Communication Multimeter - PC via adapter

The multimeters can communicate in different modes:

a) **Normal mode**: In addition to measurement the multimeter receives most of commands from PC and sends responses.
b) **Send mode** : the multimeter autonomously sends measured data to the optical interface.
The multimeter is brought into this mode when switched on by depressing <DATA> and <ON> buttons together or when item *Send on* is chosen or by command from PC.
c) **Block send mode:-** the multimeter stores measured data into short internal temporary FIFO memory. PC must read this memory in short time so as it is not overwritten. The multimeter is brought into this mode by command from PC.
d) **PC mode:** the multimeter works according to the commands from PC, keyboard is not in operation. The lower left display shows the symbol -PC- . **PC mode is not used!**
e) **PC test mode:** the multimeter works according to the commands from PC, keyboard is not in operation. The main display shows the symbol PCtESt .

The multimeter 22S/M - 29S can work:

a) alone
b) with unidirectional adapter RS232
c) with bidirectional adapter BD232
d) with uni-directional adapter with memory SI232
e) with new bi-directional adapter with memory SI232 II

Following table shows which types of multimeters can work with which types of adapters:

	RS232 Adapter	**SI232 Adapter**	**New SI232 II Adapter (bi-directional)**	**BD232 Adapter**
Multimeters 12S ...18S	Yes	Yes	Yes	Yes
Multimeters 22S/M ...28S	Yes, multimeter in SEND mode only	Yes, multimeter in SEND mode only	Yes	Yes
Powermeter 29S	Yes, multimeter in SEND mode only	Yes, multimeter in SEND mode only	Yes	Yes

The multimeter 22S/M-29S works with 9600 Bd , 8 bits + Start+Stop bit (only lower 6 bits are used) and 8192 Bd 6 bits+Start bit+Stop bit (in send mode, when item *AdAPt = SI232 onlinE* or *SI232 StorE*)

The multimeter 22S/M-29S can communicate with PC and adapter in two directions:

a) The multimeter measures the input quantity and sends the measured values to the optical output -SEND mode. The attached adapter sends the received data to the PC or (in case of SI-232 adapter and new SI-232 II adapter) it can store the data into the adapter's memory.
b) The PC sends data to the BD-232 or new SI-232 II adapter, the adapter recognises it as data for its multimeter (in case of new SI-232 II adapter) and sends it to the multimeter. The multimeter recognises the data as a command, executes this command and generally sends the answer into its adapter, the adapter sends this data to the PC.

Format of data for the bidirectional communication

Serial flow of data, each byte is start bit, 8 bits of data (6 valid) and stop bit, 9600 Bd.

a) data from PC into adapter BD-232 or new SI-232 II
data comes in block of bytes
each byte noticed in this paragraph a) and b) is sent in 3 bytes in fact:
byte D7 D6 D5 D4 D3 D2 D1 D0 is sent as: B1 B1 B1 B1 B0 B0 B0 B0 B3 B3 B3 B3 B2 B2 B2 B2

B5 B5 B5 B5 B4 B4 B4 B4
1. byte = address of the adapter (and its multimeter)
D7 ..... D0

X X A3 A2 A1 A0 0 1
the block of data is for the adapter itself (adapter with the address A3-A0)
X X A3 A2 A1 A0 1 1
the block of data is for the multimeter attached to the adapter with address A3-A0

2.- n. byte - the meaning of following bytes is in table of commands TC1 (if the block is for the multimeter)

b) data from the adapter to the multimeter
the same block of data coming from PC into the adapter is sent into the multimeter, bits D7-D6 not used

c) data from the multimeter (answer) into the adapter
format according the table of commands TC1

d) data from the adapter to PC
the same block of data coming from multimeter into the adapter is sent into PC

Send mode

The multimeter autonomously sends measured data to the optical interface.

The multimeter is brought into this mode when switched on by depressing <DATA> and <ON> buttons together or when item *Send on* is chosen or by command from PC.

Rate of data beeing sent into interface depends on item *rAtE* set in menu - see table TSR, interface rate (with respect to the fastest possible rate depending on the measuring function).

If the *rate* is less than *10* seconds, multimeter switches never off (auto-power-off disableed).

If the *rate* is equal *10* seconds or slower, multimeter switches off between send events to save battery. Multimeter switches on about 3 seconds before following send time. This switching off is not in efect if multimeter is set into permanent operation mode (<FUNC>+<ON> together when switching on). Auto-power-off is also disabled in functions Events, Counter, Stop watch, Mains analysis (29S) and Power (29S).

If menu item *rAtE* equals *dAtA* then multimeter sends value into interface only when data event occures (function DATA is chosen in multimeter by depressing <DATA> button and multimeter recognizes new stable value, displays it on the left display and makes beep or double beep).

If attached adapter is SI-232 (menu item *AdAPt* is set for *SI-232 onlinE* or *SI-232 StorE*), it is necessary to wake up the adapter before sending data at slow rates. Thats why multimeter sends 3 blocks of data in time distance 0.2 sec instead of only 1 block if the *rate* is equal *10* seconds or slower or *dAtA* or *SAMPLE* or when measuring function is capacitance.

It is convenient to set menu item *rAtE* on SI-232 to the same as on multimeter. If in multimeter menu item *rate* is set to *dAtA*, then in SI-232 menu item *rAtE* should be set to *1* sec.

If multimeter recognizes any signal coming from interface, it stops sending for 5 seconds. In this period PC may make communication with multimeter. If during this time multimeter is not set into non-send mode, it continues sending.

Table TM1 *- Format of data coming from multimeter in SEND mode*

1) V DC, A DC - rate 50 ms

a) Measured data

Byte No.	Output unit	Bit5	Bit4
1	Measuring range, sign	0	1
2	Units	1	1
3	Tens	1	1
4	Hundreds	1	1
5	Thousands	1	1
6	TenThousands	1	1

b) Instruments setting and special character

Byte No.	Output unit	Bit5	Bit4
1	Device code *	0	0
2	Current type and measured variable 1	1	1
3	Special character 1	1	1
4	Special character 2	1	1
5	Measuring range, sign 1	1	1

*** device code is 1101 like multimeter 18S**

2) V AC, V AC+DC, I AC+DC, Ohm, Ohm with buzzer, F, Hz , Temp., dB, V-diode, V-diode with buzzer, Events, Counter, Mains analysis (29S) and Power (29S) and V DC, A DC and functions when send interval >50 ms

Byte No.	Output unit	Bit5	Bit4
1	Device code	0	0
2	Current type and measured variable 1	1	1
3	Special character 1	1	1
4	Special character 2	1	1
5	Measuring range, sign	1	1
6	Units	1	1
7	Tens	1	1
8	Hundreds	1	1
9	Thousands	1	1
10	TenThousands	1	1
11	HundredThousands	1	1
12	Current type and measured variable 2	1	1
13	Send interval	1	1

If menu item *AdAPt* is *SI-232 StorE*, then device code is 1101 like multimeter 18S and bytes 11, 12, 13 are not sent.

29S: In case of power measurement there are sent 3 of these blocks with delay 200 ms in order power -W, voltage - V, current -A. In block of voltage byte No.6 is on bit 0 inserted inductive/capacity load.

29S: In case of mains measurement there is sent TRMS value AC+DC regulary according menu rate. If dropout event happens then it is sent. If pulse event happens then it is sent.

Output units (bit3 - bit0)

1) Device code

Device	Code
12S	0100
13S	1000
14S	1001
15S	1010
16S	1011
18S	1101
22S/M	0010
23S	0011
24S/M	1111
25S/M	0101
26S/M	0001
28S	1100
29S	1110

2) Send interval

Code	Send interval
0000	0.05
0001	0.1
0010	0.2
0011	0.5
0100	00:01
0101	00:02
0110	00:05
0111	00:10
1000	00:20
1001	00:30
1010	01:00
1011	02:00
1100	05:00
1101	10:00
1110	----
0111	data

3) Current type and measured variable 1, 2

a) menu item *AdAPt* is *SI-232 StorE*

function	variable 1
-	0000
V AC	0001
V(AC+DC)	0010
V DC	0011
Ω, Ω + buzzer	0100
Diode, Diode + buzzer	0101
°C °F	0110
Farad	0111
mA DC	1000
A DC	1001
mA(AC+DC)	1010
A(AC+DC)	1011
Hz AC, Hz AC+DC	1100
dB	1101
Events AC, Events AC+DC	1110
-	1111
29S only:	
W on power	0001
mA on power	1010
A on power	1011
V on power	0010
Press	0011
Counter	0011
pulse W	0011
TRMS V on mains	0001
pulse on mains	0010
dropout on mains	0011

b) menu item *AdAPt* is **not** *SI-232 StorE*

function	variable 2	variable 1
-	0000	0000
V DC	0000	0001
V(AC+DC)	0000	0010
V AC	0000	0011
mA DC	0000	0100
mA(AC+DC)	0000	0101
A DC	0000	0110
A(AC+DC)	0000	0111
Ω	0000	1000
Farad	0000	1001
dB	0000	1010
Hz Uacdc	0000	1011
Hz Uac	0000	1100
W on power, mA range (29S)	0000	1101
W on power, A range (29S)	0000	1110
Diode	0000	1111
Diode + buzzer	0001	0000
Ω + buzzer	0001	0001
Temp	0001	0010
-	0001	0011
-	0001	0100
Press (29S)	0001	0101
pulse W (29S)	0001	0110
TRMS V on mains (29S)	0001	0111
Counter	0001	1000
Events Uacdc	0001	1001
Events Uac	0001	1010
pulse on mains (29S)	0001	1011
dropout on mains (29S)	0001	1100

4) Special character 1, 2

Display	Spec.ch. 1
FUSE	xxx1
LOW BATT	xx1x
BEEP	x1xx
ZERO	1xxx

Display	Spec.ch.2
DATA	xxx1
-	xx1x
-	x1xx
MAN	1xxx

5) Measuring range, sign - table TR

V ,Events	mA	A	Ω	Ω+buzzer	Hz	dB *	Diode,Diode +buzzer	Temp	F	mains	Code
300mV	300uA	3A	300 Ω	300 Ω	300Hz	300mV	-	full range	3nF	300V	a000
3V	3mA	30A	3kΩ	-	-	3V	3V	-	30nF	1000V	a001
30V	30mA	-	30kΩ	-	30kHz	30V	-	-	300nF		a010
300V	300mA	-	300kΩ	-	300kHz	300V	-	-	3uF		a011
1kV	-	-	3MΩ	-	-	1kV	-	-	30uF		a100
-	-	-	30MΩ	-	-		-	-	300uF		a101
-	-	-	-	-	-		-	-	3000uF		a110
-	-	-	-	-	-		-	-	3000uF		a111

- dB - range means the voltage range, the value has decimal point on 3.place e.g. 012.34 dB
  a=1 sign -
  a=0 no sign

6) Numeric characters

Display	Code	Display	Code
0	0000	8	1000
1	0001	9	1001
2	0010	OL	1010
3	0011	Reserved	1011
4	0100	Reserved	1100
5	0101	Reserved	1101
6	0110	Reserved	1110
7	0111	Reserved	1111

Block send mode

In this mode the multimeter stores measured data into short internal temporary memory. Storing sample rate is determined by menu item *rate* (but min 0.05 s, max 5 sec) and with respect to the minimum sample rate depending on actual measuring function. PC must read this memory in short time so as it is not overwritten. Worst case is in rate 0.05 sec where the internal buffer is full in approx. 6 seconds. If PC is not able to read the stored data in time (case of many multimeters connected through adapters into 1 COM port , case of slow computer or case of errors in communication), PC may set menu rate variable into slower rate.

Reading is done in bidirectional communication PC - multimeter - see next paragraph.
The multimeter is brought into this mode by command from PC.
The multimeter is brought out of this mode by command from PC or from menu - item *Send OFF* or by switching off the multimeter.
In block send mode flashes symbol ON in triangle on multimeter display (periode 2 s, 1.5 sec on, 0.5 sec off).

Bidirectional communication PC - multimeter

Format of data blocks for all commands - tables TC1

meanings of the shortcuts:

ca address sent from PC to multimeter or 0 (for all multimeters)
address (0..15) is in binary coding on bits D5-D2, D1-D0=log 1 (e.g. address 1 = 7H)
aa address sent from multimeter
chs complement of the checksum of previous 13 ** bytes
first row of 14 ** bytes means data sent from PC
second row of 14 ** bytes means data sent from multimeter

**) except of commands for reading content of multimeter's RAM - there is different length

Command for reading the content of multimeter's RAM

Content of multimeter's RAM is sent from multimeter in blocks:

1) PC sends block of 14 bytes containing the begin address in
RAM into the multimeter , (RAM = 128 KB), begin address can be XXXXXXX0000000 (A14-A0)

ca	2BH	3FH	0H	BA0	BA1	BA2	BA3	type	X	X	X	X	chs

BA0 D3 - address bit A7 of begin address
BA1 D3-D0 - bits A11-A8 of begin address
BA2 D3-D0 - bits A15-A12 of begin address
BA3 D0 - address bit A16 of begin address
type = 0H

2) multimeter sends block of data from its RAM to the adapter
The block has 8+128*2+2 bytes

aa	stat	sa1	sa2	len1	len2	chs1	chs2	rd1	rd2	.....	rd256	chs3	chs4

;format of sent bytes:

aa: adapter's address in D3-D0, D4=D5=0
stat: 0H - OK, 3H - error - multimeter is not in normal or memory mode (only 8 + 2 bytes are sent in this case)
sa1: begin address of sent RAM A12-7 on bits D5-0
sa2: begin address of sent RAM A16-13 on bits D3-0
len1: length of block L5-L0 on D5-0 (block length 266)
len2: length of block L11-6 on D5-0
chs1: check sum of bytes 1..6 (aa ..len2) CHS3-0 on D3-0
chs2: check sum of bytes 1..6 CHS7-4 on D3-0
rd1..rd256 -128 bytes from RAM (D7-D0) in 2*128 bytes:
first byte from RAM (D7-D0) in two bytes:
low nibble(D3-D0) in D3-D0, (rd1)
D4 holds odd parity of D1 and D0 bits
D5 holds odd parity of D3 and D2 bits
high nibble(D7-D4) in D3-D0, (rd2)
D4 holds odd parity of D1 and D0 bits
D5 holds odd parity of D3 and D2 bits
second byte from RAM

128 byte from RAM in two bytes

chs3: check sum of 128 bytes from RAM computed in 8 bits, CHS3-0 on D3-0
chs4: check sum CHS7-4 on D3-0

Command for reading multimeter's internal buffer keeping measured values in block send mode

In block send mode the multimeter stores measured data into short internal buffer of length approx. 400 bytes. (in power measurement and mains analysis the length is approx. 200 bytes). After writing new value into last byte of the buffer, next writing continues from the begin of the buffer again.

PC must read this buffer time to time so as this bufer is not overwritten - in this case the buffer is cleared, the content is lost and this event is set into status bit RESET being read by PC .

Disturbances are expected on the communication line and that is why following procedure for reading is made:

Blocks sent into PC are in multimeter numbered as even and odd block. This number is part of the sent block. PC sends command for reading either even or odd block. If the received block (into PC) is OK, next time will PC ask for new block (number + 1) modulo 2 , if the received block is wrong or no block has come then will PC ask for the same block (the same number as before) immediately.

If the internal buffer was overwritten, this is reported in received block - RESET bit - part of measured curve is lost.

The length of received blocks varies according ammount of stored values. No matter whether PC asks for new or old block, multimeter sends stored values with the begin of the block according requested number but up to the very end of stored values. It means that first succesful reading wil get all the stored values and it is not necessary to ask immediately for next block.

Coding of data stored in internal buffer is the same like the coding of data in 128 KB memory in memory mode. - see paragraph memory mode. If RESET is reported in status then the data are coded from the begin - like from address 0 in memory 128 KB.

RESET bit is set also when block send mode is started .
RESET bit is set also when multimeter starts new measuring function which uses different length of internal buffer than the previous one.

1) PC sends block of 14 bytes

ca	2BH	3FH	0H	X	X	X	X	type	X	X	X	X	chs

type: 1H or 3H

1H: request for even block
3H: request for odd block

2) multimeter sends block of data from its RAM to the adapter

The block has 8+n*2+2 bytes

aa	stat1	stat2	X	len1	len2	chs1	chs2	rd1	rd2	.....	rd n*2	chs3	chs4

;format of sent bytes:

aa: adapter's address in D3-D0, D4=D5=0
stat1: 2H - OK, 3H - error - multimeter is not in block send mode (only 8 + 2 bytes are sent in this case)
stat2: D0 = 0 = even block sent
D0 = 1 = odd block sent
D1 not used
D2 = 1 = RESET - restart of block send mode
(buffer overwritten or change of the length of the buffer
- when meas function changes from mains,power to other function
or back)
D3 = 1 = omit first byte (rd1,rd2) - first valid byte is rd3+rd4
D4 = 1 = omit last byte (rd n*2-1, rd n*2) - last valid byte is rd*2-3 + rd n*2-2
D5 = 0 = lo nibble is first free nibble in last valid byte (this byte not used at all)
D5 = 1 = hi nibble is first free nibble in last valid byte (lo nibble is the last)
len1: length of block L5-L0 on D5-0 (block length = 8 + n*2 +2)
len2: length of block L11-6 on D5-0
chs1: check sum of bytes 1..6 (aa ..len2) CHS3-0 on D3-0
chs2: check sum of bytes 1..6 CHS7-4 on D3-0
rd1..rdn*2- n bytes from RAM (D7-D0) in 2*n bytes:
first byte from RAM (D7-D0) in two bytes:
low nibble(D3-D0) in D3-D0, (rd1)
D4 holds odd parity of D1 and D0 bits
D5 holds odd parity of D3 and D2 bits
high nibble(D7-D4) in D3-D0, (rd2)
D4 holds odd parity of D1 and D0 bits
D5 holds odd parity of D3 and D2 bits
second byte from RAM
.
.
n-th byte from RAM in two bytes

chs3: check sum of n bytes from RAM computed in 8 bits, CHS3-0 on D3-0
chs4: check sum CHS7-4 on D3-0
For debugging of PC software see command set debug variables

Command for reading first free and first occupied address in RAM

ca	2BH	3F	1H	X	X	X	X	X	X	X	X	X	chs

aa	27H	-||-	-||-	FFN0	FFN1	FFN2	FFN3	FFN4	FON0	-||-	-||-	-||-	chs

FFN0 - D3-D0: first free address A3-A0
FFN1 - D3-D0: first free address A7-A4
FFN2 - D3-D0: first free address A11-A8
FFN3 - D3-D0: first free address A15-A12
FFN4 - D0: first free address A16
D1: which nibble of byte is free
D3: 1:RAM in multimeter is full
(This equals 1 only when first free address = first occupied address)
FON0 - D5-D0: first occupied address A13-A8
A7-A0 of first occupied address equals 0

Command for clearing all the RAM in multimeter's memory

ca	2BH	3F	2H	X	X	X	X	X	X	X	X	X	chs

aa	27H	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	chs

Read version A.B of multimeter firmware, status of the multimeter

ca	2BH	3F	3H	**Idx**	X	X	X	X	X	X	X	X	chs

aa	27H	-||-	-||-	B	A	RS	MF	RA	PwRU	PwRI	BAT	TYPE	chs

version is A.B
RS position of the rotary switch
0 : left position
.
9 : right position

MF Measuring function
D5-0: see table TF
RA Range on this function, not in case of counter
D2-0: see table TR_2
D5: 0 = auto, 1=MAN
in case of frequency and counter - range for voltage, D2-0: see table TR_2
PwRU 29S only: in case of power measurement - range for voltage, D2-0: see table TR_2
in case of frequency and counter - range for voltage, D2-0: see table TR_2
PwRI 29S only: in case of power measurement - range for current, D2-0: see table TR_2
BAT battery voltage on D5-D0, unit is 0,1 V
ZERO incase UDC, R, 0 = ZERO OFF; 1 – ZERO ON
TYPE D4-D0: multimeter type
1 = 26; 2 = 22; 3 = 23; 4= 24; 5 = 25; D5: 0 – Without memory // 1 – with memory
D5-D0: multimeter type 12 = 28S; 14 = 29 S

If Idx =0 then format of sent block is just described
if Idx =1 then format of sendblock is:

aa	27H	-||-	-||-	**B2**	**A2**	**Comm**	**Cntr**	**drpCi**	**drpCh**	X	X	X	chs

Internal version is A2, B2
Comm: D5-D0 1H Normal mode of multimeter
2H send mode
4H block send mode
10H PC test mode
20H memory mode
Cntr D5-D0 counter of correctly received blocks from PC modulo 64

Table of measuring function TF

function	code
none	000000
V DC	000001
V(AC+DC)	000010
V AC	000011
mA DC	000100
mA(AC+DC)	000101
A DC	000110
A(AC+DC)	000111
Ω	001000
Farad	001001
dB	001010
Hz Uacdc	001011
Hz Uac	001100
Power L	001101
Power H	001110
Diode	001111
Diode + buzzer	010000
Ω + buzzer	010001
Temp	010010
-	010011
-	010100
Press	010101
pulse W	010110
Mains	010111
Counter	011000
Events Uacdc	011001
Events Uac	011010

Table TR_2

V, dB*, Events	mA	A	Ω	Ω+buzzer	Hz	Diode, Diode+buzzer	Temp	F	W,VA	Code
300mV	100uA**	1A	300 Ω	300 Ω	300Hz	-	full range	3nF	1 mW	0000
3V	300uA	3A	3kΩ	-	-	3V	-	30nF	10 mW	0001
30V	1mA**	10A	30kΩ	-	30kHz	-	-	300nF	100 mW	0010
300V	3mA	-	300kΩ	-	100kHz	-	-	3uF	1 W	0011
1kV	10mA**	-	3MΩ	-	-	-	-	30uF	10 W	0100
-	30mA	-	30MΩ	-	-	-	-	300uF	100 W	0101
-	100mA**	-	-	-	-	-	-	3000uF	1 kW	0110
-	300mA	-	-	-	-	-	-	3000uF	10 kW	0111

*) dB - range means the voltage range, the value has decimal point on 3rd place e.g. 012.34 dB

**) - these ranges only for calibration and power measurement

Table TR_3 (equals table TR_2 , only mA and A collumns are different)

V, dB*, Events	mA	A	Ω	Ω+buzzer	Hz	Diode, Diode+buzzer	Temp	F	W,VA	Code
300mV	300uA	3A	300 Ω	300 Ω	300Hz	-	full range	3nF	1 mW	0000
3V	3mA	10A	3kΩ	-	-	3V	-	30nF	10 mW	0001
30V	30mA	-	30kΩ	-	30kHz	-	-	300nF	100 mW	0010
300V	300mA	-	300kΩ	-	100kHz	-	-	3uF	1 W	0011
1kV	-	-	3MΩ	-	-	-	-	30uF	10 W	0100
-	-	-	30MΩ	-	-	-	-	300uF	100 W	0101
-	-	-	-	-	-	-	-	3000uF	1 kW	0110
-	-	-	-	-	-	-	-	3000uF	10 kW	0111

*) dB - range means the voltage range, the value has decimal point on 3rd place e.g. 012.34 dB

Set real time

ca	2BH	3F	4H	0H	RT0	RT1	RT2	RT3	RT4	RT5	RT6	RT7	chs

aa	27H	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	chs

RT0 D3-0: seconds / 256
RT1 D3-0: seconds / 16
RT2 D3-0: seconds
RT3 D3-0: tens of seconds
RT4 D3-0: minutes
RT5 D3-0: tens of minutes
RT6 D3-0: hours
RT7 D3-0: tens of hours

Read real time

ca	2BH	3F	5H	0H	X	X	X	X	X	X	X	X	chs

aa	27H	-||-	-||-	-||-	RT0	RT1	RT2	RT3	RT4	RT5	RT6	RT7	chs

RT0- RT7 like for Set real time

Set real date

ca	2BH	3F	4H	1H	X	X	RD0	RD1	RD2	RD3	RD4	RD5	chs

aa	27H	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	chs

RD0 D3-0: days
RD1 D3-0: tens of days
RD2 D3-0: months
RD3 D3-0: tens of months
RD4 D3-0: years
RD5 D3-0: tens of years
Years over 90 are 19.. RD5 RD4
Years below 90 are 20.. RD5 RD4

Read real date

ca	2BH	3F	5H	1H	X	X	X	X	X	X	X	X	chs

aa	27H	-||-	-||-	-||-	-||-	TV	RD0	RD1	RD2	RD3	RD4	RD5	chs

TV D0: 0-time not set or set by keyboard, 1-time set from PC
RD0- RD5 like for Set real date

Set sample rate, filter, ALL Store, duration, resolution, phase .....

ca	2BH	3F	4H	2H	RA	FI	MP	HY	AL	DU	RE	PH	chs

aa	27H	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	chs

RA D5-0: code of sample rate see table TSR (for 28S : 5...20, for 28S : 0...21)
if D5-D0=3FH then no change

FI D5-0:
0 : filter on **Filter not used!**
1 : filter off
3FH:no change

MP D5-0:
0: do send the response block for received block if address is 0 or if communication error occurs
1: do not send the response
3FH:no change

HY D5-0: Hysteresis for memory mode
0 : 000000
1 : 000001
2 : 000002
3 : 000005
4 : 000010
5 : 000020
6 : 000050
7 : 000100
8 : 000200
9 : 000500
10: 001000
11: 002000
12: 005000
13: 010000
14: ALL
3FH:no change

AL D5-0 not used

DU D5-0:
0 : duration = off
1 : duration = on
3FH:no change

D0 :
0 : resolution HI for voltage DC
1 : resolution LO for voltage DC

D1 :
0 : resolution HI forcurrent DC
1 : resolution LO for current DC

D2 :
0 : resolution HI for resistance
1 : resolution LO for ressistance

D3 :
0 : resolution HI for frequency
1 : resolution LO for frequency
3FH:no change

RE D5-0 not used

PH D5-0 not used

Read sample rate, filter, ALL Store, duration, resolution....

ca	2BH	3F	5H	2H	X	X	X	X	X	X	X	X	chs

aa	27H	-||-	-||-	-||-	RA	FI	MP	HY	AL	DU	RE	PH	chs

All parameters like in Set sample rate, ...

Capture real time

ca	2BH	3F	4H	3H	X	X	X	X	X	X	X	X	chs

aa	27H	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	chs

Command set real time sets real time in multimeter with the uncertainty approx. 50 ms. If the setting is not accurate enough (case of fast storing in more multimeters together - rates 0.5 ms,...) then it is possible to use this command. PC sets real time in all multimeters together in one time (address=0 ,and if variable MP = 1 in multimeter (command set sample rate....) then multimeter does not send the answer block) , then PC sends command capture real time into all multimeters together. Each multimeter captures its actual real time with uncertainty cca. 1 ms. PC reads then captured times (command read captured time) from all multimeters one by one and gets differences in their real times.

Read captured real time

ca	2BH	3F	5H	3H	X	X	X	X	X	X	X	X	chs

aa	27H	-||-	-||-	-||-	u30	u74	u118	u1512	HSL	HSH	SL	SH	chs

u30 D3-0 of microsec. unit of captured time,
u74 D7-4 of microsec.unit of captured time
u118 D11-8 of microsec.unit of captured time
u1512 D15-12 of microsec.unit of captured time
1 microsec.unit = 1/ 3686400 Hz * 8 = 2.17013888889 us for 29S (0..4607)
1 microsec.unit = 1/ 1843200 Hz * 8 = 4.3402777778 us for 28S (0..2303)
HSL D3-0 of 1/100 s counter
HSH D7-4 of 1/100 s counter
SL D3-0 of second
SH D7-4 of second

Set trigger

ca	2BH	3F	4H	HL	CM	DP	L6	L5	L4	L3	L2	L1	chs

aa	27H	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	chs

a) trig high and low level

HL D3-0 : 4 : for trig high level (or trig contin ohm if CM=contin, or hi-trig events if CM=events)
(trig contin ohm (CM=11) are used only digits L4 L5 L6 (mean L4 L5 L6 Ohm))
5 : for trig low level (or trig contin V if CM=contin or lo-trig events if CM=events)
(trig contin V (CM=11) are used only digits L4 L5 L6 (mean L4 L5 L6 mV))

CM D4-0 : code of measurement function see table CMF(below)

DP range and sign of value:
D5 : sign (0=+, 1= -)
D4-D0 : decimal exponent in complementary bin.code (-16 ...+15) where
value = X.XXXXX E dec.exp (basic unit V, A, Ohm, Hz,Celsius, Farentheit, uF)

For trigger and events trigger values are used only digits. Position of decimal point is calculated according to the measured range when these digits are applied in measurement.

But these digits are stored in 22 – 29S as real number (floating format) with the decimal point after 6th digit. It means that exponent should be +5. In set command is the exponent being sent from PC not used (set to +5),
in send command may exponent differ from +5 in case when first digit equals 0 (22 – 29S sends the value into PC with normalised mantisa, in PC should this mantissa be denormalised so as to have digits L1 L2 L3 L4 L5 L6 and decimal point after L6).

L6 lowest digit of level (BCD)

.
.

L1 highest digit of level (BCD)

b) trig on/off,trig in/out, pretrig, time trig on/off, duration on/off, cycle RAM

HL D3-0 : 7

CM D2-0 : 0 : After in
1 : After out
2 : During in
3 : During out
4 : Off
3FH : no change

DP not used

L6 not used

L5 D3-0 : 0 : retrigger off
1 : retrigger on
3FH : no change

L4 D3-0 : 0 : time trig off
1 : time trig on
3FH : no change

L3 D3-0 : 0 : date trig off
1 : date trig on
3FH : no change

L2 D3-0 : 0 : cycle RAM on
1 : cycle RAM off
3FH : no change

L1 D3-0 : 0 : pretrigger off
1 : pretrigger on
3FH : no change

Table CMF

Quality	Code
V	0
A	1
Ohm	2
°C, °F	3
uF, nF	4
Hz	5
dB	6
events	10
contin	11

Read trigger

ca	2BH	3F	5H	HL	CM	X	X	X	X	X	X	X	chs

aa	27H	-||-	-||-	-||-	-||-	DP	L6	L5	L4	L3	L2	L1	chs

HL, CM, DP, L1 - L6 like for Set trigger parameters

Set time trigger time

ca	2BH	3F	4H	8H	X	X	RT2	RT3	RT4	RT5	RT6	RT7	chs

aa	27H	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	chs

RT2 D3-0: seconds
RT3 D3-0: tens of seconds
RT4 D3-0: minutes
RT5 D3-0: tens of minutes
RT6 D3-0: hours
RT7 D3-0: tens of hours

Read time trigger time

ca	2BH	3F	5H	8H	X	X	X	X	X	X	X	X	chs

aa	27H	-||-	-||-	-||-	-||-	-||-	RT2	RT3	RT4	RT5	RT6	RT7	chs

RT2- RT7 like for Set real time

Set time trigger date

ca	2BH	3F	4H	9H	X	X	RD0	RD1	RD2	RD3	RD4	RD5	chs

aa	27H	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	chs

RD0 D3-0: days
RD1 D3-0: tens of days
RD2 D3-0: months
RD3 D3-0: tens of months
RD4 D3-0: years
RD5 D3-0: tens of years

Years over 90 are 1 9 RD5 RD4
Years below 90 are 2 0 RD5 RD4

Read time trigger date

ca	2BH	3F	5H	9H	X	X	X	X	X	X	X	X	chs

aa	27H	-||-	-||-	-||-	-||-	-||-	RD0	RD1	RD2	RD3	RD4	RD5	chs

RD0- RD5 like for Set real date

Set duration time

ca	2BH	3F	4H	0AH	RT2	RT3	RT4	RT5	RT6	RT7	DL	DH	chs

aa	27H	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	chs

RT2 D3-0: seconds
RT3 D3-0: tens of seconds
RT4 D3-0: minutes
RT5 D3-0: tens of minutes
RT6 D3-0: hours
RT7 D3-0: tens of hours
DL D3-0: days
DH D3-0: tens of days

Read duration time

ca	2BH	3F	5H	0AH	X	X	X	X	X	X	X	X	chs

aa	27H	-||-	-||-	-||-	RT2	RT3	RT4	RT5	RT6	RT7	DL	DH	chs

RT2 - RT7, DL, DH like for Set duration time

Set temperature unit, sensor, temp.ref.value

ca	2BH	3F	4H	0BH	TU	TS	DP	L1	L2	L3	LT	IO	chs

aa	27H	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	chs

a) sensor PT100, PT1000 :

TU D5-0 : 0 : °C
1 : °F
3FH : no change

TS D5-0 : code of temperature sensor see table TS (below)
if D5-0=3FH then no change

L1 D5-0 : tenths of Ohm of lead resistance
L2 D5-0 : units of Ohm of lead resistance
L3 D5-0 : tens of Ohm of lead resistance
L4 D5-0 : 0
3FH : no change

DP not used

Table TS of temperature sensors

type of sensor	internal code
PT 100	0
PT1000	2

Read temperature unit, sensor

ca	2BH	3F	5H	0BH	X	X	X	X	X	X	X	X	chs

aa	27H	-||-	-||-	-||-	TU	TS	DP	L1	L2	L3	L4	IO	chs

TU, TS, DP, L1, L2, L3, L4, IO like for set temperature unit, ...

Set clip transformer value

ca	2BH	3F	4H	0CH	CL	DP	L1	L2	L3	L4	L5	L6	chs

aa	27H	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	chs

CL D5-0
0 : clip transformer off
1 : clip transformer on, mA
2 : clip transformer on, A
3FH : no change

Read clip transformer value

ca	2BH	3F	5H	0CH	X	X	X	X	X	X	X	X	chs

aa	27H	-||-	-||-	-||-	CL	DP	L1	L2	L3	L4	L5	-||-	chs

CL, DP, L1 - L6 like for set clip transformer value

Set reference value dB

ca	2BH	3F	4H	0DH	CM	DP	L1	L2	L3	L4	L5	L6	chs

aa	27H	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	chs

CM D4-0 : code of measurement function see command Set trigger,
see table CMF (code 0...6 !!)

DP D5 : sign (0=+, 1= -)
D4-D0 : decimal exponent in complementary bin.code (-16 ...+15) where
value = X.XXXXX E dec.exp (basic unit V, A, Ohm, Hz,Celsius, Farentheit, uF)

For exponent see note in Set trigger command.

Attention: in case of dB reference is the exponent referenced to mV (1.23456 E+5 from/to PC means 123456 mV)

L6 lowest digit of ref. value

.
.

L1 highest digit ref. value

Read dB reference value

ca	2BH	3F	5H	0DH	CM	X	X	X	X	X	X	X	chs

aa	27H	-||-	-||-	-||-	-||-	DP	L1	L2	L3	L4	L5	L6	chs

Set internal memory - debug function only

ca	2BH	3F	4H	0EH	A3-0	A7-0	A11-7	A15-12	L3-0	L7-4	H3-0	H7-4S	chs

aa	27H	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	chs

;A3-0,A7-4,A11-8,A15-12 : address in internal RAM
;L3-0,L7-4 : written byte
;H3-0,H7-4 : written byte on address+1

;H7-4 bits 54: 00 : set 1 byte
; 01 : set 2 bytes
; 02 : clear 1 bit L2-0
; 03 : set 1 bit L2-0
This command is executed only when AL in command set debug variables was set to 1 .

Read internal memory - debug function only

ca	2BH	3F	4H	0EH	A3-0	A7-0	A11-7	A15-12	x	x	x	S	chs
aa	27H	-||-	-||-	-||-	-||-	-||-	-||-	-||-	L3-0	L7-4	H3-0	H7-4	chs

;A3-0,A7-4,A11-8,A15-12 : address in internal RAM
;L3-0,L7-4 : read byte
;H3-0,H7-4 : read byte on address+1

;S: bits 54: 00 : send 1 byte
; 01 : send 2 bytes

This command is executed only when AL in command set debug variables was set to 1

Read integer time for max.demand measurement

ca	2BH	3F	5H	0FH	X	X	X	X	X	X	X	X	chs
aa	27H	-||-	-||-	-||-	unit	L1	L2	L3	L4	-||-	-||-	-||-	chs

unit, L1, L2, L3, L4 like for set integer time for max.demand measurement

Command for setting Store mode, SEND mode, local mode, switching the multimeter off

ca	2BH	3F	6H	ST	ST	X	X	X	X	X	X	X	chs
aa	27H	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	chs

in case of switching into send mode does multimeter not send any answer.

ST D2-0: 0 : norm. mode
1 : send mode
2 : block send mode
3 : PC mode (not used)
4 : PC test mode
5 : switch multimeter off
6 : start like after reset
7 : memory mode
D3: not used
D4: not used

Command for setting the measuring function, range , auto/man

ca	2BH	3F	7H	X	X	X	MF	RA	RA2	RA3	AR	AREC	chs
aa	27H	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	chs

MF Measuring function
D5-0: see table TF
RA Range on this function, not used for counter
D2-0: see table TR_2
RA2 in case of frequency,counter
D2-0: see table TR_2
AR Auto/manual range
0: auto
1: manual
AREC D5-0 = 1 : set autorecognition mode (previous bytes have no effect)

Command for getting one measured value from the multimeter

ca	2BH	3F	8H	Idx	X	X	X	X	X	X	X	X	chs
aa	27H	-||-	-||-	-||-	MF	RA	V1	V2	V3	V4	V5	V6	chs

MF D5-0: code of measurment function see table TF
RA D2-0: measuring range according table TR_3
D3: signum of the value, 0 = +
D4: 0 - old data
1 - valid data

Idx D3-0: 8: clear internal average buffer - get the very last measured value

V1 D3-0: lowest digit of value
V2 D3-0: second lowest digit of value
.
.
V6 D3-0: highest digit of value
if one byte from V1-V6 = 1010 , value is OL
if one byte from V1-V6 = 1101 , FUSE is broken
if one byte from V1-V6 = 1110 , is multimeter in function-recognition mode and on its display is OPEN

Reports of errors
==========

If block from PC doesn't match for some reasons, multimeter doesn't execute the command but sends responding block.
Length is 14, second byte is set to 0 (D3-D0), third byte contains type of error, 14. byte contains complement of check sum of first 13 bytes.
third byte: 1 - this code of command is not used

2 - incorrect check sum of received block

3 - incorrect length of received block

4 - wrong second or third byte

5 - parameter out of range

Command Set Generator rep/once, freq, user freq

ca	2BH	3FH	04H	12H.	0	rep	FRQ	U4	U3	U2	U1	x	chs
aa	27H	3FH	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	chs

Command Set Generator n. of pulses

ca	2BH	3FH	04H	12H.	1	DP	L6	L5	L4	L3	L2	L1	chs
aa	27H	3FH	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	chs

Command Set Generator delay

ca	2BH	3FH	04H	12H.	2	DP	L6	L5	L4	L3	L2	L1	chs
aa	27H	3FH	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	-||-	chs

Rep : D5-0 0=repet, 1=once 3F=no change
FRQ D5-0 code of F. 0=1Hz, 1=2Hz 2=5Hz 3=10Hz 4=20Hz … 9=1000Hz 10=user freq 3FH=no change
DP: D5-0 D5-signum D4-0 exp in compl.code
L6: D3-0 lowest digit – not used
:
L1 D3-0 highest digit

U4 D3-0 user frequency – lowest digit
:
U2 D3-0 user frequency – highest digit
U1 D3-0 user frequency –not used digit