

## MEASAR RS232 Interface Protocol Rev. E

### 1. COM-Port Settings

CEM COM01 (COM02, COM04 respectively) is a **Data Terminal Equipment**, connector is male Sub-D 9 pin, connection to the host computer is via **Null-Modem** cable.

Baudrate: 115.2 kbit / s

Data bits: 8

Stop bits: 1

Parity: none

Mode: Half-Duplex

Handshake: DTR of COM0X is asserted, as long as it is powered.

If DTR of host computer is detected, the front panel LED colour is green.

Furthermore DTR is used to override the high voltage setting:

if DTR is not detected, the high voltage is turned off.

RTS of COM0X (= host CTS in) is asserted as long as MEASAR is ready for incoming commands, it is deasserted, when MEASAR is sending data.

Data are sent in reaction to host commands as described in sections 3 and 4.

Moreover, counter data are sent automatically, if the parameter F is set to 1, see section 3.

RTS of host (= COM0X CTS in) is used for handshake:

If RTS is deasserted, MEASAR immediately stops sending data.

Restart after RTS is re-asserted is synchronized to the next message, i.e. no incomplete message is sent.

But COM0X has no buffer memory, so data are lost while RTS is deasserted.

LEDs: LED "Connection": red: no connection,  
green: connected.

LED "Meas On": red: a measurement is running,  
off: MEASAR is in idle state.

LED "High Voltage": red: HV is Off,  
green: HV has programmed value,  
orange: HV is ramping up or down to a new value.

#### Notes:

- Incorrect or not complete commands may eventually cause an interface hang-up. Remedy in this case is the interface reset command  $\emptyset\emptyset\emptyset\emptyset$ .
- Every correct host command is answered as described in sections 4 and 5. If there is no answer, the command is not accepted.  
Exceptions:
  - i) The interface reset command  $\emptyset\emptyset\emptyset\emptyset$  does not produce an answer.
  - ii) Commands to set or read a parameter, which are sent while a measurement is going on, are not answered (they might otherwise be interpreted as data).
- Correct read commands that are not valid for a plug-in, e.g. READ high voltage of MS04, are answered with the plug-in number only, no data following.
- Commands received when the system is BUSY are not accepted. The only command that is always accepted is the interface reset command  $\emptyset\emptyset\emptyset\emptyset$ .
- Default values after power-on: High voltage is zero, all other parameters are arbitrary.  
Operating the system must start therefore with the interface reset command  $\emptyset\emptyset\emptyset\emptyset$  followed by the stop command  $SU[00]_{\text{hex}}$  (in case the system is running). Next the parameters can be set.

## 2. Software-Protocol

### 2.1. Meaning of Symbols

A, C, D, F, H, I, M, O, P, Q, R, S, T, U, V, W =	=	ASCII-characters (capital letters) All write commands start with W, all read commands with R, start and stop commands with S.
∅	=	ASCII-number 0
N	=	Binary number, $N = n_7 n_6 n_5 n_4 n_3 n_2 n_1 n_0$ Higher 3 bits $n_6$ to $n_4$ are the channel number 1 to 4 in the four channel counter plug-in MS04, $n_7$ must be 0. Lower 4 bits $n_3$ to $n_0$ are the address 1 to 11 of the module (numbering from left to right, controller is 0). Example: For $N = 35_{\text{hex}}$ channel 3 in module 5 (= MS04) is addressed. If module 5 is an MS02, the upper bits are ignored and the one channel is addressed. For $N = 00_{\text{hex}}$ all MS0X modules and channels in MS04 are addressed simultaneously. In reaction to a read command with $N = 00_{\text{hex}}$ all existing MS0X modules and channels in MS04 modules are read out in succession. Commands with address $n_3$ to $n_0$ , for which a module does not exist, are ignored.
$Z_i$	=	8-bit binary numbers = $(0 \dots 255)_{\text{decimal}}$ These numbers can be assembled to an up to 32 bit binary number: $Z = Z_3 \times 2^{24} + Z_2 \times 2^{16} + Z_1 \times 2^8 + Z_0$ The meaning depends on the command: counter result (32 bit) anode current (16 bit) accumulated charge (16 bit) high voltage (16 bit) measurement interval (16 bit) discriminator threshold (8 bit) number of automatically repeated measurements (8 bit) overload threshold (4 bit) dead time (2 bit) automatic counter data sending on/off (1bit)
0, 1, x	=	binary digit with value 0, 1, don't care

### 2.2. Data Exchange

The MEASAR system reacts to every correct command with the appropriate activity (e.g. set high voltage, start measurement) as well as with an answer to the host. In this way software has a control, whether the instrument works or not.

Write and read of parameters and status data is possible whenever the system is not BUSY. i.e. MEASAR is not sending data. It is not recommended, however, to send parameter write or read commands while a measurement with automatic data transmission (parameter F = 1) is running. Data may be corrupted due to a timing conflict.

Parameters: measurement interval length M(15:0) and number of repetitions A(7:0) become effective with the next start command, all others immediately.

Measurement results can be read any time whenever the system is not BUSY, also repeatedly. They are stored in MS0X until they are overwritten by a new measurement.

As the time window for read operations is limited when measurements are automatically restarted (in particular when short time intervals are programmed), only automatic sending of the results is reliably possible. The operator has to take care, that the time interval is long enough for the read operation (20  $\mu$ s plus 87  $\mu$ s per character). If not, the data will be corrupted.

### 3. Commands

#### 3.1. Reset Interface

0000 = 4 times ASCII 0 resets the interface. This command is necessary for the situation, that the interface might be "hanged up" for any reason. This command is accepted any time and in any status and is not answered. Only the interface is reset, parameters that are set before stay unchanged.

#### 3.2. Write Commands

Host sends	MEASAR responds
<b>WHNZ<sub>0</sub>Z<sub>1</sub></b> = set high voltage in module N Z <sub>0</sub> = H <sub>3</sub> , H <sub>2</sub> , H <sub>1</sub> , H <sub>0</sub> , x, x, x, Slope Z <sub>1</sub> = H <sub>11</sub> , H <sub>10</sub> , H <sub>9</sub> , H <sub>8</sub> , H <sub>7</sub> , H <sub>6</sub> , H <sub>5</sub> , H <sub>4</sub> HV = [ H <sub>11</sub> × 2 <sup>11</sup> + H <sub>10</sub> × 2 <sup>10</sup> + ... H <sub>1</sub> × 2 + H <sub>0</sub> ] Volt slope = 1 for ± 800 V/s, slope = 0 for ± 100 V/s	NH
<b>WDNZ<sub>0</sub></b> = set dead time in channel N Z <sub>0</sub> = x, x, x, x, x, x, D <sub>1</sub> , D <sub>0</sub> dead time = 100 - 62 - 30 - 15 ns for D <sub>1</sub> D <sub>0</sub> = 11 - 10 - 01 - 00	ND
<b>WTNZ<sub>0</sub></b> = set discriminator threshold in channel N Z <sub>0</sub> = [T <sub>7</sub> T <sub>6</sub> T <sub>5</sub> T <sub>4</sub> T <sub>3</sub> T <sub>2</sub> T <sub>1</sub> T <sub>0</sub> ] <sub>dual</sub> = [0 ÷ 255] <sub>dec</sub> threshold = [3 + Z <sub>0</sub> × 0,5] mV input referred	NT
<b>WMNZ<sub>0</sub>Z<sub>1</sub></b> = set measurement time interval in module N Z <sub>0</sub> = M <sub>7</sub> , M <sub>6</sub> , M <sub>5</sub> , M <sub>4</sub> , M <sub>3</sub> , M <sub>2</sub> , M <sub>1</sub> , M <sub>0</sub> Z <sub>1</sub> = M <sub>15</sub> , M <sub>14</sub> , M <sub>13</sub> , M <sub>12</sub> , M <sub>11</sub> , M <sub>10</sub> , M <sub>9</sub> , M <sub>8</sub> time interval = [M <sub>15</sub> × 2 <sup>15</sup> + M <sub>14</sub> × 2 <sup>14</sup> + ... + M <sub>1</sub> × 2 + M <sub>0</sub> ] × 10 ms Z <sub>1</sub> Z <sub>0</sub> = [0000] <sub>hex</sub> : infinite interval, ended only by stop command.	NM
<b>WANZ<sub>0</sub></b> = set number of repetitions in module N Z <sub>0</sub> = [A <sub>7</sub> A <sub>6</sub> A <sub>5</sub> A <sub>4</sub> A <sub>3</sub> A <sub>2</sub> A <sub>1</sub> A <sub>0</sub> ] <sub>dual</sub> = [0 ÷ 255] <sub>dec</sub> for 1 to 255 automatically repeated measurements Z <sub>0</sub> = [00] <sub>hex</sub> : infinite repetitions, ended only by stop command.	NA
<b>WONZ<sub>0</sub></b> = set overload limit in channel N to turn off HV Z <sub>0</sub> = x, x, x, x, O <sub>3</sub> , O <sub>2</sub> , O <sub>1</sub> , O <sub>0</sub> for max anode current = I <sub>max</sub> = [1 ÷ 15] × 1,02 $\mu$ A (MS01 only) for max. rate = [1 ÷ 15] × 204800 counts / sec (MS02 or MS04) O(3:0) = 0 <sub>hex</sub> : overload turn-off deactivated	NO
<b>WFNZ<sub>0</sub></b> = set automatic data transmission in module N Z <sub>0</sub> = x, x, x, x, x, x, x, F <sub>0</sub> F <sub>0</sub> = 1: transmit counter result automatically F <sub>0</sub> = 0: transmit data in reaction to read command only	NF

**Note:** Parameters M, A, F can be set per plug-in only, not individually per channel in MS04. Upper bits n<sub>7</sub> to n<sub>4</sub> of N are ignored.

## 3.3. Read Commands

### 3.3.1. General

Parameters may be read back or status data (high voltage) or measurement result (counts) recorded. If  $N = [00]_{\text{hex}}$ , data of all existing MS01 or MS02 modules and channels in MS04 modules are read out cyclically with N, the channel number (bits  $n_7$  to  $n_4$ ) and the module number (bits  $n_3$  to  $n_0$ ) in the head of the data.

E.g. read high voltages:  $RH[00]_{\text{hex}}$

The system answers:  $N_1 Z_0 Z_1 N_2 Z_0 Z_1 N_3 \dots$  and so on up to  $N_i = N_{\text{max}}$

The high voltage is measured with an A/D converter. Accuracy is better than  $10^{-3}$ , however at the lower (< 5%) and upper (> 97%) ends of the scale the error is higher, in particular zero is not correctly recorded.

#### NOTE:

The ADC to measure the current, the integrator to calculate the integral charge, and the counter all have saturation characteristics, i. e. they do not overflow. Readings of I, Q, or C with all "1s" shall be rated as overflow.

### 3.3.2. Readback of Parameters

Host sends	MEASAR responds
<b>RDN</b> = read dead time in module N	$NZ_0$
<b>RTN</b> = read discriminator threshold in module N	$NZ_0$
<b>RMN</b> = read measurement time interval in module N	$NZ_0 Z_1$
<b>RAN</b> = read number of repetitions in module N	$NZ_0$
<b>RON</b> = read overload threshold in module N	$NZ_0$
<b>RFN</b> = read data transmission configuration in module N	$NZ_0$

### 3.3.3. Read Status Data

Host sends	MEASAR responds
<b>RHN</b> = read high voltage value in module N	$NZ_0 Z_1$ $Z_1 = H_{11}, H_{10}, H_9, H_8, H_7, H_6, H_5, H_4$ $Z_0 = H_3, H_2, H_1, H_0, 0, 0, 0, \text{Slope}$ $HV = [H_{11} \times 2^{11} + \dots + H_1 \times 2 + H_0] \text{ V}$
<b>RIN</b> = read value of anode current in module N (MS01 only)	$NZ_0 Z_1$ $Z_1 = I_{15}, I_{14}, I_{13}, I_{12}, I_{11}, I_{10}, I_9, I_8$ $Z_0 = I_7, I_6, I_5, I_4, I_3, I_2, I_1, I_0$ $I = [I_{15} \times 2^{15} + \dots + I_1 \times 2 + I_0] \times 250 \text{ pA}$

### 3.3.4. Read Measurement Result

Host sends	MEASAR responds
<b>RCN</b> = read counter result in module N	$NZ_0Z_1Z_2Z_3$ $\text{counts} = Z_3 \times 2^{24} + Z_2 \times 2^{16} + Z_1 \times 2^8 + Z_0$ Note: The counter has saturation characteristic, i. e. it stops at $Z = \text{FFFF}_{\text{hex}}$ and does not overflow
<b>RQN</b> = read accumulated charge in module N (MS01 only)	$NZ_0Z_1$ accumulated charge in measurement interval = $[Z_1 \times 2^8 + Z_0] \times 5.12 \text{ nC}$

### 3.3.5. Automatic Transmission of Counter Results

After each elapsed measurement time interval, either self-ended as programmed or ended by command SVN (see 4.2. below), counter data of the counter channels  $N_i$  are transmitted automatically, if the parameter  $F_i$  is asserted:  $N_1Z_0Z_1Z_2Z_3 N_2Z_0Z_1Z_2Z_3 N_3 \dots$   
 No data are transmitted after command SUN (immediate stop, incomplete time interval), but can be read by command RCN.

## 4. Course of a Measurement

### 4.1. General

The measurement is started in module N with command SPN. This activates the counter. Depending on the actual configuration of the parameters the measurement ends after the programmed number of runs or is stopped by command. Transmission of results is performed automatically or in reaction to a read command. Automatic transmission requires, that all the involved modules are started and stopped at the same time, otherwise the data transmission may be corrupted.

### 4.2. Start and Stop of a measurement

Host sends	MEASAR responds
<b>SPN</b> = start measurement in module N	NP
<b>SVN</b> = end measurement in module N measurement ends after regular end of the actual time interval	NV and after elapsed time interval, if $F_n$ is asserted: $NZ_0Z_1Z_2Z_3$
<b>SUN</b> = end measurement in module N measurement is stopped immediately	NU

**Note:** The start and stop commands can be given per plug-in only, not individually per channel in MS04. Upper bits  $n_7$  to  $n_4$  of N are ignored.

As with all commands the stop command too is ignored, if it coincides with sending of data by the system, i.e. if it is BUSY. The controller starts a polling cycle over all plug-ins after each measurement interval (and is BUSY for that time).