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SUPERVERTER® DC-DC Converters

Introduction

SUPERVERTER DC-DC Converters are designed to be highly flexible modules that accept loosely regulated dc input power and generate a tightly regulated dc output. The ***SUPERVERTER*** family of converters covers multiple input ranges with models available for 28V (18V – 36V) and 48V (36V – 75V) powered systems. The output of the module is isolated from the input providing flexibility in polarity and grounding configurations at the system level. The -150 models are form, fit, and functionally identical to the industry standard 150W half brick modules; while the -200 models provide up to 60% more power in the same direct replacement package.

Functional Descriptions

SUPERVERTER modules are highly optimized; forward topology dc-to-dc converters operating at a nominal 370 kHz fixed switching frequency. A block diagram of the ***SUPERVERTER*** module is shown in Figure 25a. The following paragraphs in this section provide a general description of the functions and features available in the ***SUPERVERTER*** modules.

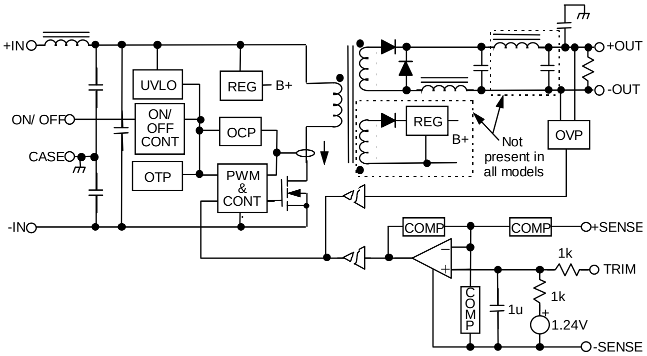


Figure 25a Block diagram of the **SUPERVERTER** *module.*

Remote Sense

The output regulation is maintained by a galvanically isolated sense circuit which allows maximum flexibility for remote sensing as well as minimizing the potential for ground loops and noise. Using the remote sense feature provides improved regulation by sensing the voltage at the load and compensating for voltage drops across connectors, traces, cables, and "ORing" diodes.

Output Voltage Trimming

Output voltage trimming allows the user to change the output voltage of the module. This greatly enhances the functionality of modules by allowing a few select, standard modules to be applied to virtually any application; regardless of the voltage requirements. This allows module users to reduce the number of models kept in stock.

Output Over–Voltage Protection (OVP)

The modules and load are protected from an over–voltage condition by an independent regulation loop that is controlled by the over–voltage protection (OVP) circuit. This loop has a regulation point that is higher than the nominal set point of the main loop and will take over the regulation of the module if the output tries to exceed the OVP level. The OVP circuit must be accounted for when remote sensing and/or trimming as it will limit the maximum voltage that the module can provide.

Under-Voltage Lockout

SUPERVERTER modules have an under-voltage lockout (UVLO) function that protects the load, the module, and the input fuse from damage or erratic operation due to an out-of-spec input voltage. The UVLO circuit will shut the module down or prevent it from starting if the input voltage is too low. This circuit has enough hysteresis to prevent a startup - shutdown oscillation from occurring in most applications. Typical UVLO performance can be seen in the datasheet graph of input characteristics.

Over-Temperature Protection

The over–temperature protection (OTP) feature provides protection against module damage if the cooling system fails or is over-loaded. The OTP circuits will shut down the module if the baseplate reaches an unsafe temperature. Once the baseplate cools to a safe temperature, the module will automatically restart.

Logic On/Off

The ON/OFF feature of the ***SUPERVERTER*** module allows the user to control when the module is on (operating), or off (disabled). There are two on/off control options available for the ***SUPERVERTER*** module: positive logic, where the unit is on with a logic high level at the ON/OFF pin; and negative logic, where the unit is on with a logic low level at the ON/OFF pin. Negative logic models have a -1 suffix on the model number. Regardless of the logic option chosen, the ON/OFF pin is internally pulled high.

Over-Current Protection

The over-current protection (OCP) feature protects the module and the system in which it is used from damage due to an overload or short circuit condition on the output of the module. At the current limit inception point, the module stops regulating the output voltage and starts to regulate the output current. In this mode of operation, the actual output voltage will be a function of the current drawn from the output of the module. Some graphs of typical output voltage vs. output current are given in the data sheet. Once the output current is reduced below the current limit inception point, the module will return to normal operation.

Applications Information

Input Capacitor Requirements

SUPERVERTER modules do not require an input capacitor, but it is strongly recommended that one be used. The purpose of the input capacitor is to maintain stability by lowering the source impedance seen by the module in the range of frequencies where the module's control loop gain is close to 1. It also provides additional filtering of the reflected ripple current emitted from the module.

The amount of capacitance Astrodyne recommends depends on the source voltage and the type of capacitor being used. For most 28V applications, Astrodyne recommends a 22µF, 50V, tantalum electrolytic capacitor, or a 47µF, 50V, aluminum electrolytic capacitor as an input capacitor. While for most 48V applications, RO recommends a 15µF, 100V, aluminum electrolytic capacitor for an input capacitor.

When selecting an input capacitor, you need to pay attention to the ripple current rating and ESR (equivalent series resistance) value of the capacitor(s). The ESR of the 15µF capacitor mentioned above should be in the range of 0.9Ω to 1.1Ω at 100 kHz. While capacitors with much lower ESR are available, the designer must pay attention to the Q of the circuit to avoid system instability. For capacitors in the range of 10µF to 100µF, the ESR should be in the range of 1000mΩ to 100mΩ.

Ceramic capacitors are only recommended as input capacitors for systems requiring small size and stable values that can justify the higher component costs. For 28V systems, RO recommends a 4µF to 10µF, 50V ceramic capacitor or capacitor array. Because of the low ESR / high Q of ceramic capacitors, most input filters employing these capacitors require the use of damping networks to maintain stability. These are typically implemented as an RLC network in parallel with the input capacitor, the series choke, or both. Design of a damping network is beyond the scope of this application note. Please contact the factory for assistance with these types of applications.

Fusing Requirements

SUPERVERTER modules are not internally fused and require that an external fuse or equivalent protection device be used. The fuse should be located between the power source and the module; and in series with the ungrounded terminal of the power source. Most applications also place the input capacitors and local circuitry on the module side of the fuse to extend its protection to those components as well.

Systems with multiple modules can protect more than one module with a single fuse. However, Astrodyne recommends that the maximum fuse rating be limited to 20A no matter how many modules are being protected. All traces, cables, and components should be capable of handling at least 1.5 times the fuse rating without failure.

For most 28V, single module applications, Astrodyne recommends an 18A, normal blow fuse for SV28-xx-200 models and a 15A, normal blow fuse for SV28-xx-150 models. Applications that must tolerate extended operation at high input currents (i.e. output overload at low line voltages) should use a 20A, normal blow fuse. Time-delay fuses are not recommended.

For most 48V, single module applications, Astrodyne recommends a 10A, normal blow fuse. Astrodyne recommends a 10A, normal blow fuse for SV48-xx-200 models and an 8A, normal blow fuse for SV48-xx-150 models. Applications that must operate at high input currents (i.e. low line voltages) for an extended time should use a 12A, normal blow fuse. Time-delay fuses are not recommended.

Whatever fuse is chosen, it must be rated to handle the module’s inrush transient current of $1A^2s$ (max) plus the inrush current of any other components between the fuse and the module.

Safety Considerations

The following issues should be considered carefully when designing ***SUPERVERTER*** modules into a product; especially if the product requires approval from one or more safety agency. Applications employing standards other than IEC 60950 should consult those documents for relevant safety considerations. The terminology used in this section comes from IEC 60950.

Electrical shock hazards

The ***SUPERVERTER*** modules provide electrical shock protection with the judicious use of insulation along with proper spacing between the primary and secondary circuits. When all of the following design and installation considerations are adhered to, the secondary side outputs of the ***SUPERVERTER*** modules are considered to be SELV outputs (+OUT, -OUT, +SENSE, -SENSE, TRIM.)

The ***SUPERVERTER*** modules were designed for use with a DC power source; either a battery pack, or the ELV or SELV output of a power supply. These modules are considered to be Class I (earthed) and must be properly bonded to the main protective earthing termination in the end product.

Most modules in the SV family provide “reinforced insulation” between the input and the output. However, in 28V systems the module‘s input voltage is not considered hazardous, so the SV28 series only provides “functional insulation” between the input and the output. All isolation transformers used in the SV family employ a planar construction, with layers of ultrathin industrial laminate insulation as the only insulating medium.

The internal spacing and clearance distances used in the ***SUPERVERTER*** modules have been selected for use in a Pollution Degree 2 environment.

Energy related hazards

Some ***SUPERVERTER*** models are capable of supplying output power at levels that can be considered hazardous. A hazardous energy level is defined by IEC 60950 as a continuous output power level of 240VA or more at voltages of 2V or more. These power levels can, in the event of a short circuit, lead to hazards such as burns, arcing, or ejection of molten metal if the external circuitry isn’t properly designed. The SV family has been designed and verified to prevent such hazards from occurring inside the module.

Fire hazard

The ***SUPERVERTER*** modules provide fire hazard reduction via material selection and functional protection features. The SV module is constructed using materials having a flammability rating of 94V-2 or better, with most materials rated as 94V-0. Protection features such as OTP, OCP, and UVLO prevent internal temperatures from becoming high enough for combustion ignition. However, even with all of these mitigation methods employed, some external mitigations must be considered. The end product shall provide a fuse or equivalent protection as described in the Fusing Requirements section of this application note. Moreover, a suitable electrical/ fire enclosure shall be provided in the end-use product.

Heat hazards

If the temperatures inside the ***SUPERVERTER*** module get too high, the internal insulation and safety-critical components can be degraded, resulting in a potential hazard. To prevent this situation from ever happening, the SV family is equipped with OTP circuitry. However, the OTP circuits are only intended to be a secondary layer of protection. To ensure good system reliability, the maximum baseplate temperature in the end-use product should be limited to 100°C by proper design of the product’s cooling system.

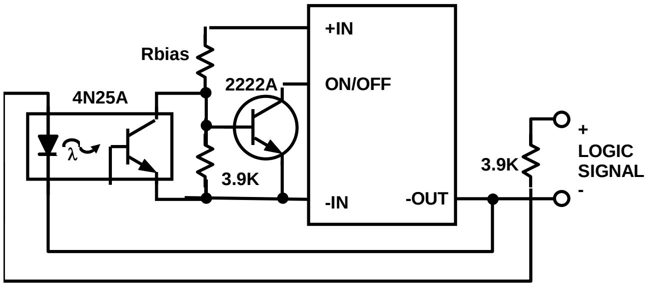
Isolation & Highpot Testing

The ***SUPERVERTER*** module consists of four galvanically isolated systems: the input stage, the output stage, the remote sense circuits, and the baseplate (case). These can be seen in Figure 25a (the baseplate is represented by the “pitchfork” ground symbol).

The isolation ratings of the module are:

Input-to-case	1500V
Output-to-case	500V
Input-to-output	1500V
Output-to-sense	50V

Highpot testing is performed on 100% of all ***SUPERVERTER*** modules at the time of manufacture; the user is therefore discouraged from performing additional tests. If additional testing is required, a DC highpot test must be used. Astrodyne uses a DC highpot tester with a 7-second rise time and a 2-second dwell time. The trip threshold for failure is 10µA. Because of the low threshold for failure, AC highpot tests are not effective. The AC current induced in the various capacitances of the module would far exceed the insulation leakage of a bad module.



Rbias = 100k for 48V systems and 51k for 24V systems

Figure 25b A typical logic on/off circuit for negative logic converters. A high level at the logic signal interface will disable the module.

Logic On/Off

The ON/OFF pin is referenced to the -IN pin. The module recognizes a logic low level as any voltage below 1.2V at the ON/OFF pin. The external circuitry must be able to sink up to 1mA from the ON/OFF pin while holding the pin at the logic low level. When the pin is at the logic high level, internal circuitry pulls up the ON/OFF pin to a voltage level of about Vin/6. The external circuitry must not sink more than 50µA while the ON/OFF pin is being commanded to the logic high level. It can, however, externally drive the pin high to any voltage up to the rating of the pin (50V.)

Astrodyne recommends the use of an open-collector or equivalent circuit to interface to the ON/OFF pin. Additional information on typical logic on/off circuits is given in AP-4. Note that all of the circuits in AP-4 assume that positive logic is used. A typical logic on/off circuit for negative logic converters is shown in Figure 25b.

In applications where the logic on/off feature is not being used the ON/OFF pin should be shorted to -IN for negative logic models or left unconnected for positive logic models.

Remote Sensing Considerations

The remote sense circuits can compensate for voltage drops up to 0.5V or 10% of nominal output voltage, whichever is greater. If the total voltage drop between the output terminals and the load exceeds this amount; other design changes, such as increasing conductor size, must be made.

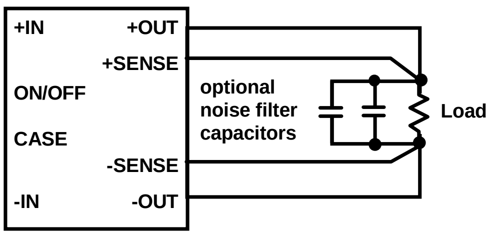


Figure 25c Remote sense implementation showing the remote sense leads and optional filter capacitors connected at the point of load.

The sense terminals must always be connected, either to the module's output terminals or to the load. For a remote sense configuration, connect -SENSE to -OUT at the load and +SENSE to +OUT at the load as shown in Figure 25c.

Additional information on remote sensing can be found in AP-6, Remote Sensing.

Output Voltage Trimming

The ***SuperVerter*** module uses a simple approach to trimming that in most cases allows the module to be trimmed with a single external resistor. Please note that the trimming equations in AP-5 do not apply to the ***SuperVerter*** module.

To trim the ***SuperVerter*** module, you must alter the internal reference voltage for the main regulation loop. A look back at Figure 25a will help to understand how this is accomplished. To trim the module, connect a resistor from TRIM to either +SENSE or -SENSE depending on whether you want a higher or lower than nominal output voltage. In trim-up applications, the resistor will be connected from TRIM to +SENSE; and in trim-down applications, the resistor will be connected from TRIM to -SENSE. Figure 25d shows the two connections.

To calculate the resistor value, use the following equations:

$$R_{trim-up} = \left(\frac{V_O(100+\Delta\%)}{1.24\Delta\%} - \frac{(100+2\Delta\%)}{\Delta\%}\right)k\Omega$$

$$R_{trim-dn} = \left(\frac{100}{\Delta\%} - 2\right)k\Omega$$

Where:

Vo = The nominal output voltage of the module with no trimming.

Δ% = The desired percentage change in the output

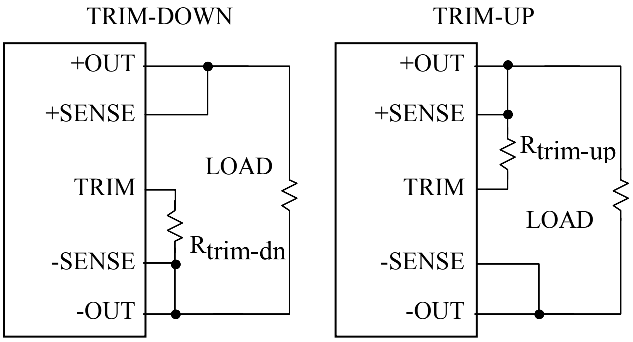


Figure 25d Basic circuits for trim-up and trim-down applications.

voltage. For example, if you desire to trim a 5V module to 4.5V then **Δ%** = 10. Note that **Δ%** is always a positive number.

Plots of the trim resistor values vs. **Δ%** for increasing and decreasing the output voltage are shown in Figure 25e and Figure 25f respectively.

EXAMPLE: An application requires 9A at 26V to drive a RF amplifier in a cellular transmitter. In this application we would use a SV28-24-200-1 module trimmed up to 26V. The 24V module has a power rating of 24V x 10A or 240W. At 26V, the output current must be limited to 240W ÷ 26V = 9.23A, which is acceptable for the application. The required trim resistor is calculated as follows:

$$V_O = 24V$$

$$\Delta\% = \left(\frac{26-24}{24}\right)100 = 8.3$$

$$R_{trim-up} = \left(\frac{24(100+8.3)}{1.24\times 8.3} - \frac{(100+2\times 8.3)}{8.3}\right)k\Omega$$

$$R_{trim-up} = 238k\Omega$$

For our application, we will use a standard 237kΩ, 1%, temperature stable resistor from TRIM to +SENSE.

Output Filtering

RO's ***SUPERVERTER*** modules are designed to have very low output ripple and noise and rarely is additional filtering needed. For those few sensitive applications that do need additional filtering, this section provides a few guidelines on how to achieve the desired goal.

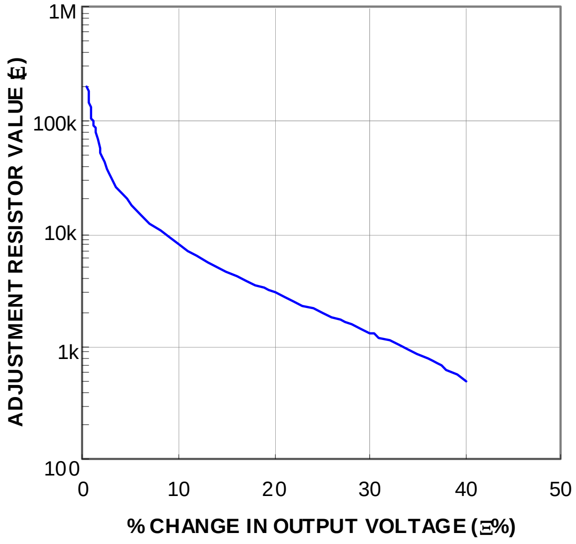


Figure 25e Resistor values for DECREASING the output voltage.

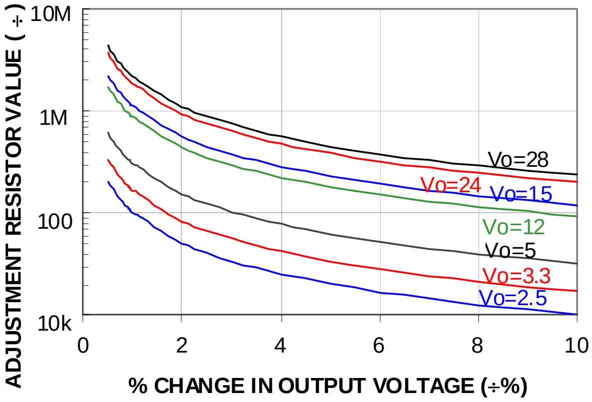


Figure 25f Resistor Values for INCREASING the output voltage

First, be sure that your measurements are accurate. If your ground lead on your scope probe is more than 1 to 2 cm it's too long. If your scope produces a reading when both the tip and the ground are connected to the same point, you can't trust its reading of ripple and noise. For more information on how to properly measure ripple and noise see Application Note 8.

Spike noise on the output is relatively easy to eliminate provided that the distribution system and load are not resonating. A small, good quality bypass cap on the order of 0.1µF to 1.0µF will usually do the trick when placed right at the load. Most system problems with spike noise are the result of a resonance in the distribution system/power supply/load combination. These resonances commonly occur when ceramic and electrolytic capacitors are mixed together where the lead/body inductance of the electrolytic cap can form a resonant tank between the ceramic and electrolytic capacitors. These resonances are usually stopped by changing the size or type of one of the capacitors involved.

Reducing the fundamental output ripple of the module is a little more difficult. This is because at these power levels the output impedance of the module is very low. To reduce the ripple by a significant amount requires that a low impedance component be placed across the output of the supply. This is typically accomplished with capacitors. Unfortunately, at the fundamental frequency of the ripple, ceramic capacitors are prohibitively large and expensive by the time their value is big enough to affect the output; and electrolytic capacitors actually perform like resistors because of their large effective series resistance (ESR). For reductions in ripple up to a factor of 5 or 10, the most cost effective approach is still the electrolytic capacitor. Table 25a shows the typical output impedances of the

SuperVerter family. To reduce the output ripple of the converter by half, the ESR of the external capacitor bank must be equal to the output impedance of the module at the ripple frequency (~370kHz).

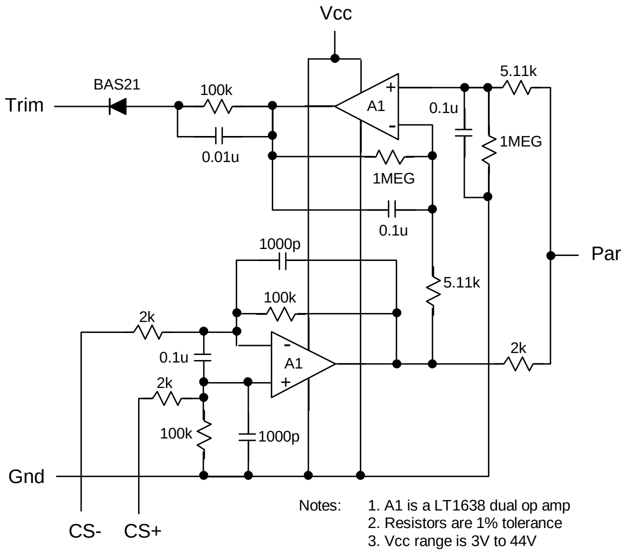
To go beyond a factor of 5 to 10 reduction in ripple usually requires that the output impedance of the converter be increased at the ripple frequency by adding a series inductor between the converter and the filter capacitor. The value of the inductance can be fairly small but it must be able to handle the full load current without saturating. For example, a 5V module would require a 34nH choke and a 10mOhm capacitor bank to reduce the ripple amplitude by a factor of 10. Obviously, many trade-offs exist between the size of the capacitor and the size of the inductor used.

Table 25a Typical output impedances of the SUPERVERTER *Family.*

Vout	*Zout @ 370kHz*
< 5V	*6mOhm*
5V	*10mOhm*
12 & 15V	*43mOhm*
24V & 28V	*110mOhm*

Paralleling

SuperVerter modules can be paralleled for increased power and/or for redundancy. Paralleling is accomplished by sensing the current of each module; and adjusting its output voltage so that the current is equal to the current of the other modules. Figure 25g shows one method of paralleling ***SuperVerter*** modules. With this method, the current share controller adjusts the output voltage of the module via the module's trim pin. The current sense resistor is selected for 40mV at the rated load current of the module. Figure 25h shows the detail of the current share controller. With the components shown, the current share controller can be powered directly from the output of supplies with output voltages ranging from 3.0V to 44V. For supplies below 3.0V, an external supply must be used to power the current share controller.



Notes:
1. A1 is a LT1638 dual op amp
2. Resistors are 1% tolerance
3. Vcc range is 3V to 44V

Figure 25h Detailed schematic of the current share controller (I-share cont.)

When paralleling modules with remote sense, be sure that the voltage drops between the module and the sense point are within the module's remote sense compensation capability. These voltage drops typically include I x R of the traces, cables, and connectors; plus the forward drop of any "ORing" diodes. **Caution: Do not remote sense around the current sense resistor. Doing so will cause the system to be unstable.**

Soldering Guidelines

The preferred method for soldering ***SuperVerter*** modules to a PC board is wave soldering. Hand soldering of the pins is acceptable but generally discouraged because of the increased chance of over-heating the module pins.

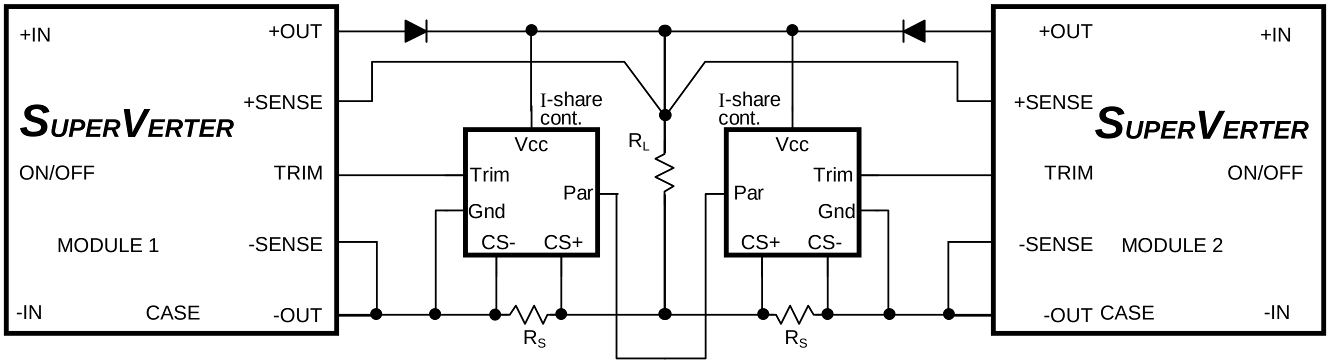


Figure 25g Paralleling SUPERVERTER *modules using TRIM pin control. (±IN, ON/OFF, and CASE connections omitted for clarity)*

For wave soldering, the solder bath temperature should be maintained at 260°C and the conveyor speed should be adjusted so that each pin is in the bath for 4 - 5 seconds. To avoid latent failure from thermal shock, the module and PCB should be preheated gradually and should be at 100°C when the pins enter the solder bath. The PCB and module should be cooled gradually as well. Do not process the module in a liquid based cleaning system until it has cooled. Otherwise, some of the cleaning fluid might be drawn into the module by contracting gasses inside an internal void or bubble.

For hand soldering, use a temperature controlled soldering iron with a maximum tip temperature of 370°C. The soldering iron should be applied to the pin for 3 to 5 seconds. Do not exceed 10 seconds or the module may be damaged.

Thermal Considerations

Thermal management is an important part of the system design process. The designer must account for all operating environments that the system will see and design a suitable cooling configuration to maintain the module(s) within an acceptable temperature range. While the maximum acceptable baseplate temperature is 100°C, many designers choose to limit the design to a lower temperature for improved reliability and design margin.

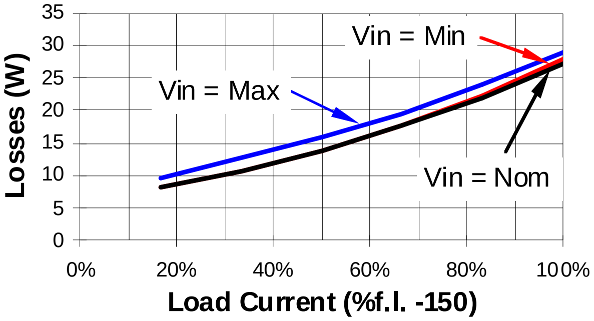


Figure 25i Power Dissipation vs. Load Current for all SV -150 modules.

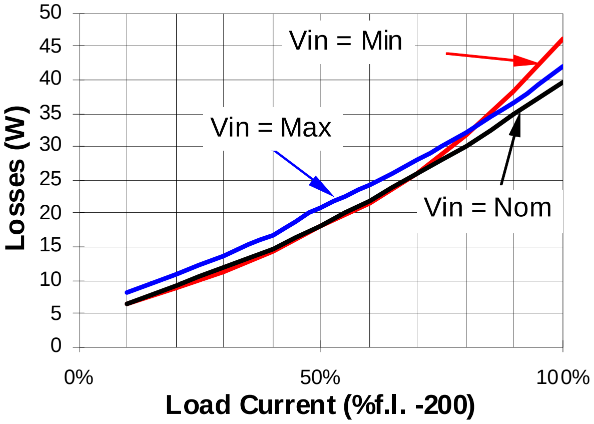


Figure 25j Power Dissipation vs. Load Current for all SV -200 modules.

SUPERVERTER modules have been designed with cooling requirements as a high priority. Their high conversion efficiency minimizes the necessary cooling while their small package size and large thermal interface allows simultaneous reductions in system size and cost along with substantial improvements in reliability.

Heat is removed from ***SUPERVERTER*** modules through the module's baseplate. The baseplate is thermally coupled to and electrically isolated from all internal components. The goal of good thermal design is to transfer heat from the baseplate to the outside world; thereby keeping the baseplate temperature below the maximum rating.

Heat energy is transferred from warm objects to cold objects by three fundamental means:

Convection: The transfer of energy through a liquid or gaseous media.
Conduction: The transfer of energy through a solid media.
Radiation: The transfer of energy between masses at different temperatures via predominantly infrared wavelengths.

While all three transfer mechanisms will be present in every application, either convection or conduction cooling is the dominant means of heat transfer in most. However, some consideration should be given to all three transfer means to ensure the cooling design is successful.

In a conduction-cooled system, heat is removed from the

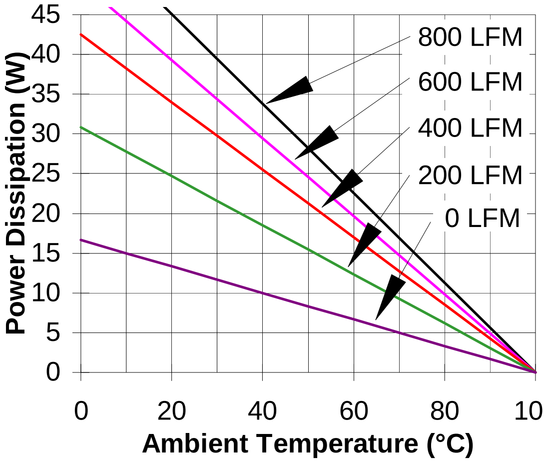


Figure 25k Power derating of the SV modules with convection cooling and no heat sink.

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Figure 25l Case to ambient thermal impedance curves.

module via a cold plate attached to the baseplate of the module. The amount of heat that can be removed from the module is a function of the baseplate temperature, the cold plate output temperature, and the amount of heat flux the cold plate can handle. Design of a conduction (cold plate) cooled system is highly dependant on the system's packaging constraints and is therefore beyond the scope of this application note.

In a typical convection-cooled system, heat is removed from the module via airflow over the surface of the module. The amount of heat that can be removed from the module is a function of the ambient temperature and the velocity of the air. Figure 25k shows the maximum power dissipation versus ambient temperature for a ***SUPERVERTER*** module with no heat sink. This figure, along with either Figure 25i for -150 modules or Figure 25j for -200 modules can be used to calculate the required airflow as shown in the following example.

EXAMPLE:

How much airflow is required to cool a SV28-5-200-1 ***SUPERVERTER*** module operating at a line voltage of 36V with an output current of 20A and an ambient temperature of 50°C?

From the design information:

Vin = 36V
Iout = 20A
Ta = 50°C

First, estimate the amount of power dissipated by the module. The output current is 20A/40A which is 50% of full load. From Figure 25j, we determine that the power dissipation is 22W.

Second, from Figure 25k, we determine that 22W and 50°C ambient corresponds to the 400 LFM line. Therefore, if we supply 400 LFM of airflow, the baseplate will be 100°C when the ambient air temperature is 50°C and the module is dissipating 22W.

For applications with more demanding cooling requirements, such as higher ambient temperatures or higher power dissipation, adding a heat sink to the module will improve the cooling efficiency of the system. The standard configuration of the ***SUPERVERTER*** module has mounting holes that are threaded all of the way through for a M3 x 0.5 screw. This configuration allows a heat sink and/or a PCB to be attached to the module using screws. An alternate configuration of the ***SUPERVERTER*** module has smooth bore mounting holes with an inner diameter of 0.130 in. The alternate configuration allows the module to be sandwiched between a PCB and a heat sink. Either the PCB or the heat sink can be designed with threads or a separate nut can be used. The alternate configuration is advantageous for situations where a large cold plate or heat sink assembly is used and it is not practical to have through holes in it.

When using the alternate configuration, it is important to avoid compressing PCB material with the screw force. Most PCBs are made from G-10 or FR-4 material, which will cold flow under compression. Over time, the material flows away from the screw reducing the contact pressure between the module and the heat sink. This will lead to a degraded cooling system and higher module temperatures. See Application Notes 2 and 19 for further information.

Figure 25l shows case-to-ambient thermal resistances for several standard heat sinks available from Astrodyne. These curves were derived empirically using a ***SUPERVERTER*** module mounted on an EB-SU evaluation board in a constant velocity air stream. The test setup was placed in a large open room maintained at 22°C. For the test, the load of the module was adjusted to obtain a baseplate temperature of 80°C. When used, heat sinks were attached to the module using four, M3 x 0.5 x 5 metric screws. The heat sink had a standard RO thermal pad attached to the mating side. Actual performance in a closed system may differ from the data presented here.

Testing Information

P-P Noise Measurement Test Setup

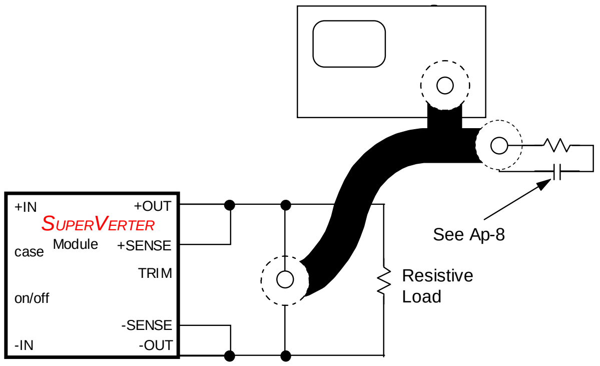

Figure 25m Test setup for P-P noise measurements.

Efficiency Measurement Test Setup

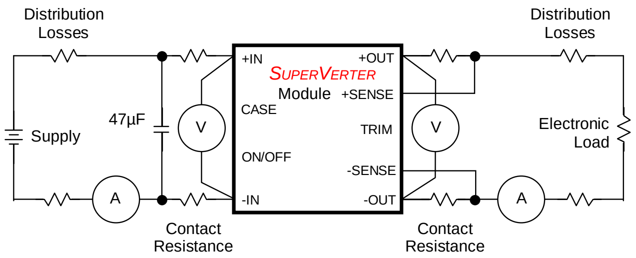

Figure 25n Test setup for efficiency measurements.

Input Reflected Ripple Test Setup

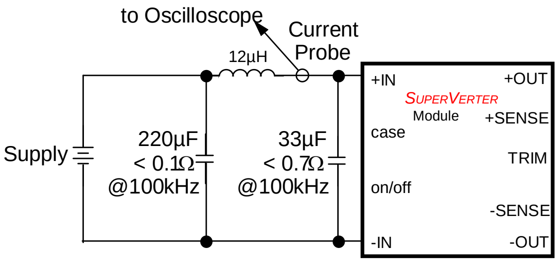

Figure 25o Test setup for reflected ripple measurements.

Layout Information

General layout guidelines can be found in Application Note 18. The ***SUPERVERTER*** series is similar in nature to RO's ***MICROVERTER***® series with the exception that the On/Off pin of the ***SUPERVERTER*** module is not noise sensitive like the Parallel-On/Off pin of the ***MICROVERTER*** module. In addition, the ***SUPERVERTER*** module has a case pin that is electrically connected to the baseplate of the module. Figure 25p and Figure 25q show the recommended PCB footprint for the ***SUPERVERTER*** module.

Recommended PCB Footprints

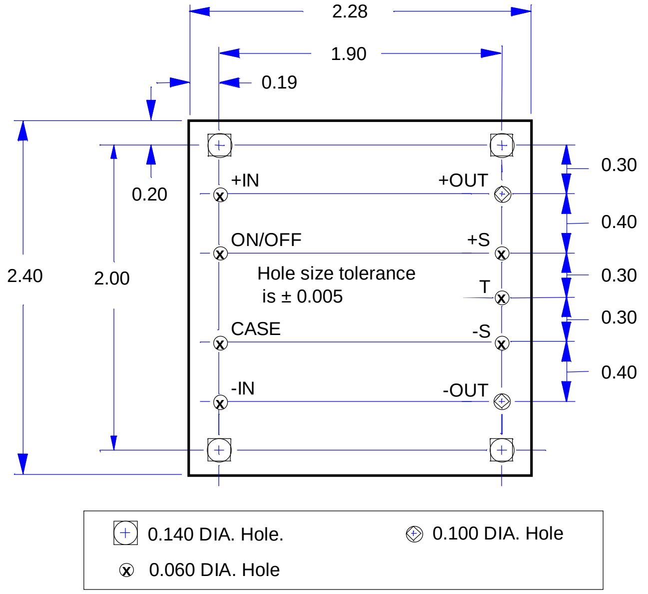

Figure 25p The recommended footprint for **SUPERVERTER** *modules. View is from the module side of the PWB.*

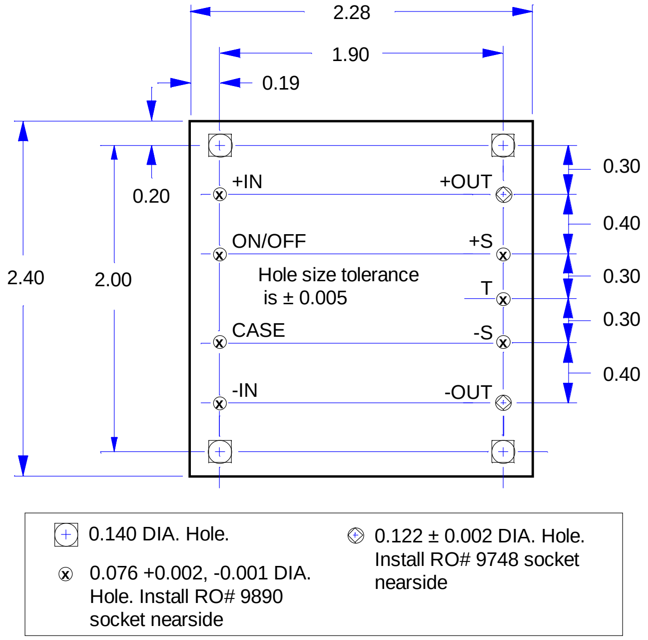

Figure 25q An example of a **SUPERVERTER** *module footprint with sockets. Other socket configurations*

are possible. View is from the module side of the PWB.

Reliability Calculations

The calculated MTBF for the ***SUPERVERTER*** module is 1.8 million hours per Belcore TR-332, issue 6, December 1998; when operated at full load, 40°C baseplate in a GB environment.

The calculated MTBF for the ***SUPERVERTER*** module is 1.2 million hours per MIL-HDBK-217 rev F, notice 2, December 2, 1991; when operated at full load, 25°C baseplate in a GB environment.

Possible Applications

COTS Military Power Systems - The small size, rugged packaging, and large thermal interface makes ***SUPERVERTER*** modules the epitome of power sources for high reliability, environmentally demanding COTS equipment employing conduction (cold-plate) cooling methods.

Vehicular Power Systems - ***SUPERVERTER*** modules are perfect for vehicles with 24 V or 48 V electrical systems because of their wide input range and compact, rugged packaging.

Distributed Power - ***SUPERVERTER*** modules are ideal for distributed power architecture applications because of their high power density and high efficiency.

Computer Equipment - The small size and ease of use of ***SUPERVERTER*** modules makes them perfect for high reliability computer equipment.

Upgrade for Existing Designs - Existing designs using the industry standard half bricks can use ***SUPERVERTER*** modules as an alternate, cost competitive source or as an upgrade path for higher power systems with little or no NRE.

Precautions

No Internal Fuse - The ***SUPERVERTER*** module does not have an internal fuse. An external fuse or equivalent device must be used.

Do not over-heat the pins - Do not exceed the recommended time or temperature when applying a soldering iron to the pins. This can cause permanent damage to the module and may lead to immediate or latent failures.

Do not apply reverse voltage - The ***SUPERVERTER*** module is not designed to withstand more than 0.3V reverse voltage on the input, the output, or the sense terminals.

Related Topics

AP-1	Module Handling Considerations
AP-2	Mechanical Mounting Considerations
AP-3	Input Ripple Measurement and Filtering
AP-4	Logic On/Off
AP-6	Remote Sensing
AP-7	Measuring Line and Load Regulation
AP-8	Measuring Output Noise and Ripple
AP-10	Thermal Considerations
AP-18	Board Layout Considerations and Recommendations
AP-19	Hole Dimensions and Socket Information

Notes: