



SP PRO - Split Phase Installation Notes

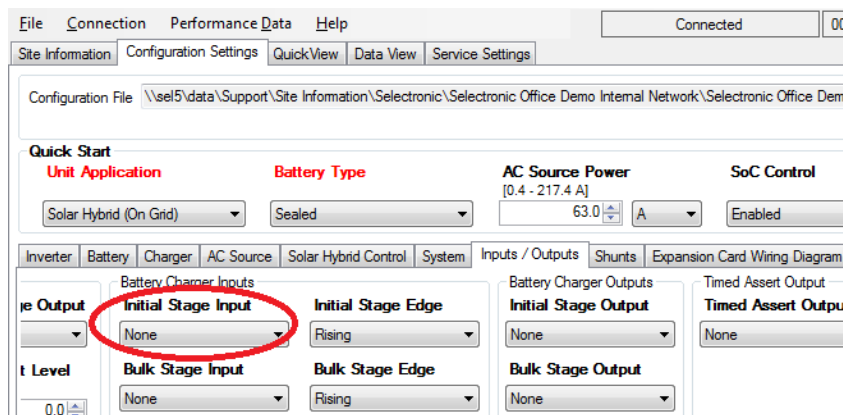
For SP PRO Firmware revision 7.01 and above.

Introduction

SP PRO – Split Phase Installation Notes detail the installation and additional configuration for two SP PRO series II inverters (with firmware revision 7.01 and above) in a split phase inverter system (commonly found on SWER line feeds). One SP PRO is installed per phase and they are interlinked and configured to allow them to operate together. The L1 phase is the prime controller of the split phase system. It controls the operation mode of the system, the synchronisation to the AC source, controlling of the generator etc. The L2 phase SP PRO is controlled by the L1 phase SP PRO via the SYNC interface.

Note: This document needs to be read in conjunction with the SP PRO Instruction Manual and SP LINK instruction manual (both found in SP LINK Help menu)

Note 2: Parameter locations will be shown as adjacent picture or as a drill down structure, such as "Configuration Settings"->"Inputs / Outputs"->"Battery Charger Inputs"->"Initial Stage Input" for



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Installation check list

The follow table summarises the steps taken to set up a split phase SP PRO system. Once the system has been installed, use the following table to check off that each step has been completed.

Refer to the pages following the tables for detailed information on each of the installation steps.

Installation step	L1	L2
Install SP PROs as per manual		
Connect AC wiring		
Connect Main DC wiring		
Wire 600A shunt in L1 and L2 Batt -ve		
Wire 600A shunt sense wires to L1 and L2 shunt 1. Note polarity		
Pre-charge and Midpoint Wiring		
Sync Interface connections		
Charge stage linking		
Battery temperature sensor installed		
Configure Parameters in each SP PRO (see separate table below)		
Verifying Phase Settings	1 flash / 2 sec	2 flash / 2 sec
Test linking of charge stages		
Test shunt 1, positive (+) means charging negative (-) means discharging.		
Zero all current shunts		
Test system function		

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SP PRO Configuration - Additional Configuration Settings		
Parameter to be program	L1	L2
Multi Phase setting ("Configuration Settings"->"System")	L1-Primary	Split phase-Secondary
System – Multiple SP PRO Charging ("Configuration Settings"->"System")	Enable	
Generator Fault input ("Configuration Settings"->" Input / Outputs" -> "Generator Inputs")	none	
External regulator control output ("Configuration Settings"->" Input / Outputs" ->"Extern. Regulator Outputs")	none	
Select "Expansion card wiring diagram" and check Digital control input 1, Digital control input 2, Digital control output 1 and Digital control output 2 are not allocated. ("Configuration Settings"->" Expansion Card Wiring Diagram")	none	
Initial stage input ("Configuration Settings"->" Input / Outputs" ->"Battery Charger Inputs")	Digital control input 2	
Initial stage edge ("Configuration Settings"->" Input / Outputs" ->"Battery Charger Inputs")	Rising	
Float stage ("Configuration Settings"->" Input / Outputs" ->"Battery Charger Inputs")	Digital control input 1	
Float stage edge ("Configuration Settings"->" Input / Outputs" ->"Battery Charger Inputs")	Rising	
Initial stage output ("Configuration Settings"->" Input / Outputs" ->"Battery Charger Inputs")	Digital control output 2	
Float stage output ("Configuration Settings"->" Input / Outputs" ->"Battery Charger Inputs")	Digital control output 1	
Shunt 1 ("Configuration Settings"->" Shunts")	System SoC	
If DC couple solar – Set Shunt 2 name ("Configuration Settings"->" Shunts")	Solar	
If DC couple solar – Set Shunt 2 Max current ("Configuration Settings"->" Shunts")	1/2 solar shunt's max current (to let each unit account for its 1/2 of the charging)	

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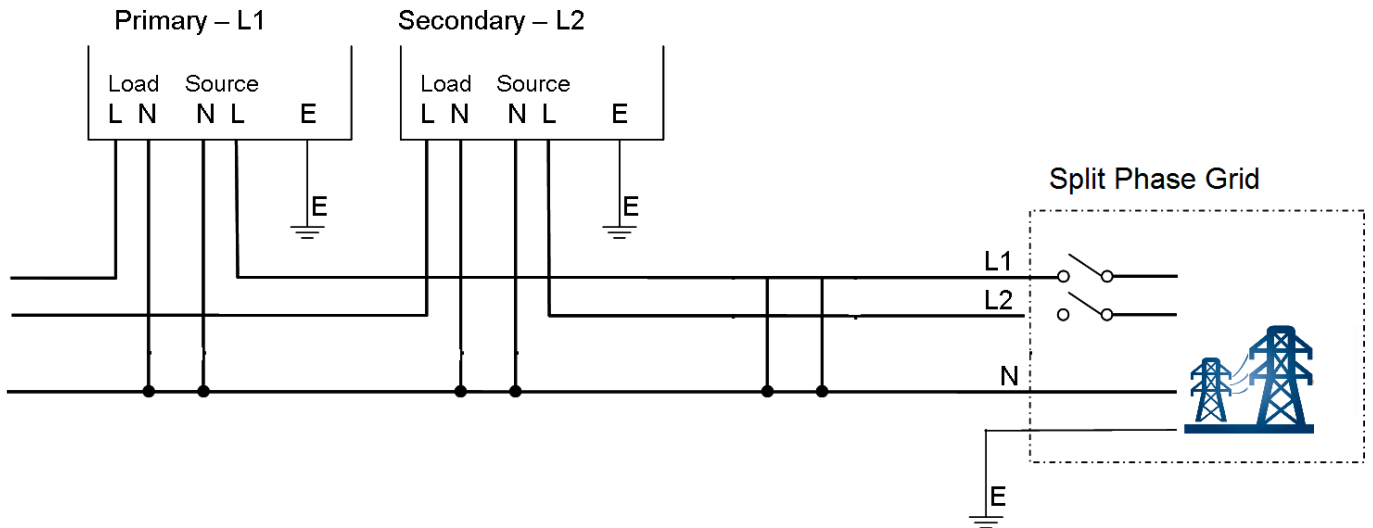
SoC control (“Configuration Settings”->“ Quick Start”)	Enabled	
Battery capacity (“Configuration Settings”->“ Quick Start”)	Battery capacity (@ C rate being used, if unknown use C20)	
Max Charge current (“Configuration Settings”->“ Charger”)	1/2 Max battery charge current	
Battery Charger voltage, time and temperature compensation settings (“Configuration Settings”->“ Charger”)	To suit battery bank	
DC shutdown voltages (“Configuration Settings”->“ Inverter”)	To suit system	Lower than L1
DC Shutdown Recovery Voltage (“Configuration Settings”->“ Inverter”)	To suit system	
Generator lockout override (“Configuration Settings”->“ AC Source”-> “Generator Auto Start”)	To suit system	Lower than L1
Generator controller (Using L1 to control generator) (“Configuration Settings”->“ AC Source”-> “Generator Controller Settings”)	Enable	Disable
AC source power (“Configuration Settings”->“ Quick Start”)	Solar Hybrid (Grid Connected) systems: Maximum required AC source power per phase.	

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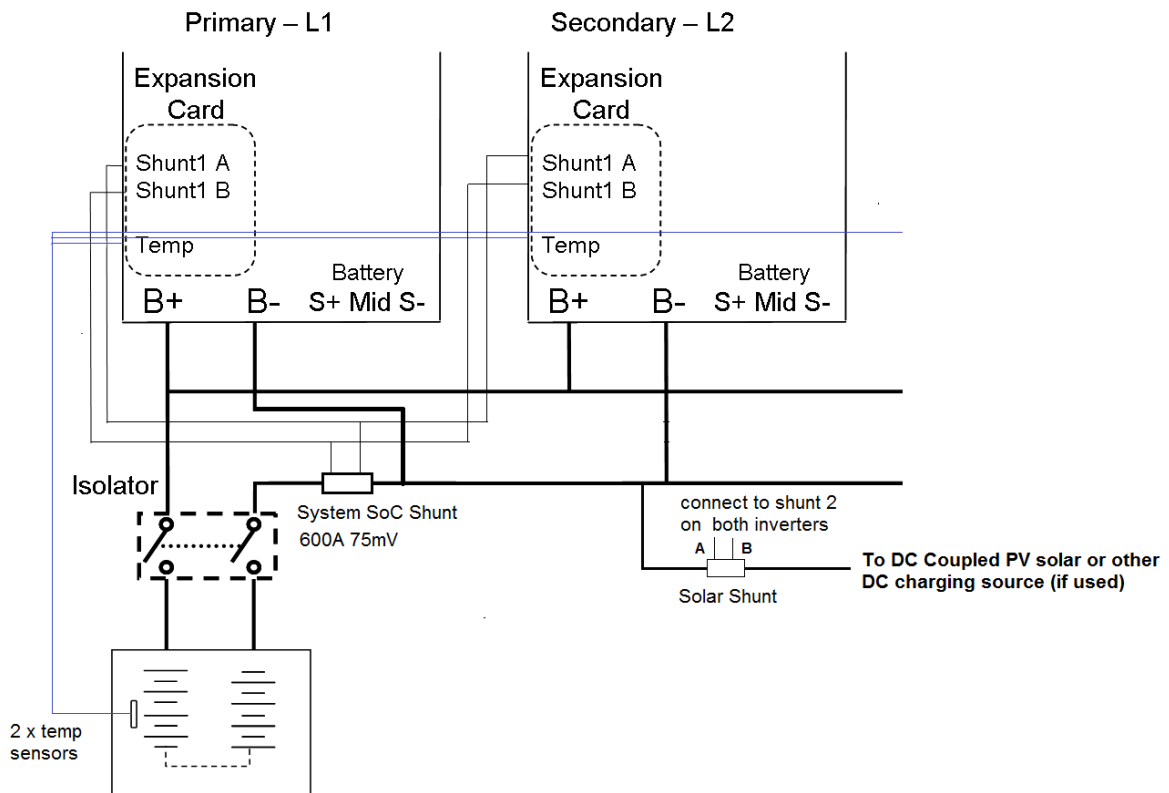
Wiring Overview

The following is an overview of the connections which form part of the SP PRO split phase system.



SP PRO Split Phase AC wiring layout

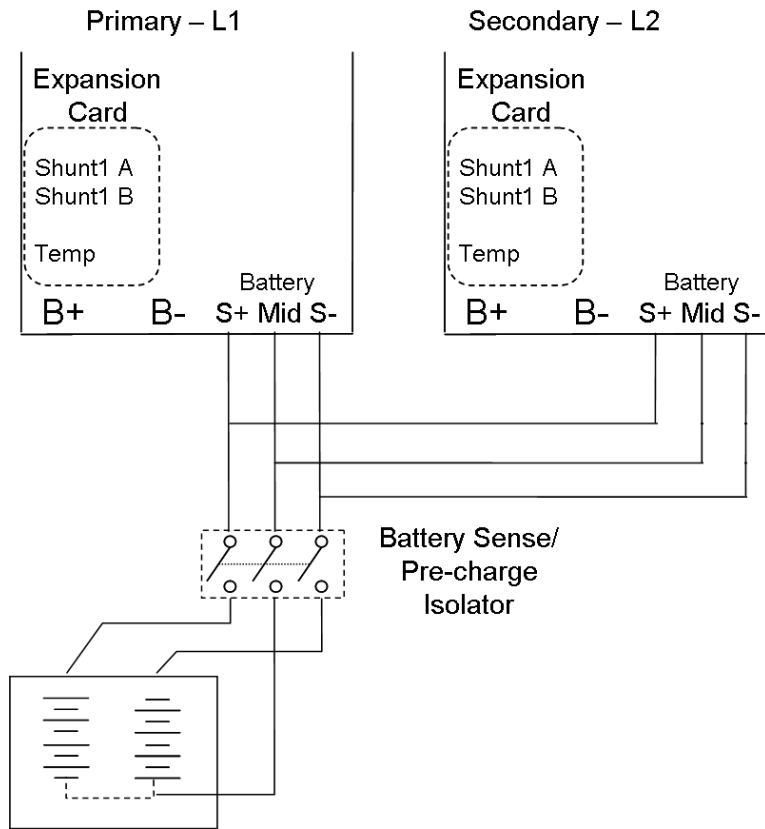
Note: Circuit breakers are not shown on the diagram for clarity.



*SP PRO 3 Phase main DC wiring layout**

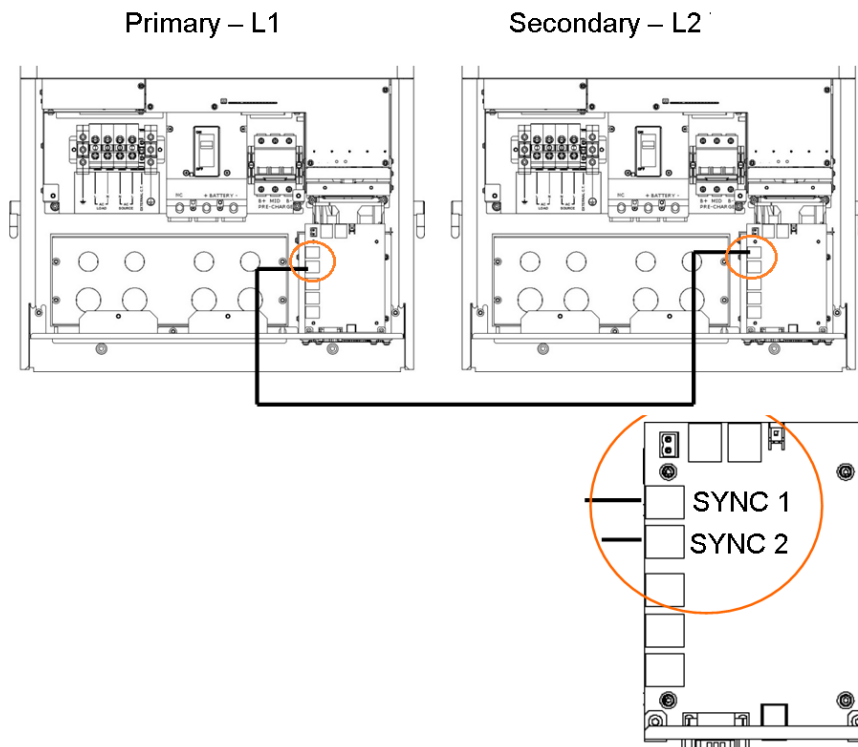
Note: For Isolator and cable ratings refer to SP PRO manual

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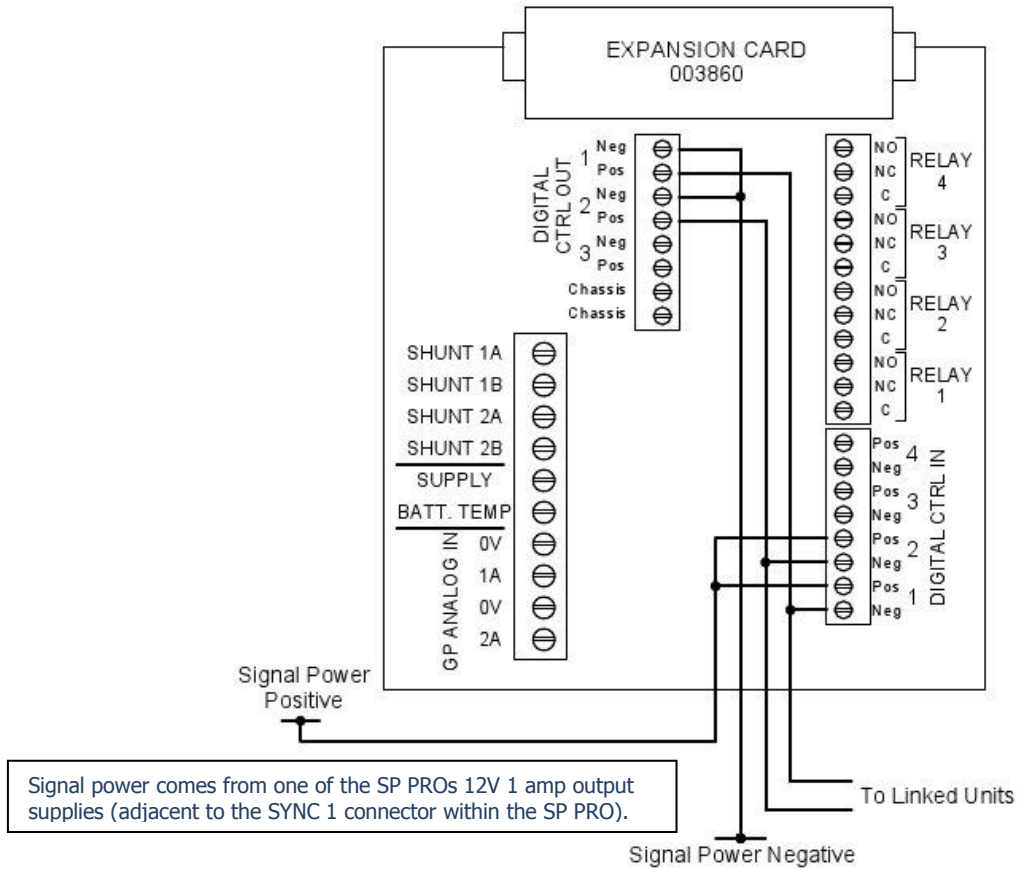
SP PRO 3 Phase DC pre-charge and midpoint wiring layout

Note: Circuit breakers / fuses are not shown on both diagrams for clarity



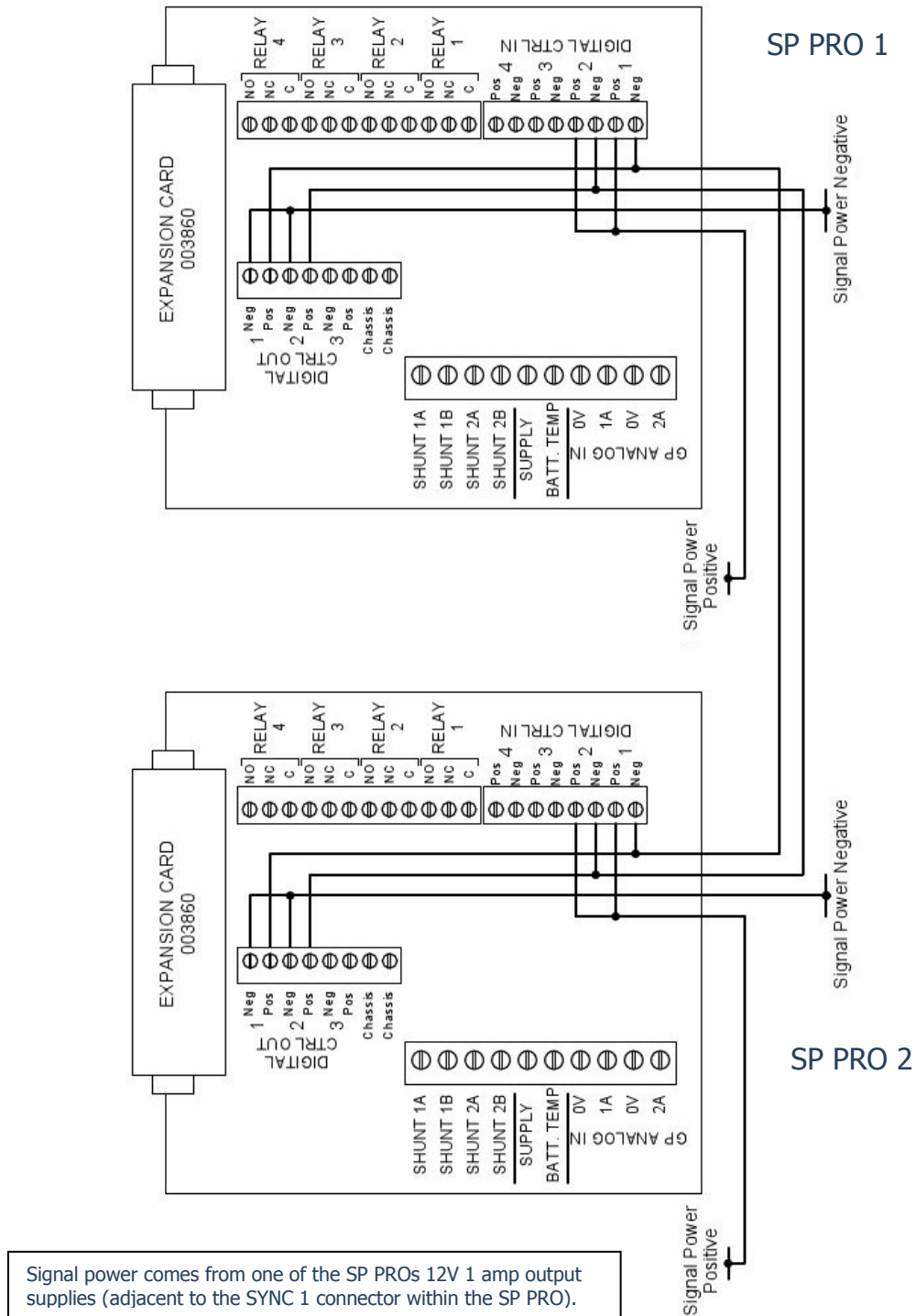
SYNC interface interconnections

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Charge Stage Linking – Common to all SP PRO units

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Charge stage link wiring between SP PRO units

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Installation

The SP PRO units are installed as per the installation instructions in the user manual. Special attention needs to be paid to the minimum spacing between the SP PROs as outlined in the "Preparation" section of the installation manual.

AC Wiring

Attention must be paid to the Neutral conductor and connection through to the loads. The neutral conductor connecting to the loads must be maintained such that operation of any external SP PRO isolators would not alter the bonding between Neutral and Earth.

The Neutral conductors from each phase must be connected. The Neutral connections from L1 and L2 AC Source must be connected together at the same common point. All the Neutral connections from L1 and L2 AC Load must be connected together at the same common point.

Main DC Wiring

L1 and L2 phases must have their main negative battery connection wired in series with a current shunt. The sense wires from the shunt are connected to the shunt inputs on the expansion cards of the L1 and L2 phase SP PROs. The "Shunt 1A" input of the expansion card is to be connected to the SP PRO L1/L2 side of the shunt. The "Shunt 1B" input of the expansion card is to be connected to the battery side of the shunt. This enables both SP PROs to read the total battery current and keep track of the battery *state of charge* (SoC).

If the system incorporates a DC charging source (such as DC coupled PV solar) then a separate current shunt is needed. This current shunt is wired onto the inverter side of the battery shunt with its sense wires connected to both SP PROs (Shunt 2). (see *SP PRO split Phase main DC wiring layout*)

Care must be taken to ensure that the cabling is rated to carry the current for the segment that it is installed in. The negative connection from the shunt to the battery will be carrying the combined current of both SP PRO inverters.

All DC cabling must be protected by suitable fuses or circuit breakers of sufficient capacity. Refer to the user manual for further details.

Pre-charge and Midpoint Wiring

The pre-charge and midpoint wiring should be wired as a bus arrangement and connected to the battery via a common connection for both phases. This will allow all both SP PROs to be pre-charged together. The pre-charge and midpoint wiring must be protected by suitable fuses or circuit breakers of sufficient capacity.

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SYNC Interface Connections

Each SP PRO must be interlinked via its SYNC interface. With reference to the diagram above (*SYNC interface interconnections*) connect each SP PRO together via either SYNC1 or SYNC 2 connection using the supplied "network" type cables. Only one cable is required to connect the two SP PRO units. Both SYNC1 and SYNC 2 connection points are the same and either can be used.

Charge Stage Linking

In order for the SP PROs units to share the charging of the battery bank, it is necessary for the charge stages to switch simultaneously. The charge stages are interconnected via wiring between each of the SP PROs Expansion cards. Each Expansion Card is wired in the same manner, then linked.

Signal power comes from one of the SP PROs 12V 1 amp output supplies (adjacent to the SYNC 1 connector within the SP PRO).

SP PRO Configuration – Additional Configuration Settings

The following details the additional settings required to activate the split phase mode on the SP PRO system. When configuring the system it is necessary to program both SP PRO inverters. It is good practise to start with the L1 Primary Phase as this will prevent false alarms on the L2 phase while loading the configurations.

Both phases must have their configuration programmed before attempting to start the system from Idle mode to On mode.

It is recommended to create a separate SP LINK site file for each SP PRO phase and add the prefix "L1", "L2" to the appropriate file.

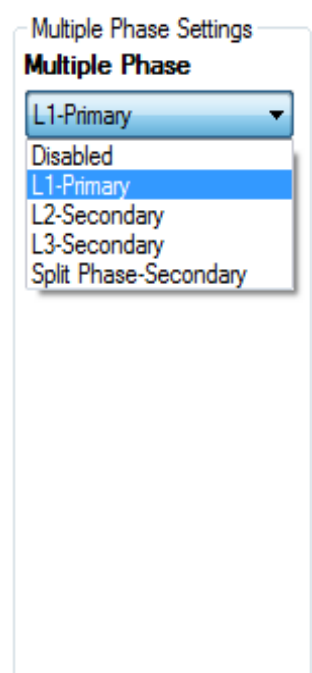
System – Multiple Phase Settings

Each SP PRO must be configured to suit the phase that it the connected to. Each SP PRO must be set to a different phase.

Disabled: SP PRO is set for normal single phase operation. *This setting is not used in a split phase system*

L1- Primary: SP PRO is set on L1 phase

Split Phase – Secondary: SP PRO is set on L2 phase

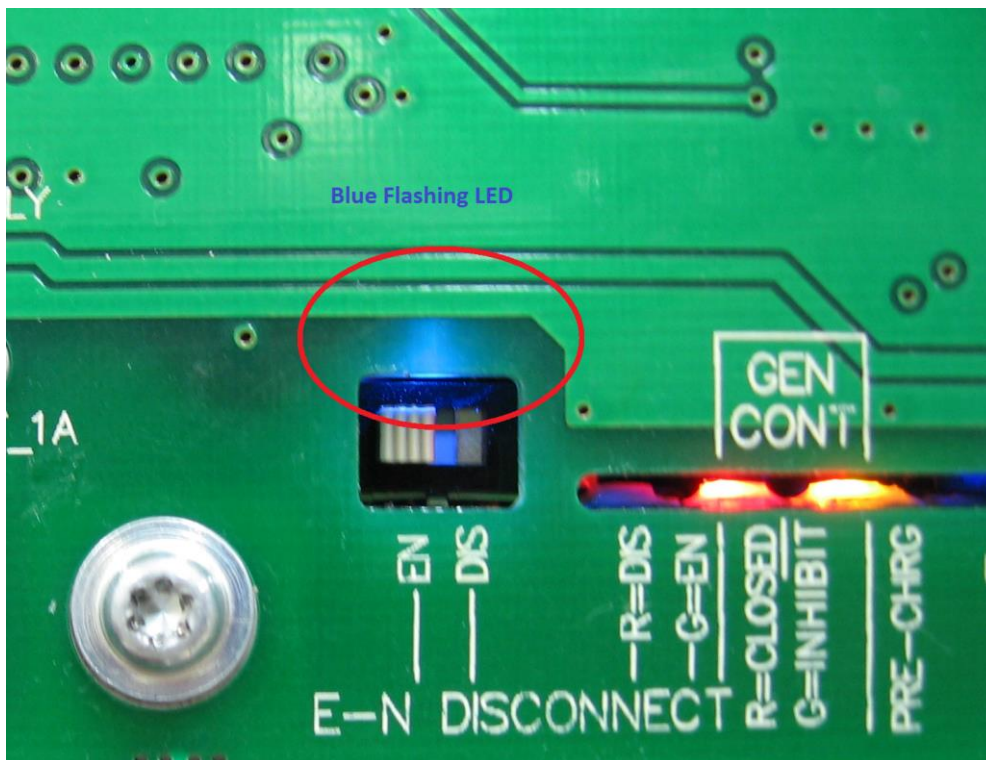


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Verifying Phase Settings

The phase settings can be verified on each SP PRO by observing the blue LED on top of the E-N disconnect switch inside the SP PRO. For standard single phase systems this LED flashes at a rate of one flash repeated every one second. When programmed to L1, the LED flashes at a rate of one flash repeated every two seconds. When programmed to L2, the LED flashes at a rate of two rapid flashes repeated every two seconds.



It is highly recommended to label each phase on the front panel with the supplied phase labels to make identification of the phases easier once the covers are installed.

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System – Multiple SP PRO Charging

In order for multiple SP PROs (as in a split phase system) to share the charging of the battery bank, it is necessary to enable the multiple chargers setting.

Disabled: SP PRO is set for normal single phase, single SP PRO operation. *This setting is not used in a 3 phase system.*

Enabled: SP PRO is set to share the charging with the other SP PROs.

Multiple SP PRO Charging
Enable Multiple Chargers

Enabled ▾
Disabled
Enabled

Charge Stage Linking

Each SP PRO must be configured to accept the link signals.

Clear the following Inputs and Outputs –

Generator Fault Input – None

External Regulator Control Output – None

Generator Inputs	Extern. Regulator Outputs
Generator Remote Start Input None ▾	External Regulator Bypass Output None ▾
Generator Available Input Digital Control Input 3 ▾	External Regulator Control Output* None ▾
Generator Low Fuel Input None ▾	
Generator No Fuel Input None ▾	
Generator Fault Input* None ▾	

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Select "Expansion card wiring diagram" and check Digital control input 1, Digital control input 2, Digital control output 1 and Digital control output 2 are not allocated to any functions. Their boxes should be blank.

Set the following Battery Charger Inputs and Outputs –

- Initial Stage Input –
Digital Control Input 2
- Initial Stage Edge –
Rising
- Float Stage Input –
Digital Control Input 1 (default setting)
- Float Stage Edge
Rising
- Initial Stage Output –
Digital Control Output 2
- Float Stage Output –
Digital Control Output 1

Battery Charger Inputs	Battery Charger Outputs
Initial Stage Input* Digital Control Input 2	Initial Stage Output* Digital Control Output 2
Bulk Stage Input None	Bulk Stage Output None
Absorb Stage Input None	Absorb Stage Output None
Float Stage Input Digital Control Input 1	Float Stage Output* Digital Control Output 1
Equalise Stage Input None	Equalise Stage Output None

Test Linking (Test linking of charge stages)

With all SP PRO units configured, test Float link by briefly touching a link wire across Digital Control Out 1 terminals. All SP PRO units should switch to the Float charge stage. Test Initial link by briefly touching a link wire across Digital Control Out 2 terminals. All SP PRO units should switch to the Initial charge stage. This can be done on any of the phases.

Shunts

The supplied shunt that is wired between the battery bank and the three SP PRO inverters must be configured on L1 and L2 SP PRO as follows:

Name = System SoC
Max Voltage = 75mV
Max Current = 600A

Note1: In "System SoC" mode, shunt currents are displayed with a sign; a positive (+) number means charging and a negative (-) number means discharging.

Note2: Only the "System SoC" shunt is used to accumulate the battery SoC. Currents in all other shunts are excluded from the SoC calculation, they are used to monitor other power source inputs. This allows the three SP PRO inverters to track the battery SoC together.

Shunt 1
Name System SoC
Max Voltage [25 - 100 mV] 75
Max Current [25-1000 A] 600

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If an additional shunt is required for monitoring battery charge current from a renewable DC charging source (such as DC coupled PV solar) then this shunt must be connected to shunt 2 input on each of the L1 and L2 phase expansion cards. The configuration setting for shunt 2 is different from that of Shunt 1. In this case each inverter only measures its share of the charge current being 1/2 of the total charge current. This allows the DC coupled renewable energy to be exported evenly between the three phase.

Name = Solar
Max Voltage = mV rating of the shunt
Max Current = 1/2 of the current rating of the shunt

For example if the Solar current shunt is a 200A 75mV shunt, the settings for shunt 2 are:

Max Voltage = 75mV
Max Current = 100 A (=1/2 of 200A)

Shunt 2

Name
Solar

Max Voltage
[25 - 100 mV]
75

Max Current
[25 - 500 A]
100

No extra shunt is required for AC coupled PV solar as this is measured via the SP PRO.

When all the current shunts have been installed and configured then each of the used current shunts in each of the SP PRO inverters must be zero set (Service Settings in SP LINK).

Zero all current shunts

Put all units into Idle Mode – Hold ON button for 2 seconds – light will flash “orange” (green/red both flashing on at the same time),
then from “Service Settings”->“Shunts”->press “Zero Shunt 1”
Zero all phases in system.

Note: All phases MUST be in IDLE mode while doing this.

Test shunt 1

This test is to check shunt polarity.

With AC Sources disconnected, Apply load to any phase.

Check “Data View”->“Now”->“DC”->“Battery Current”, this should now be negative indicating that the battery is delivering power.

SoC Control

The SoC is managed by all three phases. SoC needs to be enabled on L1 and L2

SoC Control

Enabled

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Battery Capacity

Each SP PRO needs to have the "Battery Capacity" setting configured to the full amp hour capacity of the battery bank.

Battery Capacity
[100 - 10000 Ah]

Max. Charge Current

The Max Charge Current setting in L1 and L2 phases must each be configured to one half of the maximum charge current required by the battery bank. For example if the maximum charge current is 150A then set the Max Charge Current setting to 75A in L1 and L2.

Inverter Battery **Charger** AC

Charge Settings

Max. Charge Current
(as % of of Battery Capacity)
[1 - 100 %]

 50 A

Battery Charger Voltage settings and Temperature Compensation

All of the battery charger voltages, time and temperature compensation settings should be the same on both phases. They both must have their battery temperature sensor connected. Both temperature sensors must be bonded to the same location on the battery bank.

DC Shutdown and Generator Lock Out Override

The low battery voltage generator start and DC shutdown voltages need to be lower on L2 than L1. This allows L1 to start the generator before the other phase shutdowns.

DC Shutdown

Battery 0% Load
[39.6 - 48.0 V]

Battery 100% Load
[39.6 - 48.0 V]

Recovery Voltage
[45.6 - 52.8 V]

SoC Shutdown
Enabled

Shutdown SoC
[0 - 100 %]

Generator Lock Out Override

On Low Battery Voltage

0% Battery Load
[39.6 - 48.0 V]

100% Battery Load
[39.6 - 48.0 V]

On Low SoC
Enabled

Start SoC
[1 - 100 %]

Stop SoC
[1 - 100 %]

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Disable Generator Control on L2 and L3

Normally only L1 is required to control the generator so in this case the Generator Controller setting on L2 is disabled.

AC Input | Generator Auto Start | Generator Schedule Start | **Generator Controller Settings***

Generator

Generator Controller*

Auto Start Available

Minimum Runtime
 [5 - 120 min]

Pre-synchronised Warm Up Time
 [0 - 10 min]

Warm Up Time
 [0 - 10 min]

Cool Down Time
 [0 - 10 min]

Generator Lock Out

Start Time
 [00:00 - 23:59]

Stop Time
 [00:00 - 23:59]

Gene Gen

Start
 [00:00 - 23:59]

Max
 [1 - 1]

AC Source Power

The "AC Source Power" setting in each of the SP PROs is the amount of power that is available from the phase that is connected to that SP PRO. In the case where the SP PRO is connected to a generator, each SP PRO will need to be configured to 1/2 of the generator's rating.

Example 1: If the AC source is a generator that is 20kVA then set the AC Source Power setting on each of the SP PRO inverters (L1 and L2) to 10kVA.

Example 2: If the AC source is a split phase grid with a capacity of 63 A per phase then set the AC Source Power to 63A (or 15.1 kW)

AC Source Power
 [0.1 - 62.5 kVA]

Test System Function

Every system is a little different, so these tests are just a set of tests to consider.

You must apply tests appropriate to your system design.

Some tests that may be applicable:

Test	L1	L2
Load support with No AC Source		
Batteries charging from renewable		
Batteries charging from AC Source		
Generator start activated from set triggers (such as SoC, Generator button on SPPro)		NA
Generator synchronises (Voltage and frequency in specification)		NA

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Solar Hybrid Control

The Solar Hybrid Control settings are set to the same values for both SP PRO inverters. Each group of Solar Hybrid Control settings controls the power flows for that particular phase only.

In the following example we use Priority 1 to achieve the following functions:

Priority 1	Priority 2	Priority 3	Priority 4	Priority 5	Priority 6	Priority 7	Priority 8				
Activation											
Enable Date Time Activation Enabled		Digital Control		AC Source		Inverter Control		Charger Control		Charger Override	
Active Dates		Activation Input		Grid Input Limit		AC Load Support Limit		Battery Charging		Battery Charging	
Begin Date [1 Jan - 31 Dec] 01 Jan		None		[0 - 50 kW] 3.0 kW		[0 - 50 kW] 2.0 kW		Renewable Only		Charging On	
End Date [1 Jan - 31 Dec] 31 Dec		Activation Input Edge		Grid Export Limit		SoC Support Limit		Restricted Charge Limit		Override Charge Limit	
		Rising		[0 - 50 kW] 1.5 kW		[1 - 100 %] 60		[0 - 50 kW] 4.0 kW		[0 - 50 kW] 5.0 kW	
		Active Output		Grid Disconnect		Inverter Disconnect				Start SoC	
		None		Disabled		Disabled				[1 - 100 %] 55	
										Stop SoC	
										[1 - 100 %] 70	

1. The Priority 1 Schedule is always active.
2. The Grid Input Limit is 3kW per phase or 9kW total
3. The Grid Export Limit is 1.5kW per phase or 4.5 kW total
4. Grid Disconnect is Disabled. When available and in tolerance the grid will be connected and synchronised to all three phases.
5. The AC Load support limit is 2kW per phase. This means that only those phases that have a load exceeding the Grid Input Limit (3kW) will have the excess load supported by battery power (up to 2kW). Those phases with loads less than 3kW will not be supported by battery power and will have all their power taken from the grid.
6. SoC Support Limit is 60%. When the battery SoC reaches 60% then all of the three phases will cease to support the load from the battery and all of the load power will be taken from the grid.
7. Inverter Disconnect is Disabled. The inverters on all phases will be running allowing support and Charging functions via the inverter.
8. Charger Control – Battery Charging set to Renewable Only. Charging will only be performed from any renewable charging sources available to that phase.
9. Charger Control – Restricted Charge Limit set to 4kW. This means that the renewable charging will be limited to 4kW per phase which is a total limit of 12kW of renewable charge power for the battery.
10. Charger Override – Battery Charging set to Charging On. During charger override (starting at 55% SoC and ending at 70% SoC in this example) the battery will be charged from both AC grid power and renewable charging sources.

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11. Charger Override – Override Charge Limit is set to 5kW. This means that the charging will be limited during Charger Override to 5kW per phase giving a total charging limit of 15kW for the battery.
12. Start SoC and Stop SoC are set to 55% and 70% respectively. When the SoC drops to 55% and before it rises back to 70% the Charger Override limits apply (points 10,11)

Synchronising SoC between inverters.

Each inverter tracks the battery SoC and use this for the generator control and the Solar Hybrid Schedule.

When the inverters are first powered up the SoC is set to 85%. If this SoC needs to be changed (Service Settings) then the same value must be set in all SP PROs.

When the Battery Charger reaches Float then both inverters will synchronise by resetting to 100% SoC.

Operation

Once the SP PRO units are installed and configured correctly, the system is controlled by the L1 phase. Changing the system operational mode (from "Idle" mode to "Run" mode, or Run to Idle) is done via the "On" button on the L1 phase only. L2 will follow the operational mode of L1 automatically. The "On" button on L2 is disabled.

As each inverter is tracking the battery SoC the battery indicators on the front of L1 and L2 should display the same number of bars.

Additional Information

This information applies to SP PRO Series II units only.

SP PRO web site – <http://www.selectronic.com.au> or contact the Selectronic Sales Team.