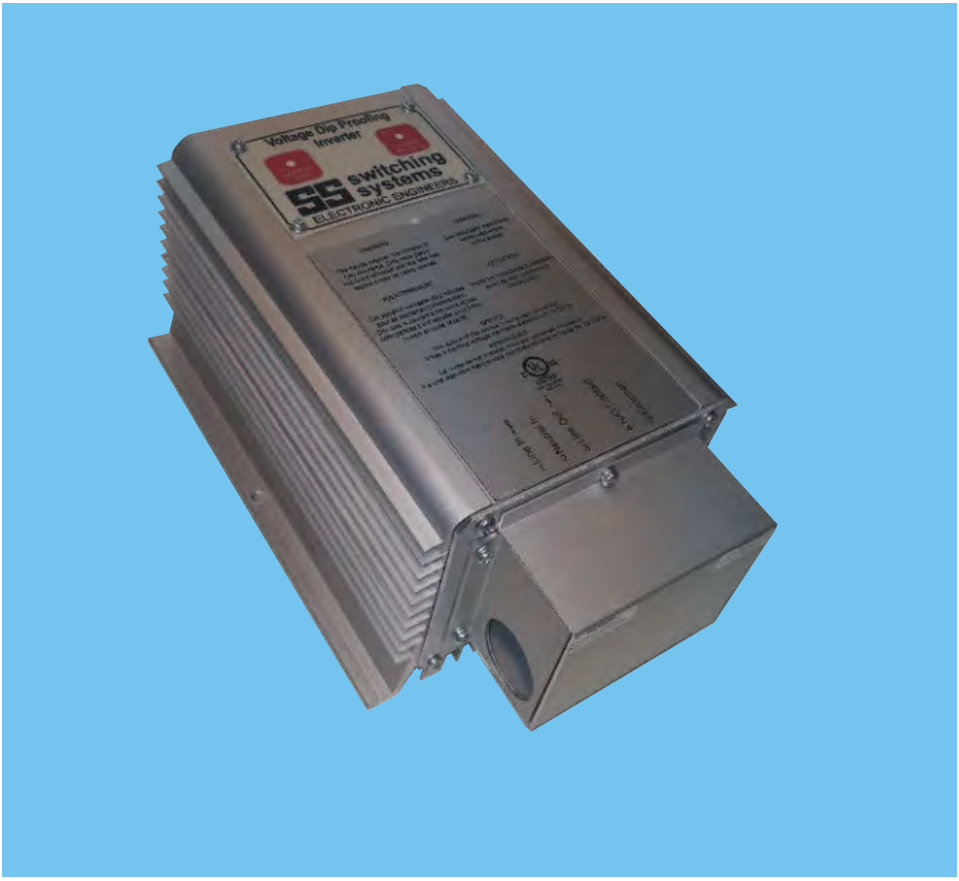
User Manual

Voltage Dip-Proofing Inverter

DPI54SUL Series



MEASURLOGIC

User Manual

Contents:

Note:

All models in the DPI54SUL Series are UL certified: File Number E483916
UL 1778 UNINTERRUPTIBLE POWER SYSTEMS - Edition 5 - Revision Date 2017/10/12
& CSA C22.2 NO. 107.3-14 UNINTERRUPTIBLE POWER SYSTEMS - Edition 3 - Issue Date 2014/06/01

Notice:

IMPORTANT SAFETY INSTRUCTIONS!
KEEP THESE INSTRUCTIONS FOR FUTURE REFERENCE

This manual contains important instructions for Model DPI54SUL Series that should be followed during installation and maintenance of the Voltage Dip-Proofing Inverters.

Introduction

The reliability of electrical power to industry is in general very high, nevertheless, voltage sags and short power interruptions or voltage dips occur. These instabilities are caused by short circuits, lightning strikes on overhead power lines and heavy load switching. The duration of such faults is generally shorter than one second.

Most plant can ride through such voltage dips by virtue of their mechanical and electrical inertia. However, this is not the case with electrically held-in contactors and relays that control the machinery. Contactors typically drop out from 5ms to 20ms after power is removed. Each short voltage dip now becomes a power failure and the plant must be restarted. This can be complicated, time-consuming and costly.

SWITCHING SYSTEMS' VOLTAGE DIP- PROOFING INVERTERS are designed to maintain the switchgear control voltage during voltage dips, effectively keeping the plant connected. The stored electrical and magnetic energy is allowed to flow, supporting the mechanical inertia of the machinery. When the power is restored after a short voltage dip, the plant is still running at near synchronous speed, the inrush currents will be small and the stress to the system minimal.

Historically, this problem has been addressed by using DC contactors, latched contactors and intelligent controls such as PLC's. These systems are complex and expensive and do not provide a solution for equipment already in existence. The current approach to this problem has been to employ intelligent control systems which provide a curative solution. In contrast, the Voltage-Dip Proofing Inverter, provides a preventative solution.

Theory of operation

The VOLTAGE-DIP PROOFING INVERTER is designed to be maintenance free and highly reliable. It consists of a static switch in series with, and an inverter parallel to, the load. Energy is stored in a capacitor bank : the inverter block diagram is shown in Fig 1.

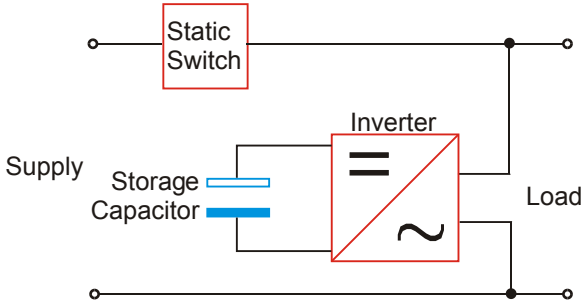


Fig 1
Inverter Block Diagram

The STATIC SWITCH is robust and can withstand large current surges. It is ideally suited for contactor operation where high peak currents of short duration occur during energizing.

The INVERTER is configured as a full bridge with overcurrent and short circuit protection. The output waveform is a square wave where the RMS and the peak voltage are the same as for a sine wave as shown in Fig 2.

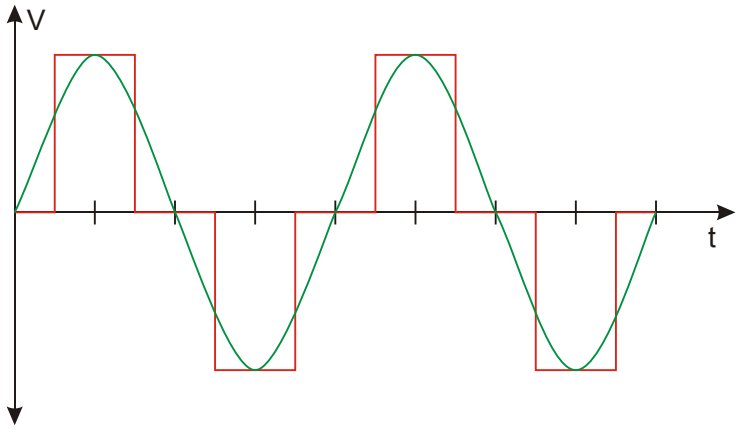


Fig 2
Inverter stepped square wave output waveform

This is important for circuits where magnetic devices, such as transformers and contactors (RMS voltage) are in circuit with electronic relays that derive their DC voltage from capacitor input filters (peak voltage).

The computer grade CAPACITOR BANK operates under ideal conditions, being charged to working voltage but carrying no ripple current most of the time.

During stand-by operation, the static switch supplies power directly to the load, the inverter is switched off and the capacitors are charged to the full operating voltage. The supply voltage is constantly monitored for deviations; should there be a deviation from Vnom which is greater than the preset value, the static switch is switched off and the inverter is activated. The switch-over is accomplished in less than 250µs. A 3.15 second timer, adjustable in increments of 50ms , starts timing the inverter out. Should the input voltage recover within the set time, the inverter supply is synchronized to the mains and the load is switched back to the supply, the capacitors are recharged and the inverter is ready to compensate for the next voltage dip. If the input voltage does not recover within the set time the load is switched back to the supply regardless of the voltage level.

Specifications DPI54SUL Series All models in the DPI54SUL Series are UL certified: File Number E483916 UL 1778 UNINTERRUPTIBLE POWER SYSTEMS - Edition 5 - Revision Date 2017/10/12 & CSA C22.2 NO. 107.3-14 UNINTERRUPTIBLE POWER SYSTEMS - Edition 3 - Issue Date 2014/06/01	**DPI54SUL 3Cap 120V 6A**	**DPI54SUL 6Cap 120V 6A**	**DPI54SUL 9Cap 120V 6A**	**DPI54SUL 18Cap 120V 8A**	**DPI54SUL 3Cap 230V 6A**	**DPI54SUL 6Cap 230V 6A**	**DPI54SUL 9Cap 230V 6A**	**DPI54SUL 18Cap 230V 8A**
Max Voltage (Vrms)	125Vrms				240Vrms			
Adjustable Voltage Range (Vrms)	100 - 125				200 - 240			
Full Load Current (Arms)	6A							
Frequency	50/60Hz							
Short Time Overload Current (1sec)	16A							
Non-repetative On-State Current (10mS)	0.7kA							
Max Load (W/VA)	750				1440			
Power Factor Range	cos$\Phi$from 1 to 0							
Wave Shape of Inverter	Stepped Square Wave							
Storage Capacitors (F)	0.0066	0.0132	0.0198	0.003960	00204	0.00408	0.00612	0.01224
Usable Stored Energy Factor (k)	0.47				0.53			
Minimum Up-time as function of the load (sec)	t = (k.Ccap.Vrms)/ (load.cos) Φ							
Maximum recovery time of capacitors to 95%Vrm	0.5s	1.1s	1.6s	2.4s	0.7s	1.4s	1.8s	3.0s
Maximum Ambient Working Temperature	104°F (40°C)							
Connection Cable, Copper Panel Wire	14AWG (2 mm2)							
Screw Terminal Torque	15 lb-in (1.76Nm)							
Cubical Construction	Extruded Aluminium							
Mass lb	4.85	5.34	6.42	9.46	4.85	5.34	6.42	9.46
Mass kg	2.22	2.42	2.91	4.29	2.22	2.42	2.91	4.29
Signal Circuit Output	10A 250V AC * Internal Wiring 16AWG 105°C.							

All units can be supplied with either a four terminal connection (see Fig. 3)or a five terminal connection (see Fig. 4).

NOTE:
The device is suitable for **Overvoltage Category II** and **Pollution Degree 3.**

CAUTION:
Upstream and downstream Overcurrent Protection must be provided externally. To reduce the risk of fire, connect only to a circuit provided with a 10A maximum branch circuit overcurrent protection in accordance with the National Electrical Code, ANSI/NFPA 70 and the Canadian C22.1" Electrical Code, Part I.

Disconnect Devices:
In applications which require no break maintenance, a DPIBPSW Bypass Switch, must be installed (See /Figure 5). The Upstream and Downstream circuit breakers will also act as disconnect devices.

Up-time considerations

The up-time that a DPI can achieve is dependent on the usable energy in the storage capacitors and on the characteristics of the supported load. Load characteristics are critical in determining the up-time. Resistive loads with a power factor near 1 consume real power and the up-time will be shortest. Resistive loads include lamps, switch mode power supplies and linear power supplies. Contactors use little real power as they are a reactive load with power factors around 0.15. Reactive loads such as contactors give the longest up-time.
The formulae below can be used to determine the minimum up-time that can be achieved for an application. It uses the load current, load voltage, load power factor, the value of the DPI storage capacitors and a stored energy factor to calculate the value.

Minimum up-time as function of the load: $t = (k * C_{cap} * V_{supply}) \div (I_{load} * \cos\Phi)$

Minimum up-time = t (sec)
Value of storage capacitor(s) = C_{cap} (F)
Stored energy factor= ηk
Load voltage = V_{supply} (rms)
Load current = I_{load} (rms)
Load power factor = $\cos\Phi$

From the formulae it can be seen that the power factor ($\cos\Phi$) has a significant influence on the up-time. *Resistive* loads with $\cos\Phi = 1$ will yield the shortest up-time while *reactive* loads with $\cos\Phi = 0.15$ will yield the longest up-time. For example:

I. Using DPI model DPI54S 6Cap 120V 6A find the minimum up-time for a predominantly *resistive* load; say a PLC power supply and some small relays.

Value of storage capacitor(s) = 0.0132F
Stored energy factor = 0.47
Load voltage = 120V
Load current = 6A
Load power factor = 0.8
Minimum up-time t = (0.47*0.0132*120) ÷ (0.6*0.8) = ***0.155 seconds***.

II. Using DPI model DPI5S 6Cap 120V 6A find the minimum up-time for a predominantly *reactive* load; say some contactors and relays.

Value of storage capacitor(s) = 0.0132F
Stored energy factor = 0.47
Load voltage = 120V
Load current = 6.0A
Load power factor = 0.15
Minimum up-time t = (0.47*0.0132*120) ÷ (0.6*0.15) = ***0.827 seconds.***

For best accuracy download the DPI Selector and input three parameters to find the correct size DPI for an application. Note that EXCEL must be installed on your computer to use this tool once it has been downloaded.

Link: http://www.switchingsystems.co.za/DPI54S_54LSelector_v1.1_Distribution.xls

Installation Guide

1. The installation must be performed by a trained person that is familiar with the National Rules for Electrical Installation. The installation must include the wiring of the upstream and downstream 10A circuit breakers. The inclusion of a DPIBPSW Bypass Switch is optional. The panel wires must be a minimum of 16AWG 105°C. Refer to Figure 4.
2. Remove the unit from its packaging.
3. Place the unit horizontally on a bench and visually check for any mechanical damage. Ensure that all the casing screws are tight then shake the unit to check that there is nothing loose internally.
4. Check that the inverter voltage is the same as the system control voltage. Refer to the rating label on the unit end plate. **WARNING: Never connect a 120V unit to a 230V supply.**
5. Decide on the location where the unit is to be installed, this will probably be inside a switch gear panel.
6. Mount the unit vertically using M6 bolts.
7. Connect unit as shown in Fig 3 using 16AWG 105°C copper panel wire.
8. Apply terminal screw tightening torque of 1.5 - 1.8Nm (13 - 16 lb-in).
9. This device does not have a disconnect switch. If such a switch is required, a DPIBPSW Must be installed. (See connection diagram on back page).

Power Wiring Connections: **For supply connections, use wire suitable for at least 75°C.**

4 Terminal Unit	5 Terminal Unit
Line In (Supply) to Terminal 1	Line In (Supply) to Terminal 1
Neutral Line In to Terminal 2	Neutral Line In to Terminal 2
Neutral Line Out to Terminal 3	Line Out to Terminal 3
Terminals 2 & 3 are linked internally	Signal Contact to Terminal 4 & 5
Line Out (Load) to Terminal 4	This contact can be configured as N/O or N/C and requested either SYSTEM OK (Green LED) or INVERTER RUNNING (Red LED). **These options must be stated at time of ordering**.

Ground screws to be connected on the unit to the panel ground point.

Signalling Circuits

Connection 4 and 5 on a five-way DPI is exclusively for signalling only. These relay contacts are part of the DPI's SELV circuit and is separated by a wall in the front connection panel of the DPI to prohibit any incorrect wiring.
Any external equipment connected to these contacts should not exceed the rated 8A / 250V AC of the relay.
Refer to Fig 4 for a connection diagram.

10. Once the unit has been mounted and the external wiring completed, power can be applied. Turn on the power to the unit. After about two seconds the green LED indicator "System OK" should come on. The unit is now fully operational.
11. In applications which require no break maintenance, a BPSW25A must be used. This switch connects 'Line In' to 'Line Out' before it disconnects the DPI completely. The supply to the load is uninterrupted.

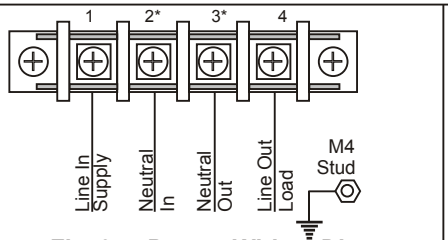


Fig 3: Power Wiring Diagram

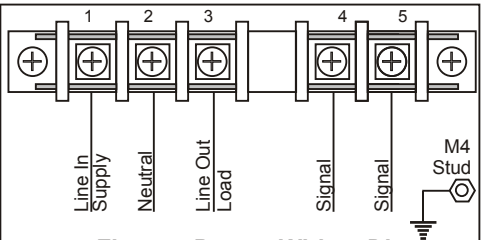


Fig 4: Power Wiring Diagram

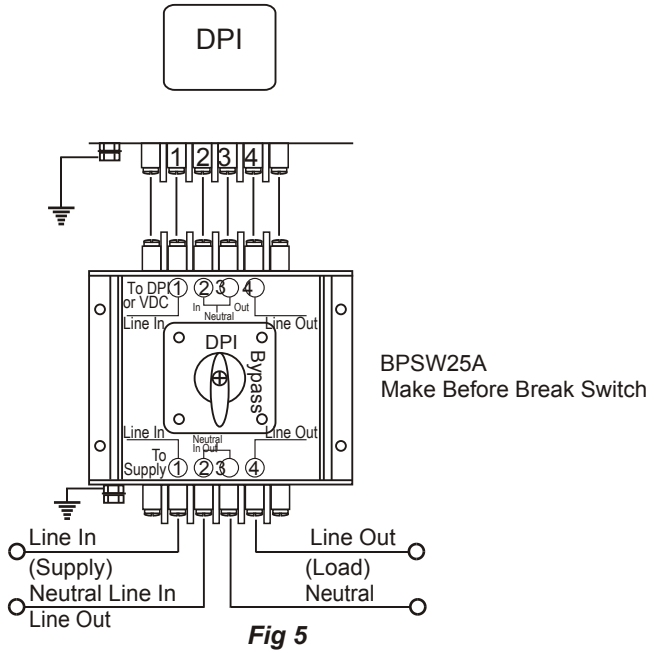


Fig 5
Housed Bypass Switch Connection Diagram

Functional Description Indicators

System OK : Green LED indicator. When the green LED is ON the system is fully functional; the unit self- test and initialization routine has run successfully.

Inverter Running : Red LED indicator. The red LED is on when the inverter is running during a voltage dip. A stepped square wave is present on the output terminals 3 and 4.

Adjustments

Adjustments

There are no user serviceable parts inside the unit. If retrospect adjustments to the operational characteristics are required or the unit is faulty, return to factory or local agent for repairs.

1. Working Voltage

Because of the working voltage of the storage capacitors, two ranges are available: The unit can be calibrated from 100 - 125Vrms or from 200 - 240Vrms.

WARNING: Never connect a 120V unit to a 230V unit or vice-versa.
If the supply voltage is permanently outside the +/- 10% range of the supply to which the unit is
calibrated (Vcal), the unit will not power up and there will be no LED indicators on. Re-calibration to the new supply voltage is necessary.

2. Run Time

The inverter run time can be set in 50ms steps to a maximum of 3.14 seconds. The default setting is 1000mS.

3. Transfer Level

The transfer level relates to the calibrated voltage. The level can be adjusted in 5% steps from 65% to 90%. The default setting is 75%.

4. Mode

Standard	250us detection time
Two level	Above 30% of nominal voltage, the run time can be customer specific Below 30% of nominal voltage, the run time is fixed to 200mS.
Noise Immune	1mS detection time. This setting is not always recommended as very sensitive and fast relays, eg. Ice cube relays do not tolerate the relative long interruption in supply.
Noise Immune & Two Level	This is a combination of Two Level and Noise Immune as above.

5. Output Contact

This contact can be configured as N/O or N/C and requested either SYSTEM OK (Green LED) or INVERTER RUNNING (Red LED). **These options must be stated at time of ordering**

NOTE: The above characteristic should be specified when ordering. Should changes be required at a later stage, the unit should be returned to the factory or local agent for adjustment.

Adjustments - DSW2

Type	DSW2 Switches				Description
	1	2	3	4	
Standard	0	0	0	0	250μsec. detection time
Two level	1	0	0	0	<30% of nom-voltage fixed run time of 200ms
Noise immune	0	1	0	0	1ms detection time
Noise immune and Two level	0	0	1	0	both of the above

Factory setting: Noise immune

TRANSFER LEVEL - DSW3
Sets the supply voltage level at which the inverter switches to run mode. The level can be varied between 65% and 90% of the nominal supply voltage by setting the switches shown in Fig.5 below.
Factory setting : 75%

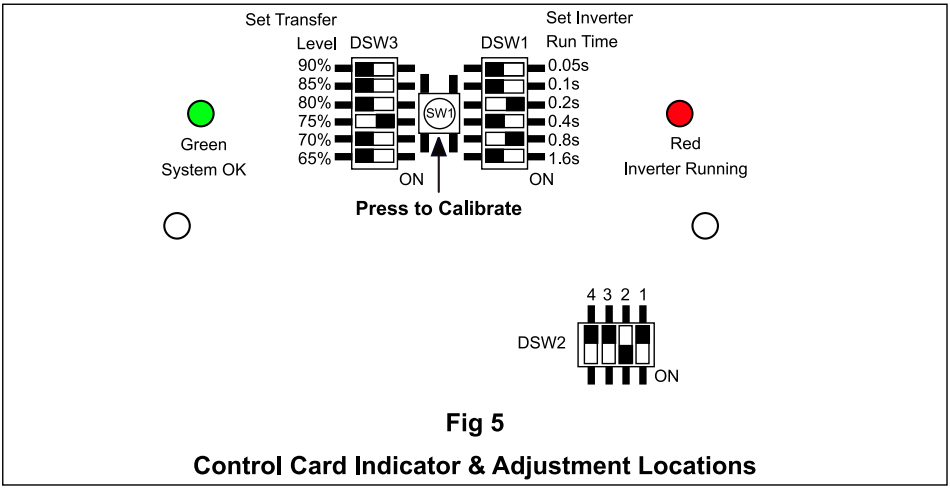


Fig 5

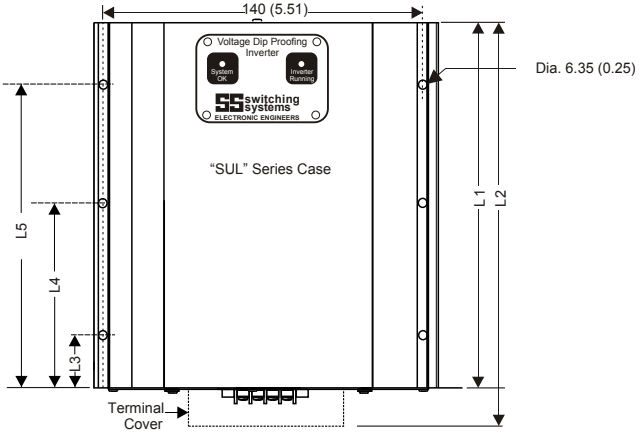
Control Card Indicator & Adjustment Locations

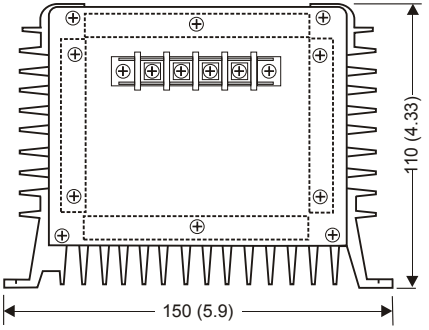
Diagnostics
1. Supply Voltage Out of Range
If the unit supply voltage is permanently outside the +/- 10% range of the supply voltage to which the unit is calibrated (Vcal) the unit will not power up and there will be no LED indicators on. Recalibration to the new supply voltage is necessary.
Diagnostic relay outputs
2. Unit faulty, relay contact opens (T6 - T7) if:
- There is no power on input (T1 - T2)
- If, at power up, the supply voltage does not exceed the set transfer level
- Unit control power supply is faulty
- Microcontroller faulty
- Microcontroller watchdog activated; program execution problem
- Inverter fuse blown
- No voltage on storage capacitors
- Unit has no output voltage (T3 & T4)

Event detection relay contact changes state (T8 - T10) when:
- The inverter runs to support an event.

Mechanical Construction

The case is made from extruded aluminium sections. The four parts that make up the case are interlocked and secured by M3 machine screws. Note, that there are no user serviceable parts inside the unit.





MODEL	DPI54SUL SERIES DIMENSIONS mm (inches)				
	L1	L2	L3	L4	L5
120V					
DPI54SUL 3Cap 120V	200 (7.87)	248 (9.76)		91 (3.58)	
DPI54SUL 6Cap 120V	200 (7.87)	248 (9.76)		91 (3.58)	
DPI54SUL 9Cap 120V	236 (9.29)	284 (11.18)		110 (4.33)	
DPI54SUL 18Cap 120V	345 (13.58)	393 (15.47)	75 (2.95)		254 (10.0)
230V					
DPI54SUL 3Cap 230V	200 (7.87)	248 (9.76)		91 (3.58)	
DPI54SUL 6Cap 230V	200 (7.87)	248 (9.76)		91 (3.58)	
DPI54SUL 9Cap 230V	236 (9.29)	284 (11.18)		110 (4.33)	
DPI54SUL 18Cap 230V	345 (13.58)	393 (15.47)	75 (2.95)		254 (10.0)

Accessories

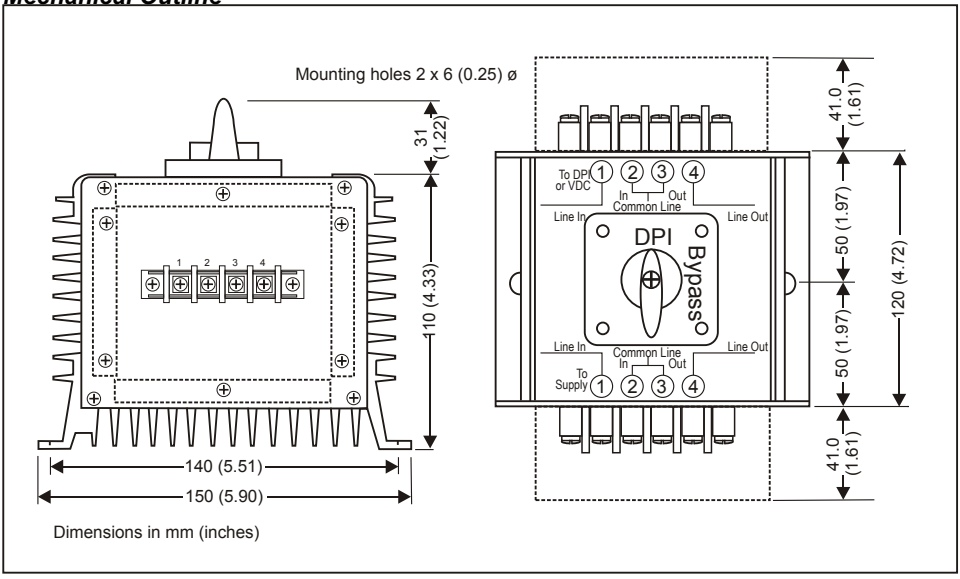
Housed Bypass Switch

Description: Where no-break maintenance is required, a bypass switch must be installed. In the 'BYPASS' position, it connects the supply directly to the load, and disconnects the power terminals of the inverter without interrupting the supply. When in "DPI" position, the load is connected to the supply via the inverter.

SPECIFICATIONS

Model	BPSW25A
ELECTRICAL	
Maximum current	25A
Maximum Input Voltage	600V AC
TEMPERATURE	
Maximum Working Temperature	40°C
HOUSING	
Construction	Extruded Aluminium
Height	202mm (7,95 in)
Width	150mm (5,9in)
Depth	141mm (5,55 in)
Mass	1kg (2.2lbs)

Mechanical Outline



Dimensions in mm (inches)

Ordering

Stock No: 5003 -006 Housed By-Pass Switch 25A

Notes

Notes

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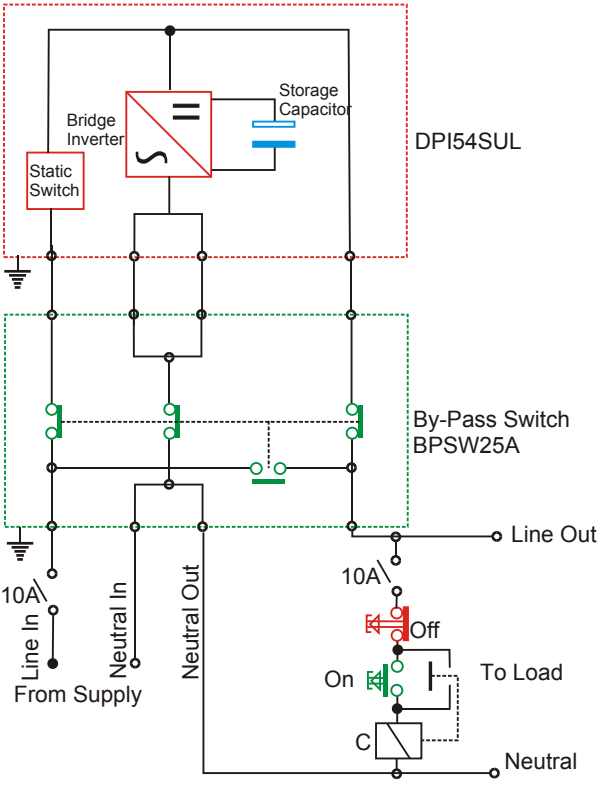
Voltage Dip-Proofing Inverter

DPI54SUL Series Models
120V & 208 / 230V 50/60Hz



A Typical DPI Connection Diagram

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