



## GMP232/x Grid Measurement and Protection Module

The GMP232/x enables the safe, reliable and fast measurement of all relevant values for three-phase electrical networks. It also provides a number of monitoring functions for generator and grid protection. Up to 2 circuit breakers/trip circuits are triggered by the module directly via relay outputs. The continuous monitoring of grid harmonics up to the 50th harmonic can be used for direct reactions as well as for evaluating the power quality.

The module is provided with an integrated real-time data recorder for the high-precision recording of up to 24 measuring channels during alarm/protection events. Error events are recorded continuously and stored permanently with a high resolution time stamp. The internal time base of the module can be synchronized to an external time source (e.g. IEEE 1588 Precision Time Protocol), which supports the analysis of the data from spatially separated measurement and protection devices.

The GMP232/x module is fully integrated in the SolutionCenter. Configurations can be created simply and stored for later reuse. Both the measured channel values and also the derived values are made available directly in the user interface. Commissioning and fault analysis are simplified with tabular, vector and time sequence displays. Event logs and recorded time sequences can be exported in CSV resp. COMTRADE format. The integrated simulation function simplifies the configuration of protection and monitoring functions.

### Features:

- Measurement of current, voltage, frequency, power, power factor, phase angle
- True RMS and fundamental RMS, symmetrical components
- High dynamic measurement
- Measurement of grid harmonics up to the 50th (PQ)
- Monitoring functions for grid and generator protection
- Direct relay outputs for circuit breaker / trip circuits
- Integrated real-time data recorder
- Integrated event logging
- 4Q energy meter
- Integrated average values, grid statistics
- Measured value simulation

Part type designation	Part number	
120 V		
1 A	GMP232/1	00025962-00
	GMP232/1 CC	00025966-00
5 A	GMP232/3	00025964-00
	GMP232/3 CC	00025968-00
690 V		
1 A	GMP232/2	00025961-00
	GMP232/2 CC	00025965-00
5 A	GMP232/4	00025963-00
	GMP232/4 CC	00025967-00

**GMP232/x – Grid measurement**

Current/voltage measurement		
Measuring method	<ul style="list-style-type: none"> <li>• True RMS (incl. harmonics up to 3 kHz)</li> <li>• Fundamental RMS (only fundamental)</li> <li>• Symmetrical components</li> </ul>	
Sampling rate	Grid frequency-dependent, approx. 100 $\mu$ s (10 kHz)	
Measurement interval (RMS values)	Phase synchronous to each zero crossing (T/6): 50 Hz: 3.3 ms 60 Hz: 2.7 ms	continuous: 50 Hz: < 1 ms 60 Hz: < 1 ms
Individual samples	Intervals that can be retrieved via function calls in the user application: 100 $\mu$ s, 200 $\mu$ s, 400 $\mu$ s, 800 $\mu$ s, 1.6 ms (via block access)	
Signal mapping	Dynamical via software (Phase sequence, inversion)	

Voltage measurement		
Module variants	/1, /3	/2, /4
Quantity	3	3
Nominal voltage	U <sub>L-L, RMS</sub> : 120 V <sub>RMS</sub> U <sub>L-N, RMS</sub> : 70 V <sub>RMS</sub>	U <sub>L-L, RMS</sub> : 690 V <sub>RMS</sub> U <sub>L-N, RMS</sub> : 400 V <sub>RMS</sub>
Voltage measuring range	U <sub>L-L, RMS</sub> : 3.6 V <sub>RMS</sub> to 340 V <sub>RMS</sub> U <sub>L-N, RMS</sub> : 2 V <sub>RMS</sub> to 196 V <sub>RMS</sub>	U <sub>L-L, RMS</sub> : 17.3 V <sub>RMS</sub> to 1173 V <sub>RMS</sub> U <sub>L-N, RMS</sub> : 10 V <sub>RMS</sub> to 677 V <sub>RMS</sub>
Accuracy <sup>1)</sup>	$\leq \pm 0.1$ % relative to U <sub>nom</sub>	$\leq \pm 0.1$ % relative to U <sub>nom</sub>
Short-term overload (10 x 1 s, interval 10 s)	U <sub>L-L, RMS</sub> : 1035 V <sub>RMS</sub>	U <sub>L-L, RMS</sub> : 1385 V <sub>RMS</sub>
Input impedance	> 2 M $\Omega$	> 2 M $\Omega$

<sup>1)</sup> Accuracy rating at 25 °C and under reference conditions

Current measurement		
Module variants	/1, /2	/3, /4
Quantity	3	3
Current transformer rated current	1 A <sub>RMS</sub>	5 A <sub>RMS</sub>
Current measuring range	2 mA <sub>RMS</sub> to 4 A <sub>RMS</sub>	10 mA <sub>RMS</sub> to 15 A <sub>RMS</sub>
Response threshold	1 mA <sub>RMS</sub>	1 mA (FCC/HCC) / 5 mA (FCS/HCS)
Accuracy <sup>1)</sup>	$\leq \pm 0.1$ % relative to I <sub>nom</sub>	$\leq \pm 0.1$ % relative to I <sub>nom</sub>
Short-term overload (10 x 1 s, interval 100 s)	100 A <sub>RMS</sub>	100 A <sub>RMS</sub>
Burden	10 mVA	250 mVA
Error correction (CT)	Amplitude and phase errors of external current transformers: dynamic current dependent correction	

<sup>1)</sup> Accuracy rating at 25 °C and under reference conditions

**GMP232/x – Grid measurement**

Frequency measurement							
Rated frequency	50/60 Hz						
Measuring range	50 Hz: 10 Hz to 65 Hz 60 Hz: 10 Hz to 75 Hz						
Measured values	Frequency (f), frequency with suppression of dynamic events (f2), mean frequency over configurable duration or number (f <sub>AVG</sub> )						
Accuracy <sup>1)</sup>	≤ ±0.001 Hz						
Measurement interval	Refresh with every zero voltage crossing (T/12) (phase-neutral voltage and/or phase-to-phase voltage), if no voltage is present, the current is used for the calculation						
	<table border="1"> <tr> <td>1-phase system:</td> <td>3-phase system:</td> </tr> <tr> <td>50 Hz: 10 ms</td> <td>50 Hz: 1.667 ms</td> </tr> <tr> <td>60 Hz: 8.3 ms</td> <td>60 Hz: 1.389 ms</td> </tr> </table>	1-phase system:	3-phase system:	50 Hz: 10 ms	50 Hz: 1.667 ms	60 Hz: 8.3 ms	60 Hz: 1.389 ms
1-phase system:	3-phase system:						
50 Hz: 10 ms	50 Hz: 1.667 ms						
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<sup>1)</sup>Accuracy rating at 25 °C and under reference conditions

Frequency change measurement	
Measured quantity	ROCOF (df/dt) as gradient of the regression line of an adjustable number of frequency measurements
Input variable	Selectable: f (direct frequency measurement) or f2 (frequency measurement with suppression of dynamic events)
Reference range	±10 Hz/s

Phase measurement, asymmetry	
Phase shift	Angles from current phasor to voltage phasor for each phase
Voltage system	Angles between the voltage phasors
Asymmetry voltage system	Quotient of negative and positive sequence system of voltages or nominal voltage as percent value
Asymmetry current system	Quotient of negative and positive sequence system of currents or nominal current as percent value
Field rotation direction	Detection for voltage and current system

Power measurement – active, reactive and apparent power							
Measured values	P, Q, S per phase and as total value Power factor per phase and as summation quantity; representation adjustable to different conventions						
Calculation methods	DIN 40110-2 (incl. harmonics up to 3 kHz) IEC 61400-21 (only fundamental), Symmetrical Components						
Measurement interval	<table border="1"> <tr> <td>Phase synchronous to each zero crossing (T/6):</td> <td>moving window:</td> </tr> <tr> <td>50 Hz: 3.3 ms</td> <td>50 Hz: &lt; 1 ms</td> </tr> <tr> <td>60 Hz: 2.7 ms</td> <td>60 Hz: &lt; 1 ms</td> </tr> </table>	Phase synchronous to each zero crossing (T/6):	moving window:	50 Hz: 3.3 ms	50 Hz: < 1 ms	60 Hz: 2.7 ms	60 Hz: < 1 ms
Phase synchronous to each zero crossing (T/6):	moving window:						
50 Hz: 3.3 ms	50 Hz: < 1 ms						
60 Hz: 2.7 ms	60 Hz: < 1 ms						
Accuracy <sup>1)</sup>	≤ ±0.2 % in relation to S <sub>nom</sub>						

<sup>1)</sup>Accuracy rating at 25 °C and under reference conditions

**GMP232/x – Grid measurement**

Energy metering		
Quantity	2 (separate measuring for True RMS and Fundamental RMS)	
Resolution	1 Ws	
Active energy	Supplied (positive), drawn (negative)	
Reactive energy	Inductive (positive), capacitive (negative)	
Type of memory	Nonvolatile (on the module)	
Measurement interval	Updating at every voltage zero crossing	
	1-phase system:	3-phase system:
	50 Hz: 10 ms 60 Hz: 8.3 ms	50 Hz: 3.3 ms 60 Hz: 2.8 ms
Power quality		
Harmonic characteristic values	Total harmonic distortion (THD) and Total demand distortion (TDD) for current and voltage per phase, in relation to nominal value or actual fundamental	
Voltage harmonics	Amplitudes of harmonics up to 50th harmonic per phase	
Current harmonics	Amplitudes of harmonics up to 50th harmonic per phase	
Calculation method	EN 61000-4-7	
Measurement interval	50 Hz: Calculation over 10 cycles	
	60 Hz: Calculation over 12 cycles	

**GMP232/x – Signal output / Tripping**

Digital relay outputs	
Number/type	2 changeover contacts
Signal nominal voltages	230 V AC, 48 V DC, 24 V DC (not mixed)
Output current max.	Nominal 0.5 A at +24 V DC, DC-13 Nominal 0.5 A at +24 V DC, resistive load Nominal 1 A at 230 V AC, AC-15 Nominal 2 A at 230 V AC, resistive load
Status indication (LED)	Green

**GMP232/x – Monitoring functions**

General	
Input values	The module calculates base quantities such as RMS or power values according to different methods in parallel (e.g. DIN 40110 TrueRMS vs. IEC 61400-21 fundamental quantities / symmetrical components). Some protection functions allow the configuration of the used calculation method – for details see the user manual.
Inhibit	An application program on the M200 CPU may inhibit the activation of a protection function at runtime (e.g. dependent on actual operating states like "startup")
Tripping delay	0 s to 600 s adjustable for time independent monitoring functions
Blocking	Several protection functions can be configured to block the tripping automatically if certain conditions apply (e.g. block tripping during under-voltage or asymmetry conditions) – For details see the user manual
Tripping action	Configurable: generating an alarm, triggering of relay 1, relay 2 or both, Trigger for real-time data recorder (disturbance recorder); Logging of tripping and optionally also the activation (start) in the event log of the module.
Time-independent overcurrent protection (ANSI <sup>2)</sup> 50TD)	
Description	Configurable monitoring of either all three phase currents or any individual concerning the violation of preset thresholds.
Protection elements	I>, I>>, I>>>
<sup>2)</sup> ANSI-Code numbers refer to IEEE Std. C37.2:2008.	
Directional overcurrent protection (ANSI 67TD)	
Description	Directional monitoring of $I_{act}/I_N$ , using the sign from the direction of active power.
Protection elements	$I_{Dir >}$ , $I_{Dir >>}$
Unbalanced load / current asymmetry monitoring (ANSI 46TD)	
Description	Monitoring of the actual asymmetry of the current system against the given threshold value. The asymmetry calculation can be configured as ratio of the actual negative sequence current to the actual positive sequence current (EN 50160) or to the rated current.
Protection elements	Asym I>, Asym I>>
Undervoltage/overvoltage protection (ANSI 27TD/59TD)	
Description	Configurable monitoring of either all three voltages or any individual concerning the violation of preset thresholds. Input variables are phase-neutral or phase- phase voltages dependent on the selected operation mode.
Protection elements	U<, U<<, U<<<, U<<<< U>, U>>, U>>>, U>>>>

**GMP232/x – Monitoring functions**

<b>Time-dependent undervoltage/overvoltage protection (VFRT)</b>	
Description	Time-dependent voltage monitoring is triggered if one of the three phase voltages (asymmetrical error) or all voltages (symmetrical fault) fall below or rises above a curve $U(t)$ configured via interpolation points. Up to 11 time/voltage pairs are available to calculate a grid-code dependent limit curve. Four separate protection functions can be used with different parameter sets. (LVRT, HVRT)
Protection elements	$U(t)_{a>}$ , $U(t)_{b>}$ , $U(t)_{c>}$ , $U(t)_{d>}$ , $U(t)_{a<}$ , $U(t)_{b<}$ , $U(t)_{c<}$ , $U(t)_{d<}$
<b>Voltage asymmetry monitoring (ANSI 47TD)</b>	
Description	Monitoring of the actual asymmetry of the voltage system against the given threshold value. The asymmetry calculation can be configured as ratio of the actual negative sequence voltage to the actual positive sequence voltage (EN 50160) or to the nominal voltage.
Protection elements	Asym $U>$ , Asym $U>>$
<b>Frequency protection (ANSI 81TD U/O)</b>	
Description	Monitoring of the measured frequency concerning the violation of preset thresholds. The input variables can be configured as either the directly measured frequency or a frequency value with suppression of dynamic events. During over or under voltage conditions the tripping can be blocked automatically.
Protection elements	$f<$ , $f<<$ , $f<<<$ $f>$ , $f>>$ , $f>>>$
<b>Rate of change of frequency protection ROCOF (ANSI 81 R)</b>	
Description	Monitoring of the measured frequency change rate concerning the violation of preset thresholds. The time interval for calculation of the gradient and the used type of frequency input can be configured. During over-voltage or undervoltage conditions the tripping can be blocked automatically.
Protection elements	$ df/dt >$
<b>Vector shift monitoring (VectorJump) (ANSI 78)</b>	
Description	Monitoring of sudden phase shifts of the voltage system e.g. to detect load changes due to islanding. Automatic time limited tripping blocking due to over-/undervoltage, neg. sequence voltage or over-/underfrequency configurable.
Protection elements	Delta_Phi_U> Delta_Phi_U>>

## GMP232/x – Monitoring functions

### Time-dependent frequency monitoring – Frequency FRT (Fault Ride Through)

Description	Time-dependent frequency monitoring is triggered if the frequency falls below or rises above a curve $f(t)$ configured via interpolation points. Up to 11 time/frequency pairs are available to calculate a grid-code dependent limit curve. Two separate protection functions can be used with different parameter sets.
Protection elements	$f(t)_{a>}$ , $f(t)_{b>}$ , $f(t)_{a<}$ , $f(t)_{b<}$

### Power quality monitoring – PQM

Description	Monitors voltage and current harmonics up to the 50th. Either the exceeding of single harmonics in any or all of the phases can be configured. Additionally the total harmonic distortion either related to the actual fundamental or to the rated value can be used as protection element. Again, the criterion may be monitored in any or all of the three phases.	
Protection elements	THD_U>, TDD_U>	Total harmonic distortion of the voltage related to actual fundamental or rated value
	THD_I>, TDD_I>	Total harmonic distortion of the current related to actual fundamental or rated value
	U <sub>2</sub> > to U <sub>50</sub> >	Individual amplitudes of voltage harmonics
	I <sub>2</sub> > to I <sub>50</sub> >	Individual amplitudes of current harmonics

### Maximum power protection (ANSI 32TD)

Description	Protective tripping on exceeding a 3-phase maximum active power according to IEC 61400-21, i.e. fundamental positive sequence power
Protection elements	$ P_{1+}  >$ , $ P_{1+}  >>$

### Reverse power protection (ANSI 32R TD)

Description	Directional monitoring of $P_{act}/P_N$ . Monitoring can be configured either for all 3 phases together ( $P_{total}$ ) or for any individual of the 3 phases.
Protection elements	$P_{Dir} >$ , $P_{Dir} >>$

### Undervoltage reactive power protection (Q/U)

Description	Voltage dependent directional reactive power protection. Used to support the voltage during grid faults. Trips if selectable the positive sequence system or all three evaluated voltages are below a certain limit (e.g. $0.85 U_{nom}$ ) and inductive reactive power is drawn from the grid. Two separate protection functions can be used with different parameter sets.
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### Individual protection functions

Description	If relay outputs of the module shall be operated by an application program on the CPU during runtime (e.g. individual protection logics, manual tripping test), this can be done via a virtual protection function. In case of tripping an event log entry is generated.
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**GMP232/x – Special functions**

Time synchronization	
Basic principle	The GMP module is synchronized automatically with the real-time clock of the PLC-CPU. This one can be time synchronized via the network.
Physical medium	Ethernet (CPU)
Protocols	IEEE 1588 PTP (Precision Time Protocol) SNTP (Simple Network Time Protocol)
Event logging with real-time stamp – SER (sequence of events recorder)	
Description	Monitoring events (configured alarm/protection functions) are logged with a precise time reference.
Type of memory	Nonvolatile (on the module)
Size	2048 entries
Real-time data recorder / digital fault recorder – DFR	
Description	A high resolution time sequence recording can be started automatically when a monitoring function is triggered. Via application program or the SolutionCenter, the recording can be exported in the COMTRADE format (IEEE C37.111)
Number of channels	24 channels (measured values, digital I/O, calculated values)
Memory depth per channel	61 440 samples (6 s at approx. 100 µs sampling rate)
Recording time	6, 12, 24, 48, 96 seconds
Pre-trigger	Yes
Grid statistics	
Description	The module is permanently monitoring a large number of grid quantities concerning their extrema (Maximum, minimum). These are automatically stored with the time stamp of their occurrence in the modules grid statistics. Application programs on the CPU or users via the SolutionCenter can retrieve the data.
Type of memory	Nonvolatile (on the module)
Reset	Via application program or SolutionCenter
Aggregates / Average value	
Description	The module can automatically generate averages, minima and maxima out of the high resolution measurements and calculated data. The time intervals of that aggregation can be configured. Aggregation unit 1 and 2 work as 2-staged system (e.g. generate the 3 s and the 10 min value of the same quantity)
Input values	Aggregation unit 1, 2: RMS values of voltages and currents, per phase and summation powers, power factors, symmetrical components, frequency, phase angles, harmonic distortion etc. Aggregation unit 3: Harmonic amplitudes of voltages and currents of all phases
Number of channels	Aggregation unit 1, 2: 24 channels configurable Aggregation unit 3: 300 channels fixed
Aggregates	Arithmetic average (mean), minimum, maximum over the interval
Time intervals	Aggregation unit 1: 0.2 to 60 s Aggregation unit 2: 1x to 120x of Agg. 1 Aggregation unit 3: 3 s to 15 min



**GMP232/x – Special functions**

Simulation	
Description	In the simulation mode, the module uses internally generated values instead of measured samples. All subsequent calculations and monitorings work exactly the same as in measurement mode. The setting of simulation parameters can be handled in the graphical user interface of the SolutionCenter (user) or directly from an application program on the M200 CPU (automated sequences). Thus, protection functions or general measurement reactions can be evaluated in many cases without using specialized grid emulation equipment.
Simulation input	3x U <sub>RMS</sub> [%pu], 3x I <sub>RMS</sub> [%pu], 3x phi_U [°], 3x phi_I [°], f

**GMP232/x – Module properties**

Electrical Safety	
Product standard	IEC/EN 61131-2
Generic standard	IEC/EN 60664-1
Pollution degree (IEC 60664-1)	2
Overvoltage category	III
Rated impulse voltage	6 kV
Protection class	2
Degree of protection acc. to IEC 60529	IP20
Self-monitoring	
Monitoring coverage	Power supply, signal path/ADC, execution time/watchdog, heart beat with CPU
Monitoring reaction	Configurable according BDEW and FNN; Logging: Module/CPU
Approvals/Certificates	
Generator Grid Connection	GER: VDE-AR-N 4110:2018, FGW TR3 (Rev. 25), FGW TR8 (Rev. 9) UK: ENA G99/1/4:2019 USA: IEEE C37.90:2005
Maritime & Offshore	ABS, BV, DNV, LR, KR, NK, RINA
Environmental conditions	
Operating temperature	-30 °C to +60 °C
Relative humidity, operation	Standard: 5 % to 95 % noncondensing ColdClimate: 5 % to 95 % with temporary condensation
Storage temperature	-40 °C to +85 °C
Relative humidity, storage	5 % to 95 % with temporary condensation
Maximum altitude	2000 m above Operation up to 4500 m on request
Power supply	
Via backplane	+5 V   ≤ 295 mA, +15 V   ≤ 21 mA, -15 V   ≤ 18 mA
External on the module	24 V   ≤ 76 mA
System requirements	
Hardware	All M200 CPU families apart from ME203, SK1 backplane not required
Software	M-Base V4.25 for full feature set (4.0 for basic functions)

## Order data

Part type designation	Part number	Description
GMP232/1	00025962-00	Grid measurement and monitoring module; 3x Un 120 V, 3x In 1 A; 2x Out relay 24/48 V DC, 230 V AC; U, I, P, Q, f measurement; 4Q energy metering, integrated monitoring/protection functions, harmonics analysis, integrated real-time data recorder (24 channels); Event logging with real-time stamp
GMP232/1 CC	00025966-00	GMP232/1; ColdClimate (❄️)
GMP232/2	00025961-00	Grid measurement and monitoring module; 3x Un 690 V, 3x In 1 A; 2x Out relay 24/48 V DC, 230 V AC; U, I, P, Q, f measurement; 4Q energy metering, integrated monitoring/protection functions, harmonics analysis, integrated real-time data recorder (24 channels); Event logging with real-time stamp
GMP232/2 CC	00025965-00	GMP232/2; ColdClimate (❄️)
GMP232/3	00025964-00	Grid measurement and monitoring module; 3x Un 120 V, 3x In 5 A; 2x Out relay 24/48 V DC, 230 V AC; U, I, P, Q, f measurement; 4Q energy metering, integrated monitoring/protection functions, harmonics analysis, integrated real-time data recorder (24 channels); Event logging with real-time stamp
GMP232/3 CC	00025968-00	GMP232/3; ColdClimate (❄️)
GMP232/4	00025963-00	Grid measurement and monitoring module; 3x Un 690 V, 3x In 5 A; 2x Out relay 24/48 V DC, 230 V AC; U, I, P, Q, f measurement; 4Q energy metering, integrated monitoring/protection functions, harmonics analysis, integrated real-time data recorder (24 channels); Event logging with real-time stamp
GMP232/4 CC	00025967-00	GMP232/4; ColdClimate (❄️)

## Accessories

Part type designation	Part number	Description
SS-GMP232/x B	00027474-00	Terminal set Phoenix screw side (1x KZ 51/03; 1x KZ 51/06; 1x SS 76/06; 1x SS 76/06 inv) with labeling strips