

GENERATION & NETWORK

Digital Protection for Synchronous Machines

GMS7000



The optimum performance of electrical power systems depends particularly upon the reliability and the availability of the protection, measuring and automation devices and the ability shown by these devices to communicate the information in their possession.

PROCOM, CEE's new modular system, satisfies these criteria by providing the possibility of using either separately or in an integrated system all of the intelligent functions of an electrical cubicle: Protection, Measurement, Automation, Communication.

CEE's exceptional experience in the field of power system protection using static relays (more than 450,000 units in operation throughout the world) enabled our engineers to define, develop and manufacture PROCOM to the standards of quality and concepts of technical innovation which have been the foundation of CEE's reputation over the past 30 years.

PRINCIPLES AND APPLICATIONS

GMSx7000 series relays are designed to protect synchronous machines connected to three phase 50 Hz or 60 Hz electrical networks.

Of a modular design, they fit perfectly into the PROCOM architecture or they can be used separately in any traditional relay scheme.

Using microprocessor technology, the GMSx7000 samples the applied signals and produces current and voltage vectors as a result of Fast Fourier Transform (F.F.T.) from the resulting values the relay derives the symmetrical components, real power and, if appropriate,

the apparent impedance of the network connected to the generator or the apparent power absorbed by the synchronous motor.

The GMSx7000 is remarkable, firstly because of its wide operating frequency range (8 Hz - 70 Hz) making it particularly suitable to supervise machines the frequency of which can vary widely (run up or over speed of hydro generators, low short circuit power island networks), and, secondly, due to its high level in insensitivity to 3rd harmonic voltages and currents which enables low earth fault settings to be applied.

PRINCIPLES AND APPLICATIONS

The GMSx7000 series is made of two families:

- The GMSx7001, designed for the protection of synchronous generators driven by any type of prime mover: steam turbines, water turbines, gas turbines, diesel engines, gas engines.
- The GMSx7002, designed for the protection of synchronous motors, driving centrifugal or reciprocating compressors, crushers or any other type of mechanism.

Each family contains three models differentiated by the detection method used for earth fault as well as the primary electrical value used, zero sequence (earth fault) voltage or zero sequence (earth fault) current:

- The GMS7000, used when the 3 phases voltages are available (3 VT / distributed neutral) and when the zero sequence voltage, built by an internal summation, is used as a characteristic value in the operation of the relay.

- The GMSH7000, used when the 2 phase to phase voltages are available and when zero sequence current is used as a characteristic value in the operation of the relay.
- The GMSV7000, used when the 2 phase to phase voltages are available and when zero sequence voltage, from a star point or open delta VT, is used as a characteristic value in the operation of the relay.

The GMSx7000 groups together all of the protection functions normally required for a synchronous machine with the exception of the stator differential protection (kept separate in order to ensure redundancy in the protection system) and the detection of rotor insulation faults which uses special operating principles and measurement quantities.

The following table n° 1 summarises the protection functions included in the GMSx7001 family (generator protection):

Functions	ANSI code	GMS7001	GMSH7001	GMSV7001
Thermal Image Overload	49	x	x	x
Negative phase sequence over current	46	x	x	x
Field failure (loss of excitation)	40	x	x	x
Under impedance	21	x	x	x
Overcurrent	51	x	x	x
Overvoltage	59	x	x	x
Over fluxing (v/f)	24	x	x	x
Undervoltage	27	x	x	x
Under and over frequency	81	x	x	x
Reverse power	32-1	x	x	x
Under and over power	32-2	x	x	x
Neutral displacement over voltage	59G	x		x
Earth fault	64		x	

Table n° 1

The following table n° 2 summarises the protection functions included in the GMSx7002 family (synchronous motor protection) :

Functions	ANSI code	GMS7002	GMSH7002	GMSV7002
Thermal Image Overload	49	x	x	x
Negative phase sequence over current	46	x	x	x
Loss of synchronism / pull out	55	x	x	x
Overcurrent	50	x	x	x
Too long start / Locked rotor	51LR	x	x	x
Overvoltage	59	x	x	x
Over fluxing (v/f)	24	x	x	x
Undervoltage	27	x	x	x
Under and over frequency	81	x	x	x
Under and over power	32-2	x	x	x
Neutral displacement over voltage	59G	x		x
Earth fault	64		x	

Table n° 2

PRINCIPLES AND APPLICATIONS

Thermal image overload [49]

The GMSx7000 produces a thermal image of the generator from an appropriate combination of the positive and negative phase sequence components of the stator current.

This arrangement accurately mirrors the thermal behaviour of the generator, equally for balanced or moderately unbalanced conditions, where the temperature reaches a near uniform value in each phase, unlike with heavily unbalanced conditions where the temperature of one of the phases can reach a much higher value than the other two.

The equivalent thermal current I is given by the formula:

$$I = \sqrt{I_{Pos}^2 + K^2 I_{Neg}^2}$$

where: I_{Pos} : positive phase sequence current,
 I_{Neg} : negative phase sequence current,
 K^2 : weighting factor for the negative phase sequence current heating effect, adjustable from 4 to 16.

The heat exchanges in the machine as well as pre-load conditions are allowed for in the form of a thermal time constant τ adjustable from 4 to 240 minutes. A thermal alarm adjustable from 80 to 100% of the rated thermal state is provided.

Negative phase sequence overcurrent [46]

Unbalanced faults result in heating effects which are much more severe than those from balanced faults. In fact, the negative phase sequence component of the stator current generates an air gap field rotating in the opposite direction to the rotor resulting in double frequency induced currents in the latter. These currents prefer to circulate in low impedance elements such as the field windings or damper circuits, and also in the body of the rotor where, due to the skin effect, they concentrate at the surface where they produce high levels of heating losses. Under these conditions, the temperature of the rotor reaches high levels accelerating the ageing of the insulation and producing high mechanical stress.

Generators are generally designed (standard IEC 34) to withstand the temperature rises due to the circulation of negative phase sequence currents according to the law:

$$(I_{Neg} / I_n)^2 \times t = C$$

where : I_{Neg} : negative phase sequence currents
 t : generator withstand (seconds)
 C : constant related to the type of generator (seconds)

The GMSx7000 protects the rotor against these unbalanced conditions by a dependent time over current characteristic which follows the above law exactly with a constant C , adjustable from 8 to 40 seconds (see figure 2). This function is also equipped with a start operating level adjustable from 4 to 40% I_n and an alarm level adjustable from 3 to 20% I_n .

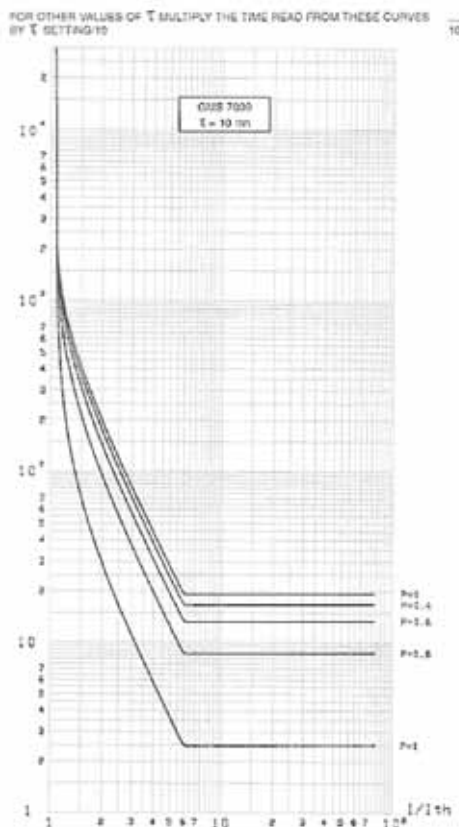


Figure 1 - Thermal image overload [49]
Operating curves - IEC 255-8

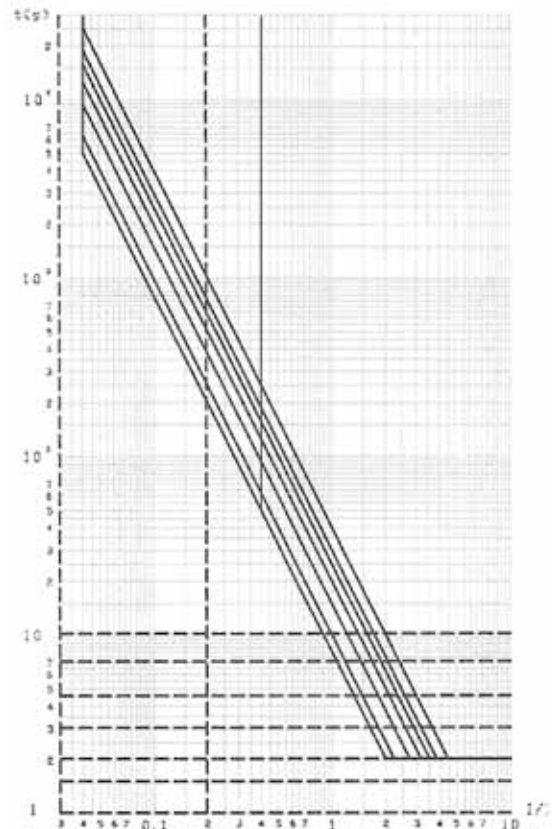


Figure 2 - Negative phase sequence overcurrent [46]
Current/time operating characteristic

PRINCIPLES AND APPLICATIONS

Field failure / Loss of excitation [40] [GMSx7001]

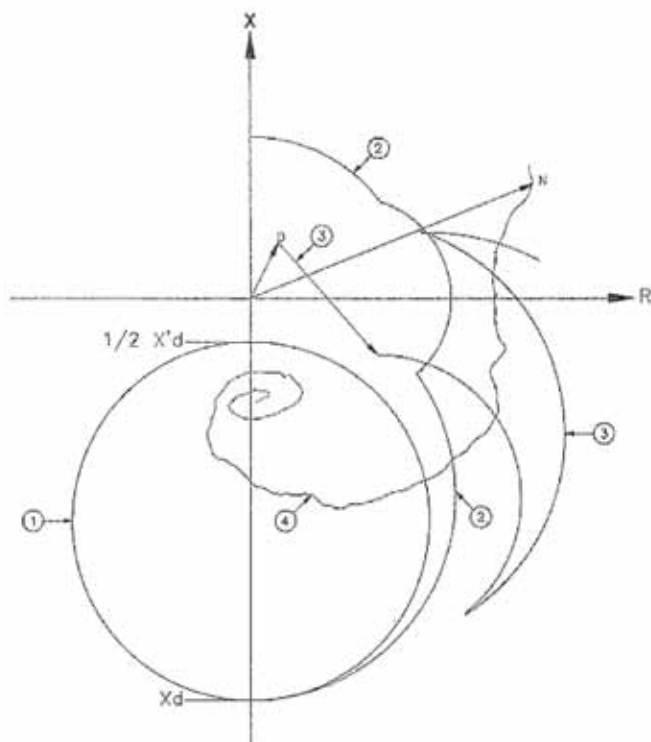
When a generator loses its excitation (inadvertent opening of the excitation circuit breaker, field circuit winding short circuit, automatic voltage regulator fault, ...), the reactive power needed for magnetisation is supplied by the network, and if the generator was previously operating at low load, the machine loses synchronism. On the one hand this results in the disturbed operation of the network (voltage drops, overloads, ...) which intensifies as the power of the generator increases. On the other hand, for the faulty machine, it results in severe heating in the stator end windings as well as in the rotor windings and body. The detection and the elimination of such conditions is hence necessary.

The analysis of the machine's operation shows that the impedance seen from the terminals varies between the direct axis synchronous reactance X_d (the machine having remained in synchronism) and the direct axis subtransient reactance X''_d (stopped machine).

In fact, the generator continues to rotate and the average apparent impedance at the terminals is slightly lower than the direct axis transient reactance X'_d .

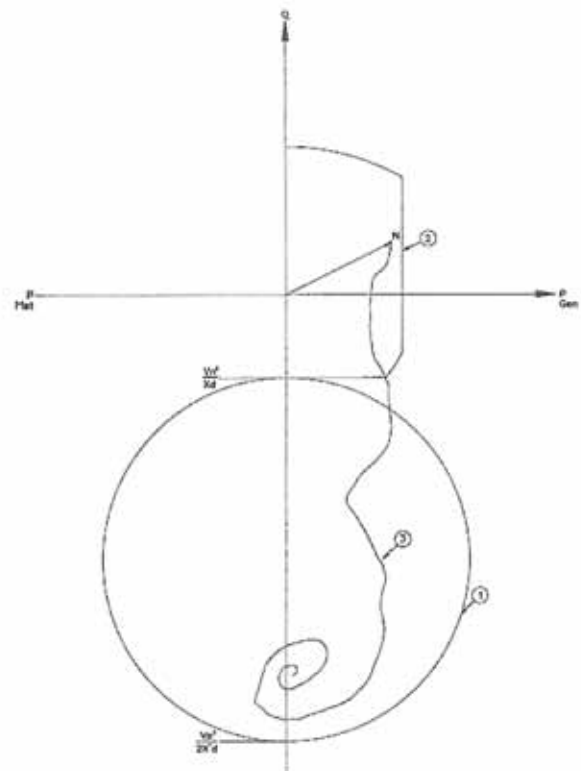
The GMSx7001 uses the measurement of the internal impedance of the generator to protect it against field failure. To this end, the operating characteristic represented on an R-X impedance diagram is an offset and centred circle on the negative X axis (induction machine). The offset with respect to the origin is generally fixed to half of transient reactance X'_d and the diameter is equal to the secondary synchronous impedance X_d less the offset $X'_d/2$ (see figure 3).

This circular characteristic gives the protection a highly secure operation whilst permitting all stable steady state generator operating conditions or transient conditions which result in severe real and reactive power oscillations with the network following the elimination of a fault.



- ① GMS characteristic
- ② Generator operating limits
- ③ Locus of the apparent impedance during and after the elimination of a fault
- ④ Locus of the apparent impedance following field failure

Figure 3 - Loss of excitation [40]
R-X diagram



- ① GMS Characteristic
- ② Generator operating limits
- ③ Locus of the apparent power during a field failure

Figure 4 - Field failure / Loss of excitation function [40]
P-Q diagram

PRINCIPLES AND APPLICATIONS

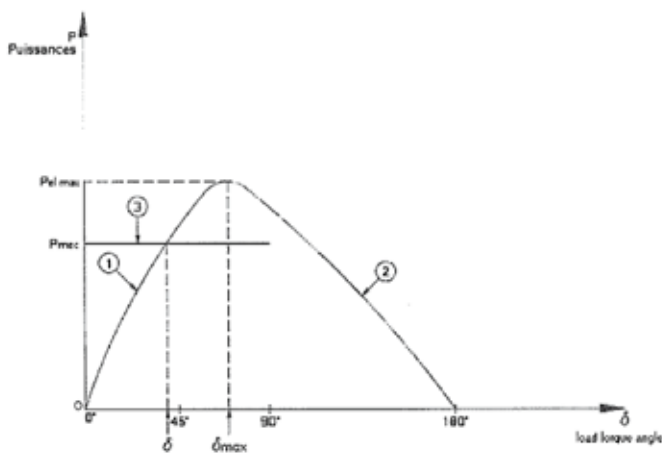
Loss of synchronism [55] [GMSx7002]

The real electrical power P_{el} absorbed by a synchronous motor under steady state conditions is given by the following formula:

$$P_{el} = \frac{3EV}{X_d} \sin\delta + \frac{3V^2}{2} \left(\frac{1}{X_q} - \frac{1}{X_d} \right) \sin 2\delta \quad [1]$$

where : V : phase to neutral voltage at the machine terminals,
 E : internal EMF,
 δ : rotor angle,
 X_d and X_q : direct and quadrature axis synchronous reactances.

During steady state synchronous operation, where E and V are constant, any change in the mechanical power P_{mec} is compensated by the corresponding change in the rotor angle δ in order to re-establish the equilibrium $P_{el} = P_{mec}$. As the electrical power P_{el} reaches its maximum value at a rotor angle δ_{max} between 45° and 90° , any increase in the mechanical power P_{mec} which requires the value δ_{max} to be exceeded cannot be compensated for. Under such conditions, the motor, having passed the steady state stability limit defined by δ_{max} , loses synchronism due to the excessive mechanical power (see figure 5).



- ① Electrical power: stable operating zone
- ② Electrical power: unstable operating zone
- ③ Mechanical power

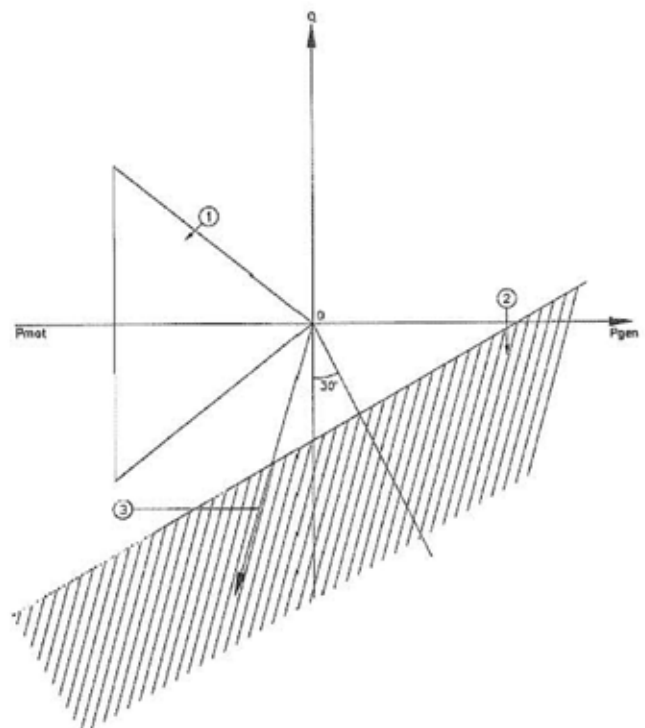
**Figure 5 - Loss of synchronism [55]
Synchronous machine stability limit**

Under transient conditions when the phase to neutral voltage V falls instantaneously or when the internal EMF changes unexpectedly, the formula [1] remains applicable to the first approximation, with E , X_d and X_q replaced by their transient values.

Electromechanical phenomena causing rapid changes in V and E can result in overshooting the rotor angle δ_{max} , giving rise to the dynamic stability limit. The motor loses synchronism due to not being able to develop sufficient electrical power.

No matter what the origin of the loss of synchronism, the result is: an increase in the stator current (up to the level of locked rotor currents if the motor stops); increased heating in the rotor in particular the damper windings, due to slip frequency circulating currents; severe overvoltages in the field circuit and high levels of mechanical vibration. For these reasons, it is important to trip the machine.

GMSx7002 relays use the apparent power $S = P + jQ$ to protect synchronous motors against loss of synchronism. The trip zone allows the synchronous motor to supply the real power P demanded by the motor load and, where necessary, allows positive or negative reactive power Q compensation. As with the loss of synchronism, the reactive power can swing (but in general is absorbed for the majority of the time), the GMSx7002's time delay system integrates these successive passages into the trip zone.



- ① Motor normal operating zone
- ② GMS 7002 tripping zone
- ③ Synchronous motor starting as an induction type motor

**Figure 6 - Loss of synchronism [55]
P-Q diagram**

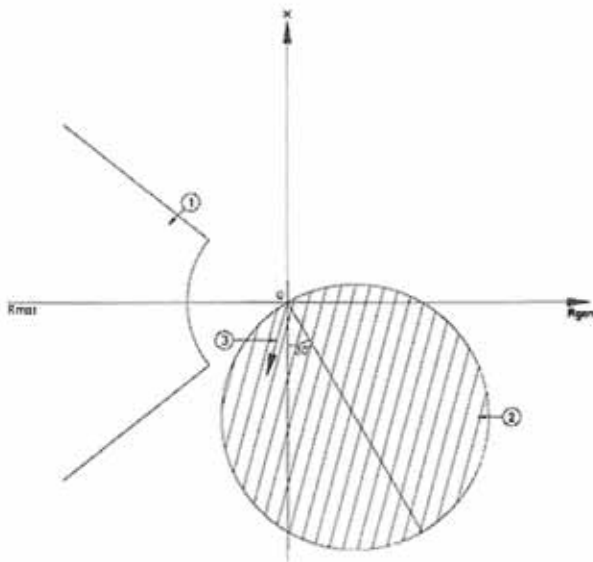
PRINCIPLES AND APPLICATIONS

Under impedance [21] [GMSx7001]

In the event of a bolted short circuit on the terminals of the generator, it supplies a fault current which varies with time. During the first instants the current, fixed by the subtransient reactance X''_d (representing the total leakage flux between the stator, the field and the damper winding), reaches a high level, then falls away according to the time constant τ''_d (some tens of milliseconds). Next, the current is limited by the transient reactance X'_d (representing mainly the leakage flux between the stator and the field) continuing its decay according to the time constant τ'_d (several tenths of a second) finally to reach a continuous value determined by the direct axis synchronous reactance X_d . From its initial value of the order of 5 to 10 times the rated current I_n , the level of the current stabilises at a fraction of I_n . These phenomena are more or less accentuated depending upon the position of the fault relative to the machine and the type of automatic voltage regulator uses (Shunt electronic, Compound, pilot generator, ...).

The "Overcurrent" protection function alone is generally not adequate as its time delayed operating level, set above rated current, cannot detect these permanent fault currents.

The GMSx7001 uses an "Under impedance" function to ensure adequate monitoring of the machine and of its network against phase faults since the "impedance" is independent of the level of current. In order to ensure stability for faults occurring on the secondary of unit transformers (particularly those connected star-delta), the operating characteristic of the relay is represented by a circle centred at the origin on an R-X diagram. Two separate impedance operating levels (2 concentric circles) are provided (see figure 8). In addition, secure operation is ensured due to a current threshold, adjustable from $0.1 I_n$ to $0.4 I_n$, supervising tripping.



- ① Motor normal operating zone
- ② GMS 7002 tripping zone
- ③ Synchronous motor starting as an induction type motor

Figure 7 - Loss of synchronism [55]
R-X diagram

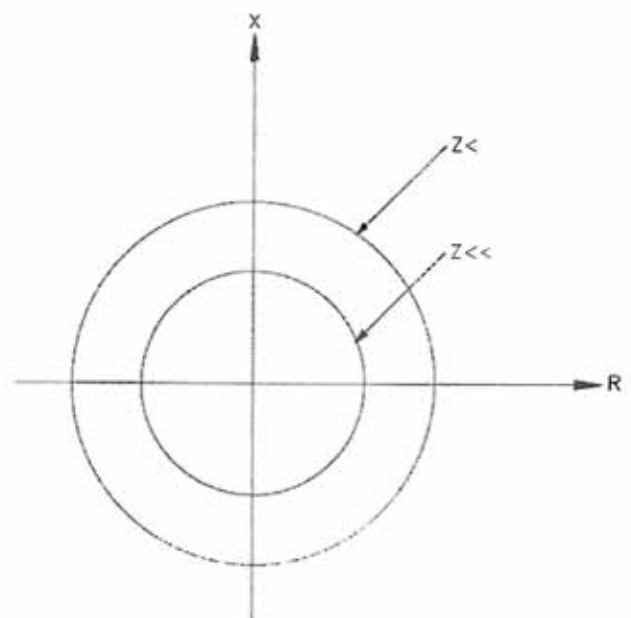


Figure 8 - Under impedance [21]
Operating characteristic

PRINCIPLES AND APPLICATIONS

Overcurrent [51] [GMSx7001]

This function is available in the GMSx7001 to complement the "Under impedance" [21] function in order to improve the coordination between the various protections for faults distant to the generator which result in initial fault currents limited to approximately $3I_n$. In these circumstances, the action of automatic voltage regulators generally results in the current being held above rated current. This can activate the network's over current relays. Coordination with "dependent time" type relays is easily obtained by using a suitable current/time operating characteristic.

In the case of a generator-transformer unit, a typical application consists of setting the high set operating level of the "Under impedance" function to detect faults situated in the zone formed by the generator-transformer (as backup to the differential protection), and of using the "Over current" function to coordinate with the protection installed downstream. The low set operating level of the "Under impedance" function provides a last line of backup protection to all the other functions and has a relatively long time setting.

Overcurrent [50] [GMSx7002]

Violent phase faults on synchronous motors have to be eliminated as quickly as possible. The GMSx7002 detects and eliminates these faults using a three phase high speed overcurrent element. The current setting should be approximately 20% greater than the short circuit current generated by the machine for a solid fault at its terminals in order to avoid any inadvertent operation for an external fault and during asynchronous starting.

Too long start / locked rotor [51LR] [GMSx7002]

Many synchronous motors are started asynchronously either direct on line or at reduced voltage using an auto-transformer or a limiting impedance.

The starting period is generally characterised by the flow of a current greater than rated current. Monitoring of the starting time and the associated current is needed to avoid overheating dangerous to the machine's insulation and to the rotor's mechanical withstand.

With this in mind, the GMSx7002 is equipped with a "Too long start" element which uses an extremely inverse three phase overcurrent measuring unit [51-1LR]. This unit is brought into operation by a circuit breaker limit switch connected to the relay's V input and indicative that motor's starting sequence has begun. If this sequence continues normally, this unit is inhibited after a time delay T_d set by the user. If this is not the case, a trip signal is sent to the circuit breaker.

A motor subject to a mechanical problem which causes the rotor to lock, must be disconnected as quickly as possible as the temperature of the rotor, when not ventilated, can reach a destructive level. The GMSx7002 has the definite time overcurrent element [51-2LR] to trip the machine rapidly if it absorbs a current greater than its setting.

This unit [51-2LR] is automatically brought into operation at the end of the time delay T_d .

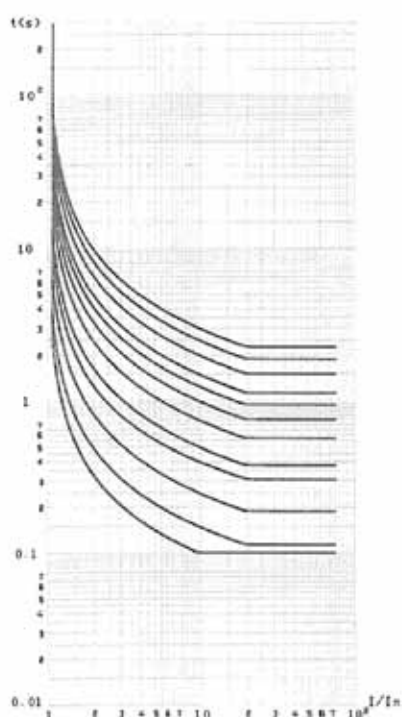


Figure 9 - Overcurrent [51]
Inverse curve IEC 255-4

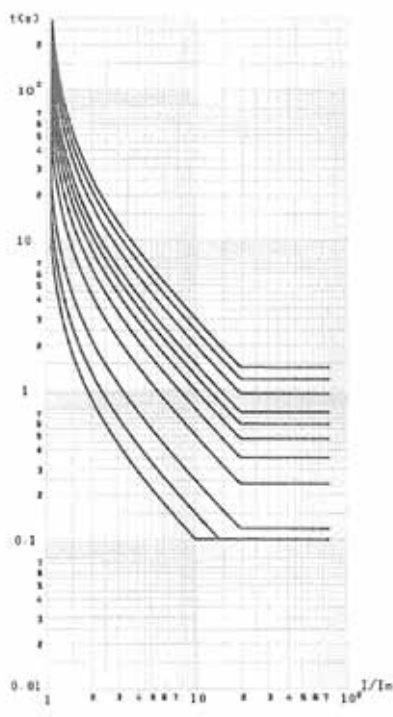


Figure 10 - Overcurrent [51]
Very inverse curve IEC 255-4

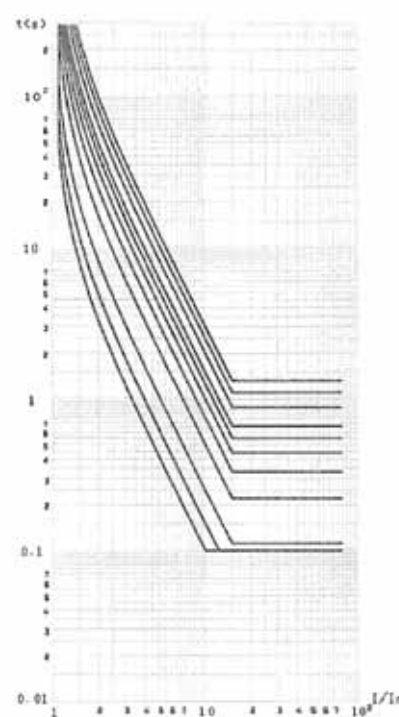


Figure 11 - Overcurrent [51]
Extremely inverse curve IEC 255-4

PRINCIPLES AND APPLICATIONS

Overvoltage [59]

The insulation of rotating machines is subject to accelerated ageing as soon as the level of the applied voltage remains above rated conditions for extended periods. The voltage at the terminals of a generator is normally correctly maintained by the automatic voltage regulator even following tripping when the over excitation of the machine results in a sudden voltage rise.

However, in the event of a failure in the regulation or of incorrect actions during manual operation, severe over voltages can occur. These phenomena are amplified if the generator is also subjected to an overspeed (hydro generators in particular).

The GMSx7000 is equipped with an "Overvoltage" function with two operating levels providing a time delayed protection for over voltages limited to less than approximately 120/130% of the rated voltage and a fast protection for higher over voltages, (GMS7000: three phase detection, GMSH7000 and GMSV7000 two phase detection).

Overfluxing [24]

For generator-transformer units, the GMSx7000 supplements the "Over voltage" function by a transformer "Magnetising flux monitor". In fact, in a modern transformer the reduction in copper losses leads to the use of magnetic cores operating at a flux density level close to their saturating point. Any significant increase in the flux density, associated with combined variations in voltage and in frequency, results in, due to saturation, the circulation of high levels of magnetising currents which cause significant losses.

This situation can result equally well from increases in the speed when the frequency is low as from operation close to rated conditions. For the reasons mentioned above, this condition cannot exist without the risk of premature ageing of the insulation.

The GMSx7000 monitors the image of the flux density Φ by generating the ratio U/f in order to protect the generators and the transformers against this type of fault.

Undervoltage [27]

The GMSx7000 contains an "Under voltage" function often used in start up or synchronising control schemes or as a back up to the other protections following a long time delay. (GMS7000: three phase detection, GMSH7000 and GMSV7000: two phase detection).

Under and Over frequency [81]

The extended operation of a generator below its rated frequency generally corresponds to the island operation of the machine, locally supplying its rated power to the load. In these circumstances, the turbine blades are subject to a fatigue phenomenon which can lead to mechanical breakdown.

Similarly when the generator is tripped, the speed of the prime mover, suddenly subject to load shedding, increases.

Mechanical elements are normally provided to protect against over speed. This function is normally accompanied, on the generator side, by an over frequency operating level. The GMSx7000 supplements the mechanical protection by a 2 operating level frequency function, adjustable as "Over " or "Under" frequency as required by the user.

Reverse power [32-1] [GMSx7001]

Importing real power is typical of the reverse operation of a generator as a synchronous motor supplying partially or wholly the mechanical losses of the rotor. Steam turbines are subjected to high temperatures and hydro generators to a phenomena known as cavitation.

When the mechanical losses are supplied totally by the "synchronous generator-motor", these are, in the case of a turbine, of the order of some percent of the rated power. If the losses are shared between the synchronous motor and the turbine, the imported real electric power becomes very low. It is hence necessary to use a sensitive and accurate method of measurement.

The GMSx7001 protects the prime mover thanks to a "Reverse power" function using a summation of the three single phase powers in the GMS7001 and using the 2 wattmeter method in the GMSH7001 and GMSV7001. In motoring, the machine generally continues to supply to reactive power to the network of a level much higher than that of the real power; this can compromise the measurement accuracy and hence, its directionality. Should the reactive power have a high level, the GMSx7001 maintains its directional stability by modifying the operating threshold.

Under and Over power [32-2]

The GMSx7000 can send an alarm to the operator or can assist certain control sequences upon the real power exceeding a given operating level. This function can be configured as "Over power" or "Under power" by the operator.

Neutral displacement overvoltage [59G]

Synchronous machines connected to isolated neutral systems or associated with a star point transformer loaded with a high resistance, are capable of operating for long periods even if an earth fault occurs in the stator or on the network.

This mode of operation must be detected in order for the operator to take the necessary steps and organise the eventual shut down of the machine before a second fault, on one of the other previously healthy phases, results in the circulation of a heavy fault current in the stator laminations.

The GMS7001 recreates the zero sequence voltage by summing the 3 phase voltages supplied by voltage transformers connected to the generator terminals.

The GMSV7001 has a special input designed to be supplied by zero sequence voltage from a star point transformer.

The "Neutral displacement over voltage" provided by these relays is equipped with two separate operating levels which can be used as alarm and trip functions. Digital filtering enables the effect of 3rd harmonic voltages to be eliminated.

PRINCIPLES AND APPLICATIONS

Earth fault [64]

When the network is earthed, the detection and the rapid elimination of earth faults is generally required so as to ensure personnel safety and to limit damage to the equipment. This protection is normally provided by earth fault over current relays.

Synchronous machines can contribute to earth fault currents and/or can themselves be affected by the fault . If the fault is external to the machine, the generator can withstand this situation for a relatively long time and stay within the associated thermal and mechanical limits. On the other hand, if the fault is within the stator, it has to be detected and eliminated as soon it reaches a level exceeding a few amperes in order to avoid an extended shut down period following the incident.

The GMSH7000 protect synchronous machines against earth faults using its "Earth fault overcurrent" function . By using a toroid , the GMSH7000 can detect fault currents of 1 A, and remain insensitive to the influence of 3rd harmonic currents thanks to digital filtering techniques.

Alternative methods of earthing the generator and the network lead to a number of applications using the GMSH7000 (connected to a toroid, to the residual connection of 3 line CTs, to a star point CT, ...). When the residual connection of three line CTs is used, the setting of the earth fault unit can affect its stability due to the partial saturation of these CTs during transient periods such as motor starting. This may mean that a stabilising resistor is required (please consult us).

MAIN ADVANTAGES

The GMSx7000 relays provide three main sets of advantage as follows:

Reliability and availability

The design and construction of this equipment meet the same standards of reliability and safety used by CEE for the manufacture of conventional static protection devices:

- Compliance with IEC 255 recommendations and standards,
- Mechanical, fool-proof fouling pins on cases and bases,
- Debugging and individual testing of certain critical components,
- Component selection based upon not only thermal withstand but also over voltages considerations, and, ...
- Withstand to severe environmental conditions: heat/humidity (40°C, 56 days), 93% relative humidity.

In addition to these basic construction details, the GMSx7000 devices incorporate an automatic self-supervision system which, together with the plug-in case facility, optimises their availability.

The automatic self-supervision system intervenes at three different levels:

- Detection of loss of auxiliary supply,
- Detection of a microprocessor failure using a "watchdog",
- Detection of a breakdown in a microprocessor peripheral (such as RAM, EEPROM...) by executing microdiagnostic programs.

The user is notified that the automatic self-supervision system has operated by the closure of a clean contact brought out to terminals and/or, if the case arises, by the interruption of the digital communication channel.

Power and flexibility of the communications

The GMSx7000 series devices communicate with the external world in three major ways:

• Local communication

Dialogue between the user and the equipment is ensured by means of a keyboard on the device itself, which may be used to set up and read back all of the quantities, recorded, calculated or measured by the GMSx7000. The user is also provided with a serial port for connection to a PC to assist in direct communication with the relay thanks to the "PROSETTING" program which is available separately. (Please consult us).

The GMSx7000 relays contains 2 separate groups of settings.

The user selects a particular group using the keyboard or via the serial communications. A password supervises the modification of the settings. An easy to read LED display unit enables the user to have direct readout of the electrical quantities in true primary values.

Alarms and trip conditions are indicated by LEDs, orange and red respectively, as well as on the display which indicates:

- for alarms, the list of the function(s) that initiated the alarm(s) and the change in their value(s).
- for trips, the associated function and its value.

In addition, the display indicates any function whose threshold is reached.

• Communication by digital channels

The GMSx7000 case is equipped with 2 serial digital communications channels type RS-232-C/DB9 and current loop (0-20 mA).

MAIN ADVANTAGES

The RS-232-C/DB9 socket on the face plate enables the relay to be directly connected to a PC, either by emulating a terminal for local monitoring without interrupting the current loop communications, or by connection to a system using a data exchange protocol such as J-Bus or others (please consult us).

The (0-20 mA) current loop plugs enable the relays to be connected into a network controlled by a PC or other equipment (please consult us).

All data available locally, measurements, alarms or settings, may be transmitted to a remote location.

When an event occurs such as the relay tripping or upon receipt of a command via the communications, the complex values of the voltages and currents, calculated during a period of approximately 3.5 seconds prior to the event and 1 second after it, are made available to the centralised system. The same applies for the 22 elementary events (starting function, alarm, trip) which are recorded by the GMSx7000.

The selection of the setting group to be used by the relay can be made via the communications.

When used in a PROSATIN system, the GMSx7000 time stamps any setting changes, the passage of any set points and of the two digital inputs. Overall, the memory capacity of the GMSx7000 enables to record these 22 events on 32 different dates.

- **Communication by digital channels**

- **Inputs**

The GMSx7000 are fitted with a 2 galvanically insulated contact inputs which enable the temporary inhibition of certain functions (chosen by the user) whilst the contact remains close (generator run up sequences ..).

- **Outputs**

The GMSx7000 relays are fitted with 6 electromagnetic output units to provide self-supervision, alarm and signalling, trip signals:

- Self-supervision: by clean contact of the "watchdog" device (unit W).
- Alarm and signalling: via the operation of "D" or "E" relays indicating the passage of a set point.
- Trip: three high closing current capacity output relays "A", "B" and "C" for controlling power equipment (line circuit breaker, field circuit breaker, and prime mover shut down).

The configuration of each of these relays A, B, C, D, E is completely under the control of the user using a matrix setup.

Adaptability and autonomy

As they are mounted in modular, plug-in, metallic type R cases, devices in the GMSx7000 series may be used either:

- as independent modules.
- as modules integrated into a rack incorporating conventional static relays from the 7000 series.
- as modules integrated into a rack as an element of the PROCOM/PROSATIN system.

The flexible presentation means that the GMSx7000 devices may be easily adapted to the user's actual technical and economic requirements and can, for example, be inserted into existing installations.

The GMSx7000 autonomous and flexible nature is further reinforced by the fact that it can, without the use of special devices, be connected to a source of AC or DC auxiliary supply having a very wide operating range (48 V to 250 V, or 24 V to 70 V).

GENERAL CHARACTERISTICS

1. Input and output quantities

Voltage

rated phase voltage

$V_n : 100/\sqrt{3}$ or $110/\sqrt{3}$ V

rated phase to phase voltage

$U_n : 100$ or 110 V

- display:

rated voltage setting range

V_n or U_n : adjustable from 0.10 kV to 100 kV (in steps of 10 V)

measurement range

0 to 150 kV

display resolution

primary value: 10 V from 0.1 kV to 10 kV, 100 V over 10 kV

secondary value: 1%

accuracy class

1

- overload:

$2 V_n$ permanently (GMS) / $1.3 U_n$ permanently (GMSH, GMSV)

- burden:

< 0.2 VA at U_n

GENERAL CHARACTERISTICS

Current

rated current	I_n : 1 A or 5 A
• display:	
rated current setting range	I_n : adjustable from 10 A to 10 kA (step 1 A)
measurement range	0 to 200 kA
resolution	primary value: 1 A from 10 A to 1 kA, 10 A over 1 kA secondary value: 1%
accuracy class	1
• overload:	2 I_n permanently - short duration: 80 I_n / 1 s (phases) - short duration: 40 I_n / 1 s (earth on CT)
• burden:	<0.2 VA at I_n

Frequency

rated frequency	f_n
• display:	
rated frequency settings	f_n : 50 Hz or 60 Hz
measurement range	8 to 70 Hz
resolution	0.01 Hz
accuracy class	0.05 Hz

Power

rated kVA	$S_n = 3 V_n I_n = \sqrt{3} U_n I_n$
rated kW	P_n
• display:	
measurement range	P_n : 1 kW to 100 MW
resolution	primary value: 0.1 kW from 1 kW to 1 MW 1 kW from 1 MW to 10 MW 10 kW from 10 MW to 100 MW secondary value: 1% of S_n
accuracy class	2

Impedance

rated impedance	$Z_n = V_n / I_n$
• display:	
measurement range	0.01 at 100 Ω
resolution	primary value: 0.01 Ω secondary value: 1% of Z_n
accuracy class	2

Flux (U/F)

rated flux	U_n / f_n
• display:	
measurement range	0.1 U_n / f_n to 2 U_n / f_n
displayed value resolution	secondary value: 1%
accuracy class	1

Thermal state

rated thermal state	θ_n corresponding to a continuous current I_n
• display:	
measurement range	0 to 130%
displayed value resolution	1%
accuracy class	1

GENERAL CHARACTERISTICS

Auxiliary voltage

burden

24 - 70 Vcc or Vac - 50 / 60 Hz
 48 - 250 Vcc or Vac - 50 / 60 Hz
 approx. 10 W (DC)
 approx. 13 VA (AC)

Output contacts

• unit A, unit B, unit C		2 NO
• unit D, unit E		1 NO
• unit W (Watchdog)		1 NC
• maximum voltage	(D, E, W)	250 V
	(A, B, C)	600 V
• maximum continuous current	(D, E, W)	2.5 A
	(A, B, C)	5 A
• closing capacity 0.2 s	(D, E, W)	5 A
	(A, B, C)	10 A
• breaking capacity		
• CC (L/R) = 40 ms	(D, E, W)	25 W (0.5 A / 48 Vcc - 0.25 A / 110 Vcc)
	(A, B, C)	50 W (1 A / 48 Vcc - 0.5 A / 110 Vcc)
• AC (cosφ = 0.4)	(D, E, W)	625 VA ; I < 1.5 A
	(A, B, C)	1250 VA ; I < 3 A
• Watchdog		Relay energised in the quiescent state (contact open), resets in the event of an abnormal condition (contact closed)
• Local indications and display		16 digits/LED display unit indicating setting and measurements, as well as differentiation of the types of fault

2. Protection

2.1 - Thermal Image Protection [49-1] / [49-2]

• Functions

overload protection
 1 alarm level
 1 trip value

ANSI code: [49-1]
 ANSI code: [49-2]

• Characteristic value

Base thermal current

thermal state q (given by the base current I_b calculated from I_{pos} positive phase sequence and I_{neg} phase negative sequence components of the 3 currents); thermal image obtained by exponential smoothing

$$I = \sqrt{(I_{pos}^2 + K^2 I_{neg}^2)}$$

I_{pos} : positive sequence, I_{neg} : negative sequence
 K^2 : negative phase sequence thermal effect constant

• Mode of operation

Operates when the thermal state q exceeds an operating level

• Current settings

- thermal setting range I_{th}
 - thermal alarm level I_{tha}
 - weighting constant k^2

0.5 to 1.2 I_n (step 0.05)
 0.8 to 1 time the thermal state q (step 0.05)
 4 to 16 (step 2)

• Operating value

constant and equals to 1.07 times the setting (corresponds to a thermal state of 114%)

• Time setting

- thermal time constant τ

4 to 240 minutes (step 1 minute)

• Operating level reset percentage

approximately 95%

• Accuracy

- on the operating levels
 - on the time delays

5% of setting with a minimum of 5% I_n
 10% for $I_b = 2$ times setting
 5% for $I_b = 6$ times setting

GENERAL CHARACTERISTICS

- **Operating curves to IEC 255-8**

$$t(s) = \tau \frac{\ln \left(\frac{I}{I_{th>}} \right)^2 - (I_p/I_{th>})^2}{(I/I_{th>})^2 - (1.07)^2}$$

τ = thermal time constant in minutes

I = base thermal current

I_{th>} = thermal setting coefficient depending upon the CT rating

I_p = preload current

1.07 = operating level

Ln = Napierian logarithm

2.2 - Phase Negative Sequence overcurrent [46-1]/[46-2]

- **Functions**

Unbalance protection

1 alarm level I_{Neg>}

1 trip level I_{Neg>>}

ANSI code: [46-1]

ANSI code: [46-2]

- **Characteristic value**

phase negative sequence current I_{Neg}

- **Mode of operation**

Operates when the phase negative sequence current exceeds an operating level

- **Current settings**

- low set alarm level I_{Neg>}

- high set I_{Neg>>}

3 to 20% of I_n (step 1% I_n)

4 to 40% of I_n (step 1% I_n)

- **Operating value**

100% of setting

- **Time settings**

- independent time alarm level t(I_{Neg>})

- C constant t(I_{Neg>>})

0.1 s fixed or adjustable from 1 to 10 s (step 1 s)

8 to 40 s (step 1 s)

- **Reset percentage for both operating levels**

approximately 95%

- **Accuracy**

- on the operating levels

- on time delays

independent time

dependent time

5% of setting or 1% I_n

5% of the time setting 1 to 10 s, ±30 ms for the fixed time setting of

0.1 s

5% at 0.5 I_n

- **Operating curve t(I_{Neg>>})**

$$(I_{Neg>}/I_n)^2 t = C$$

C : constant in seconds

2.3 - Field Failure [40] [GMSx7001]

- **Functions**

Protection against the field failure

1 trip level Y<

ANSI code: [40]

- **Characteristic value**

impedance Z (based upon U = V1-V2 and I = I1-I2)

- **Mode of operation**

operation when the apparent impedance drawn on an R-X plot enters into the circle with its origin on the X axis at the point (X1/2 + X2) and with a diameter X1.

Blocked for U< 16% U_n.

- **Impedance settings**

- offset X2

- diameter X1

8% to 40% of Z_n (step 1% of Z_n)

50% to 300% of Z_n (step 5% of Z_n)

- **Operating value**

100% of setting

- **Time setting t (Y<)**

0.1 s to 10 s (step 0.01 s)

- **Accuracy**

- on the operating level

- on the time setting

5% of setting or 3% of Z_n

5% of the time setting or ± 30 ms

GENERAL CHARACTERISTICS

2.4 - Loss of synchronism [55] [GMSx7002]

- **Functions**
protection against loss of synchronism
- 1 trip level SY>
ANSI code: [55]
- **Characteristic value**
measurement technique
apparent power S
- using the 3 phase to neutral voltages (GMS7002)
- using 2 phase to phase voltages (GMSH / GMSx7002)
- **Mode of operation**
operation when the apparent power S falls inside the zone fixed by a straight line on the P-Q diagram shown on figure 6.
- **Apparent power settings**
- SY> threshold
20% to 80% of Sn (step 0.05 Sn)
- **Time setting**
- trip time delay t (SY>)
- reset time constant
(when outside the trip zone)
0.1 - 10 s (step 0.01 s) (set value) + 0.1 s fixed
10t (SY>)
- **Reset percentage on the operating level**
approximately 50%
- **Accuracy**
- on the operating level
- on the time setting
1% of Sn (for vector S perpendicular to the trip line)
5% of the time setting or ± 30ms

2.5 - Under impedance [Z1-1] / [Z1-2]

- **Functions**
phase fault protection
1 operating level Z<
1 operating level Z<<
ANSI code: [Z1 -1]
ANSI code: [Z1 -2]
- **Characteristic value**
apparent impedance
 $Z1=(V1-V2)/(I1-I2)$, $Z2=(V2-V3)/(I2-I3)$, $Z3=(V3-V1)/(I3-I1)$
- **Mode of operation**
operation when the impedance is below the operating level provided that the current is itself greater than a given operating level ("OR" function between the 3 impedances Z1, Z2 and Z3 for the GMS7001 or the 2 impedances Z1 and Z2 for the GMSH7001 and GMSV7001)
- **Impedance setting**
- operating level Z<
- operating level Z<<
40% to 200% of Zn (step 0.05 Zn)
10% to 50% of Zn (step 0.05 Zn)
- **Operating value**
100% of setting
- **Reset percentage on the operating levels**
approximately 105 %
- **Time setting**
- t (Z<)
- t (Z<<)
0.1 to 100 s (step 0.1 s)
0.1 to 100 s (step 0.1 s)
- **Accuracy**
- on the operating levels
- on the time setting
5% of setting or 3% of Zn
5% of the time setting or ±30 ms

Overcurrent element

- **Function**
trip authorisation
operating level I(Z<)

GENERAL CHARACTERISTICS

- **Current setting** 10% to 40% I_n (step 0.05 I_n)

- 2.6 - Overcurrent [51-1] / [51-2] / [50]**
2.6.1 - Overcurrent [51-1] / [51-2] [GMSx7001]

- **Functions**
 back up protection for phase faults
 1 low set operating level I>
 1 high set operating level I>>
ANSI code: [51-1]
ANSI code: [51-2]

- **Characteristic value** current level

- **Mode of operation** operation when one of the three currents exceeds an operating level. Dependent or independent time operating curve depending upon setting.

- **Current settings**
 low set operating level I>
 high set operating level I>>
0.5 to 2 I_n (step 0.1 I_n)
1 to 10 I_n (step 0.25 I_n)

- **Operating value**
 low set operating level I>

 high set operating level I>>
100% of setting (independent time curve)
110% of setting (dependent time curve)
100% of setting

- **Reset percentage on the operating levels** approximately 95%

- **Time settings**
 low set operating level t(I>)
 - independent time
 - dependent time
 high set operating level t(I>>)
 - independent time
0.1 s to 100 s (step 0.1 s)
0.1 s to 3 s at 10 I> (step 0.05 s at 10 I>)

0.1 s to 10 s (step 0.01 s)

- **Accuracy**
 on the operating levels
 on the time settings
 - independent time
 - dependent time
5% of the setting or ±30 ms

5% of the time setting
5% of the time setting or ± 30 ms (7.5% extremely inverse curve) at 10 I>

- **Operating curves to IEC 255-4 low set unit**
 low set operating level characteristics t(I>)
 independent time or dependent time: inverse, very inverse, extremely inverse

$$t(s) = \frac{T}{(I/I_{>})^\alpha - 1} * \text{setting } t(I>)$$

T = 0.046	α = 0.02	curve 2 Inverse (I)
T = 9	α = 1	curve 3 Very inverse (VI)
T = 100	α = 2	curve 4 Extremely inverse (EI)

2.6.2 - Overcurrent [50] [GMSx7002]

- **Functions**
 overcurrent protection
 1 operating level I>>
ANSI code: [50]

- **Characteristic value** phase current level

- **Mode of operation** operation when one of the three currents exceeds the operating level. Independent time on operating curve.

GENERAL CHARACTERISTICS

- **Current settings**
operating level I>> 2 to 12 In (step 0.25 In)
- **Operating value**
operating level I>> 100% of setting
- **Reset percentage of the operating levels**
time setting approximately 95%
t(I>>) approximately 0.1 s fixed
- **Accuracy**
- on the operating level I>> 5% of the setting
- on the time setting t(I>>) 5% of the time setting or ±30 ms

2.7 - Too long start [51-1 LR] / Locked rotor [51-2 LR][GMSx7002]

- **Functions**
protection against too long starts and locked rotor
1 operating level ISR> (too long starts) ANSI code: [51-1 LR]
1 operating level ILR (locked rotor) ANSI code: [51-2 LR]
- **Characteristic value**
phase current level
- **Mode of operation**
- ISR> : [51-1 LR] Operation when one of the three currents exceeds the operating level. Extremely inverse time operating curve. Initiated by an external contact connected to the V input. Inhibited automatically at the end of the Td time delay.

- ILR> : [51-2 LR] Operation when one of the three currents exceeds the operating level. Definite time operation. Automatically brought into service at the end of the Td time delay.
- **Current settings**
- operating level ISR> 0.5 to 2 In (step 0.1 In)
- operating level ILR > 2 to 10 In (step 0.25 In)
- **Operating value**
- operating level ISR> 110% of setting
- operating level ILR > 100% of setting
- **Reset percentage on the operating levels**
approximately 95%
- **Time settings**
- operating level t(ISR>) 0.1 to 3 s at 10 ISR> (step 0.05 s at 10 ISR>)
- operating level t(ILR>) 1 s to 5 s (step 0.1 s)
- Td (time delay permitting ISR> to come into operation and to bring ILR> into service, initiated by a contact on the V input) 2 to 400 s (step 1 s)
- **Accuracy**
- on the operating levels 5% of the setting
- on the time settings 5% of the time setting or ± 30 ms
- t(ILR>) and Td 7.5% to 10 ISR> or ± 30 ms
- t(ISR>)
- **Operating curves to IEC 255-4 low set unit**
- t(ISR>) extremely inverse time (EI)

$$t(s) = \frac{100}{(I/ISR>)^2 - 1} * \text{setting } t(ISR>)$$

GENERAL CHARACTERISTICS

2.8 - Overvoltage [59-1] / [59-2]

- **Functions**
overvoltage protection
 - 1 low set operating level U> ANSI code: [59-1]
 - 1 high set operating level U>> ANSI code: [59-2]
- **Characteristic value**
voltage level
- **Mode of operation**
operation when the phase or phase to phase exceeds an operating level (programmable). Logic function "OR" between the 3 phases (GMS7000) or the 2 phases (GMSH7000 / GMSV7000)
- **Voltage settings**
 - low set operating level U> 70% Un to 150% Un (step 1% Un)
 - high set operating level U>> 70% Un to 150% Un (step 1% Un)
- **Operating value**
100% of setting
- **Reset percentage on the operating levels**
approximately 2% of Un
- **Time settings**
 - low set operating level t(U>) 0.1 s to 10 s (step 0.01 s)
 - high set operating level t(U>>) 0.1 s fixed
- **Accuracy**
 - on the operating levels 1% of Un
 - on the time settings 5% of the time setting or ± 30 ms

2.9 - Over Fluxing [24]

- **Functions**
protection against excessive flux densities
 - 1 operating level ANSI code: [24]
- **Characteristic value**
U/f (calculated from V2 - V3)
- **Mode of operation**
operation when the flux density exceeds an operating level
- **Frequency operating range**
8 Hz - 70 Hz
- **Setting**
50% to 150% of Un/fn (step 0.05 Un/fn)
- **Operating value**
100% of setting
- **Reset percentage on the operating level**
approximately 95%
- **Time setting**
 - t(U/f>) 0.2 to 10 s (step 0.01 s)
- **Accuracy**
 - on the operating level 1.5% of Un/fn
 - on the time setting 5% of the time setting ± 30 ms

2.10 - Undervoltage [27]

- **Functions**
protection against low voltages
 - 1 operating level U< ANSI code: [27]
- **Characteristic value**
choice between phase or phase to phase voltage levels

GENERAL CHARACTERISTICS

- **Mode of operation**
 - GMS7000
 - GMSH7000/GMSV7000operation when the voltage falls below an operating level phase or phase to phase voltages (selectable) - 3 phases
phase to phase voltage - 2 phases
logic functions "OR" or "AND" on the monitored phases.
- **Voltage setting**
 - operating level U<20% to 120% Un (step 1% of Un)
- **Operating value**100% of setting
- **Reset percentage on the operating levels**2% of Un
- **Time setting**
 - t(U<)0.1 s to 10 s (step 0.01 s)
- **Accuracy**
 - on the operating level
 - on the time setting1% of Un
5% of the time setting or ± 30 ms

2.11 - Over and Under Frequency [81-1 / 81-2]

- **Functions**

protection against operation at abnormal frequencies

 - 1 operating level f1 (selectable f1< or f1>)
 - 1 operating level f2 (selectable f2< or f2>)ANSI code: [81-1]
ANSI code: [81-2]
- **Characteristic value**frequency of voltages V2 and V3 (GMS7000), and U12 and U23 (GMSH7000 / GMSV7000)
- **Mode of operation**operation when the frequency is outside the under or over operating levels (depending upon the setting).
Operation blocked for $U < 5\% U_n$.
- **Frequency operating range**8 Hz to 70 Hz
- **Frequency settings**
 - rated frequency
 - f1 and f250 or 60 Hz selectable
44 Hz to 56 Hz (step 0.05 Hz) for $f_n = 50$ Hz
54 Hz to 66 Hz (step 0.05 Hz) for $f_n = 60$ Hz
- **Operating value**100% of setting
- **Reset percentage on the operating levels**
 - settingindependently adjustable for f1 and f2
0.2 to 0.4 Hz (step 0.05 Hz)
- **Time settings**
 - t(f1)
 - t (f2)0.2 s to 10 s (step 0.01 s)
0.2 s to 10 s (step 0.01 s)
- **accuracy**
 - on the operating levels
 - on the time settings < 0.05 Hz
5% of the time setting or ± 30 ms

2.12 - Reverse Power [32-1] [GMSx7001]

- **Functions**

protection against motoring

 - 1 operating level RP>ANSI code: [32-1]
- **Characteristic value**

Measurement method

real power
 - using 3 phase voltages (GMS7001)
 - using 2 phase to phase voltages (GMSH7001 / GMSV7001)(2 wattmeters method)

GENERAL CHARACTERISTICS

- **Mode of operation** operation when the real power imported exceeds an operating level
- **Power setting** 1% to 20% of S_n (step 0.5%)
- **Reset percentage on the operating level** approximately 95%
- **Time setting**
 - $t(RP>)$ 0.2 s to 100 s (step 0.01 s)
- **Accuracy**
 - on the operating level 0.5% of S_n
 - on the time setting 5% of the time setting or ± 30 ms
- **Directional stability** guaranteed for $Q < Q_n$ and $V > 20\% U_n$ and $f_n - 10 \text{ Hz} < f < f_n + 10 \text{ Hz}$

2.13 - Over and Under Power [32-2]

- **Functions**

protection against operation outside active power limits

1 operating level (selectable $P>$ or $P<$)

ANSI code: [32-2]
- **Characteristic value**

Measurement method

Real power
 - using 3 phase voltages (GMS7000)
 - using 2 phase to phase voltages (GMSH7000 / GMSV7000) (2 wattmeters method)
- **Mode of operation** operation when the real power exported exceeds a maxi or mini (selectable) operating level.
- **Power setting** 30% to 120% of S_n (step 0.5%)
- **Operating value** 100% of setting
- **Reset percentage on the operating value** approximately 95% for $P>$
approximately 105% for $P<$
- **Time setting**
 - $t(P>)$ or $t(P<)$ 0.2 s to 100 s (step 0.01 s)
- **Accuracy**
 - on the operating level 0.5% of S_n
 - on the time setting 5% of the time setting or ± 30 ms

2.14 - Neutral Displacement Overvoltage [59-G1] / [59-G2] [GMS7000 / GMSV7000]

- **Functions**

protection against earth faults

1 alarm level $V_{0>}$

1 trip operating level $V_{0>>}$

ANSI code: [59G-1]
ANSI code: [59G-2]
- **Characteristic value**

Measurement method

zero sequence voltage level
 - summation of the three phase voltages (GMS7000)
 - supplied by a star point or open delta VT (GMSV7000)
- **Mode of operation** operation when the zero sequence voltage exceeds an operating level

GENERAL CHARACTERISTICS

- **Voltage settings**
 - alarm level $V_{o>}$
 - GMS7001 3 to 15% of V_n (step 1% of V_n)
 - GMSV7001 3 to 15% of V_n (step 1% of V_n)
 - trip operating level $V_{o>>}$
 - GMS7001 6 to 30% of V_n (step 1% of V_n)
 - GMSV7001 6 to 30% of V_n (step 1% of V_n)
- **Reset percentage on the operating levels** approximately 1% of V_n
- **Time settings**
 - $t(V_{o>})$ 0.1 s to 10 s (step 0.01 s)
 - $t(V_{o>>})$ 0.1 s to 10 s (step 0.01 s)
- **Accuracy**
 - on the operating levels 1% of V_n
 - on the time settings 5% of the time setting or ± 30 ms

2.15 - Earth Fault Overcurrent [64] [GMSH7000]

- **Functions**
back up protection for earth faults
1 operating level $I_{o>}$ ANSI code: [64]
- **Characteristic value** zero sequence current level
- **Mode of operation** operation when the zero sequence current exceed an operating level
- **Current settings**
 - $I_{o>}$ (connected to a toroid) 1 to 20 A primary (step 0.5 A)
 - $I_{o>}$ (connected to 3 CTs) 0.05 to 1 In (step 0.025 In)
- **Operating value**
 - 100% of setting (independent time curve)
 - 110% of setting (dependent time curve)
- **Reset percentage on the operating levels** approximately 95%
- **Time settings**
 - independent time $t(I_{o>})$ 0.1 s to 100 s (step 0.1 s)
 - dependent time $t(I_{o>})$ 0.1 s to 3 s at 10 $I_{o>}$ (step 0.05 s at 10 $I_{o>}$)
- **Accuracy**
 - on the operating levels 5% of the value of setting or 0.5% In
 - on the time settings
 - independent time 5% of the time setting or ± 30 ms
 - dependent time 5% of the time setting or ± 30 ms (7.5% extremely inverse curve) at 10 $I_{o>}$
- **Operating curves to IEC 255-4**
low set unit $t(I_{o>})$ characteristic
independent time or dependent time: inverse, very inverse, extremely inverse (until 20 $I_{o>}$ or 200 A on Ring CT)
$$t(s) = \frac{T}{(I/I_{o>})^\alpha - 1} * \text{setting } t(I_{o>})$$
 - $T = 0.046$ $\alpha = 0.02$ curve 2 Inverse (I)
 - $T = 9$ $\alpha = 1$ curve 3 Very inverse (VI)
 - $T = 100$ $\alpha = 2$ curve 4 Extremely inverse (EI)
- **Short time withstand** 40 In / 1 s

GENERAL CHARACTERISTICS

3. Influencing quantities nominal ranges

- **Temperature** -10°C +55°C
- **Frequency** 8 Hz - 70 Hz

4. Environmental conditions

- **Storage range (IEC 68-2)** - 25°C + 70°C
- **Dampheat (IEC 68-2)** 95% RH; 40°C; 56 days
- **Saline mist** 96 hours

5. Insulation to IEC 255-5

- **Dielectric withstand**
 - all terminals together/frame and between galvanically isolated groups 2 kV - 50 / 60 Hz 1 min (except current loop 1 kV / 1 min)
 - DB25 500 V - 50 / 60 Hz 1 min
 - insulation resistance at 500 V > 10 000 MΩ
 - impulse voltage withstand (except DB25) 5 kV - 1.2/50 μs

6. Withstand capability to electromagnetic interference

6.1 - Conducted high frequency disturbance

(IEC 255-22-1) (except for the DB 25 / RS232C sockets)

- Common mode 2.5 kV - 1 MHz - Class III
- Differential mode 1 kV - 1 MHz - Class III

6.2 - Fast transients (IEC 255-22-4 / IEC 801-4)

- 5/50ns - repeated 5kHz 2 kV - Class III

6.3 - Electrostatic discharge (IEC 255-22-2 / IEC 801-2)

- Contact 4 kV
- Air 8 kV - Class III

6.4 - Radiofrequency

6.4.1 - Radiated radiofrequencies

- Amplitude modulated at 80% - 1kHz (IEC 801-3 / EN 50082-2 / ENV 50141) 80 - 1000 MHz ; 10 V/m
- Amplitude modulated at 80% - 1kHz (EN 50082-2/ENV 50141) 900 MHz ; 10 V/m

6.4.2 - Conducted radiofrequencies

- AC/DC: Inputs/Outputs
- Amplitude modulated at 80% - 1kHz
- Source impedance: 150 Ω (IEC 801-3 / EN50082-2 / ENV 50141) 0.15 - 80 MHz ; 10 V

7. Emission of electromagnetic interference

Radiated electromagnetic fields (EN55011 / EN 50081-2)

- Measured at 10 meters
- Frequency range 30 MHz - 230 MHz 40 dB (V/m) - (quasi peak value)
- Frequency range 230 MHz - 1000 MHz 47 dB (V/m) - (quasi peak value)

8. Digital communication

- Support 2 switchable channels, each having output sockets:
 - current loop: 0-20mA
 - DB9 / RS232C
- Protocol Master/Slave to J-BUS or other standard
- Operating speed 1200 - 2400 - 4800 bauds

9. Case

R4

10. Weight

5 Kg

11. Identifying drawings

GMS7001	22A3	GMS7002	26A5
GMSH7001	15A7	GMSH7002	26A4
GMSV7001	20A9	GMSV7002	28A5

OPERATION

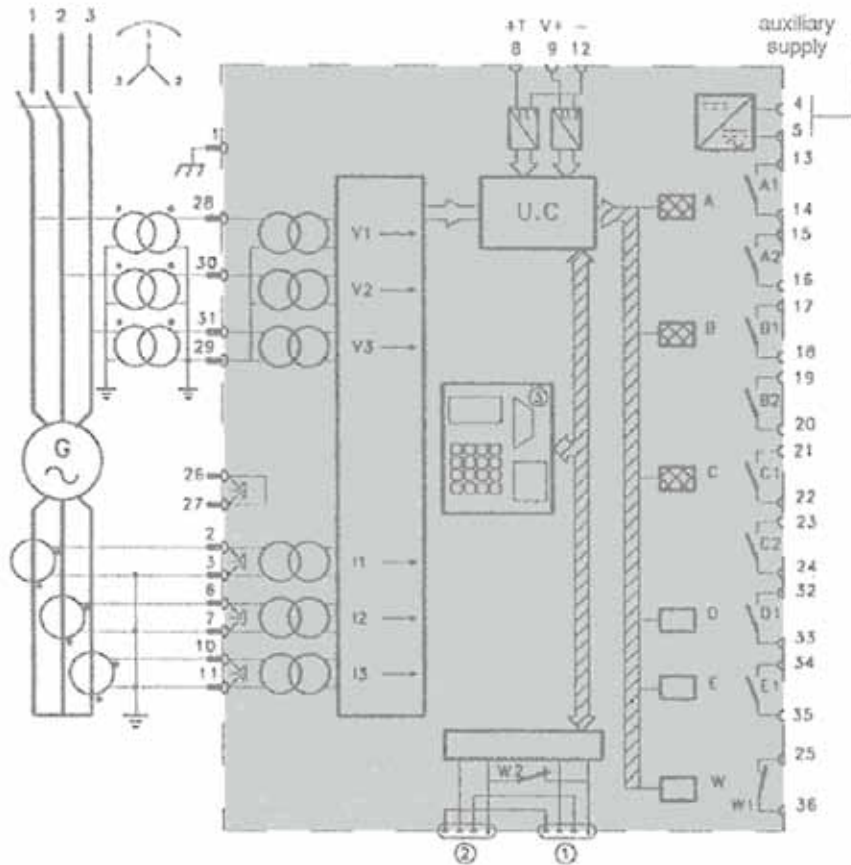


Fig. 12 - GMS7001 - Simplified operation and connection diagram

		<i>projecting rear connection</i>	<i>flush rear connection</i>
CASE DIMENSIONS	CONNECTING SCREWS Ø M4		
		$x = 89$ for panel th. < 2 $x = 90,5$ for panel th. > 2	
R4	CASE DIMENSIONS		
	DRILLING AND CUT OUT		

STYLE NUMBER IDENTIFICATION

GMS 7001 — A — B — C — D — E — F — G

Frequency	50 Hz 60 Hz	a b					
Rated current	1 A 5 A		a b				
Rated voltage	100 V/√3 110 V/√3 230 V			a b c			
Auxiliary supply dc/ac	20 66 V 48 250 V				a b		
Case R4	projecting rear connection flush rear connection					b c	
Connection diagram	index						a
Contacts Relays A, B, C	2 NO 1 NO + 1 NC						a b

GMSV 7001 — A — B — C — D — E — F — G — H

Frequency	50 Hz 60 Hz	a b						
Rated current	1 A 5 A		a b					
Rated voltage	100 V 110 V			a b				
Zero sequence voltage	100 V/√3				a			
Auxiliary supply dc/ac	20 66 V 48 250 V					a b		
Case R4	projecting rear connection flush rear connection						b c	
Connection diagram	index							c
Contacts Relays A, B, C	2 NO 1 NO + 1 NC						a b	

GMSH 7001 — A — B — C — D — E — F — G — H — I

Frequency	50 Hz 60 Hz	a b						
Rated current	1 A 5 A		a b					
Rated voltage	100 V 110 V 120 V			a b c				
Zero sequence current	3 TC secondary 1 A 3 TC secondary 5 A Ring CT				a b c			
Auxiliary supply dc/ac	20 66 V 48 250 V					a b		
Case R4	projecting rear connection flush rear connection						b c	
Connection diagram	index							a
Ring CT Type	Please refer to table ref. 142941							
Contacts Relays A, B, C	2 NO 1 NO + 1 NC							a b

STYLE NUMBER IDENTIFICATION

GMS 7002 — A — B — C — D — E — F — G

Frequency	50 Hz 60 Hz	a b					
Rated current	1 A 5 A	a b					
Rated voltage	100 V/√3 110 V/√3 120 V	a b c					
Auxiliary supply dc/ac	20 66 V 48 250 V	a b					
Case R4	projecting rear connection flush rear connection	b c					
Connection diagram	index	a					
Contacts Relays A, B, C	2 NO 1 NO + 1 NF	a b					

GMSH 7002 — A — B — C — D — E — F — G — H — I

Frequency	50 Hz 60 Hz	a b							
Rated current	1 A 5 A	a b							
Rated voltage	100 V 110 V 120 V	a b c							
Zero sequence current	3TC secondary A1 3TC secondary 5A Tore	a b c							
Auxiliary supply dc/ac	20 66 V 48 250 V	a b							
Case R4	projecting rear connection flush rear connection	b c							
Connection diagram	index	a							
Ring CT type	please refer to table ref. 142 941								
Contacts Relays A, B, C	2 NO 1 NO + 1 NF	a b							