SELCO

SIGMA S6100 S/LS Module

User's Manual

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1 Preface

The SELCO SIGMA S6100 S/LS module provides integrated bus bar monitoring, frequency stabilization, voltage stabilization, check/automatic synchronisation and active/reactive load sharing. The S6100 module relies upon the measurements and calculations broadcasted by its partner SELCO SIGMA S6000 IO/P module. The S6000 provides integrated protection, basic I/O and data acquisition. Finally, the S6100 module will operate as an interface between the optional SELCO SIGMA S6600/S6610 Power Manager and the engine related signals (e.g. start/stop, engine fail etc.).

2 Isolation and Grounding

In marine installations ground and common reference (COM) should not be connected together. In a ship installation the hull is the "ground". Connecting any of the COM connections on any of the modules within a SIGMA system to ground (hull) or switchboard chassis may cause instability within the system.

One, and only one, COM connection should to be made between SIGMA modules. This is preferably the COM connection of the CAN bus.

The Primary and Backup 24 VDC supplies are isolated from the remaining electronics of the module and therefore also from the common reference (COM). The negative poles of the 24 VDC supplies can be connected to the common reference (COM), provided that the either one, or both supplies serves as references for auxiliary relays driven by SIGMA open collector outputs. In this case the supplies negative poles should not be connected to ground (hull) or switchboard chassis.

As a general rule:

1. COM terminals should not be connected to ground (hull) or switchboard chassis.

2. Negative poles of the primary and back-up supplies should not be connected to ground (hull) or switchboard chassis.

3. Negative poles of the primary and back-up supplies and COM can be connected together, provided that the negative poles of the primary and back-up supplies are not connected to ground (hull) or switchboard chassis.

3 Function

The S6100 module provides integrated busbar monitoring as well as control for a single generator. The S6100 includes a programmable control and output scheme, which makes it adaptable to almost any brand and type of speed governor. The same applies to the control of the automatic voltage regulator (AVR).

3.1 Protection

The S6100 module provides three built-in protection functions. These protection functions operate from the 3 phased voltage measurements conducted by the S6100 module, thus all three functions are intended for monitoring of the busbar. The protection functions can be configured with trip level(s). Delays are provided for filtering. The protection functions operate on RMS readings sampled over one or four periods (depending on the rated frequency).

The C/B Trip LED will start flashing and the delay will begin counting the moment the trip level of the related protection function is exceeded. If the level is exceeded for the full duration of the delay, the C/B Trip LED will change to steady light and the circuit breaker will trip. Otherwise the LED will go off and the delay will reset.

Unlike the generator protection functions provided in the S6000 module, no dedicated front folio LED’s and digital outputs (open collector outputs) are provided. Reset can be issued by and external input (C/B RESET at the related S6000 module) or from the keyboard of the optional S6500, S6600 or S6610 module.

The S6100 module protects the external equipment by tripping the related breaker. The breaker is tripped through the built-in C/B trip relay. The C/B trip relay can be configured for normally de-energized or normally energized operation.

3.1.1 Voltage Establishment

The voltage establishment protection function can be enabled or disabled. If enabled the voltage establishment protection will trip the breaker in case the phase-phase voltages between any of the three phases becomes either too low or too high. The voltage establishment protection will act on the lowest or the highest of the three phase-phase voltage measurements, depending on whether the low or the high level is exceeded.

$$U_{12} \quad U_{23} \quad U_{31}$$

The trip level is configured as a percentage according to the nominal phase-phase voltage specified within the system configuration of the related S6000 module.

$$U_{12}\, or\, U_{23}\, or\, U_{31} \langle \frac{Lower\, Level \cdot NOMVOLT}{100}$$

Or

$$U_{12}\, or\, U_{23}\, or\, U_{31} \rangle \frac{Upper\, Level \cdot NOMVOLT}{100}$$

The delay is configured in seconds. Trip will occur only if the low or the high critical level is exceeded continuously for the duration of the delay.

3.1.2 Frequency Establishment

The frequency establishment protection function can be enabled or disabled. If enabled the frequency establishment protection will trip the breaker in case the busbar frequency becomes either too low or too high.

f

The trip level is configured as a percentage according to the rated frequency specified within the system configuration of the related S6000 module.

$$f \langle \frac{Lower\ Level \cdot RATEFREQ}{100}$$

or

$$f \rangle \frac{Lower\ Level \cdot RATEFREQ}{100}$$

The delay is configured in seconds. Trip will occur only if the low or the high critical level is exceeded continuously for the duration of the delay.

3.1.3 Frequency Deviation Protection (Rate of Change of Frequency, ROCOF, df/dt relay)

This function is only used for generators running in parallel with the grid.

When running in parallel with the grid it is very important to detect short time interruptions of the grid. When the grid returns after a short interruption it can be expected to be out of synchronism. Thus a reconnection of the generator to the grid must be avoided.

The FD function is doing that by measuring the change of frequency over time (rate of change of frequency).

The module will measure the time between two zero crossings of the measurement voltage and calculate a frequency for each period.

Slow changes in the grid frequency will not cause the unit to trip. However a rapid change in the frequency will cause the frequency deviation function to trip. Typical adjustment could be of 0.5 - 1.5 Hz/sec.

3.1.4 Start of standby generator in case of bus bar error (PM Start)

This function can be used for reducing the black-out time in case of protection trips due to voltage or frequency errors.

The function will use the frequency and voltage protection of the S6100 Module as pre-alarm. Thus the C/B trip relay output of S6100 should not be connected to the trip coil of the circuit breaker if this function should be used.

When the voltage or frequency protection function of the S6100 module trips, the S6610 Power Manager Module will start up the next available stand by generator. The standby generator will start and establish rated frequency and voltage. However it will not synchronize to the bus bar, as there is a voltage or frequency problem there.

After the voltage or frequency protection of the S6000 Module has tripped the breaker of the duty generator (and caused black-out on the bus bar), the standby generator will connect to the dead bus bar.

For this function the voltage and frequency protection functions of S6100 modules must be adjusted to the same level as the voltage and frequency protection functions of S6000 modules, however the delay must be shorter on the S6100 modules for allowing the generators to power up before black-out. Otherwise the black-out time would be increased.

The Bead bus closure (DB CLOSE) function must be enabled for this function.

3.2 Frequency Stabilization

The main purpose of the frequency stabilization function is to maintain the frequency at a fixed level, despite fluctuations in active load. The frequency stabilization is also able to provide quick and instant compensation should the frequency deviate from the preset level.

Engines controlled by conventional governors operate with speed droop. The speed droop causes engine revolutions (and generator frequency) to decrease slightly when active load is applied to the generator. The frequency will typically only drop few percent between zero to full load.

Engines controlled by electronic governors can be configured to operate in isynchronous mode. Isynchronous mode utilizes a speed feedback signal (e.g. from a flywheel pick-up) to compensate for the droop effect. Thus isynchronous mode provides zero droop (stable frequency with increase in active load). Electronic governors can also be configured to operate in droop mode with a certain percentage of droop.

The frequency stabilization function of the S6100 module will do much the same as the isynchronous feature of the electronic governor. However, there are some advantages to the S6100 frequency stabilization. First of all, it works with both conventional and electronic governors. Secondly, it provides seamless coexistence with other functions controlling the frequency (e.g. auto-synchronization and active load sharing). SELCO recommends that the governor is configured to operate with a few percent droop. This is to avoid a conflict between the S6100 frequency regulation and the isynchronous compensation feature of the governor.

The set point of the S6100 frequency stabilization is defined by the rated frequency parameter (RATEDFREQ) of the partner S6000 module. The frequency stabilization function becomes active once the power-up delay has passed, provided that the function has not been disabled.

The configuration of the frequency stabilization function depends on the chosen mode of speed control. The relay based speed control (Increase/decrease contact signals) is configured with stability and deadband, while the electronic control is set up with stability and PID parameters.

The stability parameter determines the magnitude of the control signal as a function of the actual deviation in frequency (compared to rated frequency). A high stability setting provides fast regulation, with the potential risk of over shoot and instability. A low stability setting provides accurate but slow regulation.

The deadband parameter (only used with relay based speed control) determines the level of deviation required for the frequency stabilization to regulate. The system will not do any regulation as long as the frequency deviation is within the deadband. A low deadband setting results in continues fine tuning of the frequency, while a high deadband setting results in infrequent corrections at the expense of accuracy. The deadband is expressed as a percentage of the rated frequency.

The PID parameters (only used with electronic speed control) works in conjunction with the stability parameter. Stability will affect the magnitude of the control signal when the deviation in frequency is relatively large, while the P-parameter determines the magnitude of the control signal when the deviation is small. Both stability and the P-parameter operate as a function of the frequency deviation. The I-parameter can be used to slow down the regulation (by increasing I). The D-parameter is seldom used and should be left at its default setting.

Frequency stabilization can be disabled (together with voltage stabilization) by connecting the F/V CTRL. DISABLE input to COM. If disabled, it is important to ensure that a defined signal is applied to the external frequency and voltage control input (FREQ. IN and VOLT. IN).

3.3 Voltage Stabilization

The main purpose of the voltage stabilization function is to maintain the voltage at a fixed level, despite fluctuations in reactive load. The voltage stabilization must also be able to provide quick and instant compensation should the voltage deviate from the preset level.

Alternators controlled by conventional voltage regulators operate with voltage droop. The voltage droop causes excitation (and alternator voltage) to decrease slightly when reactive load is applied to the generator. The voltage will typically only drop few percent between zero to full load.

Alternators controlled by electronic voltage regulators can be configured to operate in isynchronous mode. Isynchronous mode utilizes a voltage feedback signal to compensate for the droop effect. Thus isynchronous mode provides zero droop (stable voltage with increase in reactive load). Electronic voltage regulators can also be configured to operate in droop mode with a certain percentage of droop.

The voltage stabilization function of the S6100 module will do much the same as the isynchronous feature of the electronic voltage regulator. However, there are some advantages to the S6100 voltage stabilization. First of all, it works with both conventional and electronic voltage regulators. Secondly, it provides seamless coexistence with other functions controlling the voltage (e.g. voltage matching and reactive load sharing). SELCO recommends that the voltage regulator is configured to operate with a few percent droop. This is to avoid a conflict between the S6100 voltage regulation and the isynchronous compensation feature of the voltage regulator.

The set point of the S6100 voltage stabilization is defined by the nominal voltage parameter (NOMVOLT) of the partner S6000 module. The voltage stabilization function becomes active once the power-up delay has passed, provided that the function has not been disabled.

The configuration of the voltage stabilization function depends on the chosen mode of voltage control. The relay based voltage control (Increase/decrease contact signals) is configured with stability and deadband, while the electronic control is set up with stability and PID parameters.

The stability parameter determines the magnitude of the control signal as a function of the actual deviation in voltage (compared to nominal voltage). A high stability setting provides fast regulation, with the potential risk of over shoot and instability. A low stability setting provides accurate but slow regulation.

The deadband parameter (only used with relay based voltage control) determines the level of deviation required for the voltage stabilization to regulate. The system will not do any regulation as long as the voltage deviation is within the deadband. A low deadband setting results in continues fine tuning of the voltage, while a high deadband setting results in infrequent corrections at the expense of accuracy. The deadband is expressed as a percentage of the nominal voltage.

The PID parameters (only used with electronic voltage control) works in conjunction with the stability parameter. Stability will affect the magnitude of the control signal when the deviation in voltage is relatively large, while the P-parameter determines the magnitude of the control signal when the deviation is small. Both stability and the P-parameter operate as a function of the voltage deviation. The I-parameter can be used to slow down the regulation (by increasing I). The D-parameter is seldom used and should be left at its default setting.

Voltage stabilization can be disabled (together with frequency stabilization) by connecting the F/V CTRL. DISABLE input to COM. If disabled, it is important to ensure that a defined signal is applied to the external voltage and frequency control input (FREQ. IN and VOLT. IN).

3.4 Voltage Matching

The voltage matching function is used to match the voltage of the generator voltage to the busbar voltage. If enabled, voltage matching operates simultaneously with automatic synchronization. The voltage matching function works much like the automatic synchronization function; however voltage matching corrects the generator voltage instead of the frequency/phase deviation. The reference for the voltage matching function is the actual busbar voltage (not the nominal voltage). Do not mistake the voltage matching function with the voltage stabilization function. Voltage matching works only in conjunction with auto synchronization, while voltage stabilization work continuously (if enable). Furthermore, the reference for voltage matching function is the actual busbar voltage, as opposed to the nominal voltage which is reference for voltage stabilization.

The configuration of the voltage matching function depends on the chosen mode of voltage control. The relay based voltage control (Increase/decrease contact signals) is configured with stability and deadband, while the electronic control is set up with stability and PID parameters.

The stability parameter determines the magnitude of the control signal as a function of the actual deviation in voltage (compared to busbar voltage). A high stability setting provides fast regulation, with the potential risk of over shoot and instability. A low stability setting provides accurate but slow regulation.

The deadband parameter (only used with relay based voltage control) determines the level of deviation required for the voltage matching to regulate. The system will not do any regulation as long as the voltage deviation is within the deadband. A low deadband setting results in continues fine tuning of the voltage, while a high deadband setting results in infrequent corrections at the expense of accuracy. The deadband is expressed as a percentage of the nominal voltage.

The PID parameters (only used with electronic voltage control) works in conjunction with the stability parameter. Stability will affect the magnitude of the control signal when the deviation in voltage is relatively large, while the P-parameter determines the magnitude of the control signal when the deviation is small. Both stability and the P-parameter operate as a function of the voltage deviation. The I-parameter can be used to slow down the regulation (by increasing I). The D-parameter is seldom used and should be left at the default setting.

The purpose of the voltage matching function is typically just to bring the generator voltage within a reasonable range of the busbar voltage (e.g. +/-2 to +/-10%). Thus, voltage matching is in a way analogue to automatic synchronization, but without strict tolerances. The reference of the voltage matching function is defined by the VOLTOKWND parameter of the S6100.

3.5 Auto Synchronization

The auto synchronization function of the S6100 module is used to automatically connect the generator to the busbar. Auto synchronization is initiated the moment the S6100 module detects that a viable reference voltage exists on the busbar.

The main purpose of the automatic synchronization function is to ensure quick and automatic connection of the generator to the busbar.

A number of conditions must apply before the generator circuit breaker can be closed. First of all, the magnitude of the generator voltage must be equal or close to the magnitude of the busbar voltage (if voltage matching is enabled). Secondly, the frequency of the generator voltage must be a little higher or equal to the frequency of the busbar voltage. The third and last condition is that the phase deviation between the generator and busbar voltages must within a few degrees at the time of connection (breaker closure).

The matching of the generator voltage is done by the voltage matching function described elsewhere in this document. Voltage matching is optional.

The S6100 auto synchronization function will alter the speed of the generator (by control of the speed governor) to obtain the required deviation in frequency and phase. Once all three conditions are true, the S6100 module will issue the signal to close the circuit breaker.

The auto synchronization function works differently depending on whether the S6100 module is configured for speed control by relays (increase/decrease contact signals) or by electronic output. Governor control by the speed relay does not provide the facility to command and maintain exact frequency match and near zero phase deviation between the generator and busbar voltage. Synchronizing by speed relay is done by aiming for a small positive frequency deviation between the generator and busbar voltage, where after the closure signal is issued shortly before the generator voltage is expected to be in phase with the busbar voltage (to compensate for the circuit breaker make time).

Auto synchronization by electronic speed control provides the possibility of bringing the generator voltage in phase with the busbar voltage and thereafter closing the breaker with near zero deviation in frequency and phase.

When speed is corrected by relay signals, the auto synchronization function is configured with stability and deadband. Stability defines the magnitude of the control signal as a function of the actual frequency deviation (between the generator and busbar voltage), while the deadband defines the frequency deviation required for the auto synchronizer to regulate. When operating by the speed relay the auto synchronizing function will alter the engine speed to obtain a small positive frequency deviation between the generator and busbar voltage. The automatic synchronizing function will then issue the signal to close the circuit breaker shortly before it expects zero phase deviation between the generator and busbar voltage. The closure signal is issued prior to the moment of zero phase deviation in order to compensate for the make time of the circuit breaker.

The frequency deviation and circuit breaker closure time parameters are only used when the speed control is configured to operate by the speed relay. A low setting for the frequency deviation provides high accuracy, but will increase the time required to synchronize the generator. A high setting provides quick synchronization but might cause more wear and tear on the breaker contacts. The circuit breaker closure time must be set according to the breaker specification (breaker make time).

The auto synchronization function is a bit more advanced when speed control is done by electronic output. The speed feed back feature of an electronic governor makes it possible for the auto synchronization function to keep the generator in phase with the bus bar (without closing the breaker). In this case the synchronization will alter the frequency only to obtain close to zero phase deviation; where after the auto synchronization function can close the breaker at will. When configured for governor control by electronic output, the condition for closing the breaker is defined by tolerated phase deviation. A narrow phase deviation windows will provide accurate but slow synchronization, while a wider window provides speed at the cost of wear and tear on the breaker contacts.

The PID parameters (only used with electronic voltage control) works in conjunction with the stability parameter. Stability will affect the magnitude of the control signal when the phase deviation is outside a +/-45 deg. window, while the P-parameter determines the magnitude of the control signal when the phase deviation is small. Both stability and the P-parameter operate as a function of the frequency and phase deviation. The I-parameter can be used to slow down the regulation (by increasing I). The D-parameter is seldom used and should be left at the default setting.

The auto synchronization function can be configured to close on dead bus. The dead bus facility includes external I/O signals to prevent simultaneous dead bus connection of two or more generators.

A synchronization time parameter is provided for the purpose of automation. An error will be issued through the LED of the C/B Close relays if the synchronization is not completed within the synchronization time.

3.6 Check Synchronizer

The check synchronizer function offers the possibility of closing the circuit breaker automatically during manual synchronization. The condition for closing the breaker is defined by tolerated phase deviation.

3.7 Active Load Sharing

Active load sharing is initiated the moment that the circuit breaker is closed. The active load sharer function will increase/decrease engine speed (and thereby generator frequency) to make the generator take or release active current/load. The S6100 module will balance the active current/load based on a DC voltage communicated through the kW parallel lines. This DC voltage can be adapted to suit other types of active load sharers (e.g. SELCO T4800 or T4400).

The active load sharer is configured with load deviation, stability and deadband. The load deviation parameter is used to balance out small load deviations, which might be caused by inaccuracy within the external current transformers. Stability determines the magnitude of the speed control signal as a function of deviation in the balance of active current/load. A low stability setting will provide minimal overshoot and relatively slow balancing of the active current/load, while a high stability setting gives fast regulation with risk of overshoot (instability). The deadband simply defines the amount of load deviation required before the active load sharing kicks in.

The kW parallel lines can be adjusted to operate with any voltage in the range of -6 to +6 V DC. The voltage range of the parallel lines is programmable in order to ensure compatibility with other types of SELCO load sharers.

The active load sharing function includes the feature of unloaded trip. When activated (through the unload input) the active load sharer will decrease speed at a predefined rate (100 to 0% load). The S6100 module will then trip the breaker automatically when the pre-programmed trip level is reached (provided that the reactive current/load has also been unloaded). The active load sharing function ramps up at with the same ramp time (when the unload signal is removed).

The PID parameters (only used with electronic speed control) works in conjunction with the stability parameter. Stability will affect the magnitude of the control signal when the deviation in load is relatively large, while the P-parameter determines the magnitude of the control signal when the deviation is small. Both stability and the P-parameter operate as a function of the load deviation. The I-parameter can be used to slow down the regulation (by increasing I). The D-parameter is seldom used and should be left at the default setting. Please note that for active load sharing, deadband is also active with electronic speed control.

The active load sharing function can be disabled.

3.8 Reactive Load Sharing

Reactive load sharing is initiated the moment that the circuit breaker is closed. The reactive load sharer will increase generator voltage to make the generator take reactive current/load, and decrease generator voltage to release reactive current/load. The S6100 module will balance the reactive current/load based on a DC voltage communicated through the kVAr parallel lines. This DC voltage can be adapted to suit other types of reactive load sharers (e.g. SELCO T4900).

The reactive load sharer is configured with load deviation, stability and deadband. The load deviation parameter is used to balance out small load deviations, which might be caused by inaccuracy within the external current transformers. Stability determines the magnitude of the voltage control signal as a function of deviation in the reactive current/load balance. A low stability setting will provide minimal overshoot and relatively slow balancing of the reactive current/load, while a high stability setting gives fast regulation with risk of overshoot and instability. The deadband simply defines the amount of load deviation required before the reactive load sharing kicks in.

The kVAr parallel lines can be adjusted to operate with any voltage in the range of -6 to +6 V DC. The voltage range of the parallel lines is programmable in order to ensure compatibility with other types of SELCO load sharers.

The reactive load sharing function includes the feature of unloaded trip. When activated (through the unload input) the reactive load sharer will decrease speed at a predefined rate (100 to 0% load). The S6100 module will then trip the breaker automatically when the pre-programmed trip level is reached (provided that the active current/load has also been unloaded). The reactive load sharing function ramps up at with the same ramp time (when the unload signal is removed).

The PID parameters (only used with electronic voltage control) works in conjunction with the stability parameter. Stability will affect the magnitude of the control signal when the deviation in load is relatively large, while the P-parameter determines the magnitude of the control signal when the deviation is small. Both stability and the P-parameter operate as a function of the load deviation. The I-parameter can be used to slow down the regulation (by increasing I). The D-parameter is seldom used and should be left at the default setting. Please note that for reactive load sharing, deadband is also active with electronic speed control.

The reactive load sharing function can be disabled.

4 System Preparation

4.1 CAN Bus Address

The 4-point dip-switch located on the right hand side of the S6000 module is used to set the CAN bus address. The CAN bus address is set as a binary value on 4 ON/OFF switches. Valid CAN bus address are 1 to 15.

The CAN bus address should be set according to the generator reference number, thus the CAN address of an S6000 module and its partner S6100 should be the same.

It is advisable to assign address 1 to the first pair of S6000/S6100 modules, number 2 to the second pair etc. S6500 user interface modules can be set to any address in the range 1 to 15. However, it is typically most practical to set a single S6500 to number 1. S6600 or S6610 Power Manager modules should be configured with address 1.

Each pair of S6000 and S6100 modules must be assigned a unique CAN bus address.

The binary system works on the principle described below.

- Switch 1 represents the decimal value 1
- Switch 2 represents the decimal value 2
- Switch 3 represents the decimal value 4
- Switch 4 represents the decimal value 8

As an example, the address 1 is assigned by setting switch 1 to ON and the remaining switches to OFF. Address 10 is assigned by setting switch 2 and 4 to ON and switch 1 and 3 to OFF. The decimal value corresponds to the sum of the values ON switch values.

5 Installation

The S6100 module is secured to the rear of the switch board using four 4 mm. (3/16”) screws. DIN rail mounting is not advisable due to the weight of the module.

Please ensure that there is enough space around the module so that the plug-in terminals and RS232 connector can be removed and reinserted. The length of the cables should also allow for the easy removal and insertion of the plug-in terminals. Access to the dip-switches located at the lower right hand corner of the unit might also be necessary.

6 Connection

The S6100 module is connected using plug-in terminals. The plug-in terminals provide safe and durable connection without sacrificing ease of installation and servicing.

Wires should be good quality with a reasonable low internal resistance. It is advisable to use colour coding, as this makes trouble shooting and servicing far easier.

Please ensure that all wires are stripped properly and that the screws of the plug-in terminal rest on the copper and not on the insulation. Insufficient wire stripping is a frequent cause for poor connections.

6.1 Power Supply

The electronics of the S6100 module is powered by two individual supplies, the primary and the backup supply. Both the primary and the backup supply operate on a nominal voltage of +24 V DC.

The S6100 module is capable of operating on both or either one of the two supplies. However, an alarm will be raised if the backup supply fails. Furthermore, each supply will tolerate wide variations in the supply voltage, as required by the marine classification societies.

The primary supply occupies terminal 1 and 2 of the *POWER SUPPLY* plug-in connectors, while the backup supply occupies terminal 3 and 4.

Terminal	Description	Signal	Connection
1	PRIMARY SUPPLY +	+24 V DC	Positive terminal of primary supply
2	PRIMARY SUPPLY -	-24 V DC	Negative terminal of primary supply
3	BACKUP SUPPLY +	+24 V DC	Positive terminal of backup supply
4	BACKUP SUPPLY -	- 24 V DC	Negative terminal of backup supply

The primary and backup supplies are isolated from each other and from the remaining electronics of the module. This means that the supply reference terminals (terminal 2 and 4) have no connection to the modules COM terminals.

The primary and backup supply is designed to cope with relative large voltage fluctuations, as required by the marine classification societies. However, please note that some marine classification societies require that the S6100 module is powered by the generators voltage. This is easily done through adding an auxiliary +24 V DC supply powered by the generator voltage. Please make sure that the auxiliary supply is able to cope with the power demand.

6.1.1 Primary Supply

The switch board +24 V DC power supply system is typically used as the source of the primary supply.

The front folio Primary Supply LED illuminates with a steady green light to indicate that the supply voltage is OK and within the limits of safe operation. A failure of the primary supply will cause the Primary Supply LED to turn off (after a brief delay).

6.1.2 Backup Supply

The engine starter battery or the switch board +24 V DC backup power supply system is typically used as the source of the backup supply.

The front folio Backup Supply LED illuminates with a steady green light to indicate that the supply voltage is OK and within the limits of safe operation. A failure of the backup supply will cause the backup Supply LED to turn off (after a brief delay) and the ALARM relay to de-energize.

6.2 Voltage Inputs

The AC voltages connect to the *VOLTAGE INPUTS* plug-in terminal. The S6100 module supports both 3-wire and 4-wire power sources. As an example; busbars supplied by land based generators are typically 4-wired, while marine based generators typically use 3-wired.

The voltage inputs can operate with high voltage (up to 690 VAC nominal), so precaution must be taken to avoid electrical shock and personal injury. Do not touch the *VOLTAGE INPUTS* plug-in terminal unless you are absolutely sure that power source is off (e.g. all the generator are stopped and blocked against starting).

Voltages above 690 VAC are supported through use of external transformers (PT's). When using PT's it is important to ensure that the PT's do not affect the phase of the voltage measurement. Phase shift in the PT's will directly affect the calculation of the power factor, and thereby the calculation of active and reactive current/load.

The S6100 measures the individual phase-phase voltage between phases L1 and L2, L2 and L3 and L3 and L1. Phase-neutral voltages are also measured on 4-wire sources, while on 3-wire sources the phase-neutral voltages are estimated based on the assumption that loads are distributed equally among the three phases.

Terminal	Description	Signal	Connection
L1	VOLTAGE INPUTS L1	AC voltage	Busbar phase L1
L2	VOLTAGE INPUTS L2	AC voltage	Busbar phase L2
L3	VOLTAGE INPUTS L3	AC voltage	Busbar phase L3
N	VOLTAGE INPUTS N	Neutral	Busbar Neutral (optional)

The three phases of the source L1, L2 and L3 should be connected to L1, L2 and L3 of the *VOLTAGE INPUTS* plug-in terminal. Intermediate 2 A slow-blow fuses should be inserted between the individual phases and the related voltage inputs. It is very important that the phases are connected in the correct order. Interchanging the phases will affect the measurements. It is very import that the three phases are connected to the corresponding terminals (phase 1 to L1, phase 2 to L2 and phase 3 to L3).

Connection of the neutral terminal (terminal N) is optional. The neutral terminal (terminal N) is isolated from the remaining electronics of the module. This means that the neutral terminal have no connection to the modules COM terminals.

The VOLTAGE OK LED shows whether or not the voltage levels measured between each of the three phases are within limits. The reference is the nominal phase-phase voltage (NOMVOLT). The voltage levels are compared to the limits defined by the voltage OK window (VOLTOKWND) of the configuration. The VOLTAGE OK LED will flash if generator is not on voltage and the busbar is live.

The PHASE OK LED will ignite (steady green light) to indicate that the phase sequence is correct. However, the S6100 module is not able to verify that the each phase is connected to the correct terminal. The S6100 module cannot detect the difference between L1-L2-L3, L3-L1-L2 and L2-L3-L1. The S6100 module can only verify that 120 degrees displacement exist between the three phases. The PHASE OK LED requires a “reasonable” level of voltage to become operational.

The best way to ensure correct connection is to follow the wire all the way from the phase copper rail to the specific terminal within the *VOLTAGE INPUTS* plug-in connector.

6.3 Sync

The *SYNC* plug-in terminal provides a synchronization signal from the partner S6000 module.

The synchronization signal is used by the S6100 module to determine the zero crossing of the alternator voltage AC curves. This time critical information is required by the S6100 module in order to do automatic synchronization.

The synchronization signal is based on dedicated non-isolated RS485 interface. Thus, wiring must be done according to standard RS485 requirements.

Terminal	Description	Signal	Connection
1	SYNC A	RS485 A	Terminal 1 of the partner S6000 SYNC
2	SYNC B	RS485 B	Terminal 2 of the partner S6000 SYNC
3	COM	COM	Terminal 3 of the partner S6000 SYNC

The wires from terminal 1 and 2 should be twisted. A 150 ohm termination resistor must be placed between terminal 1 and 2 (directly at the plug-in terminal) to prevent signal reflections. Terminal 1 must be connected to terminal 1 of the *SYNC* terminal on the partner S6000 module. Likewise terminal 2 must be connected to terminal 2 of the *SYNC* terminal on the partner S6000 module. Lastly, terminal 3 must be connected between the *SYNC* terminals of both modules. Terminal 3 will also serve as the common COM connection between the S6100 and the S6000 module.

6.4 I/O

The *I/O* plug-in connector houses a number of digital and analogue inputs. The digital inputs works with negative reference, meaning the inputs are considered active when at COM level and inactive when left open (disconnected). The analogue signals use negative reference as well, which means that the analogue voltages (e.g. 0 - 1 V DC signals) must have COM as reference.

Terminal	Description	Signal	Connection
1	UNLOAD	NO contact to COM	External switch, output or relay
2	F/V CTRL. DISABLE	NO contact to COM	External switch, output or relay
3	VOLT. IN	DC voltage	External output (-1 to 1 V DC)
4	FREQ. IN	DC voltage	External output (-1 to 1 V DC)
5	C/B CLOSE BLOCK	NO contact to COM	External switch, output or relay

6.4.1 Unload

The *UNLOAD* input is used to do a ramped unload of the generator before the breaker is tripped. *UNLOAD* is typically initiated from an external switch. Unload starts once the *UNLOAD* signal is put to COM level. Disconnecting the *UNLOAD* signal causes reconnection of the generator, where after the load is applied by ramp.

6.4.2 F/V Ctrl. Disable

The *F/V CTRL. DISABLE* input is used to deactivate the voltage and frequency stabilization of the S6100 module. The signal is considered active when the input is connected to COM level, and inactive when left open. The signal is typically used when the generator is operated in parallel with a shaft generator or the grid (power sources that determines the voltage and frequency), or when the voltage and frequency is controlled by external equipment (through the *VOLT. IN* and *FREQ. IN* analogue inputs).

6.4.3 Volt. In

The *VOLT. IN* input is an analogue input. The input can be used for external control of the generator voltage, provided that the *F/V CTRL. DISABLE* input is active (connected to COM). The analogue control signal must be a voltage between -1 and 1 V DC. The *VOLT. IN* input uses the COM terminal as reference. If not used, the *VOLT. IN* input should be connected to COM. This is especially important while the *F/V CTRL. DISABLE* input is active.

6.4.4 Freq. In

The *FREQ. IN* input is an analogue input. The input can be used for external control of the generator frequency, provided that the *F/V CTRL. DISABLE* input is active (connected to COM). The analogue control signal must be a voltage between -1 and 1 V DC. The *FREQ. IN* input uses the COM terminal as reference. If not used, the *FREQ. IN* input should be connected to COM. This is especially important while the *F/V CTRL. DISABLE* input is active.

6.4.5 C/B Close Block

The *C/B CLOSE BLOCK* can be used to disable the closure of the circuit breaker. The input is active when at COM level and inactive if left open. The *C/B CLOSE BLOCK* will not prevent auto synchronization, it will only prevent closure of the circuit breaker (activation of the *C/B CLOSE* relay). Thus, the C/B CLOSE BLOCK input is handy during test and commissioning (e.g. to test auto synchronization without closing the breaker).

6.5 C/B

The terminals of the relays intended for closing and tripping the circuit breaker (closing by auto synchronization and tripping by the busbar protection functions) is on the *C/B* plug-in connector. The built-in C/B close relay has two contact sets and is normally de-energized by default. The C/B trip relay has two contact sets and is also normally de-energized by default. Note that the C/B trip relay can be reconfigured to be normally energized operation.

Terminal	Description	Signal	Connection
1	C/B CLOSE 1	Relay de-energized position	Breaker remote close
2	C/B CLOSE 2	Relay contact	Signal source
3	C/B CLOSE 3	Relay energized position	Breaker remote close
4	C/B TRIP 4	Relay de-energized position	Breaker remote trip

5	C/B TRIP 5	Relay contact	Signal source
6	C/B TRIP 6	Relay energized position	Breaker remote trip

The C/B close relay connects to the remote close control input of the generator circuit breaker. Terminal 1 and 3 is typically not connected at the same time. Only one of this signals are taken to the breaker, depending on whether the C/B close relay is configured for normally de-energized or energized operation.

The C/B trip relay connects to the remote trip control input of the generator circuit breaker. Terminal 4 and 6 is typically not connected at the same time. Only one of this signals are taken to the breaker, depending on whether the C/B trip relay is configured for normally de-energized or energized operation.

6.6 Relay Contacts

The *RELAY CONTACTS* plug-in connector includes the terminals of the two built-in toggling relays necessary to control relay operated speed governors and/or AVRs (or motor/electronic potentiometers). The toggling relays can also be reconfigured for external frequency and/or voltage control. The last relay is the general alarm relay that will de-energize on system faults.

Terminal	Description	Signal	Connection
1	SPEED +	Relay position 1	Governor speed increase
2	SPEED REF	Relay contact (toggle)	Governor ref
3	SPEED -	Relay position 2	Governor speed decrease
4	VOLT +	Relay position 1	AVR voltage increase
5	VOLT REF	Relay contact (toggle)	AVR ref
6	VOLT -	Relay position 2	AVR voltage decrease
7	ALARM 1	Relay de-energized position	ALARM signal
8	ALARM 2	Relay contact	Signal source
9	ALARM 3	Relay energized position	All OK signal

6.6.1 Speed +/-

The speed relay is a toggling relay, which means that the relay contact is disconnected from both positions (1 and 2) when the speed/frequency regulation rests. When in operation, the S6100 module will toggle the relay between position 1 and 2. The duration of the relay pulses, and the rest time between pulses, will depend on the speed/frequency deviation as well as the configuration of the controlling function.

6.6.2 Volt +/-

The volt relay is a toggling relay, which means that the relay contact is disconnected from both positions (1 and 2) when the voltage regulation rests. When in operation, the S6100 module will toggle the relay between position 1 and 2. The duration of the relay pulses, and the rest time between pulses, will depend on the voltage deviation as well as the configuration of the controlling function.

6.6.3 Alarm

The ALARM includes two contact sets. The alarm relays can only operate as a normally energized relay. This is to ensure that the ALARM relay will trip in case both supplies fail.

6.7 Analogue Outputs

Two sets of analogue outputs are provided on-board of the S6100 module. The analogue outputs are intended for direct control of electronic speed governors and/or AVR's. Each of the two outputs can be individually configured to provide a DC voltage, current or PWM signal in relation to the speed or voltage control.

Each analogue output can be configured to provide a DC voltage within the range of -10 to +10 V DC, a DC current within the range of 0 to 20 mA or a PWM signal with a default base frequency of 500 Hz. The outputs are isolated from each other and from the remaining electronics of the module. This means that the references of the outputs have no connection to each other or to the common reference (COM) of the module.

Terminal	Description	Signal	Connection
1	ANALOG OUTPUT 1 VDC	DC voltage	Governor voltage input
2	ANALOG OUTPUT 1 mA	DC current	Governor current input
3	ANALOG OUTPUT 1 PWM	PWM signal	Governor PWM input
4	ANALOG OUTPUT 1 REF	reference (isolated)	Governor reference
5	ANALOG OUTPUT 2 VDC	DC voltage	AVR voltage input
6	ANALOG OUTPUT 2 mA	DC current	AVR current input
7	ANALOG OUTPUT 2 PWM	PWM signal	AVR PWM input
8	ANALOG OUTPUT 2 REF	reference (isolated)	AVR reference

It is important to note that each analogue output is protected against short-circuit by an internal 10 kOhm resistor. The resistor is placed in series on the output terminal. The output resistor might affect the magnitude of the output signal if the internal resistance of the driven equipment is low. The principle of voltage division applies between the output resistor and the internal resistance of the driven equipment. Example: equipment with an internal resistance of only 10 kOhm would reduce a +10 V DC output voltage to +5 VDC. The two 10 kOhm resistors in series would make up a 1:2 voltage divider. Likewise, the amplitude of the PWM signal is limited to +8 V DC.

Speed control is done either by the speed relay described elsewhere in this manual, or by the electronic outputs described above. The same applies to the voltage control. It is of cause possible to do speed control by electronic output, while doing voltage control by relays - and opposite. The mode of control and also be mixed among the parallel operating generators.

6.8 Manual I/O & COM

The S6100 module can be switched into manual mode. When in manual, all control of both speed and voltage will stop - the speed and voltage relays will stop operation and the analogue outputs will stay at the present levels. Inputs are provided for manual external control of both speed and voltage.

The *C/B Trip Cause & COM* plug-in terminal also houses a COM terminal.

Terminal	Description	Signal	Connection
1	MANUAL CTRL.	NO contact to COM	External switch, output or relay
2	SPEED INCR.	NO contact to COM	External push-button, output or relay
3	SPEED DECR.	NO contact to COM	External push-button, output or relay
4	VOLT INCR.	NO contact to COM	External push-button, output or relay

5	VOLT DECR.	NO contact to COM	External push-button, output or relay
6	COM	Common reference	External reference

The manual control signals has no function when the *MANUAL CTRL.* signal is active.

6.9 Par Lines

The signals of the parallel lines plug-in connector is used for balancing the active and reactive current/load between multiple S6100 modules. The signal levels of the parallel lines can also be adapted to suit other types of SELCO load sharers (e.g. the SELCO T-series).

Terminal	Description	Signal	Connection
1	KW BALANCE	DC voltage	KW BALANCE of other S6100 modules
2	COM	Common reference	COM of the other S6100 modules
3	KVAR BALANCE	DC voltage	KVAR BALANCE of other S6100 modules

6.10 RS485

The S6100 module includes an isolated RS485 interface.

Terminal	Description	Signal	Connection
1	REF	Reference (isolated)	Reference of the RS485 bus
2	A	RS485 A	A signal of the RS485 bus
3	B	RS485 B	B signal of the RS485 bus

It is important to note that the RS485 reference is isolated from the common COM of the module.

The 3-wires RS485 bus is connected from module to module.

A termination resistor of 150 ohm must be connected between terminal 2 and 3 at each end of the RS485 bus, preferably directly on the RS485 bus plug-in connector of the first RS485 slave and on the master.

The maximum cable length is 1000 meters. The cable type should be 0.25 - 0.34 mm^2 (AWG23/AWG22). Wires for A and B must be twisted (twisted-pair).

6.11 CAN Bus

The CAN bus is the backbone of the SIGMA system. The CAN bus carries all the measured and calculated parameters between the modules.

Terminal	Description	Signal	Connection
1	COM	Common reference	Reference of the CAN bus
2	CAN L	CAN Lo (data)	CAN Lo signal of the CAN bus
3	-	-	-
4	CAN H	CAN Hi (data)	CAN Hi signal of the CAN bus
5	-	-	-

Terminals 3 and 5 are not used.

The CAN L, CAN H and COM wires starts at one end of the total network, a termination resistor of 124 Ohm is connected between CAN L and CAN H, preferably directly on the CAN bus plug-in connector. The cable is connected form SIGMA module to SIGMA module, without T connections. On the other end of the cable again a 124 Ohm terminator resistor is connected between the CAN lines.

The maximum cable length is 40 meters. The cable type should be 0.25 - 0.34 mm^2 (AWG23/AWG22). Wires for CAN Lo and CAN Hi must be twisted (twisted-pair). The reference COM must be interconnected between all modules and the cable should be shielded. The shield must only be connected to chassis/ground at one end.

Every SIGMA module of the installation must be connected to the same CAN bus network. Third party CAN nodes may not be connected to the SIGMA CAN bus.

6.12 Auxiliary I/O

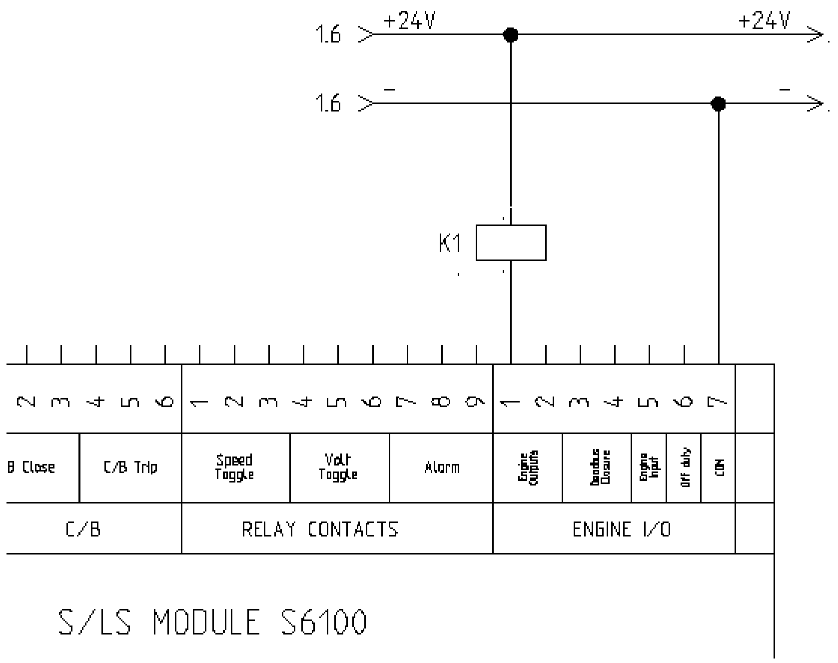
The auxiliary I/O plug-in connector houses general purpose I/O signals.

The Inputs are considered activated when connected to COM, inactive when open.

The outputs are open collector outputs. An open collector output works as an electronic contact to COM.

Please note that the COM terminals are isolated from the power supplies. Therefore it is necessary to connect the minus of the power supply that supplies the equipment that is to be used with the open collector output, with one of the COM terminals of the SIGMA module.

Example: In case a relay is to be activated by an open collector output, the minus of the power supply of this relay must be connected with one of the COM terminals of the SIGMA Module. This power supply must be 24V DC.



Terminal	Description	Signal	Connection
1	ENGINE START	Open collector output	Engine Controller start input
2	ENGINE STOP	Open collector output	Engine Controller start input
3	DB OUT	Open collector output	DB IN/OUT of other S6100
4	DB IN	NO contact to COM	DB IN/OUT of other S6100
5	ENGINE FAILED	NO contact to COM	Engine Controller fail output
6	OFF DUTY	NO contact to COM	External switch, output or relay
7	COM	Common reference	External reference

6.12.1 Engine Start

The Engine Start outputs can be controlled either from the RS485 MODBUS, or from the optional S6600 module. The signal is typically used to start the generator.

6.12.2 Engine Stop

The Engine Stop outputs can be controlled either from the RS485 MODBUS, or from the optional S6600 module. The signal is typically used to stop the generator.

6.12.3 DB Out

The DB Out signal is together with in DB In input. These two signals are used to prevent simultaneous closure to dead bus among multiple S6100 modules. All DB Out and DB In terminals should be connected to a common point in the installation, preferably with wires of equal length.

6.12.4 DB In

The DB In input is together with in DB Out signal. These two signals are used to prevent simultaneous closure to dead bus among multiple S6100 modules. All DB Out and DB In terminals should be connected to a common point in the installation, preferably with wires of equal length.

6.12.5 Engine Failed

The Engine Failed input is used by the optional S6600 module to determine if the generator has failed (e.g. on engine error).

6.12.6 Off Duty

The Off Duty input is used in conjunction with the optional S6600 module. The input is used as external request to set the generator off duty (e.g. for servicing).

7 Configuration

The S6100 module can be configured in three different ways. This section describes the configuration by RS232, as this method of configuration does not require the use of additional modules (the S6500 or S6600). The S6100 module will however require a partner S6000 module, as the S6000 provides many of the basic parameters required by the S6100.

The S6100 module is delivered with a default configuration.

7.1 PID Regulation

The S6100 module includes a total of six independent PID regulators. The PID regulators are only used when the modules is configured for electronic control (e.g. control by voltage, current or PWM signal). There is one PID controller for each of the following functions.

- Frequency Stabilization
- Voltage Stabilization
- Auto-Synchronization
- Voltage Matching
- Active Load Sharing
- Reactive Load Sharing

7.1.1 Proportional control parameter (P)

The proportional control parameter (P) determines the strength of the control signal as a function of the deviation (the difference between the actual value and the target value). Too much P will make the control unstable (hunting) and too little P will disable the control all together. The correct P setting will make the control responsive with no instability. I should be noted that Stability parameter works in a similar way. Stability operates as P when the deviation is large, while P is used at smaller deviations.

7.1.2 Integrator control parameter (I)

The integrator control parameter (I) works as a delay. It provides the “patience” of the system as it allows the system to wait for a response (change in the actual value) before it proceeds to step up the control signal. A large I will slow down the response of the system, but it may be necessary if the response of the speed control or voltage regulator is slow.

7.1.3 Differentiator control parameter (D)

This parameter is not used and should be left at its default setting.

7.2 Console Password

By default the RS232 console will operate in read only mode. The console can be switched to read/write mode by the enable command.

ENABLE

Enable mode will prompt for a pin code. The default pin code is 0000.

The console can be switched back to read only mode by the disable command.

DISABLE

Please note that the RS232 console pin code is separate for each module. Also, the RS232 pin code is independent from the menu pin code of the UI or PM module.

7.3 System Settings

The first thing to do is to configure the S6100 to fit the controls of the generator (including the speed governor and the automatic voltage regulator).

7.3.1 Power-up Delay

The power-up delay determines the time between generator start-up (generator on voltage) and initiation of regulation (when the S6100 will begin frequency and voltage stabilization). The power-up delay should be set so that the generator has time to “settle” before the S6100 starts regulation of the speed and voltage.

The power-up delay is expressed in seconds without decimals. The power-up delay is set by the following command. The resolution is 1 s.

WRITE SYS POWERUPDELAY *duration*

7.4 Voltage OK Window

The S6100 module needs to verify whether or not the busbar voltage is OK - that is whether or not the voltage level on each of the three phase-phase voltages are within limits.

The voltage window defines the boundaries around (+/-) the nominal voltages which the module regards are acceptable for safe operation. The VOLTAGE OK LED will be lit provided that all three phase-phase voltage measurements are within the limits defined by the voltage window.

The voltage window is configured by the following command. The resolution is 1 %.

WRITE SYS VOLTOKWND <Voltage Window>

7.5 Speed Control

Speed control can be done using either increase/decrease relay signals or analogue output 1. The contact signals are well suited for control of either a conventional governor or a motorized/electronic potentiometer. Alternatively speed control can be done by analogue output 1 using a voltage, current or PWM signal. The analogue speed output is intended for direct control of an electronic speed governor.

The S6100 speed regulator can reconfigured to operate as a frequency control signal (e.g. for remote control of other S6100 modules through the FREQ IN input).

A minimum pulse time defines the minimum closure time for the relay contacts; likewise min/max references define the operational range of analogue output. The S6100 speed regulator is configured using the following commands.

7.5.1 Speed control enabled

The speed control can be enabled or disabled by following command.

WRITE SYS SPEEDCTRL ENABLED <Choice>

The choice can be YES or NO. The speed control function is required for frequency control, synchronizing and load sharing.

In case the speed control is not used it should be disabled.

7.5.2 Mode

The mode of operation is either governor control or frequency output. The choice can be either GOVCTRL or FREQOUT.

WRITE SYS SPEEDCTRL MODE <Choice>

7.5.3 Output

The output can be either the speed increase/decrease relay contacts or analogue output 1. The choice can be set to SPEEDRELAY or ANAOUT1.

WRITE SYS SPEEDCTRL OUT <Choice>

7.5.4 Minimum Pulse Duration

The minimum pulse duration determines the duration of the shortest possible speed control pulse. The pulse duration setting is only in use when speed control is done by relays. Resolution is 1 ms.

WRITE SYS SPEEDCTRL MINPULSE <Duration>

Setting the parameter too low will result in slow regulation, while a high setting will result in overshoot on the speed regulation.

7.5.5 Duty Cycle

The duty cycle parameter is only used when the speed control is done by relays. The duty cycle defines the minimum duration of the pulse and the rest time until the next pulse is issued. Resolution is 0.1 s.

WRITE SYS SPEEDCTRL DUTYCYCLE <Duration>

Setting the duty cycle too low might result in overshoot and instability with a slow reacting (lagging) governor. A high setting might slow down the regulation.

7.5.6 Analogue Signal

The speed control by analogue output 1 can be configured to operate with either a DC voltage, current or a PWM signal. The type of output signal is set by the following command. Choice can be VOLT, CUR or PWM.

WRITE SYS SPEEDCTRL ANAOUT SIGNAL <Choice>

The *signal* can be set to *VOLT*, *CUR* or *PWM*. The default setting is *VOLT*.

7.5.7 Voltage Range

The voltage minimum and maximum references define the lower and upper limits of the voltage output signal. These parameters are only used when speed control is done by analogue output and when the analogue signal has been set to voltage. The resolution is 0.001 V DC.

WRITE SYS SPEEDCTRL ANAOUT VOLTMIN <Voltage>

WRITE SYS SPEEDCTRL ANAOUT VOLTMAX <Voltage>

7.5.8 Current Range

The current minimum and maximum references define the lower and upper limits of the current output signal. These parameters are only used when speed control is done by analogue output and when the analogue signal has been set to current. The resolution is 0.001 mA.

WRITE SYS SPEEDCTRL ANAOUT CURMIN <Current>

WRITE SYS SPEEDCTRL ANAOUT CURMAX <Current>

7.5.9 PWM Settings

The PWM settings describe the properties of the pulse-width modulated (PWM) output signal. These settings are only used when speed control is done by analogue output and when the analogue signal has been set to PWM.

The resolution of the PWM base frequency is 1 Hz.

WRITE SYS SPEEDCTRL PWMOUT FREQ <Frequency>

The PWM maximum reference defines the amplitude of the PWM signal (0 VDC being the minimum reference). The resolution is 0.001 V DC.

WRITE SYS SPEEDCTRL PWMOUT VOLTMAX <Voltage>

7.6 Voltage Control

Voltage control can be done using either increase/decrease relay signals or analogue output 2. The contact signals are well suited for control of either a conventional governor or a motorized/electronic potentiometer. Alternatively speed control can be done by analogue output 2 using a voltage, current or PWM signal. The analogue voltage output is intended for direct control of an electronic AVR.

The S6100 voltage regulator can reconfigured to operate as a voltage control signal (e.g. for remote control of other S6100 modules through the VOLT IN input).

A minimum pulse time defines the minimum closure time for the relay contacts; likewise min/max references define the operational range of analogue output. The S6100 voltage regulator is configured using the following commands.

7.6.1 Voltage control enabled

The voltage control can be enabled or disabled by following command.

WRITE SYS VOLTCTRL ENABLED <Choice>

The choice can be YES or NO. The voltage control function is required for voltage regulation, voltage matching and reactive load sharing.

In case the voltage control is not used it should be disabled.

7.6.2 Mode

The mode of operation is either AVR control or voltage output. The choice can be either AVRCTRL or VOLTOUT.

WRITE SYS VOLTCTRL MODE <Choice>

7.6.3 Output

The output can be either the speed increase/decrease relay contacts or analogue output 2. The choice can be set to VOLTRELAY or ANAOUT2.

WRITE SYS VOLTCTRL OUT <Choice>

7.6.4 Minimum Pulse Duration

The minimum pulse duration determines the duration of the shortest possible voltage control pulse. The pulse duration setting is only in use when voltage control is done by relays. Resolution is 1 ms.

WRITE SYS VOLTCTRL MINPULSE <Duration>

Setting the parameter too low will result in slow regulation, while a high setting will result in overshoot on the voltage regulation.

7.6.5 Duty Cycle

The duty cycle parameter is only used when the voltage control is done by relays. The duty cycle defines the minimum duration of the pulse and the rest time until the next pulse is issued. Resolution is 0.1 s.

WRITE SYS VOLTCTRL DUTYCYCLE <Duration>

Setting the duty cycle too low might result in overshoot and instability with a slow reacting (lagging) AVR. A high setting might slow down the regulation.

7.6.6 Analogue Signal

The voltage control by analogue output 2 can be configured to operate with either a DC voltage, current or a PWM signal. The type of output signal is set by the following command. Choice can be VOLT, CUR or PWM.

WRITE SYS VOLTCTRL ANAOUT SIGNAL <Choice>

The *signal* can be set to *VOLT*, *CUR* or *PWM*. The default setting is *VOLT*.

7.6.7 Voltage Range

The voltage minimum and maximum references define the lower and upper limits of the voltage output signal. These parameters are only used when voltage control is done by analogue output and when the analogue signal has been set to voltage. The resolution is 0.001 V DC.

WRITE SYS VOLTCTRL ANAOUT VOLTMIN <Voltage>

WRITE SYS VOLTCTRL ANAOUT VOLTMAX <Voltage>

7.6.8 Current Range

The current minimum and maximum references define the lower and upper limits of the current output signal. These parameters are only used when voltage control is done by analogue output and when the analogue signal has been set to current. The resolution is 0.001 mA.

WRITE SYS VOLTCTRL ANAOUT CURMIN <Current>

WRITE SYS VOLTCTRL ANAOUT CURMAX <Current>

7.6.9 PWM Settings

The PWM settings describe the properties of the pulse-width modulated (PWM) output signal. These settings are only used when voltage control is done by analogue output and when the analogue signal has been set to PWM.

The resolution of the PWM base frequency is 1 Hz.

WRITE SYS VOLTCTRL PWMOUT FREQ <Frequency>

The PWM maximum reference defines the amplitude of the PWM signal (0 VDC being the minimum reference). The resolution is 0.001 V DC.

WRITE SYS VOLTCTRL PWMOUT VOLTMAX <Voltage>

7.7 Protection

Voltage and frequency establish protection is provided for monitoring the bus bar.

7.7.1 Voltage Establishment Protection

The voltage establishment protection can be enabled or disabled. This is done by the following command. The choice can be set to either *YES* or *NO*.

WRITE PROTECT VE ENABLED <Choice>

The lower trip level is expressed in percent without decimals. The trip level refers to the nominal phase-phase voltage. The lower trip level is set by the following command. Resolution is 1 %.

WRITE PROTECT VE LOWLEVEL <Level>

The upper trip level is expressed in percent without decimals. The trip level refers to the nominal voltage. The upper trip level is set by the following command. Resolution is 1 %.

WRITE PROTECT VE UPLEVEL <Level>

The lower delay is expressed in seconds with one decimal. The delay is set by the following command. Resolution is 0.1 s.

WRITE PROTECT VE LOWDELAY <Duration>

The upper delay is expressed in seconds with one decimal. The delay is set by the following command. Resolution is 0.1 s.

WRITE PROTECT VE UPDELAY <Duration>

7.7.2 Frequency Establishment Protection

The frequency establishment protection can be enabled or disabled. This is done by the following command. The choice can be set to either *YES* or *NO*.

WRITE PROTECT FE ENABLED <Choice>

The lower trip level is expressed in percent without decimals. The trip level refers to the nominal phase-phase voltage. The lower trip level is set by the following command. Resolution is 1 %.

WRITE PROTECT FE LOWLEVEL <Level>

The upper trip level is expressed in percent without decimals. The trip level refers to the nominal voltage. The upper trip level is set by the following command. Resolution is 1 %.

WRITE PROTECT FE UPLEVEL <Level>

The lower delay is expressed in seconds with one decimal. The delay is set by the following command. Resolution is 0.1 s.

WRITE PROTECT FE LOWDELAY <Duration>

The upper delay is expressed in seconds with one decimal. The delay is set by the following command. Resolution is 0.1 s.

WRITE PROTECT FE UPDELAY <Duration>

7.7.3 Frequency Deviation Protection

The frequency deviation protection can be enabled or disabled. This is done by the following command. The choice can be set to either *YES* or *NO*.

WRITE PROTECT FD ENABLED <Choice>

The trip level is expressed in hertz per second with one decimal. The lower trip level is set by the following command. Resolution is 0.1 Hz.

WRITE PROTECT FD LEVEL <Level>

7.7.4 PM Start (pre-start of generator in case of bus bar fault)

The PM START function can be enabled or disabled. This is done by the following command. The choice can be set to either *YES* or *NO*. In default configuration this function is disabled.

WRITE PROTECT PMSTART <Choice>

7.8 Frequency Stabilization

The frequency stabilization feature ensures that the generator frequency is kept at a fixed level. The frequency control facility uses the rated frequency as its reference. The frequency stabilization feature will compensate for frequency deviations caused by change in active load.

7.8.1 Stability

The stability parameter determines the response of the frequency stabilization. The response determines how much signal is provided to the governor and thereby how quickly the frequency is stabilized as a function of the actual deviation in frequency. A low setting will result in slow but accurate stabilization, while a high setting provide fast regulation with the potential risk of overshoot and instability. Stability is expressed as a number without decimals. Stability is set by the following command. Resolution is 1.

WRITE FREQSTAB STABILITY <Value>

7.8.2 Deadband

The deadband parameter is only used when the speed adjustment is configured to operate with the speed relay. The deadband parameter determines the responsive range of the frequency stabilization feature. The frequency stabilization function will only attempt to correct the frequency if it is outside the deadband. A deadband which is too narrow will cause constant fine tuning of the frequency, while an overly wide deadband will cause deviation according to the reference (rated frequency). The deadband is expressed in percent with one decimal and is set by the following command. Resolution is 0.1 %.

WRITE FREQSTAB DEADBAND <Percentage>

7.8.3 PID

The PID parameters are only used when the speed adjustment is configured to operate with the analogue output signal. The P (proportional) parameter is expressed as a gain factor and is set by the following command. Resolution is 0.1.

WRITE FREQSTAB PID P <Factor>

The I (integral) parameter is expressed in milliseconds and is set by the following command. Resolution is 1 ms.

WRITE FREQSTAB PID I <Duration>

The D (differential) parameter is expressed in milliseconds and is set by the following command. Resolution is 1 ms.

WRITE FREQSTAB PID D <Duration>

7.9 Auto Synchronizing

The configuration of the auto synchronizing function depends on whether the speed control is done by the speed relay (increase/decrease contacts) or by analogue output 1. The difference exists due to the fact that synchronization by conventional and electronic speed governor works according to different principles. A generator controlled by an electronic governor can be locked in phase, while this is not possible with conventional speed control.

The main difference in the configuration is that the relay driven operation is configured with frequency difference and circuit breaker close time, while the analogue control is configured with close angle.

7.9.1 Check Synchonizer function

The check synchronizer function offers the possibility of closing the circuit breaker automatically during manual synchronization. The condition for closing the breaker is defined by tolerated phase deviation.

The function can be disabled or enabled. Choice can be YES or NO.

WRITE AUTOSYNC CHKSYNC <Choice>

In default configuration this function is disabled.

7.9.2 Dead Bus Closure

The dead bus closure function provides the possibility of closing the circuit breaker when no voltage exists between either one of the three phases (on the busbar). The dead bus closure function requires the connection of the DB IN and DB OUT I/O signals. These two signals are used to prevent simultaneous closure by two or more S/LS modules. The dead bus closure function can be disabled or enabled. Choice can be YES or NO.

WRITE AUTOSYNC DBCLOSE <Choice>

7.9.3 Stability

Stability defines the response of the auto synchronizer. The auto synchronizer will alter the frequency in order to obtain the required frequency and phase deviation, or in case of electronic governor control, in order to obtain zero frequency and phase deviation. The auto synchronizer changes the frequency by increasing or decreasing engine speed through control of the speed governor. The magnitude of the governor control signals, compared to the actual deviation in frequency, is determined by the synchronizer stability parameter. Too much stability provides accurate but slow synchronization, while too little stability introduces the risk of overshoot and instability. Stability is expressed as a number without decimals. Stability is set by the following command. Resolution is 1.

WRITE AUTOSYNC STABILITY <Value>

7.9.4 Deadband

The deadband parameter is only used when the speed adjustment is configured to operate with with the speed relay. The deadband parameter determines the responsive range of the auto synchronizer. The synchronizer will only attempt to correct the frequency while is outside the deadband (compared to the frequency on the bus bar). A deadband which is too narrow will cause constant fine tuning of the frequency, while an overly wide deadband will cause deviation according to the reference. The deadband is expressed in percent with one decimal and is set by the following command. Resolution is 0.1 %.

WRITE AUTOSYNC DEADBAND <Percentage>

7.9.5 Frequency Deviation

The frequency deviation parameter is only used when the speed adjustment is configured to the speed relay. This parameter describes the tolerated frequency deviation at breaker closure. Setting this parameter to high might stress the breaker and generator. A low setting will however make the synchronization procedure a lengthy process. The frequency deviation is expressed in Hz with one decimal. The parameter is set by the following command. Resolution is 0.1 Hz.

WRITE AUTOSYNC FREQDEV <Frequency>

7.9.6 Phase Deviation

The phase deviation is only used when the speed adjustment is configured to use analogue output 1. This parameter describes the tolerated phase deviation for closing the circuit breaker. The phase deviation is expressed in degrees without decimals. The parameter is set by the following command. Resolution is 1 deg.

WRITE AUTOSYNC PHASEDEV <Degrees>

7.9.7 Circuit Breaker Close Time

The circuit breaker closure time is only used when the speed control is configured to the speed relay. This parameter determines when the actual closure signal is issued to the circuit breaker (through the C/B close relay). Auto synchronization by relay control requires the existence of a small positive frequency deviation, thus in order to compensate for the breaker closure time it is necessary to issue the closure signal just before phase accordance is expected to occur. The circuit breaker closure time is expressed in milliseconds without decimals. The parameter is set by the following command. Resolution is 1 ms.

WRITE AUTOSYNC CBCLOSETIME <Duration>

7.9.8 PID

The PID parameters are only used when the speed adjustment is configured to operate with an analogue output signal. The P (proportional) parameter is expressed as a gain factor and is set by the following command. Resolution is 1.0.

WRITE AUTOSYNC PID P <Factor>

The I (integral) parameter is expressed in milliseconds and is set by the following command. Resolution is 1 ms.

WRITE AUTOSYNC PID I <Duration>

The D (differential) parameter is expressed in milliseconds and is set by the following command. Resolution is 1 ms.

WRITE AUTOSYNC PID D <Duration>

7.10 Active Load Sharing

The S/LS module moves active load to and from the generator by increasing or decreasing the speed (and generator frequency). The active load balance is communicated two a set of “parallel lines” that operates with a pre-configured DC voltage. The active load sharer includes a bonus feature of de-loaded trip together with programmable ramp-up and ramp-down of active load.

7.10.1 Load Deviation

The load deviation parameter can be used to fine tune the balance of the active load sharing. Imbalance might occur due to inaccuracy within the current transformers etc. The load deviation is set according to ideal zero deviation. The parameter is expressed as a percentage without decimals. The parameter has reference to perfect balance. Resolution is 1%.

WRITE ACTLS LOADDEV <Percentage>

7.10.2 Stability

Stability defines the response of the active load sharer. The active load sharer will alter the active load (by altering the frequency) in order to obtain the required load balance. The active load sharer changes the active load level by increasing or decreasing engine speed through the governor. The magnitude of the governor control signals, compared to the actual deviation in active load, is determined by the stability parameter. Too mush stability provides accurate but slow load sharing, while too little stability introduces risk of overshoot and instability. Stability is expressed as a number without decimals. Stability is set by the following command. Resolution is 1.

WRITE ACTLS STABILITY <Value>

7.10.3 Deadband

The deadband parameter determines the responsive range of the active load sharer. The active load sharer will only attempt to outbalance the deviation in active load when deviation falls outside the deadband (compared to the pre-configured load deviation). A deadband which is too narrow will cause constant fine tuning of the active load balance, while an overly wide deadband will cause deviation according to the reference. The deadband is expressed in percent with one decimal and is set by the following command. Resolution is 0.1 %.

WRITE ACTLS DEADBAND <Percentage>

7.10.4 Parallel Lines

The parallel settings of the lines minimum and maximum DC voltage determines the voltage level used to communicate balance in active load between multiple S/LS modules. The voltage range can be changed to obtain compability with e.g. SELCO T4400 or T4800 load sharers. However the default range should be maintained to provide the best possible dynamics. Resolution is 0.1 V DC.

WRITE ACTLS PARLINES VOLTMIN <Voltage>

WRITE ACTLS PARLINES VOLTMAX <Voltage>

7.10.5 Ramp Time

Ramp time defines how quickly the load sharer takes or releases active load. The active load is ramped-up when the active load sharing is enabled. This happened after synchronization or after the unload signal has been released. The load is ramped-down when the unload signal is enabled. The parameters defines the time to go from zero to full load (nominal load), or opposite. The ramp time parameter is expressed in seconds without decimals. Resolution is 1 s.

WRITE ACTLS RAMPTIME <Duration>

7.10.6 Ramp Stability

Ramp stability defines the response of the active load sharer during ramp-up and ramp-down. The active load sharer will alter the active load (by altering the frequency) in order to obtain the required ramp ratio. The active load sharer changes the active load level by increasing or decreasing engine speed through the governor. The magnitude of the governor control signals, compared to the actual deviation in active load, is determined by the ramp stability parameter. Too mush stability provides accurate but slow correction of the ramp ratio, while too little stability introduces risk of overshoot and instability. Ramp stability is expressed as a number without decimals. Ramp stability is set by the following command. Resolution is 1.

WRITE ACTLS RAMPSTABILITY <Value>

7.10.7 CB Trip Level

CB trip level defines the level of active load where, following an unload, the circuit breaker should be automatically tripped. The CB Trip level works in AND relation to the reactive CB Trip level. The CB trip level is expressed in percent without decimals. The trip level is set according to full load (nominal load). Resolution is 1%.

WRITE ACTLS CBTRIPLEVEL <Percentage>

7.10.8 PID

The PID parameters are only used when the speed adjustment is configured to operate with an analogue output signal. The P (proportional) parameter is expressed as a gain factor and is set by the following command. Resolution is 0.1.

WRITE ACTLS PID P <Factor>

The I (integral) parameter is expressed in milliseconds and is set by the following command. Resolution is 1 ms.

WRITE ACTLS PID I <Duration>

The D (differential) parameter is expressed in milliseconds and is set by the following command. Resolution is 1 ms.

WRITE ACTLS PID D <Duration>

7.11 Voltage Stabilization

The voltage control feature ensures that the generator voltage is kept at a fixed level. The voltage control facility uses the nominal phase-phase voltage as reference. The voltage stabilization feature will compensate for voltage deviations caused by change in reactive load.

7.11.1 Stability

The stability parameter determines the response of the voltage stabilisation. The response determines how much signal is provided to the AVR and thereby how quickly the voltage is stabilized as a function of the actual deviation in voltage. A low setting will result in slow but accurate stabilization, while a high setting provide fast regulation with a potential risk of overshoot and instability. Stability is expressed as a number without decimals. Stability is set by the following command. Resolution is 1.

WRITE VOLTSTAB STABILITY <Value>

7.11.2 Deadband

The deadband parameter is only used when the voltage adjustment is configured to operate with the voltage relay. The deadband parameter determines the responsive range of the voltage control feature. The voltage control function will only attempt to stabilize the voltage if it is outside the deadband. A deadband which is too narrow will cause constant fine tuning of the voltage, while an overly wide deadband will cause deviation according to the reference. The deadband is expressed in percent with one decimal and is set by the following command. Resolution is 0.1.

WRITE VOLTSTAB DEADBAND <Percentage>

7.11.3 PID

The PID parameters are only used when the voltage adjustment is configured to operate with the analogue output signal. The P (proportional) parameter is expressed as a gain factor and is set by the following command. Resolution is 0.1.

WRITE VOLTSTAB PID P <Factor>

The I (integral) parameter is expressed in milliseconds and is set by the following command. Resolution is 0.1 ms.

WRITE VOLTSTAB PID I <Duration>

The D (differential) parameter is expressed in milliseconds and is set by the following command. Resolution is 0.1 ms.

WRITE VOLTSTAB PID D <Duration>

7.12 Voltage Matcher

The S/LS module includes voltage matching, which can be enabled or disabled. Voltage matching can automatically bring the voltage within the range specified by the Voltage OK Window. The S/LS module will control the voltage by the AVR. If enabled, voltage matching will be conducted before automatic synchronization is initiated. The voltage matching function is configured with stability and deadband. Stability determines the response of the voltage control signal as a function of voltage deviation, while the deadband defines the active area of regulation. PID parameters are provided for tuning the voltage matcher when it controls an electronic AVR.

7.12.1 Stability

The stability parameter determines the response of the voltage matching function. The response determines how much signal is provided to the AVR and thereby how quickly the voltage is brought into the permitted operational area (compared to the Voltage OK Window). A low setting will result in slow but accurate correction, while a high setting provide fast correction with a potential risk of overshoot and instability. Stability is expressed as a number without decimals. Stability is set by the following command. Resolution is 1.

WRITE VOLTMATCH STABILITY <Value>

7.12.2 Deadband

The deadband parameter is only used when the voltage adjustment is configured to operate with relays. The deadband parameter controls the accuracy of the voltage matching function. The voltage matching function will only attempt to correct the voltage if the is outside the voltage OK window, plus/minus the deadband. A deadband which is too narrow will cause constant fine tuning of the AVR, while an overly wide deadband will cause an inaccurate setting. The deadband is expressed in percent with one decimal and is set by the following command. Resolution is 0.1 %.

WRITE VOLTMATCH DEADBAND <Percentage>

7.12.3 PID

The PID parameters are only used when the voltage adjustment is configured to operate with an analogue output signal. The P (proportional) parameter is expressed as a gain factor and is set by the following command. Resolution is 0.1.

WRITE VOLTMATCH PID P <Factor>

The I (integral) parameter is expressed in milliseconds and is set by the following command. Resolution is 1 ms.

WRITE VOLTMATCH PID I <Duration>

The D (differential) parameter is expressed in milliseconds and is set by the following command. Resolution is 1 ms.

WRITE VOLTMATCH PID D <Duration>

7.13 Reactive Load Sharing

The S/LS module moves reactive load to and from the generator by increasing or decreasing the voltage. The reactive load balance is communicated two a set of “parallel lines” that operates with a pre-configured DC voltage. The load sharer includes a bonus feature of programmable ramp-up and ramp-down of reactive load.

7.13.1 Load Deviation

The load deviation parameter can be used to fine tune the balance of the reactive load sharing. Imbalance might occur due to inaccuracy within the current transformers etc. The load deviation is set according to ideal zero deviation. The parameter is expressed as a percentage without decimals. The parameter has reference to perfect balance. Resolution is 1%.

WRITE REACTLS LOADDEV <Percentage>

7.13.2 Stability

Stability defines the response of the reactive load sharer. The reactive load sharer will alter the reactive load (by altering the voltage) in order to obtain the required load balance. The reactive load sharer changes the reactive load level by increasing or decreasing generator voltage through the AVR. The magnitude of the AVR control signals, compared to the actual deviation in reactive load, is determined by the stability parameter. Too mush stability provides accurate but slow load sharing, while too little stability introduces risk of overshoot and instability. Stability is expressed as a number without decimals. Stability is set by the following command. Resolution is 1.

WRITE REACTLS STABILITY <Value>

7.13.3 Deadband

The deadband parameter determines the responsive range of the reactive load sharer. The reactive load sharer will only attempt to outbalance the deviation in reactive load when deviation falls outside the deadband (compared to the pre-configured load deviation). A deadband which is too narrow will cause constant fine tuning of the reactive load balance, while an overly wide deadband will cause deviation according to the reference. The deadband is expressed in percent with one decimal and is set by the following command. Resolution is 0.1 %.

WRITE REACTLS DEADBAND <Percentage>

7.13.4 Parallel Lines

The parallel settings of the lines minimum and maximum DC voltage determines the voltage level used to communicate balance in active load between multiple S/LS modules. The voltage range can be changed to obtain compability with e.g. SELCO T4900 VAr load sharer. However the default range should be maintained to provide the best possible dynamics. Resolution is 0.1 V DC.

WRITE REACTLS PARLINES VOLTMIN <Voltage>

WRITE REACTLS PARLINES VOLTMAX <Voltage>

7.13.5 Ramp Time

Ramp time defines how quickly the load sharer takes or releases reactive load. The reactive load is ramped-up when the reactive load sharing is enabled. This happened after synchronization or after the unload signal has been released. The load is ramped-down when the unload signal is enabled. The parameters defines the time to go from zero to full load (nominal load), or opposite. The ramp time parameter is expressed in seconds without decimals. Duration is 1 s.

WRITE REACTLS RAMPTIME <Duration>

7.13.6 Ramp Stability

Ramp stability defines the response of the reactive load sharer during ramp-up and ramp-down. The reactive load sharer will alter the reactive load (by altering the voltage) in order to obtain the required ramp ratio. The reactive load sharer changes the reactive load level by increasing or decreasing voltage through the AVR. The magnitude of the AVR control signals, compared to the actual deviation in reactive load, is determined by the ramp stability parameter. Too mush stability provides accurate but slow correction of the ramp ratio, while too little stability introduces risk of overshoot and instability. Ramp stability is expressed as a number without decimals. Ramp stability is set by the following command. Resolution is 1.

WRITE REACTLS RAMPSTABILITY <Value>

7.13.7 CB Trip Level

CB trip level defines the level of reactive load where, following an unload, the circuit breaker should be automatically tripped. The CB Trip level works in AND relation to the active CB Trip level. The CB trip level is expressed in percent without decimals. The trip level is set according to full load (nominal load). Resolution is 1 %.

WRITE REACTLS CBTRIPLEVEL <Percentage>

7.13.8 PID

The PID parameters are only used when the voltage adjustment is configured to operate with an analogue output signal. The P (proportional) parameter is expressed as a gain factor and is set by the following command. Resolution is 0.1.

WRITE REACTLS PID P <Factor>

The I (integral) parameter is expressed in milliseconds and is set by the following command. Resolution is 1 ms.

WRITE REACTLS PID I <Duration>

The D (differential) parameter is expressed in milliseconds and is set by the following command. resolution is 1 ms.

WRITE REACTLS PID D <Duration>

7.14 I/O & Relays

This part of the configuration determines the functions and properties of the relays. The relays can be configured for normal de-energized or energized operation. Non-latching relays can also be configured with regard to reset delay.

7.14.1 Alarm Relay Function

The alarm relay can be configured to signal either system alarm or system and protection alarms.

The relay function is set by the following command. The choice can be either SYS or SYSPROT.

WRITE IORELAYS ALARMRELAYFUNC <Choice>

7.14.2 C/B Trip Relay

The C/B trip relay can be configured for normally de-energized or normally energized operation. The command to set this property is as follows. Choice can be ND or NE.

WRITE IORELAYS CBTRIP CONTACT <Choice>

7.14.3 Start Signal

This function is only active in connection with a S6600 or S6610 PM Module. The output is the start signal to the engine. It can be programmed to be continous (active as long as the engine is running) or a pulse signal.

WRITE IORELAYS STARTSIGNAL <Choice>

Choice can be CONT or PULSE, default is pulse.

7.14.4 Start Pulse

This function is only active in connection with a S6600 or S6610 PM Module. In case the start signal is programmed as a pulse signal, the length of the pulse can be programmed by following command:

WRITE IORELAYS STARTPULSE <ms>

The range can be between 100ms and 5000ms. The resolution is 1ms and default is 1000ms

7.14.5 Start Time Out

This function is only active in connection with a S6600 or S6610 PM Module. After S6100 has issued the start command to the generator it expects the voltage to be built up within the Start Time Out delay. If the generator does not build up voltage, S6100 will generate an ENGINE START ERROR and the Power Manager Module will issue a start command to the next stand by generator. The length of this delay can be defined by following command:

WRITE IORELAYS STARTTIMEOUT <s>

The range of this delay is between 0 and 5000s. The resolution is 1s and the default setting is 10s.

7.14.6 Stop Signal

This function is only active in connection with a S6600 or S6610 PM Module. The output is the stop signal to the engine. It can be programmed to be continous (active as long as the engine is stopped) or a pulse signal.

WRITE IORELAYS STOPSIGNAL <Choice>

Choice can be CONT or PULSE, default is pulse.

7.14.7 Stop Pulse

This function is only active in connection with a S6600 or S6610 PM Module. In case the stop signal is programmed as a pulse signal, the length of the pulse can be programmed by following command:

WRITE IORELAYS STOPPULSE <ms>

The range can be between 100ms and 5000ms. The resolution is 1ms and default is 1000ms

7.14.8 Cool Down Time

This function is only active in connection with a S6600 or S6610 PM Module.

With this command the cool down time for the engine can be defined. The cool down time is the time the engine continues running after the circuit breaker has been tripped.

The length of the cool down time can be programmed by following command:

WRITE IORELAYS COOLDOWN <s>

The range of this delay is between 0 and 10000s. The resolution is 1s and the default setting is 5s.

7.15 Grid parallel operation/ power import

During grid parallel operation it is necessary to assign one pair S6000/ S6100 to the grid. This unit must be connected across the tie breaker. The parameters mentioned under are only relevant for the S6100 module assigned to the grid. For more detailed information regarding grid parallel operation please see manual “S6100 Paralleling with grid or shaft” on the SELCO internet page.

7.15.1 Power Import

In case power shall be imported from the grid into the system, the power import function has to be enabled. This can be done by following command:

WRITE SYS PWRIMPORT ENABLED <Choice>

The choice can be YES or NO, default is NO.

7.15.2 Power Import Max

With this command the maximum limit of power to be imported can be defined as a percentage of the capacity defined in the S6000 module assigned to the grid.

WRITE SYS PWRIMPORT MAX <Value>

The range is between 1 and 100, the resolution is 1% and the default value is 100%.

7.15.3 Power Import Mode

With this command the import mode can be defined:

WRITE SYS PWRIMPORT MODE <Choice>

The choice can be FIXED or PEAK, default is FIXED.

“FIXED” means that a fixed amount of power (defined by the command PWRIMPORT VALUE) will be imported from the grid.

“PEAK” means that all load above a certain value (defined by the command PWRIMPORT VALUE) will be imported from the grid.

7.15.4 Power Import Value

With power import mode configured to FIXED this command defines how much power will be imported from the grid. The amount of power is expressed as a percentage of the rated power defined in the S6000 module assigned to the grid.

With power import mode configured to PEAK this command defines the maximum load of the connected generators. This max load level is expressed as a percentage of the rated power of the connected generators and defined by the command PWRIMPORT VALUE. In case the installation requires more power than defined by this parameter, all excess power will be imported from the grid.

WRITE SYS PWRIMPORT VALUE <value>

The value can be between 1 and 100, the resolution is 1% and default is 25%.

7.16 Grid parallel operation/ power export

During grid parallel operation it is necessary to assign one pair S6000/ S6100 to the grid. This unit must be connected across the tie breaker. The parameters mentioned under are only relevant for the S6100 module assigned to the grid. For more detailed information regarding grid parallel operation please see manual “S6100 Paralleling with grid or shaft” on the SELCO internet page.

7.16.1 Power export

In case power shall be exported to the grid, the power export function has to be enabled. This can be done by following command:

WRITE SYS PWREXPORT ENABLED <Choice>

The choice can be YES or NO, default is NO.

7.16.2 Power Export Max

With this command the maximum limit of power to be exported can be defined as a percentage of the capacity defined in the S6000 module assigned to the grid.

WRITE SYS PWREXPORT MAX <Value>

The range is between 1 and 100, the resolution is 1% and the default value is 100%.

7.16.3 Power Export Mode

With this command the export mode can be defined:

WRITE SYS PWREXPORT MODE <Choice>

The choice can be FIXED or EXCESS, default is FIXED.

“FIXED” means that a fixed amount of power (defined by the command PWREXPORT VALUE) will be exported to the grid.

“EXCESS” means that all power above a certain value (defined by the command PWREXPORT VALUE) will be exported to the grid.

7.16.4 Power Export Value

With power export mode configured to FIXED this command defines how much power will be exported to the grid. The amount of power is expressed as a percentage of the rated power defined in the S6000 module assigned to the grid.

With power export mode configured to EXCESS this command defines the load of the connected generators. This load level is expressed as a percentage of the rated power of the connected generators and defined by the command PWREXPORT VALUE. In case the installation requires less power than defined by this parameter, all excess power will be exported to the grid.

WRITE SYS PWREXPORT VALUE <value>

The value can be between 1 and 100, the resolution is 1% and default is 25%.

7.17 Powersource

This command defines if the S6100 module is assigned to an auxiliary generator (or any power source that allows the S6100 to control its speed), a shaft generator or the grid.

WRITE SYS POWERSOURCE <Choice>

The choice can be AUXILIARY, SHAFT OR GRID, default is AUXILIARY.

7.18 Dutyhour

This command defines the running hours of the generator set. It is used in connection with the S6600 or S6610 PM Module for the Duty Hour start stop scheme.

When the generator is running, S6100 will count the running hourson this parameter. It is possible to assign the amount of running hours. This is necessary when the control equipment of an older generatyor will be replaced by S6100 or after a firmware upgrade of the S6100 module.

The amount of running hours can be defined by following command:

WRITE SYS DUTYHOUR <value>

The value is the amount of running hours. The range can be between 0 and 999999. The resolution is 1h and the default value is 0.

7.19 Priority

This parameter is only relevant in connection with the S6600 or S6610 PM Module. It defines the start/ stop priority for the generators.

The priority can be assigned by following command:

WRITE SYS PRIORITY <Value>

The value can be between 1 and 15, the resolution is 1 and default is 1.

7.20 RS485

The RS485 communication interface can be configured with regard to MODBUS slave address, baud rate, data bit, parity and stop bits. It is important to ensure that the address is unique on the bus and that the remaining parameters are set according to specifications.

The MODBUS slave address is set by the following command.

WRITE RS485 ADDRESS <Addr>

The data transmission rate is defined by the baud rate, which is set as follows.

WRITE RS485 BAUDRATE <Baudrate>

The parity can be set by the following command.

WRITE RS485 PARITY <Parity>

The number of data bits is set as follows.

WRITE RS485 DATABITS <Databits>

The number of stop bits is set as follows.

WRITE RS485 STOPBITS <Stopbits>

In case the data from the MODBUS master is send irregular (compared to MODBUS specification) it is possible to adjust a delay for detection of the end of the MODBUS frame send by the master. Following command is used for that:

WRITE RS485 TXDELAY [0-2552] (0)

The range is between 0 and 2552ms. Default is 0ms.

In case the frames send by the MODBUS master comply with the MODBUS specifications it is not necessary to change this parameter (it can remain in default setting).

7.21 Restoring to factory default configuration

The factory default configuration can be restored at any time by issuing the command:

WRITE SYS SETUPDEFAULT YES

The default configuration is then restored after the power to the module has been turned off and on.

8 Specifications

Primary Supply:	+24 V DC (-30 % / +30 %) Isolated
Backup Supply:	+24 V DC (-30 % / +30 %) Isolated
Busbar phase-phase voltage (BPPV):	63 to 690 VA C (-2 % / +2 %) three phased, default 400 V AC
Busbar phase-neutral voltage (BPNV):	BPPV / √3 (measured only with neutral connection)
Frequency Stabilization	
On/Off Control:	By F/V Disable input
Conventional Speed Control	
Stability:	Pulse duration as a function deviation from rated frequency (GRF) 1 to 100, default 10
Deadband:	+/- offset around rated frequency (GRF) where no regulation occurs to 0.1 % to 20.0 %, default 0.2 %
Electronic Speed Control	
Stability:	Ramp rate used before optimized PID control is released 1 to 100, default 10
P:	Proportional control, 1.0 to 20.0, default 4.0
I:	Integral control, 0 to 100 ms, default 10 ms
D:	Derivative control, 0 to 100 ms, default 1 ms
Voltage Stabilization	
On/Off Control:	By F/V Disable input
Conventional AVR	
Stability:	Pulse duration as a function deviation from nominal voltage (GPPV) 1 to 100, default 5
Deadband:	+/- offset around nominal voltage (GPPV) where no regulation occurs, 0.1 % to 20.0 %, default 0.2 %
Electronic AVR	
Stability:	Ramp rate used before optimized PID control is released 1 to 100, default 5
P:	Proportional control, 1.0 to 20.0, default 1.0
I:	Integral control, 0 to 100 ms, default 10 ms
D:	Derivative control, 0 to 100 ms, default 1 ms
Voltage Matching	
On/Off Control:	By configuration
Conventional AVR	
Stability:	Pulse duration as a function deviation from actual busbar voltage 1 to 100, default 5
Deadband:	+/- offset around actual busbar voltage, where no regulation occurs, 0.1 % to 20.0 %, default 5.0 %
Electronic AVR	
Stability:	Ramp rate used before optimized PID control is released 1 to 100, default 5
P:	Proportional control, 1.0 to 20.0, default 1.0
I:	Integral control, 0 to 100 ms, default 10 ms
D:	Derivative control, 0 to 100 ms, default 1 ms
Auto-Synchronization	
Dead Bus Closure:	3 phase (configurable)
On/Off Control:	By Manual input
C/B Close Disable:	By C/B Block input
Conventional Speed Control	
Stability:	Pulse duration as a function deviation from busbar frequency 1 to 100, default 1
Deadband:	+/- offset around deviation from busbar frequency, where no regulation occurs, 0.1 to 20.0 %, default 1.0 %

Frequency Deviation:	Tolerated frequency deviation from busbar voltage when breaker is closed +0.1 to +10.0 Hz, default +0.2 Hz
C/B Close time:	Anticipated closure time of the circuit breaker 1 to 1000 ms, default 80 ms
Electronic Speed Control	
Stability:	Ramp rate used before optimized PID control is released 1 to 100, default 1
Phase Deviation:	Tolerated phase deviation from busbar voltage when breaker is closed 1 to 15 degrees, default 5 degrees
P:	Proportional control, 1.0 to 20.0, default 6.0
I:	Integral control, 0 to 100 ms, default 10 ms
D:	Derivative control, 0 to 100 ms, default 1 ms
Active Load Sharing	
On/Off Control:	By Manual input or by configuration
Load Deviation:	Offset compared to 50/50 balance in active load -100 to 100 %, default 0 %
Parallel Lines:	Communication of active load balance to other load sharers ±6.0 to ±6.0 V DC, default 0.0 to +6.0 V DC
Ramp Time:	Time to ramp up/down from zero to max. or max. to zero active load 1 to 100 s, default 20 s
C/B Trip Level:	Level of active load for automatic trip of C/B (at de-loaded trip) 1 to 50 %, default 5 %
Conventional Speed Control	
Stability:	Pulse duration as a function of deviation in active load balance 1 to 100, default 5
Deadband:	+/- offset around dev. from active load balance, where no regulation occurs, 0.1 to 20.0 %, default 2.0 %
Electronic Speed Control	
Stability:	Ramp rate used before optimized PID control is released 1 to 100, default 5
Deadband:	+/- offset around dev. from active load balance, where no regulation occurs, 0.1 to 20.0 %, default 2.0 %
P:	Proportional control, 1.0 to 20.0, default 1.0
I:	Integral control, 0 to 100 ms, default 10 ms
D:	Derivative control, 0 to 100 ms, default 1 ms
Reactive Load Sharing	
On/Off Control:	By Manual input or by configuration
Load Deviation:	Offset compared to 50/50 balance in reactive load -100 to 100 %, default 0 %
Parallel Lines:	Communication of reactive load balance to other load sharers ±6.0 to ±6.0 V DC, default 0.0 to +6.0 V DC
Ramp Time:	Time to ramp up/down from zero to max. or max. to zero reactive load 1 to 100 s, default 20 s
Conventional Speed Control	
Stability:	Pulse duration as a function of deviation in reactive load balance 1 to 100, default 5
Deadband:	+/- offset around dev. from reactive load balance where no regulation occurs, 0.1 to 20.0 %, default 2.0 %
Electronic Speed Control	
Stability:	Ramp rate used before optimized PID control is released 1 to 100, default 1
Deadband:	+/- offset around dev. from reactive load balance, where no regulation occurs, 0.1 to 20.0 %, default 2.0 %
P:	Proportional control, 1.0 to 20.0, default 1.0

I:	Integral control, 0 to 100 ms, default 10 ms
D:	Derivative control, 0 to 100 ms, default 1 ms
Governor/Frequency Control	
Function:	Control of speed governor or frequency out signal
Increase/Decrease Relay	
Relay response time:	20 ms (worst case)
Contact set(s):	2 (Increase / decrease)
Contact rating:	AC: 8 A, 250 VAC, DC: 8 A, 35 VDC
Function:	Normally de-energized (at middle position)
Minimum Pulse Duration:	10 to 10000 ms, default 250 ms
Duty Cycle:	0.0 to 25.5 s, default 2.0 s
Analogue Output 1	
DC Voltage:	±10.000 to ±10.000 V DC, default -5.000 to +5.000 V DC
Current:	0.000 to +24.000 mA, default +4.000 to +20.000 mA
PMW:	100 to 32000 Hz / -8.000 to +8.000 V DC, default +8.000 V DC / 500 Hz, nominal duty cycle 50 %
AVR/Voltage Control	
Function:	Control of AVR or voltage out signal
Increase/Decrease Relay	
Relay response time:	20 ms (worst case)
Contact set(s):	2 (Increase / decrease)
Contact rating:	AC: 8 A, 250 VAC, DC: 8 A, 35 VDC
Function:	Normally de-energized (at middle position)
Minimum Pulse Duration:	10 to 10000 ms, default 250 ms
Duty Cycle:	0.0 to 25.5 s, default 2.0 s
Analogue Output 2	
DC Voltage:	±10.000 to ±10.000 V DC, default -5.000 to +5.000 V DC
Current:	0.000 to +24.000 mA, default +4.000 to +20.000 mA
PMW:	100 to 32000 Hz / -8.000 to +8.000 V DC, default +8.000 V DC / 500 Hz, nominal duty cycle 50 %
Frequency In:	External Frequency Control -1.0 to +1.0 VDC
Voltage In:	External Voltage Control -1.0 to +1.0 VDC
C/B Close Relay:	
Relay response time:	20 ms (worst case)
Contact set(s)	1
Contact rating:	AC: 8 A, 250 VAC, DC: 8 A, 35 VDC
Function:	Normally de-energized (Default) or normally energized
C/B Trip Relay:	
Relay response time:	20 ms (worst case)
Contact set(s)	1
Contact rating:	AC: 8 A, 250 VAC, DC: 8 A, 35 VDC
Function:	Normally de-energized (Default) or normally energized
Alarm Relay	
Relay response time:	20 ms (worst case)
Contact set(s)	2
Contact rating:	AC: 8 A, 250 VAC, DC: 8 A, 35 VDC
Function:	Normally energized
Voltage OK	
Level:	0 to 20 % of BPPV, default 10 %
Indication:	Steady light within limits
Phase OK indication	
Indication:	Steady light when all three phases are live and sequence is correct
Power-up delay:	Delay before controls becomes active

	0 to 60 s, default 5 s
CAN Bus	
Connection	Screw terminals, 2-wire with COM (limp back function)
Protocol:	CANOpen derivative
RS232	
Connection:	Customized plug, 4-wire (non-isolated)
Function:	Configuration, Debugging or firmware update
Protocol:	ANSI terminal
Baud rate:	1200, 2400, 4800, 9600 or 19200 baud
Parity:	None, even or odd
Data bits:	7 or 8
Stop bits:	1 or 2
RS485	
Connection:	Screw terminals, 2-wire (isolated)
Protocol:	MODBUS-RTU
Address range	1 to 254
Baud rate:	1200, 2400, 4800, 9600 or 19200 baud
Parity:	None, even or odd
Data bits:	7 or 8
Stop bits:	1 or 2
EMC / EMI tests:	EN 50081-2:1993 (Generic: Residential, commercial & light industry)
	EN 50263:1999 (Product: Measuring relays and protection equipment)
Marine tests:	EN 60945:1997 (Marine: Navigation and radio comm. equipment and systems)
	IACS E10:1997 (IACS unified environmental test specification)
Connections:	Plug-in screw terminals (spring terminals available as option)
Dimensions:	145 x 190 x 64.5 mm (H x W x D)
Weight:	1150 g
Fixation:	Screw mounting (4 pcs. 4.2 x 12 mm)

The specifications are subject to change without notice.