

SMV, SMP, SMPQ
Multifunctional Panel Meters & Power Quality Analyzers
Communication Protocol Manual

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For device firmware revision 0.9.x

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1 Communication Between the Device and the Host System

Each SMV, SMP or SMPQ device is equipped by default with a USB communication. This port is capable to emulate virtual serial communication to the host PC. The USB port can be used for data acquisition, configuration and status checks using the proprietary protocol KMB Long supported by the ENVIS software suite. Optionally each device can be equipped with RS232 or RS485 line. With this remote serial communication option exclusively the KMB Long or Modbus RTU is supported to provide all information to the operator's PC. The most advanced communication option for this products line is the Ethernet support. With this option the user gets simultaneous access to various type of data over: TCP/IP based implementation of the Modbus RTU, KMB Long protocol and embedded web server with actual data and configuration.

2 SMP/SMPQ Modbus Description

SMxx instruments implement a Modbus RTU or Modbus TCP server interface. For more details about various Modbus implementations see <http://www.modbus.org/specs.php>.

Devices with serial line (RS232, RS485) can be configured to use the Modbus RTU protocol. For this option the address, baud rate and parity bit are specified (see the respective part of user manual for configuration details). A gap between bytes corresponding to maximum 1.5 characters (bytes) is allowed while receiving a command or transmitting a reply.

For Ethernet the Modbus TCP implementation is available. The listening port can be configured together with other TCP/IP settings (default port: 502). The instrument sends back a reply within 200 ms time frame after receiving each command. Up to three requests can be processed concurrently by each device.

2.1 Supported Functions

- 3 (0x03) read holding registers
- 4 (0x04) read input registers
- 16 (0x10) write multiple registers

The “broadcast” mode is not supported.

2.2 Modbus Quantity Encoding

Access to data structure components is provided using read/write from/to relevant registers as shown in the chart in the following subsections. Single-byte data are stored in a register in the format of 0x00nn where nn is a single-byte parameter. The data structure components that hold the instrument status information are stored in an array of ‘holding’ registers. The currently measured data can be read as the contents of the ‘input’ registers. Each structure component is stored within the array of registers using the base addresses.

Each value is encoded in the following way:

1. if not stated otherwise, each register is encoded in the same way as the corresponding variable in the respective message of the KMB Long protocol (Section 3).
2. Actual data values of float type (voltage, current, powers, etc.) hold the true value of the respective quantity, no recalculation is needed.

ANSI C and .NET functions(sample code) for time and value conversions can be provided upon request.

2.3 Modbus Register Map

– mapping top input and holding registers:

IR = input register, 16-bit, read only

HR = holding register, 16-bit, read and write

blocks in registers	base address	type
Action	0x100	HR
Identification	0x200	IR
Configurable Settings	0x700	HR
Inconfigurable Settings	0x800	IR
Actual Data	0x1000	IR
Electricity Meter	0x2000	IR

IR and HR have separated address spaces. For simplicity those are now taken together so it is possible to map HR in IR space and read them also with function 0x04.

2.4 Data Mapping in 16-bit Registers.

Identification

Offset IR	size/type	mapped data
0	16b	DEVICE_NUMBER
1	16b	DEVICE_TYPE
2	16b	PROPS_TYPE
3	16b	SOFTWARE_VERSION
4	16b	HARDWARE_VERSION

Configurable Settings

Offset IR	Offset HR	size/type	mapped data
0	0	16b	VT
1	1	16b	VT N
2	2	16b	CT
3	3	16b	CT N
4	4	8b	Measurement Method
5,6	5,6	32b, float	Nominal Voltage
7,8	7,8	32b, float	Nominal Power

Inconfigurable Settings

Offset IR	size/type	mapped data
0	16b	Default Frequency
1	8b	Device Address
2	8b	Remote Baud Rate
3	8b	Protocol
4,5	32b	IP Address
6	16b	Port
7,8,9,10	64b	GMT Time

Actual Data

Offset IR	size/type	mapped data
0	8b	Config Change counter
1	16b	Error Code
2	16b	Sample Overflow/Underflow
3	16b	Input/Output status
4,5	32b, float	Frequency
6,7	32b, float	Analog value
8,9	32b, float	I_4
10,11	32b, float	Voltage Unbalance
12,13	32b, float	Current Unbalance
14,15	32b, float	Phase of Current Unbalance
16,17	32b, float	U_{LN1}
18,19	32b, float	U_{LN2}
20,21	32b, float	U_{LN3}
22,23	32b, float	U_N
24,25	32b, float	U_{LL1}
26,27	32b, float	U_{LL2}
28,29	32b, float	U_{LL3}
30,31	32b, float	I_1
32,33	32b, float	I_2
34,35	32b, float	I_3
36,37	32b, float	I_N
38,39	32b, float	P_1
40,41	32b, float	P_2
42,43	32b, float	P_3
44,45	32b, float	P_N
46,47	32b, float	P_{fh1}
48,49	32b, float	P_{fh2}
50,51	32b, float	P_{fh3}
52,53	32b, float	P_{fhN}
54,55	32b, float	Q_1
56,57	32b, float	Q_2
58,59	32b, float	Q_3
60,61	32b, float	Q_N
62,63	32b, float	Q_{fh1}
64,65	32b, float	Q_{fh2}
66,67	32b, float	Q_{fh3}
68,69	32b, float	Q_{fhN}
70,71	32b, float	$THDU_1$
72,73	32b, float	$THDU_2$
74,75	32b, float	$THDU_3$
76,77	32b, float	$THDU_N$
78,79	32b, float	$THDI_1$
80,81	32b, float	$THDI_2$
82,83	32b, float	$THDI_3$
84,85	32b, float	$THDI_N$

Electricity Meter

Offset IR	size/type	Mapped Data	period, type of energy
0,1	32b, float	I_1	actual reading
2,3	32b, float	I_2	imported energy
4,5	32b, float	I_3	
6,7	32b, float	E_1	exported energy
8,9	32b, float	E_2	
10,11	32b, float	E_3	
12,13	32b, float	L_1	inductive
14,15	32b, float	L_2	
16,17	32b, float	L_3	
18,19	32b, float	C_1	capacitive
20,21	32b, float	C_2	
22,23	32b, float	C_3	
24,25	32b, float	I_{T1}	by tariff
26,27	32b, float	I_{T2}	imported energy
28,29	32b, float	I_{T3}	
30,31	32b, float	E_{T1}	exported energy
32,33	32b, float	E_{T2}	
34,35	32b, float	E_{T3}	
36,37	32b, float	L_{T1}	inductive
38,39	32b, float	L_{T2}	
40,41	32b, float	L_{T3}	
42,43	32b, float	C_{T1}	capacitive
44,45	32b, float	C_{T2}	
46,47	32b, float	C_{T3}	
48,49	32b, float	I_1	last month
50,51	32b, float	I_2	imported energy
52,53	32b, float	I_3	
54,55	32b, float	E_1	exported energy
56,57	32b, float	E_2	
58,59	32b, float	E_3	
60,61	32b, float	L_1	inductive
62,63	32b, float	L_2	
64,65	32b, float	L_3	
66,67	32b, float	C_1	capacitive
68,69	32b, float	C_2	
70,71	32b, float	C_3	
72,73	32b, float	I_{T1}	by tariff
74,75	32b, float	I_{T2}	imported energy
76,77	32b, float	I_{T3}	
78,79	32b, float	E_{T1}	exported energy
80,81	32b, float	E_{T2}	
82,83	32b, float	E_{T3}	
84,85	32b, float	L_{T1}	inductive
86,87	32b, float	L_{T2}	

88,89	32b, float	L_{T3}	
90,91	32b, float	C_{T1}	capacitive
92,93	32b, float	C_{T2}	
94,95	32b, float	C_{T3}	
96,97,98,99	64b	Electricity Meter Time	last month
100,101,102,103	64b	Electricity Meter Reset Time	
104,105	32b, float	T1 $3P_{MAX-TOT}$	over all
106,107	32b, float	T23 $P_{MAX-TOT}$	
108,109	32b, float	T33 $P_{MAX-TOT}$	
110,111	32b, float	$3P_{MAX-TOT}$	
112, 113, 114, 115	64b	Time of T1 $3P_{MAX-TOT}$	
116,117,118,119	64b	Time of T23 $P_{MAX-TOT}$	
120,121,122,123	64b	Time of T33 $P_{MAX-TOT}$	
124, 125,126,127	64b	Time of $3P_{MAX-TOT}$	
128,129	32b, float	T1 $3P_{MAX-TOT}$	current month
130,131	32b, float	T2 $3P_{MAX-TOT}$	
132,133	32b, float	T33 $P_{MAX-TOT}$	
134,135	32b, float	$3P_{MAX-TOT}$	
136, 137, 138, 139	64b	Time of T1 $3P_{MAX-TOT}$	
140,141,142,143	64b	Time of T2 $3P_{MAX-TOT}$	
144,145,146,147	64b	Time of T3 $3P_{MAX-TOT}$	
148, 149,150,151	64b	Time of $3P_{MAX-TOT}$	
152,153	32b, float	T13 $P_{MAX-TOT}$	last month
154,155	32b, float	T23 $P_{MAX-TOT}$	
156,157	32b, float	T33 $P_{MAX-TOT}$	
158,159	32b, float	$3P_{MAX-TOT}$	
160, 161, 162, 163	64b	Time of T1 $3P_{MAX-TOT}$	
164,165,166,167	64b	Time of T1 $3P_{MAX-TOT}$	
168,169,170,171	64b	Time of T1 $3P_{MAX-TOT}$	
172, 173,174,175	64b	Time of $3P_{MAX-TOT}$	
176, 177,178,179	64b	$3P_{MAX-TOT}$ reset time	over all

3 KMB Long Communication protocol

The communication channel uses the setting of 8 data bits, no parity, and one stop bit. The address and data flow rate can be set. The communication protocol employs the master-slave philosophy. In response to receiving a proper message or command the instrument sends back a relevant reply. All supported messages do have a uniform format (frame):

1. instrument address (1 byte), values 0 and 255 are reserved
2. length of message body (two bytes)
3. type of message (1 byte)
4. message body – varies in accordance with type of message
5. 16-bit CRC –

When the instrument receives a command, it sends back a relevant reply. The type-of-message byte in answer contains zero if no problem has occurred. In case of error the type-of-message code is ORed with 0x80 and followed by one-byte message body containing error code value. All values are coded in the Network notation (Big Endian).

3.1 KMB Long Quantity Encoding

1. times and dates are all 64-bit values coded as a number of milliseconds since 00:00:00 1.1.2000.
2. MTN, MTNN, MTP and MTPN are multipliers defining the current transformer ratio. The xxxN ratios are used for the fourth phase/channel.
 - (a) For MTN, MTNN (voltage) if the is 0xffff that means a direct measurement, otherwise the value is ratio for xxx/100.
 - (b) For MTP and MTPN (current) - the ratio xxx/1A or xxx/5A is defined by the most significant bit - if it is set that means the ratio is $(VALUE \& 0x7FFF)/5(A)$ otherwise it is $VALUE/1(A)$.
3. specific interpretation of values or bit mapping for special variables is explained in the message structure in the following text.
4. Measured data are optimally coded according to the following table.

Quantity	Coding			Invalid Value
U_LN	u16	$\ast\{MTN|MTNN\}/40$	V	
U_LL	u16	$\ast\{MTN\}/40$	V	
I	u16	$\ast\{MTP|MTPN\}/5000$	A	
I_{calc}	u16	$\ast MTP/5000$	A	
Powers	float	$\ast\{MTP|TPN\} \ast \{MTN|MTNN\}$	W, Var, VA	
Voltage Unbalance	u16	/100		0xFFFF
Voltage THD	u16	/100	%	0xFFFF
Current THD	u16	/100	%	0xFFFF
Voltage Harmonics	u16	$\ast MTN/40$	V	0xFFFF
Current Harmonics	u16	$\ast MTP/5000$	A	0xFFFF
Harmonic Angle	s16	/4096	rad	0x7FFF
Frequency	u16	/100	Hz	0xFFFF
Flicker	u16	/100		0xFFFF
Energies	u32	$\ast MTN \ast MTP$	Wh, Varh	

3.2 Available functions

3.2.1 0x01 Identify

This message identifies the communicating device and holds basic information about it. It is used for device enumerations, firmware upgrades, data interchange and prior to most other common tasks.

u16 DeviceNo; serial number
 u16 DeviceType; device type code, defining options
 u16 PropsType; device family ID, should be 0x30
 u16 SoftwareVersion; version of the firmware
 u16 HardwareVersion; revision of the hardware
 u16 SoftwareModules; b0: 1 = MODULE_PQEVENTS
 u8 DeviceAddr; communication address of the device
 u8 BootloaderVersion; version of the bootloader
 u8 Reserved;

3.2.2 0x3A Actual Data

Request should contain a MessageConfigInt mask, defining the composition of the reply. Actually all measured data can be partitioned by several groups especially to optimize performance on slow communication links. In the reply there is a copy of the request mask and a selected subgroup of the actual data. Message config int value masks groups of data for inclusion.

Meaning of Bits in MsgCfgInt:

- 0-3 bit phase selection (1,2,3,N)
- 4 main actual data group (U, I, P, Q, cos, THDU, THDI)
- 5 voltage harmonics
- 6 current harmonics
- 7 harmonic phase shift
- 8 voltage interharmonics
- 9 current interharmonics
- 10 whether odd values are included
- 11-16 maximal order of the harmonic
- 17 power quality data (P_{lt} , P_{st})
- 18 phasors of U and I
- 23-31 wave shape samples (U1,...,UN, I1,...,IN)

Actual data structure

u32 MsgCfgInt;

Header Quantities

u8 CFG_change_count;	.....	increased each time configuration changes
u16 ErrCode;	.....	device error code
		b7: error in archive CRC,
		b4: error in RTC,
		b2: calibration damaged,
		b1: configuration damaged
u16 flags;	.....	measurement flags
		b0: power supply failure,
		b1: voltage event,
		b2: frequency change,
		b3: RTC adjustment,
		b4: frequency error,
		b5: DAC synchronization error
u8 overfl;	.....	samples are out of DAC linearity range,
		U1..UN, I1..IN
u8 underfl;	.....	TRMS value is bellow the defined range
		0: OFF, 1: ON, U1..UN, I1..IN
u16 InputOutput;	.....	state of the inputs & outputs
		b0 = Led1, b1 = Led2, b2 = OUT1, b3 = OUT2,
		b15 = Input,

Global Variables

u16 Freq;	.....	frequency
float Analog;	.....	analog input or temperature based on the actual device type
u16 Icomp;	.....	Calculated (virtual) I_{PE} or I_{PEN}
u16 RESERVED;	.....	reserved
u8 phaseOrder;	.....	automaticlay detected phase order
		0: L1L2L3, 1: L1L3L2, 2: unrecognised

Phase Quantities

u16 uLN[4];	.....	line-to-neutral voltages
u16 uLL[3];	.....	line-to-line voltages
u16 iL[4];	.....	currents 1, 2, 3, N
float pwr[4];	.....	active power 1, 2, 3, N
float pwrh[4];	.....	active power of the first harmonic 1, 2, 3, N
float var[4];	.....	reactive power 1, 2, 3, N
float varh[4];	.....	reactive power of the first harmonic 1, 2, 3, N

Actual Evaluation of Flicker Severity

u16 Pst[4];	.....	short time flicker severity index
u16 Plt[4];	.....	long time flicker severity index

Harmonic Distortion

u16 uTHD[4]; Total Harmonic Distortion of Voltage
 u16 iTHD[4]; Total Harmonic Distortion of Current
 u16 HsgU[4][HARMONIC_COUNT]; voltage harmonics
 u16 HsgI[4][HARMONIC_COUNT]; current harmonics
 u16 fiHI[4][HARMONIC_COUNT]; angle (phase shift) of each harmonic
 u16 HsgiU[4][HARMONIC_COUNT]; voltage interharmonic group
 u16 HsgIi[4][HARMONIC_COUNT]; current interharmonic group

Waveshape Samples

u16 u_wave[4][64]; voltage
 u16 i_wave[4][64]; current

3.2.3 0x26, 0x27 SmpInstallConfig

This structure contains values regarding to the basics of the installation of the device such as instrument transformer ratios and nominal values for voltage and power. The data is organised in the following structure:

u16 MTN; VT ratio, x/100, 0xFFFF if not used
 u16 MTNN; VT ratio for N, x/100, 0xFFFF if not used
 u16 MTP; CT ratio, MSB bit-> CT secondary=5A
 u16 MTPN; CT ratio for N, MSB bit-> CT secondary=5A
 u16 defFreq; actually supports only 50Hz
 u8 MeasureMethod; 2 = 3-Y, 3 = 3-d, 5 = 4f
 float NomU; nominal voltage without VT
 float NomPwr; nominal power without VT and CT
 u32, u8 5 bytes reserve

3.2.4 0x4E, 0x4F SmpConfig

This configuration handles additional device configuration such as communication option, display behavior, time zone related settings, administrator access, averaging and flicker meter configuration.

Communication Option Configuration

u8 DeviceAddr; node address
 u8 RemoteBdRate; communication speed
 0: 4.8, 1: 9.6, 2: 19.2, 3: 38.4, 4: 57.6, 5: 115.2, 6: 230.4 [kbaud]
 u8 Protocol; serial line communication protocol
 0: KMB,
 1: Modbus no parity, 2: ModBUS parity even, 3: ModBUS parity none
 4: NMEA - GPS time synchronization
 u32 IPAddress; device ip address in binary form
 u32 Netmask; network mask
 u32 Gateway; default gateway ip address
 u16 KMB_Port; TCP/IP port for KMB Long
 u16 ModBus_Port; TCP/Ip port for Modbus
 u16 Web_Port; TCP/IP port for embedded webserver

Display Option Configuration

u8 DisplayManner;	display behavior configuration
... bits 7-6 backlight	0-OFF 1-ON 2-AUTO
... bits 5-4 display behavior	0: scroll each 3sec, 2: wait 10 sec, then def. val., def: hold last selected screen
... bits 0-3: displayed value	0: ULL, 1: uLN, 2: I, 3: P (power), 4: Q (var), 5: S (VA), 6: pf , 7: $\cos(\phi)$, 8: THD U, 9: THD I, 10: harm U, 11: harm I, 12: Energies, 13: 3P energies, 14: PavgMax, 15: Frequency & Temperature
u8 DisplayResolution;	0: 4 digits, 1: 3 digits
u8 Language;	0: EN, 1: CZ, 2: HR

Device Lock

u8 Lock;	0: unlocked, other: locked
u16 AdminPassword;	defined by administrator

Clock Configuration

u8 TimeZone;	selected time zone - 12: GMT
u8 SummerTime;	0: none, other: summer time enabled
u8 Synchronization;	0: none, 1: network frequency (not supported), 2: communication line, 3: external output

Averaging Option Configuration

u8 UI_WidowType;	voltage and current window type
	0: fixed averaging 1: sliding averaging 2: thermal function
u8 PQS_WindowType;	window type for powers, same as previous
u8 PmaxWindowType;	PavgMax window type - 0: fixed, 1: floating
u8 UI_WindowLength	averaging window length [s, m ¹]
u8 PQS_WindowLength;	averaging window length [s, m (if >100)]
u16 PmaxWindowLength;	averaging window length [s, m (if >100)]
u8 UI_AutoErase;	0: off, 1: day, 2: week, 3: month, 4: year
u8 PQS_AutoErase;	0: off, 1: day, 2: week, 3: month, 4: year

¹The window length is in minutes if value is >100. Value in minutes is obtained by decreasing the actual value by 100.

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