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ATQ150 SERIES

9-75VDC INPUT / 150W OUTPUT

8:1 ISOLATED DC-DC CONVERTER



"Achieve Total Assurance and Quality in Power."

EFFICIENT - INNOVATIVE - VERSATILE

The ATQ150 Series provides a high-performance solution for demanding power conversion applications. With its 150-Watt output power, 9 - 75VDC input voltage and 8:1 input voltage range, this isolated DC-DC converter ensures reliable operation and high efficiency. It is engineered for robustness supports a wide operating temperature range and complies with industrial standards.

- I. Compliant with MIL-STD-1275^(*) with external components
- II. Compliant with MIL-STD-704^(*) with external components

NOTE:

* Suitable for COTS use. If the product is intended to be used with a military system, it must be tested in the internal structure of a system subject to military tests. ATAQ does not guarantee the use of this product in military and medical products.

FEATURES TABLE

| Feature | Specification | Details |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ultra-Wide Input Voltage: Efficiency: Switching Frequency: Output Regulation: Remote On/Off: Protection: Isolation Voltage: Operating Case Temperature: Package Size: Safety Approval: | 9 – 75 VDC Up to 90% Fixed, 200kHz Regulated Outputs Yes Fully (OTP/OCP/OVP/UVLO) 1500Vdc I/O Isolation -40°C to +100°C Half Brick Size UL60950-1 2nd Edition | - Over-Temperature, Over-Current, Short-Circuit, Over-Voltage, Under-Voltage Lockout protection. - Turned off by the ON/OFF input. - Output voltage trim range of $\pm 10\%$. - Remote sense for the output voltage. - 2.40" L x 2.28" W x 0.50" H (61.0mm L x 57.9mm W x 12.7mm H) - Complies with safety standards for reliable operation. |

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| MODEL NUMBER | INPUT VOLTAGE | OUTPUT VOLTAGE | OUTPUT CURRENT | | INPUT CURRENT | | % EFF. | CAPACITOR LOAD MAX. |
|----------------|---------------|----------------|----------------|--------|---------------|----------|-----------------------------|-----------------------------|
| | | | MIN. | MAX. | NO LOAD | FULLLOAD | Nominal Input Voltage 36VDC | |
| ATQ150-WH36S24 | 9-75 VDC | 24 VDC | 0 mA | 6.25 A | 60 mA | 4.66 A | 89.1 ⁽¹⁾ | 2000 μ F ⁽²⁾ |

NOTE:

1. The output terminal of 24Vout models required a minimum capacitor 100 μ F to maintain specified regulation
2. The input external capacitor recommends to parallel with 330 μ F ESR<0.5 Ω to reduce the input ripple voltage

PART NUMBER

| Series | Input Voltage Range | Dimension | Nominal Input Voltage | Number of Outputs | | Nominal Output Voltage | Remote On/Off Logic | |
|---------|-------------------------------------------------|--------------------------|-----------------------|-------------------|----------------------|------------------------|---------------------|--------|
| ATQ150- | X | X | XX | X | | XX | X | |
| | W Wide Input Voltage Range (9-75 VDC) | H (Half Brick) | 36 (36 VDC) | Single Double | S D | 24 (24 VDC) | High Low | - L |

TECHNICAL SPECIFICATIONS

(All specifications are typical at nominal input, full load at 25°C unless otherwise noted.)

ABSOLUTE MAXIMUM RATINGS:

| PARAMETER | NOTES and CONDITIONS | Device | Min. | Typ. | Max. | Units |
|----------------------------|----------------------------------|--------|------|------|------|-------|
| Input Voltage | Continuous | 24Vo | -0.3 | | 75 | Vdc |
| Input Surge Voltage | 100ms max. | 24Vo | | | 100 | Vdc |
| Input Surge Voltage | 100ms max. | 24Vo | | | 80 | Vdc |
| Operating Case Temperature | At the Center Part of Base Plate | 24Vo | -40 | | 100 | °C |
| Storage Temperature | | 24Vo | -55 | | 105 | °C |

INPUT CHARACTERISTICS:

| PARAMETER | NOTES and CONDITIONS | Device | Min. | Typ. | Max. | Units |
|----------------------------------------------|--------------------------------------------------|--------|------------------------------|------|-----------|---------|
| Operating Input Voltage | | 24Vo | 9 | 36 | 75 | Vdc |
| Input Under Voltage Lockout | | | | | | |
| Turn-On Voltage Threshold | | 24Vo | 8.5 | 9.0 | 9.5 | Vdc |
| Turn-Off Voltage Threshold | | 24Vo | 7.5 | 8.0 | 8.5 | Vdc |
| ON/OFF control, positive remote ON/OFF logic | Logic low (Module OFF) Logic high (Module ON) | 24Vo | 0 3.5V or open circuit | | 1.2 75 | Vdc |
| Lockout Hysteresis Voltage | | 24Vo | 1 | | | Vdc |
| Maximum Input Current | V _{in} =9V, Full Load. | 24Vo | 20 | | | A |
| No-Load Input Current | V _{in} =36V, I _o =0A | | 20 | | | mA |
| Input Filter | LC filter | 24Vo | | | | |
| Recommended Input Fuse | Fast acting type | 24Vo | 30 | | | A |
| Input Capacitance (External) | < 0.5 Ω ESR | 24Vo | 330 | | | μ F |
| Switching frequency | | 24Vo | 200 | | | kHz |

OUTPUT CHARACTERISTICS:

| PARAMETER | NOTES and CONDITIONS | Device | Min. | Typ. | Max. | Units |
|----------------------------------------------------------|-----------------------------------------------------------|--------|---------------------------|------|-----------|---------|
| Voltage Set Point Accuracy | $V_{in}=36V$, Full Load, $T_c=25^{\circ}C$ | 24Vo | -1.0 | | +1.0 | % |
| Output Voltage Regulation | | | | | | |
| Load Regulation | Full Load to No Load | 24Vo | | | ± 0.2 | % |
| Line Regulation | V_{in} =High Line to Low Line, Full Load | 24Vo | | | ± 0.2 | % |
| Output Voltage Ripple and Noise (5Hz to 20MHz bandwidth) | | | | | | |
| Peak-to-Peak | Full load, 10uF tantalum and 1.0uF ceramic capacitors | 24Vo | | | 280 | mV |
| RMS | | 24Vo | | | 100 | mV |
| Output Current Range | $V_{in}= 9$ to 75V | | 0 – 6.25 | | | A |
| Over Current Protection | <90% V_o | 24Vo | 105 | 160 | 200 | % |
| Short Circuit Protection | Hiccup Mode / Auto Recovery | 24Vo | Continuous, Auto Recovery | | | |
| External Load Capacitance | Full load (Constant resistive load) | | 2000 | | | μF |
| Output Voltage Trim Range | $P_o \leq \text{max rated power}$, $I_o \leq I_{o_max}$ | 24Vo | -10 | | +10 | % |
| Start-up time | | 24Vo | 110 | | | ms |

EFFICIENCY:

| PARAMETER | NOTES and CONDITIONS | Device | Min. | Typ. | Max. | Units |
|-----------|----------------------|--------|-----------|------|------|-------|
| 100% Load | $V_{in}=24V$ | | up to 90% | | | % |

GENERAL SPECIFICATIONS:

| PARAMETER | NOTES and CONDITIONS | Device | Min. | Typ. | Max. | Units |
|-----------------------|---------------------------------------------------------------------------------------------------------|--------|------|------|---------|---------|
| MTBF | $I_o=100\%$ of I_{o_max} ; MIL-HDBK-217F_Notice 1, GB, $25^{\circ}C$ | 24Vo | | 800 | | K hours |
| Weight | | 24Vo | | 109 | | Grams |
| Isolation resistance | 10^7 ohms, min. | | | | | |
| Isolation capacitance | 2500pF typ. (24VDC output) | | | | | |
| Isolation voltage | Input / Output : 1500VDC min. (1 minute) Input / Case : 1500VDC min. Output / Case : 1500VDC min. | | | | | |
| Case Material | Plastic, DAP, UL 94V-0 | | | | | |
| Dimensions | 57.9 x 61.0 x 12.7 mm | | | | | |
| Base plate Material | Aluminum | | | | | |
| Potting Material | UL 94V-0 | | | | | |
| Pin Material | Base: Copper Plating: Nickel with Matte Tin | | | | | |
| Shock/Vibration | MIL-STD-810F Compliant | | | | | |
| Humidity | 95% RH max. non-condensing | | | | | |
| Altitude | 2000m Operating Altitude, 12000m Transport Altitude | | | | | |
| Thermal Shock | MIL-STD-810F | | | | | |
| EMI | Meets EN55032 (with external filter) | | | | Class A | |

| STANDARDS COMPLIANCE | | | | | | |
|----------------------|------------------------------|-----|-----|------|------|--------|
| MIL-STD-1275D | | | | | | |
| No | Parameters | Min | Typ | Max | Unit | Status |
| 1 | 5.1.3.1 Steady-State Voltage | 25 | - | 30 | VDC | Passed |
| 2 | 5.1.3.2 Ripple | - | - | 2 | VDC | Passed |
| 3 | 5.1.3.3 Surges | 28 | - | 40 | VDC | Passed |
| 4 | 5.1.4.1 Steady-State Voltage | 23 | - | 33 | VDC | Passed |
| 5 | 5.1.4.2 Ripple | - | - | 7 | VDC | Passed |
| MIL-HDBK-704-8 | | | | | | |
| No | Parameters | Min | Typ | Max | Unit | Status |
| 1 | LDC101 | - | - | - | - | Passed |
| 2 | LDC102 | 16 | 28 | 40 | VDC | Passed |
| 3 | LDC105 | 28 | - | 100 | VDC | Passed |
| 4 | LDC201 | - | - | - | - | Passed |
| 5 | LDC301-704E | 20 | - | 31,5 | VDC | Passed |
| 6 | LDC302-704E | 22 | - | 50 | VDC | Passed |
| 7 | LDC401-704E | 18 | - | 29 | VDC | Passed |
| 8 | LDC501 | 12 | - | 29 | VDC | Passed |
| 9 | LDC601 | 0 | - | 28 | VDC | Passed |

Table-1: MIL-STD-1275 and MIL-STD-704 baseline test results applied with external components (TVS+EMC filters).

CHARACTERISTIC CURVE & GRAPHS

POWER DERATING CURVE:

Note: Figure 1 shows the results of thermal tests for different heatsinks.

Heatsink - 1 / VHS-95 (517-95AB) / , Heatsink - 2 / VHS-45 (528-45AB), Heatsink - 3 / M-C308

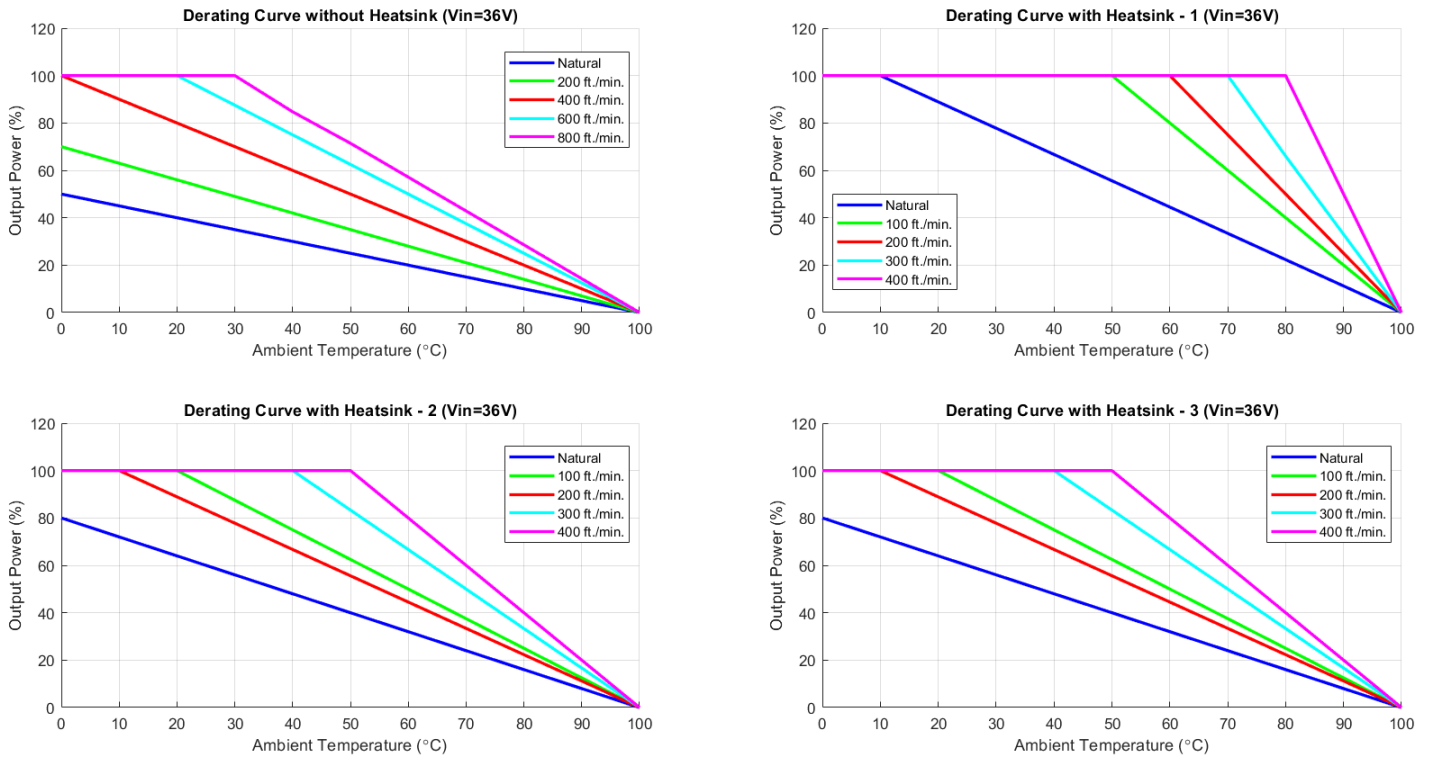


Figure-1

PERFORMANS INFO & DATA

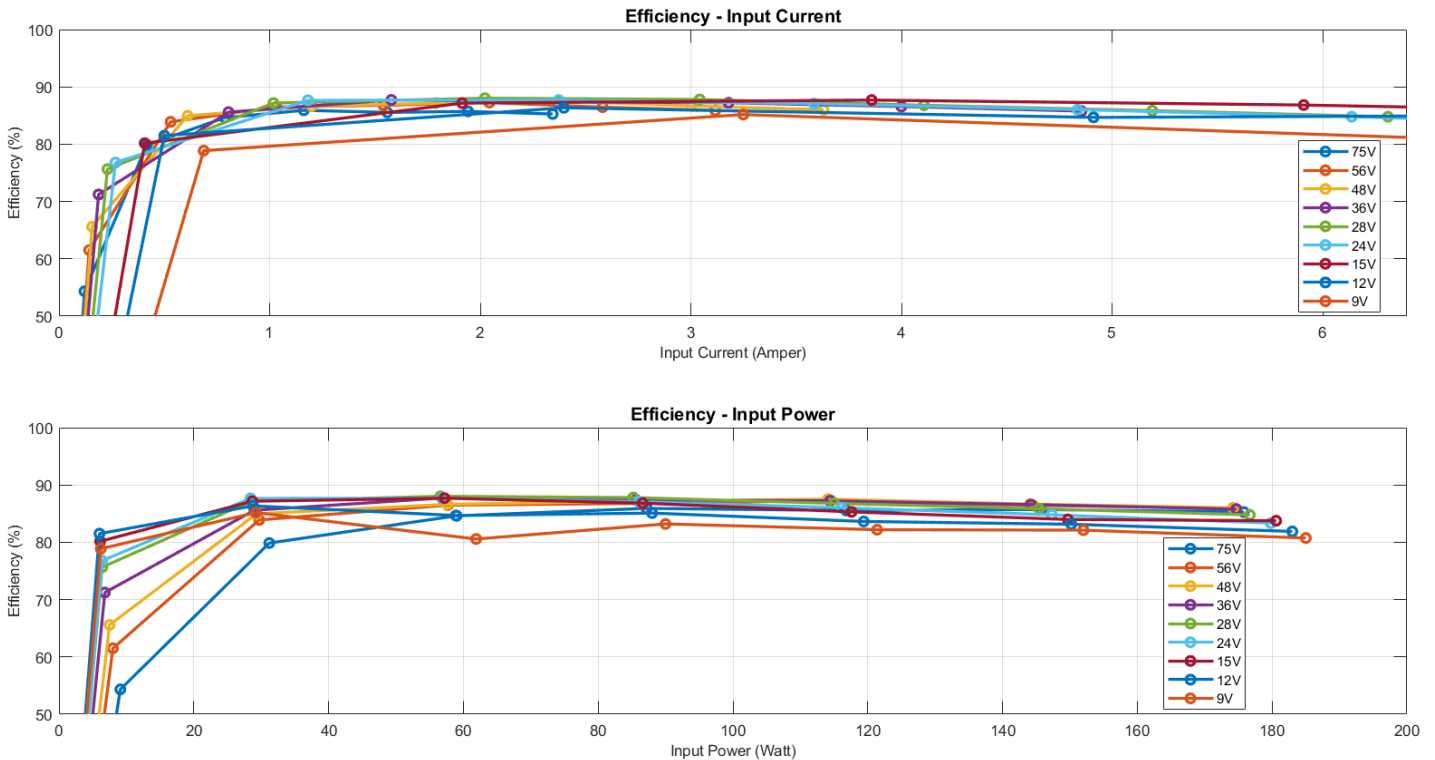


Figure-2

Note: The Efficiency-Output Power graph provides a clearer view of the relationship between output power and efficiency for each load value. (Figure-3 / Efficiency – Output Power Graph)

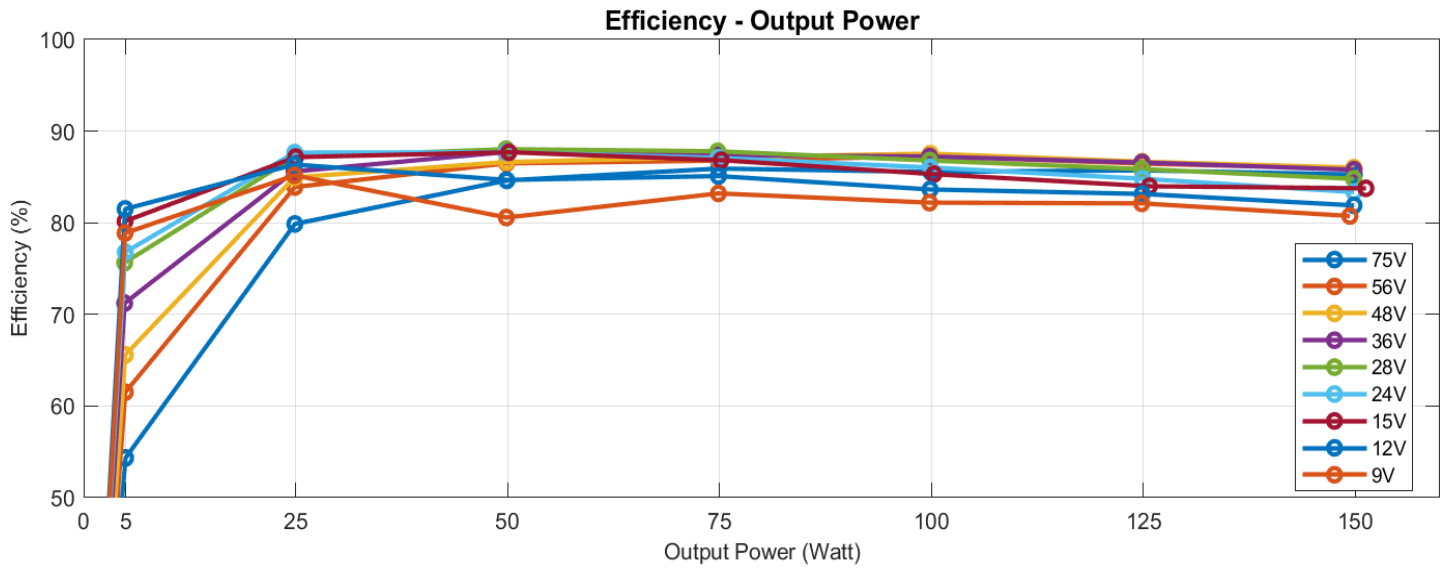


Figure-3

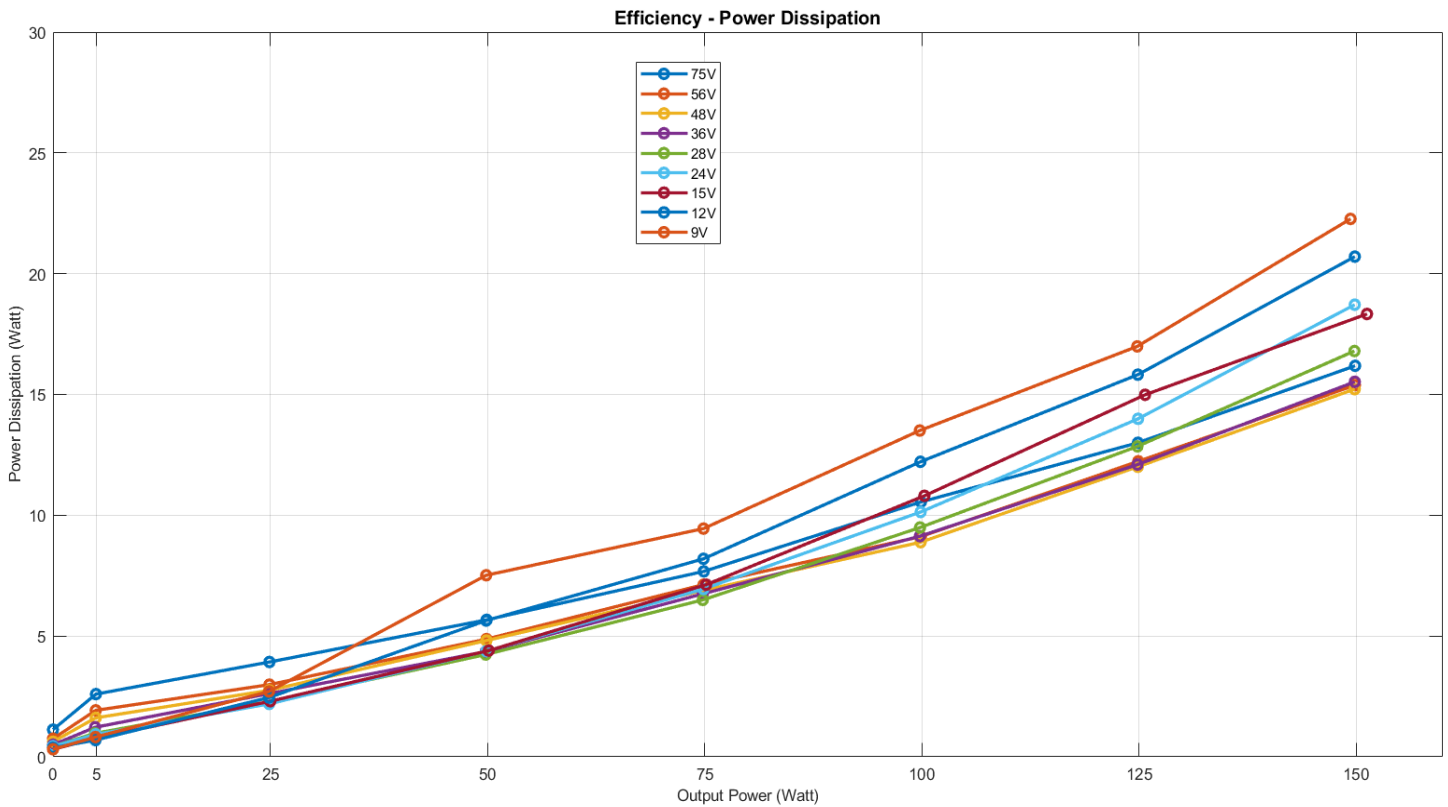


Figure-4

ELECTRICAL BLOCK DIAGRAM:

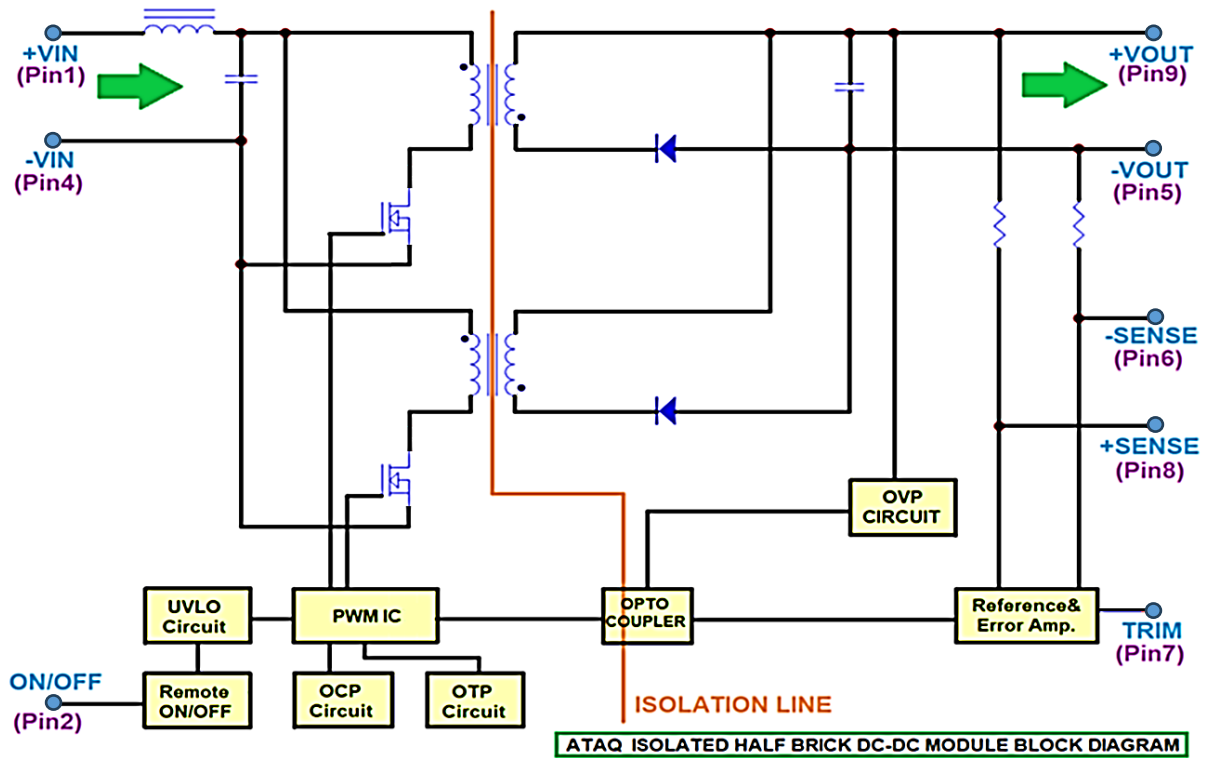


Figure-5

INPUT FILTERING AND EXTERNAL CAPACITANCE:

Figure 5 provides a diagram showing the internal input filter components. This filter dramatically reduces input terminal ripple current, which otherwise could exceed the rating of an external electrolytic input capacitor.

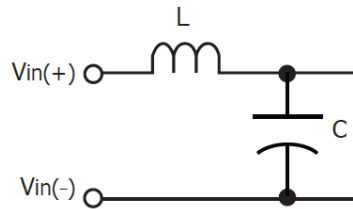


Figure-6: Internal Input Filter Diagram

OUTPUT CAPACITANCE:

For good transient response, low ESR output capacitors should be located close to the point of load. PCB design emphasizes low resistance and inductance tracks in consideration of high current applications.

Output capacitors with their associated ESR values have an impact on loop stability and bandwidth. The minimum output capacitance is 100uF which needs three or four-times capacitance when operating below -20°C and the absolute maximum value of ATQ150 series' output capacitance, please refer to maximum output capacitance.

REMOTE ON/OFF:

The ON/OFF input pin permits the user to turn the power module ON or OFF via a system signal. The remote ON/OFF is available. Positive logic turns the module on during a logic high voltage on the ON/OFF pin, and off during a logic low.

A properly de-bounced mechanical switch, open collector transistor, or FET can be used to drive the input of the ON/OFF pin. If not using the remote on/off feature: For positive logic, leave the ON/OFF pin open.

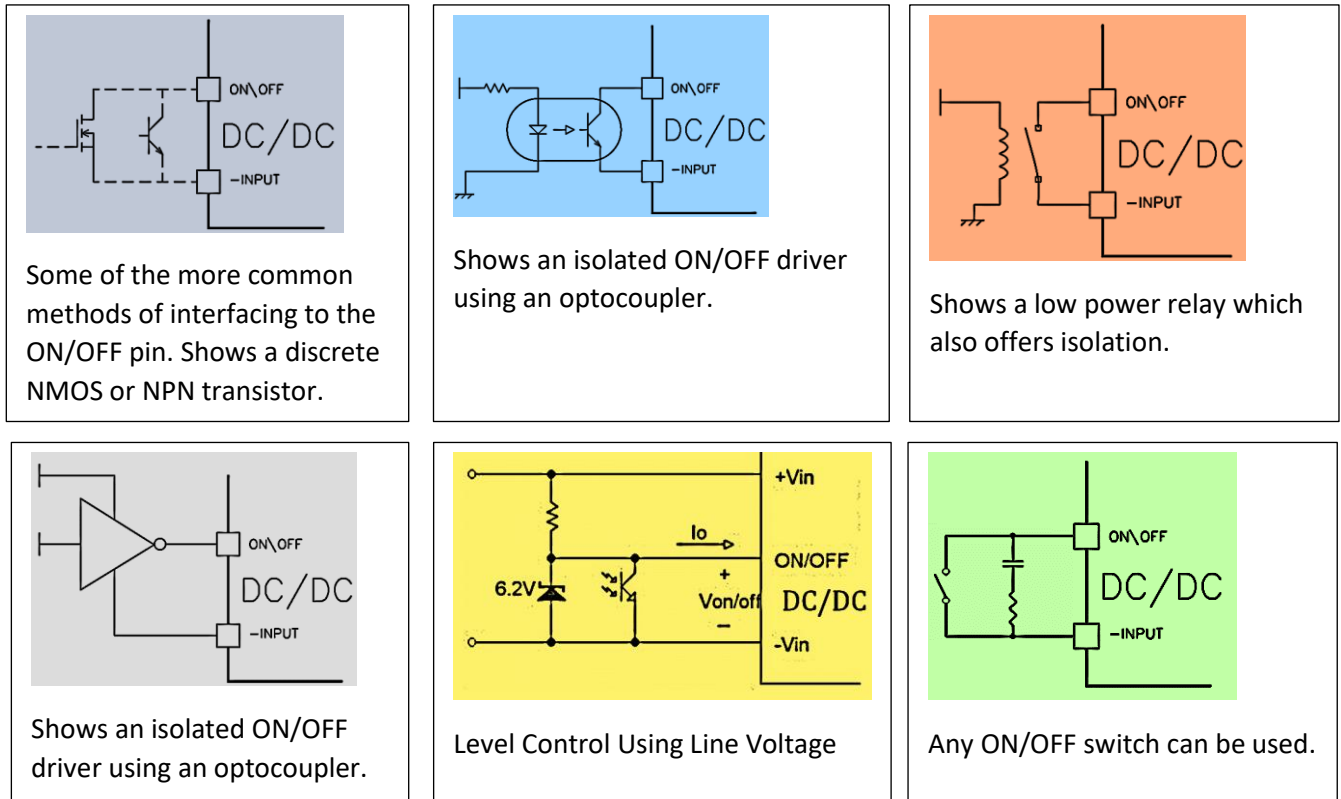


Figure-7: Remote ON/OFF

OUTPUT OVER VOLTAGE PROTECTION:

The converter is protected against output over voltage conditions. When the output voltage is higher than the specified range, the module enters a hiccup mode of operation. The operation is identical with over current protection.

OVER TEMPERATURE PROTECTION:

These modules have an over-temperature protection circuit to safeguard against thermal damage. When the case temperature rises above over temperature shutdown threshold, the converter will shut down to protect it from overheating. The module will automatically restart after it cools down.

OPERATING TEMPERATURE RANGE:

The ATQ150 series converters can be operated within a wide case temperature range of -40°C to 100°C. Consideration must be given to the de-rating curves when ascertaining the maximum power that can be drawn from the converter.

The maximum power drawn from half-brick models is influenced by usual factors, such as:

- Input voltage range
- Output load current
- Forced air or natural convection

OUTPUT VOLTAGE ADJUSTMENT:

The Trim input permits the user to adjust the output voltage up or down 10%. This is accomplished by connecting an external resistor between the Trim pin and either the Vo (+) pin or the Vo(-) pin (TRIM pin). Please see Figure.

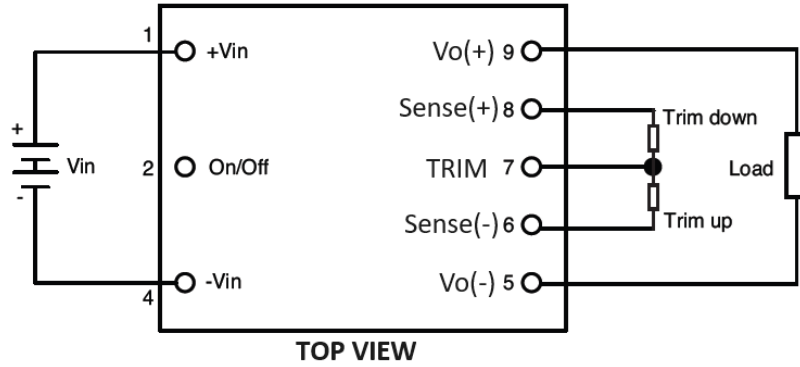


Figure-8

The Trim pin should be left open if trimming is not being used. Connecting an external resistor (Rtrim-down) between the Trim pin and the Vout(+) (or Sense(+)) pin decreases the output voltage.

The following equation determines the required external resistor value to obtain a down percentage output voltage change of $\Delta\%$.

Vout=24V:

$$R_{trim_down} = 20 * \frac{(V_{o,set} - \Delta\% * V_{o,set} - 2.5)}{\Delta\% * V_{o,set}} - 100K\Omega$$

Where

For example, to trim-down the output voltage of 24V module (ATQ150-WH36S24) by 5% to 22.8V, Rtrim-down is calculated as follow:

$\Delta\% = 5\%$

$$R_{trim_down} = 20 * \frac{(24 - 5\% * 24 - 2.5)}{5\% * 24} - 100K\Omega$$

$$R_{trim_down} = 238.33K\Omega$$

Connecting an external resistor (Rtrim-up) between the Trim pin and the Vout (-) (or Sense (-)) pin increases the output voltage. The following equations determine the required external resistor value to obtain an up percentage output voltage change of $\Delta\%$.

Vout=24V:

$$R_{trim_up} = 20 * \frac{(2.5 - \frac{0.46 * 100}{100 + 5.6})}{\Delta\% * V_{o,set}} - \frac{5.6 * 100}{100 + 5.6} K\Omega$$

Where

$$V_{out} = V_{o,set}, \Delta\% = \left(\frac{V_{desired} - V_{o,set}}{V_{o,set}} \right) \times 100$$

For example, to trim-up the output voltage of 24V module (ATQ150-WH36S24) by 5% to 25.2V, Rtrim-up is calculated as follow:

$$\Delta \% = 5\%$$

$$R_{trim_up} = 20 * \frac{(2.5 - \frac{0.46 * 100}{100 + 4.3})}{5\% * 24} - \frac{5.6 * 100}{100 + 5.6} K\Omega$$

$$R_{trim_up} = 29.013 K\Omega$$

Note:

Although the output voltage can be increased by both the remote sense and by the trim, the maximum increase for the output voltage is not the sum of both.

The maximum increase is the larger of either the remote sense or the trim. The amount of power delivered by the module is defined as the voltage at the output terminals multiplied by the output current.

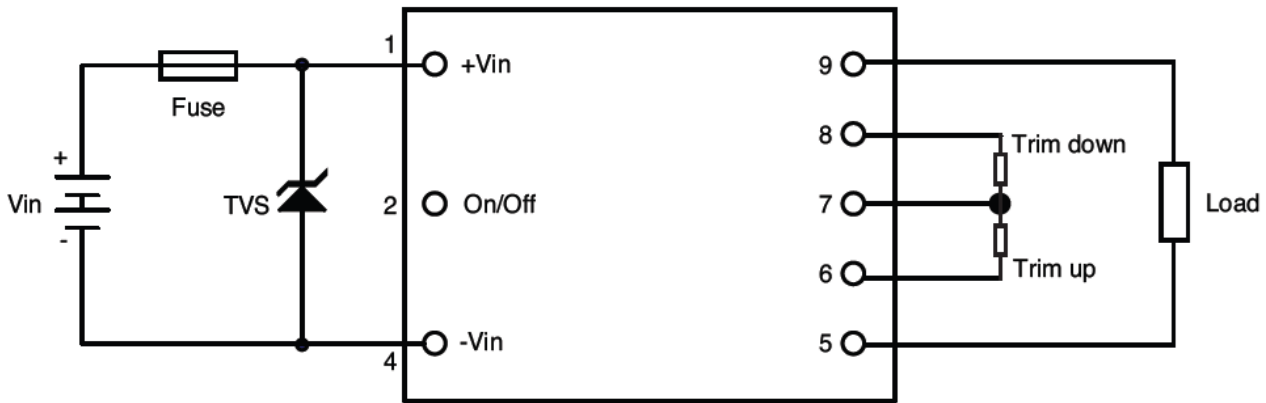
When using remote sense and trim, the output voltage of the module can be increased and consequently increase the power output of the module if output current remains unchanged.

Care should be taken to ensure that the maximum output power of the module remains at or below the maximum rated power (Maximum rated power = $V_{o,set} \times I_{o,max}$)

The output voltage on 24V models is adjustable within the range of +10% to -10%.

Only one of the trim-up or trim-down resistors should be used to increase or decrease the output voltage.

INPUT FUSING AND SAFETY CONSIDERATIONS:



TOP VIEW

Figure-9

The ATQ150 series converters have no internal fuse. In order to achieve maximum safety and system protection, always use an input line fuse. We recommend a 30 A fast-acting fuse.

To avoid security identification issues, we recommend choosing products certified in both America and Europe. Most fuses are approved for use on the AC side. Choosing a fuse that is also approved for use on the DC side will be an advantage.

Fuses can be simply classified into two types: fast-acting and time-delayed. Generally, the fast-acting type can activate instantly when the current flowing into the system exceeds the fuse's current rating.

The time-delayed type can hold for a short period before failing. Normally, the selection standard depends on the inrush current of the DC-DC modular system.

The time-delayed type will be suitable for high inrush current systems, and the fast-acting type is used for low inrush current systems.

In a DC-DC modular system, the operating voltage must always be below the fuse's maximum voltage rating. This is important because the fuse is not sensitive to voltage variations.

In addition to peak current protection for a DC-DC modular system, transient high voltage, such as sudden surges or fluctuations, also damages components in the modular power system. TVS (Transient Voltage Suppressor) diodes are commonly used at the front end to protect the entire power system.

It is recommended that the circuit has a transient voltage suppressor diode (TVS) across the input terminals to protect the unit against surge or spike voltages and input reverse voltage (as shown). A suitable part would be SMCJ78A.

COMMERCIAL CONDUCTED EMISSIONS:

EMI Test standard : EN55032 Class A and Class B Conducted Emission

Test Condition : Input Voltage: Nominal, Output Load: Full Load

Component Ranges : CX1, CX2 = 220uF / CY1, CY2 = 1-4.7nF / CM CHOKE=100-470uH /

DM INDUCTOR= 1-47uF (or Short)

EMI and conducted noise meet EN55032 Class A:

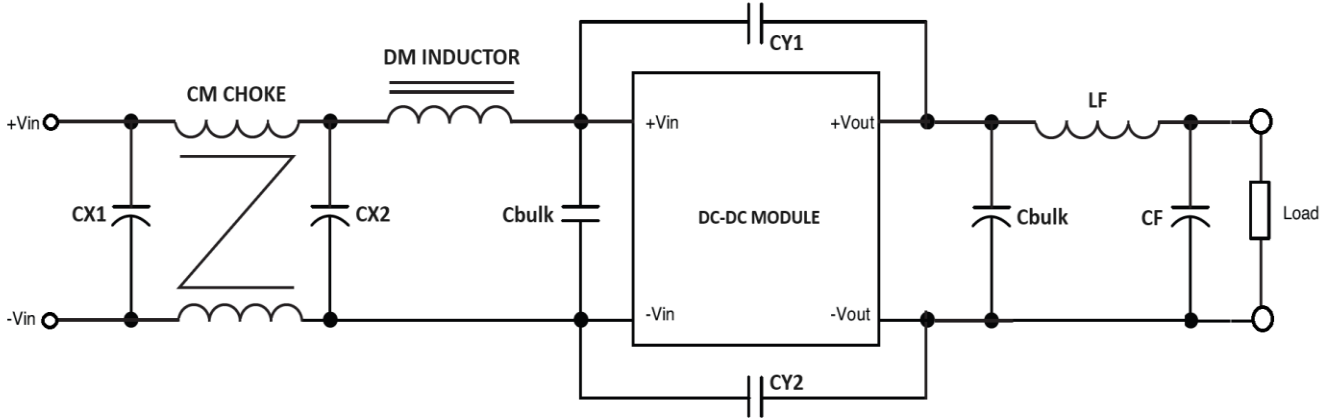


Figure-10

TEST SETUP:

For a typical electrical connection, please refer to the connection above. The basic test setup to measure parameters such as efficiency and load regulation is shown below. When testing the modules under any transient conditions please ensure that the transient response of the source is sufficient to power the equipment under test.

- Put input capacitor, CF1 more than 330uF for ATQ150 36Vin models. If the ambient temperature is less than -20°C, use twice the recommended capacitor above. If the impedance of the input line is high, the input capacitor must be more than above.
- Put output capacitors; CF2 and Cb2, according to minimum and maximum capacitor recommendations. If the ambient temperature is less than -20°C, use at least 3 pieces of the recommended minimum capacitors.
- Use an external fuse for each unit.
- Cb capacitors can be taken as 100nF bypass capacitors.

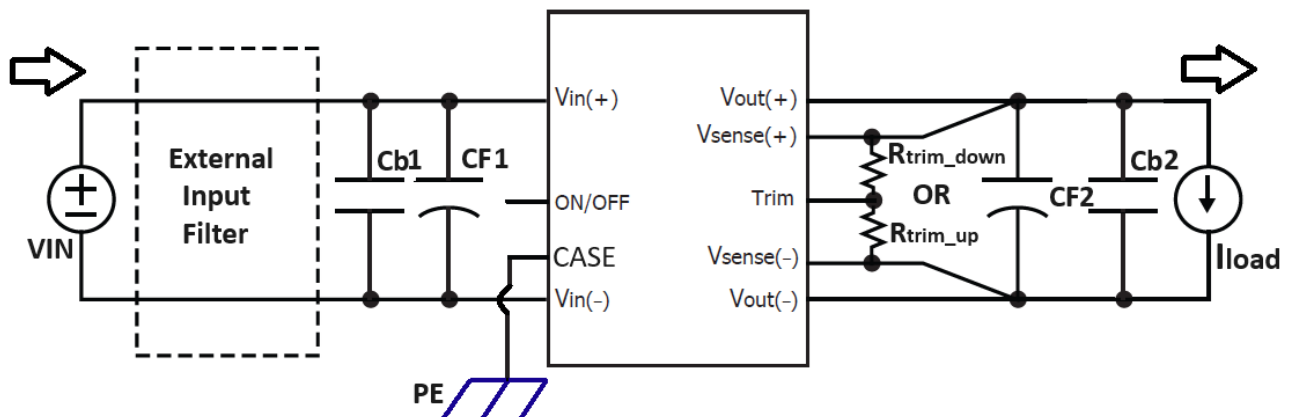


Figure-11: Typical electrical connection (Positive logic)

EFFICIENCY TEST SETUP:

The basic test set-up to measure parameters such as efficiency and load regulation is shown above. When testing the modules under any transient conditions please ensure that the transient response of the source is sufficient to power the equipment under test.

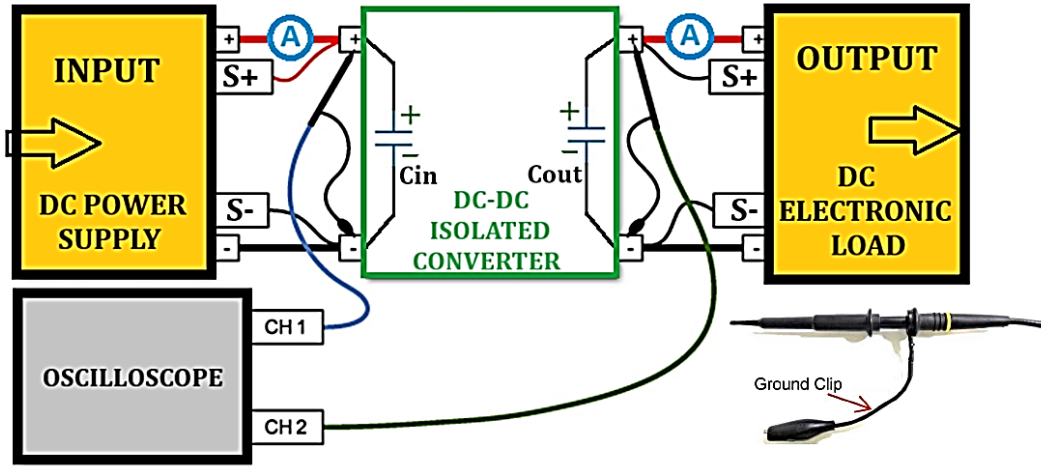


Figure-12a

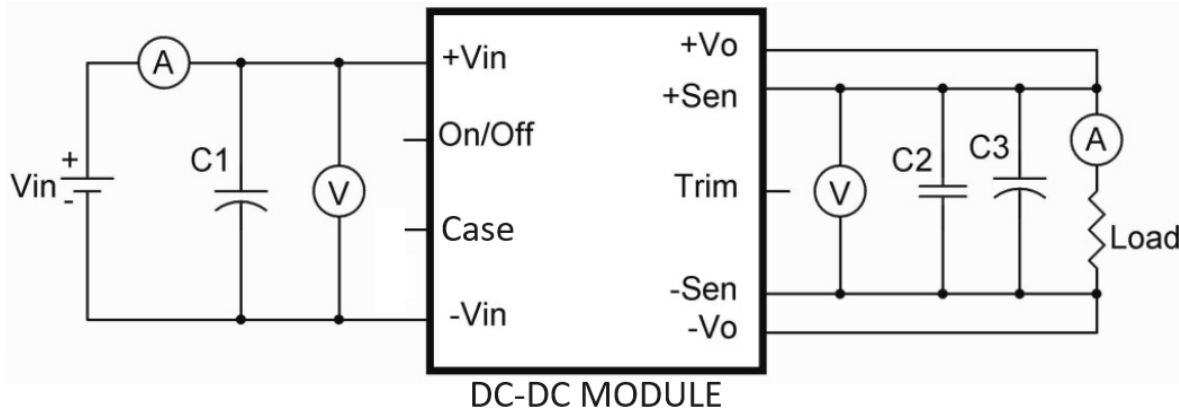


Figure-12b

All measurements are taken at the module terminals.

The value of efficiency is defined as:

$$\eta = \frac{V_o \times I_o}{V_{in} \times I_{in}} \times 100\%$$

Where:

- V_o is output voltage
- I_o is output current
- V_{in} is input voltage
- I_{in} is input current.

OUTPUT RIPPLE AND NOISE:

Output ripple and noise are measured with 10uF solid tantalum capacitors and 1.0uF ceramic across the output.

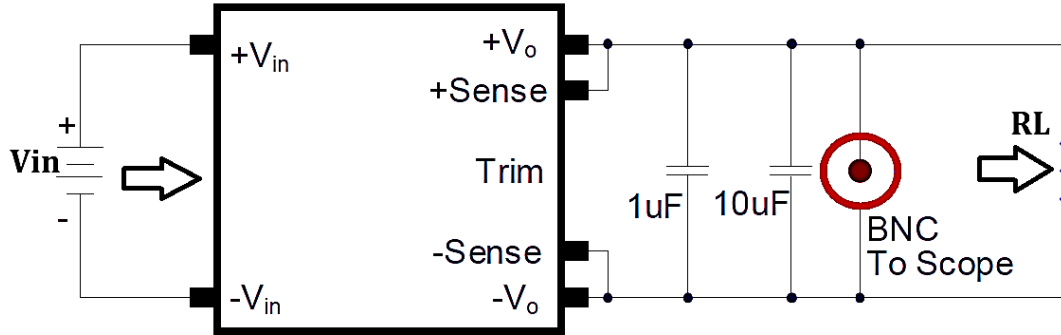


Figure-13

POWER MODULE PARALLEL CONNECTION:

Since each power module has a tolerance, if they are directly connected in parallel without taking measures that evenly distribute the current for the power modules, It will cause the output load unbalanced, as shown in Figure-14a.

The power converter with higher output current will bear greater stress, and long-term used will reduce the life of the power module. Or the current limit is triggered by one power module, and then the protection makes the output function invalid.

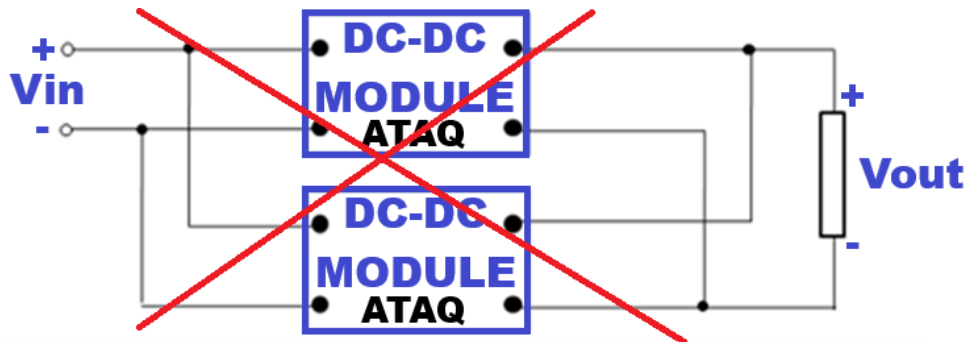


Figure-14a

The voltage droop method is connecting an external resistor at the output of the power converter to let the output voltage reduce, as the load current increases. This method has no signal connection between the power converters and is not affected by each other. It is an open loop current sharing method.

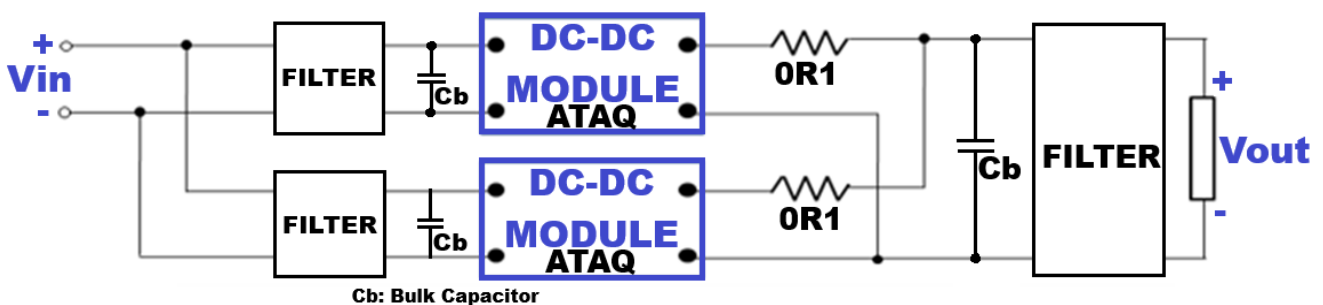


Figure-14b

POWER MODULE N+1 PARALLEL CONNECTION:

If the converters are used in parallel, it is recommended to connect ORing diode in series.

The current limit of ORing diode should be higher than the converter's output current. This kind of application is only suitable for spare function. It is not suitable to operate both converters at full load.

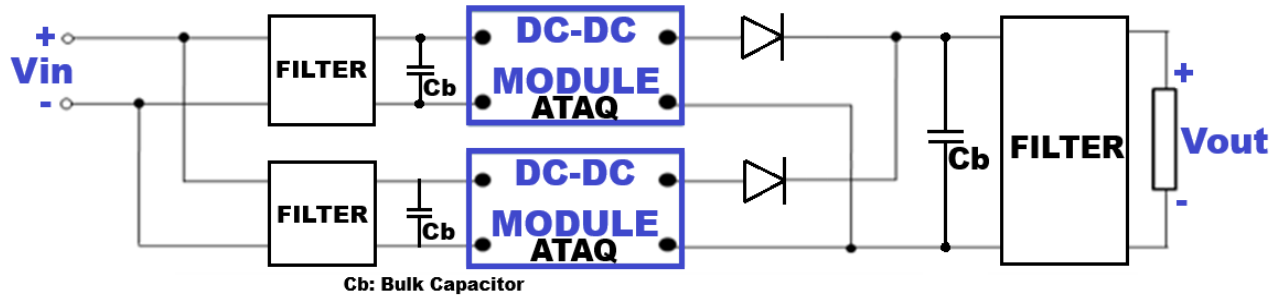


Figure-14c

POWER MODULE SERIAL CONNECTION:

When two isolated DC-DC converters are connected in series to generate a higher Vout, reverse-connected high-current fast clamp diodes (preferably Schottky or ultrafast types) are used at the series junction to prevent one module from being driven into reverse polarity / reverse voltage stress if the other module is off, faulted, or momentarily unbalanced; the diodes clamp the junction within approximately one diode drop, protecting the converters and improving series-DC-DC modules robustness.

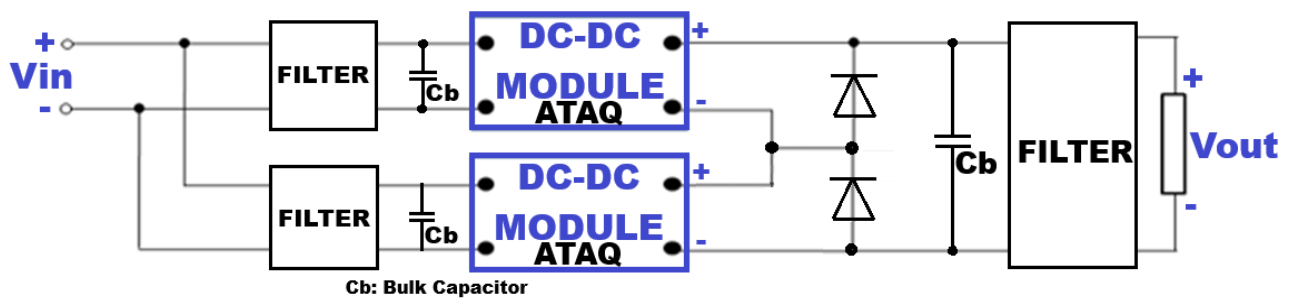


Figure-15

RECOMMENDED APPLICATION FOR BETTER EMI/EMC COMPLIANCE:

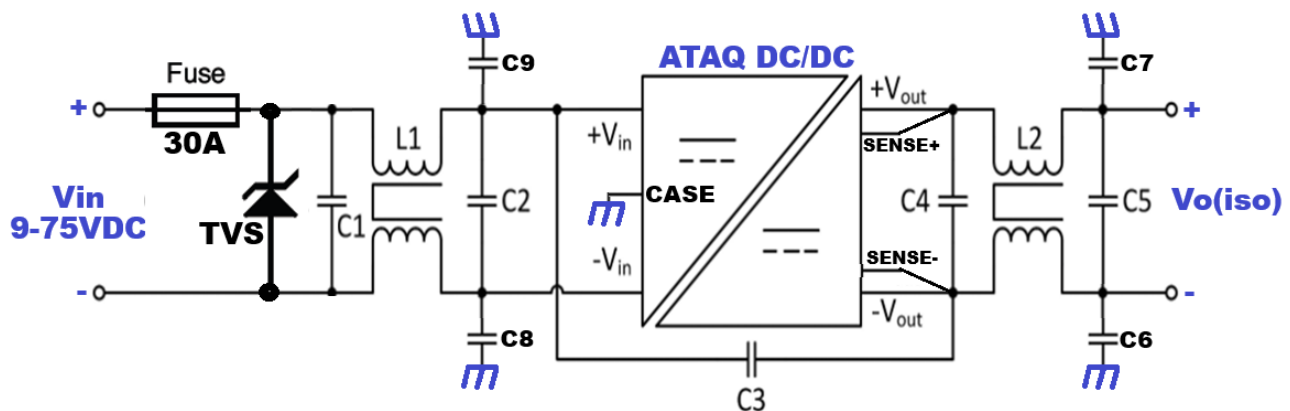


Figure-16

MECHANICAL SPECIFICATION:

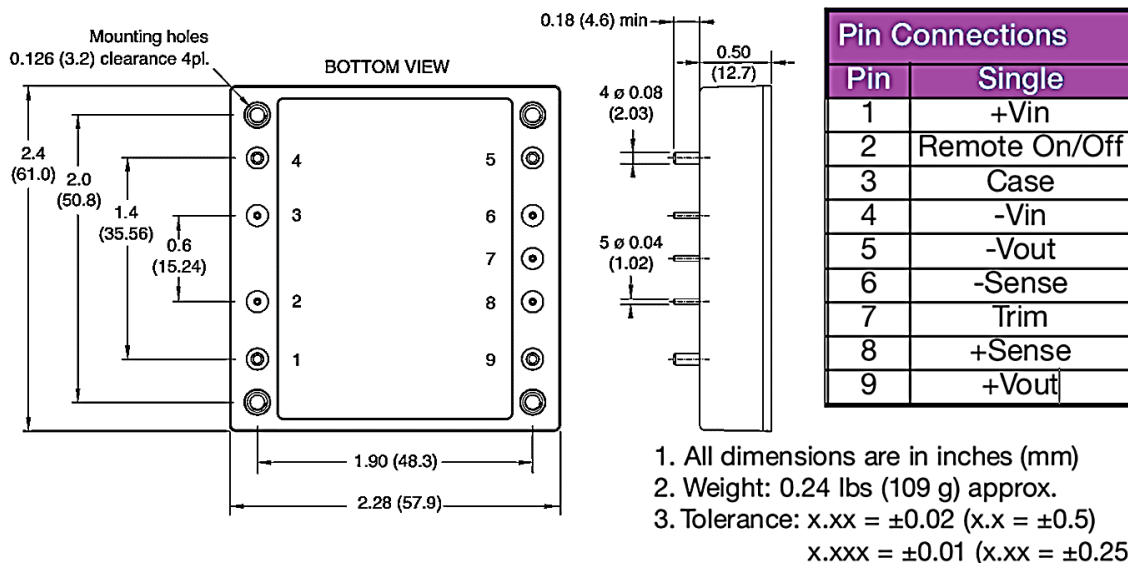


Figure-17

THERMAL CONSIDERATIONS:

The power module is designed to operate in a variety of thermal environments. However, to ensure reliable operation, adequate cooling must be provided. Heat dissipation occurs through conduction, convection, and radiation to the surrounding environment.

To verify proper cooling, measure the temperature at the test point shown in the figure below. The temperature at this location must not exceed the "Maximum Case Temperature." During operation, maintain the test point temperature at or below this limit. For applications requiring extremely high reliability, you may choose to limit the temperature to a lower value.

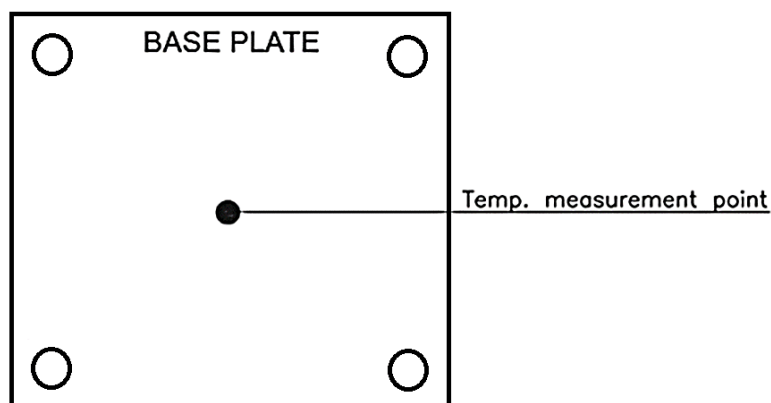


Figure-18

HEAT SINK USAGE:

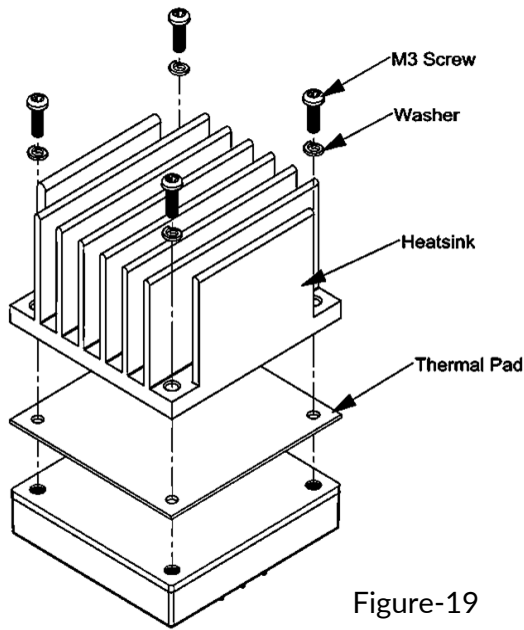


Figure-19

Heat sinks can be purchased separately and are designed to be easily mounted onto the converter using a set of four screws, four washers, and a thermal pad. These components work together to ensure optimal thermal contact and efficient heat dissipation, thereby enhancing the overall performance and reliability of the power module.

The heat sink kits include all the necessary hardware for installation, consisting of one high-quality heat sink, a precisely cut thermal pad, and a complete set of screws and washers. The thermal pad plays a critical role in improving heat transfer between the converter and the heat sink, ensuring that the module operates within safe temperature limits even under demanding conditions.

By incorporating a heat sink, users can significantly extend the lifespan of the converter, especially in environments with high ambient temperatures or continuous high-load operation.

You may want to use a cooler for half-brick DC-DC converters. In this case; the cooler selection is important so that the air inside the device flows in the specified flow direction.

Depending on the air flow direction, you can choose one of the following. The cooler types given below are cheaper due to the way they are produced. With these coolers; “**Lengthwise Air Flow**” or “**Crosswise Air Flow**” can be provided.

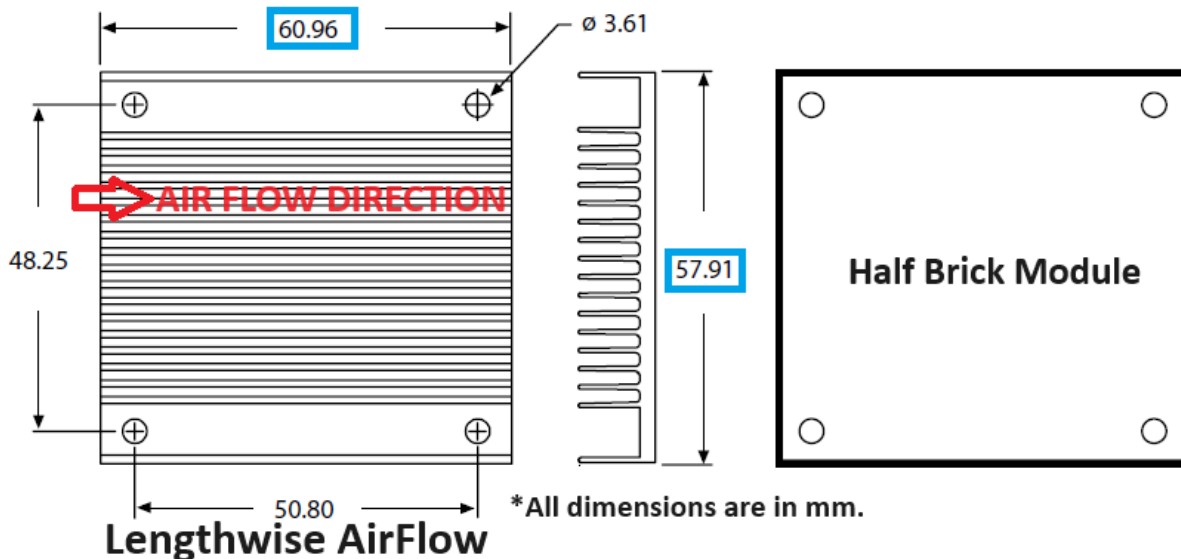


Figure-20a

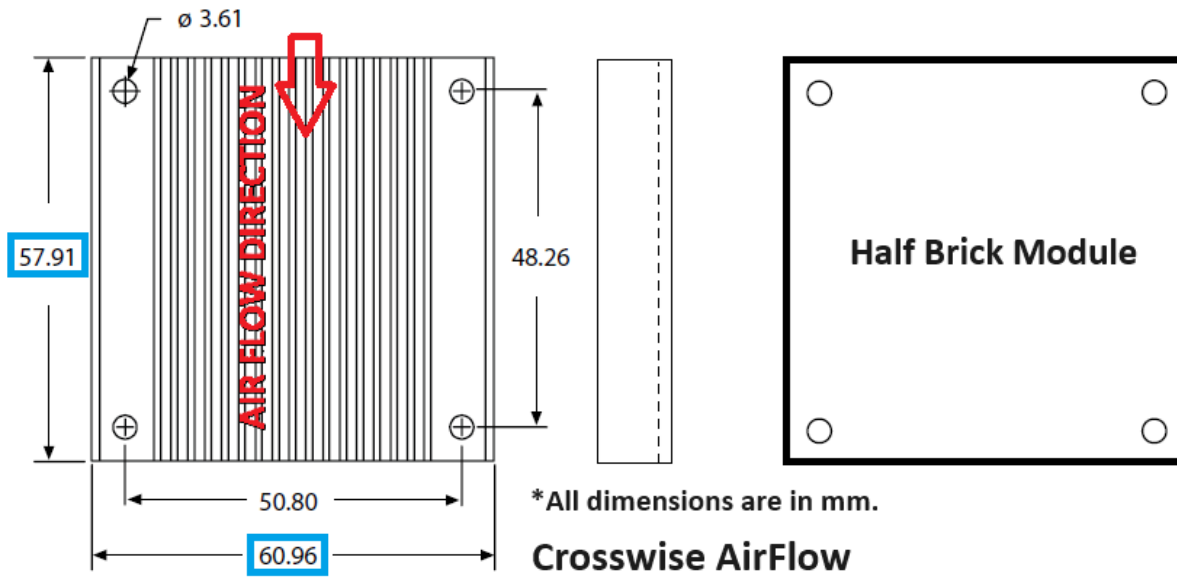


Figure-20b

Contact ATAQ for further information and to order.