MEASAR RS232 Interface Protocol Rev. H

1. COM-Port Settings

CEM COM04 is a **D**ata **T**erminal **E**quipment, connector is male Sub-D 9 pin, connection to the host computer is via **Null-Modem** cable.

Baudrate:	115.2 kbit/s or 230,4 kbit/s, set by jumper inside the controller. The jumper is accessible through an opening in the right side of the controller case. Chosen baud rate is indicated by LEDs in the frontpanel.
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 sended. But COM0x has no buffer memory, so data are lost while RTS is deasserted.

LEDs:

<u>Controller:</u>

LED "Connection":	red:	no connection,
	green:	connected.
LED "Meas On":	red:	a measurement is running,
	off:	MEASAR is in idle state.

LEDs "115 kHz, 230 kHz" show the valid baudrate.

<u>High voltage plug-in:</u>

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

LEDs "POS, NEG" show HV polarity (applicable for HV-plug-ins with switchable polarity only)

Notes:

- Incorrect or incomplete commands may eventually cause an interface hang-up. Remedy in this case is the interface reset command ∅∅∅∅.
- 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 ∅∅∅∅ 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).

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- 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 ∅∅∅∅.
- Default values after power-on: High voltage is zero, all other parameters are arbitrary.
  No measrurement running.
  Operating the system must start therefore with the interface reset command ∅∅∅∅ . 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 (000 adresses all 4 channels), 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 $N = 35_{hex}$ 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 $N = 00_{hex}$ all MS0x modules and channels in MS04 are addressed simultaneously.
In reaction to a read command with $N = 00_{hex}$ 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 = $(0....255)_{decimal}$
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 (if applicable 16 bit)
- accumulated charge (if applicable16 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)
- trigger arming (2 bit)

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 $F_0 = 1$) 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 µs plus 450 µs per channel for 115.2 kHz baudrate, half of that for 230,4 kHz). If not, the data will be corrupted.

3. Commands

3.1. Reset Interface

∅∅∅∅ = 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
WHNZ_0Z_1 = set high voltage in module N $Z_0 = H_3, H_2, H_1, H_0$, x, x, x, Slope $Z_1 = H_{11}, H_{10}, H_9, H_8, H_7, H_6, H_5, H_4$ $HV = [H_{11} \times 2^{11} + H_{10} \times 2^{10} + ... H_1 \times 2 + H_0]$ Volt slope = 1 for ± 800 V/s, slope = 0 for ± 100 V/s	NH
WDNZ_0 = set dead time in channel N Z_0 = x, x, x, x, x, x, D_1, D_0 dead time = 100 - 65 - 30 - 15 ns for D_1D_0 = 11 - 10 - 01 - 00	ND
WTNZ_0 = set discriminator threshold in channel N $Z_0 = [T_7T_6T_5T_4T_3T_2T_1T_0]_{dual} = [0 \div 255]_{dec}$ threshold = $[3 + Z_0 \times 0{,}5]$ mV input referred	NT
WMNZ_0Z_1 = set measurement time interval in module N $Z_0 = M_7, M_6, M_5, M_4, M_3, M_2, M_1, M_0$ $Z_1 = M_{15}, M_{14}, M_{13}, M_{12}, M_{11}, M_{10}, M_9, M_8$ time interval = $[M_{15} \times 2^{15} + M_{14} \times 2^{14} + ... + M_1 \times 2 + M_0] \times 10$ ms $Z_1Z_0 = [0000]_{hex}$: infinite interval, ended only by stop command.	NM
WANZ_0 = set number of repetitions in module N $Z_0 = [A_7A_6A_5A_4A_3A_2A_1A_0]_{dual} = [0 \div 255]_{dec}$ for 1 to 255 automatically repeated measurements $Z_0 = [00]_{hex}$: infinite repetitions, ended only by stop command.	NA

WONZ$_0$ = set overload limit in channel N to turn off HV Z_0 = x, x, x, x, O_3, O_2, O_1, O_0 for max anode current = I_{max} = [1 ÷ 15] × 1,02 µA (MS01 only) for max. rate = [1 ÷ 15] × 204800 counts / sec (MS02 or MS04) O(3:0) = 0_{hex} : overload turn-off deactivated	NO
WFNZ$_0$ = set automatic data transmission in module N Z_0 = x, x, TR_1, TR_0, x, x, x, F_0 TR(1:0): trigger arming TR_1 TR_0 | trigger input 0 0 | deactivated 0 1 | activated for 1 measurement 1 x | permanently activated F_0 = 1: transmit counter result automatically F_0 = 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_7 to n_4 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 = $[00]_{hex}$, 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$[00]_{hex}$
The system answers: $N_1Z_0Z_1$ $N_2Z_0Z_1$ N_3 ... and so on up to $N_i = N_{max}$
The high voltage is measured with an A/D converter. Accuracy is better than 5×10^{-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
RDN = read dead time in module N	NZ_0
RTN = read discriminator threshold in module N	NZ_0
RMN = read measurement time interval in module N	NZ_0Z_1
RAN = read number of repetitions in module N	NZ_0
RON = read overload threshold in module N	NZ_0
RFN = read data transmission configuration and trigger arming in module N	NZ_0

3.3.3. Read Status Data

Host sends	MEASAR responds
RHN = read high voltage value in module N	NZ_0Z_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, Slope $HV = [H_{11}\times2^{11} + ... + H_1\times2 + H_0]$ V
RIN = read value of anode current in module N **(**MS01 only)	NZ_0Z_1 $Z_1 = I_{15}, I_{14}, I_{13}, I_{12}, I_{11}, I_{10}, I_9, I_8$ $Z_0 = I_7, I_6, I_5, I_4, I_3, I_2, I_1, I_0$ $I = [I_{15}\times2^{15} + ... + I_1\times2 + I_0] \times 250$ pA

3.3.4. Read Measurement Result

Host sends	MEASAR responds
RCN = read counter result in module N	$NZ_0Z_1Z_2Z_3$ counts = $Z_3\times2^{24} + Z_2\times2^{16} + Z_1\times2^8 + Z_0$ Note: The counter has saturation characteristic, i. e. it stops at Z = $FFFF_{hex}$ and does not overflow
RQN = read accumulated charge in module N (MS01 only)	NZ_0Z_1 accumulated charge in measurement interval = $[Z_1\times2^8 + Z_0] \times 5.12$ 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_0 is asserted: $N_1Z_0Z_1Z_2Z_3\ N_2Z_0Z_1Z_2Z_3\ N_3$.....
No data are transmitted after command SUN (immediate stop, incomplete time interval), but can be read by command RCN.

Note:

- If some modules are not stopped at the same time, automatic readout (F_0) must not be asserted. Data will be corrupted, because the readout is started as soon as the measurement in one module is finished, so the two readout cycles will interact, if another module finishes measurement while readout of the former module is still going on.

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
SPN = start measurement in module N	NP
SVN = end measurement in module N measurement ends after regular end of the actual time interval	NV and after elapsed time interval, if F_0 is asserted: $NZ_0Z_1Z_2Z_3$
SUN = 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).

The measurement can alternatively be started by an external trigger. In this case all measurement plug-ins are started, and the controller sends $(00)_{Hex}$P to the host computer. Counter results are automatically transferred or not, depending on whether parameter F_0 is asserted or not.