

Voltage Dip-Proofing Inverter

**DPI54S / 54L Series Models
120 & 208/230V 50/60Hz**



SS switching systems
ELECTRONIC ENGINEERS

Leaders in:
Voltage Dip-Proofing
Earth Continuity Monitoring

Installation & Service Manual

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Notice:

IMPORTANT SAFETY INSTRUCTIONS! SAVE THESE INSTRUCTIONS.

This manual contains important instructions that should be followed during installation and adjustment of all DPI54 Series Voltage Dip-Proofing Inverters.

1. 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.

2. 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.

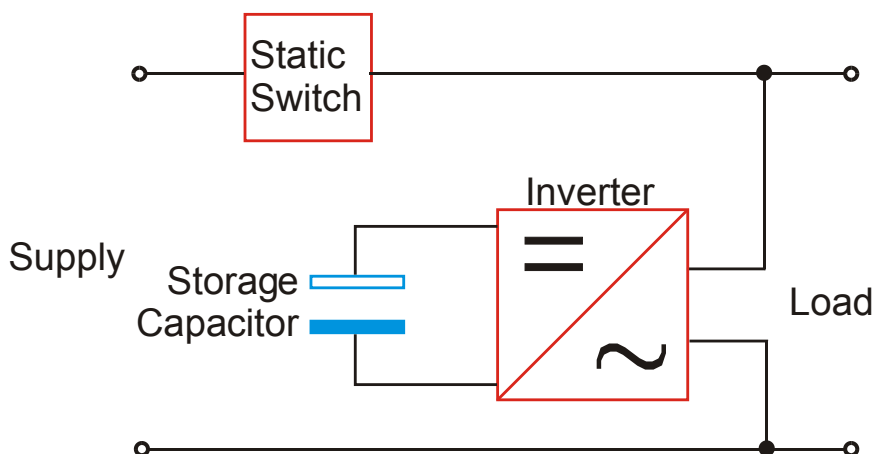
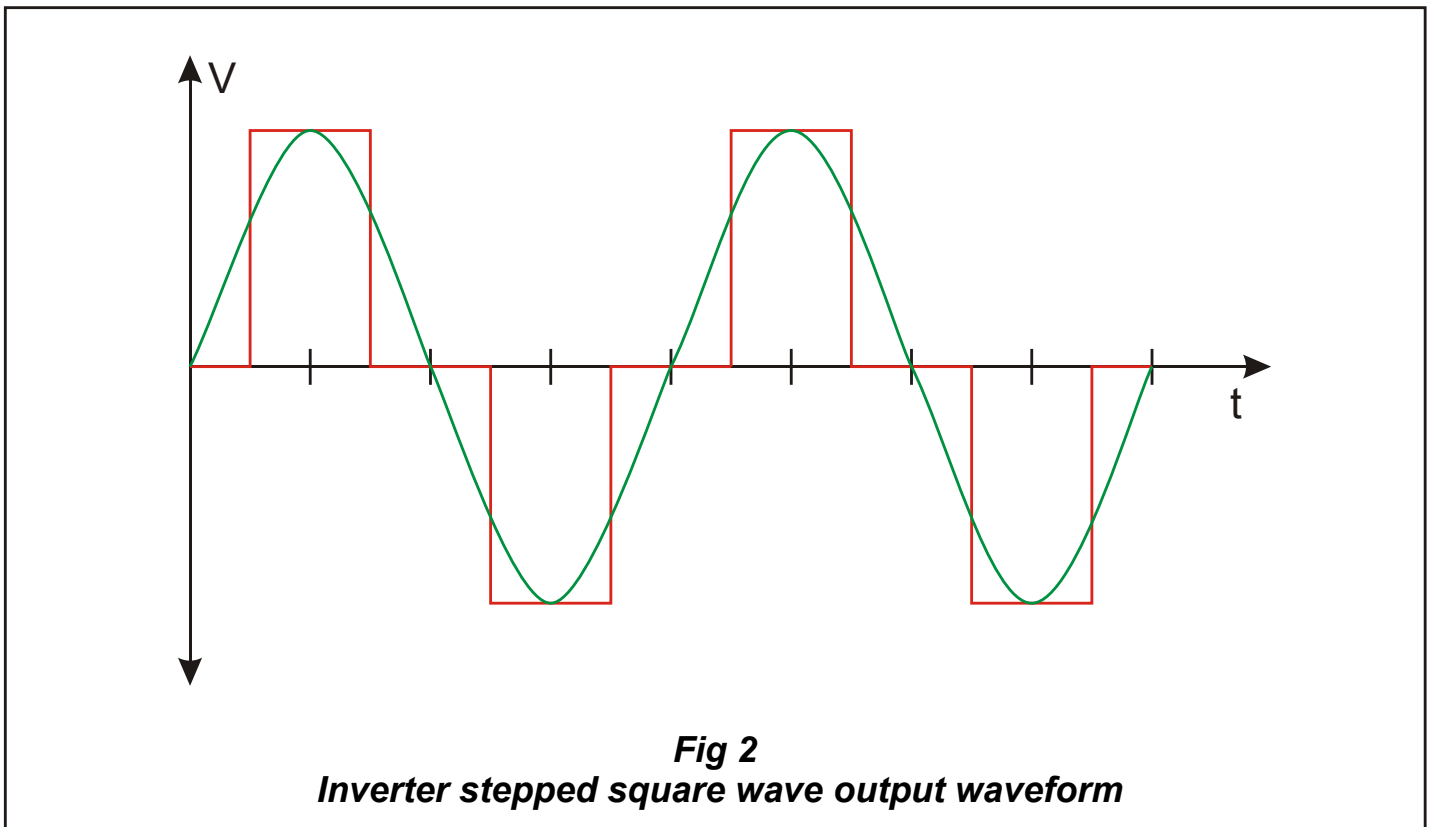


Fig 1
Inverter Block Diagram

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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.



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 V_{nom} 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 $200\mu s$. 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 in less than one second 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 DPI 54S / 54L Series 120V Models	DPI54S6.6mF120V6A	DPI54S13.2mF120V6A	DPI54S19.8mF120V6A	DPI54S39.6mF120V8A	DPI54L33mF120V25A	DPI54L66mF120V25A	DPI54L99mF120V25A	DPI54L198mF120V25A	DPI54L297mF120V25A	DPI54L396mF120V25A	DPI54L495mF120V25A	DPI54L594mF120V25A	DPI54L693mF120V25A
AC INPUT SUPPLY													
Single phase supply voltage								120V 50/60Hz					
Maximum input voltage								+10%					
Full load current (A)		6A		8A				25A					
STATIC SWITCH													
Nominal off-state voltage								150Vac RMS					
Peak off-state voltage								800V					
Nominal current (A)		6A		8A				25A					
Short time overload current (<100ms)			30A					60A					
Non-repetitive peak on-state current (10ms)			170A					700A					
INVERTER													
Nominal output voltage								120Vac RMS					
Voltage fluctuations over full operating range								±10%					
Nominal load current (A)		6A		8A				25A					
Overload Current (A)			15A					30A					
Power factor range								cosΦ from 1 to 0					
Wave shape								Stepped square					
Nominal load (VA)			720	960				3000					
Storage capacitors (F)	.0066	.0132	.0198	.0396	.033	.066	.099	.198	.297	.396	.495	.594	.693
Usable stored energy factor (η)								0.47					
Minimum up-time as function of the load								$t = (\eta * C_{cap} * V_{supply}) / (I_{load} * \cos \Phi)$					
Output frequency								50/60Hz ±1%					
Max recovery time of capacitors to 95%Vin	0.5s	1.1s	1.6s	2.4s	0.6s	1.2s	1.8s						
SETTINGS													
Timer Range and Setting								0.05 - 3.15s in 0.05s steps					
Transfer Level Range and Setting								90% to 65% of calibrated supply voltage V_{cal} in 5% steps					
INDICATORS													
System OK								green LED					
Inverter running								red LED					
TEMPERATURE													
Maximum ambient working temperature								45°C (113°F)					
CUBICLE													
Construction								Extruded Aluminum					
Height (L3) (mm)	219	254	362	284	284	284	409	500	591	682	773	864	
Height (L3) (in)	8.62	10.00	14.25	11.18	11.18	11.18	16.10	19.69	23.27	26.85	30.43	34.02	
Width (mm)		150 (5.90)					350(13.78)						
Depth (mm)		110 (4.33)					231(9.09)						
Mass (kg)	2.2	2.5	2.7	4.4	8.7	10	11.5	19	25	31	37	43	49
Mass (lbs)	4.8	5.4	5.9	9.6	19.1	22	25.3	41.8	55	68.2	81.4	94.6	108
CONNECTION													
Cable, Copper panel wire		1mm ² (17AWG)				6mm ² (10AWG)							
Screw terminal torque						1.76 Nm (15.6 lb-in)							

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Specifications DPI 54S / 54L Series 208 / 230V Models	DPI54S2.04mF230V6A	DPI54S4.08mF230V6A	DPI54S6.12mF230V6A	DPI54S12.24mF230V8A	DPI54L15mF230V25A	DPI54L30mF230V25A	DPI54L45mF230V25A	DPI54L90mF230V25A	DPI54L135mF230V25A	DPI54L180mF230V25A	DPI54L225mF230V25A	DPI54L270mF230V25A	DPI54L315mF230V25A
AC INPUT SUPPLY													
Single phase supply voltage								230V 50/60Hz					
Maximum input voltage								+10%					
Full load current (A)		6A		8A				25A					
STATIC SWITCH													
Nominal off-state voltage								250Vac RMS					
Peak off-state voltage								800V					
Nominal current (A)		6A		8A				25A					
Short time overload current (<100ms)			30A					60A					
Non-repetitive peak on-state current (10ms)			170A					700A					
INVERTER													
Nominal output voltage								230Vac RMS					
Voltage fluctuations over full operating range								±10%					
Nominal load current (A)		6A		8A				25A					
Overload current (A)			15A					30A					
Power factor range								cos φ from 1 to 0					
Wave shape								Stepped square					
Nominal load (VA)		1380		1840				5750					
Storage capacitors (F)	.00204	.00408	.00612	.01224	.015	.030	.045	.090	.135	.180	.225	.270	.315
Usable stored energy factor (η)			0.53							0.55			
Minimum up-time as function of the load								$t = (\eta * C_{cap} * V_{supply}) / (I_{load} * \cos \Phi)$					
Output frequency								50/60Hz ±1%					
Max recovery time of capacitors to 95%Vin	0.7s	1.4s	2.0s	3.0s	1.0s	2.1s	3.2s	8.0s	8.0s				
SETTINGS													
Timer Range and Setting								0.05 - 3.15s in 0.05s steps					
Transfer Level Range and Setting								90% to 65% of calibrated supply voltage V_{cal} in 5% steps					
INDICATORS													
System OK								green LED					
Inverter running								red LED					
TEMPERATURE													
Maximum ambient working temperature								45°C (113°F)					
CUBICLE													
Construction								Extruded Aluminum					
Height (L3) (mm)	219	254	362	284	284	284	409	500	591	682	773	864	
Height (L3) (in)	8.62	10.00	14.25	11.18	11.18	11.18	16.10	19.69	23.27	26.85	30.43	34.02	
Width (mm)		150 (5.90)				350 (13.78)							
Depth (mm)		110 (4.33)				231 (9.09)							
Mass (kg)	2.2	2.5	2.7	4.4	8.7	10	11.5	19	25	31	37	43	49
Mass (lbs)	4.8	5.4	5.9	9.6	19.1	22	25.3	41.8	55	68.2	81.4	94.6	108
CONNECTION													
Cable, Copper panel wire	1mm ² (17AWG)				6mm ² (10AWG)								
Screw terminal torque					1.76 Nm (15.6 lb-in)								

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: $t = (\eta * C_{cap} * V_{supply}) \div (I_{load} * \cos \Phi)$

Minimum up-time = t

Value of storage capacitor(s) = C_{cap}

Stored energy factor = η

Load voltage = V_{supply}

Load current = I_{load}

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:

A. Using DPI model DPI54L15mF230V25A find the minimum up-time for a predominantly *resistive* load; say a PLC power supply and some small relays.

Value of storage capacitor(s) = 0.015F

Stored energy factor = 0.55

Load voltage = 230V

Load current = 6A

Load power factor = 0.8

Minimum up-time $t = (0.55 * 0.015 * 230) \div (6.0 * 0.8) = \mathbf{0.39 \text{ seconds}}$.

B. Using DPI model DPI54L15mF230V25A find the minimum up-time for a predominantly *reactive* load; say some small contactors and relays.

Value of storage capacitor(s) = 0.015F

Stored energy factor = 0.55

Load voltage = 230V

Load current = 6.0A

Load power factor = 0.15

Minimum up-time $t = (0.55 * 0.015 * 230) \div (6.0 * 0.15) = \mathbf{2.1 \text{ seconds}}$.

The examples illustrate the importance of knowing the load power factor when calculating the minimum up-time for a DPI application.

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

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Installation Guide

1. Remove the unit from its packing
2. 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.
3. Check that the inverter voltage is the same as the system control voltage. Refer to the rating label on the unit end plate.

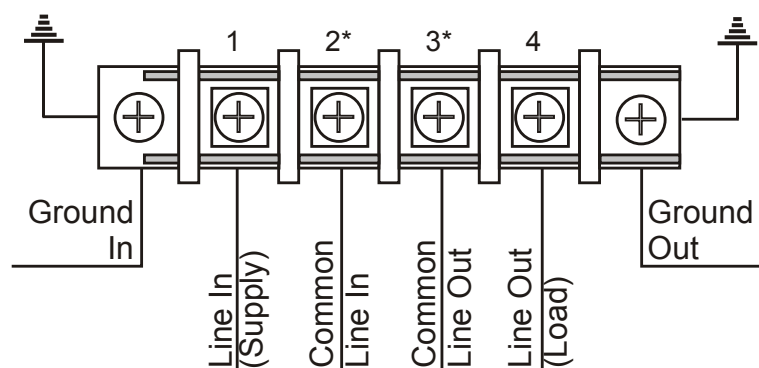
WARNING: Never connect a 120V unit to a 230V supply!

4. Decide on the location where the unit is to be installed, this will probably be inside a switch gear panel.
5. Mount the unit vertically using M6 bolts.
6. Connect unit as shown in Fig 3 using 1mm² (17AWG) DPI54S Series & 6mm² (10AWG), DPI54L Series copper panel wire.
7. Apply terminal screw tightening torque of 1.5 - 1.8Nm (13 - 16 lb-in).
8. This device does not have a disconnect switch. If such a switch is required it must be provided by others.

Power Wiring Connections

Line In (Supply)	to	Terminal 1
Common Line In	to	Terminal 2
Common Line Out	to	Terminal 3
Line Out (Load)	to	Terminal 4

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



* Note:
Terminals 2 and 3 are linked internally

Fig 3
Power Wiring Diagram

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Test and Maintenance

There are no user serviceable parts inside the unit, if faulty return to factory or local agent for repairs.

WARNING: Risk of electric shock, capacitor(s) store hazardous energy.

NEVER attempt any maintenance on the DPI until storage capacitors are fully discharged. Dangerously high voltages can be present up to 2 hours after the DPI has been disconnected unless the storage capacitors have been manually discharged.

Adjustments

All adjustment points are marked on the top cover plate and can be reached by removing the two screws securing the main label.

INVERTER RUN TIME - DSW1

This switch sets the running time of the inverter and can be set in 50ms steps to a maximum of 3,15 seconds. To determine the inverter run time which is currently set, add the figures printed next to each switch which is in the ON position. For example, a running time setting of one second requires that the following switches be in the ON position:- 200 + 800 : these figures added give 1000ms or 1s.

Factory Setting : 1000ms

CALIBRATION TO A SUPPLY VOLTAGE - SW1 - Cal

The unit can be calibrated for a different supply voltage, for example a 230V unit used on a 208V supply. The Calibrate button (Cal) is used to program the unit to operate on a specific supply voltage.

WARNING: Never connect a 120V unit to a 230V supply! Refer to the unit rating label before connecting the supply.

Connect the unit to the supply and switch on.

Press the Calibrate button (Cal). The System OK (green) LED will switch off for approximately 3 seconds and then switch back on.

The unit is now calibrated for the supply voltage to which it is connected.

Factory Setting : Calibrated to rating label Vnom

ADJUSTMENTS - DSW2

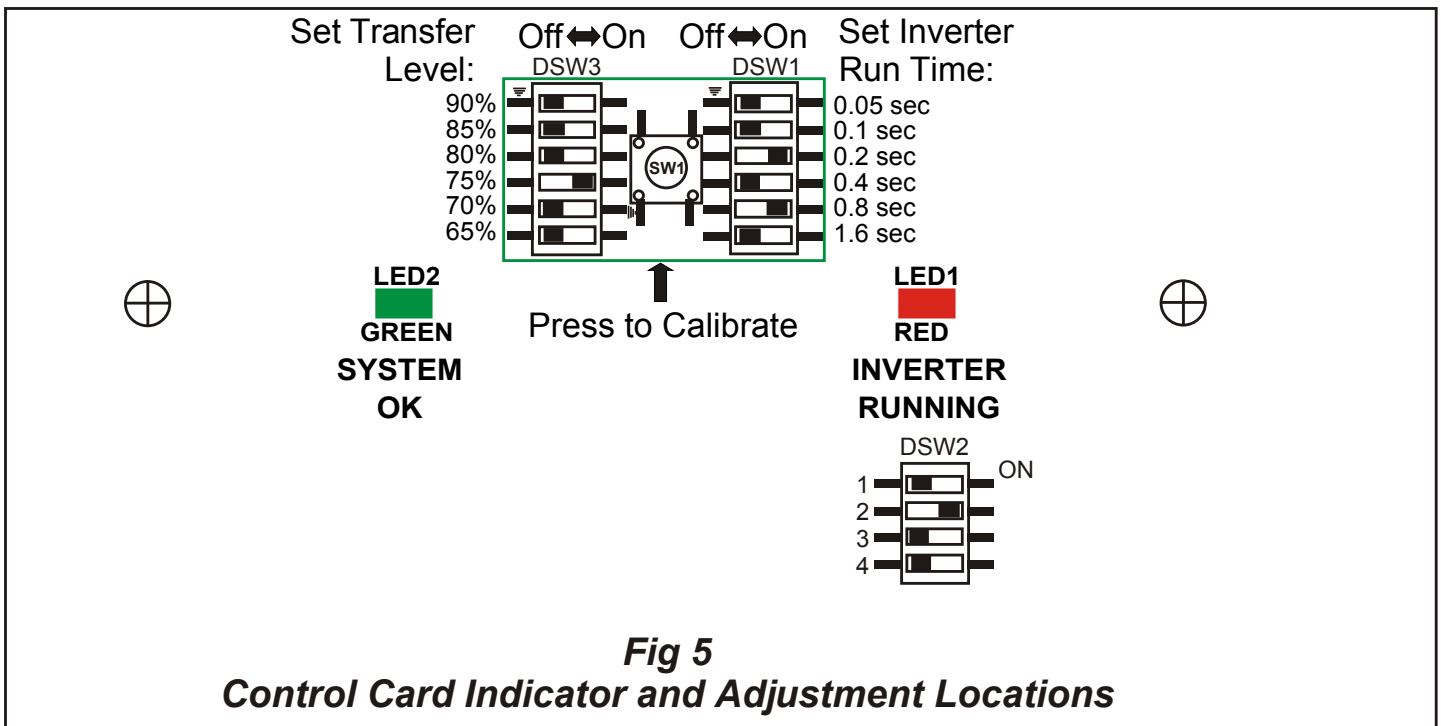
TYPE	SWITCHES				DESCRIPTION
	1	2	3	4	
Standard	0	0	0	0	250µsec. detection time
Two level	1	0	0	0	<30% of nom-voltage fixed run time 200msec
Noise immune	0	1	0	0	1msec detection time
Noise immune and Two level	0	0	1	0	both of the above

Factory setting : Standard

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 according to the table in Fig.5.

Factory setting : 75%



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. Re calibration 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
- Micro controller faulty
- Micro controller 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.

Note: The options for diagnostic and event detection outputs should be specified when ordering. They are also available as a retrofit kit.

Due to space restrictions, the DPI54S Series supports the Event Detection option only.

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Mechanical Construction

54S Series - The DPI case is made from extruded aluminium sections. The four parts that make up the case are interlocked and secured by screws. To remove the front cover, unscrew four screws: the two top screws from the end plate where the terminal block is located and the two bottom screws from the other end plate. Slide the front cover away from the terminal block. Note that there are no user serviceable parts inside the unit. All adjustment points are marked on the top cover plate and can be reached by removing the two screws securing the main label.

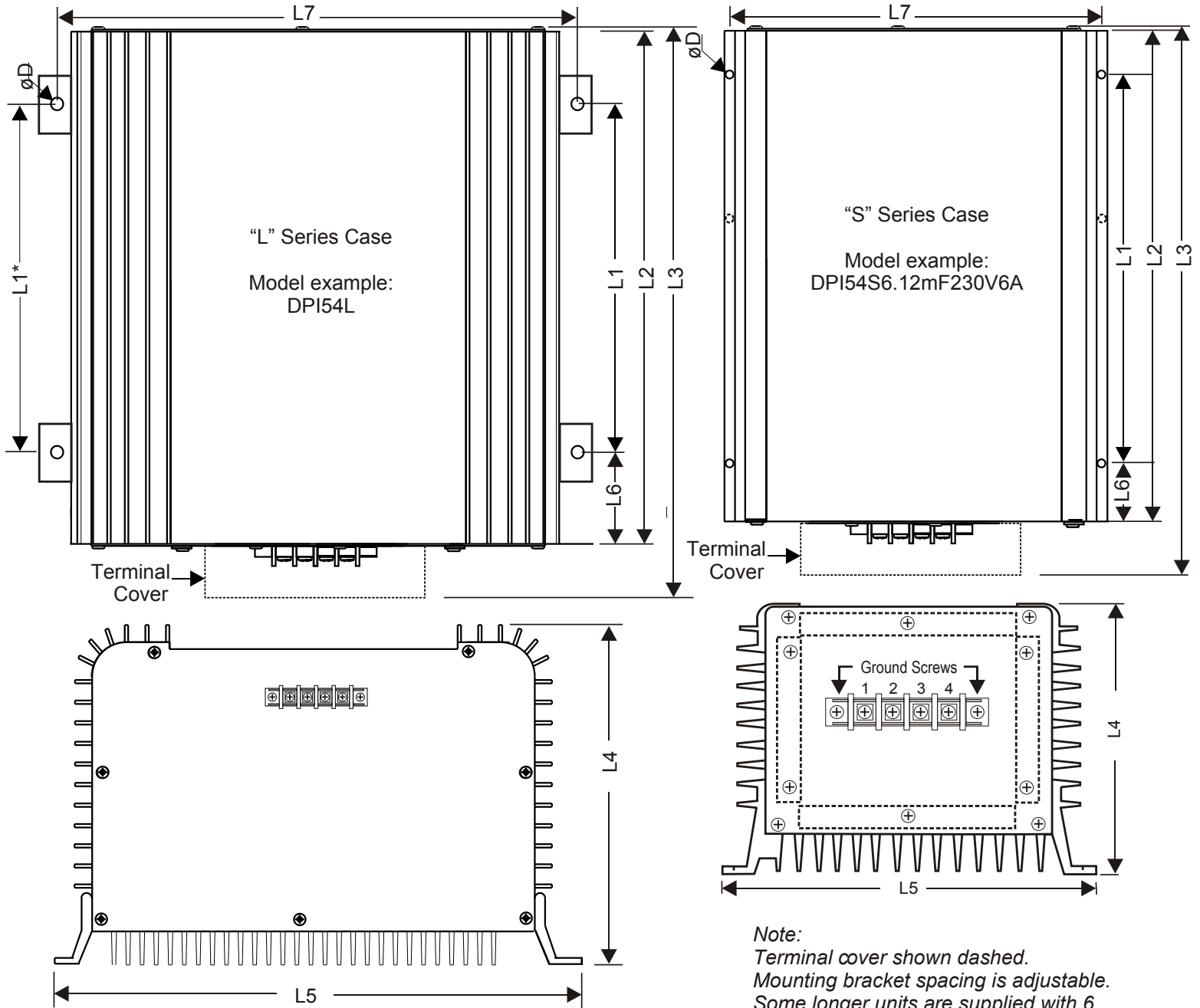
54L Series - The DPI case is made from extruded aluminium sections. The six parts that make up the case are interlocked and secured by screws. To remove the front cover, unscrew five screws: one from the front cover and two each from the top and bottom end plates. Units are supplied with four or six mounting brackets depending on the case length. The bracket positions are adjustable along the length of the case (Dim. L1 and L6). Note that there are no user serviceable parts inside the unit. All adjustment points are marked on the top cover plate and can be reached by removing the two screws securing the main label.

Dimension Table

MODEL	DPI54 SERIES DIMENSIONS mm (inches)							
	L1	L2	L3	L4	L5	L6	L7	D
DPI54S6.6mF120V6A	0 (0)	170 (6.69)	219 (8.62)			85 (3.35)		
DPI54S13.2mF120V6A	0 (0)	170 (6.69)	219 (8.62)	110 (4.33)	150 (5.90)	85 (3.35)	140 (5.50)	6.0 (0.24)
DPI54S19.8mF120V6A	0 (0)	205 (8.07)	254 (10.0)			102.5(4.04)		
DPI5S39.6mF120V8A	160 (6.29)	313 (12.32)	362 (14.25)			75 (3.00)		
DPI54L33mF120V25A								
DPI54L66mF120V25A	115 (4.53)	235 (9.25)	284 (11.18)					
DPI54L99mF120V25A						60 (2.36)		
DPI54L198mF120V25A	240 (9.45)	360 (14.17)	409 (16.10)					
DPI54L297mF120V25A	331 (13.03)	451 (17.76)	500 (19.69)	231 (9.09)	350 (13.78)		330.5(13.0)	8.0 (0.31)
DPI54L396mF120V25A	422 (16.61)	542 (21.33)	591 (23.27)					
DPI54L495mF120V25A	513 (20.20)*	633 (24.92)	682 (26.85)					
DPI54L594mF120V25A	604 (23.78)*	724 (28.50)	773 (30.43)					
DPI54L693mF120V25A	695 (27.36)*	815 (32.08)	864 (34.02)					
DPI54S2.04mF230V6A	0 (0)	170 (6.69)	219 (8.62)			85 (3.35)		
DPI54S4.08mF230V6A	0 (0)	170 (6.69)	219 (8.62)	110 (4.33)	150 (5.90)	85 (3.35)	140 (5.50)	
DPI54S6.12mF230V6A	0 (0)	205 (8.07)	254 (10.0)			102.5(4.04)		6.0 (0.24)
DPI54S12.24mF2308A	160 (6.29)	313 (12.32)	362 (14.25)			75 (3.00)		
DPI54L15mF230V25A								
DPI54L30mF230V25A	115 (4.53)	235 (9.25)	284 (11.18)					
DPI54L45mF230V25A								
DPI54L90mF230V25A	240 (9.45)	360 (14.17)	409 (16.10)					
DPI54L135mF230V25A	331 (13.03)	451 (17.76)	500 (19.69)	231 (9.09)	350 (13.78)	60 (2.36)	330.5(13.0)	8.0 (0.31)
DPI54L180mF230V25A	422 (16.61)	724 (28.50)	591 (23.27)					
DPI54L225mF230V25A	513 (20.20)*	815 (32.08)	682 (26.85)					
DPI54L270mF230V25A	604 (23.78)*		773 (30.43)					
DPI54L315mF230V25A	695 (27.36)*		864 (34.02)					

* Indicates 6 mounting brackets; dimension L1* = L1/2

Mechanical Outline



Terminal Block for 54L Series Options



- Terminal 1 Line In (Supply)
- Terminal 2 Common line in
- Terminal 3 Common line out
- Terminal 4 Line out (Load)
- Terminal 5 Unit Faulty n/o
- Terminal 6 Unit Faulty n/o
- Terminal 7 Event detection n/o
- Terminal 8 Event detection n/o

Terminal Block for 54S Series Options



- Terminal 1 Line In (Supply)
- Terminal 2 Common line in / out
- Terminal 3 Line out (Load)
- Terminal 4 Unit Faulty n/o
- Terminal 5 Unit Faulty n/o

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Accessories

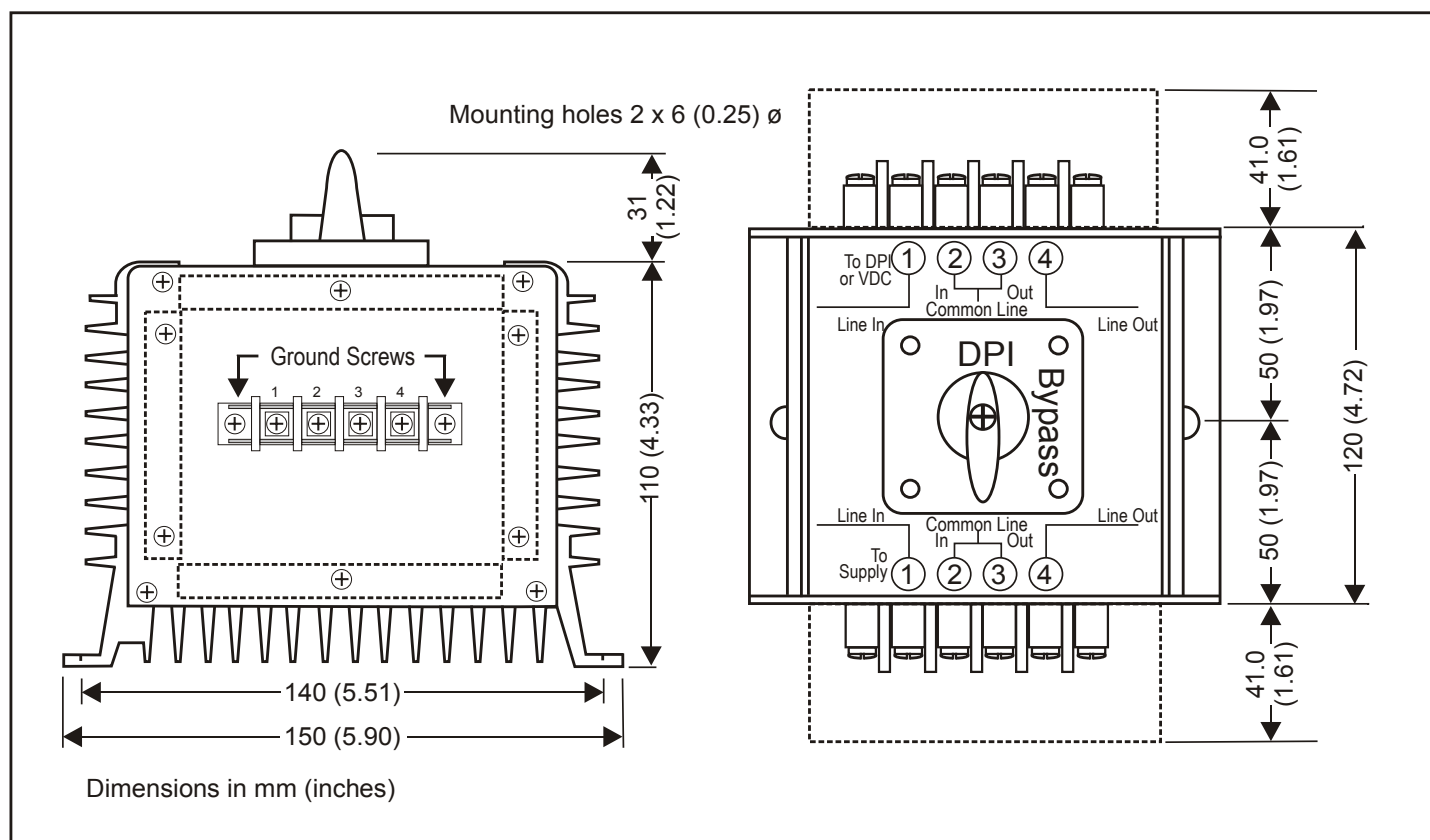
Housed Bypass Switch

Description: Where no-break maintenance is required, a bypass switch must be installed. It connects the supply directly to the load, “Bypass” position, 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	45°C (113°F)
HOUSING	
Construction	Extruded Aluminium
Height	202mm (7,95in)
Width	150mm (5,9in)
Depth	141mm (5,55in)
Mass	1kg (2.2lbs)

Mechanical Outline

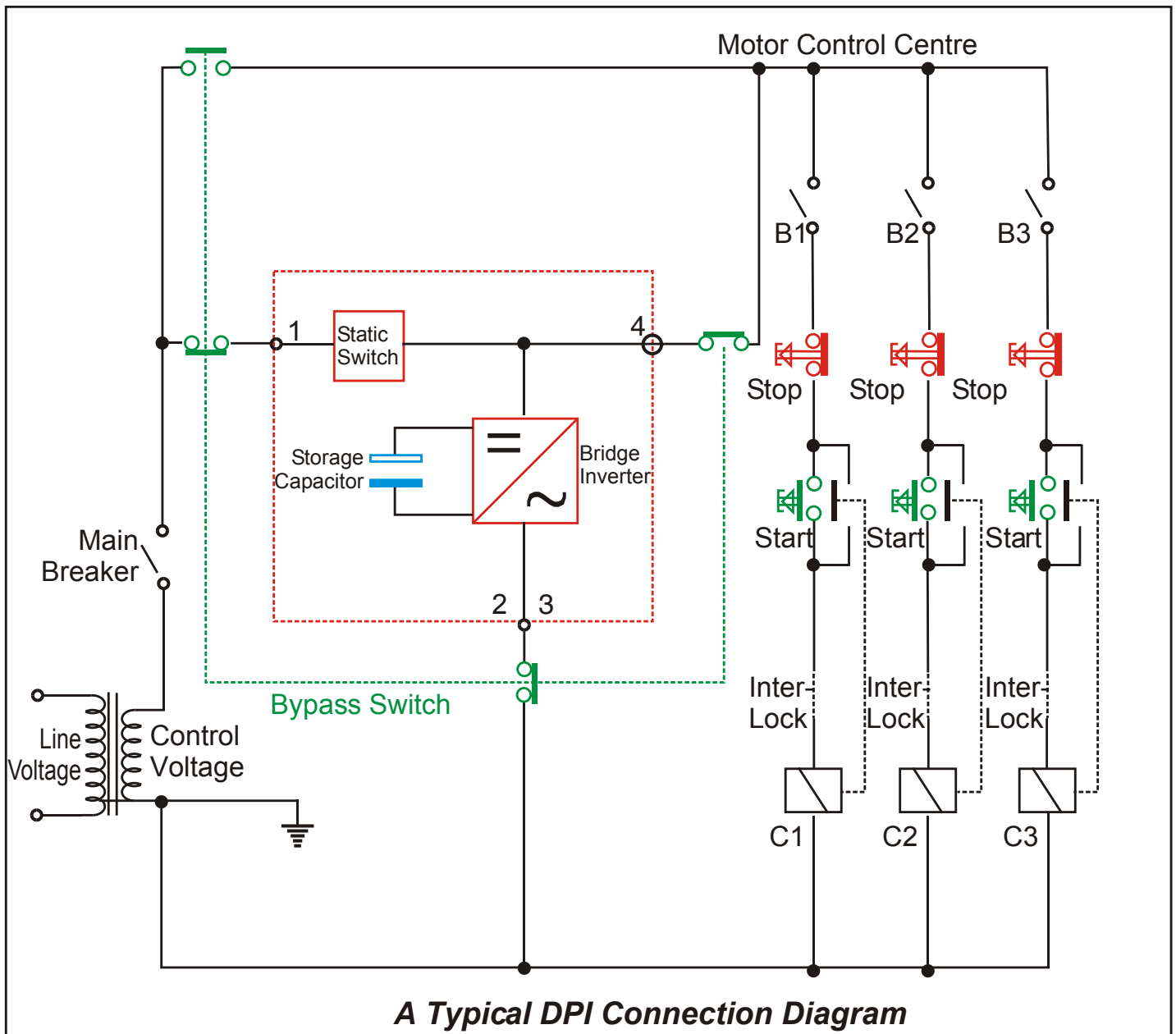


Ordering

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

Voltage Dip-Proofing Inverter

DPI54S / 54L Series Models 120 & 208/230V 50/60Hz



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