MQ9208ET540

Isolated 18~36V input, Eighth-brick, single output 80W DC-DC Converter

FEATURES

- Compliant to RoHS II EU "Directive 2011/65/EU (-Z versions)
- Industry standard, DOSA compliant footprint
  - ✓ 58.4mm x 22.8mm x 9.0 mm
  - ✓ 2.30 in x 0.90 in x 0.35 in
- Wide operating voltage:18~36V
- Tightly regulated single output:
  - ✓ 54V/80W
- Output power up to 80W
- High Efficiency 91%(54V output, Full load)
- Output Voltage adjust: 90% to 110% of $V_{O,NOM}$
- Constant switching frequency
- Remote sense
- Output over-current / short-circuit protection
- Over-temperature protection
- Input under-voltage Protection
- ON/OFF control polarity selectable
  - ✓ Negative: R/C connect Vin- for normal operation
  - ✓ Positive: R/C floating or High Level for normal operation
- Monotonic start-up
- Wide Operating Temperature: -40℃~+85℃

APPLICATIONS

- Industrial Equipment
- Surveillance
- Wireless Networks
- Distribute Power Architecture

Description

The ***MQ9208E*** Series Power Modules are isolated single output dc-dc converter that operates over a wide input voltage range of18V_{dc} to36V_{dc} and provide a precisely (1%) regulated dc output in standard 1/8-brick size. The module provides 54V_{dc} nominal output voltage rated for 80W output, achieves 91% high efficiency at 24V_{dc} input voltage application. Its 54V_{dc} voltage and high efficiency is ideal for POE applications which equips with 24V battery as backup power source. Standard features include remote On/Off, remote sense, output voltage adjustment, overvoltage, over current and over temperature protection.

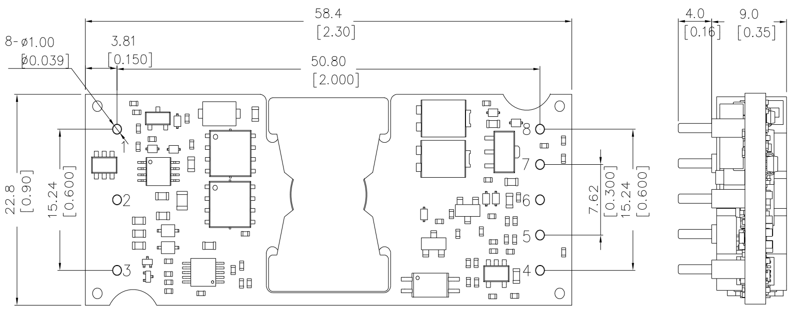
************************************* ***Typical Application Circuit*** *********************************

Performance Specifications(at TA=+25˚C)

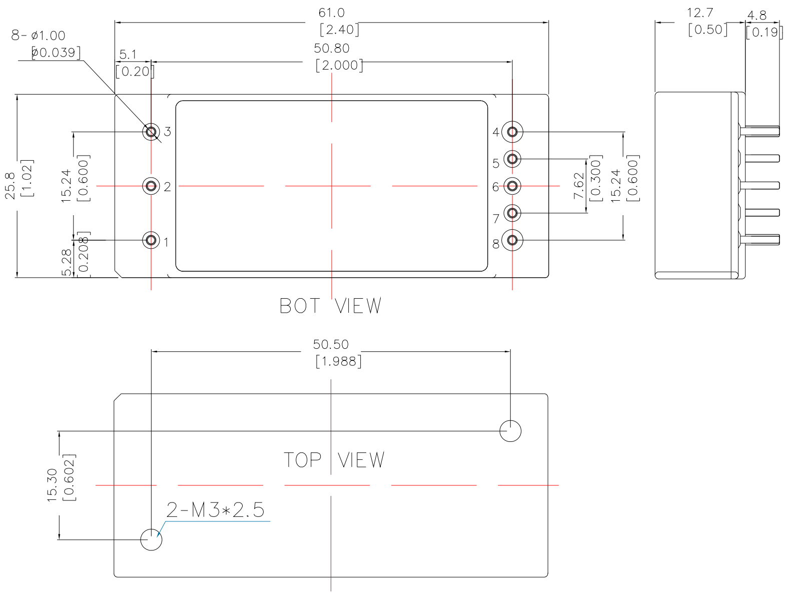
Model	**Input V_{IN} Range** (V)	**Output**				**Efficiency (%)**
		P_{OUT}(W)	V_O(V)	**Regulation**		
				Line (%)	**Load** (%)	
MQ9208ET540	18~36	80	54	1	1	91

Mechanical Outline Diagram

Unit: millimeters and [inches]
Tolerances: x.x ±0.5mm [x.xx in. ±0.02in.], x.xx ±0.25mm [x.xxx in. ±0.010 in.] , unless otherwise noted



MQ9208ET540-P



MQ9208ET540-P-HS

PIN	**DESCRIPTION**
1	Vin+
2	R/C: Remote Control
3	Vin-
4	Vo-
5	R/S-: Negative Remote Sense
6	Trim
7	R/S+: Positive Remote Sense
8	Vo+

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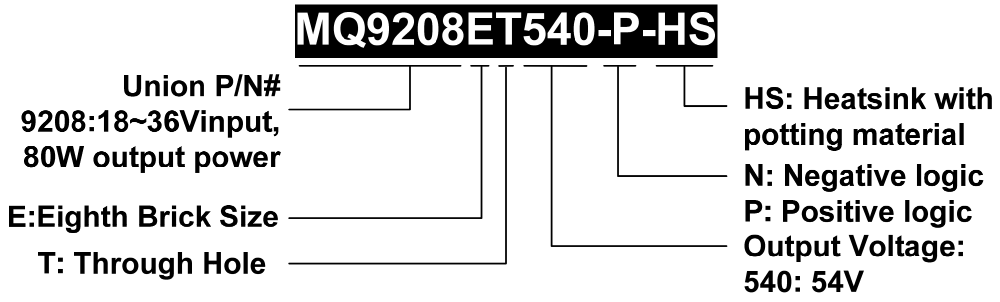
Ordering Information



Absolute Maximum Ratings

Note: These are stress ratings. Exposure of devices to any of these conditions may adversely affect long-term reliability. Proper operation under conditions other than those listed in the Performance Specifications Table is not implied.

Parameter	Symbol	Min	Max	Unit
Input Voltage	V_{IN}	18	36	V
Operating Ambient Temperature	T_A	-40	85	℃
Storage Temperature	T_{STG}	-55	125	℃
Altitude			4000	m
I/O Isolation voltage (100% factory Hi-pot tested)			2250	V_{dc}

Electrical Specifications: *(T_A=+25°C)*

Unless otherwise indicated, specifications apply overall operating input voltage, resistive load, and temperature conditions.

Parameter	Symbol	Min	Typ	Max	Unit
Maximum Input Current (V_{IN}=18V to 36V, I_O=$I_{O,MAX}$)	$I_{IN,max}$			tbd	Adc
Operating Input Voltage	V_{IN}	18	24	36	V_{dc}
Inrush Transient	I^2t			tbd	A^2s
Input Reflected Ripple Current, peak-to-peak (5Hz to 20MHz, 12μH source impedance; V_{IN}=0V to 36V, I_O= $I_{O,MAX}$; see Fig 1)				tbd	mA_{p-p}
Input No Load Current V_{IN} = 24V, (Io = 0A, module enabled)			tbd		mAdc
Input Stand-by Current (V_{IN} = 24V, module disabled)				tbd	mAdc
Input Ripple Rejection (120Hz)			50		dB
Output Voltage Set-point (V_{IN} = $V_{IN,NOM}$, I_O=$I_{O,MAX}$, Tc =25°C)	$V_{O,set}$		54		V_{dc}
Output Voltage Set-Point Total Tolerance (Overall operating input voltage, resistive load, and temperature conditions until end of life)	V_O	53.5	—	54.5	V_{dc}
Output Regulation Line (V_{IN}=V_{IN}, min to $V_{IN.MAX}$) Load (I_O=$I_{O,MIN}$ to $I_{O,MAX}$) Temperature (T_{CASE} = -40°C to +100°C)		— — —	0.2 0.5 0.4	0.5 0.75 0.75	$\%V_{o,set}$ $\%V_{o,set}$ $\%V_{o,set}$
Output Ripple and Noise on nominal output (V_{IN}=$V_{IN,NOM}$ and I_O=$I_{O,MIN}$ to $I_{O,MAX}$) RMS (5Hz to 20MHz bandwidth) Peak-to-Peak (5Hz to 20MHz bandwidth)		— —	100 300	200 600	mV_{rms} mV_{pk-pk}
External Capacitance (2.5mΩ< ESR < 80mΩ)*	Co.	220	—	1500	μF
Output Power (Vo=54V)	$P_{O,max}$	—	—	80	W
Output Current	Io	0		1.48	A_{dc}
Output Current Limit Inception (Constant current until Vo<$V_{TRIM,MIN}$, duration <4s)	$I_{O,lim}$	tbd	—	—	A_{dc}
Output Short Circuit Current (V_O≤ 0.25V_{dc})	$I_{O,sc}$			30	A_{rms}
Efficiency (Vin=24V) V_{IN}=$V_{IN,NOM}$, T_c=25°C I_O=$I_{O,MAX}$, V_O= $V_{O,SET}$	η	—	91	—	%
Switching Frequency	f_{sw}	—	tbd	—	KHz
Dynamic Load Response ($\Delta I_o/\Delta t$=0.1A/μs; V_{IN}=$V_{IN,NOM}$; Tc=25°C; Tested with a 220μF aluminum and a 10μF ceramic capacitor across the load.) Load Change from I_O= 25%-50%-25% of $I_{O,MAX}$: Peak Deviation Settling Time (V_O<10% peak deviation) Load Change from I_O= 50%-75%-50% of $I_{O,MAX}$: Peak Deviation Settling Time (V_O<10% peak deviation)	V_{pk} t_s V_{pk} t_s	— — — —	2 1.5 2 1.5	— — — —	$\%V_{o,set}$ mS $\%V_{o,set}$ mS

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($\Delta I_o/\Delta t$=10%$I_{O,max}$ /10µs; V_{IN}=$V_{IN,NOM}$; Tc=25°C; Tested with a 470µF aluminum and a 10µF ceramic capacitor across the load, see Fig 7. Load Change from I_O= 0%-120% of $I_{O,MAX}$: Peak Deviation Settling Time (V_O<10% peak deviation) Load Change from I_o= 120% to 50% of $I_{O,MAX}$: Peak Deviation Settling Time (V_o<10% peak deviation)	V_{pk} t_s V_{pk} t_s	— — — —	2 1.5 2 1.5	— — — —	$\%V_{o,set}$ mS $\%V_{o,set}$ mS

*Note: use a minimum 220uF output capacitor. Recommended capacitor is Nichicon CD series, 220uF/35V. If the ambient temperature is less than -20°C, use more than 3 of recommended minimum capacitors.

CAUTION: This power module is not internally fused. An input line fuse must always be used.

This power module can be used in a wide variety of applications, ranging from simple standalone operation to being an integrated part of complex power architecture. To preserve maximum flexibility, internal fusing is not included. Always use an input line fuse, to achieve maximum safety and system protection. The safety agencies require a time-delay or fast-acting fuse with a maximum rating of 10A in the ungrounded input connection (see Safety Considerations section). Based on the information provided in this data sheet on inrush energy and maximum dc input current, the same type of fuse with a lower rating can be used. Refer to the fuse manufacturer's data sheet for further information.

Isolation Specifications

Parameter	Symbol	Min	Typ	Max	Unit
Isolation Capacitance	C_{iso}	—	15	—	nF
Isolation Resistance	R_{iso}	10	—	—	MΩ

General Specifications

Parameter	Symbol	Min	Typ	Max	Unit
Calculated Reliability based upon Telcordia SR-332 Issue 2: Method I Case 3 (I_O=80%$I_{O,MAX}$, T_A=40°C, airflow = 1m/S, 90% confidence)	FIT MTBF		TBD TBD		10^9/Hours Hours
Weight			TBD		g

Feature Specifications

Unless otherwise indicated, specifications apply overall operating input voltage, resistive load, and temperature conditions. See Feature Descriptions for additional information.

Parameter	Symbol	Min	Typ	Max	Unit
Remote On/Off Signal Interface (V_{IN} = $V_{IN,MIN}$ to $V_{IN,MAX}$,open collector or equivalent, Signal referenced to V_{IN-} terminal) Negative Logic: device code suffix "N" Logic Low = module On, Logic High = module Off Positive Logic: device code suffix "P" Logic Low = module Off, Logic High = module On Logic Low - Remote On/Off Current Logic Low - On/Off Voltage Logic High Voltage – (Typ = Open Collector) Logic High maximum allowable leakage current	$I_{ON/OFF}$ $V_{ON/OFF}$ $V_{ON/OFF}$ $I_{ON/OFF}$	— 0 2.5 —	— — —	1.0 1.2 10 50	mA V_{dc} V_{dc} µA
Turn-On Delay and Rise Times (V_{IN}=$V_{IN,NOM}$, I_O=$I_{O,MAX}$, 25°C) Case 1: T_{delay} = Time until V_O = 10% of $V_{O,SET}$ from application of Vin with Remote On/Off set to ON, Case 2: T_{delay} = Time until V_O = 10% of $V_{O,SET}$ from application of Remote On/Off from OFF to ON with V_{IN} already applied for at least one second. T_{rise} = time for V_O to rise from 10% of $V_{O,SET}$ to 90% of $V_{O,SET}$	T_{delay} T_{delay} T_{delay}	 — —	30 30 50	 —	ms ms ms
Output Voltage Overshoot (I_O=80% of $I_{O,MAX}$, T_A=25°C)				3	% $V_{O,set}$
Output Voltage Adjustment Output Voltage Remote-sense Range Output Voltage Set-point Adjustment Range (trim) Note: see Fig 6	 V_{sense} V_{trim}	 — 15.0	 — ----	 2 35.2	 $\%V_{o,nom}$ Vdc

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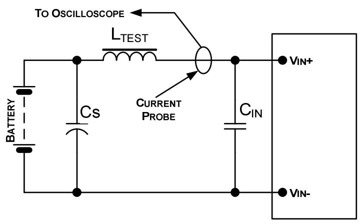
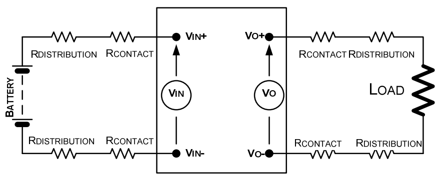
Output Overvoltage Protection	$V_{O,limit}$	37	—	42	Vdc
Over Temperature Protection (See Feature Descriptions, Fig 8)	Tref	—	120	—	°C
Input Under Voltage Lockout Turn-on Threshold Turn-off Threshold Hysteresis	$V_{IN,UVLO}$	 31 	 35 32 3	 36 	 V_{dc} V_{dc} V_{dc}
Input Over voltage Lockout Turn-on Threshold Turn-off Threshold Hysteresis	$V_{IN,UVLO}$	 — 81 ----	 79.5 83 3	 81 — ----	 V_{dc} V_{dc} V_{dc}

Test Configurations



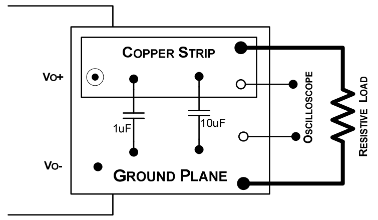
NOTE: Measure input reflected ripple current with a simulated source inductance (L_{TEST}) of 12μH. Capacitor CS offsets possible battery impedance. Measure current as shown above.

Fig 1. Input Reflected Ripple Current Test Setup



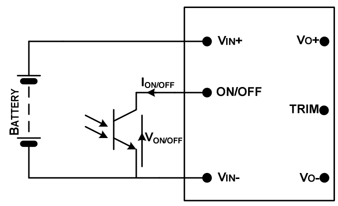
NOTE: All voltage measurements to be taken at the module terminals, as shown above. If sockets are used then Kelvin connections are required at the module terminals to avoid measurement errors due to socket contact resistance.

Fig 2. Output Voltage and Efficiency Test Setup



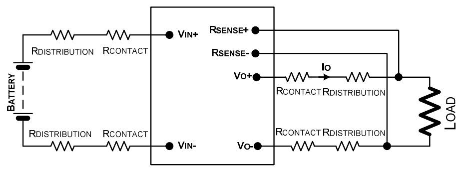
NOTE: All voltage measurements to be taken at the module terminals, as shown above. If sockets are used then Kelvin connections are required at the module terminals to avoid measurement errors due to socket contact resistance.

Fig 3. Output Ripple and Noise Test Setup



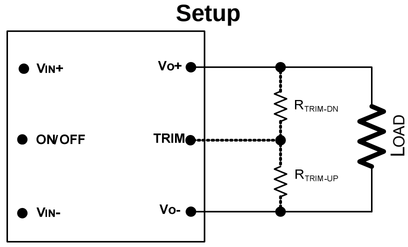
NOTE: An open collector switch is recommended for remote on/off control, controlling this switch to turn on or off the unit.

Fig 4. Remote On/Off



NOTE: Remote sense function is used to minimize the effects of distribution losses by regulating the voltage at the remote-sense connections.

Fig 5. Remote Sense



NOTE: Trimming function is allowed the output voltage set point to be adjusted from the default value in a allowed range.

Fig 6. Output Trim

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Input Filtering

The power module should be connected to a low ac-impedance source. Highly inductive source impedance can affect the stability of the power module. For the test configuration in **Fig1**, a 150μF low ESR electrolytic capacitor C_{IN}, mounted close to the power module helps ensure the stability of the unit. For more information, please consult the factory.

Conversation efficiency

To see Fig 2 for the test setup, the efficiency can be calculated as below:

Output Capacitance

The power module requires a minimum output capacitance of 220μF Low ESR aluminum capacitor, C_{OUT} to ensure stable operation over the full range of load and line conditions, see **Fig 3**. If the ambient temperature is under -20℃, it is required to use at least 3pcs of minimum capacitors in parallel. In general, the process of determining the acceptable values of output capacitance and ESR is complex and load-dependent.

Safety Considerations

For safety-agency approval of the system in which the power module is used, the power module must be installed in compliance with the spacing and separation requirements of the end-use safety agency standard, i.e. UL60950-1, CSA C22.2 No.60950-1, and VDE0805-1(IEC60950-1).

For end products connected to –48V dc, or –60Vdc nominal DC MAINS (i.e. central office dc battery plant), no further fault testing is required.

For all input voltages, other than DC MAINS, where the input voltage is less than 60V dc, if the input meets all of the requirements for SELV, then:

- □ The output may be considered SELV. Output voltages will remain within SELV limits even with internally-generated non-SELV voltages. Single component failure and fault tests were performed in the power converters.
- □ One pole of the input and one pole of the output are to be grounded, or both circuits are to be kept floating, to maintain the output voltage to ground voltage within ELV or SELV limits. However, SELV will not be maintained if VI(+) and VO(+) are grounded simultaneously.

For all input sources, other than DC MAINS, where the input voltage is between 60 and 75V dc (Classified as TNV-2 in Europe), the following must be meet, if the converter's output is to be evaluated for SELV:

- □ The input source is to be provided with reinforced insulation from any other hazardous voltages, including the ac mains.
- □ One VIN pin and one VOUT pin are to be grounded, or both the input and output pins are to be kept floating.
- □ Another SELV reliability test is conducted on the whole system, as required by the safety agencies, on the combination of supply source and the subject module to verify that under a single fault, hazardous voltages do not appear at the module's output.
- □ The input pins of the module are not operator accessible.

All flammable materials used in the manufacturing of these modules are rated 94V-0, or tested to the UL60950 A.2 for reduced thickness.

The input to these units is to be provided with a maximum 10A fast-acting fuse in the ungrounded lead.

Remote On/Off

Two remote on/off options are available. Positive logic (device code suffix "P") turns the module on during a logic high voltage on the ON/OFF pin, and off during a logic low. Negative logic remote On/Off, device code suffix "N", turns the module off during a logic high and on during a logic low.

To turn the power module on and off, the user must supply a switch (open collector or equivalent) to control the voltage ($V_{ON/OFF}$) between the ON/OFF terminal and the $V_{IN(-)}$ terminal, see **Fig 4.** Logic low is $0V \le V_{ON/OFF} \le 0.6V$. The maximum $I_{ON/OFF}$ during a logic low is 0.15mA; the switch should maintain a logic low level whilst sinking this current. During a logic high, the typical maximum $V_{ON/OFF}$ generated by the module is 5V, and the maximum allowable leakage current at $V_{ON/OFF}$ = 5V is 1μA.

If not using the remote on/off feature:

- For positive logic, leave the ON/OFF pin open.
- For negative logic, short the ON/OFF pin to $V_{IN(-)}$.

Remote Sense

Remote sense minimizes the effects of distribution losses by regulating the voltage at the remote-sense connections, see **Fig 5.** for the detail configuration. The voltage between the remote-sense pins and the output terminals must not exceed the output voltage sense range given in the Feature Specifications table:

$$[V_{O(+)} - V_{O(-)}] - [SENSE(+) - SENSE(-)] \le 0.5V$$

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, which at the same output current would increase the power output of the module.

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 = $V_{O,SET}$ X $I_{O,MAX}$).

Output Trim

MQ9208ET540 output can be trimmed up or down by connecting one resistor to output negative or positive end as **Fig 6.**

Connecting an external resistor (R_{DN}) between the TRIM pin and the $V_O(+)$ (or Sense (+)) pin decreases the output voltage set point. To maintain set point accuracy, the trim resistor tolerance should be ±1.0% or better. The following equation determines the required external resistor value:

$$R_{DN} = \left(\frac{5.11 * V_{O,SET}}{V_{O,SET} - V_{O.DN}} - 10.22\right) K\Omega$$

$V_{O,SET}$ is the output default set-point voltage of the module, $V_{O.DN}$ is the desired trim-down output voltage.

Connecting an external resistor (R_{UP}) between the TRIM pin and the $V_O(-)$ (or Sense(-)) pin increases the output voltage set point. The following equation determines the required external resistor value:

$$R_{UP} = \left[\frac{5.11 * V_{O,SET}}{V_{O.UP} - V_{O,SET}} * \left(\frac{V_{O.UP}}{1.225} - 1\right) - 10.22\right] K\Omega$$

$V_{O,SET}$ is the output set-point voltage of the module, $V_{O.UP}$ is the desired trim-up output voltage.

Input Under-Voltage Lockout

At input voltages below the input under-voltage lockout limit, the module operation is disabled. The module will only begin to operate once the input voltage is raised above the under-voltage lockout turn-on threshold, $V_{UV/ON}$. Once operating, the module will continue to operate until the input voltage is taken below the under-voltage turn-off threshold, $V_{UV/OFF}$.

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Over-temperature Protection

To provide protection under certain fault conditions, the unit is equipped with a thermal shutdown circuit. The unit will shutdown if the thermal reference points, Tref, exceed135℃(typical)respectively, but the thermal shutdown is not intended as a guarantee that the unit will survive temperatures beyond its rating. The module will automatically restart upon cool-down to a safe temperature.

Output Overvoltage Protection

The output over voltage protection scheme of the modules has an independent over voltage loop to prevent single point of failure. This protection feature latches in the event of over voltage across the output. Cycling the on/off pin or input voltage resets the latching protection feature. If the auto-restart option is ordered, the module will automatically restart upon an internally programmed time elapsing.

Over current Protection

To provide protection in a fault output overload condition, the module is equipped with internal current limiting protection circuitry, and can endure continuous over current by providing constant current output, for up to 4 seconds, as long as the output voltage is greater than VTRIM,MIN. If the load resistance is too low to support $V_{TRIM,MIN}$ in an over current condition or a short circuit load condition exists, the module will shut down immediately.

An auto-restart option is standard. Following shutdown, the module will restart after a period of 3 seconds if the shutdown happens due to over-current protection being triggered or the module will restart after a period of 2.5 seconds when the shutdown happens due to output over-voltage protection getting enabled. A latching shutdown option (4) is also available in a case where an auto recovery is required. If over current greater than 4A persists for few milli-seconds, the module will shut down and auto restart until the fault condition is corrected. If the output overload condition still exists when the module restarts, it will shut down again. This operation will continue indefinitely, until the over current condition is corrected. If the unit is configured with the auto-restart option, it will remain in the hiccup mode as long as the Over current condition exists; it operates normally, once the output current is brought back into its specified range. The average output current during hiccup is 10% Io, max.

Thermal Considerations

The power modules operate in a variety of thermal environments; however, sufficient cooling should be provided to help ensure reliable operation. Considerations include ambient temperature, airflow, module power dissipation, and the need for increased reliability. A reduction in the operating temperature of the module will result in an increase in reliability.The thermal data presented here is based on physical measurements taken in a wind tunnel, using automated thermocouple instrumentation to monitor key component temperatures: FETs, diodes, control ICs, magnetic cores, ceramic capacitors, opto-isolators, and module pwb conductors, while controlling the ambient airflow rate and temperature. For a given airflow and ambient temperature, the module output power is increased, until one (or more) of the components reaches its maximum derated operating temperature, as defined in IPC-9592. This procedure is then repeated for a different airflow or ambient temperature until a family of module output derating curves is obtained.

The output power of the module should not exceed the rated power for the module as listed in the ordering Information table. Although the maximum T_{REF} temperature of the power modules is discussed above, you can limit this temperature to a lower value for extremely high reliability.

The thermal reference points, T_{REF}, used in the specifications for this module is shown in Fig8. For reliable operation, the temperature should not exceed 115℃.

Fig 8 Case Temperature (T_{REF}) Measurement Location (Top view).

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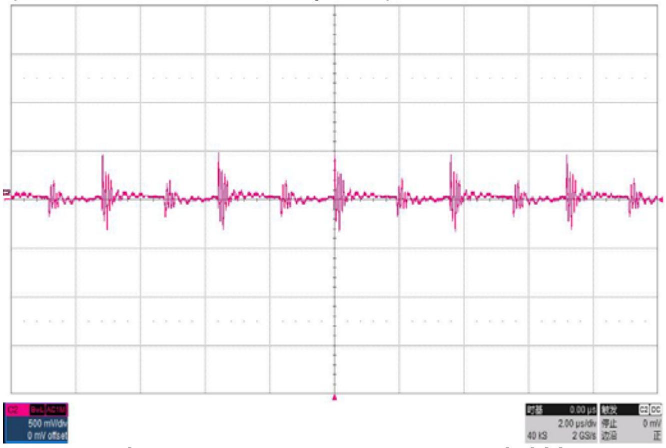
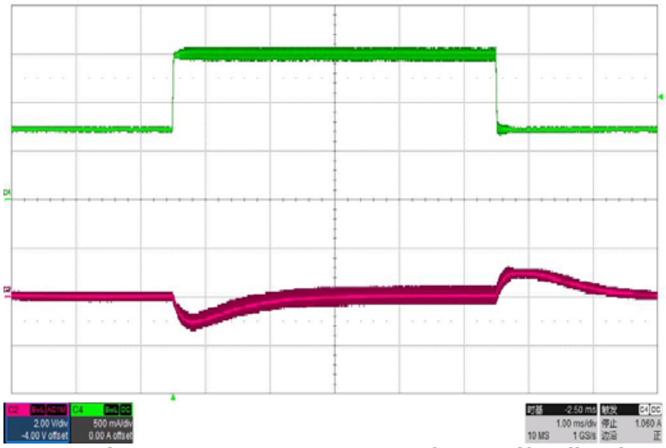
Typical Characteristics– output adjusted to 54V

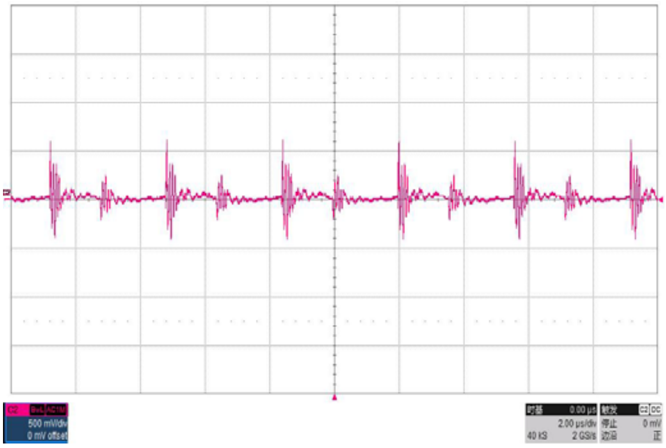
General conditions:
Input filter: 100uF/100V Electrolytic cap
Output filter:100uF/100V Electrolytic Cap



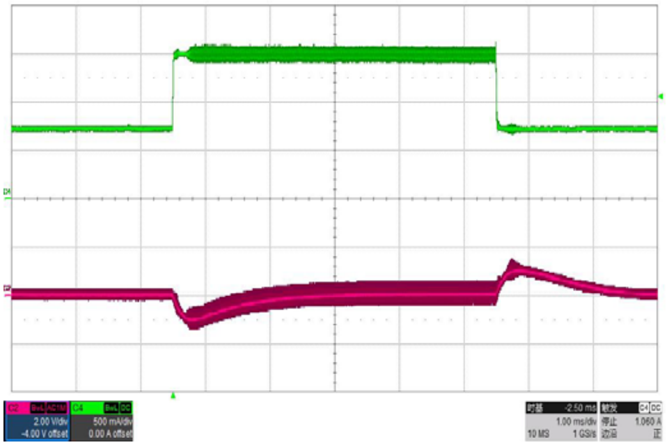
Noise V_{IN}=24V, I_O=1.48A, 20MHz Bandwidth



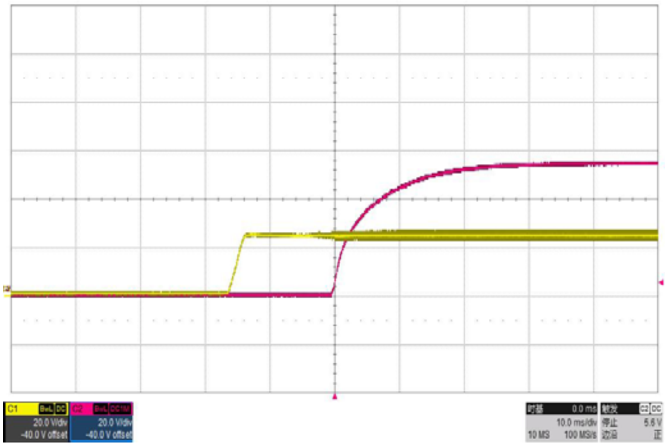
Transient Response V_{IN}=24V, Step from Half-Full-Hal



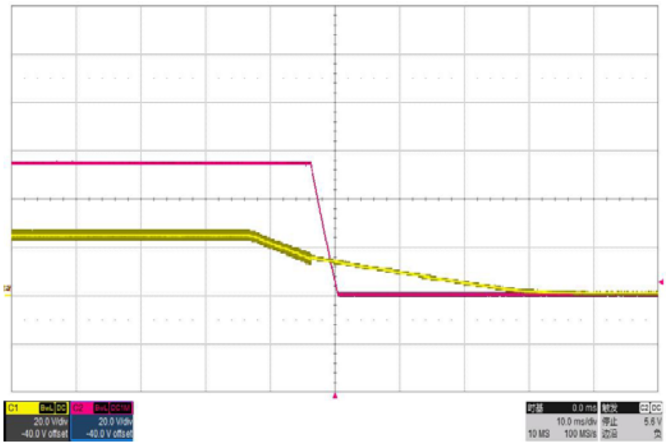
Noise V_{IN}=36V, I_O=1.48A, 20MHz Bandwidth



Transient Response V_{IN}=36V, Step from Half-Full-Half-



Start-up V_{IN}=24V, I_O=FL
C2-- output Voltage, C1-- input Voltage



Shut-down V_{IN}=24V, I_O=FL
C2-- output Voltage, C1 -- input Voltage

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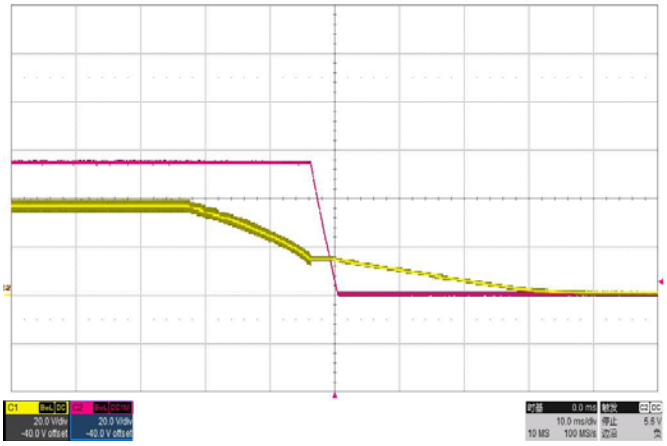
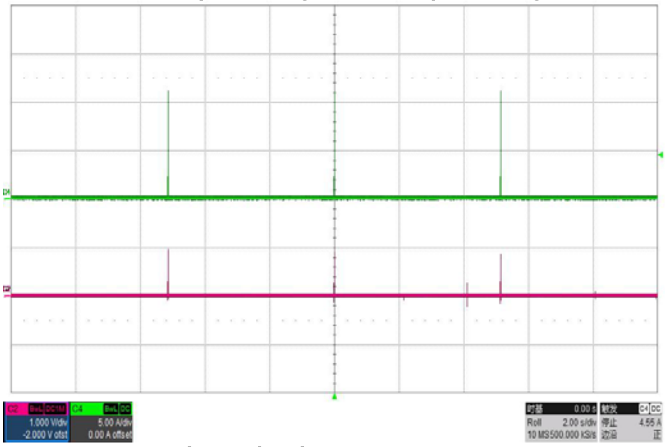
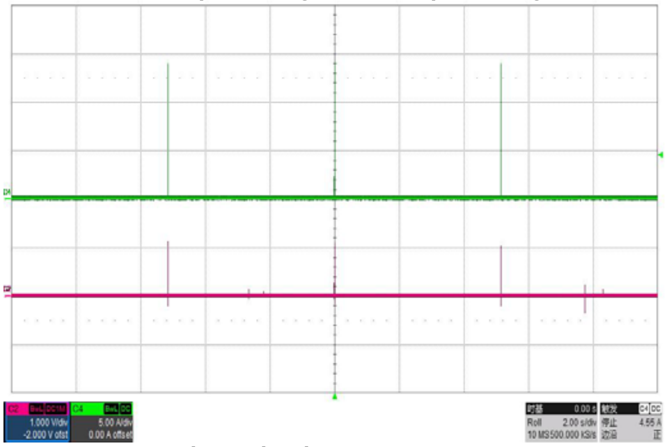
Start-up V_{IN}=36V, I_O=FL
C2-- output Voltage, C1 -- input Voltage



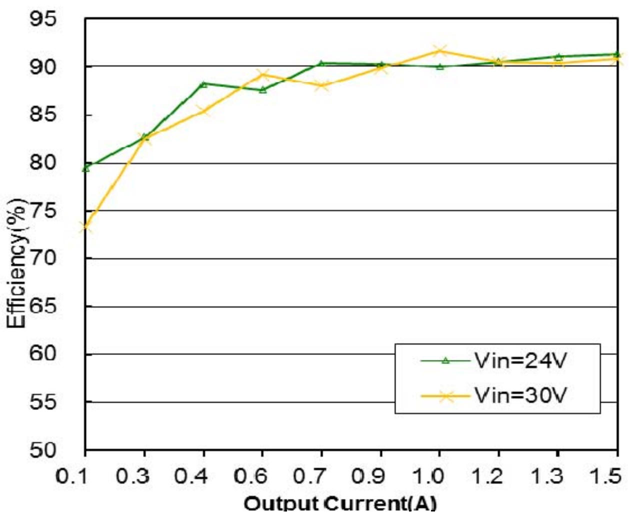
Shut-down V_{IN}=36V, I_O=FL
C2-- output Voltage, C1 -- input Voltage



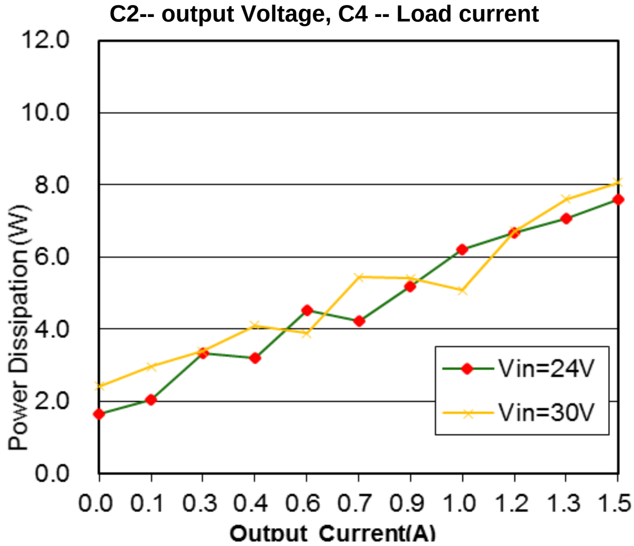
Short-Circuit Output VIN=24V
C2-- output Voltage, C4 -- Load current



Short-Circuit Output V_{IN}=36V
C2-- output Voltage, C4 -- Load current



Efficiency vs. Load Current



Power Dissipation vs. Load Current

Union Microsystems, Shanghai
Tel: *+86 21 5109 5021*
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sales@union-pwr.com
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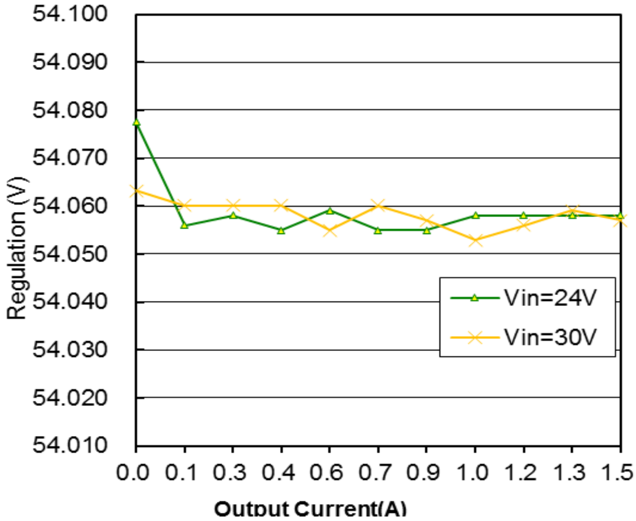
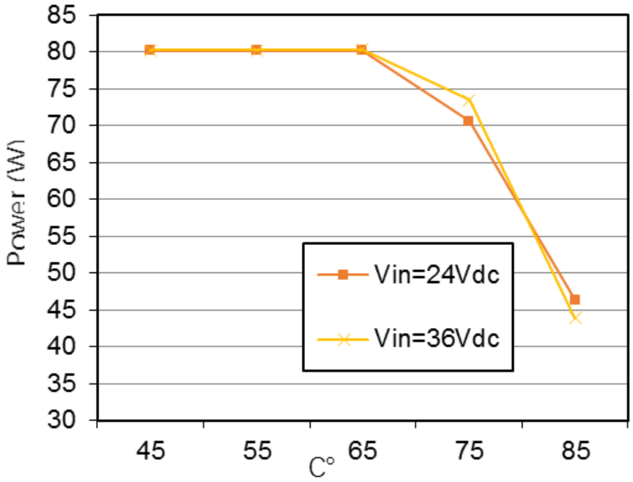


Regulation: Output voltage vs. Load Current



Ambient Temperature vs. Load Current

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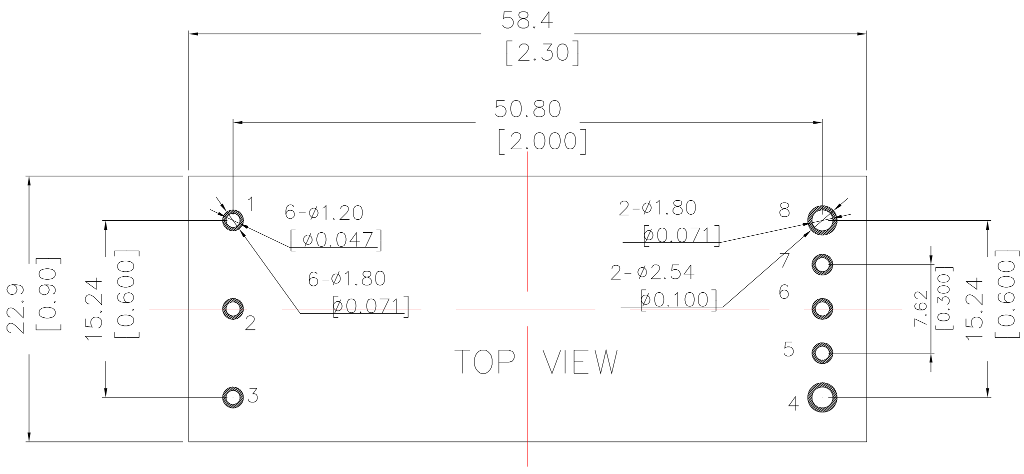
Recommended Hole Pattern

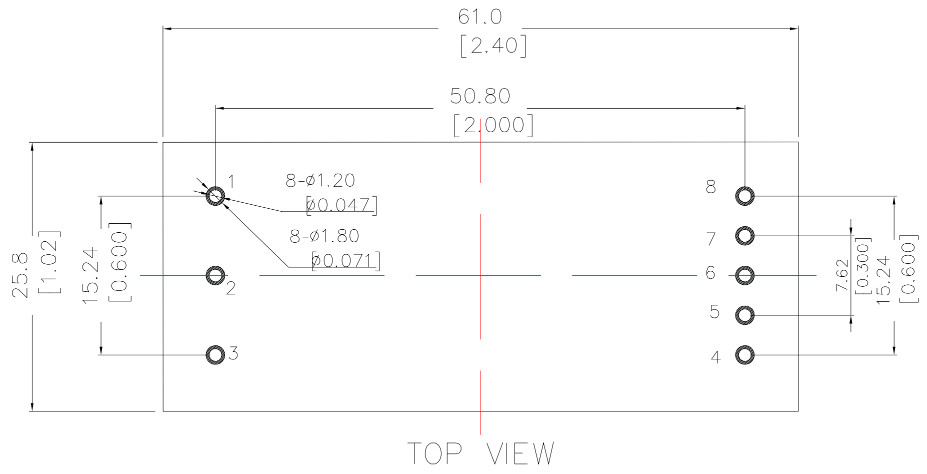
Unit: millimeters (inches)
Tolerances: x.x ±0.5 mm (0.02in), x.xx ±0.25 mm (0.010in), unless otherwise noted



Component side footprint

Recommended Hole Pattern for "HS"

Unit: millimeters (inches)
Tolerances: x.x ±0.5 mm (0.02in), x.xx ±0.25 mm (0.010in), unless otherwise noted



Component side footprint

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Application Notes

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