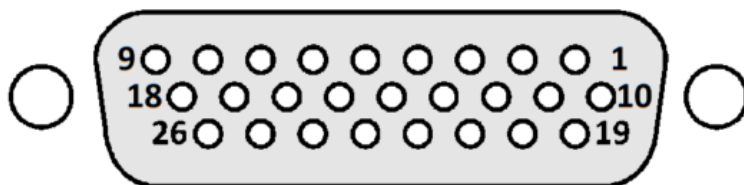


Fig. 1: MIO card with the D-SUB scheme.

1 digital input # 4+  
 2 digital input # 4 -  
 3 digital input # 3+  
 4 digital input # 3 -  
 5 digital input # 2+  
 6 digital input # 2 -  
 7 digital input # 1+  
 8 digital input # 1 -  
 9 GND

10 digital output # 4 +  
 11 digital output # 4 -  
 12 digital output # 3 +  
 13 digital output # 3 -  
 14 digital output # 2 +  
 15 digital output # 2 -  
 16 digital output # 1 +  
 17 digital output # 1 -  
 18 GND

19 analog output # 4 +  
 20 analog output # 4 -  
 21 analog output # 3 +  
 22 analog output # 3 -  
 23 analog output # 2 +  
 24 analog output # 2 -  
 25 analog output # 1 +  
 26 analog output # 1 -

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## 2.1 Analog vs. digital channels

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The analog outputs are 16-bit channels with a  $\pm 10$  V range, whereas the digital I/O channels are 1-bit each, switching between on and off state.

The digital output channels can be turned on by the corresponding binary code for the channel(s) in the "Signal Acquisition & Output Control" window. The binary codes for the digital channels are provided below.

MIO digital channel	Bit value	Binary	Bit
1	$2^0 (=1)$	0000 0001	0
2	$2^1 (=2)$	0000 0010	1
3	$2^2 (=4)$	0000 0100	2
4	$2^3 (=8)$	0000 1000	3
5	$2^4 (=16)$	0001 0000	4
6	$2^5 (=32)$	0010 0000	5
7	$2^6 (=64)$	0100 0000	6
8	$2^7 (=128)$	1000 0000	7

**Table 1:** MIO digital channels with the corresponding binary code and bit value.

For example, if the user wants to turn on digital channel 2, then the signal 0010 is used. If the user wants to turn on two channels simultaneously, the binary numbers for the corresponding channels must be added. For example, the binary code for simultaneously turning on channels 2 and 3 reads as 0110 (sum of 0100 + 0010).

The digital output channels can be considered a switch or a relay. When a channel is turned on (e.g., channel 3), the Zahner potentiostat creates a short circuit between digital output #3 + and digital output #3 -. This short circuit completes the electrical circuit of whatever is connected to the digital output channel.

An analog signal can also be used to trigger digital inputs. For MIO digital input channels, a signal exceeding 4.5 V should be used for triggering.

### 3 Software configuration

The MIO channels are directly configured from the Thales software. In the classic mode of the Thales software (Fig. 2), hover the cursor over the **Signal Acq.** icon, which will open a submenu (Fig. 2a). From there, click on the **Signal Acquisition Setup** icon. This will open the “Signal Acquisition & Control Set-Up” window.

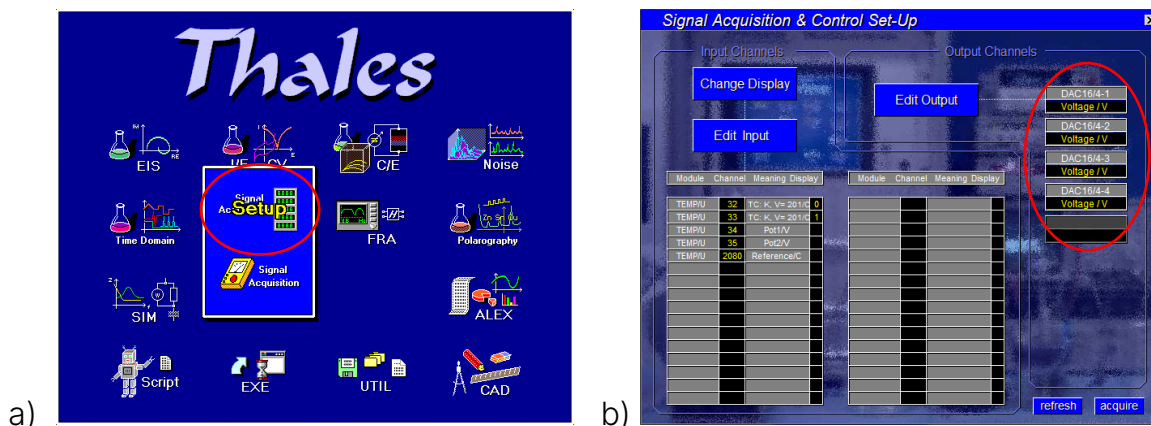
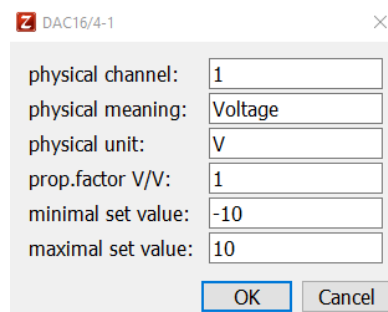


Fig. 2: Configuring output channels of MIO cards in Thales Classic mode.

As default, only four output channels (marked red in Fig. 2b) are shown for one MIO card. If the ZENNIUM series potentiostat is equipped with more than one MIO card, the additional channels must be activated first. Therefore, click on “Edit Output” and then on the fifth unmarked channel (marked red in Fig. 2b). This will open the data box (see right) and the user can set up the channel with the appropriate channel number, physical meaning and unit.



Using “Edit Output”, the physical meaning, unit and voltage range can also be modified for the first four channels.

After configuring the channels, click on **acquire** (see Fig. 2b) to open the “Signal Acquisition & Output Control” window. Here, enter the desired output voltages for different analog output channels.

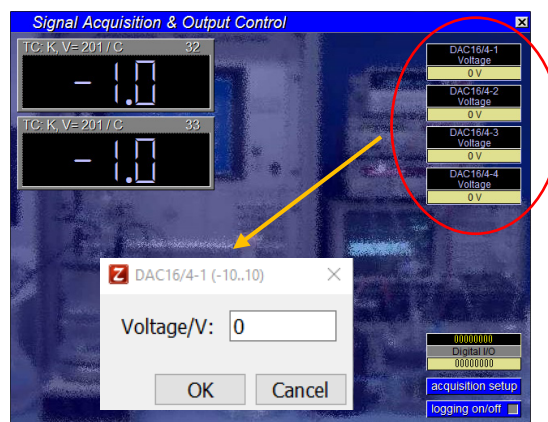


Fig. 3: Setting output signal on MIO analog channel(s)

The MIO output analog channels can be used as a trigger during series measurements. For this, the channel for series measurement can be set up in the “Impedance Spectra vs. Parameter Scan” window.

An example of such a measurement would be using the Zennium potentiostat with a rotating disk electrode (RDE) setup. The MIO analog output can be used to trigger the different rotation speeds for each measurement. Similarly, any setup which allows analog inputs can be configured with the MIO card and the measurements can be automatized.

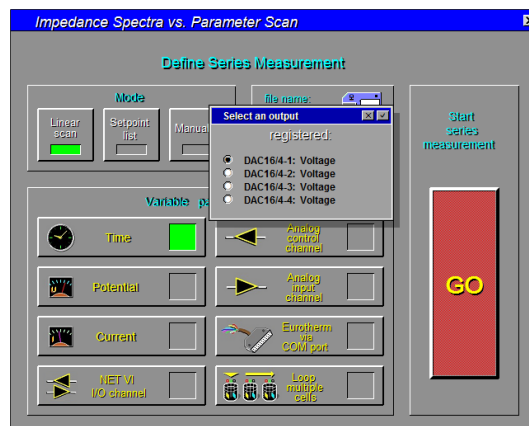


Fig. 4: Select analog control channel for series measurements triggered by the MIO card.

## 4 MIO in SCRIPT

The input and output channels can be configured in the SCRIPT software to trigger the measurements.

### 4.1 Analog output

For the analog output channels, the user can use the following codes to apply a voltage signal.

```
OUTA (5, 2)      'OUTA (VALUE, CHANNEL) → set a voltage of 5 V on channel 2
OUTA (0, 2)     'OUTA (VALUE, CHANNEL) → set 0 V on channel 2
```

### 4.2 Digital input

The `ind(128)` command reads out the digital input channels. With the `lprint` command, it is possible to find out which channel is closed (or turned on) and which is open.

```
DIN%=ind(128)  'read digital input channels
lprint, DIN%   'print active channel bit value(s) in Z-trace
```

The `lprint` command returns the bit value (see Table 1) of the active channel(s). If MIO digital input channel 3 is active then the bit value will be 4. If more than one channel is active, the result will be the sum of the bit values from the respective channels. For example, if channels 2 and 4 are active, the `lprint` command will result in 12 (4+8).

## 4.3 Digital output

The `outd` command activates the digital output channel(s) of the MIO card:

```
outd1,128      'outd(CHANNEL BIT VALUE,128), here digital output channel 1
```

With this command, the digital output channel (here, of channel 1) will close. If multiple digital output channels are to be closed, the bit values of all digital output channels (see Table 1) must be added up and put into the command:

```
outd15,128     'close all digital channels
```

Here, 15 is the sum of all the bit values for the first four channels (1+2+4+8). If the second channel is to be opened but all other channels should remain closed, the sum amounts to 13 (1+4+8):

```
outd13,128     'close digital channels 1,3 and 4
```

With `outd0,128` all closed channels can be opened:

```
outd0,128     'open all digital channels
```

## 5 Technical specifications

In this chapter, the technical specifications of the analog/digital IO channels are provided.

MIO – Digital input channels	
Input type	Optically isolated (optocoupler) with overcurrent & reverse voltage protection
Ground reference	All inputs floating (separate ground for each input)
Input current	< 10 mA
Input voltage range	±30 V (absolute maximum)
Input voltage low	< 1.5 V
Input voltage high	> 3.3 V (TTL compatible)

**Table 2:** Technical specifications of digital input channels of MIO card.

<b>MIO – Digital output channels</b>	
Output type	Optically isolated (solid state relay)
Ground reference	Floating, external pull-up/ground connection required
Absolute maximum voltage	40 V
Absolute maximum current	250mA
Typical on resistance	1 $\Omega$

**Table 3:** Technical specifications of digital output channels of MIO card.

<b>MIO - Analog output channels</b>	
Number of analog output channels	4
Analog output range	$\pm 10$ V
Resolution	16 bit

**Table 4:** Technical specifications of analog output channels of MIO card.