ATQ150 SERIES
9-75VDC INPUT / 150W OUTPUT
8:1 ISOLATED DC-DC CONVERTER

ATAQ
Advanced Technology Applications Qualified

"**A**chieve **T**otal **A**ssurance and **Q**uality 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 ±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.

MODEL NUMBER	INPUT VOLTAGE	OUTPUT VOLTAGE	OUTPUT CURRENT		INPUT CURRENT		% EFF.	CAPACITOR LOAD MAX.
			MIN.	MAX.	NO LOAD	FULL LOAD	Nominal Input Voltage 36VDC	
ATQ150-WH36S51	9-75 VDC	51 VDC	0 mA	2.94 A	60 mA	4.63 A	90 (1)	1000μF (2)

NOTE:

1. The output terminal of 24Vout models required a minimum capacitor 100uF to maintain specified regulation
2. The input external capacitor recommends to parallel with 330uF ESR<0.5Ω 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 **W**ide Input Voltage Range (9-75 VDC)	**H** (**H**alf Brick)	**36** (**36** VDC)	**S**ingle **D**ouble	**S** **D**	**28** (**28** VDC)	High **L**ow	- **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	51Vo	-0.3		75	Vdc
Input Surge Voltage	100ms max.	51Vo			100	Vdc
Input Surge Voltage	100ms max.	51Vo			80	Vdc
Operating Case Temperature	At the Center Part of Base Plate	51Vo	-40		100	°C
Storage Temperature		51Vo	-55		105	°C

INPUT CHARACTERISTICS:

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typ.	Max.	Units
Operating Input Voltage		51Vo	9	36	75	Vdc
Input Under Voltage Lockout						
Turn-On Voltage Threshold		51Vo	8.5	9.0	9.5	Vdc
Turn-Off Voltage Threshold		51Vo	7.5	8.0	8.5	Vdc
ON/OFF control, positive remote ON/OFF logic	Logic low (Module OFF) Logic high (Module ON)	51Vo	0 3.5V or open circuit		1.2 75	Vdc
Lockout Hysteresis Voltage		51Vo		1		Vdc
Maximum Input Current	Vin=9V, Full Load.	51Vo		20		A
No-Load Input Current	Vin=36V, Io=0A			20		mA
Input Filter	LC filter	51Vo				
Recommended Input Fuse	Fast acting type	51Vo		30		A
Input Capacitance (External)	< 0.5Ω ESR	51Vo		330		uF
Switching frequency		51Vo		200		kHz

OUTPUT CHARACTERISTICS:

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typ.	Max.	Units
Voltage Set Point Accuracy	Vin=36V, Full Load, Tc=25°C	51Vo	-1.0		+1.0	%
Output Voltage Regulation						
Load Regulation	Full Load to No Load	51Vo			±0.2	%
Line Regulation	Vin=High Line to Low Line, Full Load	51Vo			±0.2	%
Output Voltage Ripple and Noise (5Hz to 20MHz bandwidth)						
Peak-to-Peak	Full load, 10uF Aluminum and 1.0uF ceramic capacitors	51Vo			480	mV
RMS		51Vo			200	mV
Output Current Range	Vin= 9 to 75V			0 – 2.94		A
Over Current Protection	<90% Vo	51Vo	105	160	200	%
Short Circuit Protection	Hiccup Mode / Auto Recovery	51Vo	Continuous, Auto Recovery			
External Load Capacitance	Full load (Constant resistive load)			1000		uF
Output Voltage Trim Range	Po≦max rated power, Io ≦ Io_max	51Vo	-10		+10	%
Start-up time		51Vo		110		ms

EFFICIENCY:

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typ.	Max.	Units
100% Load	Vin=28V	51Vo		up to 90%		%

GENERAL SPECIFICATIONS:

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typ.	Max.	Units
MTBF	Io=100% of Io_max; MIL-HDBK-217F_Notice 1, GB, 25°C	51Vo		800		K hours
Weight		51Vo		109		Grams
Isolation resistance	10^7 ohms, min.					
Isolation capacitance (Typical)	Input to Output			2500		pF
	Input to Case (Base Plate)			1000		
	Output to Case (Base Plate)			1000		
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

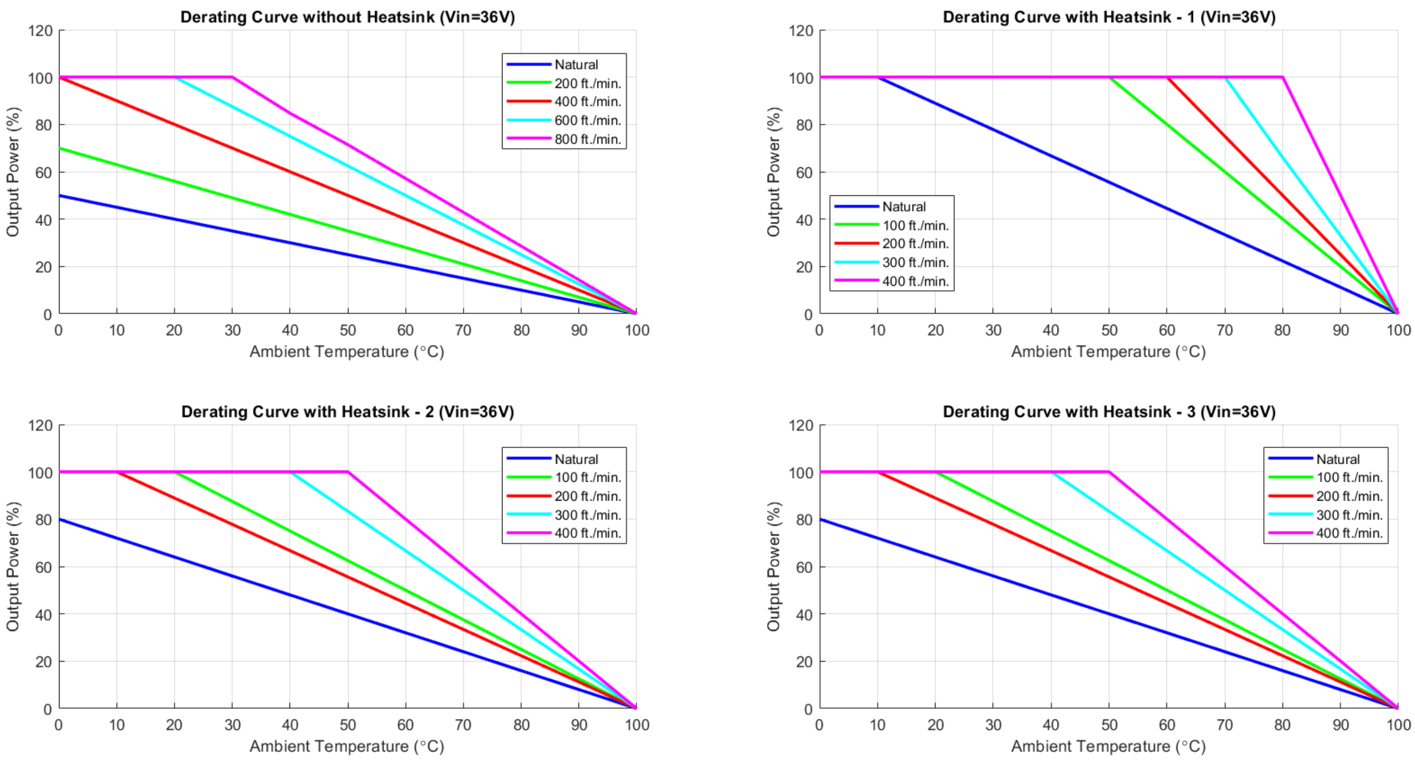


Figure-1

PERFORMANS INFO & DATA

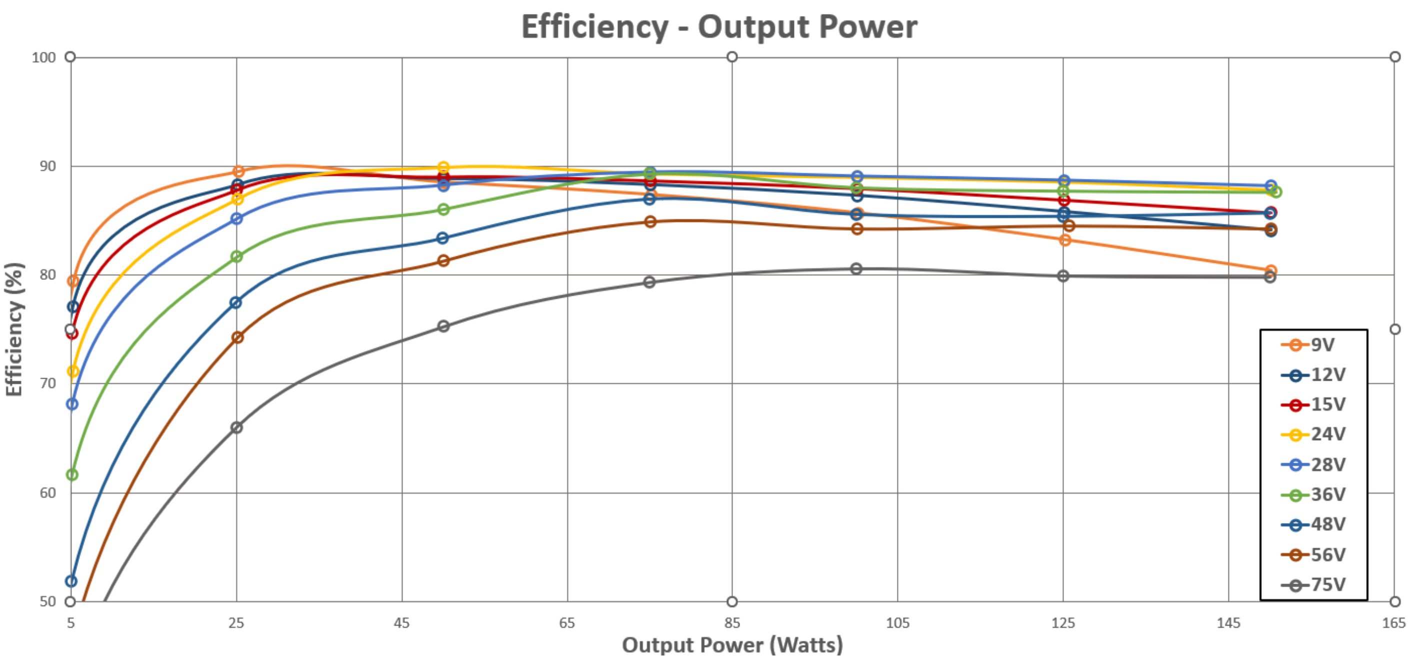


Figure-2a

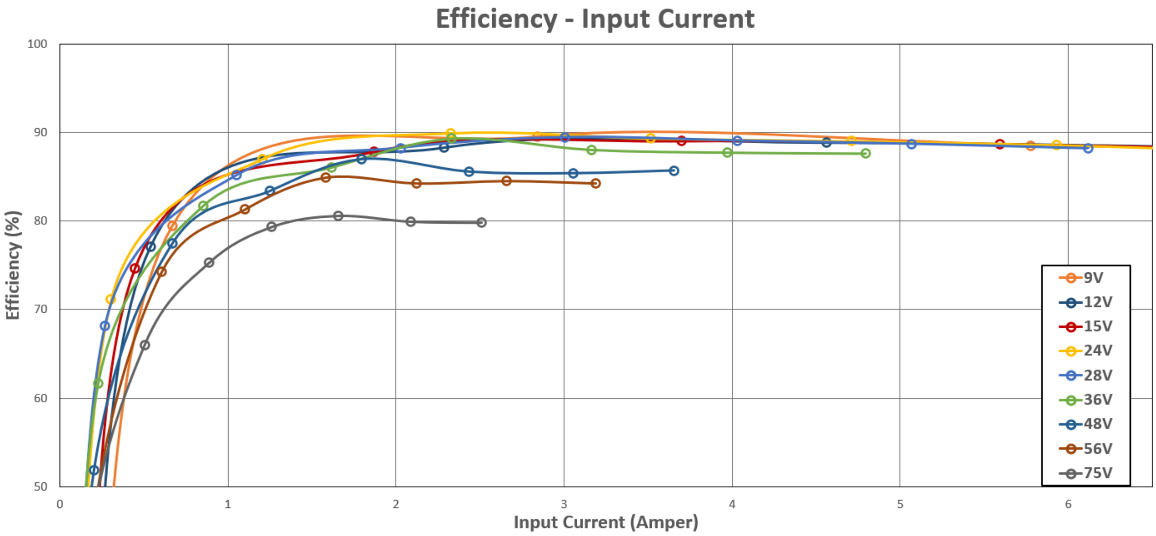


Figure-2b

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)

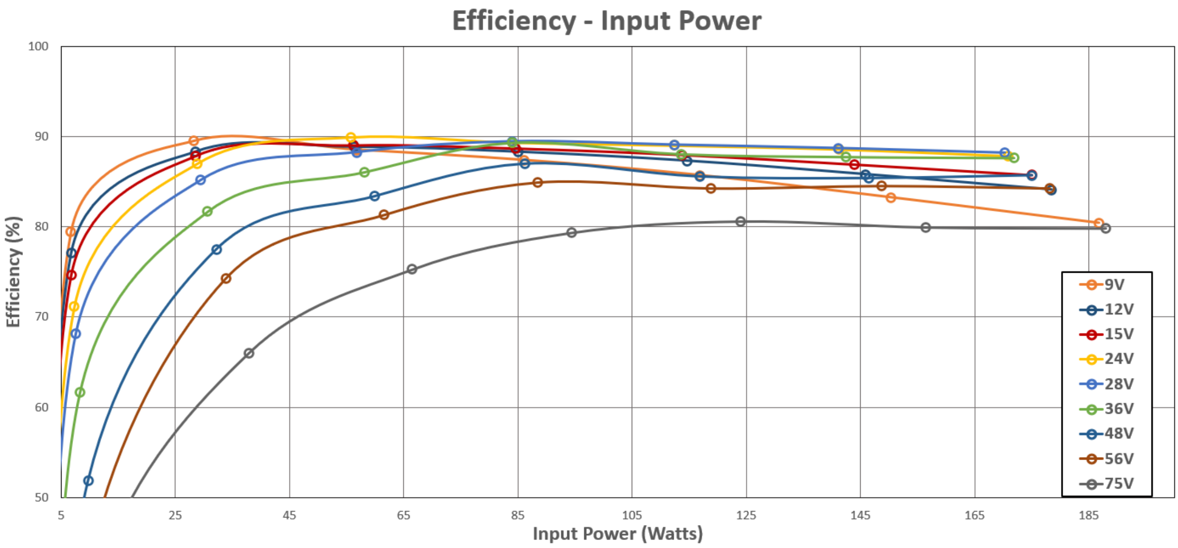


Figure-3

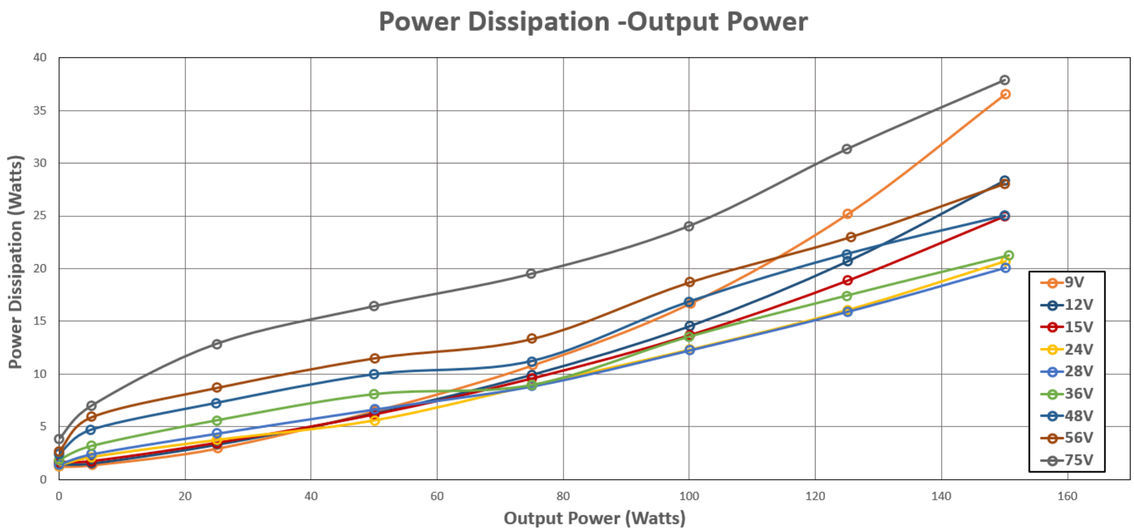


Figure-4

ELECTRICAL BLOCK DIAGRAM:

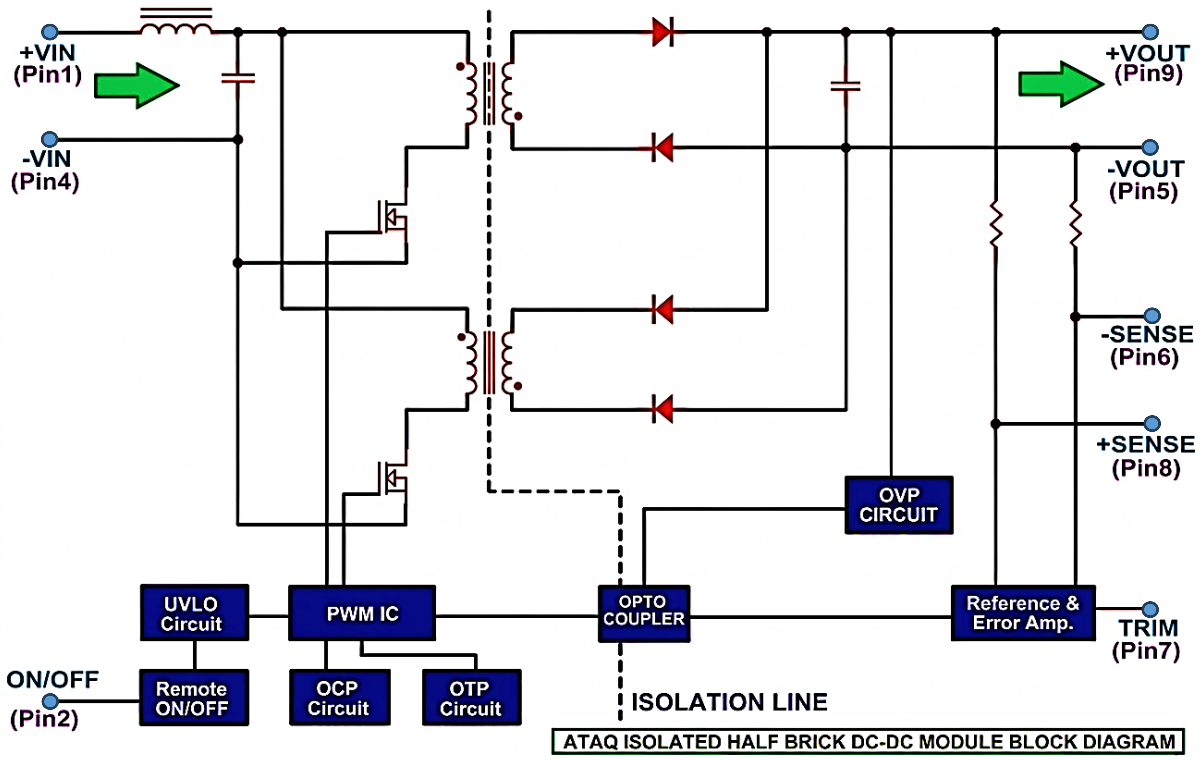


Figure-5

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.

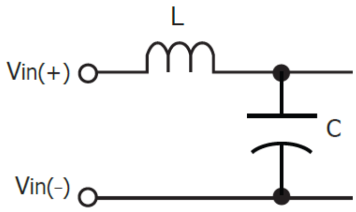


Figure-6: *Internal Input Filter Diagram*

OUTPUT CAPACITANCE:

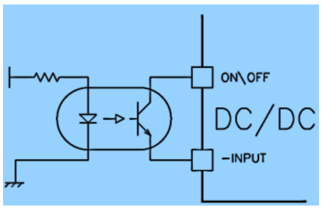
For good transient response, low ESR output capacitors should be located close to the point of load. PCB design emphasizes low resistance and inductance tracks in consideration of high current applications.

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℃ and the absolute maximum value of ATQ150 series' output capacitance, please refer to maximum output capacitance.

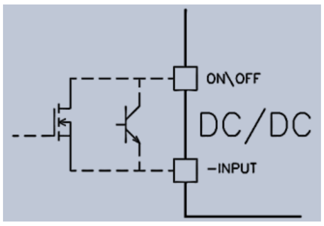
REMOTE ON/OFF:

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.

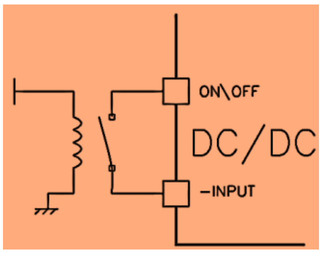
A properly de-bounced mechanical switch, open collector transistor, or FET can be used to drive the input of the ON/OFF pin. If not using the remote on/off feature: For positive logic, leave the ON/OFF pin open.



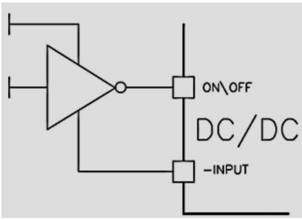
Shows an isolated ON/OFF driver using an optocoupler.



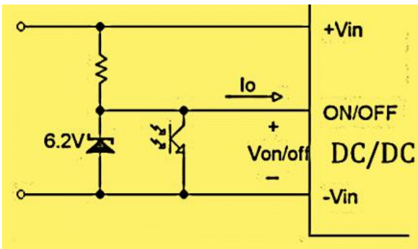
Some of the more common methods of interfacing to the ON/OFF pin. Shows a discrete NMOS or NPN transistor.



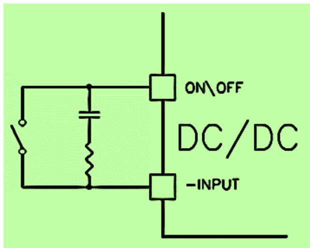
Shows a low power relay which also offers isolation.



A standard TTL or CMOS driver can sometimes be used although open collector is always preferred.



Level Control Using Line Voltage



Any ON/OFF switch can be used.

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.

<u>**The maximum power drawn from half-brick models is influenced by usual factors, such as:**</u>

- 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.

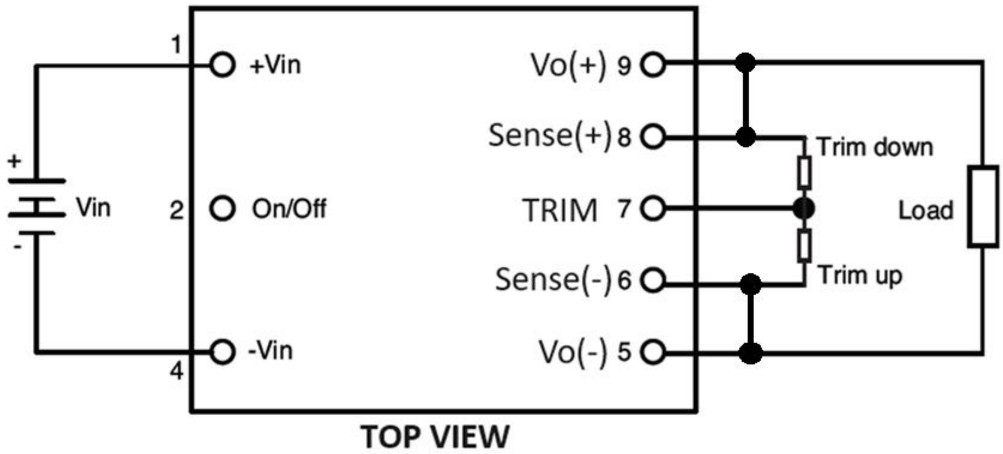


Figure-8

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 Δ%.

Vout = 51V:

$$Rtrim\_down = 36 * \frac{(Vo,set - \Delta\% * Vo,set - 2.5)}{\Delta\% * Vo,set} - 200K\Omega$$

Where

For example, to trim-down the output voltage of 51V module (ATQ150-WH36S51) by 5% to 48.45V, Rtrim-down is calculated as follow:

Δ % = 5%

$$Rtrim\_down = 36 * \frac{(Vo,set - \Delta\% * \mathbf{51} - 2.5)}{\Delta\% * \mathbf{51}} - 200K\Omega$$

Rtrim_down = 448.70KΩ

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 Δ%.

Vout=51V:

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

Where

For example, to trim-up the output voltage of 51V module (ATQ150-WH36S51) by 5% to 53.55V, Rtrim-up is calculated as follow:

Δ % = 5%

$$Rtrim\_up = 36 * \frac{(2.5 - \frac{0.46 * 200}{200 + 5.1})}{\Delta\% * Vo,set} - \frac{5.1 * 200}{200 + 5.1} K\Omega$$

$$Rtrim\_up = 36 * \frac{(2.5 - \frac{0.46 * 200}{200 + 5.1})}{\Delta\% * \mathbf{51}} - \frac{5.1 * 200}{200 + 5.1} K\Omega$$

Rtrim_up = 23.99 KΩ

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 = Vo,set x Io,max)

The output voltage on 51V 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:

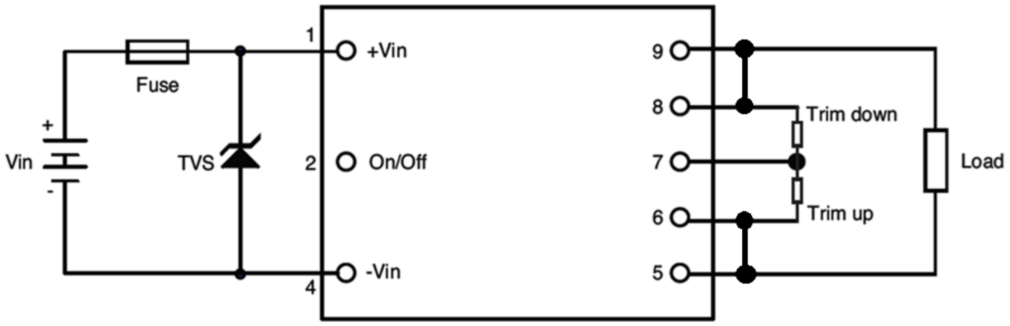


Figure-9

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.

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:

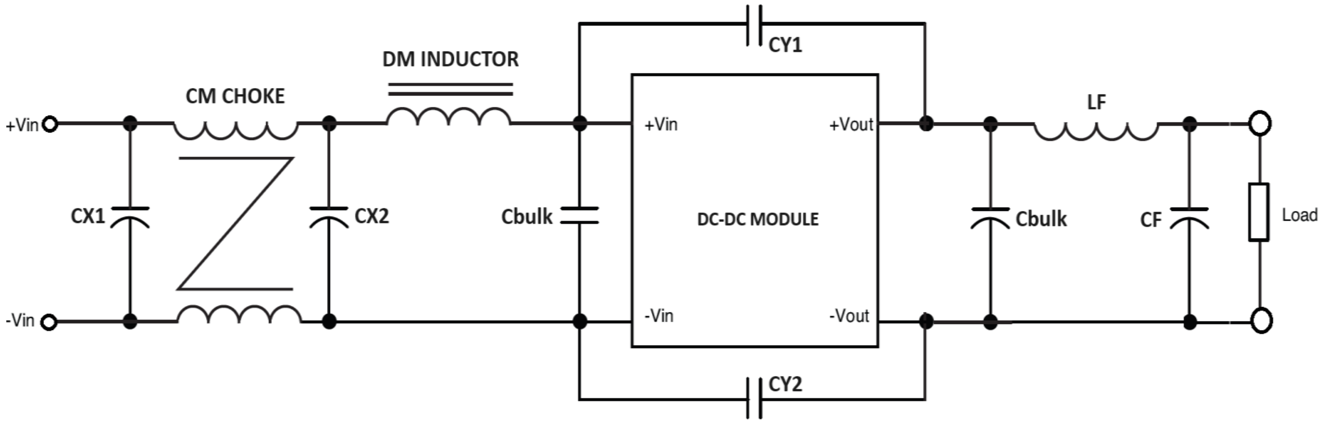


Figure-10

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℃, 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℃, 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.

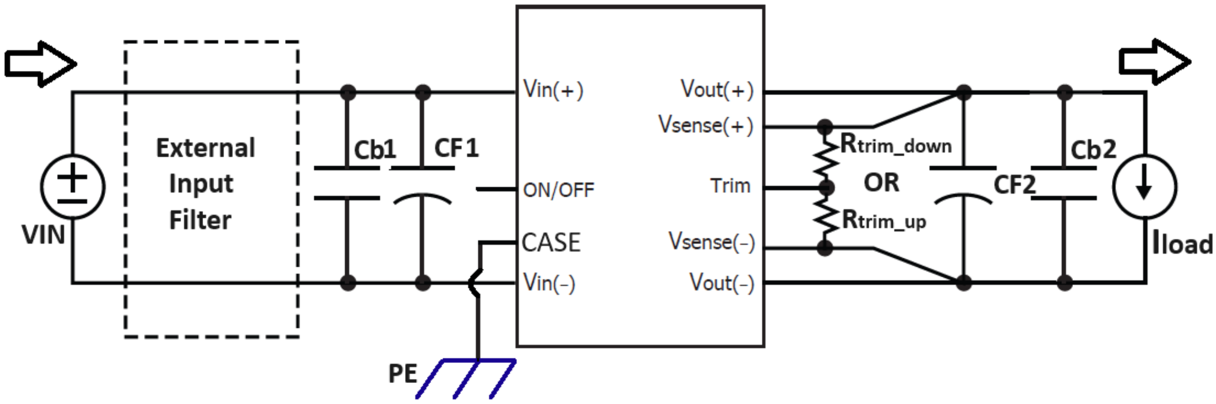


Figure-11: Typical electrical connection (Positive logic)

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.

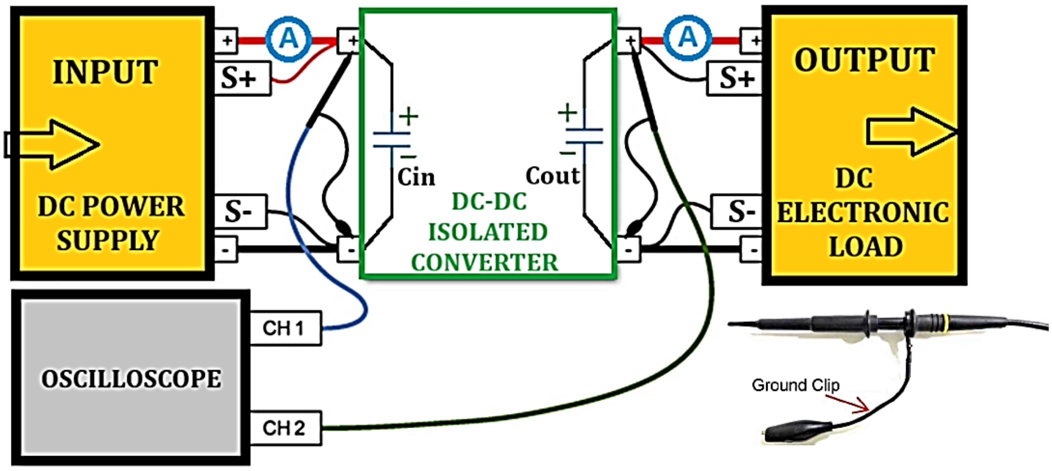


Figure-12a

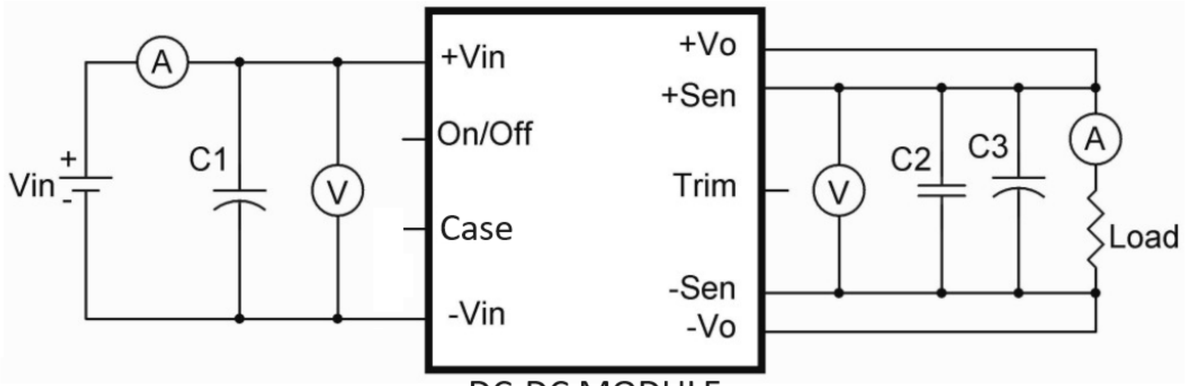


Figure-12b

All measurements are taken at the modüle terminals.

The value of efficiency is defined as:

$$\eta = \frac{Vo \times Io}{Vin \times Iin} \times 100\%$$

Where:

- Vo is output voltage
- Io is output current
- Vin is input voltage
- Iin 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.

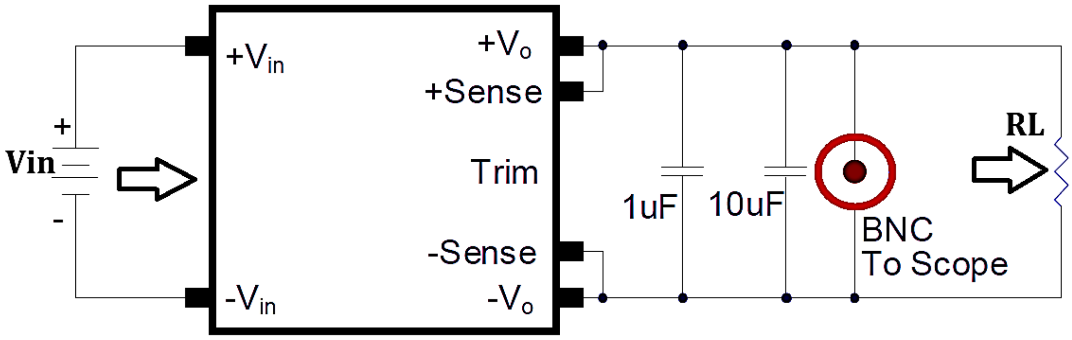


Figure-13

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 trigged by one power module, and then the protection makes the output function invalid.

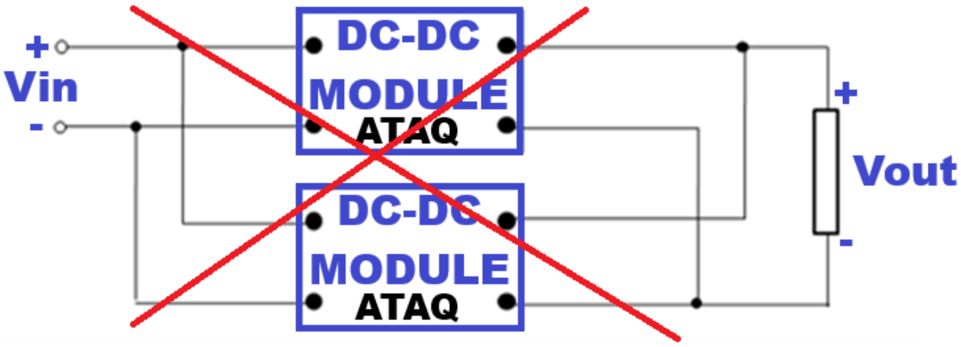


Figure-14a

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.

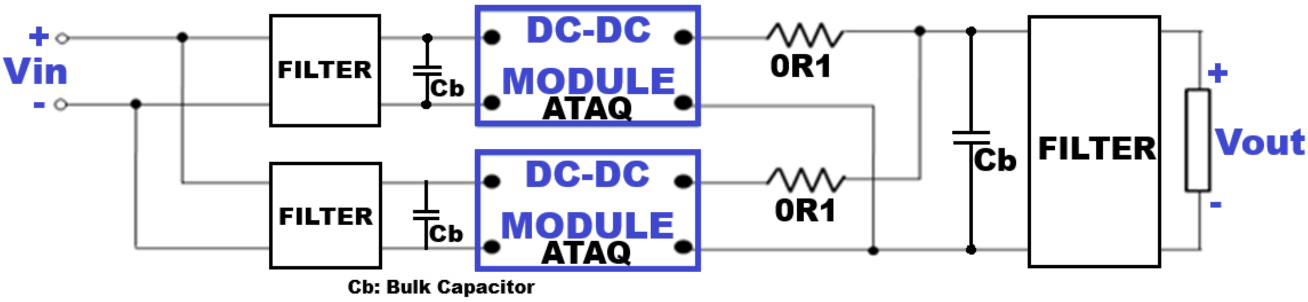


Figure-14b

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.

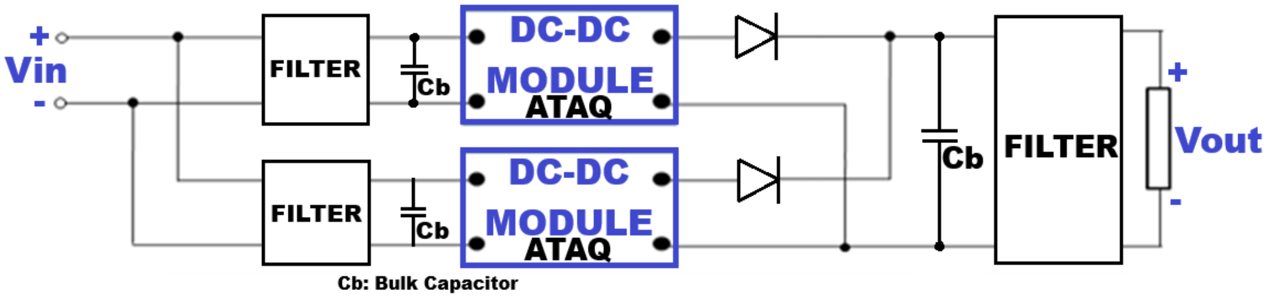


Figure-14c

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.

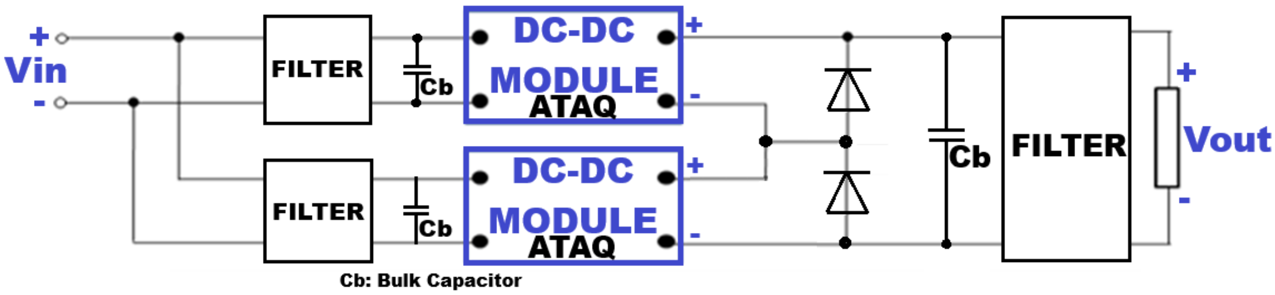


Figure-15

RECOMMENDED APPLICATION FOR BETTER EMI/EMC COMPLIANCE:

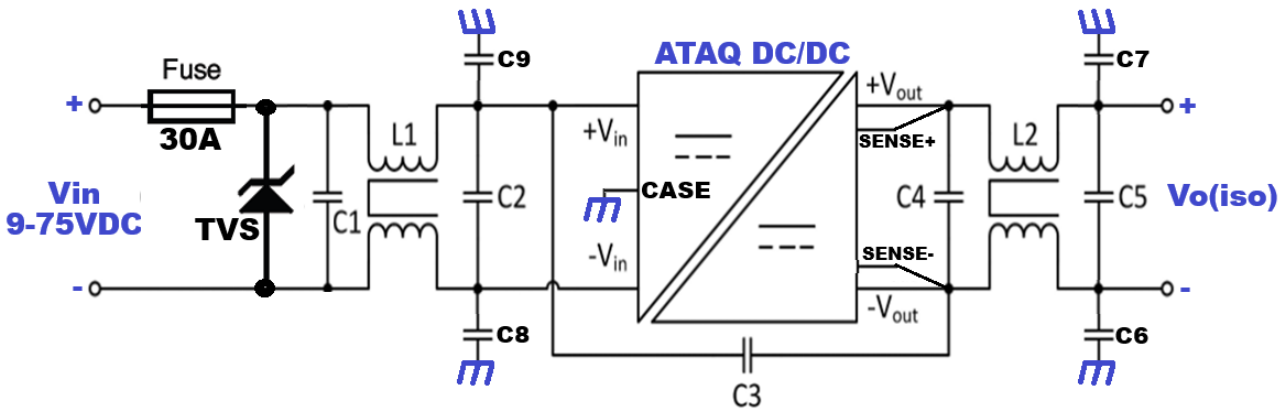
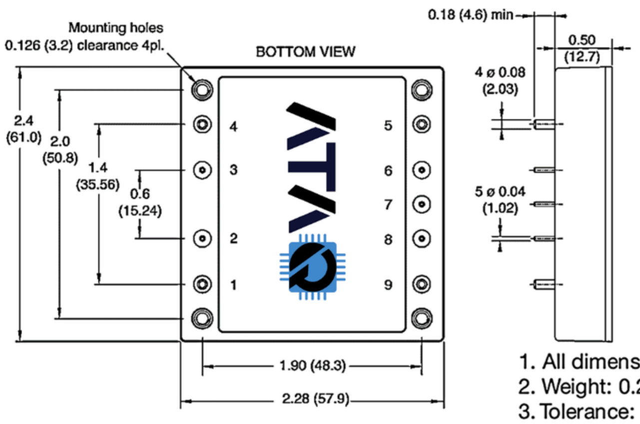


Figure-16

MECHANICAL SPECIFICATION:



Pin Connections	
Pin	Single
1	+Vin
2	Remote On/Off
3	Case
4	-Vin
5	-Vout
6	-Sense
7	Trim
8	+Sense
9	+Vout

1. All dimensions are in inches (mm)
2. Weight: 0.24 lbs (109 g) approx.
3. Tolerance: x.xx = ±0.02 (x.x = ±0.5)
   x.xxx = ±0.01 (x.xx = ±0.25)

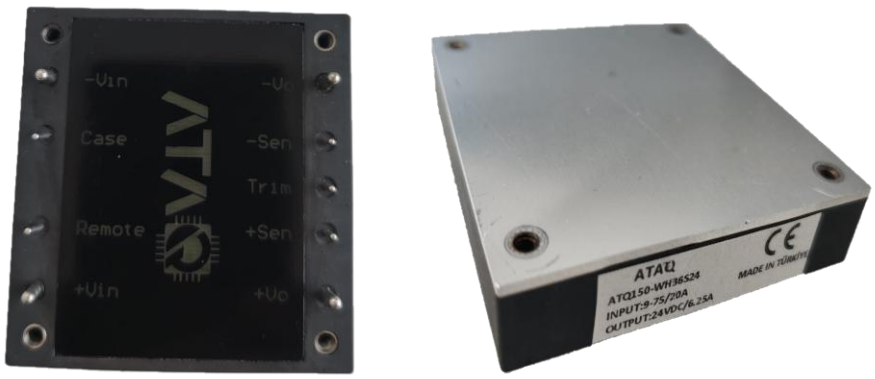


Figure-17

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.

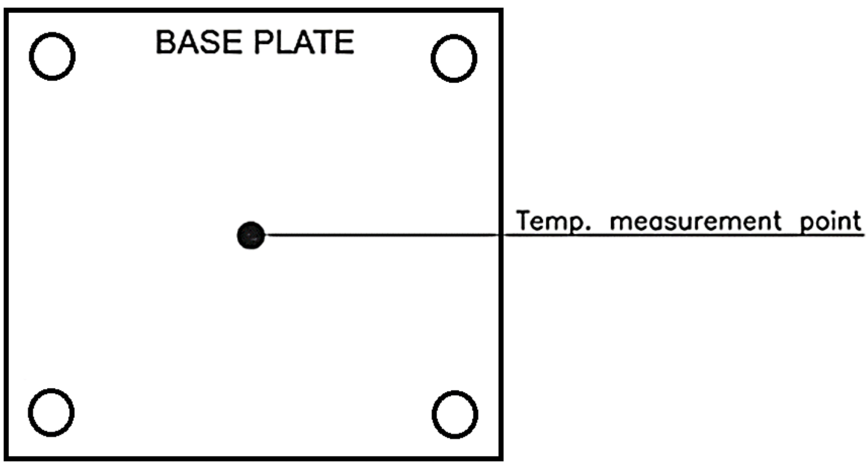


Figure-18

HEAT SINK USAGE:

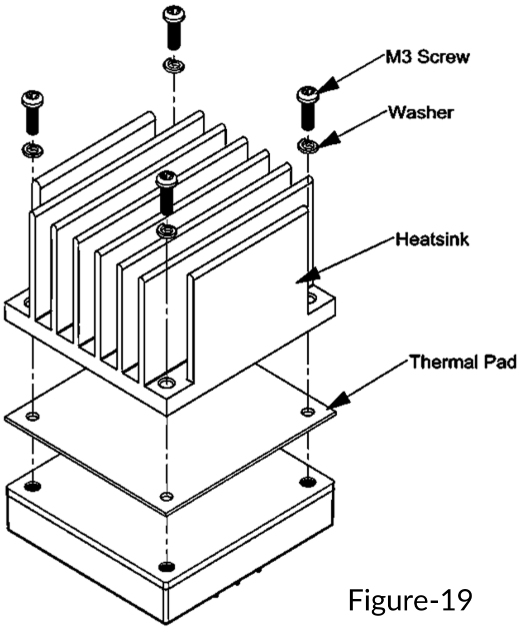


Figure-19

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.

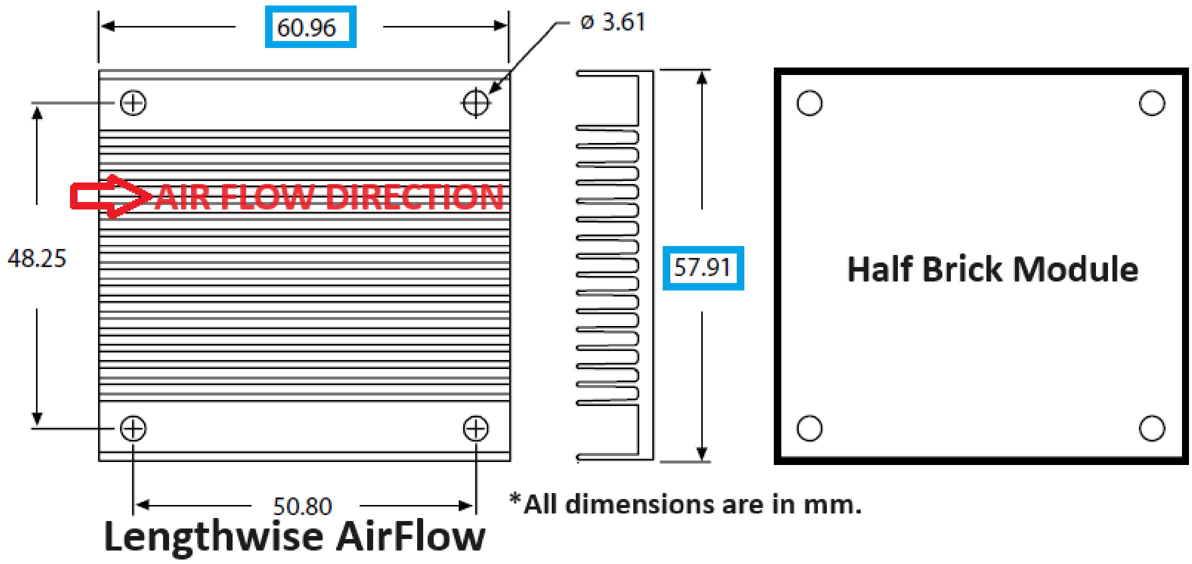


Figure-20a

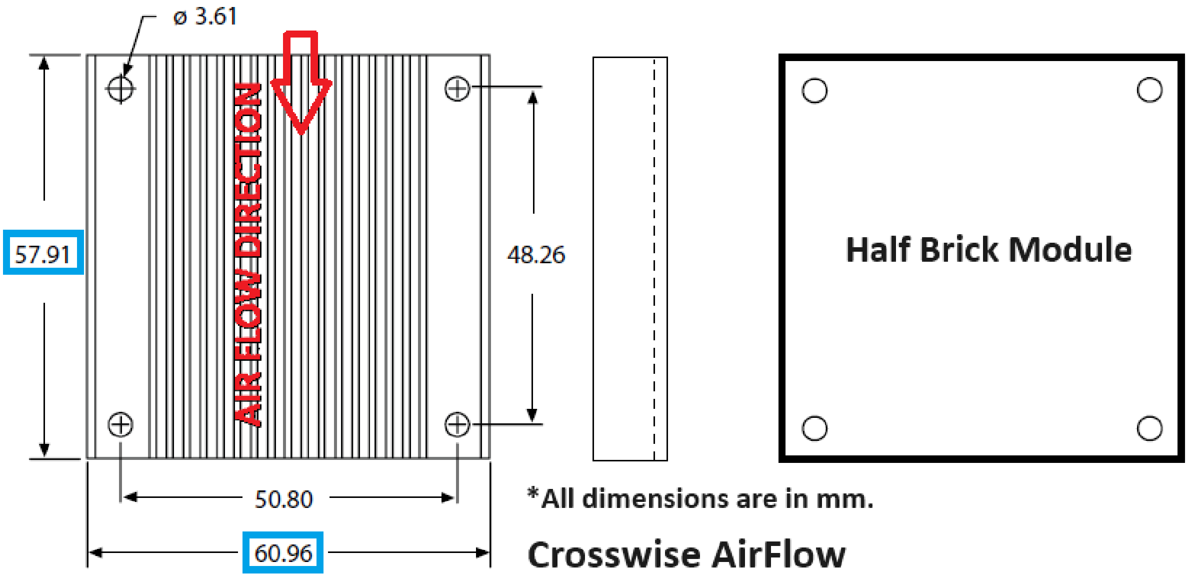


Figure-20b

PACKAGING:

Due to ATAQ' s value-added services, the packaging type may change when purchasing quantities below the standard package.

Figure-21

Contact ATAQ for further information and to order.