SHIFTING THE LIMITS

APPLICATION GUIDE
SETTING UP FULL BATTERY BACKUP WITH FRONIUS PRIMO GEN24 PLUS

THIS DOCUMENT AIMS TO PROVIDE EASY-TO-FOLLOW INSTRUCTIONS ON HOW TO BEST DEPLOY THE BATTERY BACKUP FUNCTION OF FRONIUS PRIMO GEN24 PLUS INVERTER SYSTEM

Application Guide

Version 5.0/2022

1. CHANGE LOG

Date	Version	Comments	Author
23/12/22	5.0	K3 wiring diagram + Table data updates	Fronius Australia
18/03/22	4.0	Minor SLD changes (IO0 + UPS integration)	Fronius Australia
08/09/21	3.0	Multiple major changes	Fronius Australia
16/11/20	2.0	Minor wording changes	Fronius Australia
11/11/20	1.0	Initial release	Fronius Australia

2. GENERAL

Fronius Primo GEN24 Plus offer the opportunity to supply select electrical loads or possibly entire household during grid outages. This functionality is referred to as *Full Backup* function.

This solution works in combination with an energy storage system and supplies electrical loads whenever sufficient energy is available.

Key features are:
- ✓ Supply electrical loads in grid outage (1-phase loads),
- ✓ Automatic switch to backup power in the event of grid failure,
- ✓ Efficient energy flows due to the Multi-Flow Technology, even in backup power situation.
  - This means even in backup mode PV is operational and could charge the battery.

3. REQUIREMENTS

Basic requirements for using the full backup functionality are correctly installed and configured:
- ✓ Fronius Smart Meter,
- ✓ Compatible BYD battery,
- ✓ External backup control and switchover components.

Having PV installed is optional but recommended because it could charge the battery in backup mode during sun hours (if sufficient power is available) which makes this solution self-sustainable.

Additionally, for successful integration please make sure following items are ticked:
- ✓ Inverter is **Fronius Primo GEN24 3.0/3.6/4.0/4.6/5.0/6.0 Plus**,
- ✓ Suitable battery installed,
- ✓ Inverter+Battery capacity suitable for the backup loads connected,
- ✓ Fronius Smart Meter correctly installed (feed-in point),
- ✓ Correct Hardware applied,
- ✓ Correct Software Settings applied,
- ✓ Warning notice - Backup Power Supply installed, see appendix A,
- ✓ Backup power checklist completed, see appendix B.

4. TECHNICAL INFORMATION

4.1 Battery compatibility

Compatible batteries are listed below.

Table 4.1.a: Primo GEN24 Plus compatible BYD batteries

BYD Battery-Box Premium HVS / HVM	Primo GEN24 Plus
HVS 5.1	✓
HVS 7.7	✓
HVM 11.0	✓
HVM 13.8	✓
HVM 16.6	✓
HVM 19.3	✓

4.2 BYD Battery-Box Premium information

Key relevant specifications of the BYD Battery-Box Premium batteries are shown below. For more information visit BYD's online documentation available here.

Table 4.2.a: BYD Battery-Box HVS/HVM Premium specifications

BYD BATTERY-BOX PREMIUM *	HVS 5.1	HVS 7.7	HVM 11.0	HVM 13.8	HVM 16.6	HVM 19.3
Usable capacity of the battery [kWh]	5.1	7.7	11.0	13.8	16.6	19.3
Nominal voltage of thebattery [V]	204	307	204	256	307	358
Battery operating voltage [V]	160 - 240	240 - 360	160 - 240	200 - 300	240 - 360	280 - 420
Max. charge/discharge current Primo/Symo GEN24 Plus [A]	22					
Max. charge/discharg current Symo Hybrid (A)	16					

* Values according to BYD.

Table 4.2.b: Charging/discharging power capability of Fronius Primo GEN24 Plus inverters and BYD HVM/HVS

MAXIMUM CHARGING AND DISCHARGING POWER WITH GEN24 PLUS (KW)	HVS 5.1	HVS 7.7	HVM 11.0	HVM 13.8	HVM 16.6	HVM 19.3
Primo GEN24 3.0 Plus	3.2	3.2	3.2	3.2	3.2	3.2
Primo GEN24 3.6 Plus	3.9	3.9	3.9	3.9	3.9	3.9
Primo GEN24 4.0 Plus	4.2	4.2	4.2	4.2	4.2	4.2
Primo GEN24 4.6 Plus	4.5	4.9	4.5	4.9	4.9	4.9
Primo GEN24 5.0 Plus	4.5	5.3	4.5	5.3	5.3	5.3
Primo GEN24 6.0 Plus	4.5	6.3	4.5	5.6	6.3	6.3

It is possible to combine multiple BYD batteries to increase energy storage capacity, with key information show below. Compatibility confirmation is available here.

Table 4.2.c: Energy capacity of paralleled BYD HVM/HVS batteries.

	BYD BATTERY-BOX PREMIUM					
	2x / 3x HVS 5.1	2x / 3x HVS 7.7	2x / 3x HVM 11.0	2x / 3x HVM 13.8	2x / 3x HVM 16.6	2x / 3x HVM 19.3
Capacity [kWh]	10.24 / 15.36	15.36 / 23.04	22.08 / 33.12	27.60 / 41.40	33.12 / 49.68	38.64 / 57.96
Primo GEN24 Plus	✓	✓	✓	✓	✓	✓

** Follow BYD's installation manual on correct installation/configuration instructions when paralleling multiple batteries.*

4.3 Primo GEN24 Plus information

Inverter's backup and battery technical details are shown below:

Table 4.3.a: Primo GEN24 Plus technical details

			Primo GEN24 Plus		
			3.0	3.6	4.0
Output data FULL Backup[1]	Nom. output power Full Backup	VA	3000	3600	4000
	Grid connection Full Backup	V	1~ NPE 220/230		
	Switching time	sec.	< 90		
Battery connection	Number of DC inputs		1	1	1
	Max. input current ($I_{dc\ max}$)	A	22	22	22
	DC input voltage range ($U_{dc\ min}$ - $U_{dc\ max}$)	V	150 - 455	150 - 455	150 - 455
	DC battery connection technology		1x BATT+ and 1x BATT- push-in spring terminals 2.5 - 10 mm²		
	Max. DC input/output power[2]	W	3110	3810	4140
	Max. charging power for AC coupling[2]	W	3000	3680	4000
	Compatible batteries		BYD Battery-Box Premium HVS/HVM[3]		

			Primo GEN24 Plus		
			4.6	5.0	6.0
Output data FULL Backup[1]	Nom. output power Full Backup	VA	4600	5000	6000
	Grid connection Full Backup	V	1~ NPE 220/230		
	Switching time	sec.	< 90		
Battery connection	Number of DC inputs		1	1	1
	Max. input current ($I_{dc\ max}$)	A	22	22	22
	DC input voltage range ($U_{dc\ min}$ - $U_{dc\ max}$)	V	150 - 455	150 - 455	150 - 455
	DC battery connection technology		1x BATT+ and 1x BATT- push-in spring terminals 2.5 - 10 mm²		
	Max. DC input/output power[2]	W	4750	5170	6200
	Max. charging power for AC coupling[2]	W	4600	5000	6000
	Compatible batteries		BYD Battery-Box Premium HVS/HVM[3]		

4.4 Backup Capability - Nominal and Overload

Continuous and overload capability[1] of the inverters are listed below.

Table 4.4.a: AC output capability for Primo GEN24 Plus

Power Class	*3.0*	*3.6*	*4.0*	*4.6*	*5.0*	*6.0*
Continuous [VA]	3000	3600	4000	4600	5000	6000
Continuous [A] @ 230Vac	13	15.6	17.3	20	21.7	26
Overload (5sec) [VA]	6200 (27.9A @ 230Vac)					

Any active power demand imposed to the inverter from the loads will be met with energy coming from the battery and PV, if available.

Any reactive power demand imposed to the inverter from the loads will be met without discharging the battery or without using energy from PV, if available.

4.4.1 System Capacity Limitations - Examples

To better explain the continuous capacity constraints of the whole system comprised of batteries and inverter, an example with different load configurations is shown below.

Example 1: Primo GEN24 6.0 Plus + BYD HVM 11

- ✓ Max battery discharge: 4.5 kW,
- ✓ Max inverter capacity (total): 6 kVA.

Table 4.4.1.a: Example 1 System and loads capacity considerations

	Load	*Comment*
Example 1	3 kW / 3 kVA	Ok
Example 2	4 kW / 6 kVA	Ok
Example 3	5 kW / 5 kVA	Battery capacity surpassed

The key takeaway is to understand the capacity limitations of the whole system comprised of a battery and an inverter.

As PV might be present during the backup operation, it will top up the battery capacity if available and if needed. However, as PV by nature is not a reliable energy source this can't be guaranteed.

[1] *Note 1: Battery size/capacity may limit this further, refer to table 4.2.2.b*

5. OPERATIONAL MODES

There are two main operational modes, *Grid* and *Backup* as well as one informational *Energy Saving* mode, discussed in detail below.

5.1 GRID MODE

This mode denotes that the inverter is AC coupled with the local grid, backup control logic is turned off and backup loads supplied from the grid.

5.1.1 GRID-TO-BACKUP TRANSITION

Successful transition to backup mode requires the following conditions to be met:

1) Grid (via the AC port of the inverter) is monitored by the inverter's internal protection unit and Fronius Smart Meter.
2) Grid fails (blackout).
3) The inverter carries out measurement according to country standard and then shuts down.
4) The inverter starts Backup mode after a short time window.
5) Backup control logic is switched on and loads connected to the backup power circuit are supplied by the inverter.

5.2 BACKUP MODE

Operation in Backup mode usually means the grid is not available and the inverter is supplying backup loads. The interlocking mechanism from the backup control components is on/activated.

In backup mode inverter's AC output acts as a voltage source with AC voltage set at 230 Vac (L-N) and AC frequency set at **53 Hz**. AC frequency is purposely increased with the intention of disconnecting other inverters connected to the backup circuit if any.

5.2.1 BACKUP-TO-GRID TRANSITION

Successful transition to grid mode requires the following conditions to be met:

1) Inverter operating in backup power mode.
2) The grid is back and stable.
3) Fronius Smart Meter monitors grid voltage values and passes this information to the inverter.
4) Inverter checks if the grid voltage is within the correct range.
5) Inverter ends backup power mode.
6) Backup control logic is turned off and AC loads are reconnected to the grid.
7) The inverter checks if the grid is within specified parameters (relevant standard) and if successful starts producing energy.

5.3 ENERGY SAVING MODE

Energy Saving mode usually means that the battery is running at or below the minimum state of charge and there is no sufficient power to charge (PV or grid).

The inverter enters this mode if either of the following is true:

1) The battery is discharged to the minimum state of charge and no energy is coming from the PV modules.
2) The inverter/battery is set to Energy Saving mode (standby mode).

If battery and inverter are in Energy Saving mode, the system could be reactivated by one of the following:

1) Enough energy is available from the solar PV modules.
2) Grid is functioning again.
3) The battery is switched off and on.

6. HARDWARE SETUP

6.1 Required Components – Backup Control

For successful battery backup interfacing, external components **K1 (main)** and **K3 (interface)** are required, and not supplied with the unit. They will need to be purchased separately from your electrical wholesaler or electrical supplier.

Compatible options for K1 are shown below. Options two and four require two devices *main* and *auxiliary* component, while options one and three require *main* component only.

Table 6.1.a: Options for K1 – Main

Option	1	2		3	4	
Manufacturer	Noark	Schneider		IMO	IMO	
Type	Ex9CH63 11	A9C20862	A9C15914	HC63-11230	HC63-20230	HCA11
Component description	Main	Main	Auxiliary	Main	Main	Auxiliary
Control Coil Rated Voltage	230 Vac @ 50 Hz	230 Vac @ 50 Hz	230 Vac @ 50 Hz	230 Vac @ 50 Hz	230 Vac @ 50 Hz	Mechanical interlock
Control Coil Power Consumption	5.10 VA	4.6 VA	n/a	5-7 VA	5-7 VA	n/a
Pole Configuration	1 NO + 1 NC	2 NO	1 NO + 1 NC	1 NO + 1 NC	2 NO	1 NO + 1 NC
Rated Voltage	230 Vac @ 50 Hz	230 Vac @ 50 Hz	as main module	230 Vac @ 50 Hz	230 Vac @ 50 Hz	as main module
Rated Current	63 A	63 A	2 A	63 A	63 A	3 A
Image						

Compatible devices for K3 are shown in the table below. Unfortunately, only one option is available at the moment. If you have an alternative that matches the requirements feel free to contact us directly at the email supplied at the end of the document.

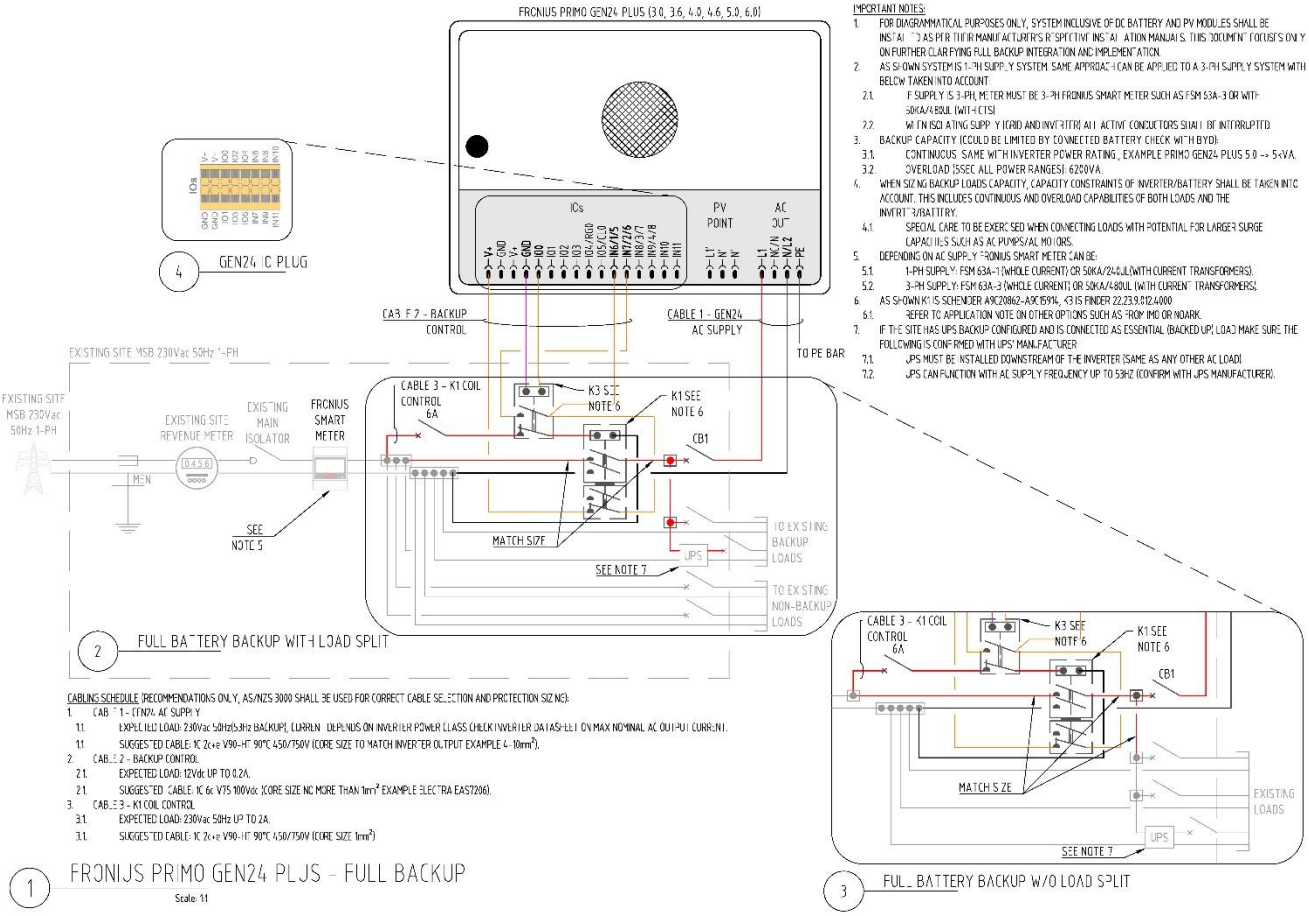
Table 6.1.b: Options for K3 – Interface

Option	1	2
Manufacturer	Finder	IMO
Type	22.23.9.012.4000	HME-2 1-PN/12DC
Control Coil Rated Voltage	12 Vdc	12 Vdc
Control Coil Power Consumption	1.25 W	0.53 W
Pole configuration	1 NO + 1 NC	1 NO + 1 NC
Rated Voltage	230 Vac @ 50 Hz	250 Vac @ 50 Hz
Rated Output	20 A	8 A
Image		

6.2 Control Wiring

The figure below shows a typical wiring diagram of the backup control interface with necessary backup control components. Also shown in Appendix D for better clarity.

Figure 6.2.a: Backup control wiring diagram (K1 matching option 2)



Important notes to consider:

1) Components K1 and K3 need to be purchased separately from relevant electrical suppliers.
2) When selecting/installing K1 ensure connected load capacity is lower than the capacity of the contactor. Special considerations must be in place for sites that have only backup loads and/or other inverter in backup circuit.

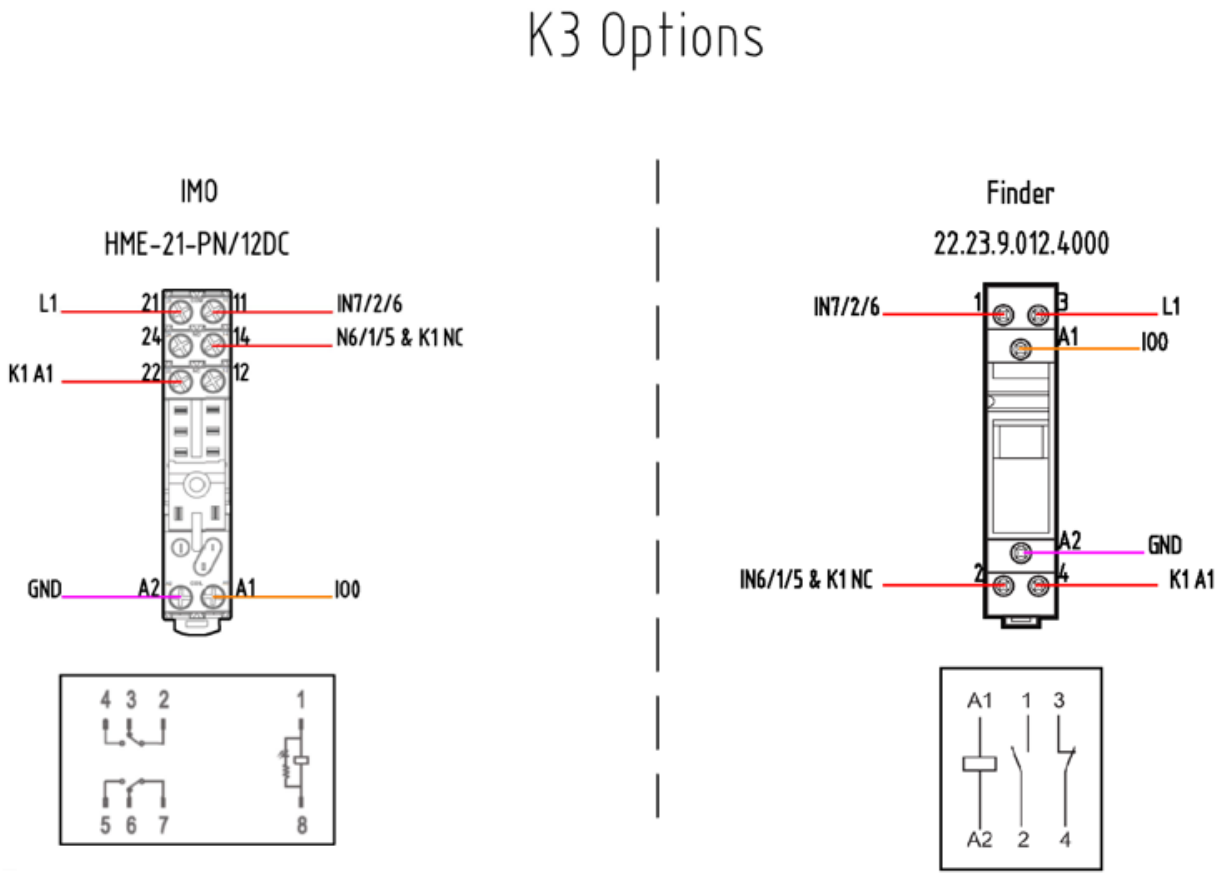


Figure 6.2.b: Backup control wiring diagram (K3 wiring labels)

6.2.1 Control Wiring – Correct Device Positioning

When following the Control Wiring it's important to understand correct device positioning is crucial to ensure correct operation of the full backup functionality.

Important points relevant to correct device positioning are as follows:

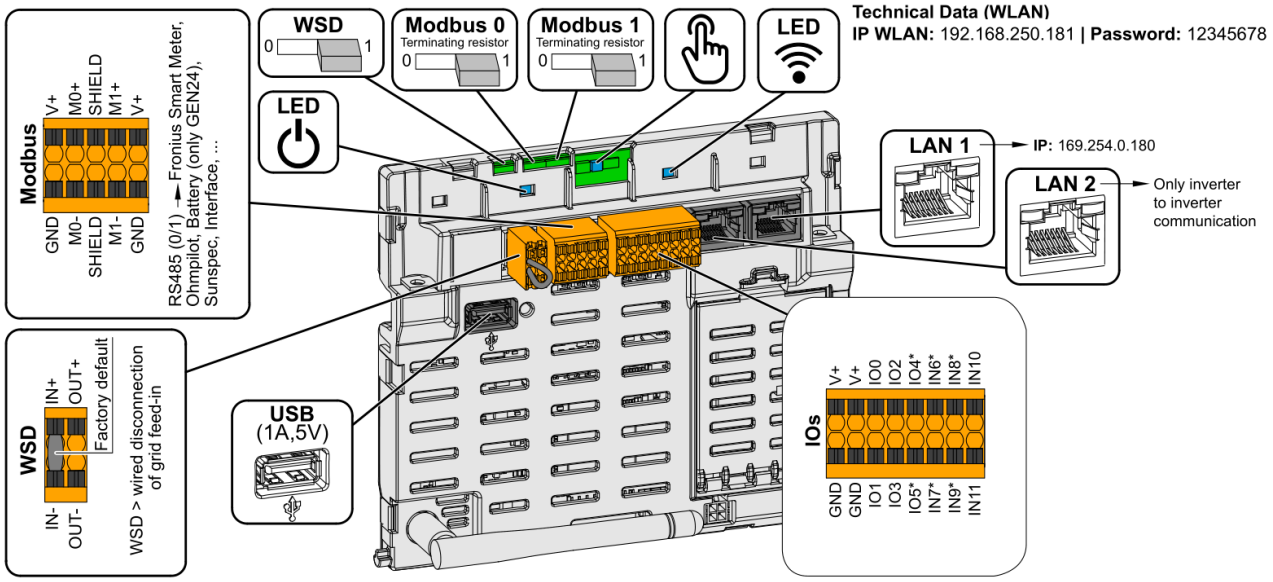
1) Fronius Smart Meter installed at the *feed-in* point.
2) K1 main contacts:
    a. 3xNO installed at:
        i. *Load side* of Fronius Smart Meter and,
        ii. *Supply side* of Backup loads/GEN24 Inverter.
    b. 1xNC installed at:
        i. *Supply side* of K3 NC coil and,
        ii. *Load site* of V+ terminals.
3) K1 control coil installed at *load side* Fronius Smart Meter (L1/Red phase) and *supply side* of K1 main contacts.
4) Backup loads & GEN24 inverter installed at *load side* of K1 main contacts (3xNO).
5) Non-backup loads (if present) installed at *load side* of Fronius Smart Meter and *supply side* of K1.

Additional PV inverters – Grid only (AS/NZS 4777 compliant) can be installed in the backup power circuit. As operational frequency in backup mode is 53 Hz they will not produce power.

6.2.2 GEN24 Pilot – Connection Area

Figure 6.2.2.a: Backup control wiring connection area (GEN24 Pilot)

Figure 6.2.2.b: GEN24 Pilot connection area



7. SOFTWARE SETUP

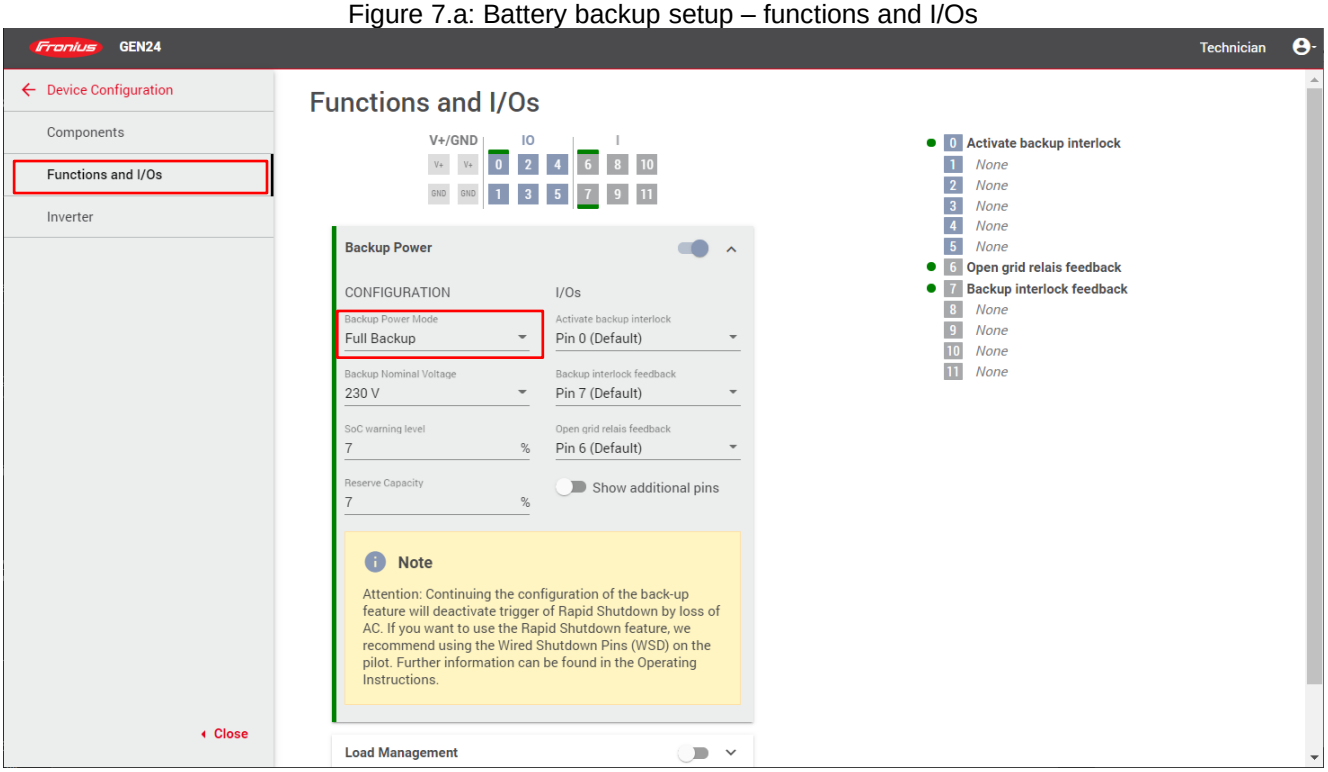
The following assumes standard commissioning process for the battery and inverter (including Fronius Smart Meter) have been completed.

Primo GEN24 installation instructions → **GEN24 Operation manual,**
GEN24 commissioning → **Fronius Solar.Start** from your phone/tablet/pc.

When ready to set the full backup mode, follow the steps below:

1) From the WebUI, log in as **Technician**
2) Go to **Device Configuration → Functions and I/Os**
3) Select **Backup Power** and set **Backup Power Mode** to **Full Backup**, refer to below.

Figure 7.a: Battery backup setup – functions and I/Os



8. TESTING & TROUBLESHOOTING

8.1 Testing

Test backup mode functionality when the system is installed and commissioned for the first time. The battery should have a state of charge of at least 30% when performing the test.

Furthermore, we have developed a checklist that clearly shows steps to be followed for successful integration, shown in Appendix B (click on the image for the actual document).

Upon successful commissioning, Fronius Battery Warning Notice, shown in Appendix A, could be used to denote Backup presence at premises.

8.2 Troubleshooting

The table below summarises states of important control parameters which could be used for troubleshooting or assessing faulty components. For example, when Grid mode is active K1 is Engaged, IO0 is OFF, etc.

Table 8.2.a: Input/output states as a function of main operational modes

Mode	*Grid*	*IO0*	*DI6*	*DI7*	*K3*	*K1*	*Backup loads*	*Non-backup loads*
Grid	ON	OFF	OFF	OFF	DISENGAGED	ENGAGED	**ON**	**ON**
Backup	OFF	ON	ON	ON	ENGAGED	DISENGAGED	**ON**	**OFF**

Additional clarification of the control logic and used contacts with their accompanying actions is shown below.

Table 8.2.b: Backup control functions and relevant contacts

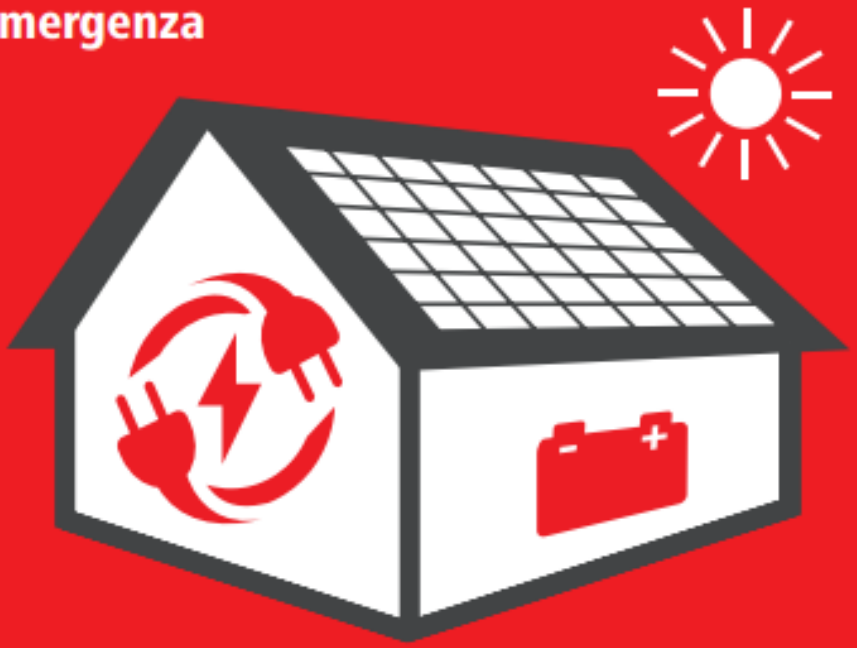
Function	*Contact*	*Purpose & clarification*
Activate feedback	K3 COIL/IO0	When the inverter wants to turn on Backup Mode IO0 is energized (12Vdc), which in turn engages K3 -> disengages K1
Grid Isolation	K3 NC	Supplies 230Vac to K1 coil which in turn connect or disconnect backup loads and inverter to the grid
Backup interlock feedback	K3 NO	Signals the state of the backup mechanism
Open grid relay feedback	K1 NC	Signals the state of the grid to the inverter

9. APPENDIX A – WARNING NOTICE BACKUP POWER

/ Perfect Welding
/ Solar Energy
/ Perfect Charging

CAUTION
ATTENTION
ACHTUNG
ATTENZIONE

This house is being supplied with backup power.
Dieses Haus wird mit Notstrom versorgt.
Cette maison utilise une alimentation de secours.
Questa abitazione dispone di una alimentazione di emergenza



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10. APPENDIX B – BACKUP INSTALLATION CHECKLIST

/ Perfect Welding / Solar Energy / Perfect Charging

CHECKLIST - BACKUP POWER

Once installation, configuration, and commissioning have been successfully completed, this checklist must be worked through to ensure the back-up power changeover function and backup power mode are operating correctly.

TASK	TEST	CONFIRMATION
The inverter, battery, and all other necessary components have been installed and assembled correctly.		☐
The backup power changeover unit has been installed and commissioned in accordance with the country-specific installation guidelines and as outlined in the documentation.		☐
The software settings have been carried out in accordance with the „Backup power configuration" chapter in the documentation.		☐
A warning notice has been put on the switch cabinet to warn that a backup power supply has been installed.		☐
Start the inverter in grid power feed operation.	Check whether the inverter starts in grid power feed operation and a power shift takes place. (Test duration 6 minutes).	☐
Disconnect the PV system from the public grid. This can be effected using a disconnecting device in the upstream AC path or the disconnecting devices (e.g. NH fuse) of the building connection. The disconnection must occur before the Smart Meter (grid side).	Check whether the inverter starts in stand-alone operation. The changeover can take more than 1 minute.	☐
Measure the voltage/frequency in the established stand-alone operation.	Set value: 230 V / ± 10 % / 53 Hz USA: 120 V / ± 10 % / 63 Hz	☐
Reconnect the PV system to the public grid.	The time taken from the end of stand-alone operation until the subsequent connection of the contactors in the backup power changeover unit must be at least 10 seconds. The changeover can take more than 1 minute. Only then may the inverter resume grid power feed operation. This must be checked by the inverter (test duration 6 minutes).	☐

I hereby confirm that the backup power changeover function and backup power mode are operating correctly.

Place, date

Signature

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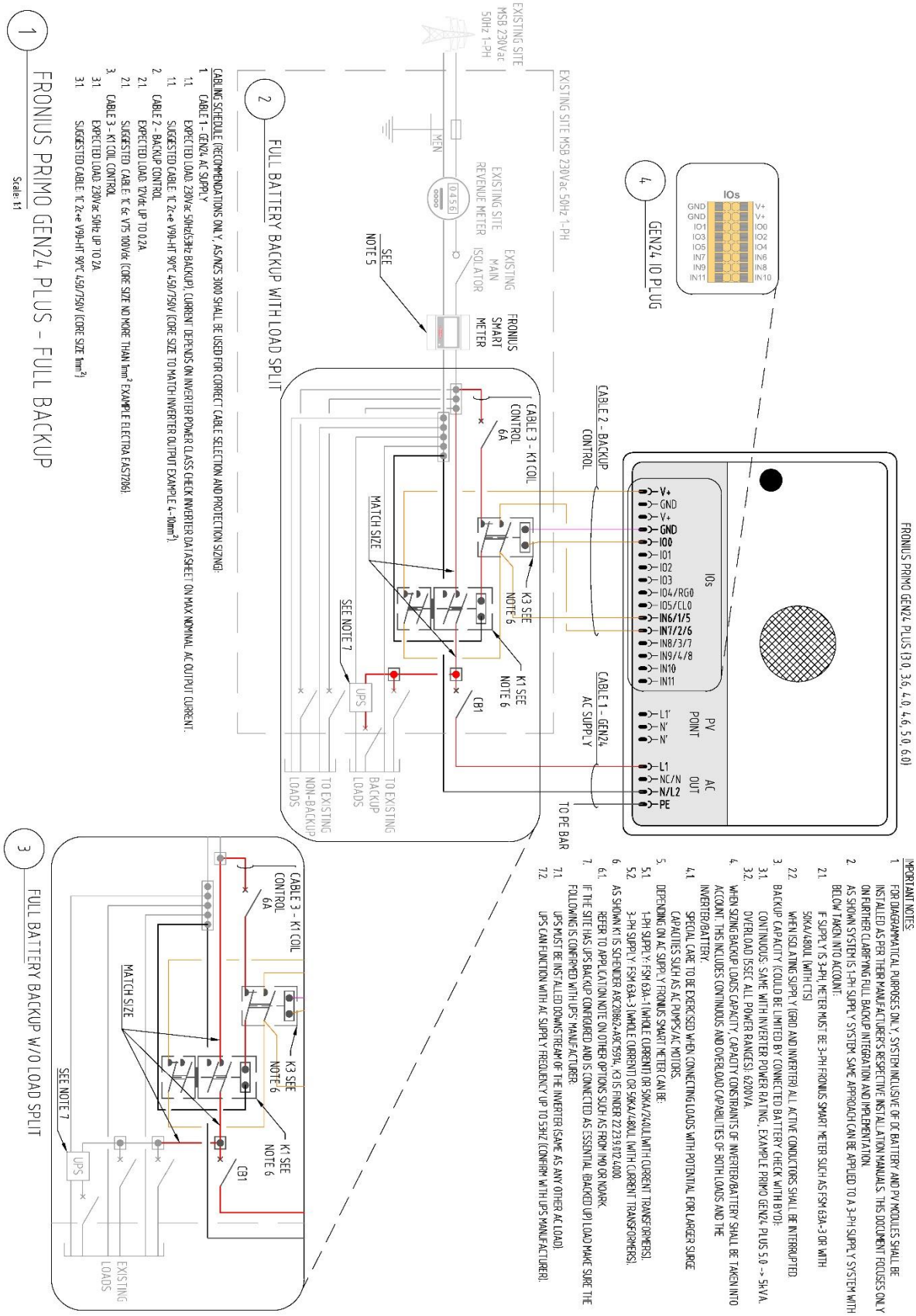
11. APPENDIX C – BACKUP CONTROL K1 AND K3 REQUIREMENTS

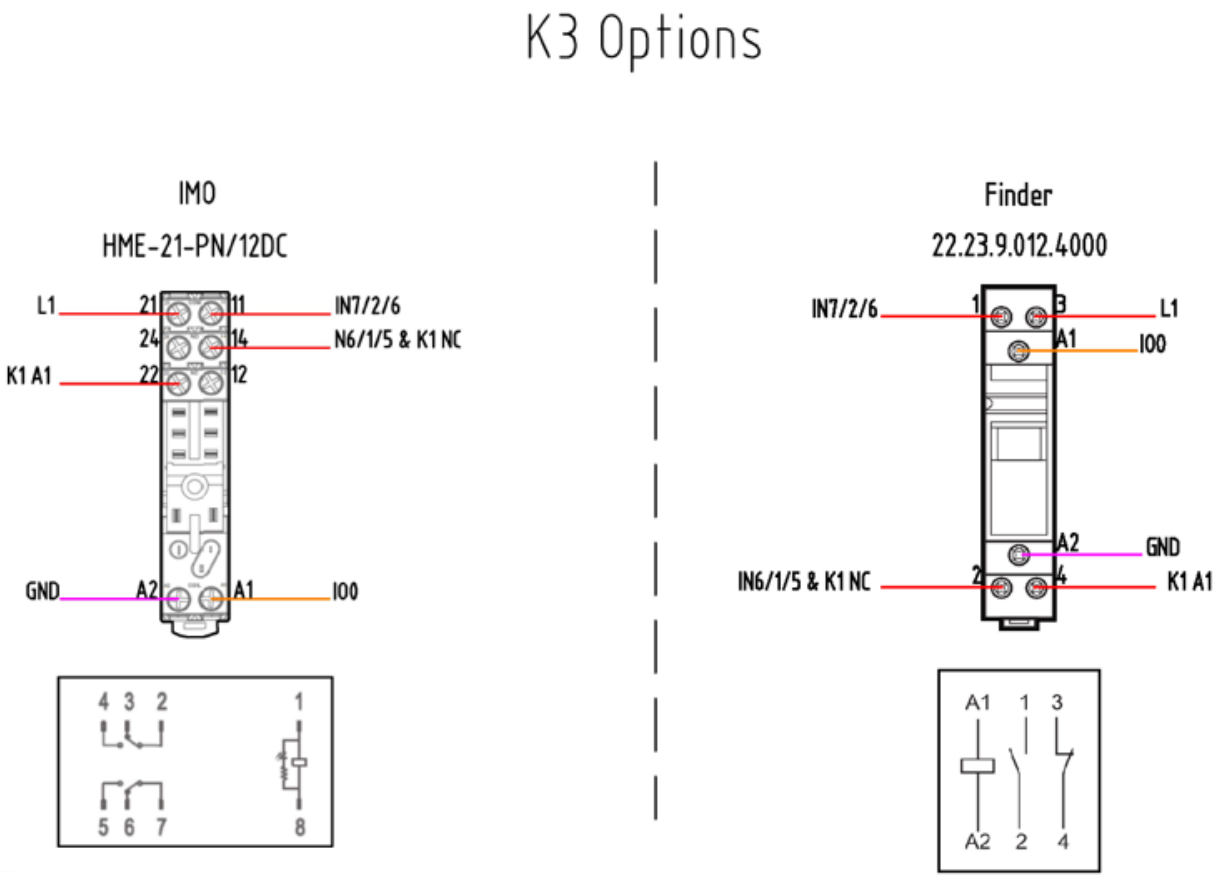
Table C.1: Backup control components – operational requirements

	K1 – main	K3 – interface
Main Contacts		
Main pole configuration	1 NO + 1 NC	1 NO + 1 NC
Rated Operational Voltage	230 Vac	230 Vac / 12 Vdc
Rated Operational Current	at least 63 A	at least 10 A
Rated Operational Frequency	50 Hz	50 Hz / DC
Control Coil		
Rated Operational Voltage	230 Vac	12 Vdc
Rated Operational Frequency	50 Hz	n/a (DC)
Rated Inrush Power	below 100 VA	below 3 W

12. APPENDIX D – CONTROL WIRING



13. APPENDIX E – K3 WIRING



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Fronius Australia Technical Support
Email: PV-Support-Australia@fronius.com
Phone: 03 8340 2910

For more detailed information see the operation manual available on the product specific page on http://www.fronius.com/en-au/australia