Installation & Service Manual

Voltage-Dip Proofing Inverters

For DPI 52 Series Models
120V & 208 / 230V 50/60Hz

DIP-PROOFING
TECHNOLOGIES INC.
LEADERS IN VOLTAGE-DIP PROOFING

MEASURLOGIC

Contents:

Notice

IMPORTANT SAFETY INSTRUCTIONS.
SAVE THESE INSTRUCTIONS!

This manual contains important instructions that should be followed duringinstallation and adjustment of all DPI52 series 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.

DIP-PROOFING TECHNOLOGIES' 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.

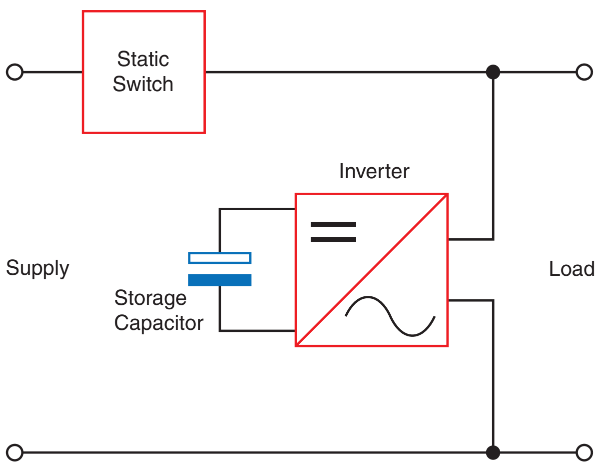


Fig 1
Inverter Block Diagram

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.

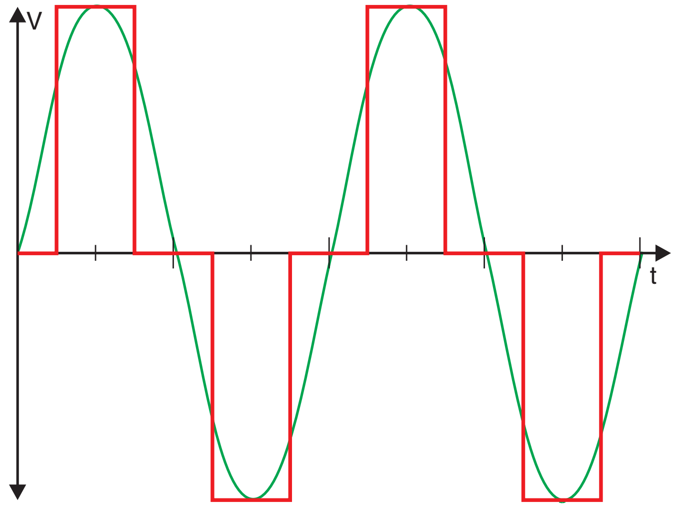


Fig 2
Inverter stepped square wave output waveform

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 700µs. A 3.1 second timer, adjustable in increments of 100ms , 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 52 series 120V models

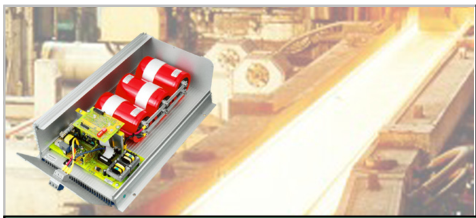
	120V MODELS													
	DPI52S25-12	DPI52S50-12	DPI52S95J12	DPI52S190J12	DPI52L1K5-12	DPI52L238J12		DPI52L475J12	DPI52L713J12	DPI52L3K12	DPI52L950J12	DPI52L1188J12	DPI52L1663J12	DPI52L2376J12
AC INPUT SUPPLY														
Single phase supply voltage:	120V 50/60Hz													
Maximum input voltage:	+10%													
Full load current (A):	2.1A	4.2A			8.4A		16.7A			25A				
STATIC SWITCH														
Nominal off-state voltage:	150Vac RMS													
Peak off-state voltage:	800V													
Nominal current (A):	2.1A	4.2A			8.4A		16.7A			25A				
Short time overload current (<100ms):	26A				60A									
Non-repetitive peak on-state current (10ms):	26A				180A									
INVERTER														
Nominal output voltage:	120Vac RMS													
Voltage fluctuations over full operating range:	-15% to +10%													
Nominal load current (A):	2.1A	4.2A			8.4A		16.7A			25A				
Power factor range:	cos Φ from 1 to 0													
Wave shape:	Stepped square													
Nominal inductive load (VA):	250	500			1500		2000			3000				
Storage capacitors (F):	.0066	.0132		.0264	.033	.033		.066	.099	.066	.132	.165	.231	.33
Usable stored energy factor (η):	0.33	0.36			0.38		0.39							
Minimum up-time as function of the load (t):	$t = (\eta * C_{cap} * V_{supply}) \div (I_{load} * \cos \Phi)$													
Transistor peak current limit:	26A				50A									
Output frequency:	50/60Hz ±1%													
HBC fuse rating :	16A				32A									
TIMER														
Range:	0.1 to 3.1s													
Setting:	0.1s steps													
Maximum recovery time of capacitors to 1,4Vin:	<1s		<1.5s		<1s	<1.5s		<3s	<2.5s	<1s	<3s	<3.7s	<3.4s	<4.9s
INDICATORS														
System OK:	green LED													
Inverter running:	red LED													
TEMPERATURE														
Maximum ambient working temperature:	45°C (113°F)													
CUBICLE														
Construction:	Extruded Aluminum													
Height (mm) (Dim. L3 on p14):	259	309	309	379	329	329		355	419	419	507	507	644	1145
Height (in) (Dim. L3 on p14):	10.20	12.17	12.17	14.92	12.95	12.95		13.98	16.50	16.50	20.28	20.28	25.76	45.08
Width mm (in):	150 (5.90)				311 (12.24)									
Depth mm (in):	110 (4.33)				162 (6.38)									
Mass (kg):	3.0	3.6	3.3	4.3	7.5	7.5		9.3	9.3	9.3	14.4	15.7	20.6	27.0
Mass (lbs):	6.61	7.93	7.30	9.50	16.53	16.53		20.50	25.27	25.7	31.75	34.61	45.42	59.52
CONNECTION														
Cable, Copper panel wire:	$2mm^2$ (14 AWG)				$5mm^2$ (10AWG)									
Screw terminal torque:	1.76 Nm (15.6 lb-in)													
LISTINGS														
Underwriters Laboratories Inc:	UL Listed, Control # 37WJ / File # E205817													

WARNING

Risk of electric shock! Dangerously high voltages can be present up to 2 hours after the DPI has been disconnected. NEVER attempt maintainance on the DPI during this period unless storage capacitors have been manually discharged.

Specifications

DPI 52 series 208 / 230V models



	208 / 230V MODELS													
	DPI52S25-23	DPI52S50-23	DPI52S108J23	DPI52S216J23	DPI52L2K23	DPI52L396J23	DPI52L4K5-23	DPI52L794J23	DPI52L1587J23	DPI52L2381J23	DPI52L3174J23	DPI52L3968J23		
AC INPUT SUPPLY														
Single phase supply voltage:	208 / 230Vac 50/60Hz													
Maximum input voltage:	+10%													
Full load current (A):	1.1A	2.2A			8.7A		20A							
STATIC SWITCH														
Nominal off-state voltage:	250Vac RMS													
Peak off-state voltage:	800V													
Nominal current (A):	1.1A	2.2A			8.7A		20A							
Short time overload current (<100ms):	26A				60A									
Non-repetitive peak on-state current (10ms):	26A				180A									
INVERTER														
Nominal output voltage:	208 / 230Vac RMS													
Voltage fluctuations over full operating range:	-15% to +10%													
Nominal load current (A):	1.1A	2.2A			8.7A		20A							
Power factor range:	cos Φ from 1 to 0													
Wave shape:	Stepped square													
Nominal inductive load (VA):	250	500			2000		4500							
Storage capacitors (F):	.00204	00408		.00828	.015		.03		.06	.09	.12	.15		
Usable stored energy factor (η):	0.39	0.43		0.42	0.46		0.47							
Minimum up-time as function of the load (t):	$t = (\eta * C_{cap} * V_{supply}) \div (I_{load} * \cos \Phi)$													
Transistor peak current limit:	26A				50A									
Output frequency:	50/60Hz ±1%													
HBC fuse rating :	16A				32A									
TIMER														
Range:	0.1 to 3.1s													
Setting:	0.1s steps													
Maximum recovery time of capacitors to 1,4Vin:	<1s							<1.4s		<2s	<3s	<3.6s		
INDICATORS														
System OK:	green LED													
Inverter running:	red LED													
TEMPERATURE														
Maximum ambient working temperature:	45°C (113°F)													
CUBICLE														
Construction:	Extruded Aluminum													
Height (mm) (Dim. L3 on p14):	259	309	309	379	329	329	419	419	595	785	974	1145		
Height (in) (Dim. L3 on p14):	10.20	12.17	12.17	14.92	12.95	12.95	16.50	16.50	23.43	30.91	38.35	45.08		
Width mm (in):	150 (5.80)				311 (12.24)									
Depth mm (in):	110 (4.33)				162 (6.38)									
Mass (kg):	3.0	3.6	3.3	4.3	7.9	7.88	11.0	11.0	17.25	23.64	30.12	36.2		
Mass (lbs):	6.6	7.93	7.31	9.46	17.42	17.37	24.25	24.25	38.03	52.12	66.40	79.81		
CONNECTION														
Cable, Copper panel wire:	$2mm^2$ (14 AWG)				$5mm^2$ (10AWG)									
Screw terminal torque:	1.76Nm (15.6lb-in)													
LISTINGS														
Underwriters Laboratories Inc:	UL Listed, Control # 37WJ / File # E205817													

WARNING

Risk of electric shock! Dangerously high voltages can be present up to 2 hours after the DPI has been disconnected. NEVER attempt maintainance on the DPI during this period unless storage capacitors have been manually discharged.

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 an efficiency 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 DPI52S50-23 find the minimum up-time for a predominantly *resistive* load; say a PLC power supply and some small relays.

   Value of storage capacitor(s) = 0.00408F
   Stored energy factor = 0.46
   Load voltage = 230V
   Load current = 0.43A
   Load power factor = 0.8

   Minimum up-time t = (0.46*0.00408*230) ÷ (0.43*0.8) = **1.25 seconds.**

B. Using DPI model DPI52S50-23 find the minimum up-time for a predominantly *reactive* load; say some small contactors and relays.

   Value of storage capacitor(s) = 0.00408F
   Stored energy factor = 0.46
   Load voltage = 230V
   Load current = 0.43A
   Load power factor = 0.15

   Minimum up-time t = (0.46*0.00408*230) ÷ (0.43*0.15) = **6.69 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 use the on line DPI Selector to find the correct size DPI for an application. Link: www.dipproof.com/products/dpi_selector.asp

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.

   Note : Please inform your shipping agent if any damage has occurred during transit : the damaged unit(s) and all packing material should be kept in case the insurers wish to inspect the damage.
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 2mm^2 (14AWG), DPI52 S series & 5mm^2 (10AWG), DPI52 L series copper panel wire.
7. Apply terminal screw tightening torque of 0.6 - 0.8Nm (5.2 - 7 lb-in), DPI52 S series & 1.5 - 1.8Nm (13 - 16 lb-in) DPI52 L series.
8. This device does not have a disconnect switch. If such a switch is required it must be provided by others.

Power Wiring

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

Connect the ground screw(s) on the unit to the panel ground point.

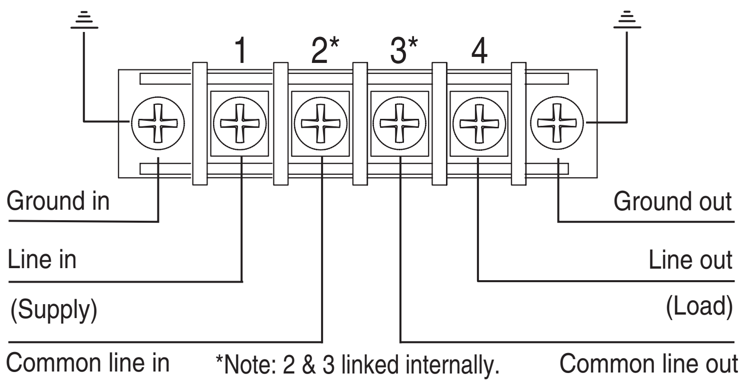


Fig 3
Power Wiring Diagram

9. 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.

10. In applications which require no break maintenance, a bypass switch must be installed. Order Housed Bypass Switch model DPIBPSW which should be con nected as shown in Fig 4.

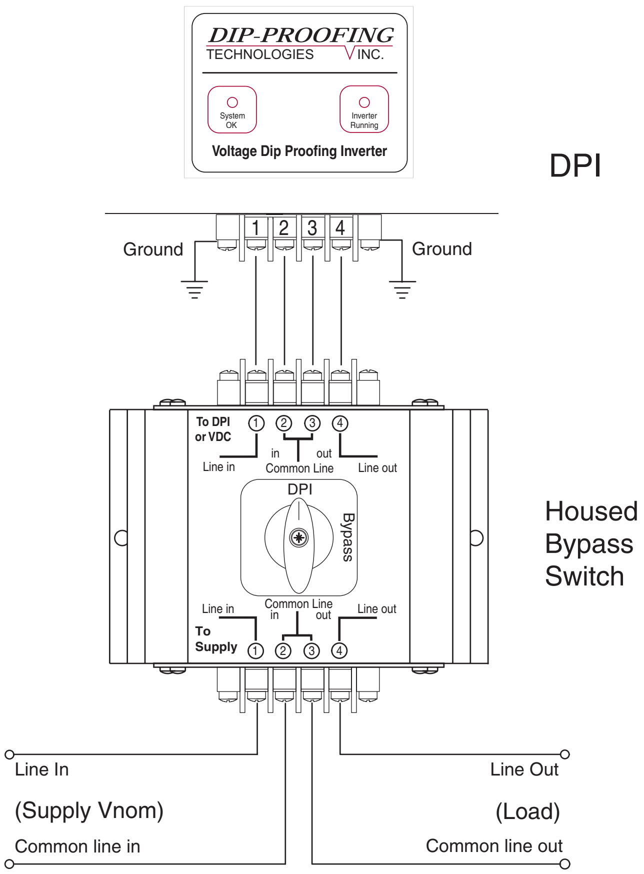


Fig 4
Housed Bypass Switch Connection Diagram

Functional Description Indicators

System OK : Green LED indicator

When the green LED is ON the system is fully functional; the unit self test & 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 & 4.

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 control card and can be reached by removing the front cover of the DPI; see Mechanical Construction on page 14. Note that the Set Inverter Run Time switch (SW1) is dual function. It is used to set the inverter run time and to program the inverter output voltage.

INVERTER RUN TIME - SW1 (see Fig.5 page 11)

This switch sets the running time of the inverter and can be set in 100ms steps to a maximum of 3,1 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 switch es be in the ON position:- 200 + 800 : these figures added give 1000ms or 1 second.

Factory Setting : 1000ms

INVERTER OUTPUT VOLTAGE - SW1(see Fig.5 page 11)

The inverter output voltage can be reset to match a different supply voltage, for example a 230V unit used on a 208V supply. The Set Inverter Run Time switch (SW1) is dual function and is used to program the inverter output voltage.

With the unit energized switch all switches (SW1-1 to 6) OFF.
Set the switch (SW1-1 to 5) equal or closest to the supply voltage ON.
To program the inverter output voltage set “Test 2min” switch (SW1-6) to ON.
The System OK LED will begin to flash.

Return the switch (SW1 - 6) to the OFF position, the System OK LED will remain on continuously.

The inverter output voltage now equals the DPI supply voltage and programming is complete.
Reset the Inverter Run Time switches (SW1-1 to 5) to the required run time.

Factory Setting : Vnom @ full load - Refer to Specification Sheet on page 5 & 6

TRANSFER LEVEL - SW2 (see Fig.5 page 11)

Sets the supply voltage level at which the inverter switches to run mode. The level can be varied between 55% and 90% of the nominal supply voltage by setting the switches according to the table in Fig.5.

Factory setting : 75%

Fuses

The inverter fuse is mounted on the motherboard.

52 S series *- Main Fuse Type SIBA70 125 40 : 16A 6x32mm Ultra Rapid.*
52 L series *- Main Fuse Type SIBA 50 138 06 : 32A 14x51mm UltraRapid.*
Alternate - Buss FPW-32A14F : 32A 14x51mm UltraRapid.

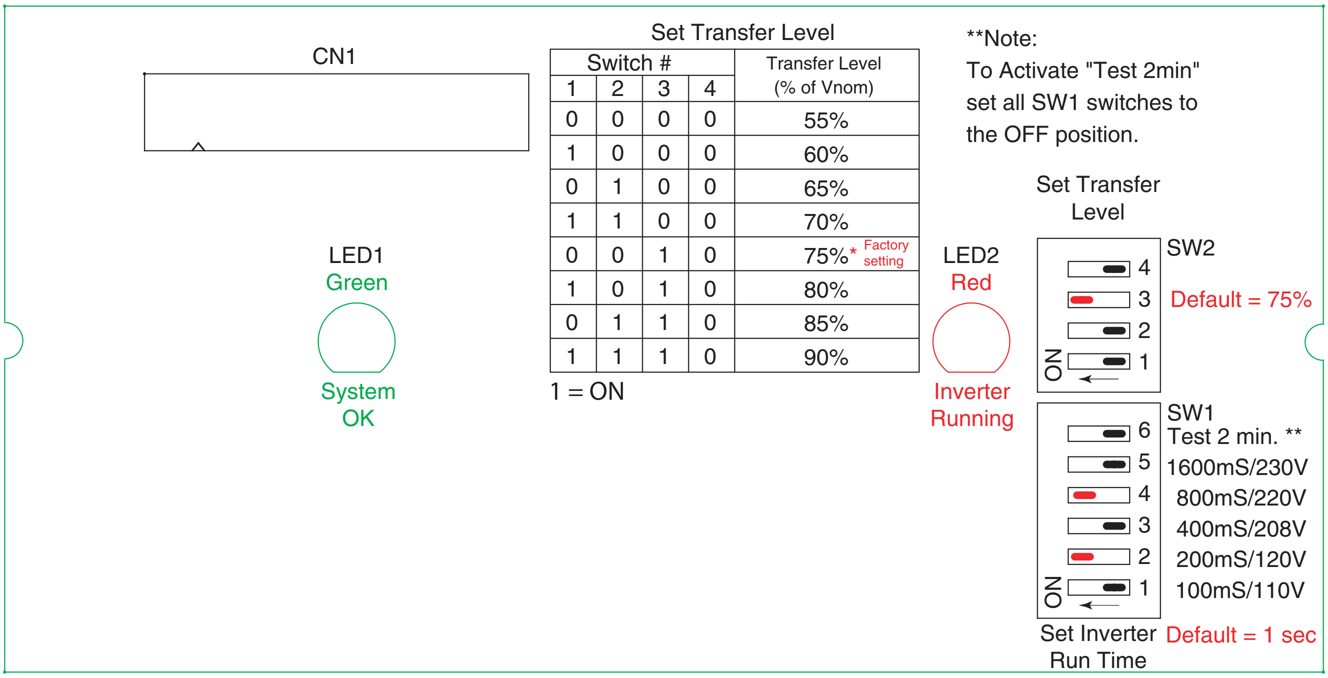


Fig 5

Control Card Indicator & Adjustment Locations

Fault Diagnosis Chart

Symptom	Probable Cause	Remedy
System OK LED is off, no voltage on output terminals.	No supply voltage on input terminals (1 & 2).	Check supply.
	Short circuit on the output.	Disconnect the load from terminal 4. Switch off the supply voltage then switch it on again. If unit is not damaged the System OK indicator will come on. Check for short circuit on the load side.
System OK LED is off, voltage on terminals 3 & 4 no voltage on 1 & 2.	Supply and load wires are reversed. Terminals 1 & 4.	Swap supply & load wires. Connect supply to terminal 1 & load to terminal 4. There is a possibility that the unit may be damaged by incorrect connection.
System OK LED is off, voltage present on output terminals.	A 230v unit is being used with a 120v supply.	Change unit to 120v model.
Unit failure when supply switched on.	A 120v unit is being used with a 230v supply.	Change unit to 230v model. Note: The 120v unit will be damaged.

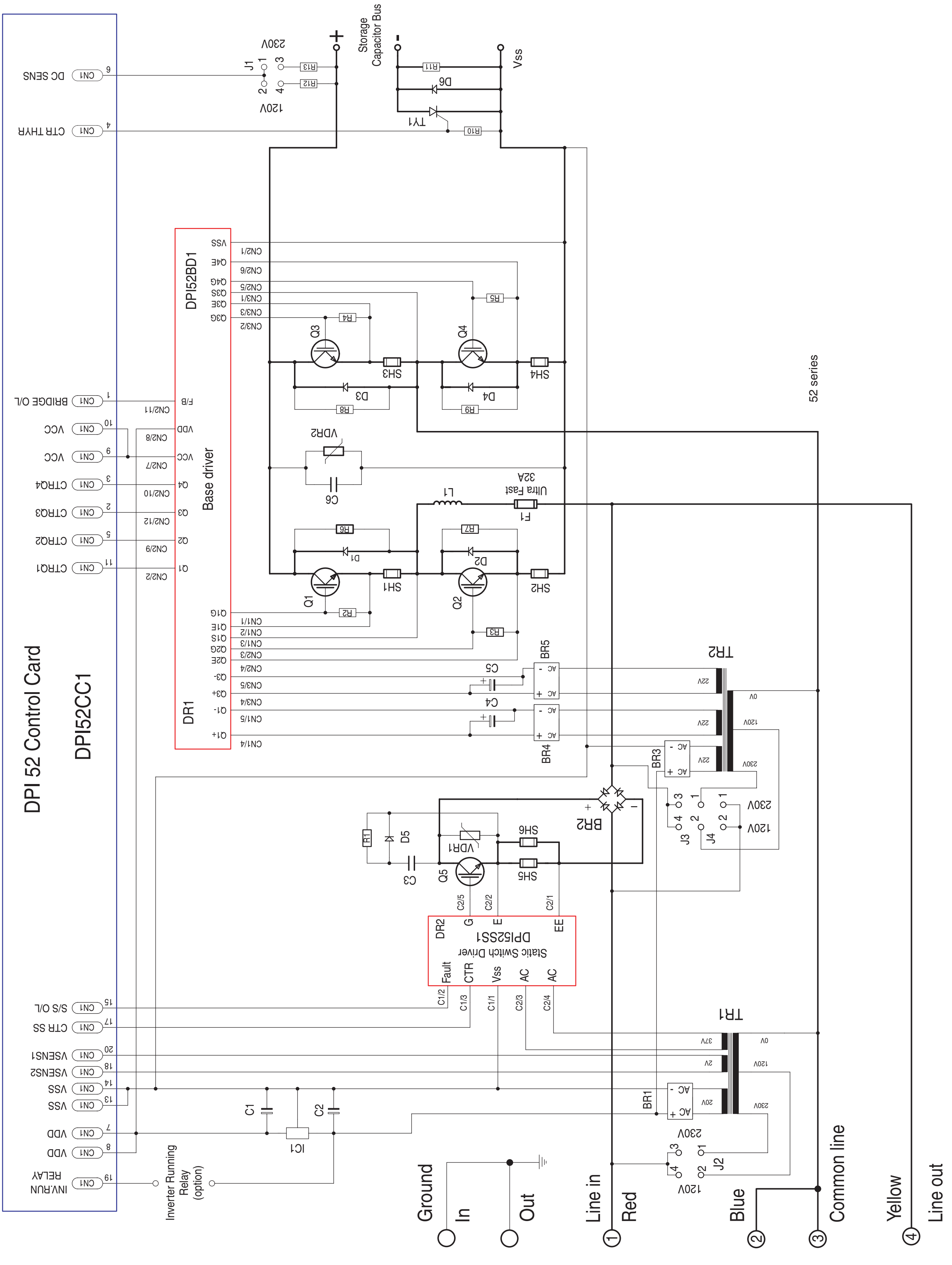


Fig6

Block Wiring Diagram

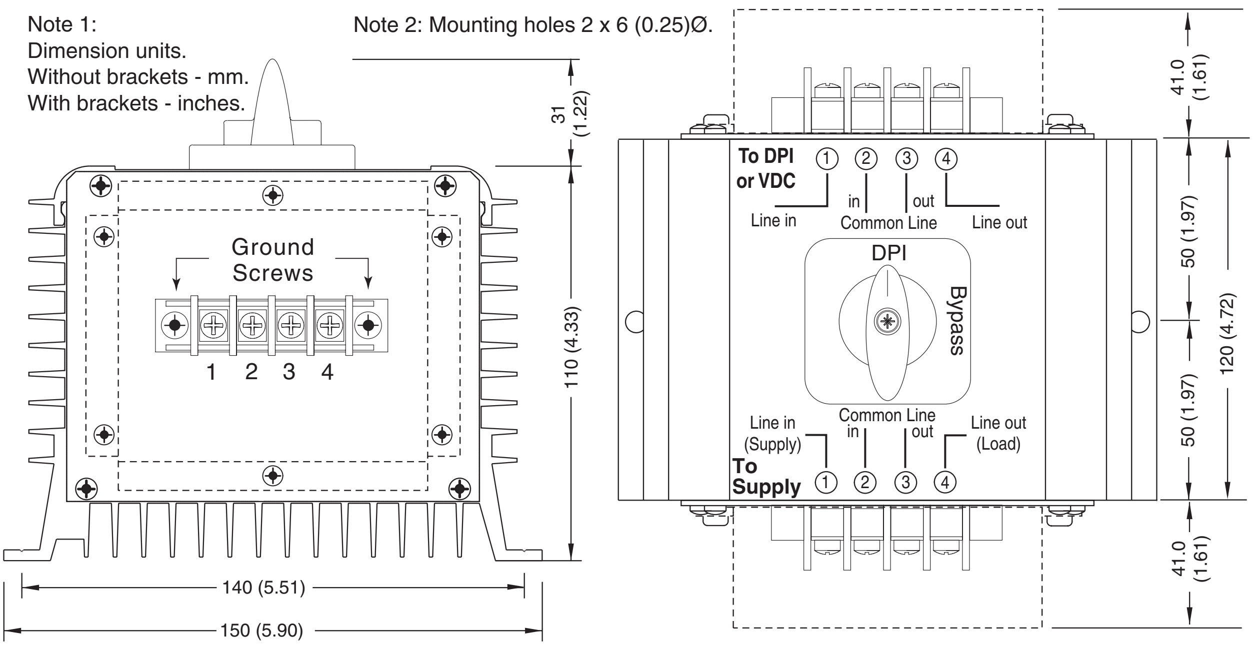
Accessories
Housed Bypass Switch
Description

Where no-break maintenance is required a by pass 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:	600Vac
TEMPERATURE	
Maximum working temperature:	45°C (113°F)
HOUSING	
Construction:	Extruded Aluminum
Height:	202mm (7.95in)
Width:	150mm (5.9in)
Depth:	141mm (5.55in)
Mass:	1kg (2.2lbs)

Mechanical outline



Ordering

Stock No:	Description
5003-006	Housed By-Pass Switch 25Amp

Mechanical Construction

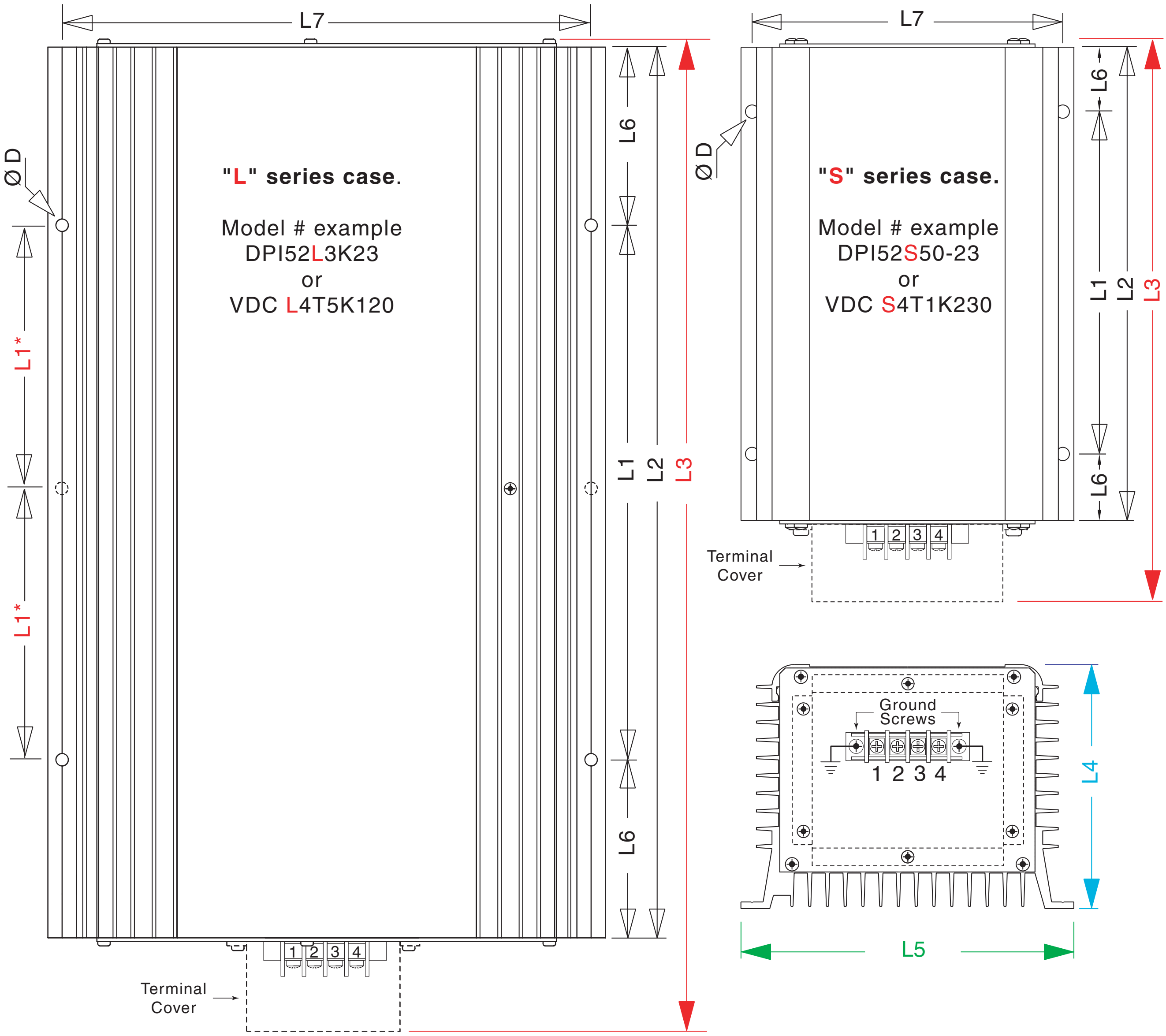
52 S series - The DPI case is made from extruded aluminium sections. The four parts that make up the case are interlocked and secured by screws. To remove the front cover unscrew four screws : the two top screws from the end plate where the terminal block is located and the two bottom screws from the other end plate. Slide the front cover away from the terminal block to access adjustment area.

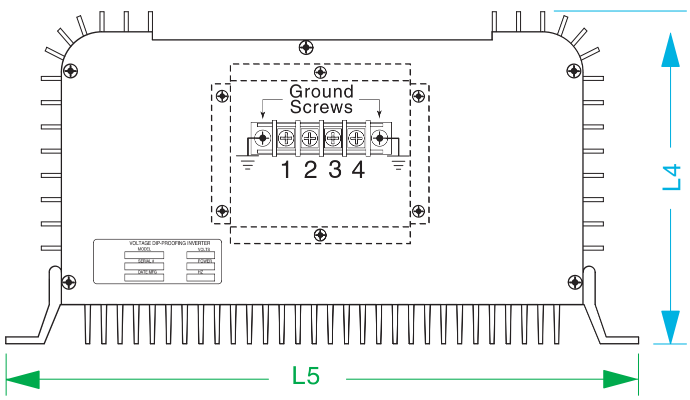
52 L series - The DPI case is made from extruded aluminium sections. The six parts that make up the case are interlocked and secured by screws. To remove the front cover unscrew three screws : one from the front cover and one each from the top and bottom end plates.

Dimension Table

Model	DPI & VDC Dimensions mm (in)							
	L1	L2	L3	L4	L5	L6	L7	D
DPI52S25-12	150 (5.91)	210 (8.27)	259 (10.20)	110 (4.33)	150 (5.90)	30 (1.18)	140 (5.50)	6.0 (0.24)
DPI52S50-12	200 (7.87)	260 (10.24)	309 (12.12)					
DPI52S95J12								
DPI52S190J12	270 (10.63)	330 (12.99)	379 (14.92)					
DPI52L1K5-12	160 (6.30)	280 (11.02)	329 (12.95)	162 (6.38)	311 (12.24)	60 (2.36)	296 (11.65)	8.0 (0.31)
DPI52L238J12								
DPI52L475J12	186 (7.32)	306 (12.05)	355 (13.98)					
DPI52L713J12	250 (9.84)	370 (14.57)	419 (16.50)					
DPI52L3K12	250 (9.84)	370 (14.57)	419 (16.50)					
DPI52L950J12	198 (7.80)	458 (18.03)	507 (19.96)			130 (5.12)		
DPI52L1188J12								
DPI52L1663J12	355 (13.98)	595 (24.43)	644 (25.35)					
DPI52L2376J12	418 (16.46)*	1096 (43.15)	1145 (45.08)					
DPI52S25-23	150 (5.91)	210 (8.27)	259 (10.20)	110 (4.33)	150 (5.90)	30 (1.18)	140 (5.50)	6.0 (0.24)
DPI52S50-23	200 (7.87)	260 (10.24)	309 (12.12)					
DPI52S108J23								
DPI52S216J23	270 (10.63)	330 (12.99)	379 (14.92)					
DPI52L2K23	160 (6.30)	280 (11.02)	329 (12.95)	162 (6.38)	311 (12.24)	60 (2.36)	296 (11.65)	8.0 (0.31)
DPI52L396J23								
DPI52L4K5-23	250 (9.84)	370 (14.57)	419 (16.50)					
DPI52L794J23								
DPI52L1587J23	286 (11.26)	546 (21.50)	595 (23.43)			130 (5.12)		
DPI52L2381J23	478 (18.82)	738 (29.06)	787 (30.98)					
DPI52L3174J23	332.5 (13.09)*	925 (36.42)	974 (38.35)					
DPI52L3968J23	418 (16.46)*	1096 (43.15)	1145 (45.08)					
	* Indicates 6 mounting holes see dimension L1*							

Mechanical Outline





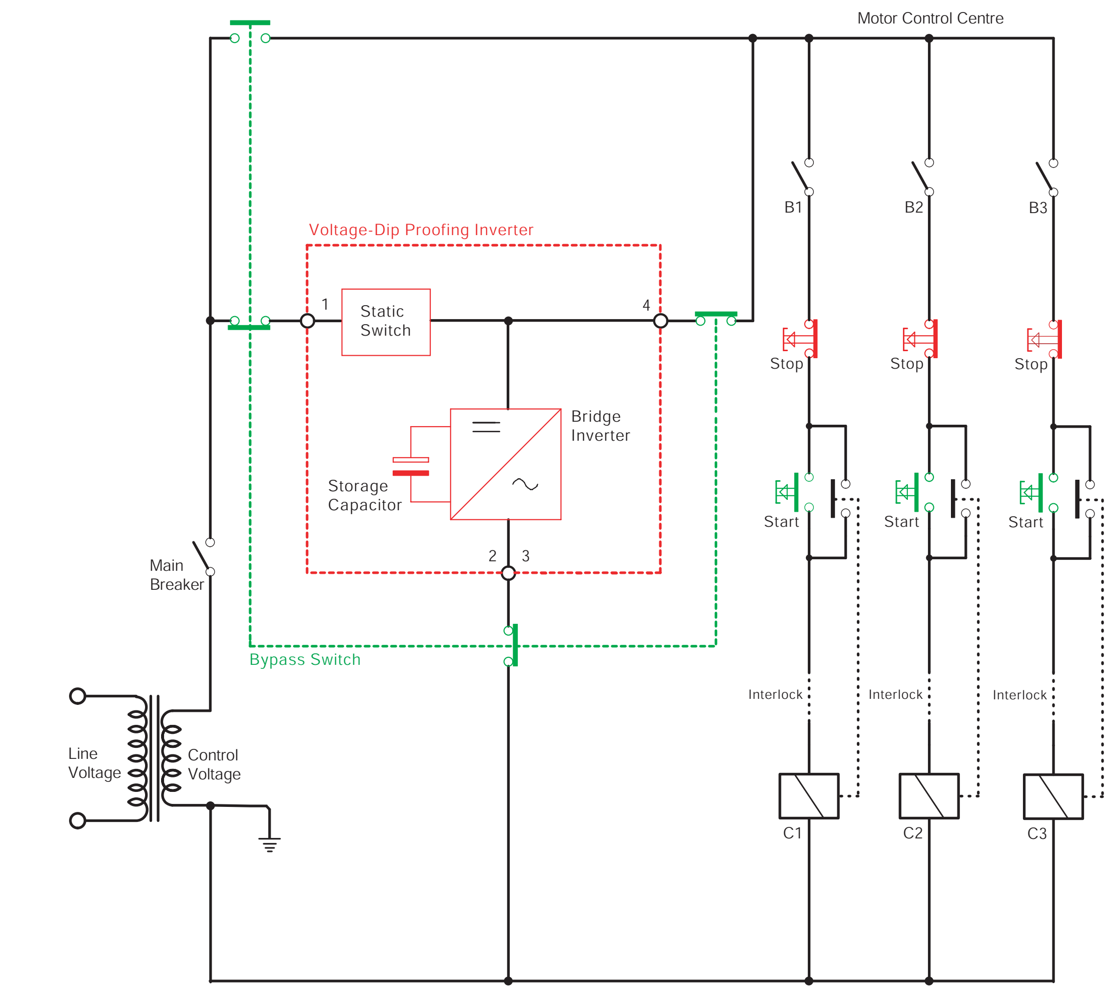
Note 1:
Terminal cover shown dashed.
Note 2:
Terminal #1 - Line in (Supply)
Terminal #2 - Common line in
Terminal #3 - Common line out
Terminal #4 - Line out (Load)

Fig 7
Dimensions of the DPI 52 Series in mm & (in inches)

Installation & Service Manual

Voltage-Dip Proofing Inverters

For DPI 52 Series Models
120V & 208 / 230V 50/60Hz



A typical DPI connection diagram

DIP-PROOFING TECHNOLOGIES INC.

LEADERS IN VOLTAGE-DIP PROOFING

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