Applications Manual

Vega Series
Power Supply

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Rev: A3
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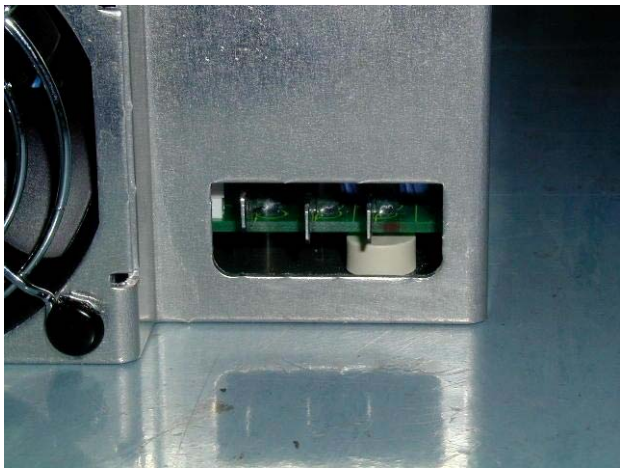
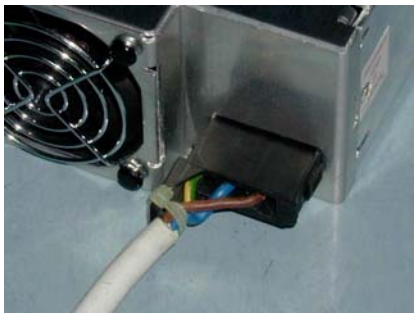
Connecting Vega to the input supply.

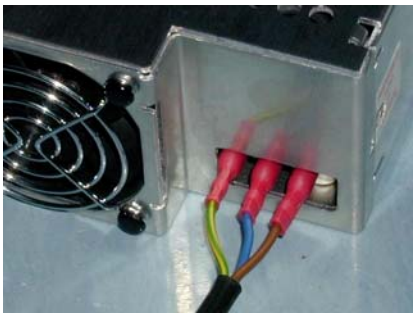


The AC input connection is situated adjacent to the cooling fan inlet as shown above. The faston tabs are tin plated 6.3 x 0.8mm at 9mm centres. Connection is made using insulated 6.35mm 'faston' connectors rated at 15amps each.

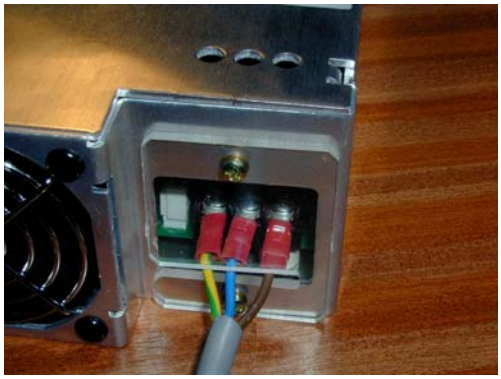
Wire Size (awg)	AMP termination	Colour
22-18	2-520407-2	RED
16-14	3-520408-2	BLUE

A moulded connector housing is also available which accepts 3 low insertion force 'faston' connectors (fastons are AMP 42100-2). The housing incorporates two locking tabs and a tywrap may be used for additional strain relief of the AC cable. Kits of 25pcs including the moulded housing and faston connectors and ty-wraps are available, Lambda part number = KT-AC-88537.





There is also available a screw terminal input version of Vega. This has a perspex safety cover and access to fit the screw terminals to the input is via 3 holes in the lid.



Vega imposes no special requirements for mains installation over and above standard good practise in using switchmode power supplies:

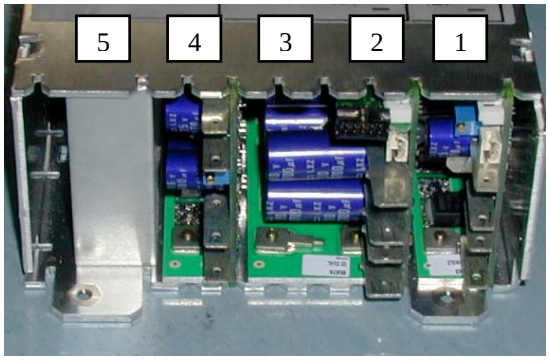
1) Use either twisted cable of about 1 twist per centimetre or standard sheathed mains cable. Efficiency of a Vega power supply is typically 75% (depends on the configuration). Efficiency is slightly worse with many low voltage / high current outputs and slightly better with high voltage outputs. Input power will be 1 / (efficiency) times greater than the specified output power. Use 75% as an estimate and consult technical sales for more accurate efficiency estimate if it is vital.

2) Avoid running the input mains cable near to the DC output cables. This is likely to cause noise pickup which result either in generally high levels of noise on the system power rails or worse, random system errors which can be very hard to trace and solve and poor RFI performance.

3) Pay special attention to the design of the system earth to prevent earth loops. The system earth should be connected via a "star" network with all earth connections joining at the system earth starpoint at the input filter.

4) Vega power supplies are designed to meet EN55022 conducted RFI emissions. However, this may not remove the requirement for an RFI filter at the system inlet due to noise picked up from looming as part of the system installation. Cable runs within the system can pick up noise which can degrade the overall RFI performance. Also, when connecting power supplies in parallel, each power supply will contribute it's own noise to the total emitted RFI.

Connecting Vega to the Load



The picture shows a typical Vega configuration with faston output connections :-

Slot 5 = blank slot.
Slot 4 = Single slot, Twin module (2outputs)
Slot 3&2 = Dual slot module (1 output)
Slot 1 = Single slot module (1 output)

Output Voltages are delivered factory set according to customer requirement. Adjustment can be made via multi-turn potentiometers at the front of each module. CLOCKWISE = INCREASE VOLTAGE.

Refer to the handbook for module adjustment range when adjusting output voltages and ensure that maximum power and maximum ampere turns are not exceeded.

Modules are available with SCREW TERMINALS or FASTON TERMINALS specified at purchase.

Suggested faston Terminals & Current handling capacities of Copper Multi Stranded TRI-Rated cable.

Cross sectional Area (sq mm)	Cable Gauge AWG	Typical Rated Current (Amps)	Suggested FASTON Terminal
0.5	22	11	AMP faston 2-520407-2 (red)
0.75	20	14	
1.0	18	17	
1.5	16	21	AMP faston 3-520408-2 (blue)
2.5	14	30	
4	12	41	AMP faston 280223-2
6	10	53	USE AMP ringtag 130191 and specify screw terminals
10	8	75	USE AMP ringtag 130552 and specify screw terminals
16	6	100	

Suggested sources for RING TAGS for use with SCREW TERMINATIONS.

Up to 50 Amps = AMP PIDG ringtags.

	RED	BLUE	YELLOW
M3	36151	320561	---------
M4	320551	320560	320568
M5	130660	130663	130167

Crimp tool = 169400, Die set 169404

Over 50 Amps = AMP AMPOWER III ringtags.

	TAGS
M5 - 6AWG	719551-1
M5 - 8AWG	719538-2

Terminals with crimp tool = 708777-4

General Installation.

All switch mode power supplies can be sensitive to stray inductance in the power leads and specifically in remote sense leads if installed poorly. Poor transient response or high noise pickup and also intermittent tripping of Overvoltage protection are possible problems. Observing a few simple installation rules will ensure trouble free function :-

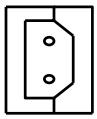
When connecting Vega by means of a cable harness, run the remote sense and power output cables as separate pairs twisted tightly together with at least 1 twist per centimetre. Keep cable runs as short as possible.

When connecting Vega to the load by means of a PCB backplane, run the power tracks "back to back" on the PCB to minimise the projected area of the loop connecting the positive and negative outputs. Run the remote sense and power connections as separate pairs, avoiding close parallel runs and only coming together at the load.

The load should be de-coupled with 10uF of capacitance per Amp of load current. The greater the amount of de-coupling, the better the transient response of the system will be. (NB Max recommended de-coupling is 1000uF/Amp).

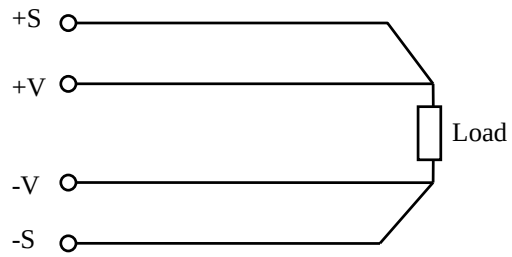
Remote Sense.

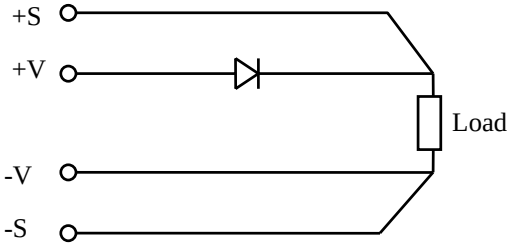
All single output Vega modules are provided with remote sense connector as standard. Twin output Vega modules are available with remote sense but need to be ordered with a secondary option “R” specified. In both cases the Molex connector viewed from the back of the power supply is :-



Remote sense can be used to compensate for the drop in voltage along the load cables or for the drop in voltage across blocking diodes. The voltage at the output terminals will be higher than that at the load by an amount equal to the voltage drop due to load lead resistance and/or blocking diodes if used. The maximum voltage at the terminals cannot exceed the maximum voltage specified for that module.

Always observe the following general rules for remote sense operation :-





Ensure that the remote sense cables are twisted pairs.

PCB tracks for remote sense should be run back to back.

Ensure that the remote sense cables / tracks are as short as possible.

Ensure that the sense cables are not twisted together with the power cables.

PCB power tracks and remote sense tracks should be kept away from each other as far as is possible.

Do not fit components (resistor, inductor or diode) into remote sense lines. This could make the system unstable.

See the data sheets for each module to see the maximum voltage drop that remote sense can compensate for, do not exceed this value.

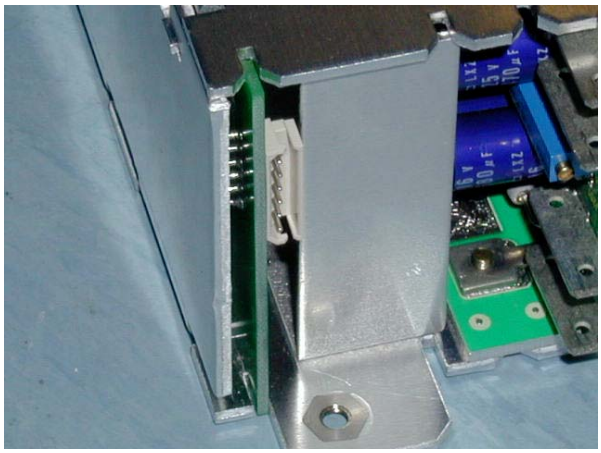
Mating connector information:
Note: housing and pins supplied with each power supply.
Housing: Molex 50-37-5023
Crimp pin: Molex 08-70-1039
Hand Crimp Tool: 69008-0959 (Europe or Japan) Or 11-01-0204(USA)

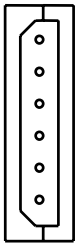
OPTION E, EV, F, FV, xEV, xFV

The Analogue primary option is a factory fitted option board which provides the following functions:

1) Warning the AC input has been lost or that the converter has overheated.
2) Global inhibit / enable (Global meaning the option inhibits/enables all modules or outputs at the same time).
3) 5V auxiliary supply (5V being present when AC is applied and regardless of inhibit/enable status).

The option board occupies a position to the left of slot 5 as shown:





Mating connector information:
Note: housing and pins supplied with each power supply.

Molex housing 50-37-5063
Molex crimp pins 08-70-1039
Molex hand crimp tool 11-26-0167 (Japan)
Or 11-01-0194 (Europe or USA)

Pin No.	Function
1	AC fail and over temperature warning, C
2	AC fail and over temperature warning, E
3	0V of auxiliary supply and 0V "reference" or "return" for global inhibit / enable.
4	5V auxiliary supply
5	Global inhibit/enable logic "0" input
6	Global inhibit/enable logic "1" input

INHIBIT OR ENABLE.

One of two options are available (**required option must be specified at time of ordering**) : Inhibit or Enable.
Both are TTL compatible.
They are physically the same but with different functionality.

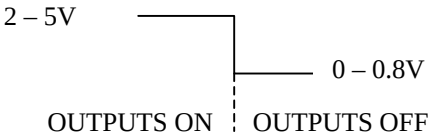
Option specified = "INHIBIT" All outputs normally "ON" (even if not connected)	PIN 5 taken to 0V-0.8V will turn outputs OFF.	PIN 6 to be taken to 2-5V will turn outputs OFF.
Option specified = "ENABLE" All outputs normally "OFF" (even if not connected)	PIN 5 taken to 0V-0.8V will turn outputs ON.	PIN 6 to be taken 2-5V will turn outputs ON.

All voltages are with respect to auxiliary 0Volts (PIN3). Both Pin 5 and Pin 6 will draw almost no current being the input to a comparator with suitable hysteresis.

Either 'INHIBIT'

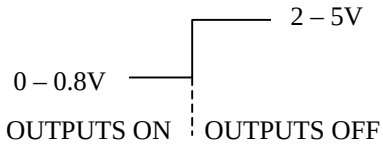
Global Inhibit Logic 0

Pin 5 to be taken to 0-0.8V to turn outputs off, otherwise outputs normally on



Global Inhibit Logic 1

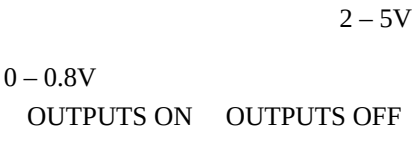
Pin 6 to be taken to 2 – 5V to turn outputs off, otherwise outputs normally on



Or 'ENABLE'

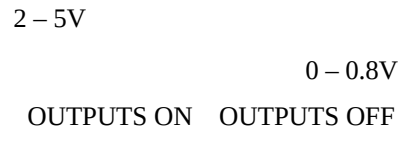
Global Enable Logic 0

Pin 5 to be taken to 0 – 0.8V to turn outputs on, otherwise outputs normally off



Global Enable Logic 1

Pin 6 to be taken to 2 – 5V to turn outputs on, otherwise outputs normally off

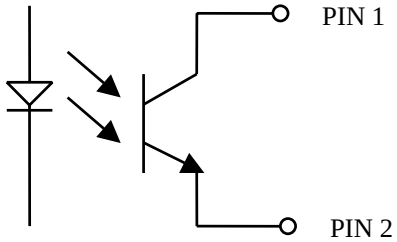


5V Auxiliary supply.

This is available for powering auxiliary circuits and is present when AC input is applied regardless of inhibit/enable state of the PSU outputs. The output is rated as SELV.

Output voltage	5V +/- 5% (Option E, F, EV, FV) or 5-15V (Option xEW, xFW)
Max continuous output current	100 mA (Option E, F) or 300mA (Option EV, FV) or 1A (Option xEW, xFW)
Overload protection	Current limited and thermally protected
Hold up time	1 Sec minimum
Isolation to earth	500V DC max

AC FAIL

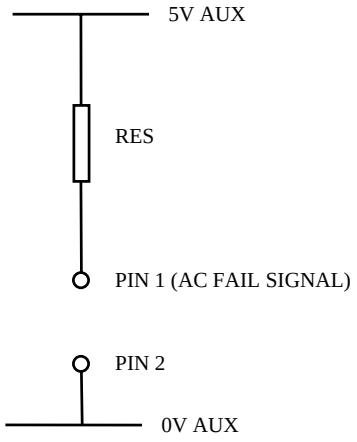


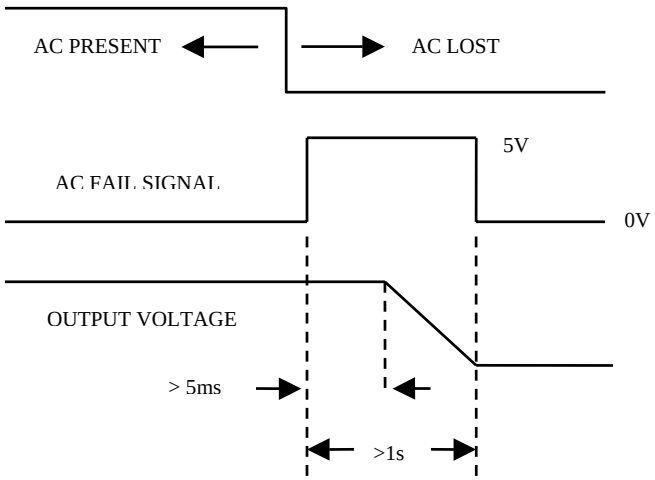
This provides an opto-isolated output which provides a minimum of 5mS warning before loss of output power due to either loss of AC input or over temperature of the converter.

Ic max	5mA
Vce max	30V
Warning time to DC output fall	5mS min (see timing diagrams below)
Vce saturated	Less than 0.4V

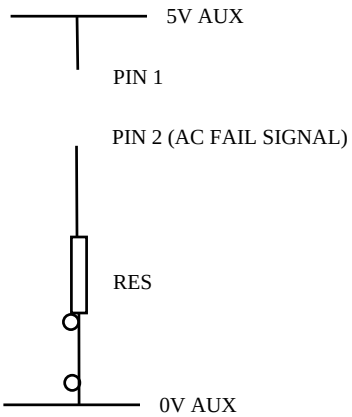
The signal can be configured in two ways:

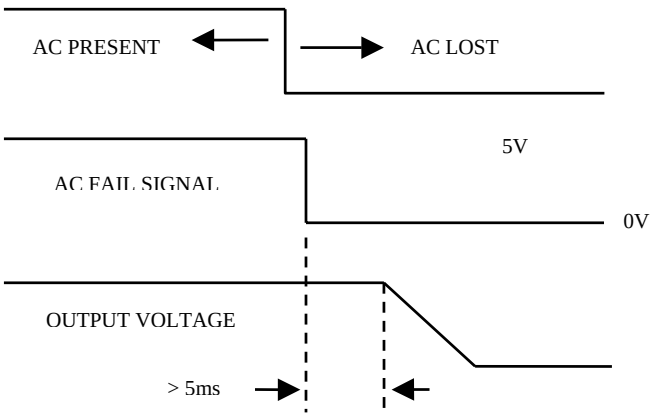
Either:





Or:





Secondary Option N.

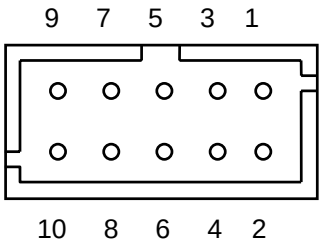
The N option is a factory fitted assembly that can be specified for output modules. The option has the following function:

Module Good, output signal that indicates when the module is within 10% of the set voltage level.

Module Inhibit, this enables the individual module to be shut down by application of an inhibit signal.

Starpoint Paralleling, can be used in N+1 redundant applications to force paralleled modules to share the load current or can be used to parallel 2 or more modules to increase the available output current.

N option for SINGLE, One and a Half and Dual slot modules.



Viewed from rear of PSU

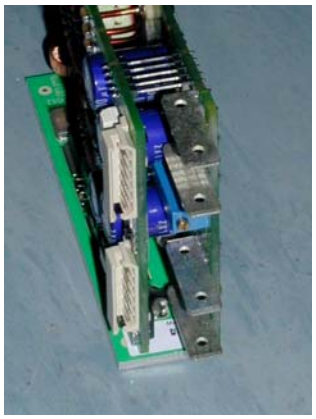
Mating connector information:
Note: housing and pins supplied with each power supply.
Housing: Molex 51110-1060
Crimp pin: Molex 50394-8051
Hand Crimp Tool: 69008-0959 (Europe or Japan) Or 11-01-0204(USA)

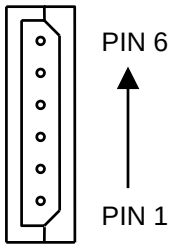
Pin No	Function
1	Unused.
2	Module Good E
3	+Ve Sense. *1
4	Module Good C
5	Starpoint Parallel.
6	Unused.
7	Starpoint Parallel.
8	Module Inhibit -Ve
9	-Ve Sense. *1
10	Module Inhibit +Ve

Note *1: Option board +ve sense and module +ve sense (2pin molex) are internally connected.

N option for TWIN (2 output) modules.

There is one 6 pin connector for EACH output. The connector for that output is directly adjacent to the faston output terminals for that output.





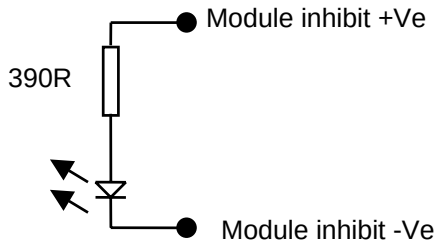
Viewed from rear of PSU

Mating connector information:
Note: housing and pins supplied with each power supply.
Housing: Molex 50-37-5063
Crimp pin: Molex 08-70-1039
Hand Crimp Tool: 11-26-0167 (Japan)
Or 11-01-0194(Europe or USA)

Pin No	Function
1	Module inhibit -Ve
2	Module inhibit +Ve
3	Module Good E
4	Module Good C
5	-Ve sense. *1
6	+Ve sense. *1

Note *1 : option board +ve sense and module +ve sense (2pin molex) are internally connected.

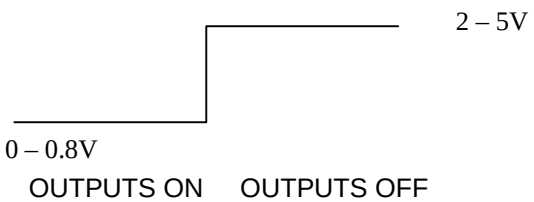
Module Inhibit circuit connection



Internal to the module inhibit is a 390ohm 1/8W resistor and the diode of an opto-coupler.

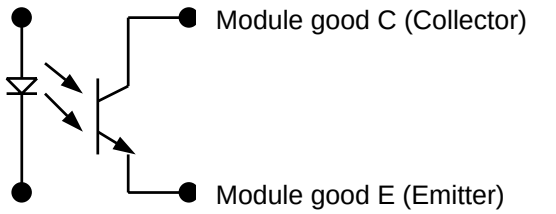
To INHIBIT the module apply 2-5V between +ve and -ve. Do not apply >6V or damage may result, although higher voltages may be used to drive the circuit in which case additional series resistor should be used to limit the current. A current of 1-10mA will inhibit the module. Ensure 13mA is not exceeded.

When a module is inhibited, there may be up to 0.6V remaining at the outputs of the module.



Module Good Circuit connections.

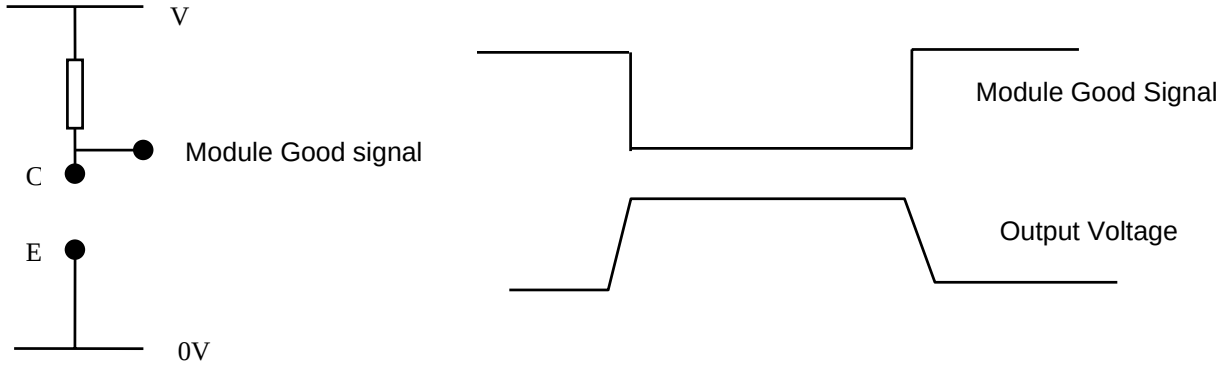
The output stage is an uncommitted transistor of an opto-coupler. The transistor is “ON” (saturated) when module is “GOOD”.



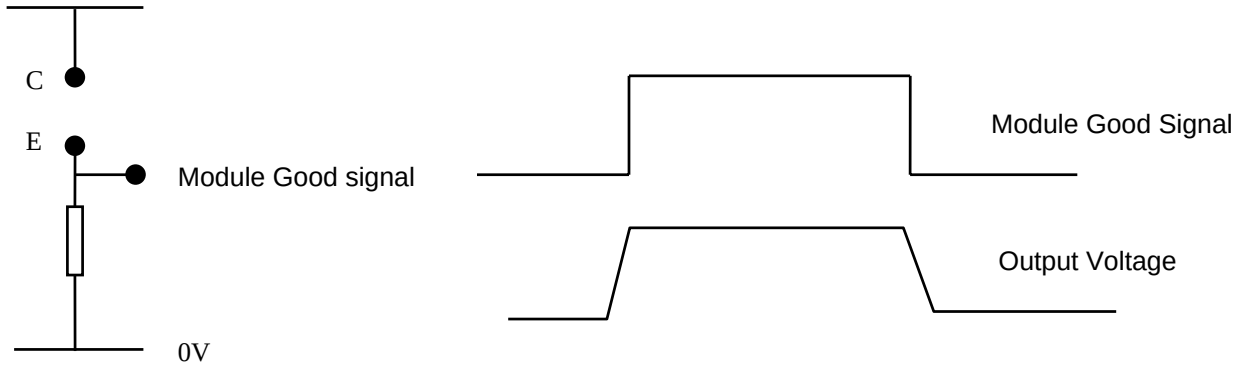
Module is GOOD when output voltage is between 90%(+/-5%) and 110%(+/-5%) of its factory set voltage.

Vce max	30V
Vce sat	<0.4V at 1mA current
Ic max	1mA

"Low" when module good.

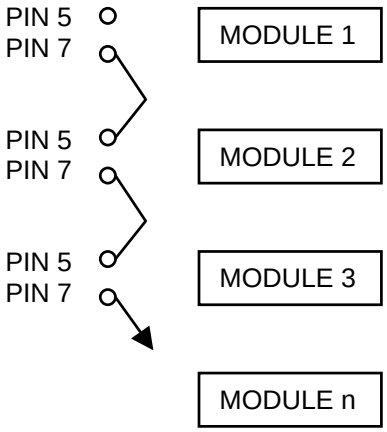


"High" when module good.



Starpoint Parallel Circuit connection.

Starpoint parallel circuit connection is achieved by "daisy chaining" all the parallel pins together in any group of modules required to share.



All the PIN 5 and PIN 7 perform the same function and are linked internally in the module.

Functionally, the shared parallel connection forces each module of a pair to drive approximately the same current. Whichever module is driving the least current has it's voltage increased slightly to balance it. The load current is shared evenly amongst the modules. This improves the reliability by ensuring that no one module takes more stress than any others in a sharing group.

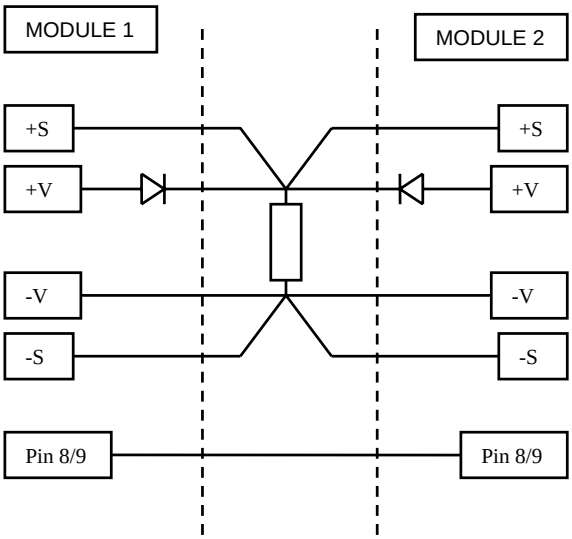
Sharing can take place from module to module within the same power supply or between modules configured in different power supplies.

N+1 redundant & "Hot Swap"

Vega power supplies can be connected in 1+1 redundant with active current share utilising the "N" option. This allows one of the power supplies to fail and the system remain running as the other power supply can drive the required current. Further, whilst both power supplies are running neither supplies more power than the other so the currents and hence stresses and heating effects are evenly shared. This principal can be extended to N+1 redundant where any number of power supplies can be connected in parallel actively sharing the required current such that the failure of one will not affect the system.

The principal can be extended further to "hot swap". This allows a failed power supply to be removed and replaced with the system fully live and driving the full load current. Normally a Vega power supply would be incorporated in a "shuttle" on sliding rails with a "hotswap" self aligning output which can be easily connected / disconnected from a system.

The diagram below shows a typical arrangement for 1+1 redundant system.



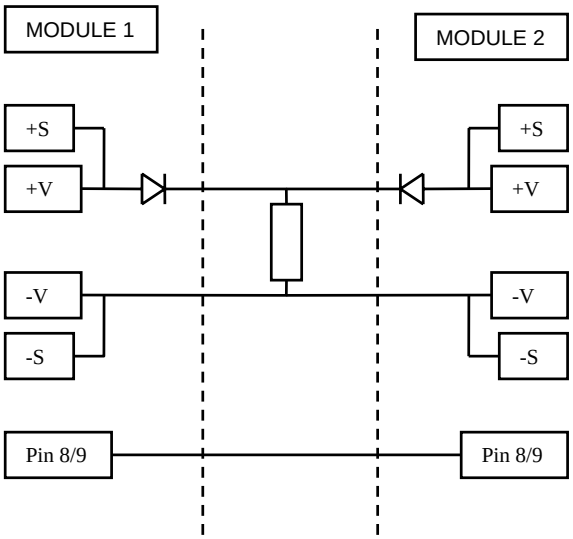
1+1 Current sharing system Remote Sensed.

Remote sense is NOT TRUE redundant function. Shuttle 1 or 2 failing can influence shuttle 2 via the sense lines.

Not shown are the L, N and Earth connections. It is important when designing connectors for hot swap applications that the EARTH is made first and broken last (ie use an extended earth pin).

The +S and -S should be made first and broken last also.

Remember a lot of heat may be dissipated by the blocking diodes. Be sure to rate them correctly.

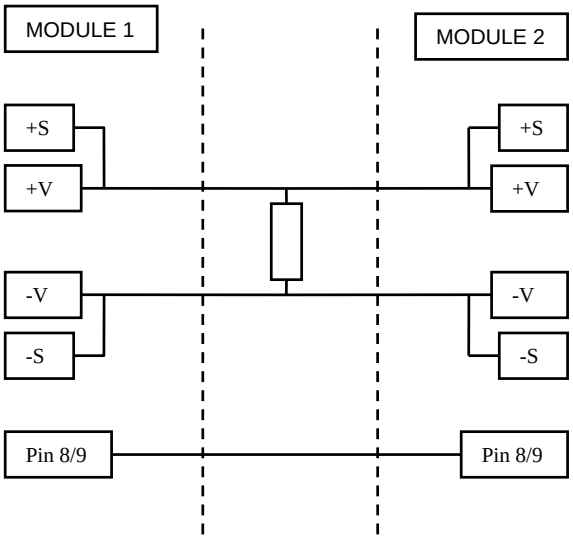


1+1 Current sharing system Locally Sensed

Locally sensed is TRUE redundant function. Shuttle 1 or 2 failing cannot influence the other shuttle. The system will always remain functional.

Not shown are the L, N and Earth connections. It is important when designing with connectors for hot swap applications that that EARTH is made first and broken last (ie use an extended earth pin).

Remember a lot of heat may be dissipated by the blocking diodes. Be sure to rate them correctly.



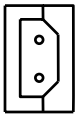
Parallel for increased current : Not redundant.

In the absence of blocking diodes, there is no redundancy. A short circuit in shuttle 1 will pull shuttle 2 down. This is normally used just to increase the available output current.

Remote Sense option "R" (Twin output only)

(All single, one and a half and dual slot single output modules have remote sense provided as standard, remote sense is also provided with "N" option fitted to twin output modules)

The "R" option is a factory fitted board that can be specified for twin (2 output) modules only. It enables remote sensing at the load. For twin output modules the "R" option is required to achieve remote sensing.
There is one 2 pin connector for each output. The connector for that output is directly adjacent to the faston output terminals for that output.
When connecting the remote sense leads to the load, always use cables twisted together at approx 1 twist per centimetre. This will minimise noise pickup.
Application note "Power Connection" has more detailed information on the recommended way to connect Vega to function with remote sense.

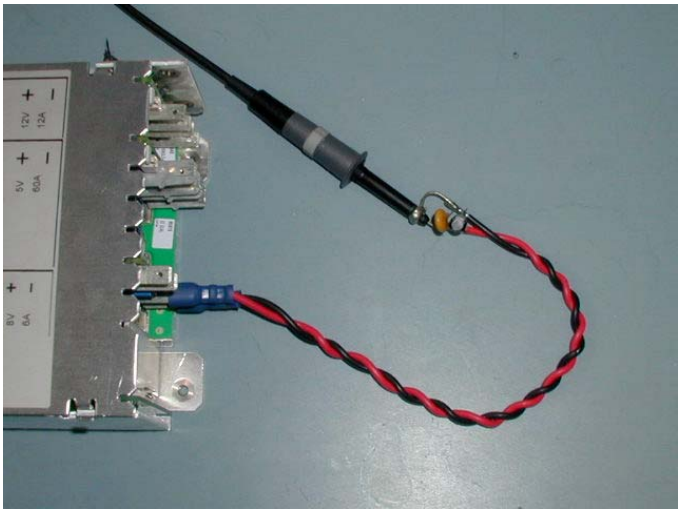


Mating connector information:
Note: housing and pins supplied with each power supply.
Housing: Molex 50-37-5023
Crimp pin: Molex 08-70-1039
Hand Crimp Tool: 11-26-0167 (Japan)
Or 11-01-0194(Europe or USA)

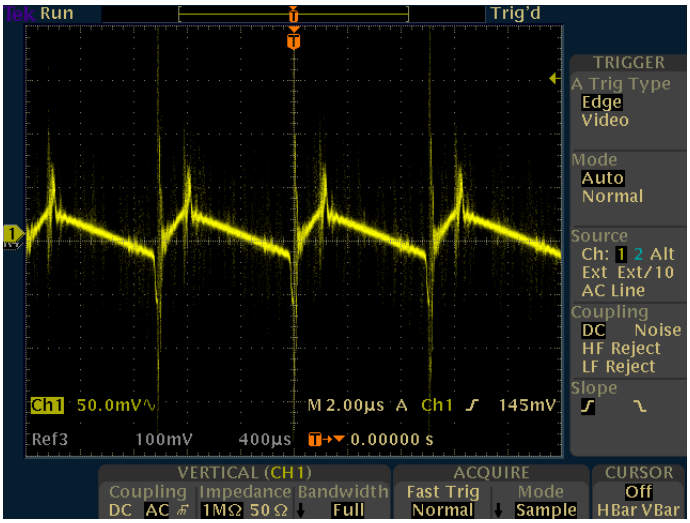
Pin No	Function
1	+ve sense
2	-ve sense

The Measurement of ripple and noise.

Lambda measures ripple and noise on switching power supplies using an oscilloscope with the bandwidth limited to 20Mhz. The measurement is taken at the end of a 150mm length pair of twisted cables terminated with 10uF electrolytic capacitor and 0.1uF ceramic capacitor. The earth wire of the oscilloscope probe should be as short as possible, winding link wire around the earth collar of the probe is the preffered method.



Noise from a switching power supply is made up of two distinct elements "ripple" and "high frequency". "Ripple" noise is the variation at the switching frequency of the supply. "High frequency" noise is superimposed on top of the "ripple" and results in a typical waveform as below.



The term PARD means "Periodic and Random Deviation" and is a measure of the TOTAL noise (ie high fequency noise + ripple) quoted as peak to peak. This is the figure quoted in the specifications of each module.

Minimising System noise.

The application note "Vega Connection" gives information on basic connection of Vega and good wiring practice. This includes using twisted pairs for cabling and de-coupling at loads. This will help minimize noise in a system designed using Vega power supplies.
There is also an Application note "EMC Installation Notes" in Section 8 which gives more detailed information on installation to improve EMC performance and reduce system noise.

During system design, if there are any noise problems encountered, there are a number of common causes:

1) No (or insufficient) de-coupling on the PCB and/or at the load.
2) Poor system earthing.
3) Poor routing of the wiring cables.
4) Faulty wiring connection or bad terminations.
5) PCB tracking or cabling insufficient for peak currents carried.
6) Power supply being intermittently overloaded. (High switching currents drawn).

There are a number of practical steps that can be used to help reduce or identify the source of high frequency noise:

1) Try and ascertain if the noise is radiated or conducted by re-orienting the PSU or by screening. If neither helps, the noise is likely to be conducted noise.

2) Common zero volt connections should be made with the shortest possible wiring either directly or via a capacitor to the nearest point on the chassis.

3) Ensure the common earth / zero volt connection is connected to the system starpoint earth once only and not by any other route.

4) Twist all pairs of power and sense cables separately.

5) Try connecting a "ring" of capacitors (100nF ceramics) from rail to rail.

6) Decouple individual rails at the load using capacitors (eg 100nF ceramics).

Installation for best Airflow.

The exceptional power densities of Vega are achieved by careful thermal design and forced air cooling from an integral fan. Airflow can be forward in which case air is drawn in at the fan end and exhausted from the module or reverse in which air is drawn in at the module end and exhausted via the fan end. In the specification "Ambient air temperature" is taken to be the air entering the fan (forward) or entering the module end (reverse).

Best performance is achieved using forward flow air. Forward or reverse airflow must be specified at time of purchase. The available output power is de-rated for reverse air applications. Contact Technical sales to discuss carefully any reverse air requirements to ensure adequate cooling is maintained or the correct de-rating of output power is adhered to.

In both forward and reverse flow, adequate cooling can only be maintained by ensuring that obstructions to airflow are kept 50mm from the fan end and 50mm from the module end of the power supply where air is drawn in / exhausted.

Always design a system so that the coolest possible air is routed to the intake of the power supply. Try and avoid using "re-circulated air" by having highly enclosed boxes with the exhaust in the box itself. A clear flow path from an intake of the coolest available air (ie outside of an installation box), through power supply and exhausted back out into the same air is always best. Where Vega is used in a fully enclosed box with re-circulating air it is important to ensure that the air temperature being drawn into the Vega itself is sufficiently cool.

Audible noise from the Fans.

Measurements have been taken with a background noise level of approximately 38dB. All measurements were taken at a distance of 1m from the fan grill, with the fan end closest to the noise meter.

Results

Fan option nomenclature	Air Direction	Fan Type	Typ fan Voltage	Audible Noise (dB @ 1m)
F	Forward	Papst 612NHH	12.5V	55.0
	Forward	Sanyo 109R0614E402	14V	57.0
Q	Forward	Papst 612	12.2V	49.1
	Forward	Papst 612NH	12.4V	49.7
R	Reverse	Sanyo 109R0614E402	14V	61.0
	Reverse	Papst 612NHH	12.5V	60.3
P	Reverse	Papst 612	12.2V	56.4
	Reverse	Papst 612NH	12.4V	53.2

Restricting the air intake by placing (for example) another grill in front of the fan can cause a "chopping" effect created by non-planar flow of the air into the fan which may increase the audible noise as well as reduce airflow.

Vega Outline Drawings
Issue 5

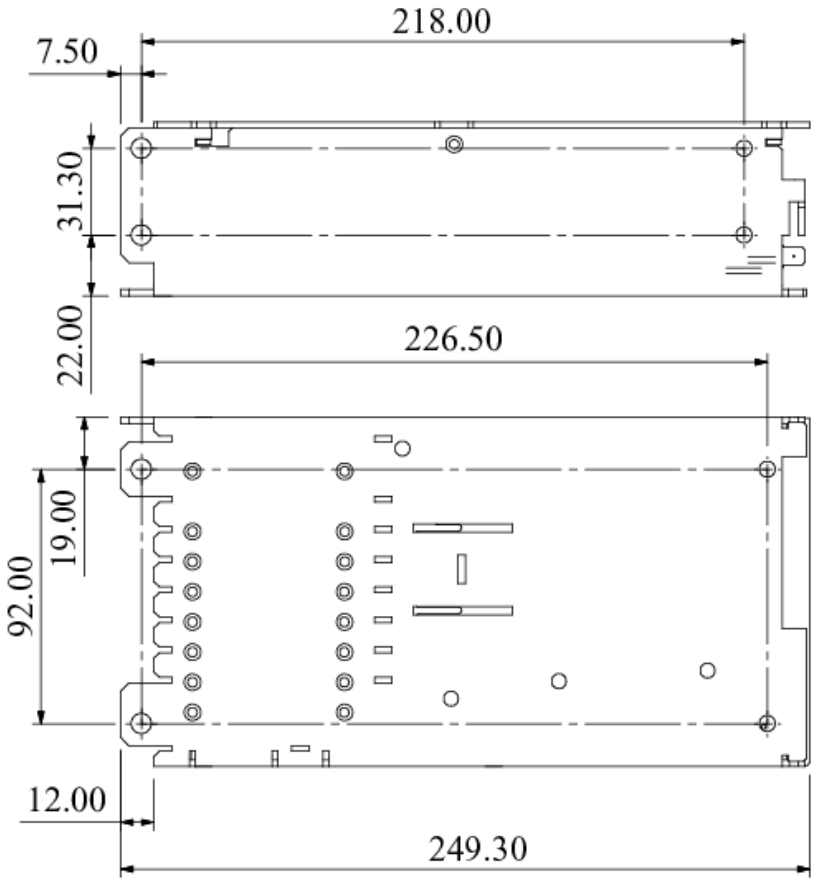
The following document details the casing for Vega. The unit is available in several case styles to suit different mains input options as follows:

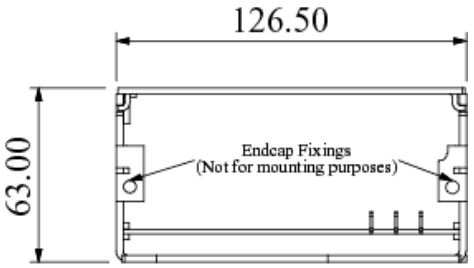
- o Screw Terminal 6/32 8.3mm barrier strip (vertical or horizontal)
- o 6.35mm quick connect spade terminals (Fastons)
- o IEC 320 switched connect
- o Customer air option. (No fan or endcap)

All endcap options are field replaceable (by trained service personnel) The endcaps are removeable from the fan end without the need to remove the power supply from its mountings.

Tolerances (Unless otherwise stated) +/-0.5

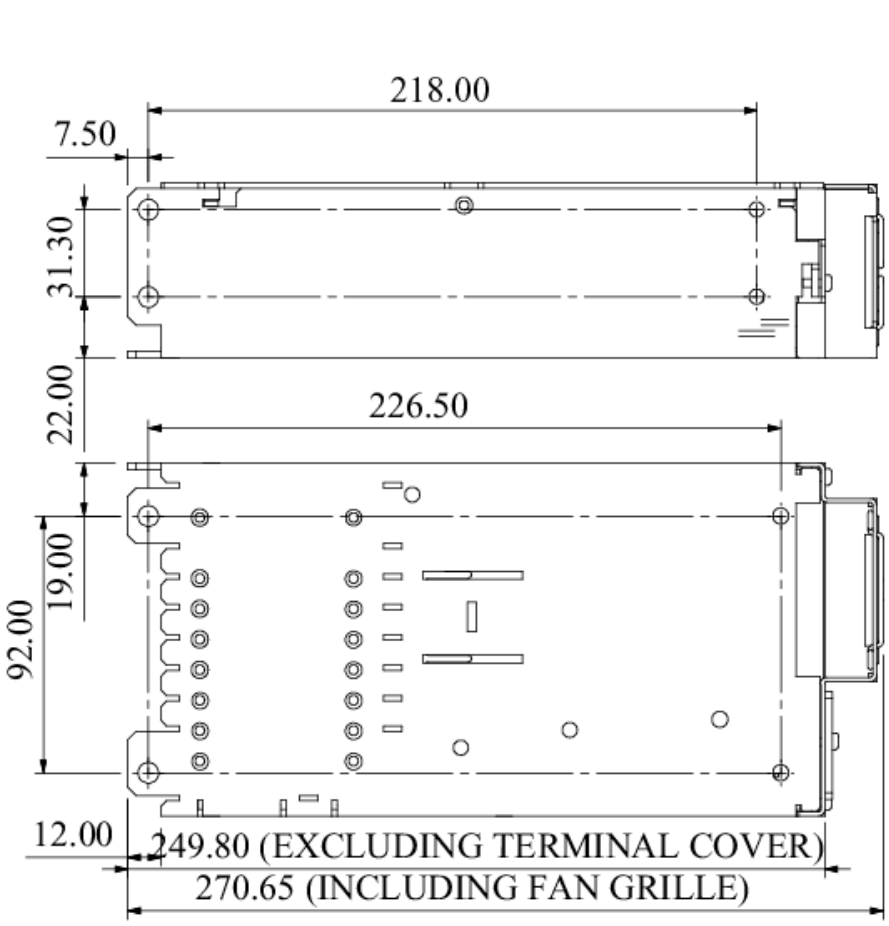
Vega 650 Customer Air & Fixing Detail Issue 5

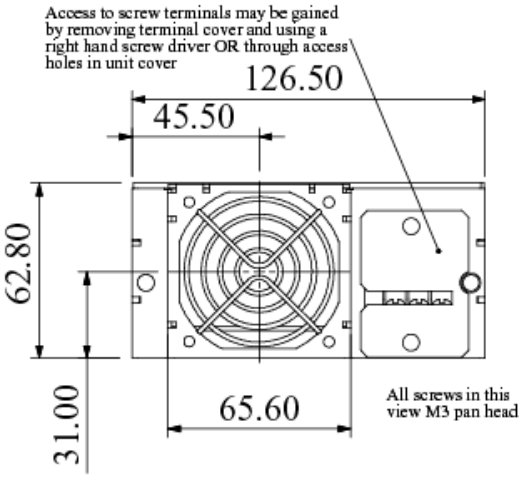




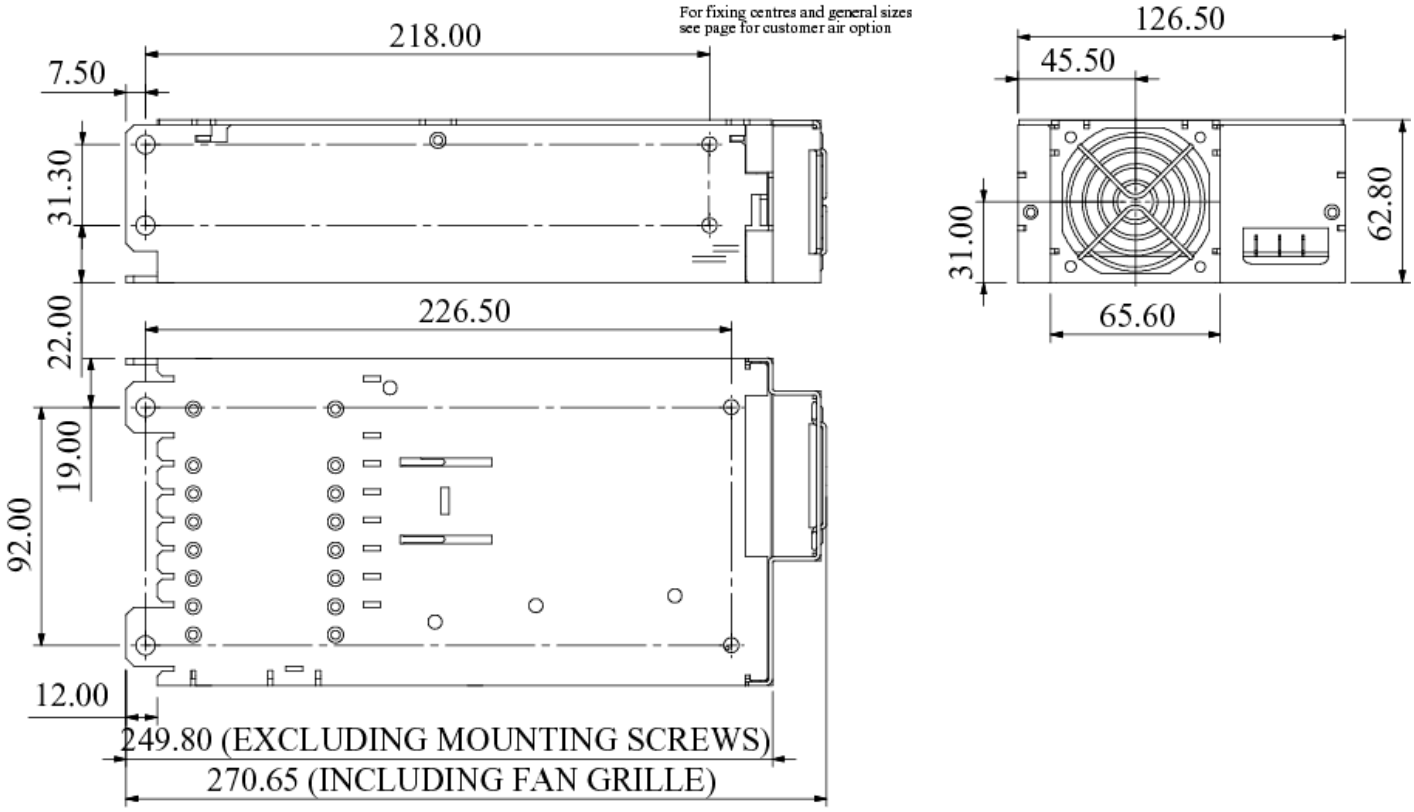
Customer fixings are M4

Vega 650 Screw Terminal Input
Issue 5

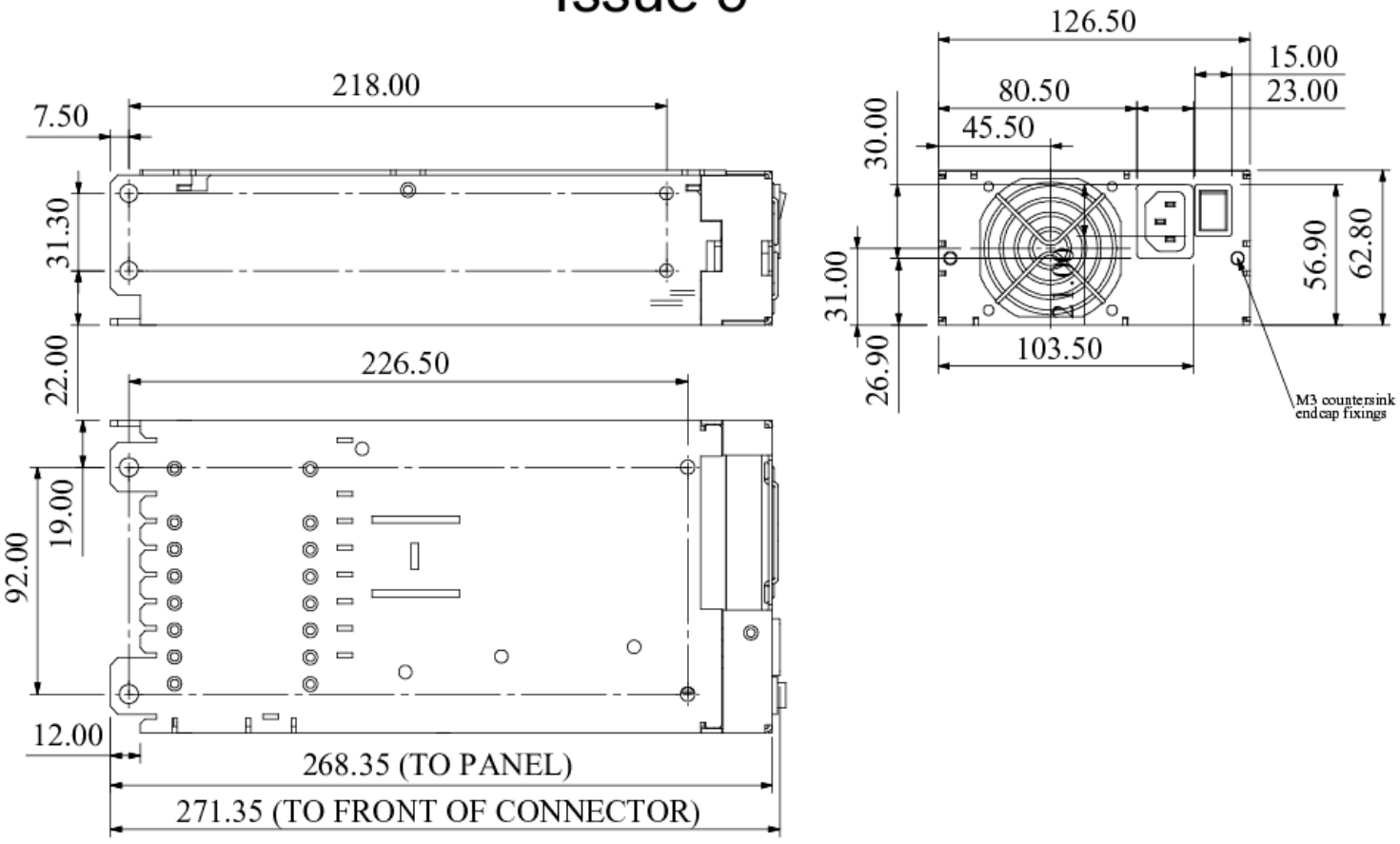




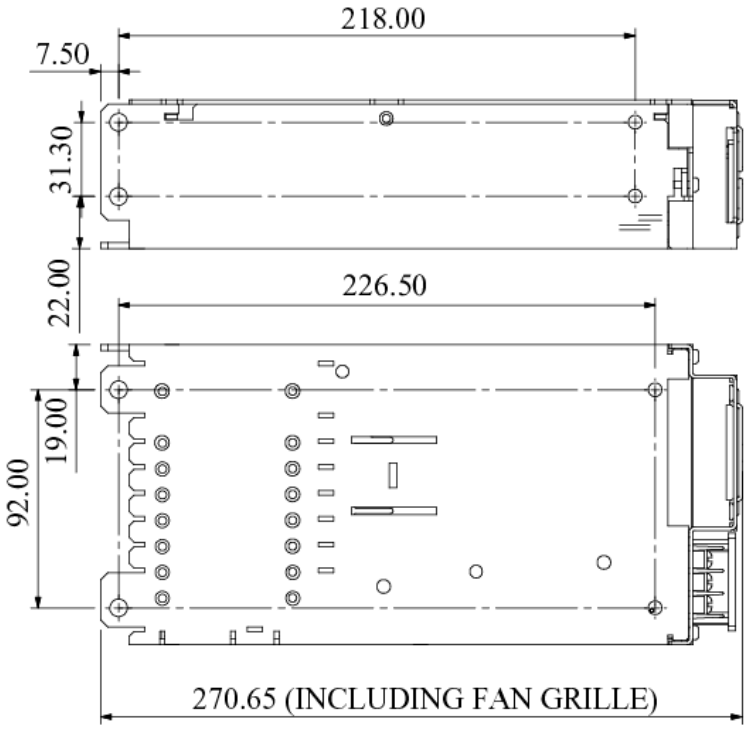
Vega 650 Quick Connect (Faston) Input Issue 5

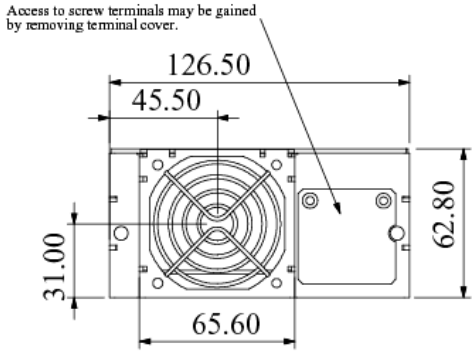


Vega 650 IEC 320 (Switched) Input
Issue 5



Vega 650 Right Angle Screw Terminal Input Issue 5





MTBF's have been calculated using MIL-HDBK-217F Ground benign.
The modular nature of the product makes it difficult to determine the MTBF for every combination of output voltages and load, the numbers given are therefore typical.

The table below gives the failure rate per million hours (FPMH) for each of the assembly types at different ambient temperatures.

Description	0C	25C	40C	50C
Vega 650W Converter	5.17	7.1	8.72	10
Vega 450W Converter	5.17	7.1	8.72	10
Any module starting with B (Std single)	1.19	1.51	1.82	2.13
Any module starting with C (HC single)	1.23	1.57	1.91	2.25
Any module starting with D (one and a half slot)	1.36	1.75	2.14	2.52
Any module starting with E (dual slot)	1.36	1.75	2.14	2.52
Any module starting with H (twin)	1.88	2.34	2.8	3.23
Any module starting with L (Single)	1.19	1.51	1.82	2.13

To Calculate the MTBF for a given configuration, sum the FPMH figures for each individual assembly/module to produce a total FPMH. The MTBF is then simply given by 1/FPMH and is expressed in hours.

Example.

Vega 650 B1L E5H H2/1H MTBF at 40°C.

FPMH 650W converter	8.72
FPMH B module	1.82
FPMH E module	2.14
FPMH H module	2.80
	15.48

MTBF = 1/FPMH = 1/15.48 = 0.0646 million hours or 64,600 Hours

NB, the above calculation does not include the cooling fan. MIL217F models the fan as a motor and as such, if included, the figure generated would dominate the overall MTBF figure.

To include the fan then add the FPMH of the fan to the total FPMH :

At 25C Failure rate = 4.09

At 50C failure rate = 7.51

Connecting Vega to Maximise EMC performance.

Good EMC performance comes by carefully considering the installation of the power supply. Installation without due consideration to cable/PCB layout can lead to current carrying loops that can radiate noise into the system and that can have noise currents induced into them.

What is most important is that cables/PCB tracks are arranged to minimise current carrying loops that could radiate and to minimise loops that could have noise currents induced into them. Treat all cables and all PCB tracks as radiation sources / receivers and try and minimise their interaction.

Vega power supplies are designed to comply with EN (European Normative) radiated and conducted limits when properly installed. Vega also complies with EN limits for mains distortion.

Radiated and conducted performance can be further enhanced by :-

1) Inclusion of a proprietary mains input filter. Lambda has a wide range of suitable mains filters available for all circumstances. Contact Technical Support at Lambda for advice and details on specific filter performance and attenuation or for advice on designing for good EMC performance.

Type of noise	Connect type	Vega450	Vega650
Wideband	Block	MB1210	MB1216
	Faston	MF1210	MF1216
High attenuation.	Block	MXB1210-33	MXB1220-33
	Block	PNF1210-F	PNF1215-F
Narrow band	Block	MYB1210-33	MYB1220-33
Pulse noise	Faston	MAF1210-33	MAF1215-33
High attenuation	Stud	MAS1210-33	MAS1215-33

2) Enclosure in a metal rack with suitable EMC gaskets. Technical support can assist in specific recommendations.

The conditions under which Test measurements are made for Vega is available in the application note "Vega EMC Report".

Always adhere to these outline rules :-

Use twisted pairs for power cables with as tight a twist as possible for the thickness of cable used. (Always try to minimise projected area of power carrying loops to minimise radiation).
For PCB's run all power tracks back to back.

Use twisted pairs for sense cables with at least 1 twist per cm. (Always try to minimise projected area of non power carrying loops as well, this will minimise noise currents being induced in signal carrying cables). Do not twist power cables and sense cables together.

Try to avoid running power and sense cables together in the same cable harness to avoid coupling.
Do not run any output power or signal cables close to or interwoven with mains cabling.

Keep all cable runs as short as physically possible; power, mains and control.
The earth for the system should always be a "starpoint". The "input" earth should come from the filter / inlet of the user equipment and go to a "starpoint" as soon as possible. All other earths should go from this central starpoint. The PSU earth should be connected direct to the starpoint. Be careful to ensure that there are no earth loops in the system.

Always de-couple the load using approximately 10 -1000uF of capacitance per Amp of running current . Fit the capacitor as close as is possible to the load.

The aim of this application note is to describe and explain the function of the Vega 450W and 650W converters and the function of Vega modules. It is not a description of the circuits and topologies, but purely a description of practical functionality.

This application note does not contain the specifications of the converters and modules themselves but aims to expand and explain them. Please refer to the "Vega Specification" documents themselves for each module and converter.

Outline.

Each Vega power supply consists of a case containing a 450W or 650W primary converter and a number of power modules. The power modules can be fitted in thousands of possible combinations or configurations.

The Primary converter can be fitted with a number of options (primary options). The output modules can also be fitted with a number of options (secondary options).

Please refer to Vega specifications to see the available modules and allowed configurations and to see how to order the right line-up of modules for your application. The Vega specification also shows the primary and secondary options available and how to order them.

Overview function.

The primary converter (450W and 650W) :-

Mains is fed to a power factor correction circuit via an input filter. The Power factor correction (boost converter) reduces the harmonic distortion of the mains supply. Current is drawn sinusoidally, rather than in sudden burst at the peak of each mains cycle as it would be if simple rectification was used. The boost converter and bulk capacitors provide rectified and smoothed DC to the forward converter. The forward converter chops the DC at 200Khz using a power switching device controlled by a Pulse width modulator. The waveform is then applied to the primary of a transformer.

The primary converter is protected against current limit and has thermal protection.

The output modules :-

The secondary of each module fits within the primary windings of the forward converter transformer. Each output module rectifies, smooths the secondary waveform and regulates the voltage using a Magnetic-Amplifier (saturable reactor). Smooth, stable, safety isolated, DC voltage at the required current level is thus provided.

The modules monitor their output current via a current transformer and in event of current exceeding a set point keeps the current to a safe level via the control circuit.

The modules also monitor their output voltage level and in event of an overvoltage being detected feeds the information to the primary converter which is shut down (see "Overvoltage" later).

Input Voltage.

Vega functions from 85-264 VAC 47-63Hz. Active power factor correction is always present to ensure Vega meets the requirements for distortion of the mains (EN61000-3-2).

Inrush current.

At initial turn on a surge of input current will flow to charge the internal capacitors. At turn on, the current flows through a thermistor which offers high resistance and impedes the flow of current to <40A. When the voltage of the bulk

capacitors charges to a set level the thermistor is "switched out" via a relay and current will become the nominal input current which depends on load. Actual nominal input current = (actual output power/efficiency)/Input voltage.

If circuit breakers or fuses are used in a customer system, ensure they are capable of handling a 40A turn on surge. They should be of time lag or slow type. Breakers should be type C breakers to handle the inrush.

The Fuse.

The input fuse is INTERNAL to the PSU and is not user accessible. It is designed to protect the PSU. If the fuse has opened, there is something wrong with the PSU to have caused it and the PSU should be treated as "failed".

Leakage current.

The leakage current is measured as the current from L&N to earth at 264VAC input and 63Hz. It is mainly due to Y capacitors. These are connected in the internal filter from Live and Neutral to Earth and to provide a path for high frequency common mode noise to return to it's source.

Surge protection

There are transient suppressors fitted to ensure Vega is protected against surges and spikes of voltage on the input lines. The level of protection is as described in the EN61000-4-5 specification.

Output Efficiency.

The efficiency is a function of output voltage, load and input voltage. Efficiency is worse at lower loads and output voltages. Also a 450W converter which is providing only 200W of output power will be a few percent lower in efficiency than the listed specification.

Efficiency decreases as the input voltage decreases

Graphs of efficiency vs both input voltage and output power are available on request.

Overvoltage Protection.

All Vega output modules have two levels of overvoltage protection.

Tracking overvoltage protection.

This is the lower of the two levels, the overvoltage setpoint will track the voltage set at the sense terminals. This will be the voltage at the output terminals of a module, if connected local sense or the voltage at the load if connected with remote sense.

Example, If a module is connected in remote sense and set to give 5V at the load then the overvoltage protection point will be at 124% = 6.2V measured at the load.

Example, If a module is connected in local sense and set to 12V, the OV point will be 14.9V measured at the output terminals of that module.

Stage 2.

Each module also has a second maximum threshold at which OV functions. This is not tracking but fixed at a level higher than the maximum voltage than the module can be adjusted to. See the specifications for each module.

On overvoltage condition from any Vega module in a given output module line-up (configuration) will effectively shut down the whole power supply, the outputs from all modules will be lost. The fan will also stop.

To re-establish the outputs, it is necessary to cycle the mains off and then back on again. Allow at least 15 seconds for the unit to recover.

The Vega can also be re-established without cycling the mains by applying an INHIBIT / ENABLE signal. The correct Vega primary option must be fitted for this to be available.

Over Current Protection.

All Vega modules have overcurrent protection as standard. Check the specification for each module for the actual value.

In an overcurrent condition, the current is very approximately constant current. ie when the current limit is reached, the output voltage reduces and the current remains at approximately the current limit value.

When the overcurrent condition is removed, the output voltage will automatically recover.

Minimum Load requirements.

There is NO minimum load required on any of the Vega modules.

Configurations OVER 450W (450W converter) or 650W (650W converter).

It is possible for a given module configuration to have more than 450W (in a 450W converter) of available output power. ie the sum of volts x amps for all outputs comes to >450W. This is not unusual BUT the actual drawn running currents should NEVER exceed 450W. This will result in the converter becoming overloaded and shutting down.

The same is true for a 650W converter / module configuration.

Combined or seriesed Modules BB@, CC@, DD@, EE@, HH@

The above modules are factory seriesed Vega modules to increase the range of output voltages and currents that are available. Eg CC@ are 2 C modules seriesed together, where @ is the No. of turns. Factory fitted bussbars are used to facilitate this, or in the case of the twin output module an onboard link is fitted. These combined modules need to be specified when a configuration is ordered.

When any module (1,1.5,2slot or twin) is specified to be connected in series, it is possible to specify faston (F) of screw (S) terminations.

The output voltage of two combined modules will be the sum of the output voltages (this applies to Vmax and Vmin)

For 1slot, 1.5slot and 2slot modules the output current of the two combined modules is the same as the current of one of the modules only (this applies to Imax, Ishortcircuit, Imin, and Inominal)
For twin modules, the output current of the two combined output voltages will be the lower of the currents for the two outputs.

For 1slot, 1.5slot, 2slot modules, the 2 modules to be combined must be adjacent to each other in the configuration. All modules must always comply with the normal Vega configuration rules.

Example 1 : Twin module H5/3 with voltages combined.

H5/3 module can be used to provide 36V nominal at 5Amps.

	Vmin	Vnom	Vmax	Imax
Output 1	16.2	24	31	5
Output 2	9.1	12	16.2	6
Combination	25.3	36	47.2	5

H5/3 is a twin module and will have a link fitted at manufacture to combine the voltages (see pictures).

The module description would become 36HH5/3 ("HH" indicates that the outputs are configured in series).

Note that the maximum current would be 5A, not 6A.

The suffix "F" for faston or "S" for screw can be added eg 36HH5/3F or 36HH5/3S.

Twin module with fastons

Example 2 : 1 slot C3 module with voltages combined.

2 x C3 modules can be combined to provide 20V nominal at 18Amps.

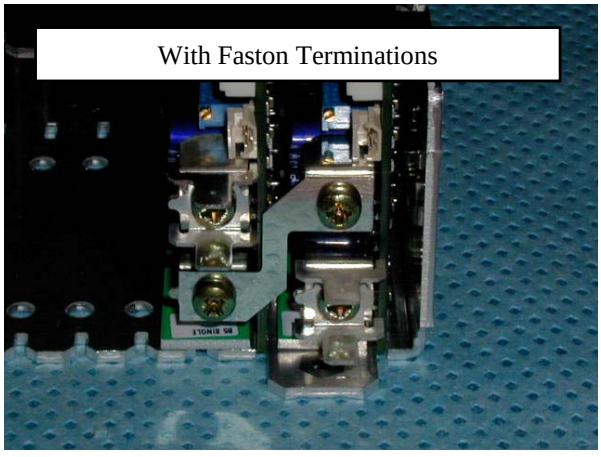
	Vmin	Vnom	Vmax	Imax
C3 module 1	9.1	10	16.2	18
C3 module 2	9.1	10	16.2	18
Combination	18.2	20	32.4	18

C3 is a single module and the combination will have a bussbar fitted at manufacture to combine the voltages (see pictures).

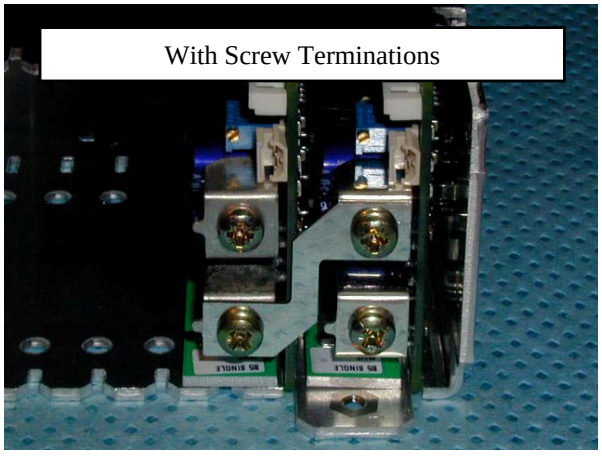
The module description would become 20CC3 ("CC" indicates that two modules are configured to sum the output voltages).

The suffix "F" for faston or "S" for screw can be added eg 20CC3F or 20CC3S.

With Faston Terminations



With Screw Terminations



Example 3 : 1.5 slot D4 module with voltages combined.

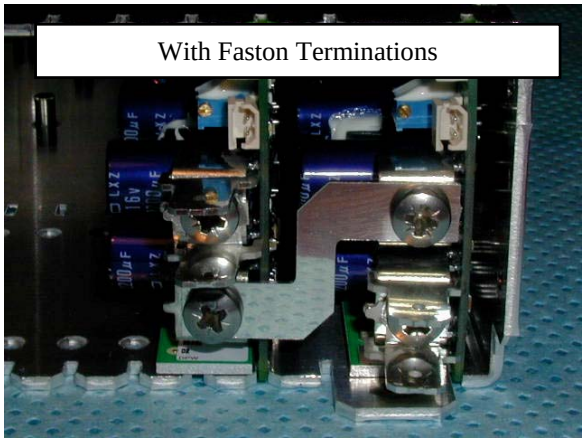
2 x D4 modules can be combined to provide 36V nominal at 18Amps.

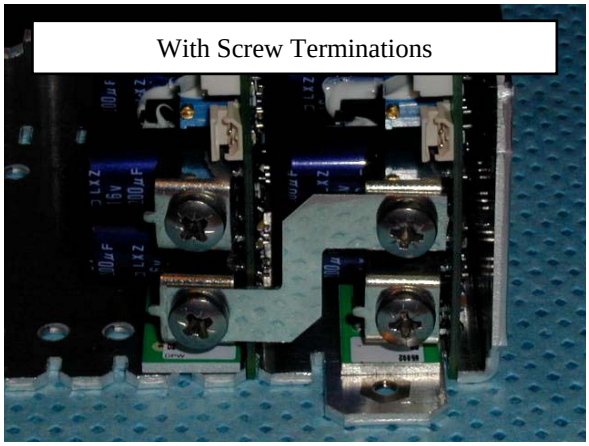
	Vmin	Vnom	Vmax	Imax
C3 module 1	14	18	21.5	18
C3 module 2	14	18	21.5	18
Combination	28	36	43	18

D4 is a single module and the combination will have a bussbar fitted at manufacture to combine the voltages (see pictures below).

The module description would become 36DD4 ("DD" indicates that two modules are configured to sum the output voltages).

The suffix "F" for faston or "S" for screw can be added eg 36DD4F or 36DD4S.





Example 4 : 2 slot D5 module with voltages combined.

2 x D5 modules can be combined to provide 48V nominal at 15Amps.

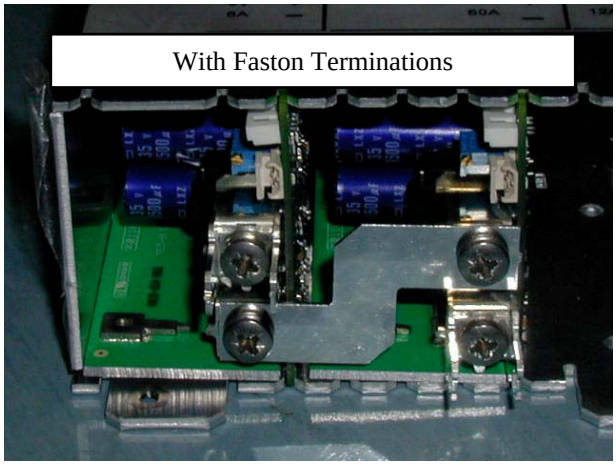
	Vmin	Vnom	Vmax	Imax
D5 module 1	21	24	28	15
D5 module 2	21	24	28	15
Combination	42	48	54	15

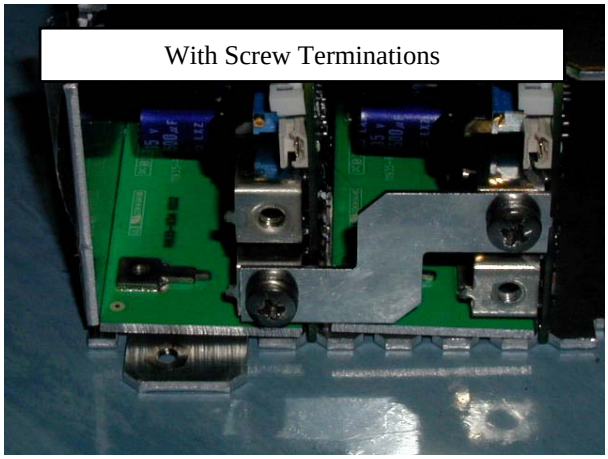
D5 is a 2 slot module and the combination of 2 x D5 modules will have a bussbar fitted at manufacture to combine the voltages (see pictures).

The module description would become 22DD5 ("DD" indicates that two modules are configured to sum the output voltages).

Note that in this case, the available output power from the module is greater than the available power the converter can provide. (48V x 15A = 820W). If this module combination was fitted to a 650W Vega converter, the maximum available power would be 650W, or 48Vat 13.5Amps.

The suffix "F" for faston or "S" for screw can be added eg 48DD5F or 48DD5S.


With Faston Terminations


With Screw Terminations

Tables of Common module combinations.

This table shows the most commonly used series combinations that are available.

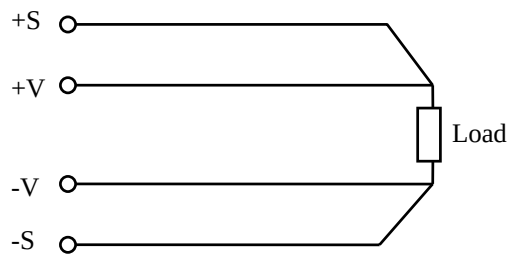
Module name	How done	Vmin	Vmax	Imax	Slots	Power @ Vmin	Power @ Vmax
EE2	E2 + E2	7.6	16	55	4	418	880
CC3	C3 + C3	18.2	32.4	18	2	327.6	583.2
HH5/3	Both halves of H5/3	25.3	47.2	5	1	126.5	236
BB4	B4 + B4	32.6	43	10	2	326	430
DD4	D4 + D4	28	43	18	3	504	774
HH5/4	Both halves of H5/4	32.5	56	4.5	1	146.2	252
C5B4	C5 + B4	43	48	10	2	430	480
CC5	C5 + C5	48.1	62	10	2	481	620
DD5	D5 + D5	42	56	15	3	630	840

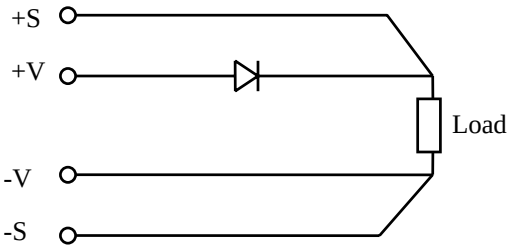
Remote Sense

Remote sense can be used to compensate for the drop in voltage along the load cables or for the drop in voltage across blocking diodes. It moves the point at which the voltage is sensed from the outputs of the power supply to some other point in the system, normally the load, or a backplane.

Mating connector information:
Note: housing and pins supplied with each power supply.
Housing: Molex 50-37-5023
Crimp pin: Molex 08-70-1039
Hand Crimp Tool: 11-26-0167 (Japan)
Or 11-01-0194(Europe or USA)

Always observe the following general rules for remote sense operation:





Ensure that the remote sense cables are TWISTED PAIRS.

PCB tracks for remote sense should be run back to back.

Ensure that the remote sense cables / tracks are as short as possible.

Ensure that the sense cables are not twisted together with the power cables.

PCB power tracks and remote sense tracks should be kept away from each other as far as is possible.

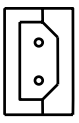
Do NOT fit components (resistor, inductor or diode) into remote sense lines. This will make the system unstable.

See the data sheets for each module to see the MAXIMUM voltage drop that remote sense can compensate for. Do not exceed this value (typically 0.75V, but varies for each module)

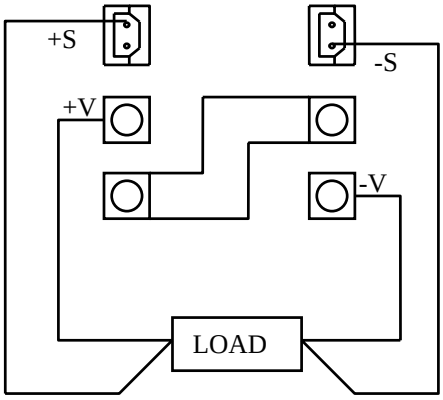
Remote Sense connection and 1slot, 1.5slot, 2slot Combination Modules.

1slot, 1.5slot and 2slot modules have remote sense fitted as standard. When 2 modules of this type are combined, remote sense can still be used.

One of the combined modules has the +V power terminal. The same module has a 2pin molex with +S and -S pins. Connect the +S from the molex on this module to the +ve side of the load.



The other module of the combination has the -V power terminal. That module also has a 2pin molex with +S and -S pins. Connect the -S from the molex on this module to the -ve side of the load.



Local Sense and Combination modules.

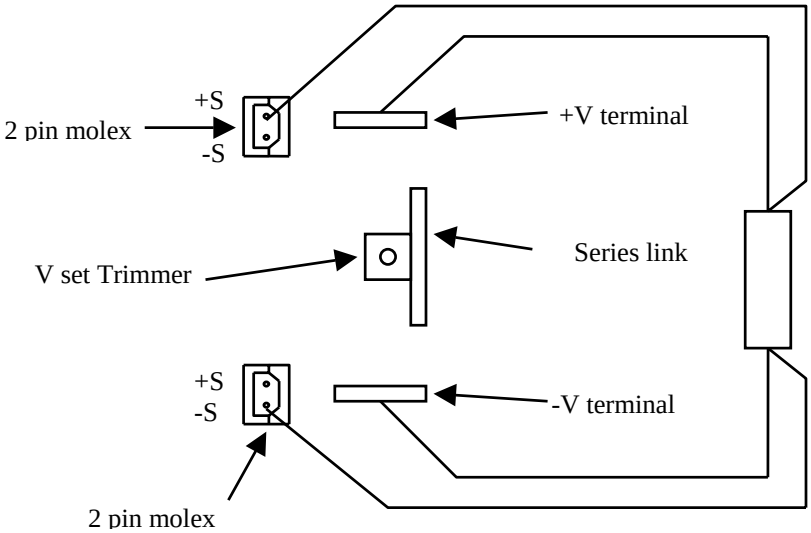
For local sense connection, it is not necessary to make any connections to the 2pin molex connectors. The only connections required are to the +V power terminal and the -V power terminal of the pair.

Remote Sense connection for twin output Combination Modules.

Twin output modules are not supplied with remote sense as standard. To have remote sense on a twin output module it is necessary to specify the "R" option. For example a twin output 24V single slot module with faston connections would be 24/24H5/4F as standard. To specify it with remote sense it would become 24/24h5/4FR (added R suffix)

When a twin output module is specified to have it's output combined, you can still specify the module to have remote sense "R" option. The module is specified as HH5/4 (not H5/4) to indicate the outputs are combined in series, the remainder of the description remains the same. For example, the module above could be specified with it's outputs combined to give 48V. The module would then become 48HH5/4FR.
In other words, the "R" option must be specified at purchase if a combination module is to be used for remote sense.

A twin module connected as a combination module will have 2 off 2pin Molex connectors. The upper Molex connector is adjacent to to +V power output terminal. The lower 2pin Molex connector is adjacent to the -V power terminal. (See picture).



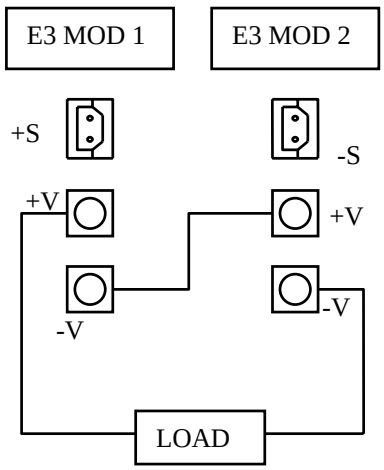
Connect +S from the top 2pin molex connector to +V of the load.
Connect -S from the bottom 2pin molex connector to -V of the load.

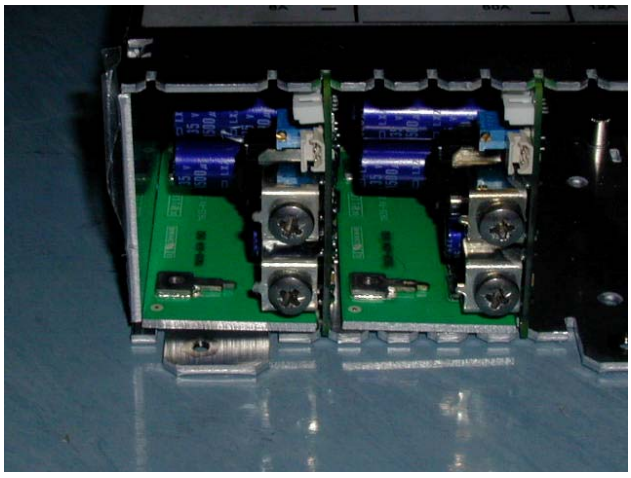
Always comply with the general guidelines for remote sense connection as listed above.

Series Connection of Vega Modules using cables.

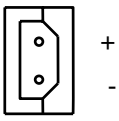
To wire the modules in series, wire such that the +V of the next module connects to the -V of the previous module.

You cannot series modules to any higher than 60V without exceeding the limits for SELV (Safe Extra Low Voltage). If voltages higher than 60V are required then contact Lambda to discuss, there will be safety implications due to the SELV allowable output voltage being exceeded.

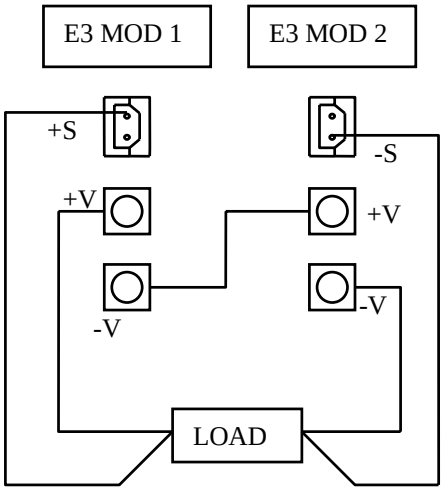




Series connection with remote sense is possible with any series combination of modules which have remote sense available.



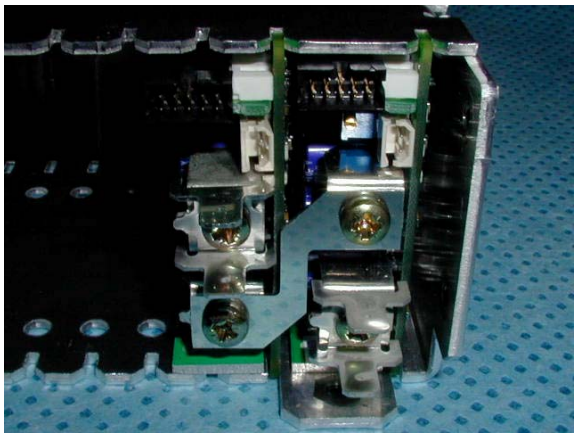
Housing = Molex 50-37-5023
Crimp pin = Molex 08-70-1039
Hand Crimp Tool = 11-26-0167

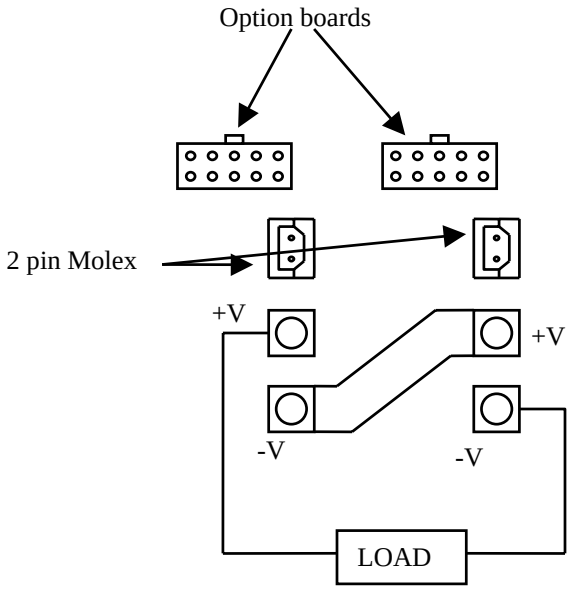


Using Options with Combination Modules.

Inhibit and Power Good Option : "N" Option.

The "N" option is available on 1slot, 1.5slot and 2slot combination modules.
When the "N" option is specified for a combination module, each module will have it's own option board fitted.



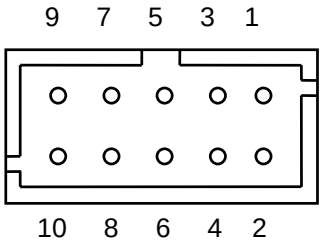


The available functions when the option is fitted are :-

Module Good.
Module Inhibit.
Remote Sense (from the option board AND from the 2pin Molex fitted as standard)

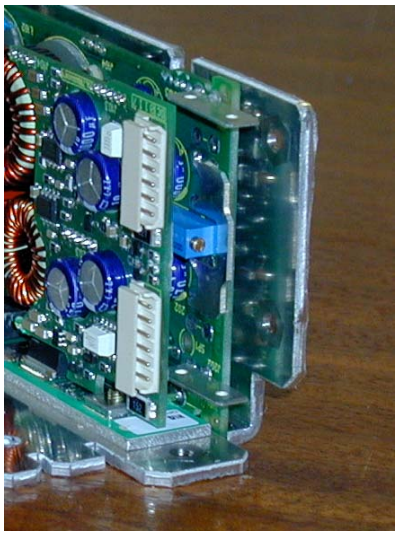
Each of the two option boards have the following pin out.

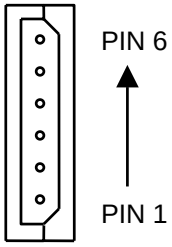
Pin No	Function
1	Unused.
2	Module Good E
3	+Ve Sense. *1
4	Module Good C
5	Starpoint Parallel.
6	Unused.
7	Starpoint Parallel.
8	Module Inhibit -Ve
9	-Ve Sense. *1
10	Module Inhibit +Ve



Mating connector information:
Note: housing and pins supplied with each power supply.
Housing: Molex 51110-1060
Crimp pin: Molex 50394-8051
Hand Crimp Tool: 69008-0959 (Europe or Japan) Or 11-01-0204(USA)

The "N" option is also available for a twin slot module :





Mating connector information:
Note: housing and pins supplied with each power supply.
Housing: Molex 50-37-5063
Crimp pin: Molex 08-70-1039
Hand Crimp Tool: 11-26-0167 (Japan)
Or 11-01-0194(Europe or USA)

The pinouts are as follows for of the two molex connectors on the twin slot module:

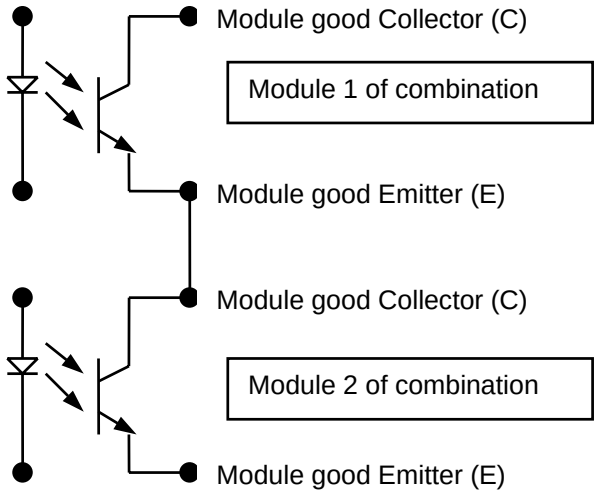
Pin No	Function
1	Module inhibit -VE
2	Module inhibit +VE
3	Module good E
4	Module good C
5	-VE sense.
6	+VE sense.

The available functions when the option is fitted are :-

Module Good.
Module Inhibit.
Remote Sense.

Module Good connection with combination modules.

Each option board fitted to each module in the combination has an opto isolated npn transistor which is ON when that module is good. Connect both transistors together in series so that both transistors will be ON when the module combination is good.

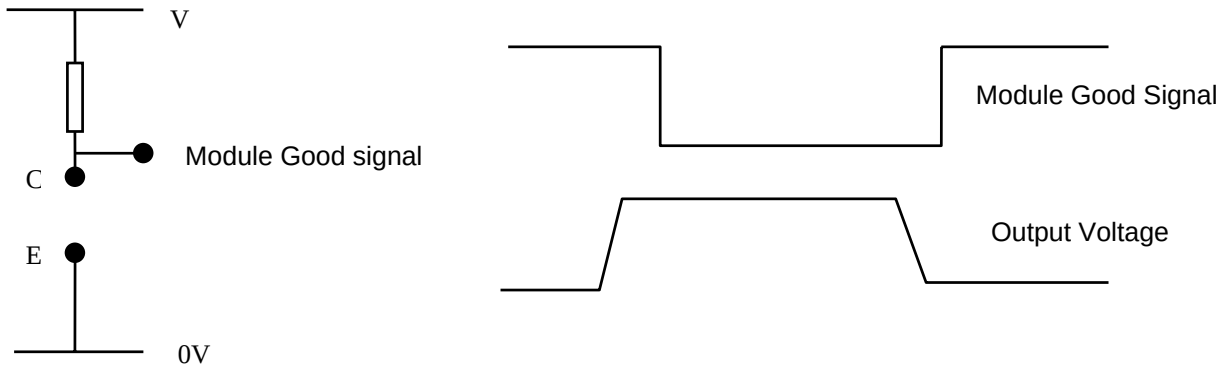


Each Transistor.

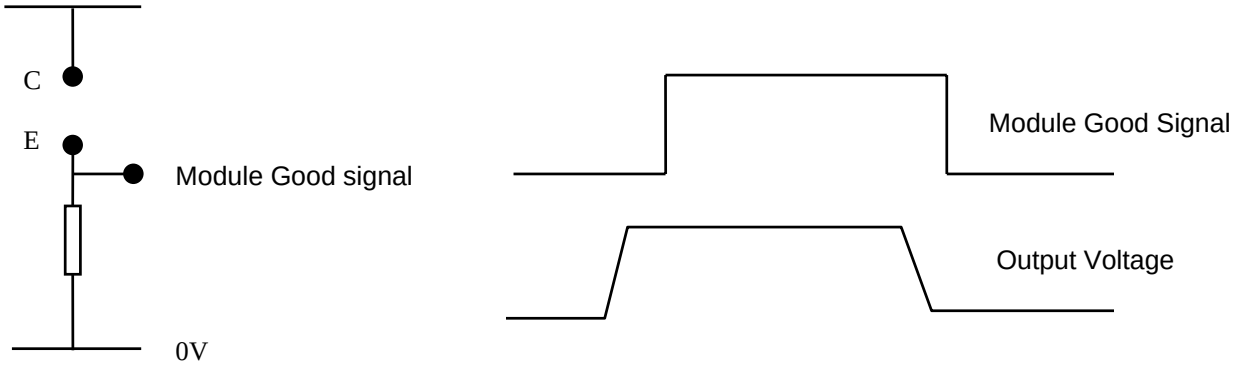
Vce saturated (on) less than 0.4V
Ic maximum 1mA
Vce max 50V

Both transistors ON = Module combination GOOD.
On, or other, or both transistors OFF = Module combination BAD.

Low" when module good.

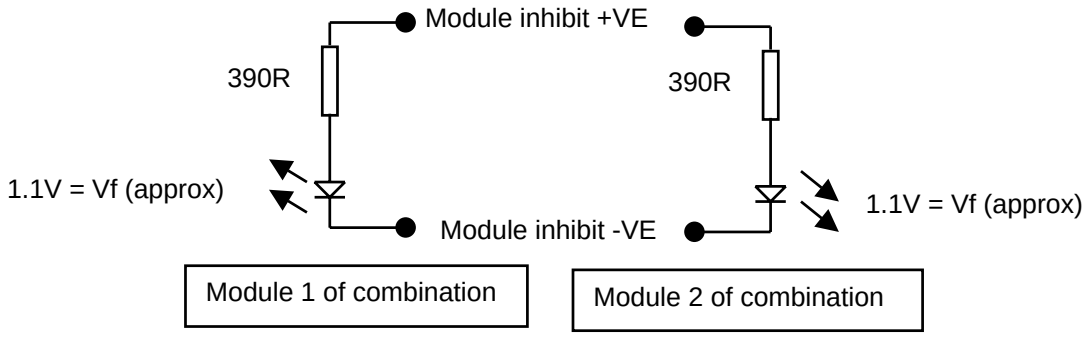


"High" when module good.



Inhibit Connection with combination modules.

Each option board fitted to each module in the combination has the diode of an opto isolted transistor in series with a 390ohm resistor.



Both options need to have the opto isolated diodes connected in parallel.

Applying 5V across the Module inhibit +VE and Module inhibit -VE, as shown, will inhibit the module combination. Do not apply >6V or damage may result. Current draw at 5V is approx 10mA. The 390ohm resistor is fitted internally to the module and is there so that no external resistor is required if the drive is from 5V.

It is also possible to use higher voltages than 5V to drive this arrangement. In that case, there should be additional external resistors to limit the current. Aim to keep the drive currents within the following limits.

1mA to 10mA = Module definitely inhibited.
Less than 0.1mA = Module definitely not inhibited.
Absolute maximum current 13mA.

W2 Programmable Module

1.1 The **single slot module W2** has a range of **0.25-7.5V DC** with a current capability of **30 amps**.
1.2 The **W2** Module **must** be fitted with any one of the control options listed in section. 2.1.
1.3 Select one of the following when designating the baseboard required: -

a. **W2TS**: - W2 module + tracking O/V + screw terminals
b. **W2TF**: - W2 module + tracking O/V + fastons
c. **W2FS**: - W2 module + fixed O/V + screw terminals
d. **W2FF**: - W2 module + fixed O/V + fastons

2. Programmable Module Options.

2.1 Options: -

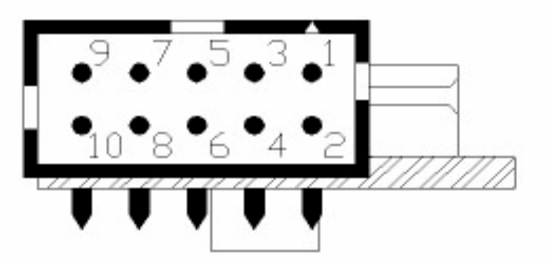
a. **V1**: - 0-5v programming + inhibit
b. **V2**: - 0-5v programming + current programming + inhibit
c. **V3**: - 0-5v programming + enable
d. **V4**: - 0-5v programming + current programming + enable
e. **R1**: - 0-32k resistive programming + inhibit
f. **R2**: - 0-32k resistive programming + current programming + inhibit
g. **R3**: - 0-32k resistive programming + enable
h. **R4**: - 0-32k resistive programming + current programming + enable

2.2 Options brief description: -

a. **Subscript V**: - voltage programming, a **0-5 volt** input from an external DC source, connected between **pin 4** (+ 0-5V) and **pins 1-3** (0V) results in a linear **0.25-7.5** volt output.
b. **Subscript R**: - resistance programming, a **0-32kΩ** external resistance connected between **pin 6** and **pins 1-3** results in a linear **0.25-7.5** volt output **(1kΩ/0.234 volts)**.
c. **Digits 1-4**: - combinations of additional options including **programmable current limit** and **Inhibit** or **Enable** see **figure 4** for further details. The programmable current limit requires a **0-5 volt** input from an external DC source, connected between **pin 5** (+ 0-5V) and **pins 1-3** (0V) results in a linear current limit **0.8-30 amps**.

2.3 Programmable module configuration example "**W2TSV1**".

2.4 Molex connector fitted to option board, connection details



Pin 1, 2, & 3	Return circuit for pins 4, 5, & 6
Pin 4	0-5V external voltage programming pin
Pin 5	0-5V current programming pin
Pin 6	0-32kΩ Resistance programming pin
Pin 7,8	Module Inhibit -Ve
Pin 9,10	Module Inhibit +Ve

***Figure 1. Pin Layout & Description*.**

Abbreviations
W2: - **W**ide range, **2** turns
F or **T**: -**F**ixed or **T**racking O/V
S or **F**: - **S**crew terminals or **F**astons
V or **R**: -**V**oltage programming or **R**esistive programming
1-4: - Combinations of current programming and inhibit or enable

3. W5 Programmable Module

3.1 The **single slot module W5** has a range of **0.25-32V DC** with a current capability of **8.5 amps**.
3.2 The **W5** Module **must** be fitted with any one of the control options listed in section. 4.1.
3.3 Select one of the following when designating the baseboard required: -

a. **W5TS**: - W5 module + tracking O/V + screw terminals
b. **W5TF**: - W5 module + tracking O/V + fastons
c. **W5FS**: - W5 module + fixed O/V + screw terminals
d. **W5FF**: - W5 module + fixed O/V + fastons

4. Programmable Module Options.

4.1 Options: -

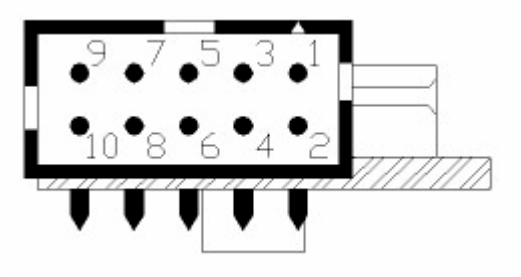
a. **V1**: - 0-5v programming + inhibit
b. **V2**: - 0-5v programming + current programming + inhibit
c. **V3**: - 0-5v programming + enable
d. **V4**: - 0-5v programming + current programming + enable
e. **R1**: - 0-32k resistive programming + inhibit
f. **R2**: - 0-32k resistive programming + current programming + inhibit
g. **R3**: - 0-32k resistive programming + enable
h. **R4**: - 0-32k resistive programming + current programming + enable

4.2 Options brief description: -

d. **Subscript V**: - voltage programming, a **0-5 volt** input from an external DC source, connected between **pin 4** (+ 0-5V) and **pins 1-3** (0V) results in a linear **0.25-32** volt output.
e. **Subscript R**: - resistance programming, a **0-32kΩ** external resistance connected between **pin 6** and **pins 1-3** results in a linear **0.25-32** volt output **(1kΩ/volt)**.
f. **Digits 1-4**: - combinations of additional options including **programmable current limit** and **Inhibit** or **Enable** see **figure 4** for further details. The programmable current limit requires a **0-5 volt** input from an external DC source, connected between **pin 5** (+ 0-5V) and **pins 1-3** (0V) results in a linear current limit **0.8-8 amps**.

4.3 Programmable module configuration example "**W5TSV1**".

4.4 Molex connector fitted to option board, connection details: -



Pin 1, 2, & 3	Return circuit for pins 4, 5, & 6
Pin 4	0-5V external voltage programming pin
Pin 5	0-5V current programming pin
Pin 6	0-32kΩ Resistance programming pin
Pin 7, 8	Module Inhibit or Enable –Ve
Pin 9, 10	Module Inhibit or Enable +Ve

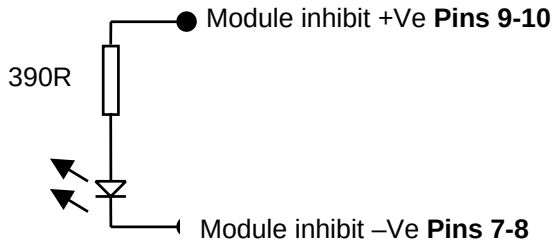
Figure 2. Pin Layout & Description.

Abbreviations
W5: - **W**ide range, **5** turns
F or **T**: -**F**ixed or **T**racking O/V
S or **F**: - **S**crew terminals or **F**astons
V or **R**: -**V**oltage programming or **R**esistive programming
1-4: - Combinations of current programming and inhibit or enable

Mating connector information:
Note: housing and pins supplied with each power supply.
Housing: Molex 51110-1060
Crimp pin: Molex 50394-8051
Hand Crimp Tool: 69008-0959 (Europe or Japan) Or 11-01-0204(USA)

Figure 3. Module with required option board fitted.

Module Selection, Inhibit or Enable circuit connections



Internal to the module inhibit/enable is a 390ohm 1/8W resistor and the diode of an opto-coupler.

To INHIBIT/ENABLE the module apply 2-5V between +ve and -ve. Do not apply >6V or damage may result, although higher voltages may be used to drive the circuit in which case additional series resistor should be used to limit the current. A current of 1-10mA will inhibit the module. Ensure 13mA is not exceeded.

When a module is inhibited, there may be up to 0.05V remaining at the outputs of the module.

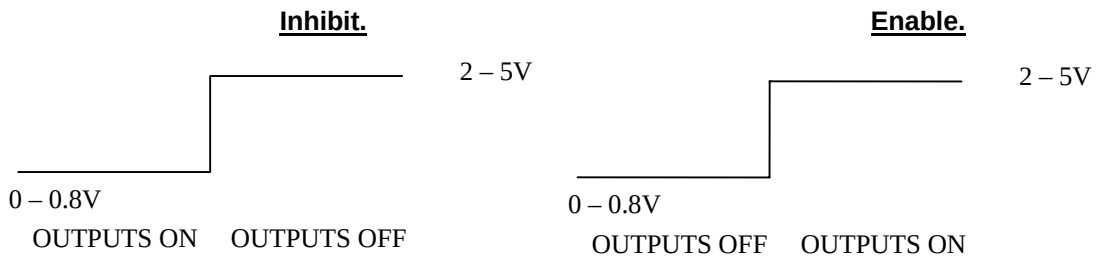


Figure 4.

General Installation

All switch mode power supplies can be sensitive to stray inductance in the power leads and specifically in remote sense leads if installed poorly. Poor transient response or high noise pickup and also intermittent tripping of Over-voltage protection are possible problems. Observing a few simple installation rules will ensure a trouble free function: -

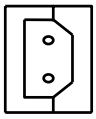
When connecting Vega by means of a cable harness, run the remote sense as a twisted pair and power output cables as a twisted pair where possible. Keep cable runs as short as possible.

When connecting Vega to the load by means of a PCB back plane, run the power tracks "back to back" on the PCB to minimise the projected area of the loop connecting the positive and negative outputs. Run the remote sense and power connections as separate pairs, avoiding close parallel runs and only coming together at the load.

The load should be de-coupled with 10uF of capacitance per Amp of load current. The greater the amount of de-coupling, the better the transient response of the system will be. (NB Max recommended de-coupling is 1000uF/Amp).

Remote Sense

All single output Vega modules are provided with remote sense connector as standard. The Molex connector viewed from the back of the power supply is:-



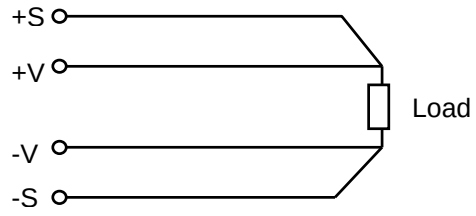
Mating connector information:
Note: housing and pins supplied with each power supply.
Housing: Molex 50-37-5023
Crimp pin: Molex 08-70-1039
Hand Crimp Tool: 69008-0959 (Europe or Japan) Or 11-01-0204(USA)

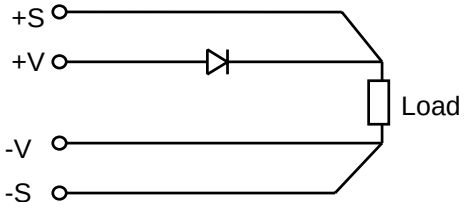
Figure 5.

Remote sense can be used to compensate for the drop in voltage along the load cables or for the drop in voltage across blocking diodes. The voltage at the output terminals will be higher than that at the load by an amount equal to

the voltage drop due to load lead resistance and/or blocking diodes if used. The maximum voltage drop between the load and sense connections should not exceed the maximum voltage specified for that module.

Always observe the following general rules for remote sense operation: -





a. Ensure that the remote sense cables are twisted pairs.
b. PCB tracks for remote sense should be run back to back.
c. Ensure that the remote sense cables / tracks are as short as possible.
d. Ensure that the sense cables are not twisted together with the power cables.
e. PCB power tracks and remote sense tracks should be kept away from each other as far as is possible.
f. Do not fit components (resistor, inductor or diode) into remote sense lines. This could make the system unstable.
g. See the data sheets for each module to see the maximum voltage drop that remote sense can compensate for, do not exceed this value.