Trusted™ Power System

Introduction

The Trusted™ Power System is a high density flexible power supply designed to convert main line voltages of either 110V or 240Vac. Outputs are either 24Vdc for Trusted™ product or 28Vdc adjustable field power.

The Trusted™ Power System consists of a 1U Power Shelf with mechanical support, containing up to three 750W Power Packs. The Power Packs load share in configurations using one or more Power Shelves. Each Power Pack has an individual supply connection via a mechanically retained IEC320 type connector. Each Power Shelf can supply 2250Watts of power or 1500Watts with n+1 redundancy from a single source. Multiple units can be connected for further capacity or redundancy requirements.

Diagnostics information of Power Pack status is provided via the Power Port, which connects to the rear of the Power Shelf. This device monitors input and output conditions and reports out of range faults and over temperature/fan failure using relay contacts. The Power Port also allows connection of the optional rack mounted Power Controller for live configuration of output voltage and current, monitoring up to 12 Power Packs in 4 Power Shelves.

Features

- Redundant and N+1 configurations
- Hot replaceable power Packs
- Current sharing
- Current limiting
- Power factor correction
- Diagnostics contacts
- Configurable output voltage
- Input/output fail diagnostics per power pack

Issue Record

Issue					
Number	Date	Revised by	Technical Check	Authorised by	Modification
1	July 04	J Bourn	G Creech	R Cockman	
2	Nov 04	J Bourn	G Creech	R Cockman	
3	April 05	J Bourn	G Creech	R Cockman	Removed CS from Con 3, added section 6.1
4	Sep 05	J W Clark			Format
5	Feb 06	Pete Stock	Nick Owens	Pete Stock	Fault relay details added.
6	Apr 07	A Holgate	Nick Owens	Pete Stock	Inrush current details added
7	Nov 07	N Owens	A Holgate	P Stock	Current sharing
8	Sep 08	N Owens	A Holgate	P Stock	TC-323 clarification
9	Sep 08	A Holgate	N Owens	P Stock	Current sharing with low loads

Figure 1 Front View - Power Shelf with Power Packs

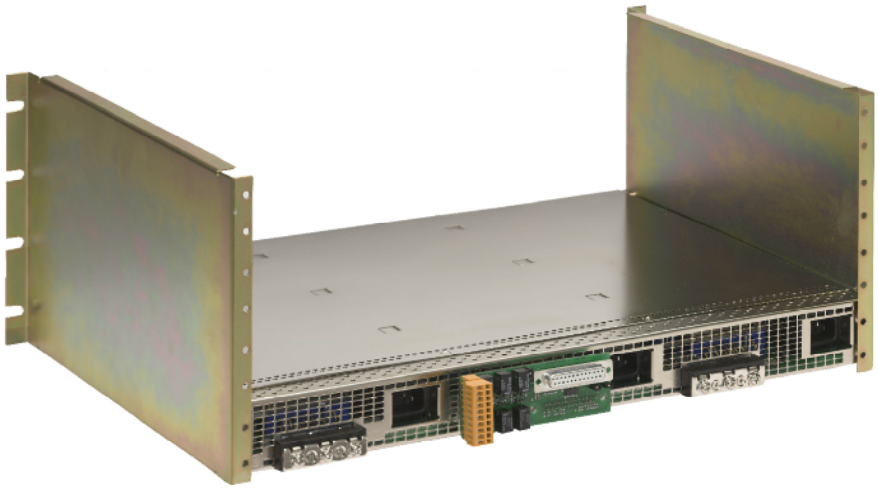

Figure 2 Rear View - Power Shelf, Power Port (uncovered) and 4U Mounting Brackets

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Warning notices call attention to the use of materials, processes, methods, procedures or limits which must be followed precisely to avoid personal injury or death.

CAUTION

Caution notices call attention to methods and procedures which must be followed to avoid damage to the equipment.

Notes:

Notes highlight procedures and contain information to assist the user in the understanding of the information contained in this document

Warning

RADIO FREQUENCY INTERFERENCE

Most electronic equipment is influenced by Radio Frequency Interference (RFI). Caution should be exercised with regard to the use of portable communications equipment around such equipment. Signs should be posted in the vicinity of the equipment cautioning against the use of portable communications equipment.

MAINTENANCE

Maintenance must be performed only by qualified personnel, otherwise personal injury or death, or damage to the system may be caused.

Caution

HANDLING

Under no circumstances should the module housing be removed.

Associated Documents

Product Descriptions (PD) provide product specific information.

The **Safety Manual** contains the recommended safety requirements for the safety system design.

The **PD8082B – Toolset Suite** provides specific guidance on system configuration and application generation.

The **Operator and Maintenance Manual** contains general guidelines on maintenance and diagnostic procedures.

For technical support email: support@icstriplex.com

1. Product Range

Catalogue No.	Product name	Description
T8230	Power Shelf	19” x 1U chassis for up to 3 Power Packs. Includes 4U fixing kit, Power Port (with push fit BLZF 3.5/10 connector), mains plugs and retaining clips.
T8231	Power Pack 24Vdc	750Watt, universal input, 24Vdc out.
T8232	Power Pack 28Vdc	750Watt, universal input, 28Vdc out.
T8233	Power Port	Plug in diagnostic interface.
T8234	Power Controller	For live adjustment of output voltage. 19” x 1U.
T8235	Power Shield	Covers unused Power Pack positions
TC-323	Power Shelf Interconnect	For connection to a Power Controller or for current sharing

Table 1 T823X Power System Product Range

2. Assembly

A pair of brackets mounted in to a 19” frame supports up to 4 Power Shelves and are required to provide support at the rear of the Power Shelf

The brackets supplied mount the equipment by its 19 inch rack ears and provide a box structure to brace the power supplies. The back of the power supplies are fixed using M3.5 screws that are fixed via tapped holes in the Power Shelf. The front of the power shelf is located and supported via screws through the lugs of the Power Shelf.

The Mounting bracket occupies 4U and can accommodate up to 4 Power supply shelves. The design is such that no space outside the 4U aperture is required. When installed it is possible to remove individual Power Shelves should this be required. The design of the mounting bracket does not obstruct access to the front or back of the Power Tray.

Power Packs are slotted into the 1U Power Shelf with the first Power Pack in the right hand slot, as shown in Figure 4. Each Power Pack provides 750W (31.25A at 24Vdc) to the DC output on the Power Shelf.

The standard AC input connection to the Power Shelf is through IEC320 type connectors rated at 10A/250Vac in Europe/Asia and 15A/120Vac in North America.

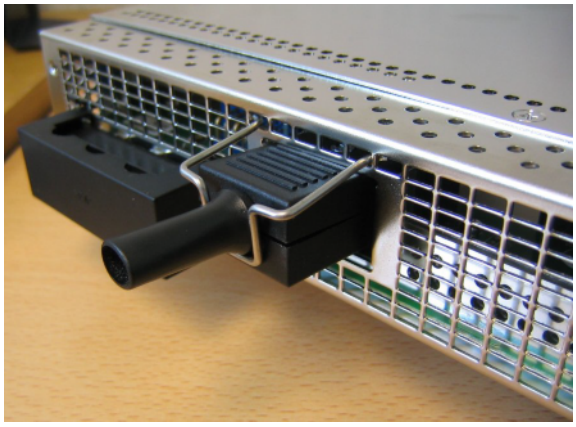

Figure 3 AC Power Connectors and Retaining Clips

Output terminal blocks on each Power Shelf have three M4 screw connections. Ring type connectors should be used when connecting from the Power Shelf to system power distribution bus bars.

The Power Port plugs into the back of the Power Shelf and requires a 24V supply. The Power Port can provide monitoring and control via a 25 way D connector when connected to a Power Controller. A separate connector (CON3) via a push fit connector (supplied), provides DC and AC fail contacts. When more than one Power Shelf is used, Power Ports are linked via the CS terminal, using a power shelf interconnect cable to enable current sharing.

Spare slots in the Power Shelf are covered by Power Shields.

The 1U Power Controller is connected via the Power Port, using a TC-323 Power Shelf Interconnect ribbon cable, and allows live configuration of output voltage. The Power Controller can monitor up to 12 Power Packs in 4 Power Shelves. Each Power Shelf is identified by the Power Controller by selecting addresses on the Power port as described in paragraph 5.2.4.

Unused slots in the 4U brackets may be used for other equipment or fitted with blanking plates.

Unused connectors on the TC-323 ribbon cable should be tied back and left unused.

3. Power Shelf Specification

The Power Shelf is designed to operate as a key element in a complete distributed Power System.

This Power Shelf can house up to three Power Packs, provides physical protection and a number of alarm and control features.

The Power Shelf can supply up to 1500W of N+1 redundant power or up to 2250W of total power depending on configuration of Power Packs. Four stacked Power Shelves can provide up to 9,000W total power.

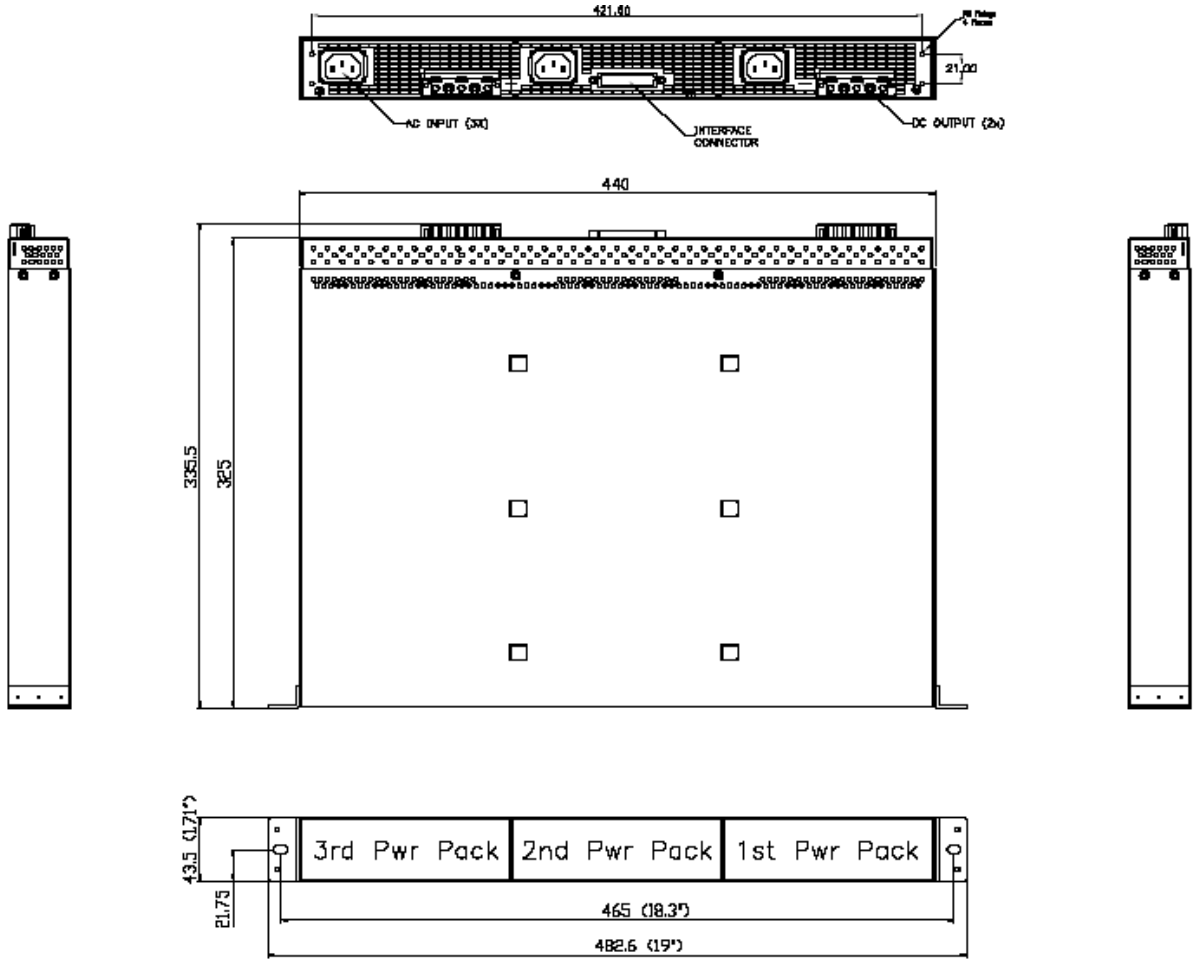

Figure 4 1U Power Shelf Mechanical Outline

3.1. Input Connector

The Power Shelf can be used with any standard global line voltages. The standard AC input connection to the Power Shelf is through three clip retained IEC320 type connectors rated at 10A / 250Vac in Europe/Asia and 15A /120Vac in North America.

3.2. Output Connector

The Power Shelf has two terminal blocks for DC output (each with three M4 screws). The V+ and V- are floating with respect to frame GND, either of which can be connected to GND as required.

3.3. Current Sharing

Note: If there is a low load on a Power Shelf (less than 2A per Power Pack) then the current sharing circuit may not work correctly and 'PWR OK' LED may not illuminate on the Power Packs.

In systems where more than one Power Shelf is being used, Shelves should connect their CS terminals by using a power shelf interconnect cable TC-323. This ensures that the Power Shelves current share.

Do not connect the TC-323 cable between 'A' and 'B' supplies or between two sets of shelves which connect to separate busbars. The supplies will attempt to share current between the two busbars, which may damage the power packs and shelves' sensing circuits.

Unused connectors on the TC-323 ribbon cable should be tied back and left unused.

3.4. Interface Connector

The Power Shelf has an optional DSB, 25-pin, female interface connector on the back. The Power System can be monitored and controlled through this interface, by a Power Controller, using a Power Shelf Interconnect. AC and DC fail alarms are available from a separate connector on the Power Port.

Pin Number	Signal Name	Description
1	DC Fail_2	DC Fail signal of the second Power Pack
2	A2	I^2C address bit 2
3	A3	I^2C address bit 3
4	ON SYNC	Not Used
5	SDA	I^2C Serial data bus
6	SCL	I^2C Clock
7	NC	No connection
8	On/Off_1	Remote on off control for the first Power Pack - Not Used
9	OTP_1	Fan Fail or Over Temperature signal for the first Power Pack
10	On/Off_2	Remote on off control for the second Power Pack - Not Used
11	V_{aux}	Not Used
12	DC Fail_1	DC Fail signal of the first Power Pack
13	AC Fail_3	AC Fail signal of the third Power Pack
14	OTP_3	Fan Fail or Over Temperature signal of the third Power Pack
15	DC Fail_3	DC Fail signal of the third Power Pack
16	INT BUS	Not used
17	AC Fail_1	AC Fail signal of the first Power Pack
18	On/Off_3	Remote on off control for third Power Pack - Not Used
19	SRTN	Signal return and V_{aux} return
20	RS-	Remote sense for V-
21	OTP_2	Fan Fail or Over Temperature signal of the second Power Pack
22	RS+	Remote sense for V+
23	AC Fail_2	AC Fail signal of the second Power Pack
24	CS	A single wire interface for current sharing
25	V-	V-

Table 2 Pin Assignment of the Interface Connector

Refer to Figure 4 - 1U Power Shelf Mechanical Outline for the locations of Power Pack 1, 2 and 3.

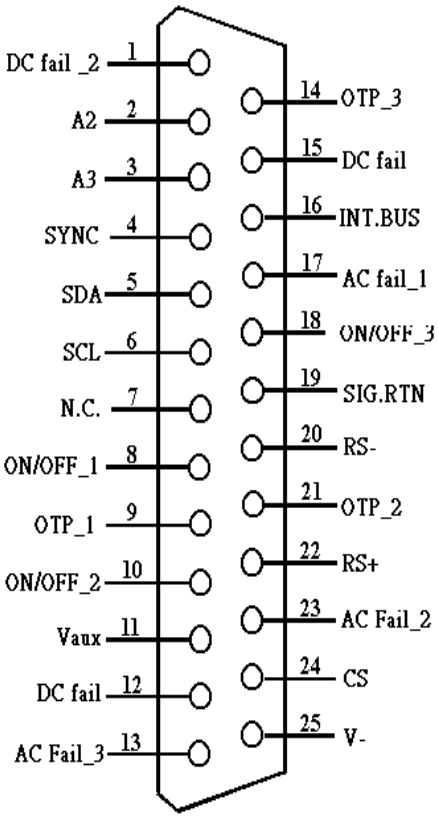

Figure 5 Interface Connector

3.5. Stacked-Up Assembly

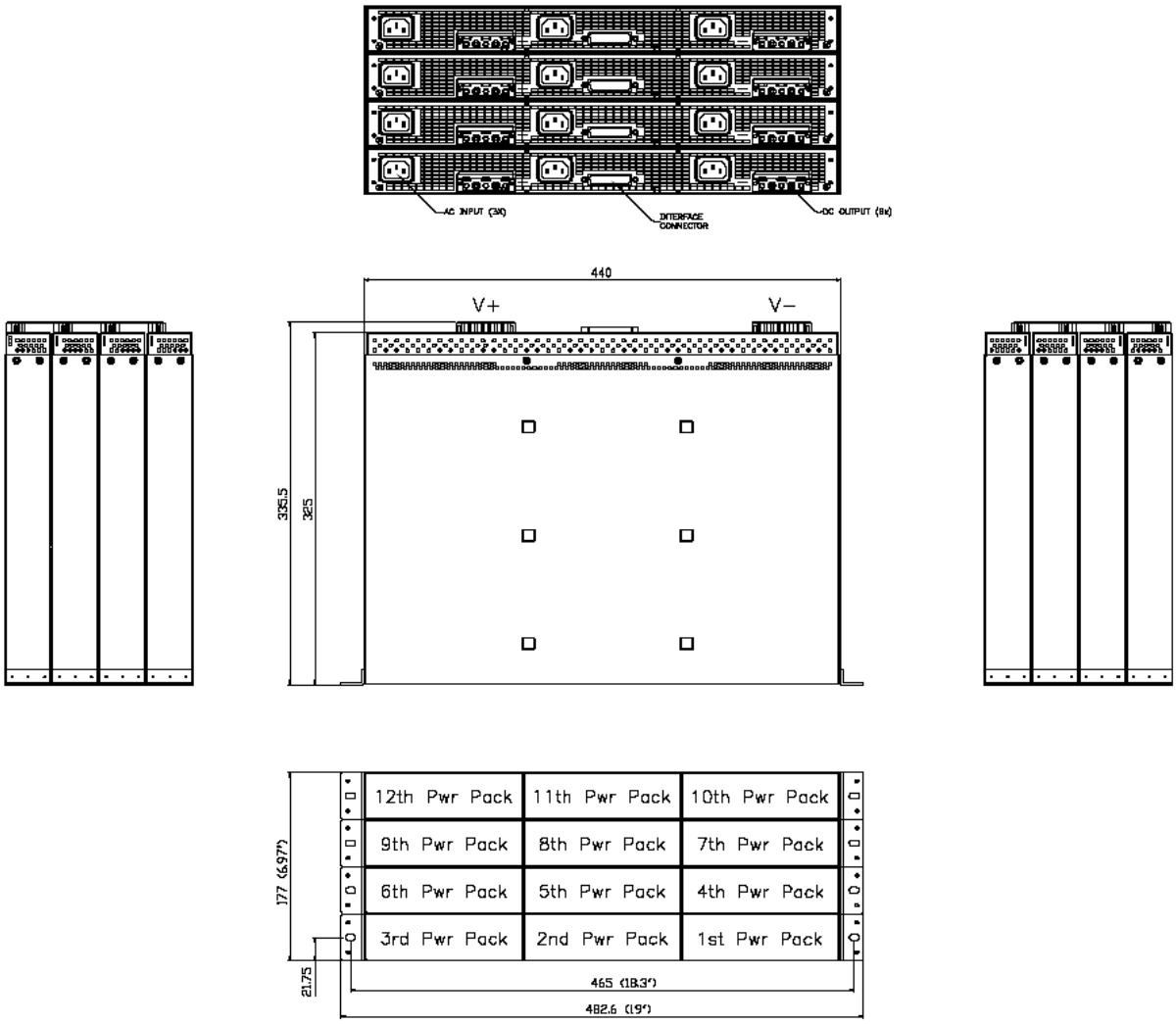

Figure 6 4U Stacked-up Assembly

4. Power Pack Specification

The Power Pack is specifically designed to operate as an integral part of a complete distributed Power System.

A full complement of protection, alarm and control features has been incorporated into the Power Pack to provide versatility for use in many applications.

Power Packs can be inserted and removed when live, allowing 'hot-swap' of Power Packs (see section 4.7). They are secured using a physical latch on the front of the Power Pack which is pushed up to release or connect the Power Pack into the Power Shelf.

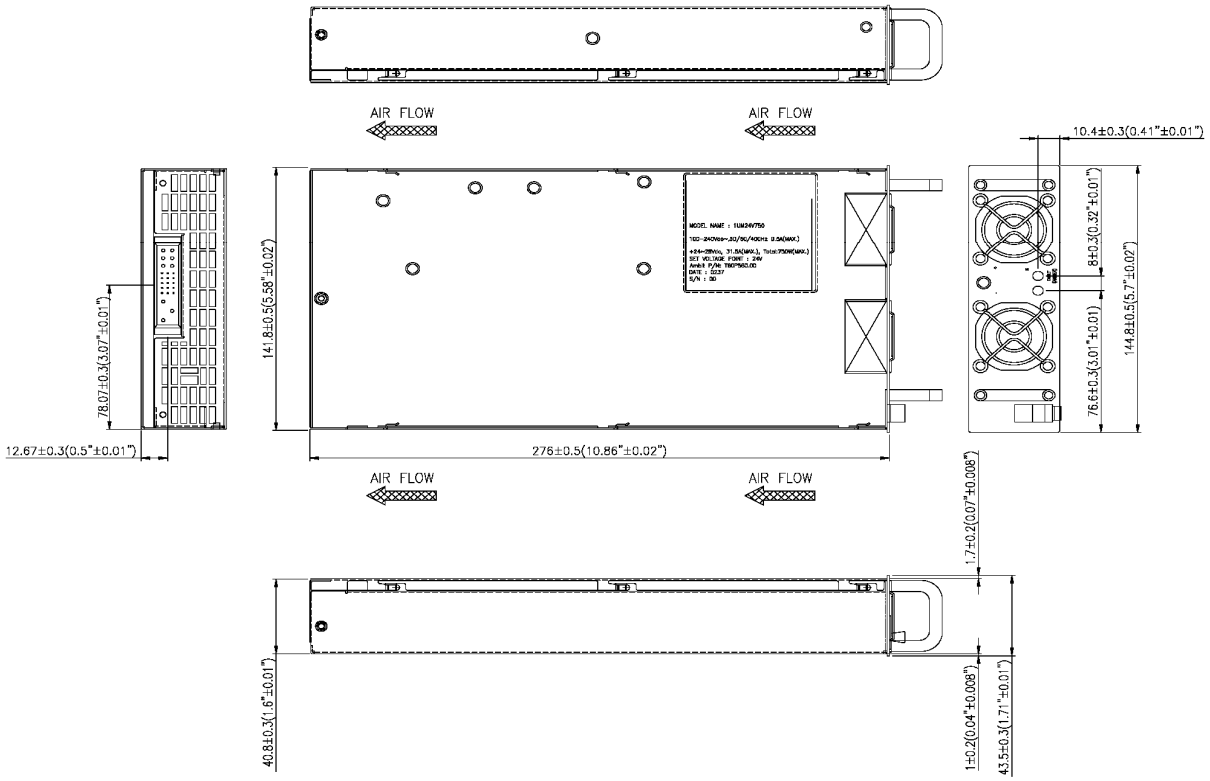

Figure 7 Power Pack Outline Drawing. Dimensions mm (inches)

4.1. Power Pack Features

4.1.1. Indicators

The Power Pack has two indicators on the front:

AC OK: The LED is green if the input voltage is within limits.

PWR OK: The LED is green if the Power Pack is healthy and within operating limits. If a fault occurs with the power supply or a fan, the LED is amber.

Failure of an internal power pack fan results in shutdown of the output of the power pack.

4.1.2. Overcurrent Protection

The overcurrent protection limits the output current in the event of an overload. There are two overload circumstances.

If the load is increased steadily a single Power Pack compensates by derating the voltage, hence at 40A (the specification limit) the voltage is derated to 18.75V. This derated voltage is on the limit of the Trusted system modules' specification. (Note: this gradual increase is not typical of a system fault.)

If 24V is maintained over a rapid current rise, the overcurrent protection will trip the power supply when 35A is reached. This rapid increase is more typical of a fault situation in a system.

4.1.3. MCB discrimination

MCB discrimination studies should be carried out when designing the system power distribution.

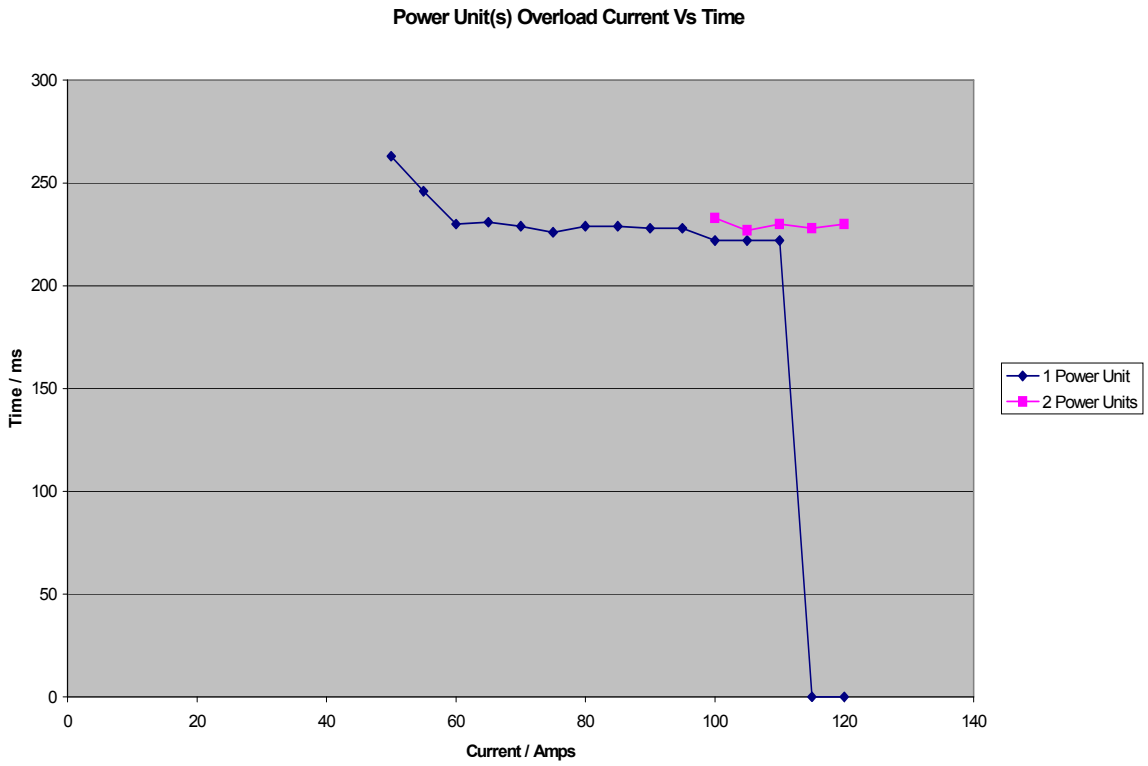

Figure 8 Power pack (s) severe overload Current v Time

The graph above shows the response of a single power module to severe overloads. As the load is increased the power supply protection mechanism operates and shuts down the output. It can be seen that for a period of just in excess of 200mS the Power module can provide currents up to 115Amps or 380% of its stated maximum(115/31 = 3.8). This 200mS/380% can be extrapolated for additional power supplies in order to perform MCB discrimination studies.

4.2. Input Specification

Parameter	Min	Typ	Max	Unit	Condition
Input voltage	90		264	Vac	
Input Frequency	47		63	Hz	
Inrush Current (peak) per pack			50 <25	A A	Full load No load
Input current			0.2	A	No load
Power Factor	0.95	0.99			> 50% of full load
Input Leakage Current			1.7	mA	264Vac, 50Hz
Lighting Surge & Transients (damage free operation)					IEC1000-4-5 Level 3 IEC1000-4-4 Level 3
Hold Up Time	20			mS	At 600W
EMC (conducted)					CISPR22 Class B, EN55022 Class B, with 3dB margin

Table 3 Input Specification

4.3. Line Harmonics

Active power-factor correction circuitry ensures that this Power Pack meets the requirements of IEC1000-3-2.

4.4. Efficiency and Power Factor vs. Input Voltage at Full Load

Input voltage	Efficiency (Typical)	Power Factor (Typical)
90Vac	78%	0.99
100Vac	79%	0.99
110Vac	80%	0.99
120Vac	81%	0.98
180Vac	82%	0.98
220Vac	83%	0.98
240Vac	83%	0.98
264Vac	84%	0.98

Table 4 Efficiency and Power Factor vs. Input Voltage at Full Load

When using this table to calculate cable feed requirements, allow, at a minimum, an extra 3% for variations between units. Actual measured results will depend upon the harmonic content of the input voltage waveform.

4.5. Output Specification

Parameter	Min	Typ	Max	Unit	Note
V_{OUT} set point: T8231 T8232		 24 28		 Vdc Vdc	
Regulation (line, load, temperature & set point)	-2		2	%	Measured at remote sense
Remote-sense Drop			0.5	Vdc	
I_{OUT} (rated): T8231 ($24V_{OUT}$) T8232 ($28V_{OUT}$)	 0 0		 31.25 26.78	 Adc Adc	 750W maximum 750W maximum
Ripple (20MHz bandwidth)			150	mVp-p	
Noise (20MHz bandwidth)			300	mVp-p	Under any load conditions
Transmission Noise (C message)			45	dBmc	
Output Rise Time	10		100	mS	Rise from 10% to 90% of final output level (resistive load)
Overvoltage Protection	29		32	Vdc	Reset by cycling ac input, on/off, or reinsertion
Output Current Limit (Steady state)			40A	Adc	
Transient Response Voltage Range	 -2		 2	 %	25% step load transient with slew rate 0.1A/us within the range from 25% to 75% of full load
Active Current Sharing Differential			±3.2	A	Single-wire current share at full load
Efficiency	80 83.5	81 84		% %	At full load, 120Vac with ORing diode At full load, 264 Vac with ORing diode
Reserve Output Current Protection					ORing diode
Start-Up delay		1.3	2	s	Measured from application of valid ac voltage
Turn-On delay			250	ms	Measured from DC on/off

Table 5 Output Specification

4.6. Environmental Characteristics

Parameter	Min	Typ	Max	Unit	Note
Storage Temperature	-40		-85	°C	
Operating Temperature (note 1)	0	-	60	°C	1. Derate at 1.333%/°C, 45°C to 50°C 2. Derate at 4.667%/°C, 50°C to 60°C
Acoustics		47	52	dBa	Sound Pressure Level at 1m
Humidity (non-condensing)	5		95	%	
Altitude	-60		3962	m	Derated at 2°C/304m above 2438m.
Electro Static Discharge					IEC1000-4-2 Level 3 stand-alone
Electromagnetic Immunity (error free)					IEC1000-4-3 Level 2 stand-alone
Isolation Voltage	3,000 1,500 1,500			VAC VAC VAC	Primary to Secondary Primary to chassis GND, Secondary to chassis GND
MTBF	4 x 10^5			hours	@110Vinput 80% load, T_A = 30°C
Vibration					Meet IEC68-2-6
Shock					Meet IEC68-2-36
Weight			2.3	kg	

Table 6 Environmental Characteristics

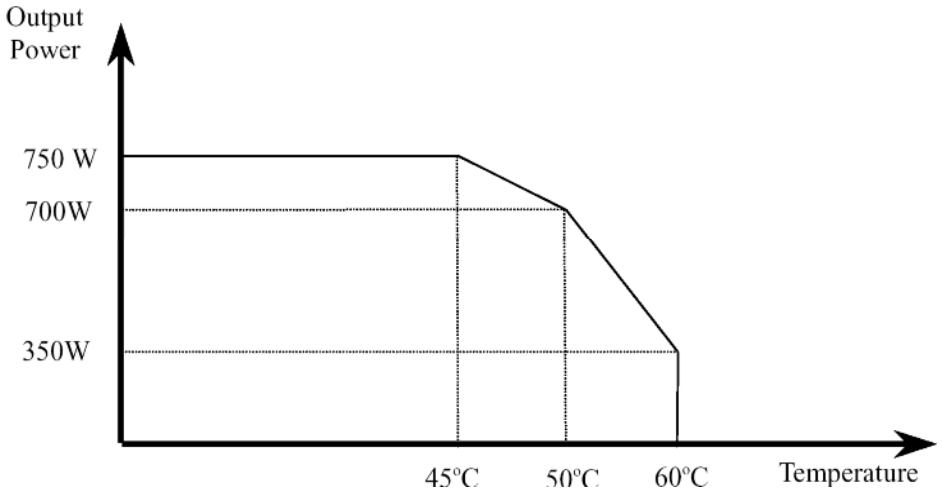

Figure 9 Operation Derating Curve

4.7. Power Pack Hot Replacement

1. Plug in slowly and smoothly.
2. To make sure the first set of pins are contacted. (The AC OK LED will ON)
3. Push to fully contacted. (The PWR OK LED will ON)

Step 1 : Plug in smoothly and slowly.

Step 2 : Let the first set of pins contacted and AC OK LED is ON.

Step 3 : Push to fully contacted and PWR OK LED is ON.

Figure 10 Power Pack Hot Replacement

5. Power Port

5.1. General Description

The Power Port is a supplied accessory and is fitted onto the rear of the Power Shelf. It converts alarm signals produced by the Power Packs and Power Shelf into volt-free alarm contacts for use by the system and enables hot replacement of Power Packs. It consists of a pcb fitted with connectors, relays and miscellaneous electronic components. The shape and size of the Power Port is shown in Figure 11.

The alarm contacts are made available on a connector for ease of wiring into the system. The system provides a supply for the Power Port, which is wired to the same connector. The connector pin-outs are shown in section 5.3.

The Power Shelf is fitted with a 25 way D female connector to which the Power Port connects. The Power Port is retained to the Power Shelf by means of the Dsub jack screws. The Power Port is fitted with a 25 way D female connector to allow the Power Shelf connectivity to be extended to a Power Controller using a Power Shelf Interconnect ribbon cable.

The Power Controller is powered from the Power Port 24V supply via pin 7, when connecting CON 2 on the Power Port to the Power Controller.

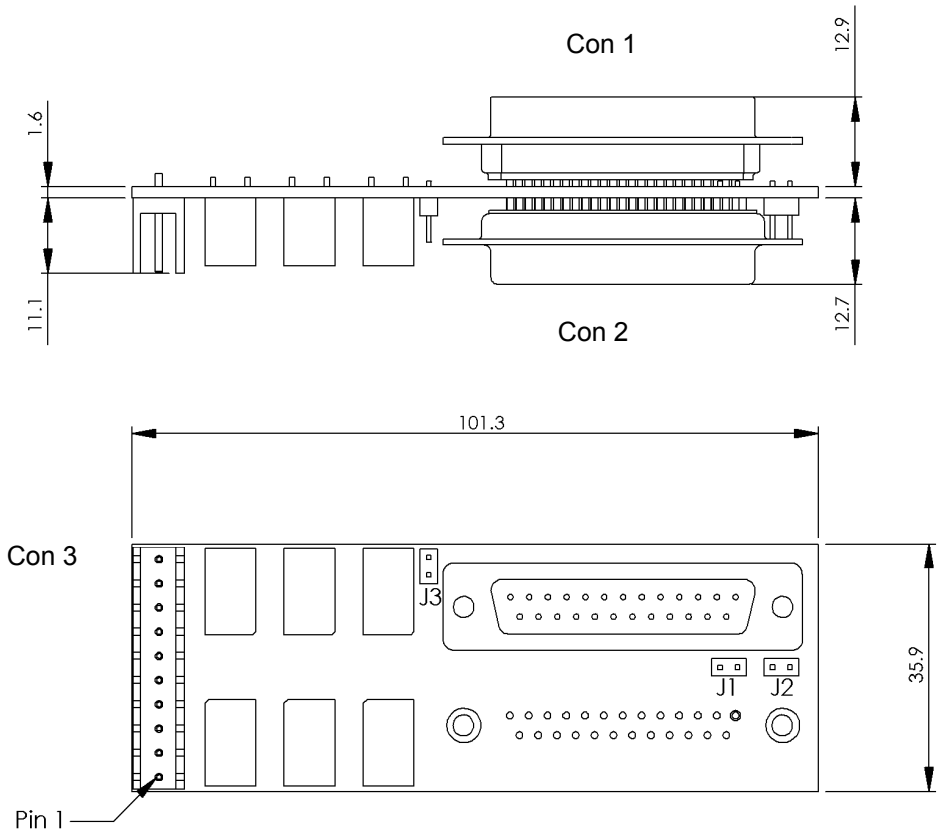

Figure 11 Power Port Outline Drawing

5.2. Circuit Description

The circuit is split into four functional sections: supply, dc alarms, ac alarms and jumpers.

5.2.1. Supply

The 24V supply is connected to CON3 pins 1 & 6. The supply should be fused close to its source, using a 500mA F rated fuse. It is nevertheless protected by a non-replaceable fuse on the Power Port. The 24V is regulated down to 5V with decoupling provided. The 5V+ is used to supply the low voltage electronics. The 24V is used to supply the relays and is connected through the CON2 to power the optional Power Controller.

5.2.2. DC Alarms

CON1 is the 25 way D male interface to the Power Shelf. The Power Pack and Power Shelf alarm outputs are derived from here. There are two dc alarms per Power Pack: DCFAIL (dc output fail) and OTP (over-temperature protection). The Power Port OR's together DCFAIL and OTP to give one DC fail alarm, via CON 3. If either alarm triggers, the corresponding relay de-energises.

Each relay operates a volt free contact. These are closed when healthy (relay energised) and open in alarm. The contacts share a common return line.

5.2.3. AC Alarms

In a similar manner, each Power Pack generates an AC alarm. When an alarm is triggered, the corresponding relay de-energises. Each relay operates a volt free contact. These are closed when healthy (relay energised) and open in alarm. The contacts share a common return line.

Fault Condition	Output OK LED	OTP Alarm	AC Fail alarm	dc Fail alarm	dc Output
No fault	Green	Low	Closed	Closed	ON
Fan locked rotor	Amber	Low	Closed	Closed	OFF
Secondary over temperature	Amber	High	Closed	Open	OFF
Primary over temperature	Off	High	Closed	Open	OFF
AC Feeder Fail	Off	Low	Open	Open	OFF

Table 7 Alarm Conditions

5.2.4. Jumpers

There are three jumpers, J1, J2 and J3.

J1 and J2 set the Power Shelf address lines for the I^2C control bus. With J1 and J2 fitted the Pack addresses are 1, 2 and 3, which is the default. Other addresses may be set by removing one or both of J1 and J2, up to 4 shelves worth (or 12 Power Packs).

Power Shelf	J1	J2
1	fitted	fitted
2	fitted	removed
3	removed	fitted
4	removed	removed

Table 8 Power Shelf Addressing

J3 connects together the common return lines of the DC alarms and AC alarms. J3 is fitted by default.

5.3. Mechanical

5.3.1. Pin-out CON 1, CON 2

CON 1 on the Power Port connects to the Power Shelf. The pin-out details are shown in Table 2.

CON 2 is used to connect to other Power Shelves to current share or to connect to a Power Controller.

Pin Number	Signal Name	Description
1		
2		
3		
4	ON SYNC	Not Used
5	SDA	I2C Serial data bus
6	SCL	I2C Clock
7	24v	Supply from Power port
8		
9		
10		
11		
12		
13		
14		
15		
16	INT BUS	Not Used
17		
18		
19	SRTN	Signal return and V_{aux} return
20	RS-	Remote sense for V-
21		
22	RS+	Remote sense for V+
23		
24	CS	Current Sharing
25	V-	V-

Table 9 Connected pins on CON 2

5.3.2. Pin-out CON 3

Pin	Description
1	+24V system supply
2	DCFAIL common
3	DCFAIL_3
4	DCFAIL_2
5	DCFAIL_1
6	0V system supply return
7	ACFAIL_1
8	ACFAIL_2
9	ACFAIL_3
10	AC Fail common

Table 10 Connector 3 Pin-out

CON 3 provides volt-free alarm contacts as detailed in section 5.2.2 and 5.2.3 for use by the system and are made available on a connector for ease of wiring into the system.

Fault Relay Technical Specifications

Contact Form SPDT

Resistive Load 0.5A at 125 VAC, 1 A at 24 VDC

Max Switching Power 62.5 VA, 30 W

Rated Voltage 3 to 24 VDC

Power Consumption 150 mW

Mechanical Endurance 5,000,000 operations min

Electrical Endurance 100,000 operations minimum

Operating temperature -40° to 70°

6. Power Controller

The Power Controller is designed to control and monitor the 19” rack mount 1U high Power Shelf units. It is used to address each Power Pack in turn and adjust the respective Power Pack voltage.

The Power Controller is a digital system and communicates with the Power Packs by means of a TC-323 Power Shelf Interconnect ribbon cable, via the Power Port. The shelf addresses are set using jumpers on the Power Port, as described in paragraph 5.2.4.

The Power Controller offers adjustment of the system voltage in 100mV steps over the range 24-28V for the Power Packs. Power supplies share through their analogue control circuitry. A Power Controller will ensure that a power supply, regardless of its voltage setting when plugged in, is adjusted (via the I^2C serial data bus) to be within the current/voltage sharing window of the power supply’s analogue control circuitry.

The front panel contains two switches. The Address switch is used to select a Power Pack. The Voltage switch is used to raise or lower the voltage of that Power Pack. The two displays show the current and voltage of that Power Pack.

Up to 12 hot swap Power Packs can be used in parallel. The Power Controller can be used to select a particular Power Pack’s position and read the current being drawn from that unit with a resolution of 100mA.

Note that the Power Controller should not be connected to power supplies on different busbars with the TC-323 cable, because it will attempt to perform load sharing between unconnected power supplies. It may also be presented with power supplies having duplicate addresses on its I^2C bus.

Unused connectors on the TC-323 ribbon cable should be tied back and left unused.

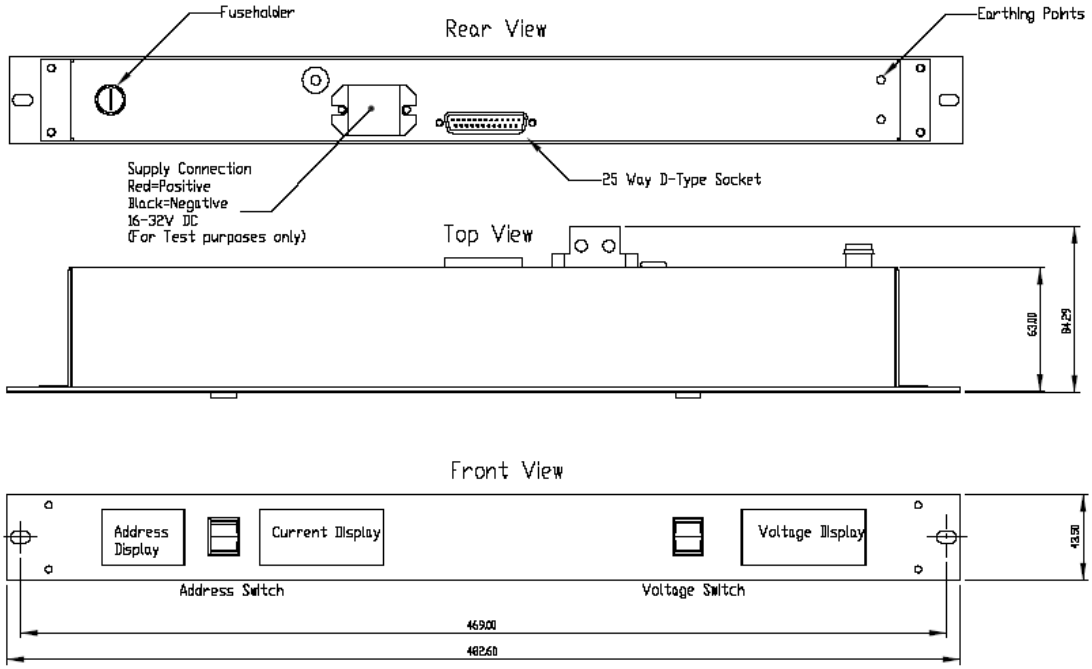

Figure 12 Power Controller Outline Drawing

6.1. Power up sequence

When a power controller is connected to more than one power shelf, power shelves should have their supplies applied in turn, e.g. power up first shelf (idents 1-3), followed by shelf two (idents 4-6) etc. This ensures that the power pack addresses are not duplicated.

7. Power Shield

If a Power Shelf is not fully populated, Power Shields are used to cover unused spare slots.

8. Power Shelf Interconnect

A ribbon cable is required to connect Power Shelves together in order to current share, or to connect shelves to a Power Controller.

The supplied ribbon cable has 5 connectors, to allow the maximum of 4 shelves and a Power Controller to be connected.

Do not connect the TC-323 cable between ‘A’ and ‘B’ supplies or between two sets of shelves which connect to separate busbars. The supplies will attempt to share current between the two busbars, which may damage the power packs and shelves’ sensing circuits.

Unused connectors on the TC-323 ribbon cable should be tied back and left unused.

9. Power System Specification

Voltage Range	
Input	90V ac to 264V ac
Output	24V dc to 28V dc
Frequency Range	47Hz to 63Hz
Inrush Current	50A Max per Pack
Power Factor	0.95 min, 0.99 typical
Efficiency	78 – 84%
Output Power	750W per Power Pack
Power Hold-up Time	20ms
Operating Temperature	0^0C to 60^0C (30^0 to 140^0 F)
Operating Humidity	5 to 95%, non-condensing
Environmental Specifications	Refer to Document N^o 552517
Power Shelf dimensions	
Height:	43mm (1.71in)
Width:	483mm (19in)
Depth:	340mm (13.36in)
Weight Data	
T8231,T8232 Power Pack	2.7kg
T8230 Shelf (without supports)	4.4kg
UL Approvals	
Power Supplies, Information Technology Equipment Including Electrical Business Equipment - Component	E223750
Power Supplies, Medical and Dental - Component	E223749