General Operating Information

General

Absolute Maximum Ratings

Some ratings, shown in ABSOLUTE MAXIMUM RATINGS, are the absolute maximum ratings referring to no destruction or design limits, normally tested with one parameter while exceeding the limits of absolute maximum ratings or electrical characteristics.

The stress exceeding the absolute maximum ratings may cause permanent damage, function and performance degraded. As far as design margin and enhancing system reliability are concerned, it is recommended that Glary DC/DC converters operate below 90˚C of case temperature. The over temperature protection set point is 5˚C ~10˚C higher of maximum operation base plate temperature.

Safety

Standards

All product series of Glary DC/DC converters are designed to comply with UL in accordance with EN60950 safety of information technology equipment including electrical business equipment. These DC/DC converters meet the U.S. and Canadian Standard for safety of information technology equipment, including electrical business equipment applicable requirement in CSA/UL60950. Most product series of Glary DC/DC converters are recognized by UL, CSA and TUV.

Isolation

Operational or Basic insulation is performed in accordance with EN60950. All product series, built in DC-to-DC converter power supplies, should be installed in end-use equipment for printed wiring board or chassis mountable, and intend to be supplied by isolated secondary circuit. Consideration should be given to measure the case temperature to comply with maximum case temperature during module operation.

When the supply to DC/DC converter meets all requirements for SELV, the output is considered to remain SELV limit. For supply voltage from 60V to 75V DC, reinforced insulation must be provided in the 75V power source that isolates the input from the mains. Single fault testing in the 75V supply circuit will be performed in combining with the DC/DC converter to demonstrate that the output meets the requirement for SELV. One pole of the input and the other one of the output are going to be grounded or both circuits are to be kept floated.

The isolation, withstanding 1500V or 2000 DC between input and output depending on different series, 1000V DC between input/output and case with all series, is verified in an electrical strength test.

Flammability

The flammability ratings of plastic parts and PCBs meet UL-94V-0.

Fusing

A fuse should be used at the input of each converter to isolate the failed one from others, keeping the system continue to operate and prevent the damage of power distribution wiring from over heating. A fast blow fuse should be used with 10A~20A rating or less, it is recommended using a fuse with the lowest current rating.

Input Side

Input (+IN, -IN)

Voltage Range

The input voltage range of 36V~75V meets the requirement of European Telecom Standard ETS 300 132-2 for normal input voltage range in -48V (-40.5V~ -57.0V) and –60V (-50.0V~ -72.0V) DC power systems. The absolute maximum continuous input voltage is 75V DC and withstands 100V DC/100ms maximum transient voltage. The range 18V~36V for 24V version is also available.

Input Capacitance

The input characteristic of a DC/DC converter may be referred as a negative-incremental impedance element in its input voltage range. Sometimes, oscillation will be occurred when high impedance power source is applied to supply power to a DC/DC converter. An external input capacitor is recommended to reduce the characteristic impedance and eliminate the oscillation between the DC/DC converter and the source.

Generally speaking, a 220uF~470uF capacitor across the input of all DC/DC converter product series will help to insure stability.

ON/OFF Control (ON/OFF or PC)

These product series of DC/DC converter has the remote on/off control pin can be connected to an external ON/OFF control signal for turning ON and OFF. The control signal of ON/OFF pin is referred to the negative power input pin and two control logic options are available.

Negative Logic

ON: Short to negative power input pin or apply voltage of logic low.

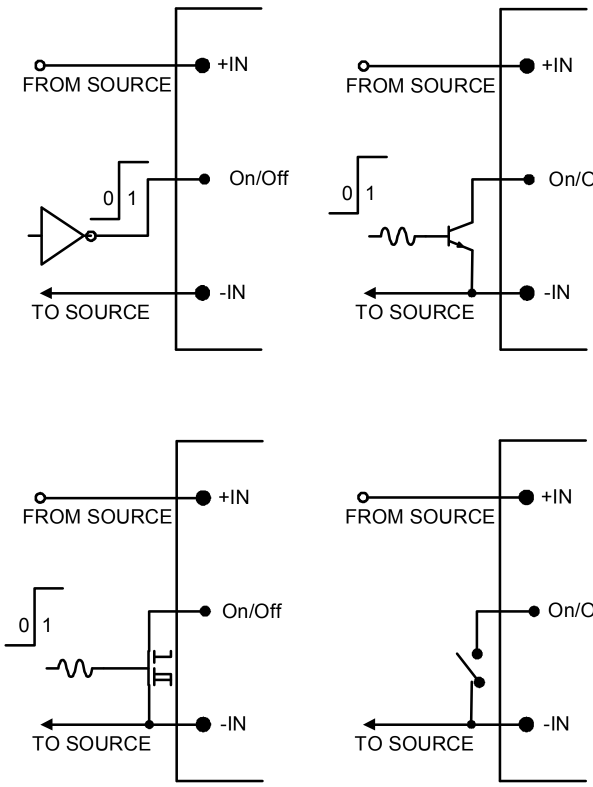
OFF: Opening circuit or apply the voltage of logic high.

Positive Logic

ON: Opening circuit or apply the voltage of logic high.

OFF: Short to negative power input pin or apply voltage of logic low.

A mechanical switch or an open collector NPN transistor (open drain N channel FET) can be used to drive the ON/OFF pin. The device must be capable of sinking 1mA minimum at a logic low voltage 1.0V and withstands 12V DC minimum.



Output Side

Output (+OUT, -OUT)

Ripple & Noise

The ripple of DC/DC converters is measured as peak-to-peak voltage from 0 to 20MHz including the noise and the fundamental ripple. The ripple and noise can be reduced significantly by paralleling a de-coupling capacitor to the output terminal.

Over Current Protection (OCP)

These DC/DC converters provide OCP function to withstand continuous overload or short circuit condition in the output. The converter will recover to normal operation after the overload is removed. The OCP set point of these DC/DC converters is 108%~125% of rated output current.

Output Over Voltage Protection (OVP)

These DC/DC converters provide OVP lockout function to prevent the damage of load from over voltage condition on the output. The converter will restart after recycling the input power or control signal of primary control pin. The OVP set point of these DC/DC converters is 115%~130% of rated output voltage.

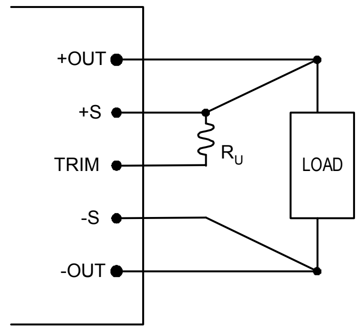
Remote Sense (+S, -S)

These DC/DC converters have the remote sense pins that can be used to compensate voltage drop due to the resistance in the distribution system. It allows the output voltage can be regulated at the load or a selected point. It should be noted that the sense line must be located close to a ground trace or a ground panel to reduce noise, a twisted wire pair is recommended for discrete wiring. The sense pin will compensate 0.5V maximum of voltage drop between the sensed voltage and the voltage of output pins.

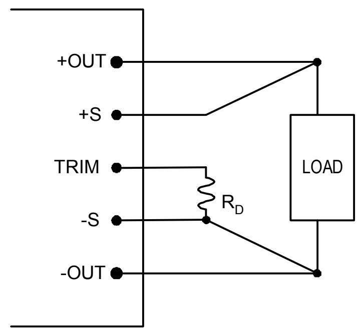
Output Voltage Adjust (TRIM or SC)

These DC/DC converters have the secondary control pin used to adjust output voltage beyond or below nominal output voltage. It should be noted that trim up to be above OVP set point may cause a converter to enter the over voltage protection state. The TRIM pin is noise sensitivity and the external resistors should be located within 1cm of the converter. If not using the trim feature, leave the TRIM pin open.

TRIM UP: connect a trim resistor (R_U) between TRIM pin and +S pin.



TRIM DOWN: connect a trim resistor (R_D) between SC pin and -S pin.



Output Capacitance

The extra output capacitance is required to improve the voltage regulation when powering a load with significant dynamic current requirement. Putting a low ESR capacitor to the load as close as possible to handle the short duration high frequency component of dynamic load current. Since the mid-frequency voltage deviation caused by step load is mainly dominated by the feedback loop performance, which also affected by the additional output capacitance. Do not put any low-bandwidth high capacitance Electrolytic capacitors very close to the power module because doing so help nothing and even introduces unwanted effects on the feedback performance, sinking or sourcing surge current damaging the power module. It should be noted that the capacitance, resistance and inductance of power distribution loop are used as feedback components that would affect stability and dynamic response performance of power converter.

In generally, 47uF~68uF/A of output current can be used for 3.3V output power module without additional analysis. For example, a 3.3V/35A DC/DC converter, the de-coupling capacitor up to 4700uF can be used on the premise of not affecting the stability. Other than that, capacitance of higher than sufficient value is however not encouraged as it may result in stability risks to the converters. Since the stored energy of the capacitor is proportional to V^2, which result in the de-coupling capacitance to be reduced by a factor of $(Vo/3.3)^2$ for modules with higher output voltage.

Moreover, the recent modern technology has been advanced enough to allow low ESR on some specific type of capacitors (such as MLCC), which features very high reliability and nearly eliminates the needs of paralleling numerous life span constrained electrolytic caps at the system end to achieve low ESR, and further allows more simplified external output filter design for the power system. Therefore, for Glary Power's full series of product lines, simply adding a MLCC of a few to a few tens of uF close to the load should be sufficient enough. Do note that an exceeded high value of external output capacitance would result in other negative impacts to the converter's feed back loop. Please as well consult with Glary Power if higher external output capacitance is needed for the system design.

Reliability

For example, calculated MTBF in accordance with Bellcore TR-332 issue 6, December 1997 of COE series, is 4,801,570hours (+25ºC), 2,015,270hours (+50ºC), or 940,807hours (+70ºC) to demonstrate the reliability of our products. This represents an average failure rate of 280.265 (+25ºC), 486.211 (+50ºC) and 1,062.918 (+70ºC) failures per million unit hours of operations. The assumptions are full load at +25ºC, +50ºC and +70ºC case temperature under ground benign (GB) environment condition.

Warranty

Glary Power Technology warrants to the original purchaser or the end user that the products conform to this data sheet are free from material and workmanship defects for a period of two years since the date of manufacturing, when the product is used within specified condition and not opened.

Handling

Open frame converters can be damaged from poor handling, excessive mechanical shock, or from a static electric discharge. The units should be:

- Carefully handled and not subjected to mechanical stress
- Treated as an ESD sensitive component
- Stored in a static protective container which physically protects the converter
- The converters should not be stored in plastic bags, or stacked on top of one another in any way

Limitation of Liability

Glary Power Technology does not make any warranties, express or imply including any warranty of merchantability or fitness for a particular purpose (including, but not limited to use in life support applications, where malfunction of product can cause injury to a person's health or life).

General Module Thermal Considerations

General

The Glary DC/DC converter product series are designed to operate in a variety of thermal environments; however sufficient cooling should be helpful for reliable operation. General speaking, the heat is removed from module by conduction, convection and radiation to the surrounding but convection is the most important method for the normal application at sea level. Increased airflow may strongly influence the module thermal performance. Proper cooling can be verified by measuring the temperature of base plate.

The available load current with different ambient air temperature and airflow at nominal input voltage for each model is according to real test done in a wind tunnel. However the actual derating performance of each module may slightly vary compared with the derating curves given by test performed in the data sheet, the 90% of available current shown in the derating curves is the highest recommended value for reliable system design. The actual system design would in fact strongly affect the derating performance and generally result in three variable factors to affect the module derating performance described as below:

Conversion Efficiency

The heat is generated by power loss, board mount power module convert input power for output to the load always has an efficiency between 0%~100%. The synchronous rectification technology can make power module converting the required power with dramatic efficiency and dissipating fewer power compared with traditional technology. This leads to a lower temperature rise if the module thermal resistance is the same; it means higher efficiency is better for any kind of cooling conditions because the temperature is always lower and the reliability could also be better secured.

However, most data sheet shows high efficiency with full load condition and not with the real load condition for a practical system. It is better to select a power module that has highest efficiency with specified load condition. This almost leads to a solid answer that to choose a power module rated about 1.2~1.5 times of the required power would be reliable than a power module rated at double of the actual required power or even higher, because large derating always has poor efficiency and more temperature rise. Higher derating always reduces the operation life because the temperature factor has more negative effect on MTBF to further eliminate the positive effect due to the reduced electrical stress.

Roughly calculations of Glary COQ module by changing the temperature stress and electrical stress to have different results as below could be used as an example of reference of power module selection in system design stage. At 25ºC, a 10% increasing of module case temperature (Tc= 90ºC to Tc= 96.5ºC) will reduce the life to about 75% of its originally designed figure. However! Module derating from 100% to 75% will cause life improve by about 2%.

Efficiency change between different modules also has significant effect on the temperature rise to affect the derating performance. This effect can be seen more clearly especially in high temperature operation.

For example, a 200LFM/83ºC of airflow is used for cooling and the maximum case temperature of power module was set as 110ºC. A COQ48050N11M-10 module with 90.2% efficiency can have a 9.5A output current with 5.16W power loss. If the efficiency is 2% lower (88.2%) at 9.5A output, it may loss 6.35W of power and further ~~to~~ cause over temperature to Tc=114ºC or the maximum operable temperature should reduced to Ta=75ºC.

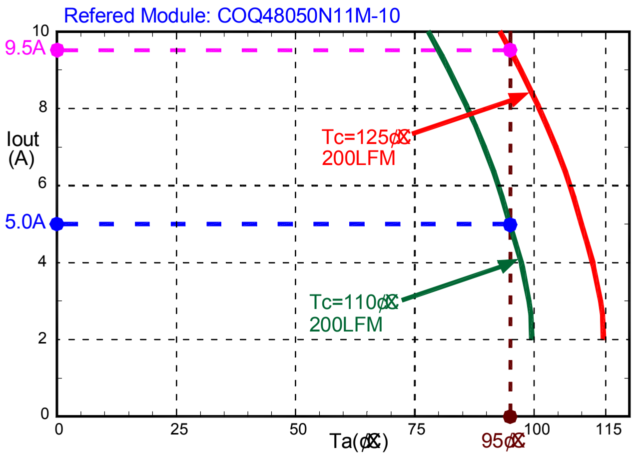
Module Temperature

Follow the result of conversion efficiency section; some power module makers provide derating curves by increasing the maximum board temperature and semiconductor junction temperature to 125ºC to have better derating performance. This method pushes converter operating at high temperature environment, which results in two effects on the thermal characteristics:

The first effect of increasing maximum allowable temperature is that it would increases the temperature rise between module and the air may cause more heat flow through module surface to air ~~if~~ assuming module thermal resistance is constant. Typically the thermal resistance of specified form factor is determined by the properties of air and the contacted surface area. The properties of air are fixed when the temperature and pressure ware specified. The only variable is the air contacted surface area of power module, but same form factor has almost same construction and the same contacted surface area due to no big difference on the components selection and its counts, so that the thermal resistance can be at the same level.

The second effect is to reduce thermal resistance by increasing nature convection due to increased temperature rise. It has about 8% improvement for thermal resistance with nature convection by changing the maximum allowable temperature from Tc=110ºC to Tc=125ºC.

Simple calculations of Glary COQ module by changing the maximum allowable temperature from Tc= 110ºC to Tc= 125ºC would demonstrate the improvement of derating performance. By operating a COQ48050N11M-10 module under conditions of Ta= 95ºC, Tc= 110ºC and Airflow=200LFM with 90.9% of conversion efficiency, it can deliver 5.0A output current with 2.50W power loss. If the allowable maximum temperature is Tc= 125ºC, the allowable power loss will go to 4.76W and the available current could be 9.5A. Plot-1 shows comparison of derating curves for reference.



Plot-1: Derating curves for Tc=110ºC and Tc=125ºC

However, even to increase the maximum allowable temperature from Tc= 110ºC to Tc= 125ºC would make dramatic improvement for derating performance. It pays too much for operation life, most of the circuit components used in modern power modules may reduced its life significantly due to operation under Tc= 125ºC condition and the total effect is to reduce module life about 50%. Generally derating rule request 38ºC derating for power semiconductor junction temperature and 15ºC derating for Tg= 130ºC rated PCB that means the maximum operation temperature is 112ºC. All Glary products are limited under 110ºC for safe operation and longer life. Set the case temperature of Glary module below 90ºC during operation would be better for high reliability system.

Module Thermal Resistance

Follow the result of module temperature section; the maximum allowable temperature for operation is limited under Tc= 110ºC. Glary provide Sink-Plate technology for almost all Glary modules to reduce the module thermal resistance, and further improve thermal performance such as the derating performance and temperature deviation among the components. By choosing the Sink-Plate, the derating performance was improved dramatically and no any compromise for the reliability and operation life because it can be used as integrated heat sink to reduce module thermal resistance when no additional cooling assemblies were attached to the module.

In general Glary modules were design for board mount application but the Sink-Plate has at least 2pcs of M3 screws to allow module to be attached to the casing, or with its heat sink to extent its thermal performance to meet the requirements of high temperature operated system. The Sink-Plate is able to reduce the deflection that it has special geometry to hold flowed gap filler due mounting force during screw mounting process and improve the thermal contact to has unified temperature map to improve the reliability again.

The simple calculations for COQ with different type of base plate are described as below, which may reflected to all Glary products and give better understanding about thermal performance and derating for specified application conditions:

For the 1.0mm metal plate:

The module thermal resistance θ_M of COQ with 1.0mm metal plate is similar to traditional power module can be listed as below:

θ_M = 11.29 (Free-Air), 7.36 (100LFM), 5.65(200LFM)
4.20 (300LFM), 3.47 (400LFM), 3.03 (500LFM)

The thermal resistance data and efficiency plot in the data sheet can be applied to the equation below to determine the available power with specified operation ambient temperature.

P_O= (110-Ta)/ (θ_M)(1/η-1)

For example: 200LFM at Ta= 80ºC for COQ with 1.0mm metal plate. The available power is P_O= (110-80)/ (5.65)(1/0.9-1)= 47.6W, or equal to 5.0V/9.5A output also can be seen in the derating plot in the data sheet directly.

For the3.0mm Sink-Plate:

The module thermal resistance θ_{S3} of COQ with 3.0mm Sink-Plate is about 30% lower compared to 1.0mm metal plate COQ module, which is listed as below:

Θ_{S3} =
9.13 (Free-Air), 5.95 (100LFM), 4.49 (200LFM)
3.40 (300LFM), 2.81 (400LFM), 2.45 (500LFM)

The thermal resistance data and efficiency plot in the data sheet can be applied to the equation below to determine the available power with specified operation ambient temperature.

$P_O = (110\text{-}Ta)/(\theta_{S3})(1/\eta - 1)$

For example: 200LFM at Ta= 85ºC for COQ with 3.0mm metal plate. The available power is P_O= (110-85)/(4.49)(1/0.9-1)= 50.01W, or equal to 5.0V/10A output.

For the5.0mm Sink-Plate:

The module thermal resistance θ_{S5} of COQ with 5.0mm Sink-Plate is about 50% lower compared to 1.0mm metal plate COQ module were listed as below:

Θ_{S5} =

7.28 (Free-Air), 4.91 (100LFM), 3.17(200LFM)
2.44 (300LFM), 2.01 (400LFM), 1.83 (500LFM)

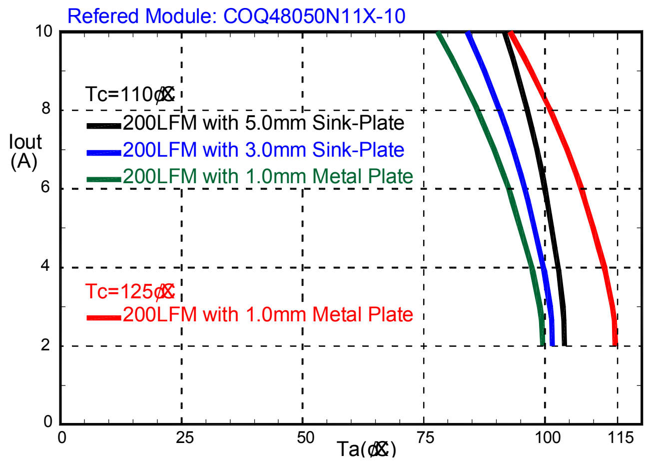
The thermal resistance data and efficiency plot in the data sheet can be applied to the equation below to determine the available power with specified operation ambient temperature.

$P_O = (110\text{-}Ta)/(\theta_{S5})(1/\eta - 1)$

For example: 200LFM at Ta= 92ºC for COQ with 5.0mm metal plate. The available power is P_O= (110-93)/(3.17)(1/0.9-1)= 48.26W, or equal to 5.0V/9.6A output.

Comparison

Simple comparison between module with 1.0mm metal plat, 3.0mm Sink-Plate, 5.0mm Sink-Plate and change setting for Tc= 125ºC can be made by using COQ module shown as Plot-2.



Plot-2: Comparison for Tc=110ºC and Tc=125ºC

The result shows the improvement of derating performance was achieved and very closed to the result of Tc= 125ºC by using 5.0mm Sink-Plate with no increase on the maximum allowable temperature. The 3.0mm Sink-Plate also have significant improvement for high load condition. The Sink-Plate technology has no significant improvement for the light load condition that it is limited by the fixed no load power consumption.

Conclusion

The high conversion efficiency characteristic is the basic requirement for the modern power module to achieve lowest power loss. However, the latest application is requesting for more power again with smaller package, which may cause higher module temperature. This technical challenge can be solved by two methods. One is to upper the thermal limit for safe operation, which would offer the best effect to extract the available current but pay much for safe operation life.

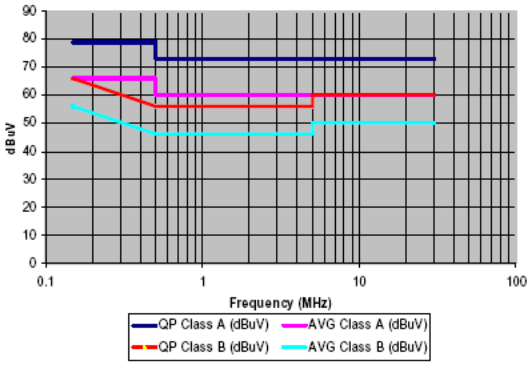
Another method is to reduce the module thermal resistance by adding more air contacted surface area, which would request low profile converter design with single board single component side mounting technology. It is able to cool down the module and deliver more power with no impact on the reliability and safe operation life.

Module Noise Considerations

Input Side Conducted Noise

Conductive EMC Regulations

In order to achieve a useful EMC filter circuit design, the limits of conducted emissions EN55011/FCC derived from CISPR22 was shown as below and must be well understood.



The class A and class B requirements referring to the industrial standard and the domestic standard depend on the antenna used for detecting the noise. The European standards give a higher limit for quasi-peak antenna and the lower limit for average antenna, and both limits must be met for the equipment to pass. The FCC standards used in North America have similar specifications.

Common Mode Noise

Common mode noise is one major noise source of a power module; it comes from a common-mode current that caused by fast voltage change on switching devices and coupled through capacitances between switching device and other components. The common-mode energy travels on all the lines or wires in the same direction at the same time and results in any device between the lines to perform no attenuation. However, a common mode choke or a ground choke may provide impedance between lines and ground to reduce common current. To connect capacitors between lines and ground properly would also be helpful to reduce the noise.

Differential Mode Noise

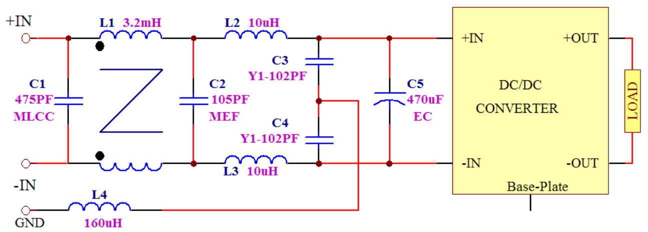
Differential-mode noise is the AC-component of input current that is caused by pulsating switching current in power stage of power module. This produces a noise voltage between the positive and negative input power terminal, which is opposite in direction or phase with respect to each other. Generally, all Glary converters have an internal π filter to differential-mode conducted noise. However, an external capacitor should be placed between input lines to reduce the noise level again to meet EMC requirement. The capacitor should be placed close to the module to minimize the loop cross-sectional area and further reduce possible emission due to high frequency ripple current. To twist the input leads or layout a PCB power planes would also be helpful for noise cancellation and to eliminate second order coupling from near field magnetic flux radiation.

Bandwidth of EMC Components

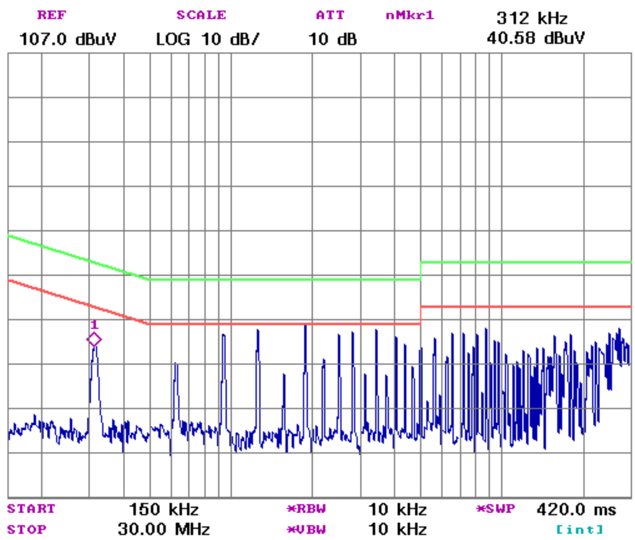
No components are ideal for all frequency ranges. Capacitor may loss its capacitive property when the lead inductance dominates its impedance and inductor will becomes a capacitive element when parasitic capacitance becomes important at high frequency. The Bandwidth of EMC Components should be taking into consideration when designing an EMC filter circuit. To connect ceramic capacitor with electricity capacitor in parallel and connect low inductance inductor with big one could get a better bandwidth.

Referenced EMC Circuit

The referenced EMC circuit was made by verifying a 600W UH48120P20M-S50 power module that is shown as below for a reference to design a useful EMC filter fit into system. It should be noted that the circuit values might need to be modified to meet different requirements of each application.



The tested curve is show as below to demonstrate the performance of the referenced EMC filter circuit with UH48120P20M-S50 module.

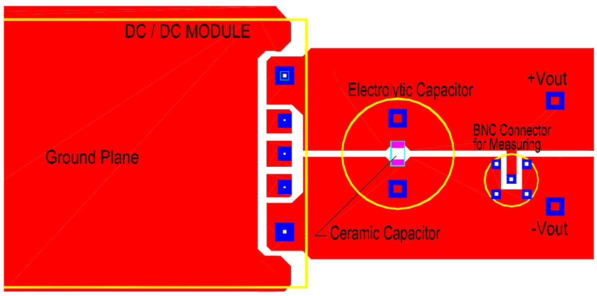


Radiated Noise

The magnetic field radiation and electric field radiation were called "near-field" radiation that decays quickly as a function of distance not usually affects the radiated measurements. However, electromagnetic radiation caused by high frequency current flow through circuit element or traces can be radiated to far distance, it can be minimized by proper board layout to keep all leads with AC current short circuit, twisted or run as ground planes to minimize loop cross-sectional area would be greatly helpful. Glary has six-side metal package option for several product series and could provide extra RFI shielding performance for critical application. It should be noted that in many cases if the device fails in the common mode current test, it will also fail in the radiated-emission test since the lines would carry common mode noise and perform as an antenna to emit radiated noise.

Output Side Ripple/Noise

The output ripple/noise performance can be improved by adding more low-ESR external capacitors closed to output terminals. The reference trace layout that should provide corrective measuring capability and improve output ripple/noise performance is show as below.



General Application Information

Storage/Handling

Module Storage

It is user's liability to avoid module being overexposure to moisture during storage; board mount assembly and board rework. A below 30˚C temperature 85%RH storage condition is acceptable for on production line 24 hours storage maximum to avoid possible risk from wave soldering process.

The solder terminal plating material of Glary module is gold metal, which can meet MSL1 level requirement for long-term storage. However, the module must go through a de-moisture process by being placed into a chamber of 85˚C for 12 hours before use, to prevent the module from risk of explosion caused by heated moisture during soldering process. The recommended module storage condition is 30˚C-60%RH.

Module Handling

The user must take responsibility during storage, board mount assembly and board rework to avoid module over stress due to drop, impact or any kind of tools touch to its surface and components. The user should also prevent the module from the damage of electrostatic discharge. Except for activities following the application notes herein stated, any extra direct work without consulting and/or consensus with Glary, including but not limit to cutting pins, adding or removing potting compound or glues or enclosures, unauthorized electrical and/or mechanical analysis, would result in waiver of Glary's service and warranty liabilities whatsoever.

Soldering

Hand Soldering

Hand soldering is the preferred method for Glary module due to the variability of the amount of solder applied, the time the soldering iron is held on the joint, the temperature of the iron, and the temperature of the solder joint. A temperature-controlled 70W solder iron with 0.125" tip and 425˚C setting is suitable for terminal soldering work. The soldering time is 3S~6S for 0.04" terminal pin diameter, 5S~10S for 0.06" terminal pin diameter and 8S~16S for 0.08" terminal pin diameter.

These guidelines above may require modification to optimize the soldering time for your particular circuit board or soldering iron. The exact soldering time and temperature for your specific application can be determined by mounting a thermocouple to the power module terminal using high-temperature solder. The minimum soldering time is defined as the time required for the terminal to reach 125°C. The maximum soldering time is the time required for the terminal to reach 165°C. The power module's internal temperature must stay below the storage temperature of 183°C or at least less than the critical continuous temperature of 183°C.

Wave Soldering

Glary understands that wave soldering is the most popular soldering method for the solder attachment of through-hole component leads for mass volume productions. Glary power modules are designed to be compatible with single-wave, dual-wave or turbid-wave soldering machines. The suggested soldering process is to keep the power module's internal temperature below 183°C. The typical recommended preheat temperature range is between 90°C and 105°C on the module-side of the circuit board. The pin-side of circuit board preheat temperature is recommended to be greater than 120°C, and preferable within 100°C of the solder-wave temperature, a maximum preheat rate of 4°C/s of the solder-wave temperature, a maximum preheat rate of 4°C/s is suggested. The maximum recommended solder pot temperature is 250°C with a typical solder-wave dwell time of 3 seconds or up to 6 seconds maximum.

Cleaning/Drying

Cleaning

Post solder cleaning is usually the final process of circuit board assembly prior to electrical-board testing. The result of inadequate circuit board cleaning can affect both the reliability of a power module and the testability of the finished circuit-board assembly. Glary power modules are compatible with most cleaning processes but the cleaning materials should be chosen to be compatible with plastic parts or potted material inside the module. Incompatible cleaning material may cause malfunction or reduce its long-term operation reliability.

Drying

The drying process should be equipped with blowers capable of generating 1000CFM of air or above so that the amount of rinse water left to be dried off with heat is minimal. Handheld air guns are not recommended due to the variability and non-consistency of the operation. For open-frame power module constructions with magnetic structures (transformers and inductors) that have un-potted windings or cavities, a heating process of 100°C-0.5 hours inside the chamber is recommended for the assembly to ensure that the moisture and other potential foreign contaminants are driven out from the open windings and cavities to ensure that no residues would affect long-term reliability and isolation voltage.

Pad Layout

The pad layout of Glary power module depends on its current rating. The low current model just requires a simple through hole to carry load current. However, the large current models would introduce high I^2R loss at the solder point, which may cause over heating effect and further reduce the reliability. The pad layout for high current terminal pins becomes the most important consideration of the circuit board design.

Through Hole Size

For the 0.04" (1.0mm) terminal pins:

Use the 0.05" 1.25mm) diameter plated through hole with minimum 0.08" (2.0mm) diameter solder pad for all modules layout.

For the 0.06" (1.5mm) terminal pins:

Use the 0.075" (1.80mm) diameter plated through hole with minimum 0.12" (3.0mm) diameter solder pad for the low current circuit board layout. Based on the layout described above, it is necessary to have 4pcs~8pcs 0.5mm diameter of current distribution via to surround each through hole for reducing the current density and I^2R loss while the current is high. The optional double pin layout will be necessary when ultra high current module was used.

For the 0.08" (2.0mm) terminal pins:

Low Current Module: use the 0.10" (2.54mm) diameter plated through hole with minimum 0.16" (4.0mm) diameter solder pad for the circuit board layout.

High Current Module: use the 0.10" (2.54mm) diameter plated through hole with minimum 0.16" (4.0mm) diameter solder pad for the circuit board layout. It is necessary to have 5pcs~10pcs 0.5mm diameter of current distribution via to surround each through hole to reduce the current density and I^2R loss. The optional double pin layout will be necessary when ultra high current module was used.