MEASAR SOLO RS232 Interface Protocol Rev. B

1. COM-Port Settings

MEASAR SOLO is a **D**ata **T**erminal **E**quipment, connector is a male Sub-D 9 plug, connection to the host computer is via **Null-Modem** cable.
Alternatively a built-in serial-to-USB bridging circuit can be used. In this case the driver software (delivered with the unit) has to be installed.
The active port is determined with a slide switch at the rear panel of MEASAR SOLO.

Baudrate:	115.2 kbit / s
Data bits:	8
Stop bits:	1
Parity:	none
Mode:	Full Duplex

Handshake:
DTR of MEASAR SOLO 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 MEASAR SOLO (= host CTS in) is asserted as long as MEASAR SOLO is ready, i. e. if the adressed port is activated.
RTS of host (= MEASAR SOLO CTS in) is used for handshake:
If RTS is deasserted, MEASAR SOLO immediately stops sending data.
Restart after RTS is re-asserted is synchronized to the next message, i.e. no incomplete message is sended.
But MEASAR SOLO 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 SOLO 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 ∅∅∅∅.
- Every correct host command is answered as described in sections 4 and 5. If there is no answer, the command is not accepted.
  Exception: The interface reset command ∅∅∅∅ does not produce an answer.
- Default values after power-on: High voltage is zero, no measurement running, interface is reset, all other parameters are arbitrary.

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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, $N = n_7\ n_6\ n_5\ n_4\ n_3\ n_2\ n_1\ n_0$
N must be = 0000 0000 or 0000 0001 for MEASAR SOLO, commands with other values of N 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 (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

MEASAR SOLO 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 any time. 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, also repeatedly. They are stored in MEASAR SOLO 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.

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 $Z_0 = H_3, H_2, H_1, H_0, x, x, x, Slope$ $Z_1 = H_{11}, H_{10}, H_9, H_8, H_7, H_6, H_5, H_4$ $HV = [H_{11} \times 2^{11} + H_{10} \times 2^{10} + ... H_1 \times 2 + H_0]$ Volt slope = 1 for ± 800 V/s, slope = 0 for ± 100 V/s	NH
$WDNZ_0$ = set dead time $Z_0 = x, x, x, x, x, x, D_1, D_0$ dead time = 100 - 62 - 30 - 15 ns for D_1D_0 = 11 - 10 - 01 - 00	ND
$WTNZ_0$ = set discriminator threshold $Z_0 = [T_7T_6T_5T_4T_3T_2T_1T_0]_{dual} = [0 \div 255]_{dec}$ threshold = $[3 + Z_0 \times 0,5]$ mV input referred	NT
$WMNZ_0Z_1$ = set measurement time interval $Z_0 = M_7, M_6, M_5, M_4, M_3, M_2, M_1, M_0$ $Z_1 = M_{15}, M_{14}, M_{13}, M_{12}, M_{11}, M_{10}, M_9, M_8$ 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 $Z_0 = [A_7A_6A_5A_4A_3A_2A_1A_0]_{dual} = [0 \div 255]_{dec}$ for 1 to 255 automatically repeated measurements $Z_0 = [00]_{hex}$: infinite repetitions, ended only by stop command.	NA
$WONZ_0$ = set overload limit to turn off HV $Z_0 = x, x, x, x, O_3, O_2, O_1, O_0$ for max anode current = $I_{max} = [1 \div 15] \times 1,02$ µA (SOLO-N only) for max. rate = $[1 \div 15] \times 204800$ counts / sec (SOLO-P) $O(3:0) = 0_{hex}$: overload turn-off deactivated	NO
$WFNZ_0$ = set automatic data transmission $Z_0 = x, x, x, x, x, x, x, F_0$ $F_0 = 1$: transmit counter result automatically $F_0 = 0$: transmit data in reaction to read command only	NF

3.3. Read Commands

3.3.1. General

Parameters may be read back or status data (high voltage, anode current) or measurement result (counts, accumulated charge) recorded.
The high voltage is measured with an A/D converter. Accuracy is better than 10^{-3} , however at the lower (< 5%) and upper (> 95%) 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	NZ_0
RTN = read discriminator threshold	NZ_0
RMN = read measurement time interval	NZ_0Z_1
RAN = read number of repetitions	NZ_0
RON = read overload threshold	NZ_0
RFN = read data transmission configuration	NZ_0

3.3.3. Read Status Data

Host sends	MEASAR responds
RHN = read high voltage value	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	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	$NZ_0Z_1Z_2Z_3$ $counts = Z_3\times2^{24} + Z_2\times2^{16} + Z_1\times2^8 + Z_0$
RQN = read accumulated charge	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 are transmitted automatically, if the parameter F is asserted.
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 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.

4.2. Start and Stop of a measurement

Host sends	MEASAR responds
SPN = start measurement	NP
SVN = end measurement measurement ends after regular end of the actual time interval	NV and after elapsed time interval, if F is asserted: $NZ_0Z_1Z_2Z_3$
SUN = end measurement measurement is stopped immediately	NU