Cebo-MSA64(W)

Cebo-MSA64(W) is a small-sized USB powered measuring box. Up to 64 resistive sensors, arranged in an 8x8 array, may be measured at once. Input sensitivity is software-adjustable. Up to four additional analog inputs are available to connect sensors with voltage output. To use PT1000 temperature sensors without additional external electronics, one software-adjustable fixed current source is provided. With the help of the data acquisition software Cebo MSA lite Tools it is easy to setup for different tasks. Even multi-point calibration of each attached sensor individually is possible. All measured data is visualized and may be stored for further off-line investigations.

Specifications

- USB2.0 full-speed, 12MBit (Cebo-MSA64 only)
- 802.11 b/g/n WLAN up to 65Mbps (Cebo-MSA64W only)
- USB bus-powered, no external power supply necessary
- Optional powered by USB charger or battery pack (Cebo-MSA64W only, not included)
- 135mA typical power consumption [1]
- Up to 64 resistive sensors
- Adjustable sensitivity
- Four additional analog inputs
- Four multi-purpose digital IO
- One trigger input
- Software-adjustable fixed current output
- Two status LEDs
- 5V DC output

1 Cebo MSA lite Tools running at 200Hz with eight sensors selected on main diagonal.

Sensor Array Connector - CON1

Use the standard 16pin RM2.54mm right-angled header CON1 to connect resistive sensors to Cebo-MSA64(W).

Pin	Function	Comment	Pin	Function	Comment
1	Column A	Sensing input [2]	2	Row 1	Voltage output [3]
3	Column B	Sensing input	4	Row 2	Voltage output
5	Column C	Sensing input	6	Row 3	Voltage output
7	Column D	Sensing input	8	Row 4	Voltage output
9	Column E	Sensing input	10	Row 5	Voltage output
11	Column F	Sensing input	12	Row 6	Voltage output
13	Column G	Sensing input	14	Row 7	Voltage output
15	Column H	Sensing input	16	Row 8	Voltage output

A single sensor always connects to one row and one column. Figure 1 shows the connection of a force sensor to Row 1 and Column A as an example. With this scheme up to 8 sensors easily can be attached to Cebo-MSA64(W) using pairs Row 1 + Column A through Row 8 + Column H, respectively. In the grid chart of Cebo MSA lite DAQ these sensors will appear at the main diagonal from top left to bottom right.

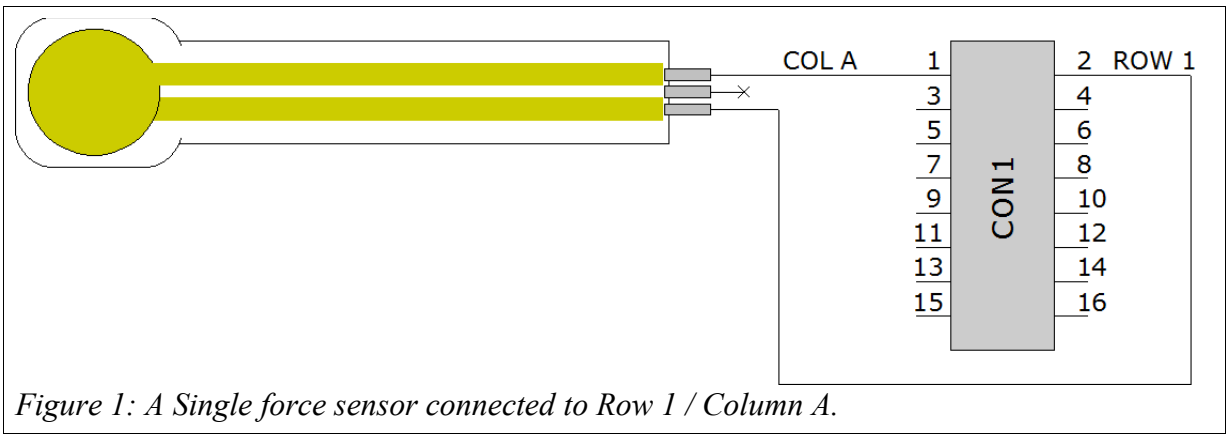

Figure 1: A Single force sensor connected to Row 1 / Column A.

2 Input to the sensing input stage. Only connect resistive sensors. Never directly connect voltage sources, as this may damage Cebo-MSA64(W).

3 Driven by operational amplifier. Only connect resistive sensors. Do not connect any power sources, as this may damage Cebo-MSA64(W).

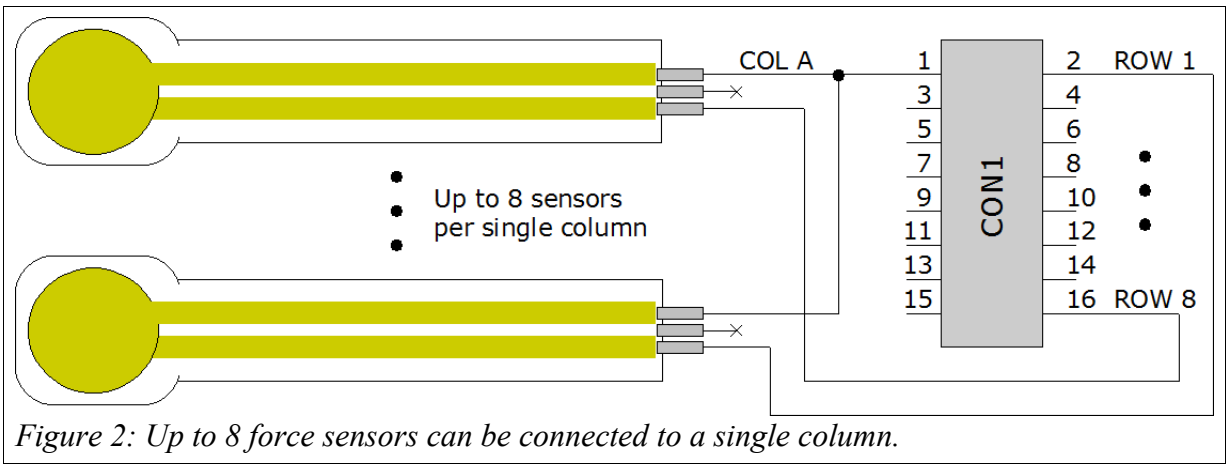

Figure 2: Up to 8 force sensors can be connected to a single column.

Another solution to connect up to 8 sensors to Cebo-MSA64(W) is shown in Figure 2. While still each sensor is attached to a single row exclusively, all sensors are connected at the other terminal and then wired to Column A. With increasing distance between sensors and Cebo-MSA64(W), this scheme might proof more feasible, because the total number of wires needed to connect to CON1 is reduced. In the grid chart of Cebo MSA lite DAQ these sensors will appear at the first column from top to bottom.

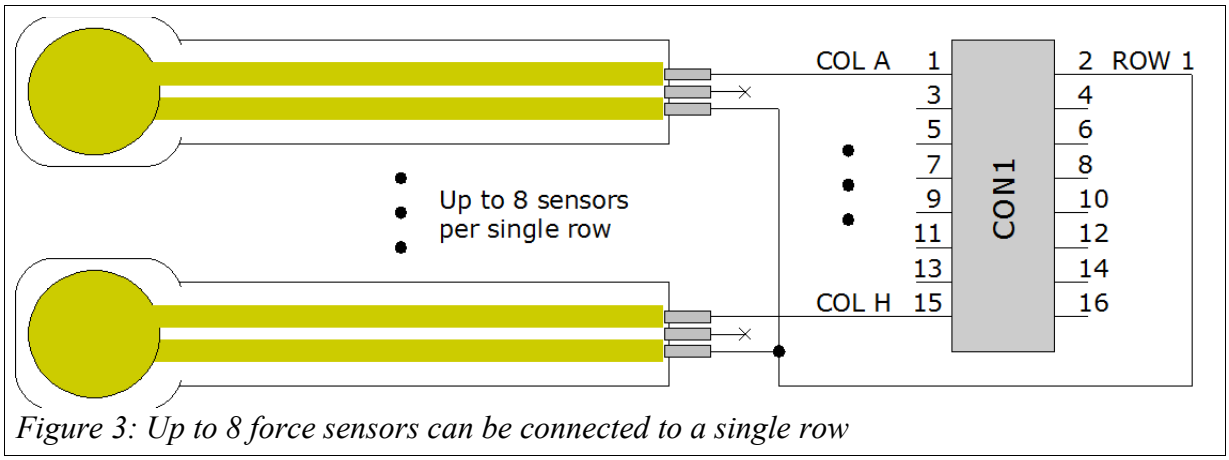

Figure 3: Up to 8 force sensors can be connected to a single row

Read-out of the sensor array is done in a row-by-row manner. Because switching from one row to another row takes some additional time for the analog signal to settle prior to reading the sensing inputs, maximum frame-rate is reduced. The highest possible frame-rate for an 8 sensor setup can be achieved, when sensors are connected at the row terminal side rather than the column side. Figure 3 shows an example. In the grid chart of Cebo MSA lite DAQ these sensors will appear at the first row from left to right. Combining the schemes shown in Figure 2 and 3 allows the connection of up to 64

resistive sensors at once, with frame-rates up to 250 frames/s.

The following table sums up some information on the characteristics of the row drivers and sensing inputs.

Parameter	Min	Typ	Max	Units
Row driving voltage range [4]	-3,0		0,0	volts
Row driving voltage, default		-2,5		volts
Sensor sensitivity range [5]	1,1k		10,0M	ohms
Column feedback resistor range [6]	1,3k		51,3k	ohms
Column feedback resistor, default		26,3k		
Scan-rate, complete frame [7], [8]		200,0		frames/s
Scan-rate, single sensor [8], [9]		12800,0		sensors/s

4 Row driving voltage is software-adjustable through an internal 12bit DAC.
5 Actual sensitivity range depends on feedback resistor setting.
6 Column feedback is software-adjustable. 64 steps are available to adjust input sensitivity.
7 One complete frame contains 64 sensors + 4 additional analog inputs.
8 Achievable maximum frame-rate depends on host PC hardware and may be less.
9 Only one sensor or additional analog input selected for read-out.

Optional Signals - CON2

Additional to the sensor array connector, Cebo-MSA64(W) comes with a 14pin standard RM2.54mm right-angled header. On this expansion connector a lot of optional signals are available:

- One 5V, DC power output
- Two GND terminals
- One trigger input
- Four analog inputs
- One fixed current output
- Four multi-purpose digital IO
- One terminal connected to USB shielding

Pin	Comment	Pin	Comment
1	5V DC [10]	2	Trigger Input
3	GND [11]	4	Analog Input 4
5	Analog Input 3	6	Analog Input 2
7	Analog Input 1	8	GND [11]
9	Digital Input/Output 1	10	Fixed Current Output
11	Digital Input/Output 2	12	Digital Input/Output 3
13	Digital Input/Output 4	14	Shield [12]

5V DC

Cebo-MSA64(W) provides one 5V DC power output on optional signals connector CON2. This port is directly connected to the USB power supply through a small series resistor, typically at least 100mA are available. Use it to supply sensors, signal conditioners or any other circuit to save an extra battery or wall-plug.

Parameter	Min	Typ	Max	Units
Typical Voltage Output		5,0		volts
Output Voltage Accuracy [13]		±5		%

10 Power output. Do not connect external power sources. Cebo-MSA64(W) is sourced from USB.
11 All GND terminals are internally connected.
12 Directly connected to USB shield.
13 Accuracy based on USB specification.

Trigger Input

Cebo-MSA64(W) comes with one Trigger Input. The digital input is compliant to 3,3V TTL signal levels, but tolerates signals as high as 5V. In case of over-voltage a small built-in series resistor limits in-rush current. On each rising edge an internal 32bit counter is incremented, enabling the count of incoming trigger events.

Parameter	Min	Typ	Max	Units
Low Level Input Voltage	-0,3		0,8	volts
High Level Input Voltage	2,0		5,0	volts
Input voltage range [14] , [15]	-1,0		6,5	volts

Multi-purpose Digital Inputs/Outputs

Additionally to the various analog inputs, Cebo-MSA64(W) features four multi-purpose digital inputs/outputs. All digital IOs are compliant to 3,3V TTL signal levels, but tolerate signals as high as 5V. In case of over-voltage a small built-in series resistor limits in-rush current.

Parameter	Min	Typ	Max	Units
Low Level Input Voltage	-0,3		0,8	volts
High Level Input Voltage	2,0		5,0	volts
Input voltage range [14], [15]	-1,0		6,5	volts
Low Level Output Voltage		0,0		volts
High Level Output Voltage		3,3		volts
Sinking 1mA		0,2		volts
Sourcing 1mA		3,1		volts
Short Circuit Current		18		mA
Output Impedance		180		Ohm

Fixed Current Output

To easily use resistive sensors, like for example temperature sensors, together with the Analog Inputs 1 through 4, a software-adjustable fixed current source is available on the optional signals connector CON2. Current output is set to 200uA, as default.

14 Voltages beyond the input voltage range may damage Cebo-MSA64(W)
15 Guaranteed by design, not production tested.

Application example

To measure a resistor value, connect one terminal of the resistor to the Fixed Current Output and one of the analog inputs (for example AIN0), while connecting the other terminal to Cebo-MSA64(W) GND. See Figure 4 for an example setup.

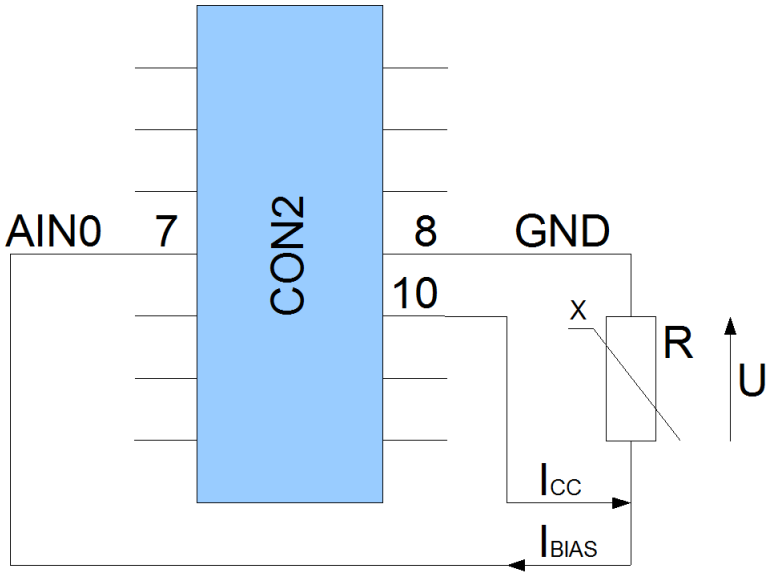

Figure 4: Example application for fixed current source.

As input bias current of Cebo-MSA64(W)'s analog inputs is much much smaller than the fixed current source, its effect can be neglected and the resistor value can be calculated using Ohm's law:

$$I_{BIAS} << I_{CC} => R = \text{Voltage drop / Fixed Current Output} = U / I_{CC}.$$

Parameter	Min	Typ	Max	Units
Adjustable Fixed Current Range	10		3000	uA
Default Fixed Current Value		200		uA
Absolute Accuracy		tbd		%
Temperature Coefficient		tbd		ppm / °C
Maximum driving voltage		4		volts

Analog Inputs

Additional to the sensing inputs for connection of resistive sensors, Cebo-MSA64(W) provides up to four analog inputs to connect to sensors with voltage output.

Features:

- 4 Single-Ended
- 12 Bit resolution
- Input range: 0 - 3,0V
- High impedance operational amplifier inputs
- Up to 12800 samples/s, depending on input channel selection

Floating Inputs

To keep input resistance at a maximum, all Analog Inputs are left floating and are not artificially pulled to 0,0V. Readings from a floating input depend on sample rate and adjacent channels and will return undefined results.

Over-voltage Protection

All Analog Inputs are rated for voltages up to 3,0V with respect to GND. To limit current flow in case of over-voltage, an internal series resistor is added at all input channels. Make sure, voltages stay within specified maximum input voltage range at any time to prevent Cebo-MSA64(W) from damage.

Noise

tbd

Specifications - Analog Input

Parameter	Min	Typ	Max [16]	Units
Input Range	0,0		3,0	volts
Input voltage range [17]	-0,2		5,0	volts
Inputs Bias current		15,0	500,0	10^{-9}A
Input Impedance		tbd		10^{9}ohms
Offest error [18]		tbd		LSB

16 Based on characterization, not production tested.
17 Voltages beyond the input voltage range may damage Cebo-MSA64(W).
18 Ambient temperature T_a = 25°C.

Parameter	Min	Typ	Max	Units
Gain error [18]		+/-0,5	+/-1,5	LSB
Differential linearity error [18]		+/-0,7	+/-1	LSB
Integral linearity Error [18]		+/-0,8	+/-1,5	LSB

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Address

CESYS Gesellschaft für angewandte Mikroelektronik mbH
Gustav-Hertz-Str. 4
D - 91074 Herzogenaurach
Germany

Revision history

Version	Date	Comment	Author	Approved
1.0		Initial release		
1.01		Corrected pin out of CON2 - optional signals.		
1.02		Updated characterizations.		
1.03		Further updates to characterizations.		
1.1		Header added, footer modified, layout modified. (mk)		
1.2	01/18/17	Software documentation separated, ported to new doc format.	th	mh