Multi-Measuring-Interface MMI 6000

Manual of operation

V 1.0 E

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Contents

Section 1: General remarks

The Multi-Measuring-Interface MMI6000 provides a variety of services combined in a single device. It can be operated as an accessory of the power factor controller BR6000 but also as a stand-alone measuring device. Employed as accessory, the coupling to the BR6000 is easily realized via the integrated RS485 interface.

The following modes of operation can be chosen for the MMI 6000:

☐ **Coupling MMI6000 - BR6000** (factory setting)
In this mode the MMI6000 is used for real current measurement (e.g. measurement of the current inside the power factor correction (PFC) installation). By an intelligent comparison of the measured PFC installation current with the respectively active capacitors, the actual currents of single capacitors can be monitored (protection of capacitors and the whole PFC installation).

☐ **Coupling MMI6000 - BR6000-T** (dynamic controller)
The main application is again the real monitoring of the current in power factor correction installations. In this mode the MMI6000 is employed for a real-time control of the dynamic, thyristor switched steps.

☐ **DYNA-I-TRIGGER**
This mode of operation is a novelty. The MMI6000 operates independently as an automatic trigger for dynamic thyristor switches. Such a trigger is required by applications with fast changing loads, where an instantaneous (real-time) reaction is necessary. Applications for example, that call for the very fast switching in of a single, large step and for which the application itself does not provide a suitable trigger signal (e.g. welding machinery, flicker compensation). Dynamic power factor correction controllers are simply not fast enough for such applications. The MMI6000 is. It provides the trigger signal within 1 ms. Needless to say that the optocoupler output type is required to make use of this mode of operation.

☐ **MODBUS RTU**
In this mode the MMI 6000 is utilization as a separate measuring device. Multiple grid parameters (voltage, current, active power, reactive power, apparent power, cos-phi, frequency, temperature) are measured and provided via MODBUS RTU protocol (e.g. further processing by PLC - application of multiple MMI6000 by separate addressing possible). In this mode of operation the MMI6000 can also be used as a comfortable trigger relay for various measuring quantities as for example current, cos-phi, or temperature.

☐ **ASCII-OUT**
Almost identical to MMI6000 MODBUS RTU. The only difference is that in this mode the mentioned measured parameters are provided in ASCII code.

The MMI6000 can easily be configured for the particular application via its 4 buttons and the display. Standard languages for all menus are German and English.

The output relay can, with respect to the individual application be configured as optocoupler or as standard relay.

Section 2: Technical specifications

Types	MMI 6000-R (standard relay) MMI 6000-T (optocoupler)
Output Interface	1x optocoupler or 1x standard relay 1 x RS 485
Display	Illuminated graphical display 2 x 16 characters
Modes of operation	Coupling MMI6000 - BR6000 Coupling MMI6000 - BR6000-T DYNA-I-TRIGGER MMI - MODBUS RTU MMI - ASCII OUT
Measurement categories	Voltage, current Power factor Active power Reactive power Apparent power Frequency Temperature Energy
Languages	German / English
Supply and measurement voltage	230V, 50/60 Hz
Power consumtion	< 4VA
Measurement current	X/5A and X/1A
Output capacity	Optocoupler: 60 VDC, 150 mA Standard relay: 250VAC, 1000W
Temperature range	0 ... 100°C
Housing Weight Range of ambient temperature Protection category according to DIN 40 050	Switchboard installation housing DIN 43 700, 100 x 100 x 55 mm 0,5 kg -10 bis +55°C Front side: IP 54, Rear side: IP 20

Section 3: Installation of MMI6000

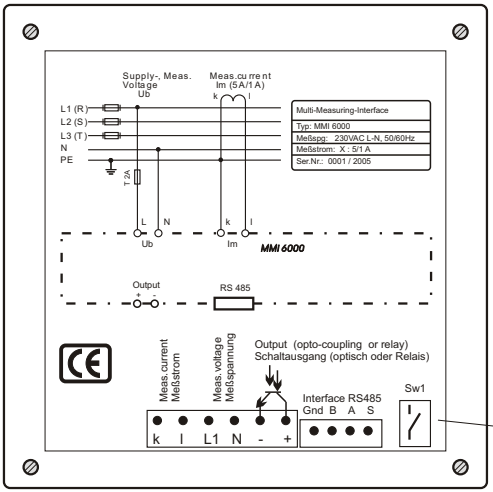
The MMI 6000 is constructed for a supply and measurement voltage of 230 VAC,50/60 Hz, and a measurement current of 5 A or 1 A (programmable). It is designed for front side integration in switching cabinets. Mounting parts for a DIN-standard bar are optionally available.
The MMI6000 has to be operated by qualified staff only and has to be operated according to the mandatory safety regulations.
Prior to connection all lines have to be tested to ensure their zero-potential. The current transformer has to be shorted-out. The correct phasing of voltage and measured current has to be respected. The current measurement circuit has to be connected by 2.5 sqmm Cu wires. It is very important to keep to the required safety measured accordingly. After the connection the MMI6000 is ready for operation without any delay.

Program:
- Display mode
- Programming
- Service
- Expert mode

ENTER
Confirmation
and save of
entered value

Increase of
chosen
parameter

Decrease of
chosen
parameter



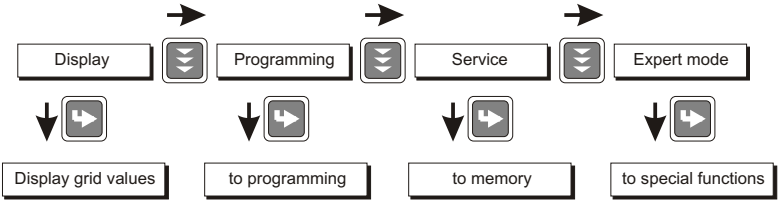
Back side MMI 6000

Connection of MMI 6000
according to adjoining
connection diagram

Switch for terminating resistor

Section 4: General operation references

By repeated pressing of the button "Program" the different menus are reached one after the other: Display, Programming, (Service), Expert mode and back again.



By pressing the button "Program" once the display mode is left and the programming mode is entered. The display always shows the parameter of interest in the first line and the editable value in the second line. Changeable values are always shown inside of square brackets [ ]. The actual change of a value is done using the buttons ↑ / ↓. By pressing the button "Enter" an adjusted value is saved/confirmed and the next parameter is displayed. The programming mode can be left during all steps by pressing "Program" again.

4.1 Setting mode of operation (programming)

Entering the programming mode the first step is to choose the language (confirm by "Enter"). As second step the transmission ratio of the current transformer (primary and secondary current) has to be entered. Subsequently the mode of operation of the MMI6000 can be selected with respect to the present application.

- Coupling MMI6000 - BR6000 (factory setting)
- Coupling MMI6000 - BR6000-T (dynamic)
- DYNA-I-TRIGGER
- MMI6000 - MODBUS RTU
- MMI6000 - ASCII-OUT

Depending on the chosen mode of operation the software menu is adapted and thus not completely the same for all modes of operation. Due to this the different modes of operation are explained on the next several pages.

4.2 Service menu

The display of the service menu depends on the chosen mode of operation. Using it, maximal values of voltage, current, active power, reactive power, apparent power, temperature, the minimal voltage, and the accumulated energy can be accessed. The time of integration for the maximal values is 1 second.

Section 5: Mode of operation MMI6000 - BR6000

Purpose:
Coupling of a MMI6000 with a BR6000 power factor controller (via RS485 interface)

In this mode of operation the MMI6000 is utilized as an additional measurement device to the BR6000. The intention is to measure the real current of the power factor correction installation. That means also an additional current transformer, installed at the input to the power factor correction setup is necessary. By an intelligent comparison of the measured installation current with the respectively active capacitors, the actual currents of single capacitors can be monitored (protection of capacitors and the whole PFC installation). The PFC current is displayed at the BR6000 selecting the display mode menu item "11 COMP.POWER".
Upon reaching the shutdown threshold "installation limit" that can be set at the BR6000, the controller switches of the single correction steps one after the other according to the set control series until the current falls below the set threshold value. The following error codes can be displayed at the BR6000 display if connected to a MMI6000:

- CURRENT > ?
- CURRENT < ?
- OVERLOAD EQUIP. (controller switches off automatically)
- C DEFECT (during C-tests only)

Programming of BR6000
For the coupling to a MMI6000 the following adjustments have to be made at the power factor controller BR6000:
Expert mode:
"19 Protocol" set to MODBUS master, "20 number MMIs" set to 1
(possible 1 up to 9)
Programming mode: "18 LIMIT VALUE"
choose shutdown threshold (factory setting 130%, possible: 110 - 200%)

Programming of MMI6000 (setting of operation mode as explained above)

3 Configuration [MMI-BR6000]

4 Grid [3-phase (DS)] (alternative: 1-phase (WS))
It is standard to measure using a single current transformer (display is 3-phase assuming grid symmetry). For real single-phase displaying [1-phase (WS)] has to be set. In this case currents and powers are referred to the particular phase. In the BR6000 configuration menu "3 MMI" has to be set.

5 Baud rate [9600] (possible: 9600 / 19200 / 38400)
RS485 interface baud rate.

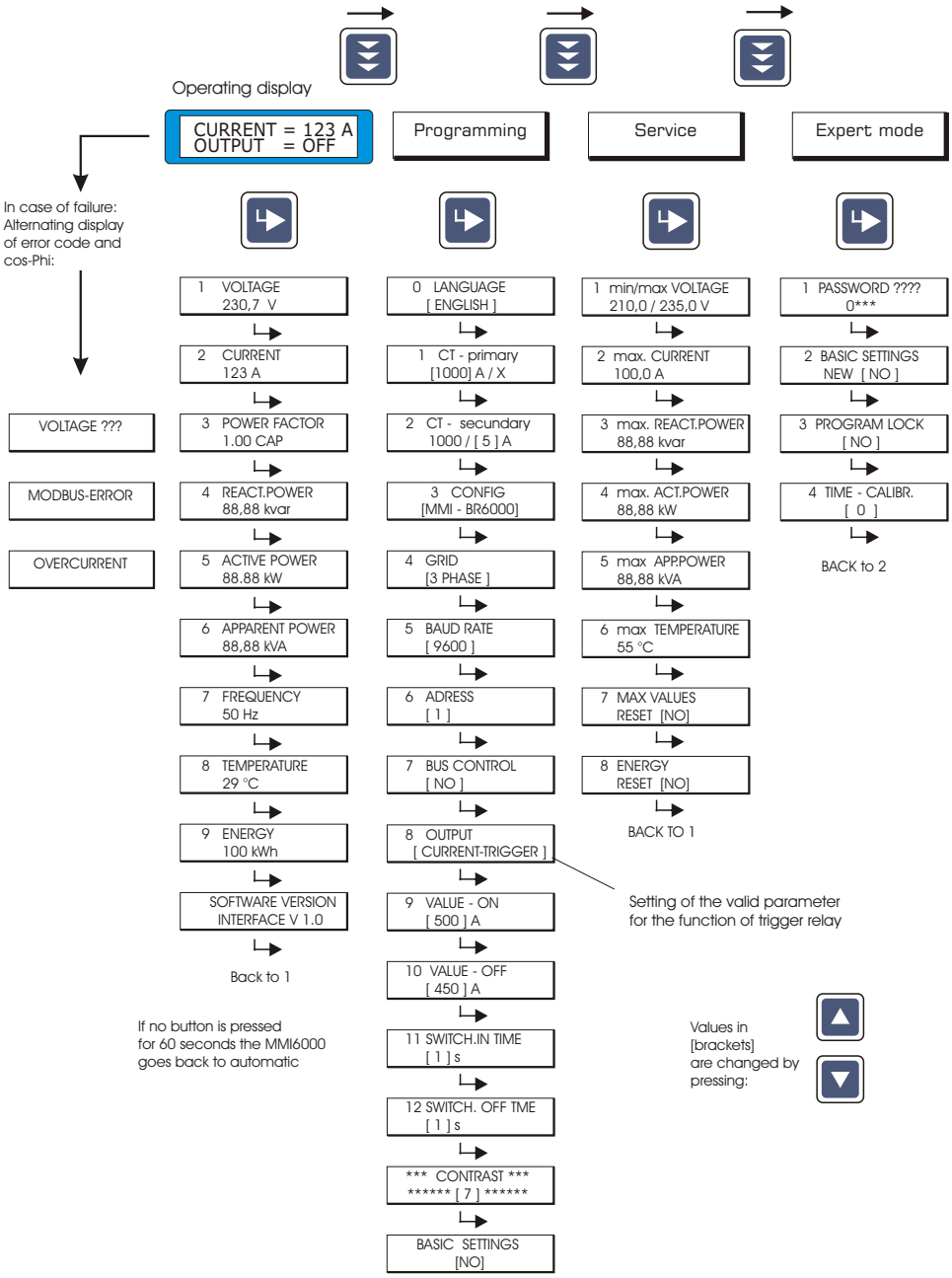
6 Address [1] (possible: 1...9)
Address range to allow the use of several MMI6000 at the same bus.

7 Bus control [NO] (alternative YES)
Control of communication. A possible bus error will be display if activated.

8 - 12 For explanation please refer to page 13

Basic settings [NO] (alternative: YES)
Choosing YES and confirming (Enter) resets all values to the factory settings.

Mode of operation MMI - BR 6000



Section 6: Mode of operation MMI6000 - BR6000-T (dynamic)

Purpose:
Coupling of a MMI6000 with a BR6000-T (dynamic) power factor controller (via RS485 interface)

In this mode of operation the MMI6000 is also used as an additional measurement device for the BR6000. The intention is to measure the real current of a dynamic PFC installation. That means also an additional current transformer, installed at the input to the power factor correction setup is necessary. By an intelligent comparison of the measured installation current with the respectively active capacitors, the actual currents of single capacitors can be monitored (protection of capacitors and the whole PFC installation). The installation current is displayed at the BR6000-T in the display mode menu item "11 COMP. POWER".
Employing this mode of operation the capacitors, thyristor switches, and fuses are monitored simultaneously. In case of a failure (under current caused by disconnected fuses or a defect capacitor / over current caused by a capacitor problem / etc.) the associated error codes are shown at the display of the BR6000-T and assigned to the respective capacitor branch.

Programming of the BR6000-T
For the coupling to a MMI6000 the power factor controller BR6000 the following adjustments have to be made:
Expert mode: "19 PROTOCOL" set to MODBUS master
Programming mode: "18 LIMIT VALUE"
choose shutdown threshold (factory setting 130%, possible: 110 ... 200%)

Programming of MMI6000 (setting of operation mode as explained above)

3 **Configuration** [MMI-BR6000-T]

4 **Grid** [3-phase (DS)] (alternative: 1-phase (WS))
Standard is to measure using a single current transformer (display is 3-phase assuming grid symmetry). For real single-phase displaying [1-phase (WS)] has to be set. In this case currents and powers are referred to the particular phase. In the BR6000 configuration menu "3 MMI" has to be set.

5 **Baud rate** [9600] (possible 9600 / 19200 / 38400)
RS485 interface baud rate.

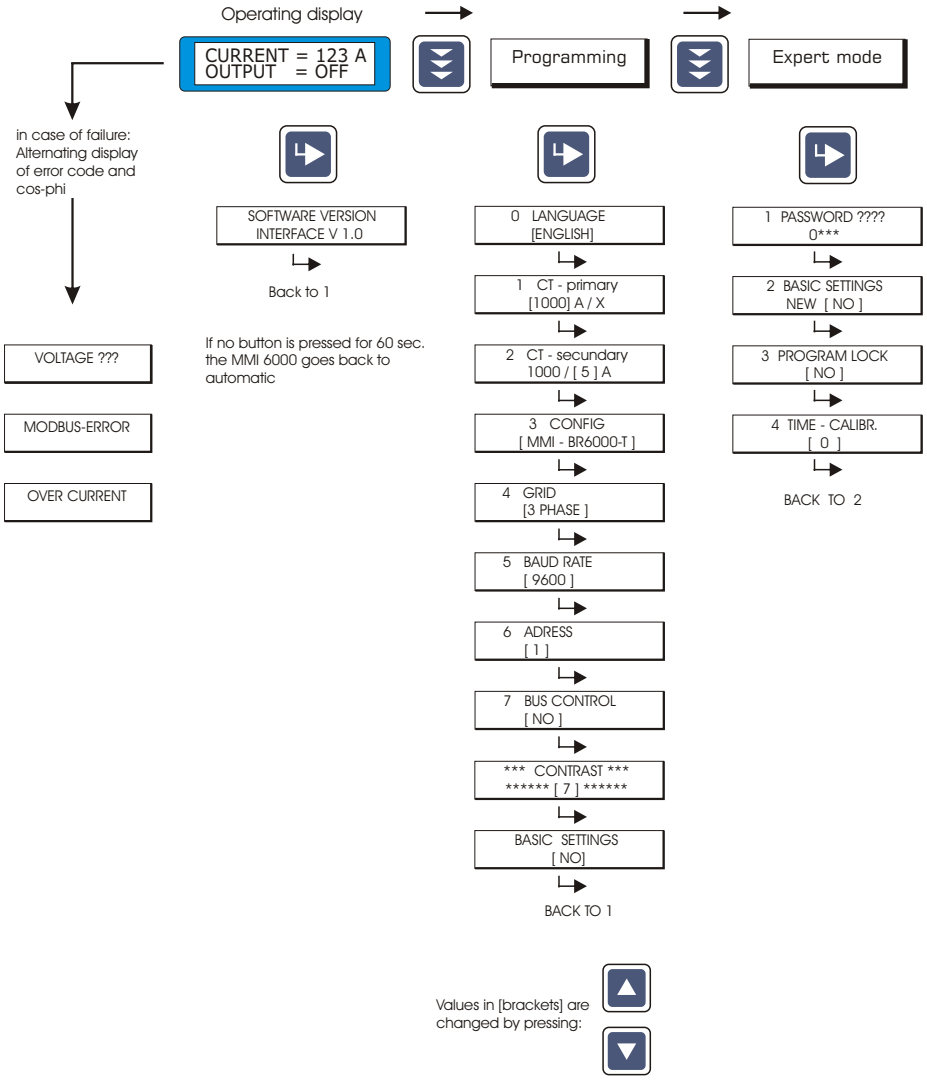
6 **Address** [1] (possible 1 ... 9)
Address range to allow the use of several MMI6000 at the same bus.

7 **Bus control** [NO] (alternative: YES)
Control of communication. A possible bus error will be display if activated.

Contrast
Setting of the display contrast.

Basic settings [NO] (alternative: YES)
Choosing YES and confirming (Enter) resets all values to the factory settings.

Mode of operation MMI - BR 6000-T (dynamic)



Section 7: Mode of operation Dyna-I-Trigger

Purpose: Dynamic current trigger

This mode of operation is a novelty. The MMI6000 operates independently as an automatic trigger for dynamic thyristor switches. Such a trigger is required for applications with fast changing loads, where an instantaneous (real-time) reaction is necessary. Applications for example that call for very fast switching in of a single, large step and for which the application itself does not provide a suitable trigger signal (e.g. welding machinery, flicker compensation).
Dynamic power factor correction controllers are simply not fast enough for such applications. The MMI6000 is. The MMI6000 features a novel measurement principle and is able to provide a switching signal within 1 ms. Making use of this ultra-fast measurement in combination with the internal optocoupler interface, dynamic thyristor switches (e.g. TSM-LC) can be controlled directly and without delay.
The measurement itself is carried out using a standard current transformer X: 5/1A.

Display:

The status of the output is displayed as follows:
L = output OFF
H = output ON,
P = output pulsing (pulse output) refer to description of "hold time"

Programming of MMI6000 (setting of operation mode as explained above)

3 **Configuration** [DYNA-I TRIGGER]

4 **Trigger ON** [30] % (possible: 3 … 100 %)
Setting of the switching on threshold - value in % of the maximal current
Example: Current transformer 1000/5A: 30% correspond to 300A

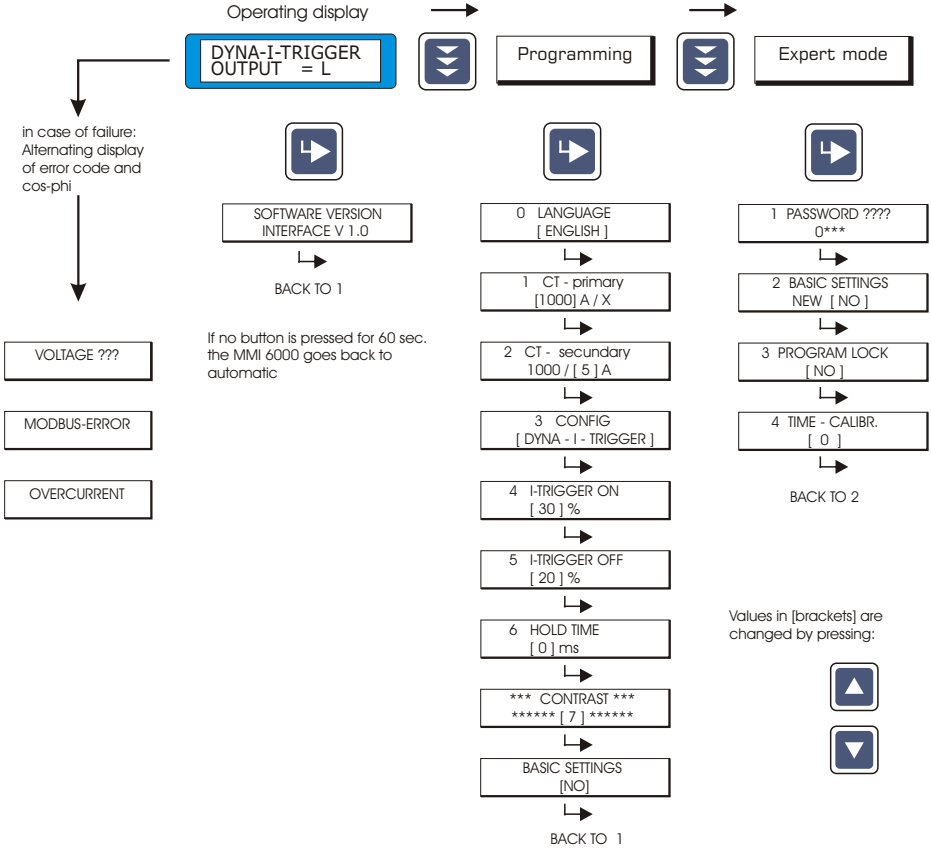
5 **Trigger OFF** [20] % (possible: 2 … Trigger ON value)
Setting of the switching off threshold

6 **Hold time** [0] ms (0 … 255)
The pulsed trigger signal is produced in real time. If a stable, static signal is necessary for further processing, it can be generated by introducing a hold time [ms] (for bypassing the zero-crossing).

Contrast
Setting of the display contrast.

Basic settings [NO] (alternative: YES)
Choosing YES and confirming (Enter) resets all values to the factory settings.

Mode of operation: Dyna-I-Trigger



Section 8: Mode of operation MMI6000 - MODBUS RTU

Purpose:

MMI6000 as separate measuring device and trigger relay
This mode of operation allows the utilization of the MMI6000 as a separate measuring device. Multiple grid parameters (voltage, current, active power, reactive power, apparent power, cos-phi, frequency, temperature) are measured and provided via MODBUS RTU protocol (e.g. further processing by PLC - application of multiple MMI6000 by separate addressing possible). In this mode of operation the MMI6000 can also be used as a comfortable trigger relay for various measuring quantities as for example current, cos-phi, or temperature.

Programming of MMI6000 (setting of operation mode as explained above)

3 **Configuration** [MODBUS RTU]

4 **Grid** [3-phase (DS)] (alternative: 1-phase (WS))
Standard is to measure using a single current transformer (display is 3-phase assuming grid symmetry). For real single-phase displaying [1-phase (WS)] has to be set. In this case currents and powers are referred to the particular phase. In the BR6000 configuration menu "3 MMI" has to be set.

5 **Baud rate** [9600] (possible: 9600 / 19200 / 38400)
RS485 interface baud rate.

6 **Address** [1] (possible: 1 ... 9)
Address range to allow the use of several MMI6000 at the same bus.

7 **Bus control** [NO] (alternative: YES)
Control of communication. A possible bus error will be display if activated.

8 **Output** [Current-trigger]
(alternatives: Current-window, Cos-phi-trigger, Cos-phi-window, Temp.-trigger, Temp.-window, Bus-error, Pulse output, Off)
If used as trigger relay this setting determines the relevant parameter for the trigger signal (current, temperature, cos-phi, output relay bus error).

9 **Value ON*** [500] A (possible: 5 ... 1000 A)
Setting of the switching on threshold. Range and unit of values depends on the parameter selected for measurement.

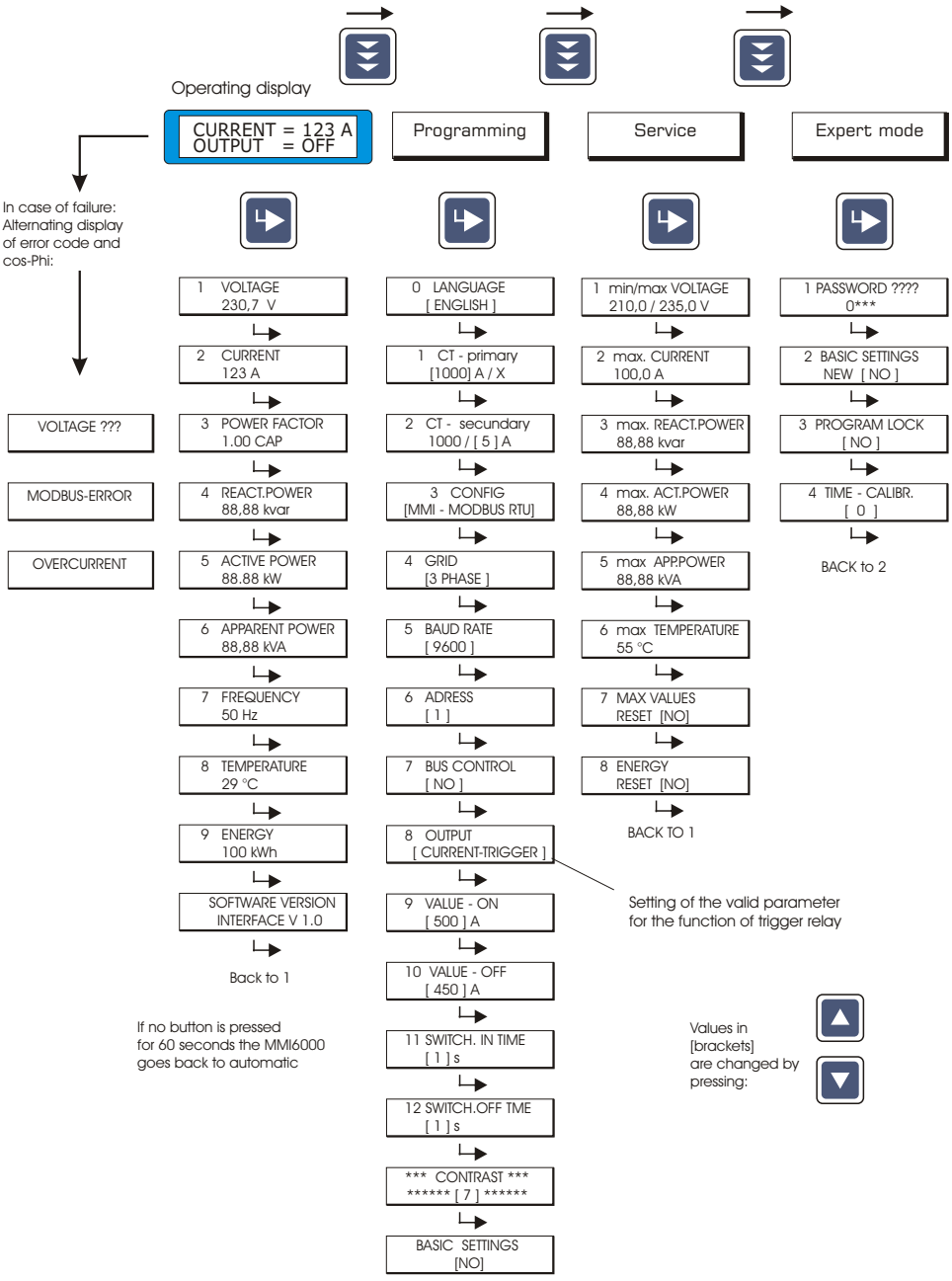
10 **Value OFF*** [450] A (possible: 5 ... 1000 A)
Setting of the switching off threshold. Range and unit of values depend on the parameter selected for measurement. Attention: In case the setting of the switching off threshold is larger than the respective switching on threshold the relay automatically operates as negated switch.

11 **Switch. in time*** [1] s (possible: 1 ... 255 s)
Setting of switching on delay.

12 **Switch. off time*** [1] s (possible: 1 ... 255 s)
Setting of switching off delay

*Not relevant in case of "Output" set to "output relay - bus error"

Mode of operation MMI6000 - MODBUS RTU



Section 9 Mode of operation MMI ASCII-OUT

Purpose: MMI6000 as separate measuring device and trigger relay

This mode of operation allows the utilization of the MMI6000 as a separate measuring device. Multiple grid parameters (voltage, current, active power, reactive power, apparent power, cos-phi, frequency, temperature) are measured and displayed. They are also provided as ASCII-data via the RS485 interface (e.g. for display and/or further processing using a common editor software). In this mode of operation the MMI6000 can also be used as a comfortable trigger relay for various measuring quantities as for example current, cos-phi, or temperature.

Programming of MMI6000 (setting of operation mode as explained above)

3 **Configuration** [MMI-ASCII OUT]

5 **Baud rate** [9600] (possible: 9600 / 19200 / 38400)

6 **ASCII submission time** [1] s (possible: 1 ... 120)
Time after which the ASCII data submission is cyclically repeated.

8 **Output** [Current-trigger]
(alternatives: Current-window, Cos-phi-trigger, Cos-phi-window, Temp.-trigger, Temp.-window, Bus-error, Pulse output, Off)
If used as trigger relay this setting determines the relevant parameter for the trigger signal (current, temperature, cos-phi, output relay bus error).

9 **Value ON*** [500] A (possible: 5 ... 1000 A)
Setting of the switching on threshold.Range and unit of values depends on the parameter selected for measurement.

10 **Value OFF*** [450] A (possible: 5 ... 1000 A)
Setting of the switching off threshold. Range and unit of values depend on the parameter selected for measurement. Attention: In case the setting of the switching off threshold is larger than the respective switching on threshold the relay automatically operates as negated switch.

11 **Switch. in time*** [1] s (possible: 1 ... 255 s)
Setting of switching on delay.

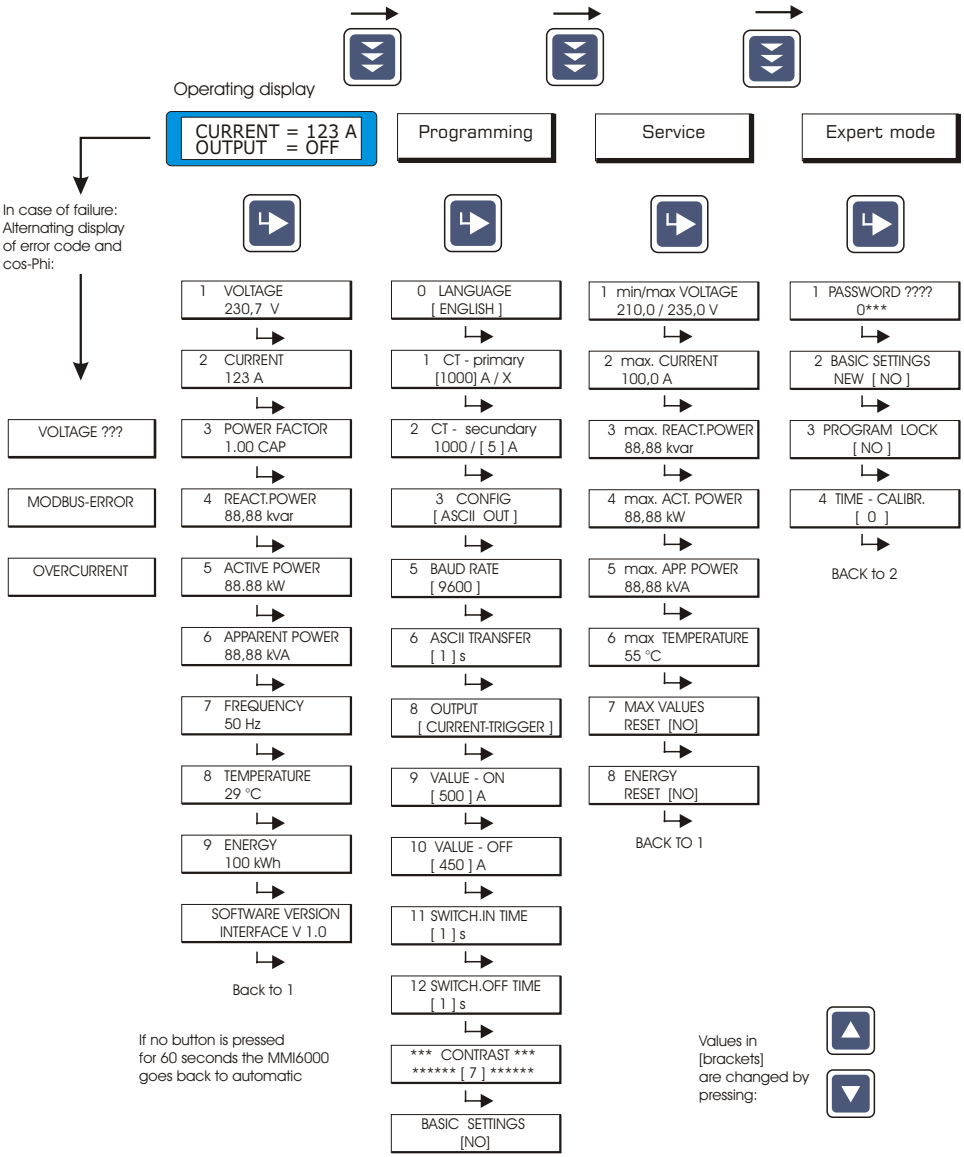
12 **Switch. off time*** [1] s (possible: 1 ... 255 s)
Setting of switching off delay.

Contrast
Setting of the display contrast.

Basic settings [NO] (alternative: YES)
Choosing YES and confirming (Enter) resets all values to the factory settings.

*Not relevant in case of "Output" set to "output relay - bus error"

Mode of operation - ASCII OUT



Section 10: Expert mode

The expert mode is identical for all modes of operation. To protect the provided special functions from misuse or the occasional mistake this level is protected by an access code. This code is 6-3-4-3. After entering this code and after confirming it (Enter) the mentioned special functions are accessible.

2 Factory settings new [NO] (alternative: YES)
Choosing YES and confirming (Enter) will store the present settings as new factory settings. ATTENTION! The original factory setting will be lost!

3 Access lock [NO] (alternative: YES)
For protection against unauthorized or accidental change of parameters the device can be locked. If locked, all set parameters can be displayed but are not accessible for changing.

4 Time calibration [0] (possible: -100 ... +100)
Calibration of the measured time (e.g. for the measurement of energy).

Section 11: Maintenance and warranty

Special periodic maintenance of the MMI6000 is not necessary, if the MMI6000 is operated according to the instructions. A regular functional test is recommended however. In case of misuse and/or manipulation inside the housing of the device any claim of warranty is void.

Appendix 1: ASCII protocol

The measured grid parameter values are cyclically submitted at the interface in the following sequence (ASCII):

(value voltage) V [CR]
(value current) A [CR]
(value reactive power)kvar [CR]
(value active power) kW [CR]
(value apparent power) kVA [CR]
(value frequency) Hz [CR]
(value temperature) °C [CR]

Appendix 2: MODBUS protocol

Interface settings: 8 data bit, 1 stop bit, no parity

Example MODBUS protocol:

MODBUS - function code 3 (read register only)
Example measurement voltage

Byte 1:	Slave adress	1	Byte 1: Slave adress		1
Byte 2:	Function code	3	Byte 2: Function Code		3
Byte 3:	Reg.start adress "H"	0	Byte 3: Number of bytes		2
Byte 4:	Reg.start adress "L"	20	Byte 4: Data H	0	
Byte 5:	Reg. number "H"	0	Byte 5: Data L	233	
Byte 6:	Reg. number "L"	1	Byte 6: CRC L	121	
Byte 7:	CRC check code "L"	196	Byte 7: CRC H	202	
Byte 8:	CRC check code "H"	14			

Appendix 2: MODBUS protocol

F	Modbus No.	register name / funktion	range / size	unit / digit
	Decimal adress			
3	0 1	Reactive power H-part Reactive power L-part	32 bit long	1 var
	2 3	Active power H-part Active power L-part	32 bit long	1 W
	4 5	Apparent power H-part Apparent power L-part	32 bit long	1 VA
	19	PF (100 = 1.00)	16 bit	0.01
	20	Measurement voltage	16 bit	1 V
	21	Measurement current	16 bit	1 A
	22	Frequency	16 bit	1 Hz
	23	Switching cabinet temperature	16 bit	1 °C
	24	Temperature	16 bit	1 °C
	25 26	Energy H-part Energy L-part	32 bit long	1 Wh
	27	Max. current with reset	16 bit	1 A
	28	Voltage at max. current	16 bit	1 V
	29	PF at max. current	16 bit	0.01
	32	Reset output relay		
	33	Set output relay		
	51	PF (100 = 1.00)	16 bit	0.01
	60	Error register	16 bit	Bit 0 …7
	85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100	Reactive power H-part Reactive power L-part Active power H-part Active power L-part Apparent power H-part Apparent power L-part Voltage Current Frequency Temperature Power Factor Error / status / identification Energy H-part Energy L-part Energy incl. RESET of H-value Energy incl. RESET of L-value	32 bit long 32 bit long 32 bit long 16 bit 16 bit 16 bit 16 bit 16 bit 16 bit 32 bit long 32 bit long 	1 var 1 W 1VA 1 V 1 A 1 Hz 1 °C 0.01 (NEG = CAP) Bit 0 ... 7 Refer to table 1 Wh 1 Wh
	101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125	Program memory (language) CT primary CT secondary Configuration Current measurement Baud rate Adress Bus control ASCII submission time Output Current trigger value ON Current trigger value OFF PF trigger value ON PF trigger value OFF Temperature trigger value ON Temperature trigger value OFF Switching ON time Switching OFF time Dyna-I-Trigger ON Dyna-I-Trigger OFF Hold time Bus error Contrast Basic settings	0 / 1 0 … 255 6 / 7 8 … 12 1 … 3 16 … 18 1 … 9 0 / 1 1 … 120 20 … 24 1 … 255 1 … 255 10 … 190 10 … 190 5 … 70 5 … 70 1 … 255 1 … 255 3 … 100 2 … 100 1 … 255 32 / 33 5 … 10 0 / 1	0 = German 0 = 5 A... 6 = 1 A... Mode of operation 1 / 2 / 3 9600 / .... 1 ... 9 NO / YES 1…120 sek Current trigger, ... 1 ... 255 1 ... 255 0.1 ind … 0.1 cap 0.1 ind … 0.1 cap 5 ... 70°C 5 ... 70°C 1 ... 255 sek. 1 ... 255 sek. 3 ... 100 % 2 ... 100 % 1 ... 255 ms OFF / ON 5 ... 10 NO / YES