



SGC

operational &  
installation  
manual

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## Introduction and Preparation

Thank you for considering our SGC to control the starter-generator on your aircraft. We believe you'll find the SGC fit and flexible to meet your specific application requirements.

### **Recommended steps**

This manual describes the preparation, installation, configuration, operation and maintenance of the SGC line-replaceable unit. We recommended the following sequence of actions:

1. Decide on which model of SGC to use while taking into consideration the starter-generator, the batteries, the engine, as well as any other requirements for your application.
2. Order the SGC (or any MCU which uses the SGC) and other parts and perform the installation.
3. Update the SGC unit's firmware to the latest version.
4. Familiarize yourself with and adjust the [configuration settings of your SGC](#) as your specific application requires. If unsure email us your configuration file and we'll help you get it set up.
5. Perform the post-installation checks listed under [Maintenance and Diagnostic Checks](#).
6. Perform a dry motor sequence to verify the working of the starter while making a recording via SetView to confirm correct operation and maybe email to us.
7. Perform an engine start and if possible cycle the generator while again doing a live recording of everything. Afterwards inspect the graphs yourself, and maybe email it to us.
8. Based on the recorded graphs if required make new adjustments to configuration settings and repeat step 7 and 8 until satisfied with all aspects of operation.

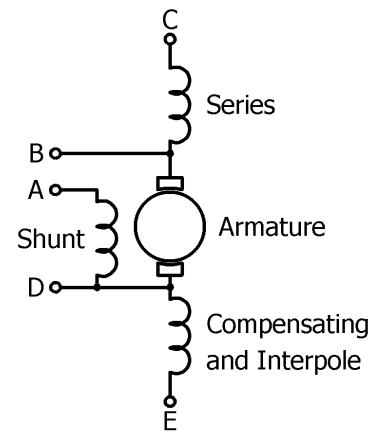
### **Model functionality matrix**

Functionality	SGC-1	SGC-2	SGC-3	SGC-4
Generator control	X	X	X	X
Start control		X	X	X
Parallel-to-series batteries control			X	
Start / motor ignition control				X
Tachometer-generator speed sense		X	X	X
Remote shunt current sense	X	X	X	X
Shunt start field weakening	X	X	X	X

### Starter-generator considerations

The SGC works with 28 VDC generators and starter-generators of various sizes, makes and models.

To the right is a schematic showing the internals of a typical starter-generator with the armature enclosed in brushes connected to four types of field windings (series, shunt, compensating and interpole) and terminals showing typical markings A through E.



Though this represents a starter-generator one would typically find, there are shunt-only ones that have no series winding (no C terminal). There are further also mostly older units that not only have non-standard (A, B, C, etc.) terminal markings than shown here, but do not have the D terminal (or interpole terminal) accessible.

The interpole terminal D provides feedback as to the load current on the starter-generator, whether as starter or as generator. For starter-generators without the interpole terminal, the SGC can, by use of an external shunt, still sense (and control) the load current during generation.

Typically starter-generators perform as a starter motor when DC power is applied on terminal C with respect to terminal E that would be grounded. The series winding thus used will ensure the field thereby established will automatically weaken as the motor increases speed and provide a fixed torque versus speed curve good for starting gas-turbine engines.

Since technology have made it possible to provide field weakening during a start via the shunt winding using a controller like the SGC, starter-generators have come out without the series winding (and C terminal), not only because of the weight, size and complexity savings, but because thereby more power can be transferred more efficiently from battery to starter.



The table below lists some important specifics that can be found on the name-plate and/or from the manufacturer.

Generator current rating (amps)	Normally on the nameplate, this indicates the rated continuous current (amps) it can deliver to the aircraft electrical bus as a generator.
Series field winding (yes/no)	Does the starter-generator have a series field winding traditionally used for starting, and normally marked as terminal C.
Shunt field resistance (ohms)	The resistance of the shunt field in ohms. For starter-generators or generators with typical markings it is measured between terminals A and E on a disconnected unit.
Interpole or "D" terminal (yes/no)	Does the starter-generator have an interpole (D terminal) accessible that can provide feedback as to the current through the starter-generator.
Interpole or "D" terminal voltage at rated generator current	The voltage on the D terminal relative to the E terminal when the rated generator current flows through the starter-generator. This can be obtained from the manufacturer or measured during operation with a current clamp and a voltmeter.

### **Battery considerations**

Aircraft batteries not only serve as a power source to start an engine or multiple engines, whether on the ground or in the air, but function as reliable essential power in the event of a generator failure.

Whether using lead-acid, lithium, or any other type of battery, it is worthwhile to take good care of them, whether discharging, charging or storing them by understanding and complying with the specifications from the battery manufacturer. Here are some key specifications to look out for:

Battery type	Lead acid, lithium iron phosphate, etc.
Voltage	The voltage to be expected on a fully charged battery – nominal voltage.
Capacity	The amp-hours a fully charged battery should last. Note that capacity changes significantly with temperature – lower temperatures, less capacity.
Self-discharge rate	The rate at which a stored battery loses charge over time.
Pulse crank amps (PCA)	The current a battery can provide typically for 3 seconds at 25°C.
Cold crank amps (CCA)	The current a battery can provide at 0°F (-18°C) typically for 30 seconds.
Continuous discharge current	The current a battery can continuously provide.
Maximum charge current	The maximum current a battery can accept to charge it.
Recommended charge current	Recommended maximum charging current for longer battery life.
Maximum charge voltage	The maximum voltage a battery can accept when charging it.

### **Engine considerations**

Some engine applications may require the incorporation of parallel-to-series switched starting for the added starter power it delivers. It is particularly useful for single shaft engines, like the Garrett TPE-331, where the starter must turn not only more mass and inertia but the propeller's drag.

The SGC-3 model will provide completely automated parallel-to-series switched starting for applications that require this particular power versus speed curve. It does so by driving various contactors, taking care when making the switch-overs to open certain ones before closing others to prevent, even momentarily, the short circuiting of the batteries.

In this scheme, when starting, two batteries will be first run in parallel, until either reaching a certain speed or manually triggered, then switched in series to apply twice the voltage, until finally when reaching turbine idle speed switching back to parallel and disengaging the starter.

Parallel-to-series switched starting using the SGC-3 is only available for use with starter-generators with a series field winding, as described under starter-generator considerations.

## Installation

### **Mounting and wiring**

The SGC unit should be mounted as close to the starter-generator as possible without exposing it to excessive heat, preferably within a MCU box. This will enable the wires that can carry a number of amps to be shorter rather than longer.

We recommend using 20 gauge aircraft grade Teflon or Tefzel insulated wire for all wiring to and from the SGC unit or thicker (18, 16 gauge) wire if and where required. We also recommend use of machined contacts (such as 205090-1), with a crimp connector housing (such as 5205207-1) and a connector hood (such as 5207908-7). To crimp the machined contacts you can use the AFM8 crimp tool and K13-1 positioner from DMC, or the less expensive PA1440 crimp tool from Paladin.

Make sure to use correct splicing techniques, to properly insulate any exposed wire, to route and strain-relieve all wires so that they will not chafe against any other object, and to secure all connections. Since improper wiring may cause damage to the SGC and/or the aircraft, we recommend making sure all wires are correctly wired before turning on power.

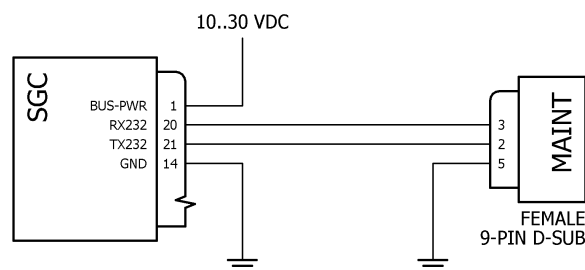
### **Maintenance port connection**

The following connection will power the unit and provide a maintenance interface to allow communication to and from a laptop or tablet PC running our SetView application.

A USB-to-serial converter may be required between the maintenance interface and the laptop.

This allows a user to power the SGC and make adjustments to the unit's configuration settings. It also allows the viewing of the operation in real time of the unit via the SetView Dash display, the making of recordings to verify and troubleshoot the system.

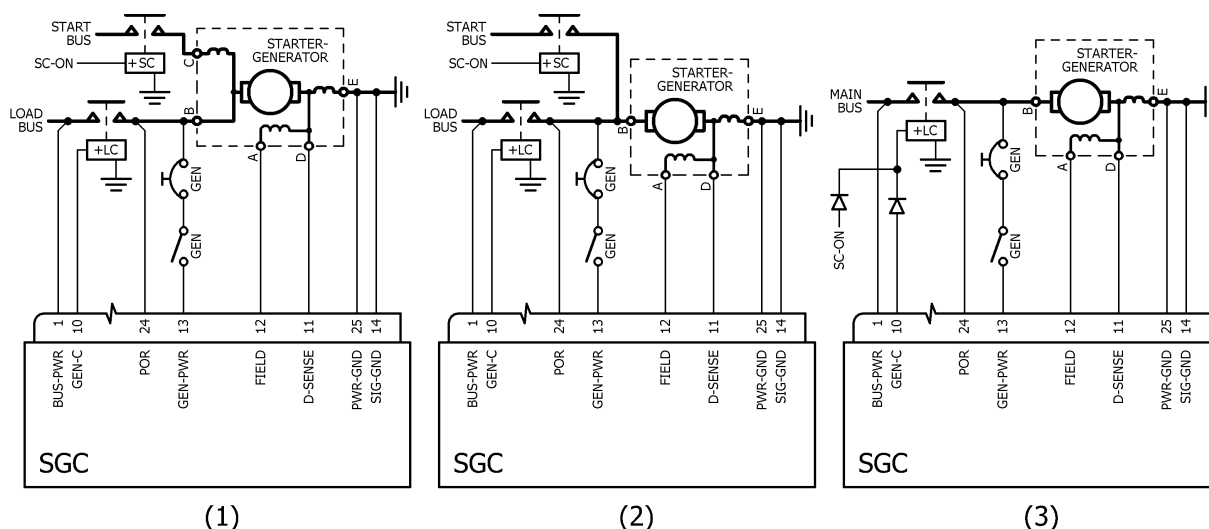
SetView can be freely downloaded from our website.





## Starter-generator connection

The circuits below show how to connect a starter-generator to the aircraft electrical system and a SGC.



Circuit 1 is for series-shunt starter-generators, while 2 and 3 are for shunt-only starter-generators. Circuit 1 and 2 have separate start and load buses, while circuit 3 have these combined into one main bus, where both the starter and the generator is switched to the same bus via the generator (also called line) contactor. All three circuits have a wire named SC-ON that engages the respective starter when powered, and links up to the circuits discussed under [starter control connection](#).

[Contactors](#) and cable/wire used must be able to carry the expected current with as little voltage drop as possible to and from the starter-generator's main terminals B and C, as well as between the starter-generator ground terminal E and aircraft ground.

Two separate wires should connect the SGC to ground, one for PWR-GND (which carries the shunt field return current) and one for SIG-GND. Both can be connected as close to the ground terminal E of the starter-generator as possible.

Wires for BUS-PWR and POR should be connected close to the the line contactor (LC) contacts, one on the load bus or main bus side and the other on the starter-generator side as shown. These wires along with the wire to GEN-PWR should all be separate wires from their origins as shown on the schematic to the SGC unit (similar to the two ground wires).

The GEN circuit-breaker is required in a worst-case scenario failure of the SGC unit's main circuit, to allow secondary circuits within the SGC to completely remove power on GEN-PWR by shorting it to D-SENSE and thereby forcing the circuit-breaker open. If a starter-generator does not have a D terminal, the D-SENSE pin on the SGC should be wired to ground via its own separate wire. See also the section on [circuit-breaker selection](#).

We recommended utilizing a GEN switch as shown, which may be combined with the START ENABLE switch into a single double pole switch as discussed under [starter control connection](#). Though alternatives exist the GEN switch here will enable an operator to force the generator offline and clear a fault that may have been triggered.

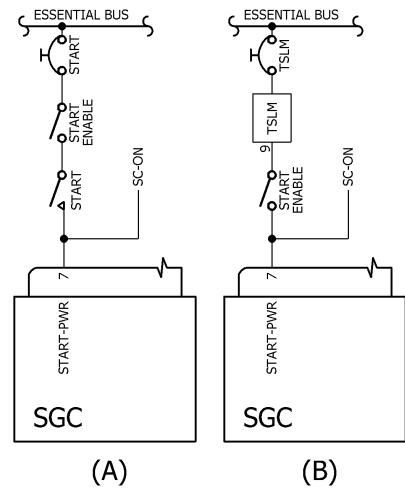
See the section on [diode selection](#) if considering circuit 3 above.

### Starter control connection

For all circuits mentioned in the following section the SC-ON signal wire depicted here links up to the circuits discussed under [starter-generator connection](#).

Circuits A and B show options for SGC-1 starter control where START ENABLE can be optional. In circuit A the starter is controlled via a momentary switch, and in circuit B by a TSLM or similar device.

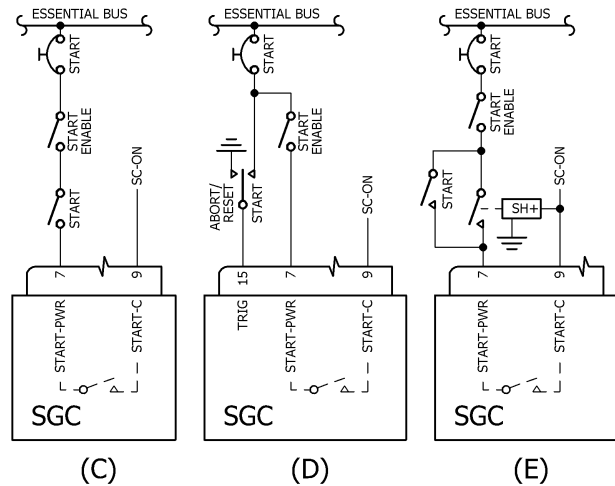
The START ENABLE switch for these and all others (circuits A thru G) can be incorporated with the GEN switch discussed under [starter-generator connection](#) into one double pole switch, which will among other things ensure that for shunt-only starter-generators the SGC will be able to energize the shunt field when a start is initiated. For certain applications the START ENABLE switch may be deemed redundant, since alternative ways to manually abort a start sequence (and motoring sequence) exist.



The SGC-1 units used in circuits A and B have no control over start contactor activation, but they will inhibit generator operation when the START-PWR pin is powered as well as perform shunt field excitation if required.

Circuits C, D and E right give options for starter control of SGC-2 and SGC-3 units that allow the SGC to automatically disengage the starter, as the SC-ON signal now passes through the SGC.

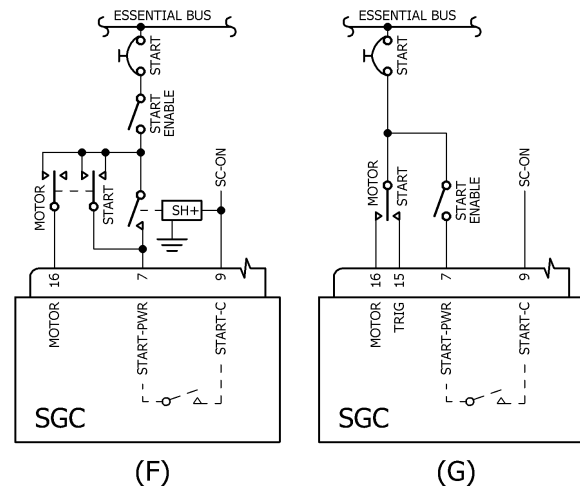
The SGC can be configured to either immediately engage the starter upon application of power to the START-PWR pin or require an additional momentary power application on the TRIG input, such as would be needed for circuit D.



Though more complex with an added relay (SH), circuit E will automatically remove power from the START-PWR pin after a start to ensure that no essential bus power can possibly engage the start contactor after completion of a start.

Circuits F and G show options for starter control of SGC-4 units which allows an operator to select between a start sequence and a motoring operation, which determines [automatic ignition activation](#).

The start hold (SH) relay mentioned in some circuits can be a single pole normally open relay but must be 24 volt and able to handle the current necessary to energize the start contactor (SC) for circuits 1 and 2, or the line contactor (LC) for circuit 3 discussed under [starter-generator connection](#).

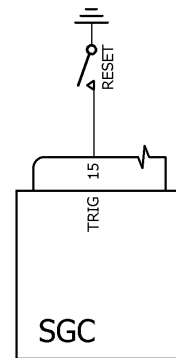


### Manual reset connection

For either an alternative or additional way to manually abort a start sequence, or motoring sequence, or clear a triggered fault, or selectively trip (disengage) a generator, the TRIG input pin may be momentarily grounded as the circuit to the right is an example of.

This function can be integrated into a single (on)-off-(on) switch together with the manual start initiation depicted in [starter control circuit D](#).

For the SGC-4 more ways to manually abort a start or motor sequence are described in section [Pilot control of start and motor sequences](#).



TRIG signal..	WHILE..	RESULT..
Grounded	STARTING	Start sequence terminated / aborted
	MOTORING	Motoring sequence terminated
	GENERATING	Generator disengaged and generator abort fault triggered
	TRIPPED FAULT	Fault cleared and normal operation resumed

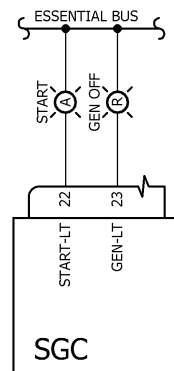
### Annunciation lights connection

The SGC can connect to two external annunciation lights, one an amber one for START (or STARTER) cautioning, and a red one for GEN OFF warning.

Each of these SGC outputs can ground up to 1 amp continuously to turn on its respective external light.

The START light provides indication about starter operation.

The GEN OFF light provides indication about generator operation and fault status.

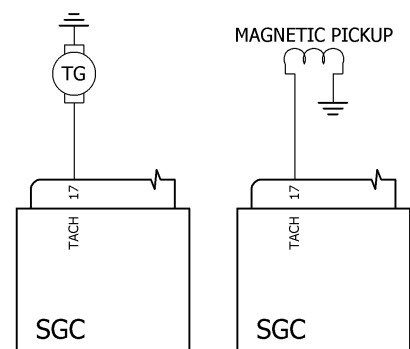


### Speed sensing connection

The SGC-2, SGC-3 and SGC-4 models can read the speed of the starter-generator from either a tachometer-generator (TG) or a magnetic pickup source as shown to the right.

The sensor may be the N1 or N2 tachometer-generator that is coupled via a fixed gears to the starter-generator shaft, or a separate sensor on the starter-generator itself.

To set it up to indicate 100% at the correct input frequency the [Tachometer-Generator Full Speed Frequency](#) must be set. This value reflects the frequency in hertz that represents 100% speed.



The TACH speed connection can be used for [automatic start sequence termination](#) and/or automatic parallel-to-series switch-over, and/or as a useful referencing parameter for recording time graphs via SetView in order to analyze system operation.

See also the section on [Automatic start sequence termination at speed](#) as well as the two configuration settings [Start Termination TACH Speed](#) and [Start Parallel-to-Series Switch-Over TACH Speed](#).

### Remote / battery shunt connection

The SGC can make remote current measurements by connecting to an external shunt (resistor).

Apart from reading the current, it will, if connected to a battery as shown to the left, allow the SGC to control the battery charging current.

This allows the SGC to realize bulk, absorption and float phases when charging a battery, while the generator still supplies other loads with a minimum of 24 volt. For more see the section on [Battery charging profile](#).

A shunt can be inserted either between the LOAD BUS and the START BUS, or between the MAIN BUS and the battery contactor. Note that in the case of the latter, the shunt will also have to carry the starting current, which though typically higher only engages for a limited time.

It is not recommended to place the measurement shunt between the battery and the contactor, since this will drain the battery, though extremely slowly (typically 0.025 mA), when the aircraft is parked and not on a charger.

To select a shunt, its resistance (R), power rating (P) and short term overload (STO) are key parameters. The SGC can read differential voltages between the SHUNT± pin up to 90mV.

If we for example take the WSBS5216L1000JK battery shunt resistor shown to the right which is made by Vishay Dale (and you can buy from online stores like [digkey.com](#)), we can get the following from its data sheet:

Resistance (R)	0.0001 Ohm
Power rating (P)	12 Watt
Short time overload (STO)	10 x rated power for 5 seconds

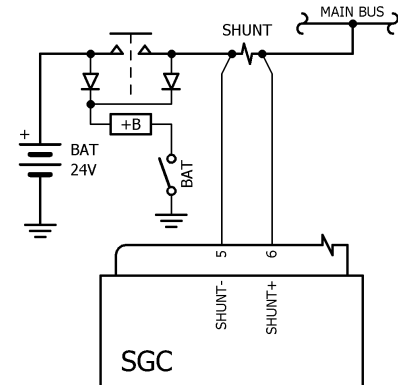
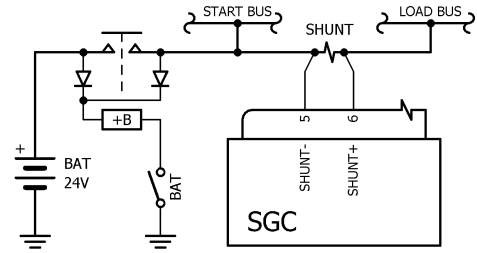


From this we can calculate the following:

Max. continuous current rating (MCC)	$\sqrt{P / R}$	346 Amps
Short time current (STC)	10 x MCC	3460 Amps (for 5 seconds)
Max. measurable current (MMC)	$0.09 / R$	900 Amps
Measurable current resolution	$MMC / 1000$	0.9 Amps
Amps value at 50mV	$0.05 / R$	500 Amps

To setup a SGC to use this shunt the [Remote Current Sensing Shunt Amps Value](#) setting must be set to the last value (500) in the table above.

The current limit for bulk phase battery charging can then be set via the [Generator Remote Current Limit](#) setting. To for example restrict the charging to 1C for a 20Ah battery to improve endurance cycle life, this setting can be set to 20.

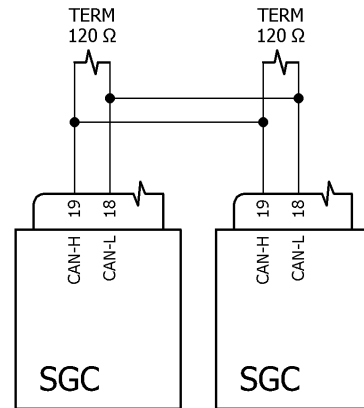


### CAN bus connection

The circuit to the right shows how one SGC can be connected to another SGC unit for working in parallel, and how two termination resistors have to be added externally at each end of the bus.

The SGC may similarly be connected to other devices for monitoring and/or control. A SGC can be commanded to initiate a start or motoring sequence (if power is applied to START-PWR), or to engage or disengage the generator (if generator voltage is applied to GEN-PWR), or to clear a fault that has been triggered.

In parallel operation two SGC units must be configured with [different reference numbers](#), which will allow them to provide generator load current sharing as well as cross-start current limiting.

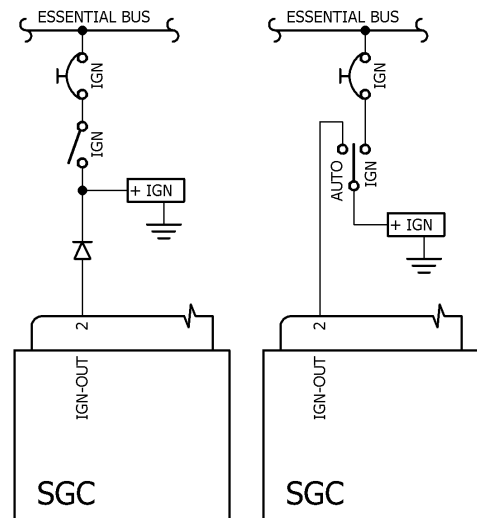


### Start ignition control connection

The circuits to the right shows how the SGC-4 can be connected to provide automated start ignition control.

The operator must deliberately select either a start or a motor operation from the outset as circuits F and G under [starter control connection](#) present, and this dictates whether IGN-OUT in the circuits to the right is activated or not, and thereby any possible confusion, which could in a worst-case scenario result in a hot-start, is greatly reduced.

The SGC-4 will switch essential bus power through from the START-PWR input to the IGN-OUT pin whenever a start is commanded in order to ensure ignition is activated. However if a motoring operation is commanded the SGC-4 will not switch power through to the ignition circuit.



One circuit above ensures the ignition is powered during a start via a diode, while the other circuit uses the IGN switch to select between on, off and auto, with the latter ensuring correct ignition activation. The diode is required in the first circuit to prevent power feeding back into the IGN-OUT pin. See also the section on [diode selection](#).

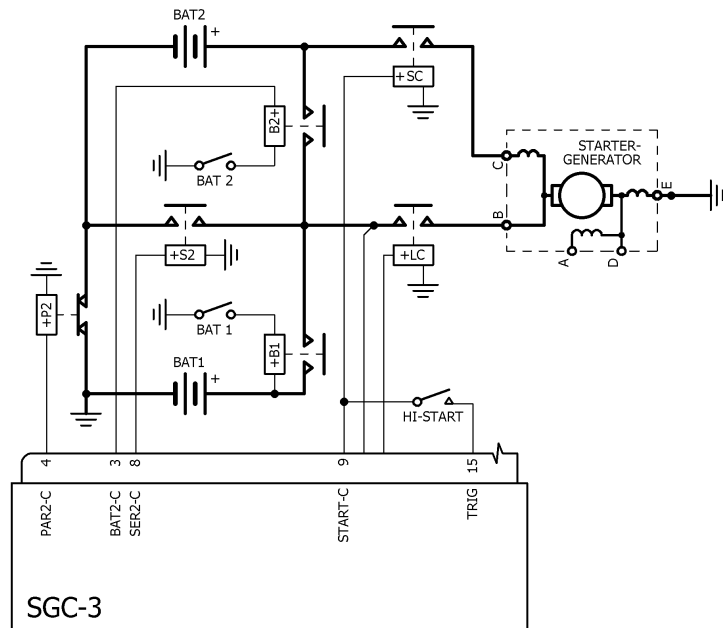
## Parallel-series start control connection

The circuit to the right shows how to connect a SGC-3 for the parallel-series control portion.

Except for the start and line contactors already discussed, four additional contactors are used - three normally open and one normally closed ones.

After start initiation contactors SC, B1, B2 and P2 are closed for parallel operation.

When the TACH input reaches a certain speed or if the TRIG input is momentarily powered via the HI-START switch, contactors B2 and P2 are opened followed by the closing of contactor S2 to engage series (or high start) operation.



When the start is terminated, manually or automatically, contactors SC and S2 opens followed by the closing of contactors B2 and P2.

## Circuit-breakers and fuses

The generator circuit-breaker (and any switch) wired to the SGC unit's GEN-PWR pin can have a current rating from 10 amp down to 7.5 amp and even lower by proper configuration of the [Maximum Field Control Voltage](#) setting. This setting's volt value divided by the starter-generator's shunt field resistance value sets the maximum current out of the FIELD pin. Since the current flow into the GEN-PWR pin equals the sum of the currents out of the GEN-C and FIELD pins, the GEN circuit-breaker rating can be determined. Just note that lowering the [Maximum Field Control Voltage](#) setting's value raises the minimum speed the generator can provide full load current at. In most cases this minimum speed is lower than the minimum idle speed of your engine, even at the lowest setting.

The current rating of the START circuit-breaker or fuse, as well as any switch wired to the SGC unit's START-PWR pin can be determined by adding together the currents out of the START-C, IGN-OUT and SER2-C pins. Note that some of these outputs are only applicable to certain SGC models.

For the SGC-3 which utilizes the PAR2-C and BAT2-C contactor outputs, an appropriate circuit-breaker or fuse inline with the BUS-PWR input would be desired. This fuse or circuit-breaker should be able to carry the inrush and stead-state current of the contactors they have to energize, as well as protect the wire leading to the SGC, without blowing or tripping.

Though solely to protect wiring and stop arcing should any low impedance wire ever short out, fuses can be included inline with SHUNT+, SHUNT-, POR and BUS-PWR inputs. BUS-PWR only for models other than the SGC-3 (covered in the previous paragraph). These three fuses can be specified anything from 1 amp up to the current rating for the relevant wire, and should preferably be placed as close to the node it originates from in order to protect more of the wire.

### **Diode selection**

The diodes if required to be used with the SGC should be able to block at least 50 volt and be capable of carrying the current for their purpose such as energizing a contactor coil or powering an ignition exciter. Diodes like the SB560-E3/54 will block 60 volt and continuously carry 5 amps and should be suitable in most instances.

### **Contactor selection**

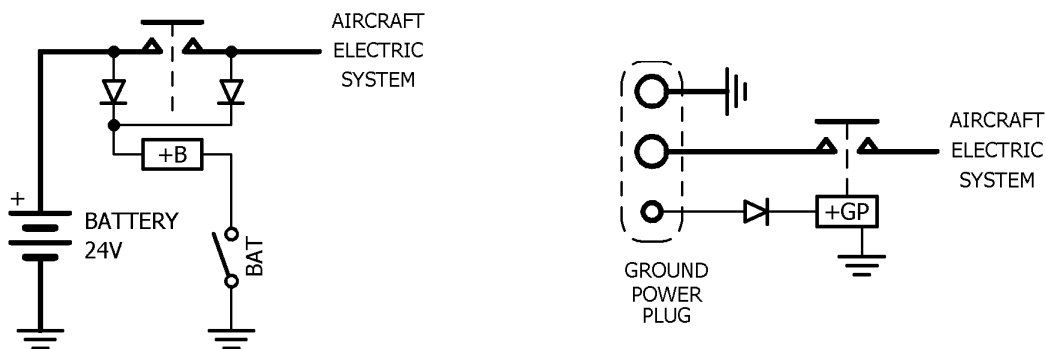
Each SGC contactor output pin is able to provide a continuous coil energizing current of at least 2.5 amp and more than ample inrush current. Choose 24 volt contactors that can make and break the necessary current.

The SGC unit's contactor outputs also provide for fast demagnetization. This not only result in somewhat faster switch-overs, but increases contactor life and reduces the risk of "sticking" between contacts. Do not add external demagnetization (also called coil suppression) for these SGC outputs.

For contactors not controlled by the SGC, such as those connecting batteries and ground power to the electrical bus, separate demagnetization may be required. See the specifications of the contactor you have chosen.

### **Battery and GPU polarity protection**

To protect your aircraft electrical system from damage resulting from accidentally connecting batteries the wrong way around, you may want to incorporate one or two diodes to a battery contactor as shown in the first circuit below. The diodes will prevent the energizing of the coil and therefore the closing of the contacts should the polarity of the battery be reversed. Similarly, your electrical system can be protected from any incorrectly wired external ground power plug hooked up to your aircraft as shown in the second circuit below.



## Configuration

The SGC have adjustable settings that determine how it functions. Each of these settings need to be gone through one by one prior to the first start – first of all to get familiar with each one's purpose, and secondly to adjust them as best prior to the first start. After doing an operational (start and generation) cycle, preferably while making a live SetView recording, these settings can be refined as required.

Configuration settings are accessed by Windows laptop or PC running our SetView software connected via a serial port to the maintenance interface of the SGC. These settings can be viewed by performing from SetView a "Synchronize", and adjusted by performing an "Adjust Configuration" operation.

### Settings for Hardware Calibration

The following hardware calibration settings are particular to a specific SGC unit and were configured by the factory. As such they will seldom if ever need adjustment. They are however accessible should re-calibration be needed and you have the necessary equipment and time at hand.

SGC	Configuration Setting	Minimum	Maximum	Factory
1	Hardware Calibration: POR Voltage	-1.00	1.00	Unit specific
2	Hardware Calibration: BUS Voltage	-1.00	1.00	
3	Hardware Calibration: D-SENSE Zero	500 (typ)	535 (typ)	
4	Hardware Calibration: D-SENSE Span	143 (typ)	149 (typ)	
5	Hardware Calibration: SHUNT Span	227 (typ)	247 (typ)	

#### Hardware Calibration: POR Voltage

This calibrates the voltage reading measured by the particular SGC at its POR pin relative to its SIG-GND pin. If the POR reading on the Dash panel of SetView is for example 0.25 volt lower than it should be, increasing this value by 0.25 should correct it. Perform this only with an accurate voltmeter.

#### Hardware Calibration: BUS Voltage

This calibrates the voltage reading measured by the particular SGC at its BUS-PWR input pin relative to its SIG-GND pin. If the BUS reading on the Dash panel of SetView is for example 0.25 volt lower than it should be, increasing this value by 0.25 should correct it. Perform this only with an accurate voltmeter.

#### Hardware Calibration: D-SENSE Zero

This calibrates the starter-generator load reading measured by the SGC at its D-SENSE pin relative to its SIG-GND pin when the starter-generator is disengaged. If the LOAD reading on the Dash panel of SetView is for example higher than 0 % when the starter-generator is disengaged, lowering this value will lower the LOAD reading. The latter needs to indicate 0 % when the starter-generator is not engaged, which occurs when there is zero voltage between the D-SENSE pin and the SIG-GND pin of the SGC.

#### Hardware Calibration: D-SENSE Span

This calibrates the starter-generator LOAD reading measured by the SGC at its D-SENSE pin relative to its SIG-GND pin when the starter-generator is engaged and current is flowing. This value must be adjusted so that when a voltage equal to that set by the [Starter-Generator Rated Current D Terminal Voltage](#) setting is applied to the D-SENSE pin (relative to the SIG-GND pin), the LOAD reading shown on the Dash of SetView will indicate 100 %. For example if the [Starter-Generator Rated Current D Terminal Voltage](#) setting is set to 1.00 volt, and this is applied to the D-SENSE pin, the LOAD should read 100 %. Perform this only with an accurate voltmeter.



## Hardware Calibration: SHUNT Span

This calibrates the remote current SHUNT reading measured by the SGC through its SHUNT+ and SHUNT- pins. This value must be adjusted so that when a shunt resistor connected to the SHUNT pins produce 0.05 volt (50mV), the SHUNT reading shown on the Dash of SetView will indicate the value set by the [Remote Current Sensing Shunt Amps Value](#) setting. For example if the [Remote Current Sensing Shunt Amps Value](#) setting is set to 250 Amps, and the SGC measures 50mV from the shunt resistor via its SHUNT+ pin relative to its SHUNT- pin, the SHUNT reading on the Dash panel should be 250 Amps. Perform this only with an accurate voltmeter.

## Settings for Generator Operation

#	Configuration Setting	Minimum	Maximum	Factory
6	Generator Regulation Absorption Phase Voltage	27.00	29.00	28.80
7	Generator Regulation Float Phase Voltage	27.00	29.00	27.60
8	Generator Regulation Absorption Time (minutes)	1	60	10
9	Generator Regulation Voltage Ramp Rate (seconds per volt)	0	1000	10
10	Generator Load Current Limit (%)	10	100	100
11	Generator Remote Current Limit (amps)	20	600	40
12	Generator Engagement Field-Volt Ratio	100	500	300
13*	Allow Generator engagement with START-PWR powered	No	Yes	No

\* used only by SGC-2, SGC-3 and SGC-4

### Generator Regulation Absorption Phase Voltage

This sets the absorption phase voltage the SGC will regulate the POR (point-of-regulation) to when the generator is engaged after voltage ramp-up have completed and no remote current limiting is being performed. See also the section [Battery charging profile](#).

### Generator Regulation Float Phase Voltage

This sets the float phase voltage the SGC will regulate the POR (point-of-regulation) to when the generator is engaged after the absorption phase have completed and no load limiting or remote current limiting is being performed. See also the section [Battery charging profile](#).

This setting must be lower than or equal to the Generator Regulation Absorption Phase Voltage setting.

### Generator Regulation Absorption Time

This setting specifies the time in minutes the SGC will spend in absorption phase before switching to float phase. See also the section [Battery charging profile](#).

### Generator Regulation Voltage Ramp Rate

This sets the rate of rise (in seconds per volt) the SGC will increase the POR (point-of-regulation) input to starting when the generator is engaged and ending when the POR input reaches the Generator Regulation Absorption Phase Voltage setting. See also the section [Battery charging profile](#).

### Generator Load Current Limit

This sets the generator load current (in %) the SGC will limit the D-SENSE (starter-generator current sense) input to by lowering the POR input voltage down to a minimum of 24 volt. Thereafter should the

generator load current still exceed this setting for 1 second, the SGC will disengage the generator and trigger an overload fault. This setting is meant to protect the generator from overloading / overheating.

### Generator Remote Current Limit

This sets the remote current (in Amps) the SGC will limit the SHUNT± (remote current sense) inputs to by lowering the POR input voltage down to a minimum of 24 volt. Thereafter should the remote current still exceed this setting for 1 second, the SGC will disengage the generator and trigger an over-current fault. See also the sections [Remote / battery shunt connection](#) as well as [Battery charging profile](#).

This setting may be ignored if no remote current shunt is connected to your SGC.

### Generator Engagement Field-Volt Ratio

This sets the value the Field-Volt Ratio (FVR) reading must equal or fall below before the SGC will engage the generator. This setting is meant to prevent (inhibit) the generator from engaging at too low a speed. The higher this value is set at the lower the generator needs to turn before the SGC will bring it online.

### Allow Generator engagement with START-PWR powered

Setting this to YES (1) the SGC will engage the generator even with power applied to its START-PWR input. With this setting at the normal NO (0), power on the START-PWR input inhibits generator activation. On a SGC-1 this setting can not be set to YES (1).

### Settings for Starter Operation

#	Configuration Setting	Minimum	Maximum	Factory
14	Start Field Weakening Control (%)	100	200	120
15*	Start Termination Field-Volt Ratio	0	300	0
16*	Start Termination Under Current (%)	0	80	0
17*	Start Termination TACH Speed (%)	40.0	80.0	55.0
18**	Start Parallel-to-Series Switch-Over TACH Speed (%)	12.0	30.0	20.0
19*	Start Initiation Must Wait for Trigger	No	Yes	Yes
20*	Start Light Output Operation	0	1	0
21***	Start Ignition Check before Starter Engagement (sec)	0	2	0

\* used only by SGC-2, SGC-3 and SGC-4

\*\* used only by SGC-3

\*\*\* used only by SGC-4

### Start Field Weakening Control

This sets the starter current the SGC will regulate the starter to by employing field weakening which affects starter performance. Starter current represented by the negative LOAD parameter is sensed through the D-SENSE input and field weakening control apportions the power from the GEN-PWR input to the FIELD output.

Shunt-only starter-generators require field weakening, but series-shunt starter-generator starting can also be augmented with field weakening. For the latter adjusting this to its highest will ensure the least impact from field weakening.

See also the section [Starter current control](#) as well as [Automatic start sequence termination at speed](#).

### Start Termination Field-Volt Ratio

The SGC will terminate a start sequence if the Field-Volt Ratio (FVR) drops below this configured value, which allows shunt-only starter-generator start sequences to be automatically terminated at a particular speed without requiring the TACH speed input. If using a series-shunt starter-generator this setting must be set to zero (0).

See also the section [Automatic start sequence termination at speed](#).

### Start Termination Under Current

The SGC will terminate a start sequence if the starter load current (in %) drops below this configured value, which allows series-shunt starter-generator start sequences to be automatically terminated at a particular speed without requiring the TACH speed input.

See also the section [Automatic start sequence termination at speed](#).

### Start Termination TACH Speed

This sets the starter speed (in %) at which a SGC will disengage the starter. Thus when the speed (sensed via the TACH input) reaches or exceeds this value, the start sequence will terminate. See also [Speed sensing connection](#) and [Automatic start sequence termination at speed](#). For a SGC-3 the two battery configuration it manages will further be switched from series (48 volt) to parallel (24 volt).

### Start Parallel-to-Series Switch-Over TACH Speed

This sets the starter speed (in %) at which a SGC-3 will perform the parallel-to-series battery transition. Thus when the speed (sensed via the TACH input) reaches or exceeds this value, the two battery configuration will be switched from parallel (24 volt) to series (48 volt).

See also the sections [Speed sensing connection](#) and [Parallel-series start control connection](#).

### Start Initiation Must Wait for Trigger

This setting determines if the SGC should also wait for momentary power to be applied to the TRIG input, or reception of a start command via the CAN-bus, before initiating a start sequence. Note that no matter what this setting is set to, a start will still be terminated if the TRIG input is grounded. On a SGC-1 this setting can not be set to YES (1).

See also [Starter control connection](#) and [Pilot control of start and motor sequences](#).

### Start Light Output Operation

This setting controls the [Start Annunciation Light](#) as follows:

Setting	Operation
0	Start light blinks when START-PWR is powered while awaiting start initiation.
1	Start light stays off when START-PWR is power while awaiting start initiation.

### Start Ignition Check before Starter Engagement

This sets the time in seconds that a SGC-4 after a start sequence is initiated by the operator, will run the ignition before engaging the starter. Setting this to 0 (zero) will remove this integrated ignition check altogether.

This setting is only applicable to the SGC-4 model, and its purpose is to provide added audible confirmation though brief back to the operator that indeed a start sequence has been initiated, as

opposed to a motor sequence where ignition are distinctly absent. It can further provide feedback about the quality of ignition. The operator may thus abort the start sequence even before the starter kicks in and thereby prevent draining the battery unnecessarily.

## General Settings

#	Configuration Setting	Minimum	Maximum	Factory
22	Last Fault Code Latched	0	4	0
23	Starter-Generator Rated Current D Terminal Voltage	0.80	2.00	1.63
24	Remote Current Sensing Shunt Amps Value (at 50mV)	50	600	500
25	CAN Bus Interface Speed	0	3	0
26	Tachometer-Generator Full Speed Frequency (Hz)	70.00	70.00	70.00
27	Maximum Field Control Voltage	16.00	24.00	24.00
28	Unit Reference Number	1	2	1

### Last Fault Code Latched

This configuration property serves to provide feedback on the source or cause of a fault detected during a previous flight. It can be reset to zero (no fault). The [Normal fault handling](#) section shows what each fault code represent.

If you are unsure whether or not you are getting a fault you can reset this setting (to zero) and after a flight come back and inspect whether it changed or not.

### Starter-Generator Rated Current D Terminal Voltage

This setting determines the voltage on the D-SENSE input that constitute 100% generator load current (the rated generator current).

As previously stated the standard D terminal on a starter-generator provides feedback of the current flowing to and from the starter-generator at any particular time. To be specific its the voltage on the D terminal relative to the voltage on the E terminal of a starter-generator that presents the current flow.

Internal to a starter-generator the circuit between the standard D and E terminals constitute copper wire with a certain resistance, that when current flows through presents a proportionate voltage drop. But unlike shunt resistors made specially for current measurement, copper does have a higher temperature coefficient of resistance (about 0.4% per degree Celsius), therefor though quite useful are less accurate. For best results we therefor recommend adjusting this configuration setting at the typical starter-generator operational temperature expected.

As an example, you have a 250 Amp starter-generator running at normal operational temperature on your aircraft, and the LOAD parameter on the Dash panel of SetView reads 31%. This calculates to  $250 \times 0.31 = 77$  amps, but you know by measuring with a reliable current clamp meter that actually only 55 amps are being delivered by your generator.

To correct the above mentioned example you need to adjust this the Starter-Generator Rated Current D Terminal Voltage setting by taking the current value multiply it by 77 and dividing it by 55. So if your current value for this setting is for example 1.16 volt, then  $1.16 \times 77 \div 55 = 1.62$  volt. Therefor adjusting this setting from 1.16 to 1.62 should fix it for you.

### Remote Current Sensing Shunt Amps Value

This setting determines the current (in amps) that represent a 50mV voltage difference between the SHUNT± (remote current sense) inputs from a remote shunt resistor. For example a 0.0001 ohm shunt will produce 50mV at 500 amps.

See also the example described in section [Remote / battery shunt connection](#).

### CAN Bus Interface Speed

This sets the speed in Kbps (kilo bits per second) of the CAN bus interface. Options are as follows:

Setting	CAN Bus Speed (Kbps)
0	142.8
1	125
2	250
3	500
4	1000

For devices to communicate with each other (such as two SGC units in a [dual engine configuration](#)) all of them need to run at the same speed.

See also the section [CAN bus interface](#).

### Tachometer-Generator Full Speed Frequency

This setting determines the frequency (in Hertz) on the TACH input that constitutes 100% starter-generator speed. Currently this setting only allows for 70.00 Hz sensors.

### Maximum Field Control Voltage

This setting determines the maximum voltage the SGC will apply on the FIELD output, which limits the maximum current the SGC can drive the starter-generator shunt field at knowing the shunt field resistance. In turn this, together with the current to energize the line contactor wired to the GEN-C pin, limits the current required from the GEN-PWR input and therefor the circuit-breaker (and switch) leading to it as discussed in [Starter-generator connection](#).

See also the section on [Circuit-breakers and fuses](#).

### Unit Reference Number

For applications where more than one starter-generator is connected to a common electrical bus, such as with a twin engine aircraft, this setting allows different reference numbers to be assigned, which then enables these units to communicate with each other over a common CAN bus. This number can match up with the assigned engine number. This allows starter-generators to equally share the load current provided to the electrical system as well as manage cross-start current limiting.

See also the section [CAN bus interface](#).

## Operational

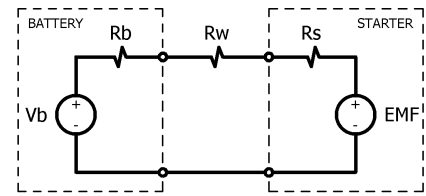
### Working Parameters

The SGC provide a stream of real time parameters via the maintenance port that can inform you of the workings of the system. These can be viewed via the Dash panel on the SetView program, which among other things allow for recordings to be made.

Parameter	Description	
BUS	BUS gives the voltage on the BUS-PWR input (pin 1).	
POR	POR gives the voltage on the point-of-regulation input (pin 24).	
FVR	FVR is the Field-Volt Ratio measured in one-thousandths of FIELD (pin 12) voltage to POR voltage.	
LOAD	LOAD is the starter-generator load current measured via D-SENSE (pin 11) as a percentage of rated generator current. It is positive as a generator and negative as a starter. The <a href="#">Starter-Generator Rated Current D Terminal Voltage</a> setting configures rated generator current.	
SHUNT	SHUNT gives the current in amps flowing through an <a href="#">external current measurement shunt</a> via the SHUNT inputs (pins 5 and 6).	
TACH	TACH is the starter-generator speed measured at the TACH input (pin 17).	
GEN ON	ON/OFF indication of generator engagement.	
STARTER	ON/OFF indication of starter engagement.	
IGNITION	ON/OFF indication of ignition engagement (only SGC-4 has capability to control ignition).	
CAN BUS	ON/OFF indication of whether the SGC is receiving <a href="#">command messages via CAN bus</a> .	
CODE	NO FAULT	No fault detected.
	INTERNAL	Fault internal to SGC unit detected.
	OVERVOLT	POR parameter over-voltage fault detected.
	OVERLOAD	LOAD parameter over-load fault detected.
	OVERCURR	SHUNT parameter over-current fault detected.
SGC	INIT	SGC is initializing. Usually for 1 second after power-up (master on).
	STANDBY	SGC is standing by.
	STBY-START	SGC is standing by with START-PWR applied.
	STBY-GEN	SGC is standing by with GEN-PWR applied.
	START-FW	SGC is doing a start sequence with field weakening or augmentation.
	START-NF	SGC is doing a start sequence with no field weakening or augmentation.
	START-HI	SGC is doing a start sequence with batteries switched in series (48V).
	MOTOR-FW	SGC is doing a motoring sequence with field weakening or augmentation.
	MOTOR-NF	SGC is doing a motoring sequence with no field weakening or augmentation.
	GEN-RAMP	SGC is slowly ramping the generator voltage up.
	GEN-LOAD	SGC is limiting the generator load current (LOAD parameter).
	GEN-RC	SGC is limiting the generator remote current (SHUNT parameter).
	GEN-ABSORP	SGC is generating battery absorption phase voltage.
	GEN-FLOAT	SGC is generating battery float phase voltage.
	GEN-EQU	SGC is generating an equalizing voltage to share the load with another SGC.
FAULT	SGC is in latched in fault mode.	

### Starter current control

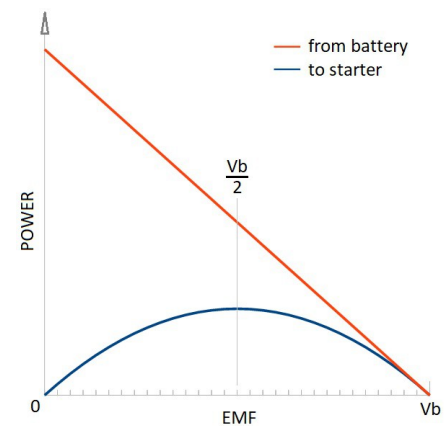
The electrical schematic to the right represents the fundamental starter circuit where a battery powers a direct current starter in a typical aircraft application.



$V_b$  represents the no-load battery voltage,  $R_b$  the battery's source resistance,  $R_w$  the resistance of wiring, contactors, etc. to the starter-generator (both positive and ground wires). Finally  $R_s$  represents the starter's internal resistance and EMF the back EMF voltage which is proportional to both starter speed and magnetic field flux.

With a shunt-only starter-generator,  $R_s$  is the sum of the armature resistance and the compensating and interpole resistance only, whereas using a series field winding to run the starter as with a series-shunt starter-generator, the resistance of the series field winding must also be added to  $R_s$ .

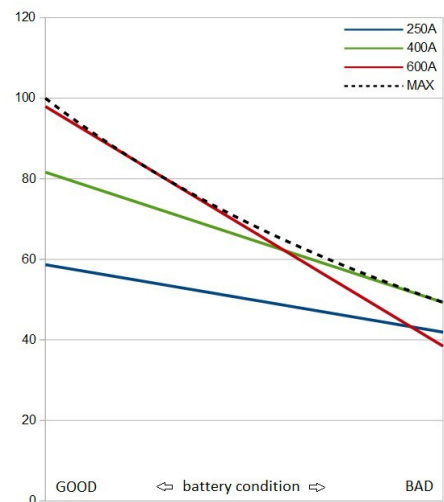
The graph to the right shows the power transfer versus EMF referenced to no-load battery voltage ( $V_b$ ) for the circuit. It also shows the point where power transfer to the starter is maximum when EMF is at half of  $V_b$ . Any EMF lower than half of  $V_b$  not only delivers less starter power, but needlessly drains battery energy into the resistances ( $R_b$ ,  $R_w$ ,  $R_s$ ). During the first few seconds of starter engagement this cannot be avoided with back EMF needing to build from zero as speed increases, up to the eventual point of control on the blue line.



The SGC employs a constant current starter control if field weakening is engaged that can be set via the [Start Field Weakening Control](#) setting.

The graph below shows the percentage starter power for three theoretical constant current configurations versus battery condition, where the latter decreases to the right due to state of charge, temperature and age. It also shows the maximum starter power achievable (at EMF equal to half of  $V_b$ ) as a reference.

As can be seen, at lower constant current settings, less power but more consistent starter performance is obtained across battery condition. The red setting may perform well for batteries in good condition, but fares quite poorly with bad batteries. Not only is less power then extracted for the starter, but much of the little battery power available gets wasted into the resistances ( $R_b$ ,  $R_w$ ,  $R_s$ ) without much use.

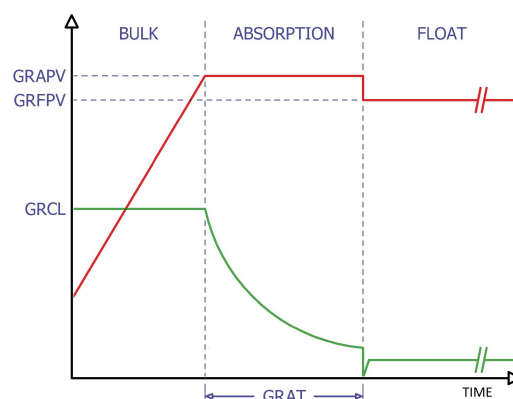


The [Start Field Weakening Control](#) setting enables fine-tuning to a specific battery, wiring and starter-generator setup in order to find the best trade-off between consistency, efficiency and performance across expected battery conditions.

## Battery charging profile

The SGC is capable of effecting a battery charging profile as shown to the right, which provides bulk, absorption and float phases of charging, where parameters can be configured to battery manufacturer recommendations.

During **bulk** phase the batteries are charged with a constant current until the [Generator Regulation Absorption Phase Voltage](#) (GRAPV) is reached. The constant current can be realized by closed loop control using a [battery shunt resistor](#) to govern battery current at the [Generator Remote Current Limit](#) (GRCL), or by open loop control which slowly ramps the generated (and battery) voltage up at the fixed [Generator Regulation Voltage Ramp Rate](#) rate, or by use of both methods.



During **absorption** phase the generated voltage is kept constant at Generator Regulation Absorption Phase Voltage (GRAPV) until the time duration in absorption phase reaches the [Generator Regulation Absorption Time](#) (GRAT).

During **float** phase battery voltage is reduced to the [Generator Regulation Float Phase Voltage](#) (GRFPV) where it then remains.

Throughout the charge profile electrical loads on the bus receive at minimum a steady state voltage of 22 volt during bulk phase and 27 volt during absorption and float phases.

## Normal fault handling

On rare occasions, especially while in generator mode, the SGC upon detecting a fault internal or external to the unit, will disengage both starter and generator and drive the GEN-OFF light to flash once a second.

The SGC can be reset from this fault mode by momentarily grounding the TRIG pin, or by cycling the GEN switch (or S/G switch) off and back on. The table below gives the fault codes and describes what each represent. See also the [Last Fault Code Latched](#) configuration property.

Code	Fault	Causes
1	INTERNAL	Internal fault was momentarily detected.
2	OVERVOLT	An over-voltage was detected during generator operation.
3	OVERLOAD	An overload was detected during generator operation, triggered 1 second after the generator was lowered to 24 volt in an effort to limit the generator load current to the set <a href="#">Generator Load Current Limit</a> .
4	OVERCURRENT	An over-current was detected at the remote current shunt during generator operation, triggered 1 second after the generator was lowered to 24 volt in an effort to limit the generator remote current to the set <a href="#">Generator Remote Current Limit</a> .



## **Abnormal fault handling**

On very rare occasions the generator (also called field) circuit-breaker may trip, usually at the onset of or during a start sequence or later during power generation. This signifies an abnormal fault event where secondary circuits within the SGC had to be deployed to protect the electrical system as well as the SGC.

Though the pilot is free to reset this fault by pushing the circuit-breaker back in, this constitutes a serious fault that requires some investigation afterwards.

## **Pilot control of start and motor sequences**

The following section deals with the SGC models that are “auto-start” capable, which thus excludes the SGC-1. With these a pilot can initiate commencement of start or motor sequences or terminate them, simply by momentarily depressing a spring-loaded switch, or actuating a non-spring-loaded switch.

Important to note is that in order to perform a start or motor sequence, it is essential for the SGC to receive power at its START-PWR pin. Without it, the SGC is unable to engage the start contactor via the START-C pin, or power the ignition via the IGN-OUT pin in the case of the SGC-4.

Should it be desired to initiate a start or motor sequence by way of momentarily depressing a spring-loaded switch, the [Start Initiation Must Wait for Trigger](#) setting must be set to Yes (1). In this configuration a momentary pulse on the TRIG input of the SGC is all that is required to set off and initiate a start sequence, and for the SGC-4 a momentary pulse similarly on the MOTOR input to do a motor sequence. On the SGC-2 and SGC-3 models that do not have ignition control, a motor sequence would be initiated just like the start sequence described.

If the [Start Initiation Must Wait for Trigger](#) setting is set to No (0), the SGC will not wait for a triggering pulse on the TRIG input pin (or a triggering command via CAN bus), but will immediately engage the start contactor when power is applied to the START-PWR input, and immediately disengage it when power to START-PWR is removed. This can thus be implemented quite easily using a non-spring-loaded switch. Note that the SGC can still terminate any sequence even if power continue to be on the START-PWR input. For example, should the SGC sense that engine idle speed is reached, it will terminate the sequence even if START-PWR gets power, as described in [Automatic start sequence termination at speed](#).

For a SGC-4 model, should a pulse be simultaneously received on both the MOTOR and TRIG inputs, a motor sequence be deemed to be initiated. During the motor sequence ignition is not activated and only the starter gets engaged. A motor sequence can be turned into a start sequence by a pulse on the TRIG input, and a start sequence turned into a motor sequence by a pulse on the MOTOR input. To abort a start sequence a (second) pulse can be applied to the TRIG input, and to abort a motor sequence a (second) pulse can be applied to the MOTOR input.

In addition to the ways described in this section to terminate a start or motor sequence, they can at any time also be terminated by momentarily grounding of the TRIG input.

### Automatic start sequence termination at speed

All SGC models except the SGC-1 can automatically terminate a start sequence when a particular speed is reached after a successful start. They do so by removing power from the START-C output pin even though power may remain on the START-PWR input pin of the SGC.

The two graphs to the right show what can typically be expected from a series-shunt (top) and a shunt-only (bottom) starter-generator. The SPEED is given in purple and the starter current is given in green by a (negative going) LOAD in %. The shunt-only start graph provide the Field-Volt Ratio (FVR) in blue.

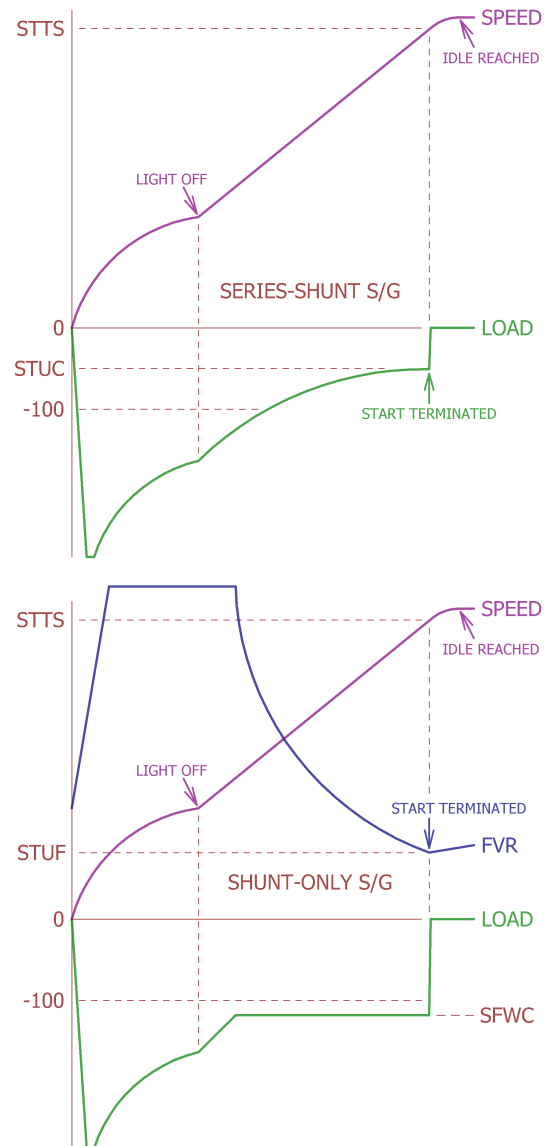
With [TACH speed sensing](#) installed, the SGC can terminate start sequences for series-shunt and shunt-only starter-generators at the exact speed set by the [Start Termination TACH Speed](#) (STTS) setting.

Sequences can alternatively or in addition be terminated if the starter-generator is equipped and wired to the D-SENSE input of the SGC.

In the top graph for series-shunt starter-generators a start will also terminate when the LOAD % parameter reaches or drops below the [Start Termination Under Current](#) (STUC) setting.

On the other hand the bottom graph for shunt-only starter-generators the termination speed can be derived through the Field-Volt Ratio (FVR). When it reaches or drops below the [Start Termination Field-Volt Ratio](#) (STUF) as shown, the start will also automatically terminate.

LOAD and FVR are [working parameters](#) as given on the Dash screen of the SetView program, and can be recorded for later viewing and analysis.

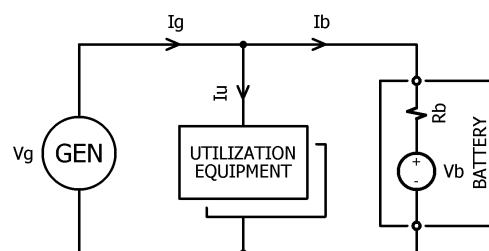


### **Generator load current and remote (battery) current limitation**

The circuit to the right illustrates a generator supplying power to the aircraft batteries as well as the various utilization equipment (electric loads) onboard.

With the generator voltage ( $V_g$ ) higher than the internal battery voltage ( $V_b$ ) the battery will receive a charging current ( $I_b$ ), which together with the current to the utilization equipment is all sourced from the generator.

Should  $V_g$  be lowered to equal the value of  $V_b$ ,  $I_b$  will become zero, and if lowered more  $I_b$  will now flow out of the battery and thereby assist the generator in supplying current to the utilization equipment ( $I_u$ ). This shows how lowering generator voltage not only lowers the charging current ( $I_b$ ) but the generator current ( $I_g$ ).



The SGC utilizes this phenomenon to limit both generator current and remote battery current by lowering the generated voltage. Should the generated voltage however reach the minimums shown in the table below, the generator will be taken off line and an overload or over-current fault is triggered.

Minimum generator steady state voltage when not performing cross-start limiting	22.0 V
Minimum generator steady state voltage during cross-start current limiting	12.0 V

These steady state minimums match that in the MIL-STD-704E standard defining the requirements of aircraft electric power provided at the terminals of electric utilization equipment, for normal operation and electric starting respectively.

### **Cross-start operation**

In twin engine aircraft after the first engine have been started, its generator can assist in starting the second engine and thereby provide some relief to the aircraft batteries.

Cross-starting is signaled via CAN bus to the SGC controlling the first engine's generator so that it triggers a generator overload at a lower than normal voltage.

See also previous section [Generator load current limitation](#).

### **Generator load equalization**

Generator load equalization ensures two generators, as found on twin engine aircraft, share the load to the aircraft electric bus equally.

It requires that the two SGC units controlling each generator can communicate via CAN bus with each other.

## CAN bus interface

The SGC sends out information and can receive commands via its CAN bus interface.

Nominal bit time / rate	Determined by <a href="#">CAN Bus Interface Speed</a> setting
Frame format / identifier bit length	Base frame format / 11 identifier bits

## Command message

Command message Identifier	0x759 – if <a href="#">Unit Reference Number</a> set to 1 0x75D – if <a href="#">Unit Reference Number</a> set to 2
Command message length	1 (byte)
Command message recommended rate	10 messages per second
Command message timeout	1 second (if no message is received in this time, the SGC will act as though receiving a GENERATE command)

Command	Value	Description
STOP / INHIBIT	0x00	To inhibit Starter, Generator and Ignition
IGNITION CHECK	0x04	To engage only the Ignition if able *
MOTOR	0x01	To engage only the Starter (motor sequence) if able *
START	0x05	To engage the Starter and Ignition (start sequence) if able *
GENERATE	0x02 **	To engage only the Generator if able *
GENERATE + IGNITION	0x06	To engage the Generator and Ignition if able *
RESET	0x08	To reset a triggered fault (only one message needed)

\* Commanded actions are executed only if able to. For example, neither the starter nor the ignition will be engaged if power on the START-PWR pin is insufficient. Similarly the generator will not engage if power on the GEN-PWR pin is insufficient. If more than one action are commanded (such as GENERATE + IGNITION) only the actions able to be executed will be engaged.

\*\* If a value other than listed in this table is commanded, it will be interpreted as a GENERATE command.

## Information message #1

Information message #1 identifier	0x75A – if <a href="#">Unit Reference Number</a> set to 1 0x75E – if <a href="#">Unit Reference Number</a> set to 2
Information message #1 length	8 (bytes)
Information message #1 send rate	10 messages per second

Parameter	Bits	Offset	Details (see also <a href="#">Working Parameters</a> for definitions)
MODE	First 4	0	0 = INIT 1 = STANDBY 2 = STBY-START 3 = STBY-GEN 4 = START-FW 5 = START-NF 6 = START-HI

<i>Parameter</i>	<i>Bits</i>	<i>Offset</i>	<i>Details (see also <a href="#">Working Parameters</a> for definitions)</i>
			7 = GEN-RAMP 8 = GEN-LOAD 9 = GEN-RC 10 = GEN-ABSORP 11 = FAULT 12 = GEN-FLOAT 13 = MOTOR-FW 14 = MOTOR-NF 15 = GEN-EQU
CODE	Next 4	0	0 = NO FAULT 1 = INTERNAL 2 = OVERVOLT 3 = OVERLOAD 4 = OVERCURR
GEN ON	Next 1	0	ON/OFF indication of generator engagement
STARTER	Next 1	0	ON/OFF indication of starter engagement
IGNITION	Next 1	0	ON/OFF indication of ignition engagement (only SGC-4 has capability to control ignition)
CAN BUS	Next 1	0	ON/OFF indication of whether the SGC is receiving command messages via CAN bus
Not used	Next 4	0	Not used
BUS volt	Next 9	0	Voltage (V) from 0.0 to 51.1 (0.1 volt resolution)
POR volt	Next 9	0	Voltage (V) from 0.0 to 51.1 (0.1 volt resolution)
FVR	Next 10	0	Ratio from 0 to 1023
LOAD	Next 10	600	Percentage (%) from -600 to 423
SHUNT	Last 10	0	Amps (A) from 0 to 1023

### Information message #2

Information message #2 identifier	0x75B – if <a href="#">Unit Reference Number</a> set to 1 0x75F – if <a href="#">Unit Reference Number</a> set to 2
Information message #2 length	4 (bytes)
Information message #2 send rate	10 messages per second

<i>Parameter</i>	<i>Bits</i>	<i>Offset</i>	<i>Details (see also <a href="#">Working Parameters</a> for definitions)</i>
TACH	First 16	0	Percentage (%) from 0.0 to 199.9 (0.1 % resolution)
NOT-USED	Last 16	0	Not used

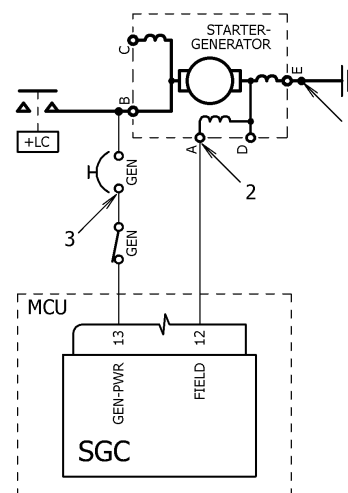
## Maintenance and Diagnostic Checks

In this section we describe some post installation checks that can be performed prior to starting, as well as other maintenance checks to be performed routinely or as the time arise to troubleshoot the system after commissioning.

### Post installation shunt field circuit check

This check confirms that the SGC would be able to energize the shunt field of the starter-generator, which is important to shunt-only starter-generators as a confirmation that field weakening can be active during the first start performed.

1. Ensure all battery master switches are off and that the GEN circuit-breaker is open (pulled out) and that the GEN (or S/G) switch is closed as shown by the circuit to the right.
2. Measure with an ohm meter the resistance between the A terminal (arrow 2) of the starter-generator and its E terminal (arrow 1) which should be at ground. This resistance should be around 2.2 ohm for most starter-generators.
3. Measure with an ohm meter the resistance between the circuit-breaker terminal (arrow 3) and the E terminal of the starter-generator (arrow 1) which should be at aircraft ground. This resistance should be about 1.5 ohm more than the resistance measured in step 2.
4. Close the GEN circuit-breaker and again measure the resistance between arrow 3 and arrow 1 (ground). It should have dropped to below 1 ohm.



### Trigger input high diagnostic check

This check confirms the correct wiring and working of the circuit leading up to the SGC unit's TRIG input pin that applies power to it, and is only relevant to applications that employ the TRIG input in this way.

1. Turn on power to the aircraft with SetView connected to your SGC.
2. On SetView select the TRIG HI - START (pin 15) diagnostic function (menu > system > diagnostic function).
3. Activate the switch that applies power to the TRIG input to the SGC and confirm that the SetView window confirms receiving that signal via the SGC.
4. Exit the test by pressing escape or clicking with the mouse within the SetView window.

### Trigger input grounded diagnostic check

This check confirms the correct wiring and working of the circuit leading up to the SGC unit's TRIG input pin that grounds it, and is only relevant to applications that employ the TRIG input in this way.

1. Turn on power to the aircraft with SetView connected to your SGC.
2. On SetView select the TRIG LO – STOP/RESET (pin 15) diagnostic function (menu > system > diagnostic function).
3. Activate the switch(es) that applies ground to the TRIG input to the SGC and confirm that the SetView window confirms receiving that signal via the SGC.
4. Exit the test by pressing escape or clicking with the mouse within the SetView window.

### **START-PWR input diagnostic check**

This check confirms the correct wiring and working of the circuit leading up to the SGC unit's START-PWR input pin that applies power to it.

1. Turn on power to the aircraft with SetView connected to your SGC.
2. On SetView select the START-PWR - START ENABLE (pin 7) diagnostic function (menu > system > diagnostic function).
3. Activate the switch that applies power to the START-PWR input to the SGC and confirm that the SetView window confirms receiving that signal via the SGC.
4. Exit the test by pressing escape or clicking with the mouse within the SetView window.

### **START light diagnostic check**

This check confirms the correct wiring and working of the external START light driven by the SGC.

1. Turn on power to the aircraft with SetView connected to your SGC.
2. On SetView select the START LIGHT (pin 22) diagnostic function (menu > system > diagnostic function).
3. Confirm that the START light slowly toggles on and off.
4. Exit the test by pressing escape or clicking with the mouse within the SetView window.

### **GEN-OFF light diagnostic check**

This check confirms the correct wiring and working of the external GEN-OFF light driven by the SGC.

1. Turn on power to the aircraft with SetView connected to your SGC.
2. On SetView select the GEN-OFF LIGHT (pin 23) diagnostic function (menu > system > diagnostic function).
3. Confirm that the GEN-OFF light slowly toggles on and off.
4. Exit the test by pressing escape or clicking with the mouse within the SetView window.

### **Generator circuit-breaker pop check**

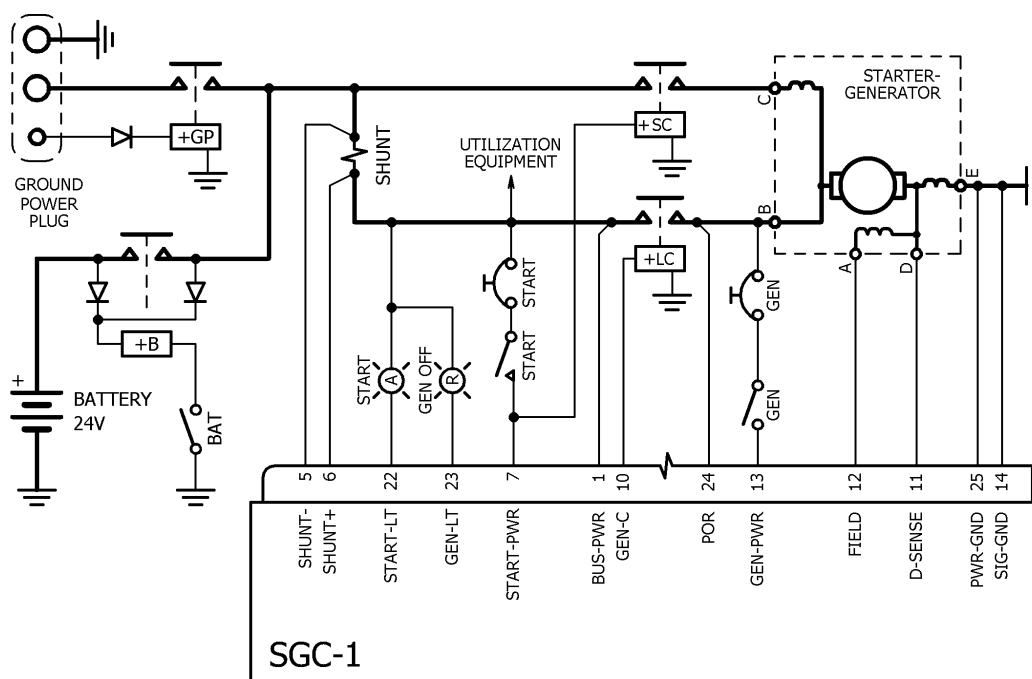
This check will confirm that secondary circuits within the SGC will be able to completely isolate [an abnormal fault](#) in the event of detection by popping open the GEN circuit-breaker external to the SGC. This test can routinely be performed.

1. Start the aircraft engine with SetView connected to its SGC.
2. Ensure the generator is turned off / disengaged (open GEN switch).
3. On SetView select the GEN C/B POP diagnostic function (menu > system > diagnostic function).
4. On SetView click inside the diagnostic window box to continue the procedure.
5. If you wish to do a recording of the test, start it (menu > system > record parameter stream).
6. Engage / turn on the generator (close GEN switch).
7. Confirm that the GEN circuit-breaker pops (opens) within 10 seconds.
8. If recording the test, stop it (menu > system > stop recording).

## Examples

The following examples have been chosen to illustrate not only different applications of the SGC models available, but different optional features available on all the models, and therefore should not be construed as the only way to implement a certain SGC.

### SGC-1 with series-shunt S/G

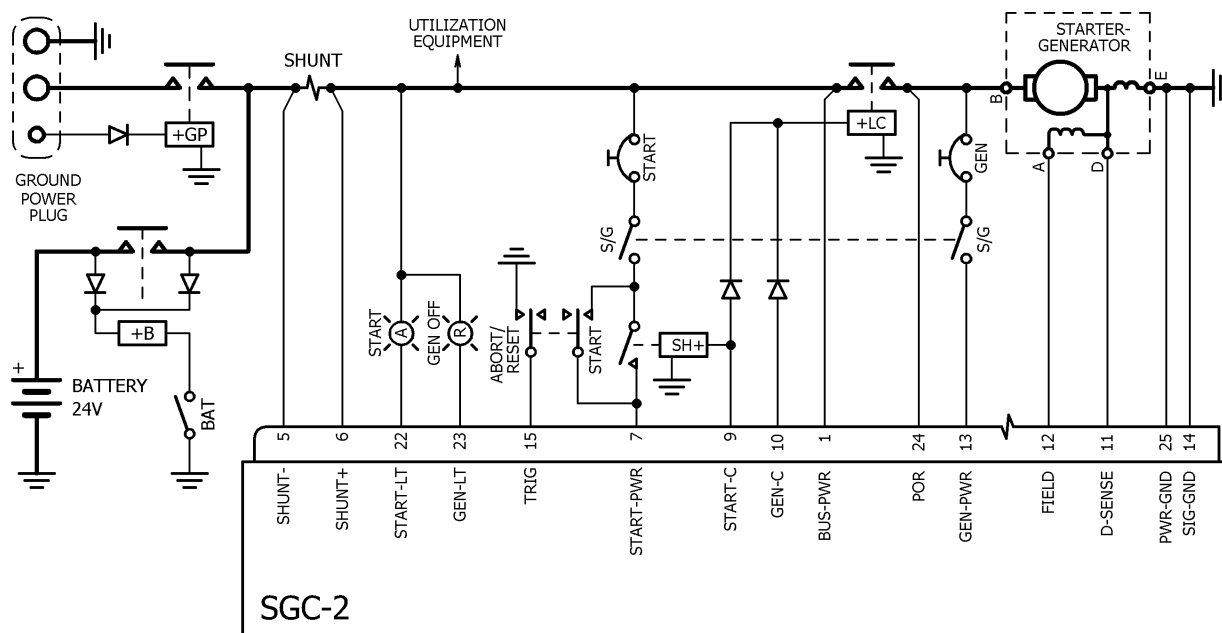


#### Notes:

- Before a start the GEN switch can be open or closed. If closed the starter field will be augmented via the shunt field. Depress and hold the START switch to engage the starter. To abort the start release the START switch. After a successful start the START switch must be released. The generator will then automatically engage if the GEN switch is closed, otherwise it waits for the GEN switch to be closed.
- To turn the generator off, open the GEN switch.
- The START light will come on while the starter is engaged (START switch is held in).
- The GEN-OFF light will go out when the generator is engaged.
- If a fault is triggered, the generator will be disengaged and the GEN-OFF light will flash. To reset the fault the GEN switch must be cycled off and back on again.
- If the engine is shut down while the generator is engaged, the generator will automatically disengage when the generator current reverses.
- If the START switch is accidentally depressed while the generator is engaged, the generator disengages and only resumes when the START switch is released.



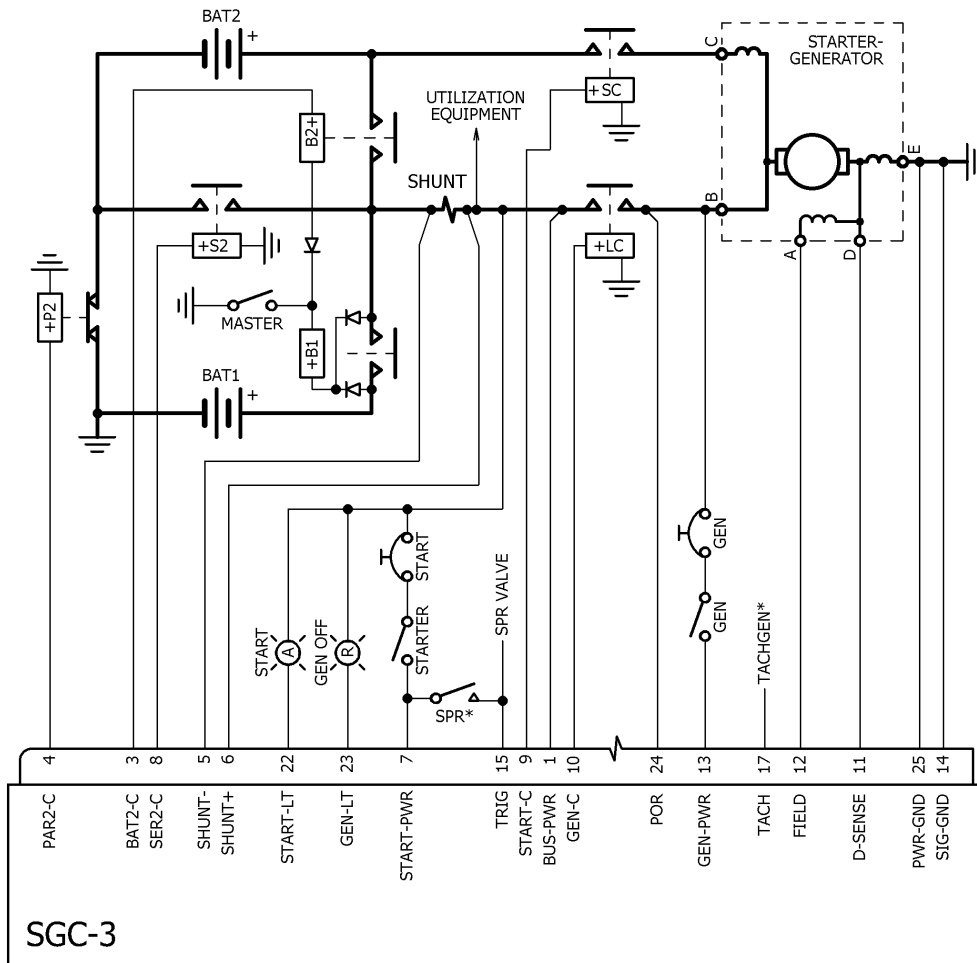
### SGC-2 with shunt-only S/G



**Notes:**

- Before a start the S/G switch must be closed. Depress the START switch momentarily to engage the starter. To abort the start depress the ABORT/RESET switch momentarily or open the S/G switch. After a successful start the starter is automatically terminated and the generator automatically engaged when turning at sufficient speed.
- To turn the generator off, open the S/G switch.
- The START light will come on while the starter is engaged.
- The GEN-OFF light will go out when the generator is engaged.
- If a fault is triggered the starter and generator will be disengaged and the GEN-OFF light will flash. To reset the fault the ABORT/RESET switch can be depressed momentarily or the S/G switch can be cycled off and back on again.
- If the engine is shut down while the generator is engaged, the generator will automatically disengage when the generator current reverses.
- If the START switch is accidentally depressed while the generator is engaged, it is ignored and the generator remains online.

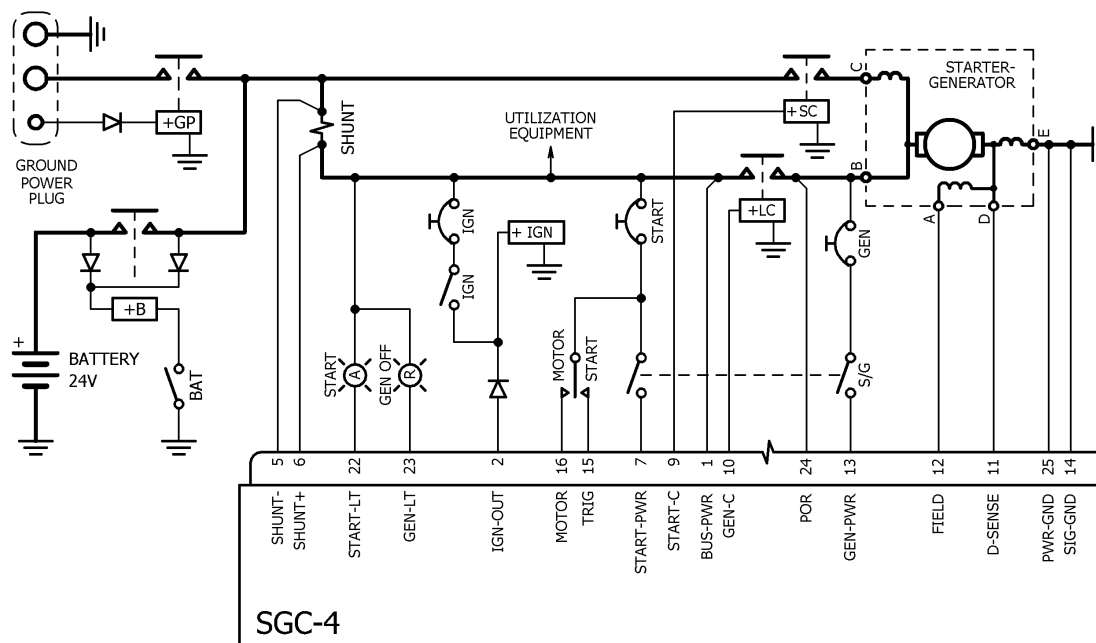
**SGC-3 with series-shunt S/G**



**Notes:**

- Before initiating a start the GEN switch should be open. Close the STARTER switch to engage the starter. To abort the start open the STARTER switch. After a successful start the starter is automatically terminated. The generator engages when the GEN switch is closed.
- To turn the generator off, open the GEN switch.
- The START light stays on while the starter is engaged, and when disengaged, will flash until the STARTER switch is opened.
- The GEN-OFF light will go out when the generator is engaged.
- If a fault is triggered the starter and generator will be disengaged and the GEN-OFF light will flash. To reset the fault the GEN switch can be cycled off and back on again.
- If the engine is shut down while the generator is engaged, the generator will automatically disengage when the generator current reverses.
- The STARTER switch is ignored if accidentally closed while the generator is engaged.
- If the GEN switch was closed during the start it will not interfere with the start, but the GEN circuit-breaker can trip (open) on over voltage when batteries are switched from parallel to series, which requires it to be pushed back in after the start.

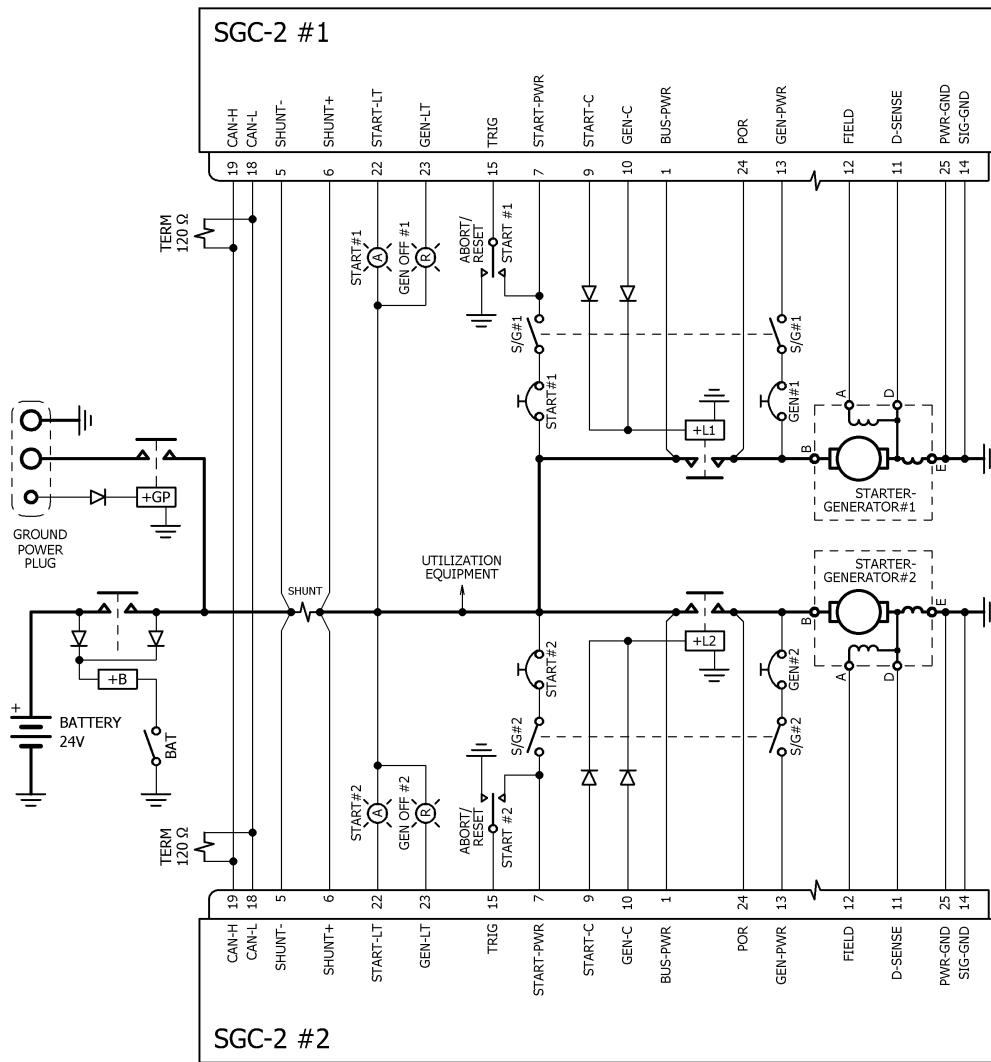
### SGC-4 with series-shunt S/G



#### Notes:

- Before initiating a start or motoring sequence the S/G switch must be closed and the IGN switch opened. Depress the START switch momentarily to engage a start sequence or depress the MOTOR switch momentarily to engage a motoring sequence. To abort a start sequence depress the START switch again. To abort a motoring sequence depress the MOTOR switch again. To alternatively abort either sequence simply open the S/G switch. To change from one sequence to the other depress the appropriate switch you wish to change to. After a successful start the engaged sequence is automatically terminated and the generator automatically engaged when turning at sufficient speed.
- During a start sequence both starter and ignition are engaged.
- During a motoring sequence only the starter is engaged, the ignition is not.
- To turn the generator off, open the S/G switch.
- The START light will come on while the start or motoring sequence is engaged.
- The GEN-OFF light will go out when the generator is engaged.
- If a fault is triggered the starter, generator and ignition will be disengaged and the GEN-OFF light will flash. To reset the fault the S/G switch can be cycled off and back on again.
- If the engine is shut down while the generator is engaged, the generator will automatically disengage when the generator current reverses.
- If the START or MOTOR switch is accidentally depressed while the generator is engaged, it is ignored and the generator remains online.

### Dual SGC-2 for twin engine shunt-only S/G's



**Notes:**

- To start first engine close its S/G switch, then depress its START switch momentarily to engage its starter. To abort the start depress its ABORT/RESET switch momentarily or open its S/G switch. After a successful start the starter is automatically terminated and the generator automatically engaged when turning at sufficient speed.
- To start the second engine with cross-start assistance leave the first engine's S/G switch closed, otherwise open it then perform the same procedure as done with the first engine.
- To turn a generator off, open its S/G switch. The START light will come on when the relevant starter is engaged. The GEN-OFF light will go out when the relevant generator is engaged.
- If a fault is triggered the relevant starter-generator will be disengaged and the GEN-OFF light will flash. To reset the fault the relevant ABORT/RESET switch can be depressed momentarily or its S/G switch can be cycled off and back on again.
- If an engine is shut down while its generator is engaged, the generator will automatically disengage when the generator current reverses.
- If a START switch is accidentally depressed while its generator is engaged, it is ignored and the generator remains online.