Item		Item-No.
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 and Protection Module

The GMP232/x enables the safe, reliable and fast measuring of all relevant values for three-phase electrical networks. It also provides a number of monitoring functions for generator and grid protection. Up to two 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 responses 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 geographically separated measurement and protection devices.

The GMP232/x is fully integrated in the Bachmann 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.

- 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 counter
- Integrated average values, grid statistics
- Measured value simulation

GMP232/x – Grid measurement		
Current/voltage measurement		
Measuring method	• True RMS (incl. harmonics up to 3 kHz) • Fundamental RMS (only fundamental) • Symmetrical components	
Sampling rate	Grid frequency-dependent, approx. 100 µs (10 kHz)	
Measurement interval (RMS values)	Phase synchronized with each zero crossing (T/6) 50 Hz: 3.3 ms 60 Hz: 2.7 ms	moving window: 50 Hz: < 1 ms 60 Hz: < 1 ms
Individual samples	Intervals that can be retrieved via function calls in the user application: 100 µs, 200 µs, 400 µs, 800 µs, 1.6 ms (via block access)	
Signalmapping	Dynamical via software (Phase sequence, inversion)	
Voltage measurement		
Model variants	/1, /3	/2, /4
Number	3	3
Rated voltage	$U_{L-L, RMS}$: 120 V_{RMS} $U_{L-N, RMS}$: 70 V_{RMS}	$U_{L-L, RMS}$: 690 V_{RMS} $U_{L-N, RMS}$: 400 V_{RMS}
Voltage measuring range	$U_{L-L, RMS}$: 3.6 to 340 V_{RMS} $U_{L-N, RMS}$: 2 to 196 V_{RMS}	$U_{L-L, RMS}$: 17.3 to 1173 V_{RMS} $U_{L-N, RMS}$: 10 to 677 V_{RMS}
Accuracy [1]	±0.1 % in relation to U_{Rated}	±0.1 % in relation to U_{Rated}
Short-term overload (10x1 s, interval 10 s)	$U_{L-L, RMS}$: 1035 V_{RMS}	$U_{L-L, RMS}$: 1385 V_{RMS}
Input impedance	> 2 MΩ	> 2 MΩ
Current measurement		
Model variants	/1, /2	/3, /4
Number	3	3
Current transformer rated current	1 A_{RMS}	5 A_{RMS}
Current measuring range	2 mA_{RMS} to 4 A_{RMS}	10 mA_{RMS} to 15 A_{RMS}
Response threshold	1 mA_{RMS}	1 mA (FCC/HCC) / 5 mA (FCS/HCS)
Accuracy [1]	≤ ±0.1 % in relation to U_{Rated}	≤ ±0.1 % in relation to U_{Rated}
Short-term overload (10x1 s, interval 100 s)	100 A_{RMS}	100 A_{RMS}
Burden	10 mVA	250 mVA
Error correction (CT)	Amplitude and phase errors of external current transformers: dynamic current dependent correction	
Frequency measurement		
Rated frequency	50/60 Hz	
Measuring range	50 Hz: 10 to 65 Hz 60 Hz: 10 to 75 Hz	
Measured quantities	Frequency (f), frequency with suppression of dynamic events (f_2), mean frequency over configurable duration or number (f_{AVG})	
Accuracy [1]	≤ ±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	
	1-phase system: 50 Hz: 10 ms 60 Hz: 8.3 ms	3-phase system: 50 Hz: 1.667 ms 60 Hz: 1.389 ms

[1] Accuracy values at 25 °C and under reference conditions

GMP232/x – Grid measurement

Frequency change measurement

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

Phase measurement, asymmetry

Phase angle	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 rated voltage as percent value
Asymmetry Current system	Quotient of negative and positive sequence system of currents or rated 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 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	Phase synchronized with 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 [1]	≤ ±0.2 % in relation to S_{Rated}

Energy meter

Number	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	Refresh at every voltage zero crossing
	1-phase system: 3-phase system: 50 Hz: 10 ms 50 Hz: 3.3 ms 60 Hz: 8.3 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

1) Accuracy values at 25 °C and under reference conditions

GMP232/x – Signal output / Tripping

Digital relay outputs

Number/type	2 changeover contacts
Signal rated voltages	230 VAC, 48 VDC, 24 VDC (not mixed)
Output current max.	Nominal 0.5 A at +24 VDC, DC-13 Nominal 0.5 A at +24 VDC, resistive load Nominal 1 A at 230 VAC, AC-15 Nominal 2 A at 230 VAC, resistive load
Status display (LED)	Green

GMP232/x – Monitoring functions

General

Input quantities	The module calculates base quantities such as RMS or power values according to different methods in parallel (e.g. DIN40110 TrueRMS vs. IEC61400-21 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 M1 CPU may inhibit the activation of a protection function at runtime (e.g. dependent on actual operating states like startup)
Tripping delay	0 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 undervoltage 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 (fault recorder); Logging of tripping and optionally also the activation (start) in the event log of the module.

Time-independent overcurrent protection (ANSI [1] 50TD)

Description	Configurable monitoring of either all three phase currents or any individual concerning the violation of preset thresholds.
Protection elements	I>, I>>, I>>>

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 (EN50160) or to the rated current.
Protection elements	Asym_I>, Asym_I>>

1) ANSI-Code numbers refer to IEEE Std. C37.2:2008

GMP232/x – Monitoring functions

Undervoltage/overvoltage protection (ANSI 27TD/59TD)

Description	Configurable monitoring of either all three voltages or any individual concerning the violation of preset thresholds. Input quantities are phase-neutral or phase-phase voltages dependent on the selected operating mode.
Protection elements	U<, U<<, U<<<, U<<<< U>, U>>, U>>>, U>>>>

Time-dependent undervoltage/overvoltage protection (VFRT)

Description	Time-dependent voltage monitoring is triggered if one of the three phase voltages (asymmetrical fault) 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<

Voltage asymmetry monitoring (ANSI 47TD)

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 (EN50160) or to the rated voltage.
Protection elements	Asym_U>, Asym_U>>

Frequency protection (ANSI 81TD U/O)

Description	Monitoring of the measured frequency concerning the violation of preset thresholds. The input quantity 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>>>

Rate of change of frequency protection ROCOF (ANSI 81 R)

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 or under voltage conditions the tripping can be blocked automatically.
Protection elements	|df/dt|>

Vector shift monitoring (VectorJump) (ANSI 78)

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
	$U_2>$ to $U_{50}>$	Individual amplitudes of voltage harmonics
	$I_2>$ to $I_{50}>$	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_{Rated}) and inductive reactive power is drawn from the grid. Two separate protection functions can be used with different parameter sets.

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.

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	61440 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 quantities	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 M1 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_{RMS} [%pu], 3x I_{RMS} [%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	2
Overvoltage category	III
Rated surge voltage	6 kV
Protection class	2
Protection type (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

Ambient conditions

Ambient conditions	Standard	ColdClimate (❄)
Operating temperature	-30 to +60 °C	
Rel. air humidity, operation	5 to 95 % no condensation	5 to 95 % with temporary condensation
Storage temperature	-40 to +85 °C	
Rel. air humidity, storage	5 to 95% with temporary condensation	5 to 95 % with temporary condensation
Maximum operating height	2,000 m above sea level (operation up to 4,500 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 M1 CPU families apart from ME203, SK1 backplane not required
Software	M-Base 4.25 for full feature set (4.0 for main functions)

Order Codes		
Item	**Item No.**	**Description**
GMP232/1	00025962-00	Grid measurement and monitoring module; 3x Un 120 V, 3x In 1 A; 2x Out relay 24/48 VDC, 230 VAC; 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	Like GMP232/1; ColdClimate (❄)
GMP232/2	00025961-00	Grid measurement and monitoring module; 3x Un 690 V, 3x In 1A; 2x Out relay 24/48 VDC, 230 VAC; 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	Like 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 VDC, 230 VAC; 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	Like 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 VDC, 230 VAC; 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	Like GMP232/4; ColdClimate (❄)
Accessories		
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