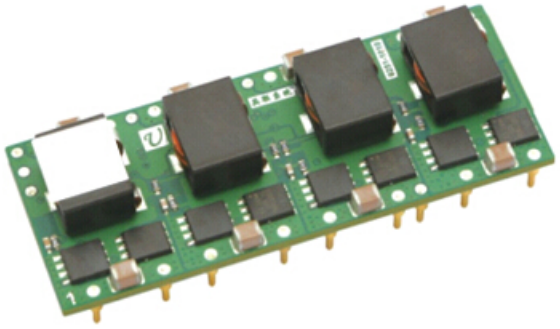
MQ8135L

Non-isolated 7~14VDCinput, 0.8~2V output, 135A with current share DC-DC Converter



APPLICATIONS

- Workstations, servers
- Desktop computers
- DSP applications
- Distributed power architectures
- Telecommunications equipment
- Data communications equipment
- Wireless communications equipment

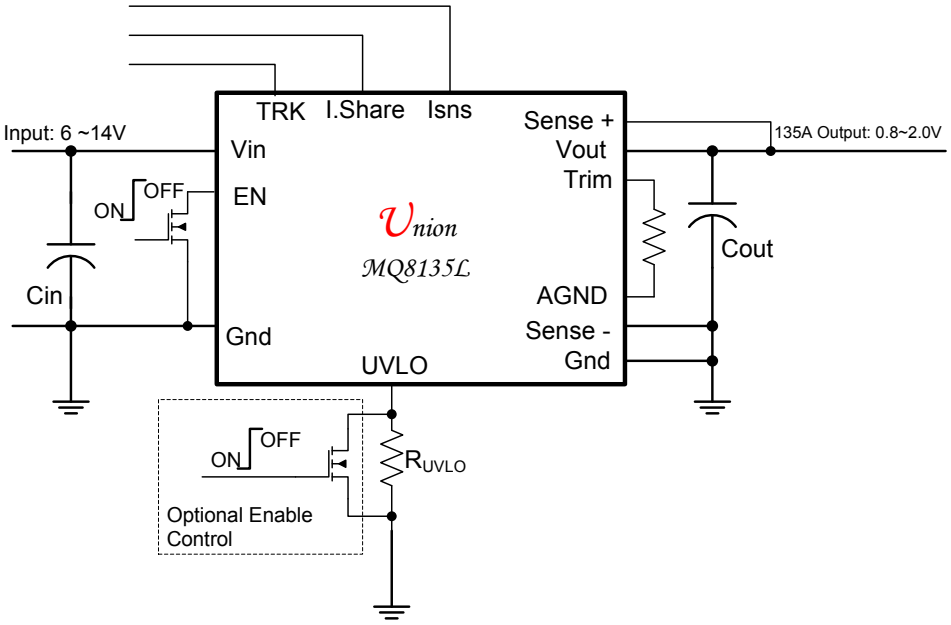
FEATURES

- Unregulated 12V input voltage
- Output Voltage: 0.8V~2V
- Output Current up to 135A
- Output voltage ripple: 40mV$_{PP}$
- High Efficiency 87%
- Remote on/off control
- Over current /short circuit protection
- Over-temperature protection
- Remote Sense
- Parallelized operation up to 5pcs
- High reliability: designed to meet 5 million hour MTBF
- Minimal space on PCB:
  - 68.1 mm x 26.5 mm x 10.6 mm or
  - 2.68 in x 1.05 in x 0.42 in
- Operating Temperature: -40℃~ +85℃
- UL/IEC/EN60950 compliant

Description

The ***MQ8135L2*** series Power Modules are non-isolated dc-dc converters that operate over a wide input voltage range of 7Vdc to 14Vdc and provide a precisely (2%) regulated dc output with industry standard pin configuration. Such a module is suitable to application with unregulated 12V power supply bus. The modules have a maximum output current rating of 135A at typical full-load efficiency over 87%. Standard features include remote on/off with positive logic and output voltage adjustment, over-current protection, over-temperature protection. Option features include through hole or SMD.

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

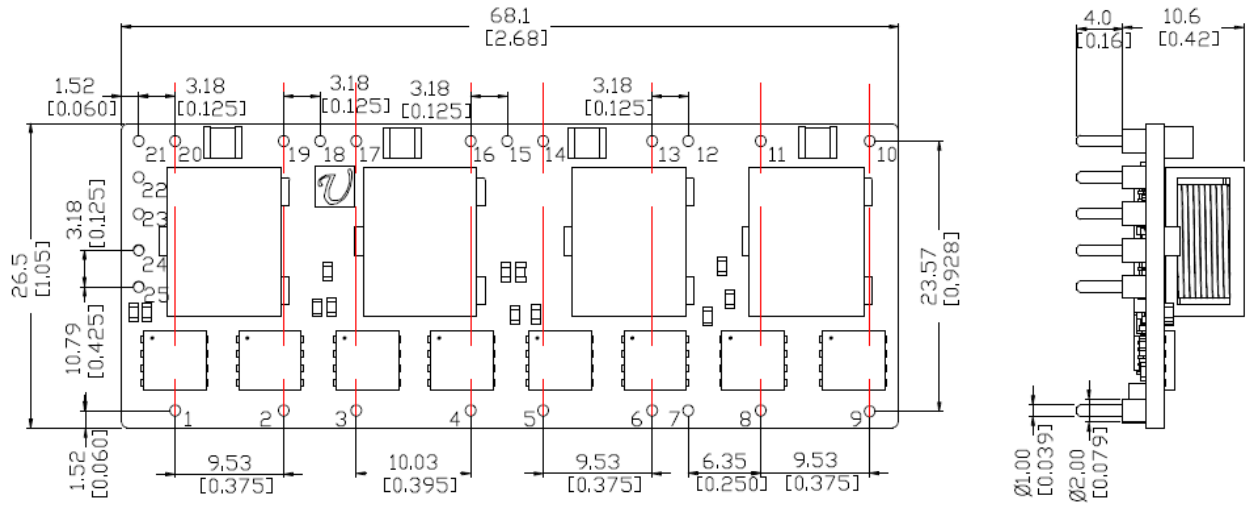


Performance Specifications(at Ta=+25℃)

Model	Input V_{IN} Range (V)	Output				Efficiency (%)
		I_{OUT} (A)	Trim Range (V)	Regulation		
				Line (%)	Load (%)	
MQ8135LT2-VX	7 ~ 14	135	0.8 ~ 2	0.5	0.5	87%
MQ8135LS2-VX						
MQ8135LT2-CX	7 ~ 14	135	0.8 ~ 2	/	/	/
MQ8135LS2-CX						

Mechanical Specifications

Dimensions are in mm (inches)
Tolerances: x.x ±0.5mm ,x.xx ±0.25mm, unless otherwise noted



DESIGNATIONS		
Pin No	**Description**	**Function**
1,3,5,8,11,14,17,20	GND	Bias and reference ground for all signals
2,4,6,9	V_{IN}	Input voltage PIN
7	ENABLE	Input pin used for enable control of Output
12	UVLO	Input pin
10,13,16,19	VOUT	Output PIN
15	R.S+	Connect to positive remote sensing point
18	R.S-	Connect to negative remote sensing point
21	Trim	This PIN is charged output voltage by connecting resistor to AGND
22	AGND	Bias and reference ground for control signals
23	I.Share	Current balance for multiple modules parallel operation
24	TRK	Track PIN
25	Isns	Input pin for output current sense if used as current source, or just left it floating.

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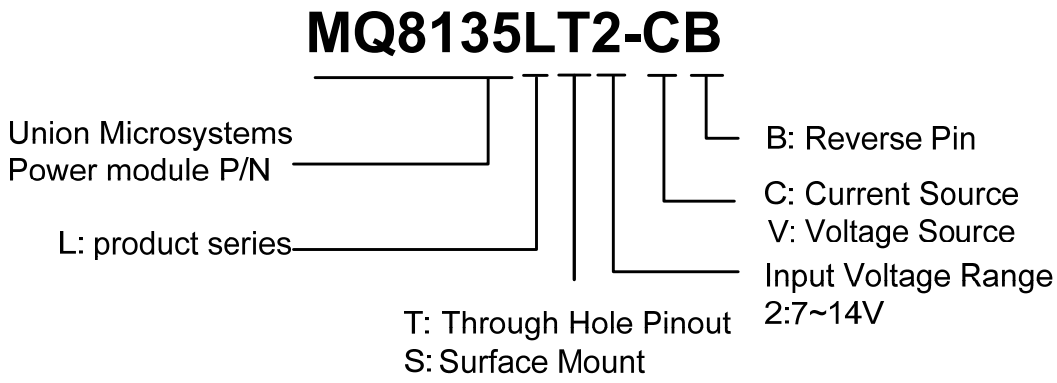
Ordering Information



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}	-0.3	16	V
Storage Temperature	T_{STG}	-40	125	℃

MQ8135Lx2 Electrical Specifications: *(T_A=+25℃)*

Parameter	Condition	Symbol	Min	Typ	Max	Unit
Input Voltage Range		V_{IN}	7		14	V
Output Current		Io	0		135	A
Output Voltage Set point	100% load	ΔVo	-2		+2	%
Temperature Regulation	T_A= $T_{A.MIN}$ To $T_{A.MAX}$	-		0.4		%$V_{O.SET}$
Remote Sense Range					0.5	V
Line Regulation	See each output's corresponding character figure					
Load Regulation						
Output Ripple and Noise Voltage	Io=20A,0~20MHz（***Detail Please see corresponding figure***）					
Transient Response						

General Specifications

Parameter	Condition	Symbol	Min	Typ	Max	Unit
Over current Protection				TBD		A
Output short-circuit current (average)	All			325		A
Under Voltage Lockout Trip Level	Input rising			6.54		V
	Input falling			5.42		
Start-up Delay				14.8		mS
Start-up Time	100A resistive load, no external output capacitors			1.85		mS
Switching Frequency		Fo		300		KHz
Operating Temperature	Natural convection		-40		85	℃
Vibration	3 Axes, 5 Min Each	10~55Hz，0.35mm，5G				
	3 Axes, 6 Times Each	Peak Deviation 300g，Settling Time 6mS				
MTBF		5,000,000				Hour

Test Configurations

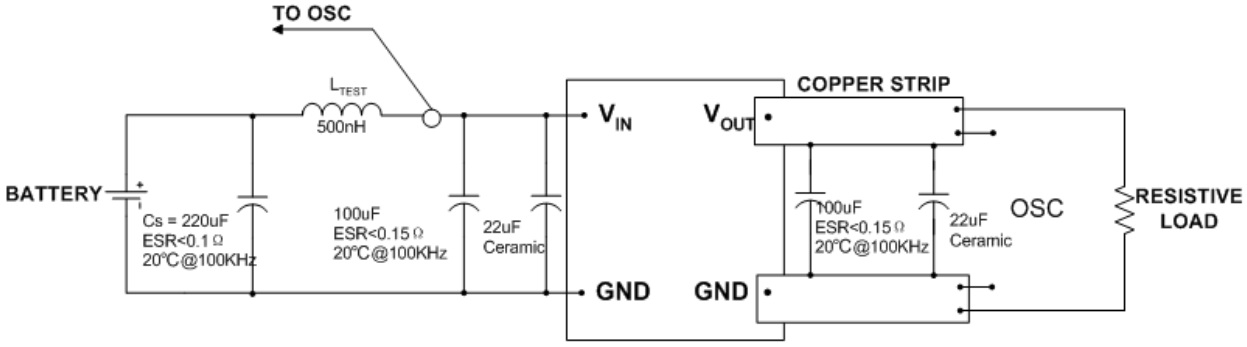


Fig 1 Test setup for input noise, output noise and ripple

Note:

Output noise is measured with 0.1μ F ceramic capacitor connected at the output. OSC measurement should be made using a BNC socket. Position the load between 50mm and 75mm（2in. and 3in）from the tested module.

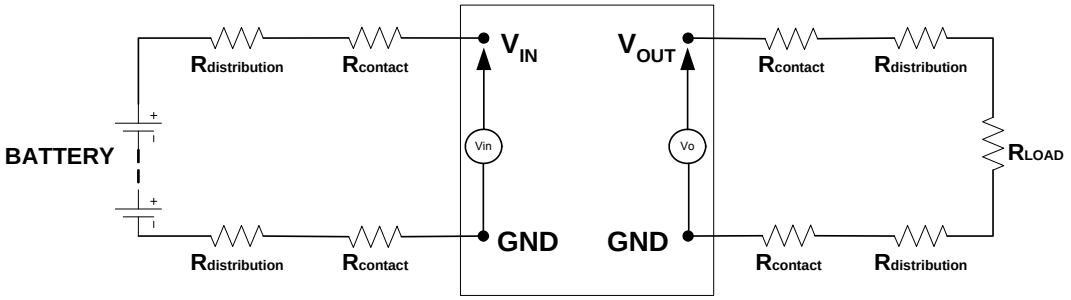


Fig 2 Test setup for efficiency

Note:

All voltage measurements must be taken at the module's terminals, as shown above. If sockets are needed, Kelvin connections are required at the module terminals to avoid measurement errors due to socket contact resistance.

Technical Notes

Input Voltage Range

The *MQ8135LX2* Series can be used in a wide variety of applications, esp. most of unregulated 12V intermediate power supply bus system. Its wide input voltage ranges can tolerate worst voltage drop from cheap isolated Brick-type Bus-converter, so it reduces total system cost on power supply.

Return Current Paths

The *MQ8135LX2* Series are non-isolated DC/DC converters. ALL Common pins are connected to each other internally. To the extent possible with the intent of minimizing ground loops, input return current should be directed through pin 1,3 (also referred to as---Input or Input Return), and output return current should be directed through pin 7,10 (also referred to as---Output or Output Return) as short as possible.

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I/O Filtering

All the specifications of the MQ8135LX2 Series are tested with specified output capacitors. However, certain input capacitors are necessary to improve the power modules' operating conditions and to reduce the ac impedance. For example, under some conditions, the power modules can't normally start up when fully loaded due to the high ac-impedance input source. External input capacitors serve primarily as energy-storage devices. They should be added close to the input pins of the MQ8135LX2 and selected for bulk capacitance (at appropriate frequencies), low ESR, and high rms-ripple-current ratings. All external capacitors should have appropriate voltage ratings. To reduce the amount of ripple current fed back to the input supply (input reflected-ripple current), an external L-C filter can be added with the inductance as close to the power module as possible.

MQ8135LX2's output ripple and transient response can be improved with the increasing output capacitance. When using output capacitors, take care that the total output capacitance does not exceed MQ8135LX2's Maximum Capacitive Load to avoid issuing the module's over-current protection mechanism in the start-up procedure.

When an external L-C filter is added to reduce ripple on load, for best results, the filter components should be mounted close to the load circuit rather than the power module.

When testing the relationship between external capacitors and output voltage noise, the oscilloscope's probe should be applied to the module's end directly with scope probe ground less than 10mm in length。

Input Fusing

The MQ8135LX2 Series is not internally fused. Certain applications and/or safety agencies may require the installation of fuses at the inputs of power conversion components. The selection of the fuses should conform to the following：

1. The fuse value should be selected to be greater than the maximum input current of the modules, which occurs at the minimum input voltage.
2. Use either slow-blow or normal-blow fuses.
3. Both input traces must be capable of carrying a current of 1.5 times the value of the fuse without opening.

Safety Considerations

MQ8135LX2's are non-isolated DC/DC converters. In general, all DC-DC's must be installed in compliance with relevant safety-agency specifications (usually UL/IEC/EN60950). In particular, for a non-isolated converter's output voltage to meet SELV (safety extra low voltage) requirements, its input must be SELV compliant. If the output needs to be ELV (extra low voltage), the input must be ELV.

Remote Sense

MQ8135LX2 Power Modules offer a positive output sense function on pin SENSE. The sense function enables point-of-use regulation for overcoming moderate IR drops in conductors and/or cabling. The sense line carries very little current and consequently requires a minimal cross-sectional-area conductor. As such, it is not a low-impedance point and must be treated with care in layout and cabling. Sense lines should be run adjacent to signals (preferably ground). If the remote sense is not needed the sense pin should be left open or connected to V_{OUT} directly.

Use of trim and sense functions can cause the output voltage to increase, thereby increasing output power beyond the MQ8135LX2's specified rating. Therefore:

$$V_{OUT}\text{（at pins）} \times I_{OUT} \leq P\text{（rated output power）}$$

ON/OFF Control

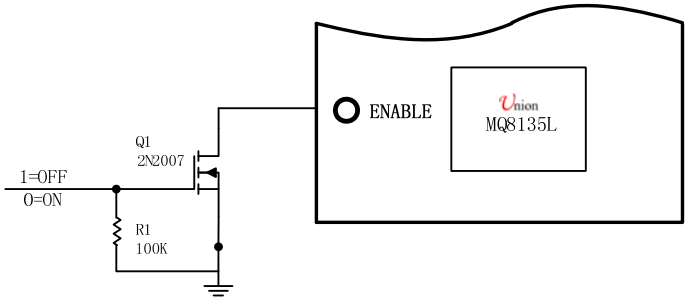

Fig 3, Remote ON/OFF Implementation with Open Drain transistor for positive logic control

The MQ8135LX2 power modules feature an On/Off pin for remote On/Off operation with positive logic. If not using the remote On/Off pin, leave the pin open (module will be On). The On/Off pin signal (Von/Off) is referenced to ground. To switch module on and off using remote On/Off, refer to Figure 3.

Output Over-voltage Protection

MQ8135LX2 Series products do not incorporate output over voltage protection. If the operating circuit requires protection against abnormal output voltage, voltage-limiting circuitry must be provided external to the power module.

Output Over current Protection (OCP)

MQ8135LX2 incorporates over current and short circuit protection. If the load current exceeds the over current protection setpoint, the MQ8135LX2's internal over current-protection circuitry immediately turns off the module, which then goes into Hiccup mode.The unit operates normally once the output current is brought back into its specified range. The typical average output current during hiccup is less than 5A.

Caution：Be careful never to operate MQ8135LX2 in a "heavy overload" condition that is between the rated output current and the over current protection setpoint. This can cause permanent damage to the components.

Over-temperature Protection (OTP)

To ensure MQ8135LX2's reliability and avoid damaging its internal components，MQ8135LX2 incorporates over-temperature protection circuit。When the temperature of the PCB is above 130℃, the over temperature protection circuit will be enabled and the module will stop working. When the temperature of the temperature-testing component is below about 100℃, the over temperature protection circuit will release and the module will automatically recover from shutdown. To avoid permanently damaging components, the surface temperature of MQ8135LX2's power components, esp. of the MOSFET (T_{REF} in Fig4) should be ensured below 125℃.

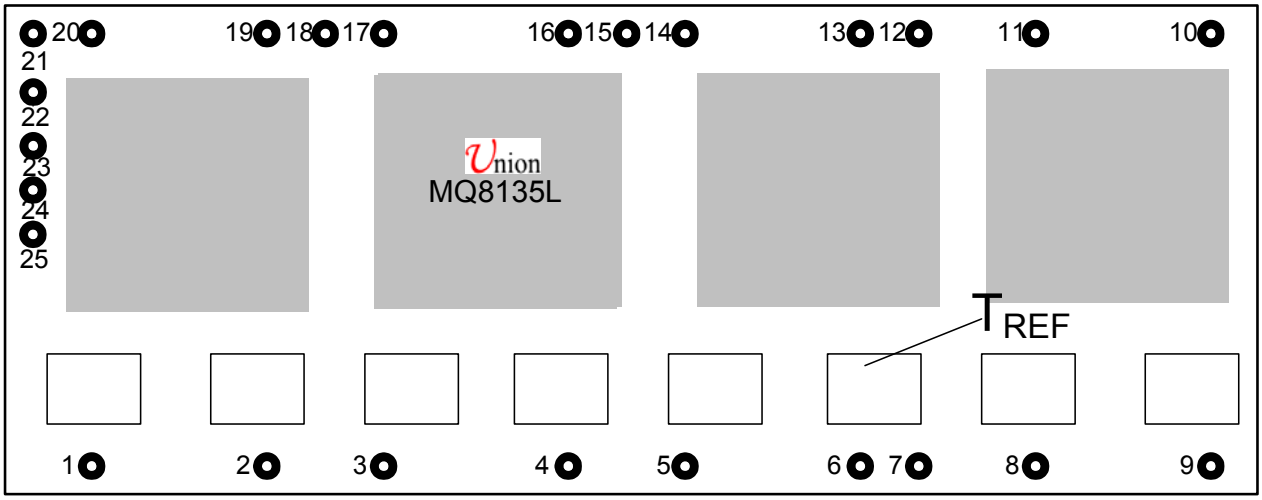

Fig 4, Temperature Reference Point

Note：The over temperature protection may be issued when MQ8135LX2 operates in a "heavy overload" condition for a long time. Thus, the airflow should be improved.

UVLO setting

MQ8135LX2's UVLO threshold can be adjusted by connecting one resistor from UVLO pin to GND. The Resistor for corresponding threshold can be calculated as below：

For MQ8135LX2:

$$R_{UVLO} = \frac{3879}{(V_{TH} - 2.5) * 31.1 - 124.75} - 1$$

Resistor values are in kΩ; V_{TH} is desired UVLO threshold.

Also ULVO can be used as Enable control. If UVLO voltage is lower than V_{th}, the module will shut down all internal ICs, input current can be lower than 1mA. For Energy harvesting application, recommend to connect UVLO PIN to GOUND for saving electric power consumption when the module is not under operation.

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Table 1, the required trim resistors R_{TRIM} for most common voltages

MQ8135LX2	
V_{TH}	R_{UVLO}
7.0V	254kΩ
7.5V	125kΩ
8.0V	82.8kΩ
9.0V	48.7kΩ
10.0V	34.8kΩ

Output Voltage Trimming

MQ8135LX2's output voltage can be trimmed in certain ranges. See Figure 5 for the programming method. See performance Specifications for allowable trim ranges in detail. Also customized products are offered.

Trim with external resistor (Fig 5), the equation as below:

For MQ8135LX2:

$$R_{TRIM} = \frac{8000}{V_O - 0.8} - 1696$$

Resistor values are in Ω; V_O is desired output voltage.

If trim the output of MQ8135LX2 to 1.5V, then

$$R_{TRIM} = \frac{8000}{1.5 - 0.8} - 1696 = 9732$$

So, R_{TRIM} =9.76kΩ

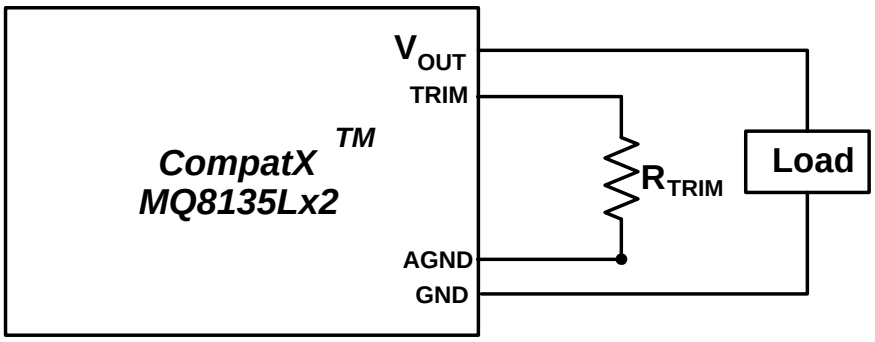

Fig5. Circuit configuration for programming output voltage using external resistor

For most common voltages, the required Trim resistors as Table 2.

Table 2, the required trim resistors R_{TRIM} for most common voltages

MQ8135LX2	
R_{TRIM}	V_{OUT}
Open	0.8V
38.3k	1.0V
18.2k	1.2V
9.53k	1.5V
6.19k	1.8V
4.97k	2.0V

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Active Load Sharing

For additional power requirements, the***MQ8135Lx2***power module is also available in parallel operation. Up to five modules can be configured, in parallel, with active load sharing.Good layout techniques should be observed when using multiple units in parallel. To implement forced load sharing, the following connections should be made:

•The I.Share and AGND pins of all units in parallel must be connected together. The path of these connections should be as direct as possible.

•All remote-sense pins should be connected to the power bus at the same point, i.e., connect all the SENSE(+) pins to the (+) side of the bus. Close proximity and directness are necessary for good noise immunity.

Some special considerations apply for design of converters in parallel operation:

•When sizing the number of modules required for parallel operation, take note of the fact that current sharing has some tolerance. In addition, under transient conditions such as a dynamic load change and during startup, all converter output currents will not be equal. To allow for such variation and avoid the likelihood of a converter shutting off due to a current overload, the total capacity of the paralleled system should be no more than 75% of the sum of the individual converters. As an example, for a system of four ***MQ8135Lx2*** converters in parallel,the total current drawn should be less that 75% of (4x 135A) , i.e. less than 405A.

•All modules should be turned on and off together.This is so that all modules come up at the same time avoiding the problem of one converter sourcing current into the other leading to an over current trip condition. To ensure that all modules come up simultaneously, the on/off pins of all paralleled converters should be tied together and the converters enabled and disabled using the on/off pin.

•The share bus is not designed for redundant operation and the system will be non-functional up on failure of one of the unit when multiple units are in parallel. In particular, if one of the converters shuts down during operation, the other converters may also shut down due to their outputs hitting current limit. In such a situation, unless a coordinated restartis ensured, the system may never properly restart since different converters will try to restart at different times causing an overload condition and sub sequent shut down. This situation can be avoided by having an external output voltage monitor circuit that detects a shutdown condition and forces all converters to shut down and restart together.

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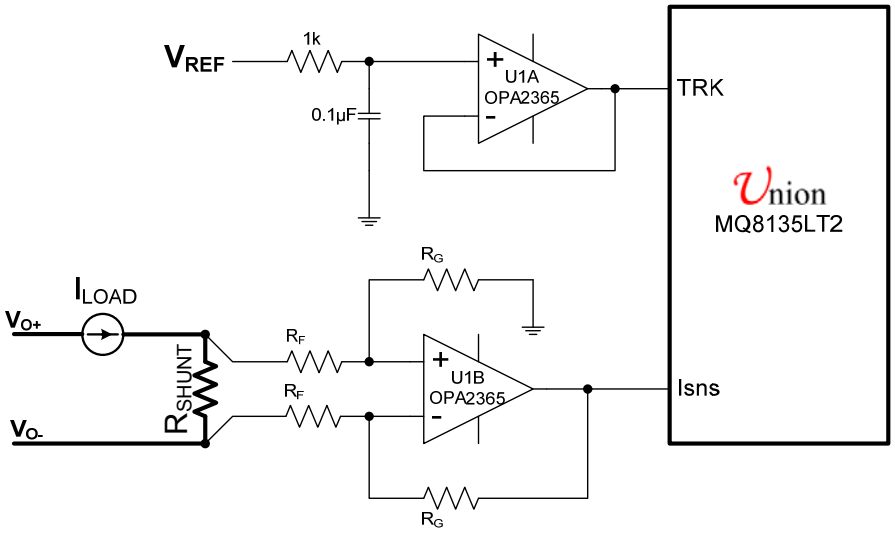
Application as a programmable constant current source



The relationship between output current (I_{out}) and V_{REF} is as below equation

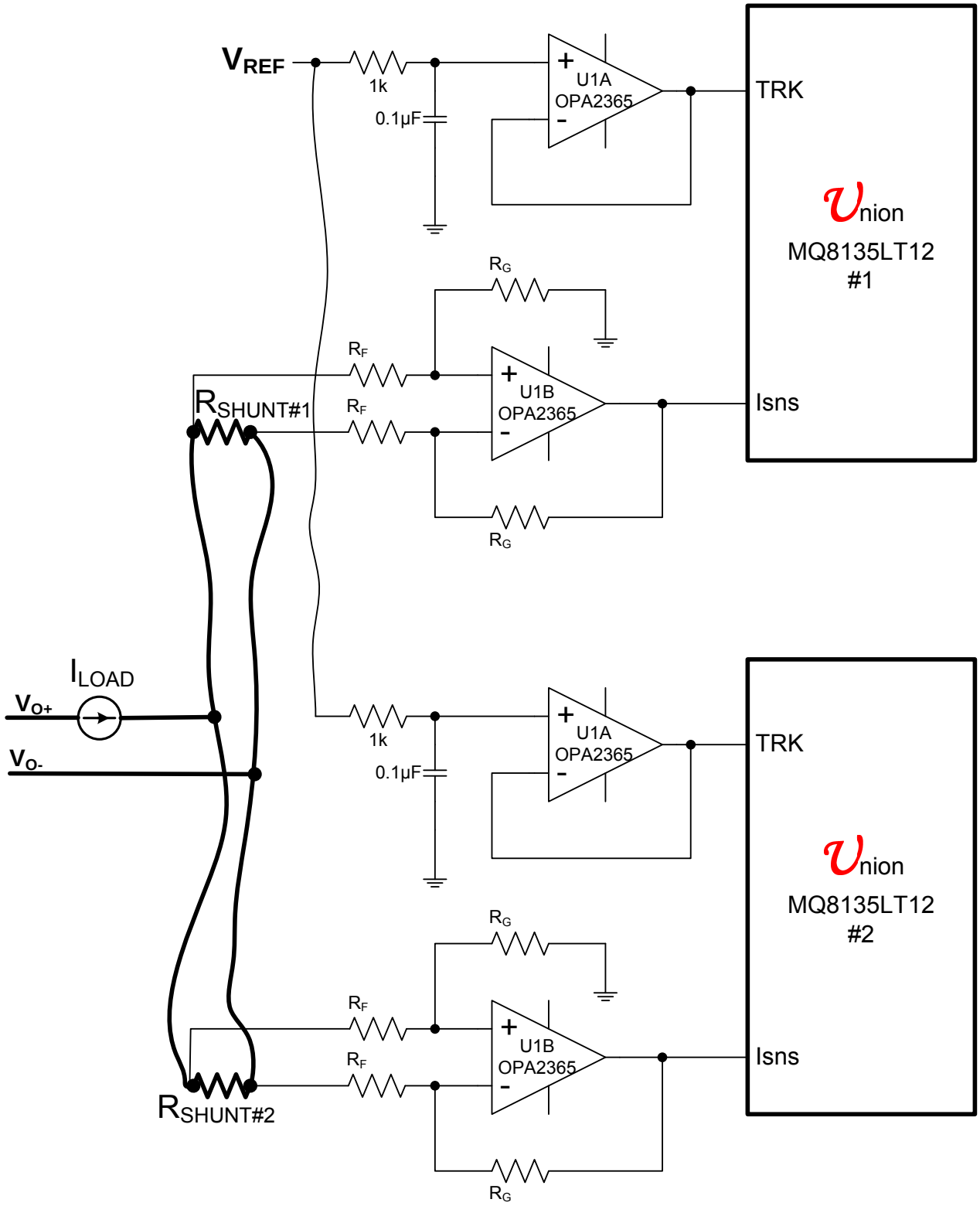
$$I_{OUT} = \frac{V_{REF} * R_F}{R_{SHUNT} * R_G}$$

Resistor values are in Ω; Voltage values are in V; I_{OUT} is desired output current.
if choosing BOM as below,
R_{SHUNT} =0.5mR;
R_F =1K,
R_G =20K,
Then, the relationship between output current and the reference voltage is as following table.

V_{REF}(V)	I_{OUT}(A)
0.5	50
0.6	60
0.7	70
0.8	80
0.9	90
1.0	100

Note: Please set the output voltage to 2V as table 2 or the output current will be limited by output voltage.

Parallel operation for two programmable constant current sources



To ensure parallel operation normally, it is necessary to choose all parameters same for two power modules. The calculation can refer to previous section. To prevent current overshoot, it is a **MSUT** to set V_{REF} to zero with more than 50mS after module is powered up.

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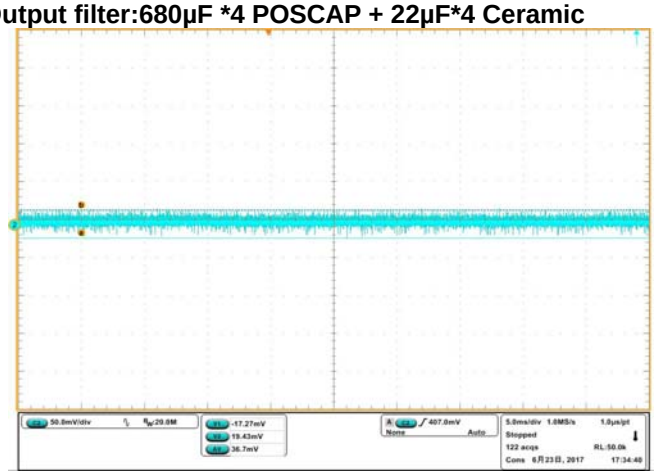
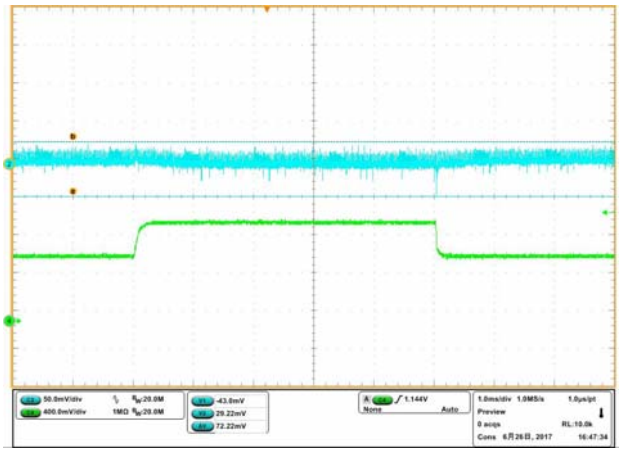
Typical Characteristics – output adjusted to 0.8V

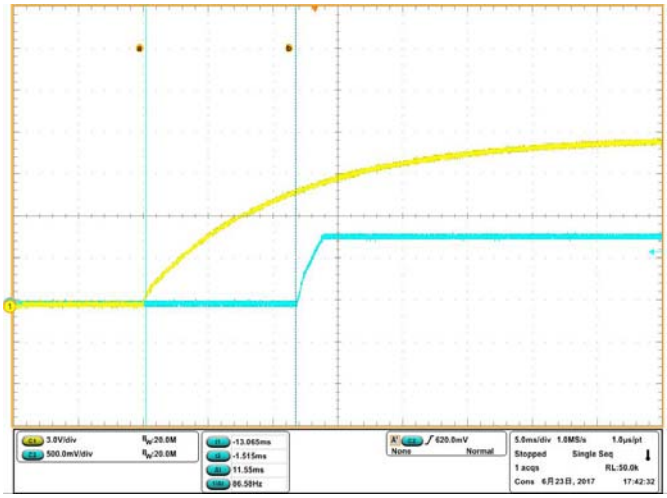
General conditions:
Input filter:330μF*4 AL-CAP;
Output filter:680μF *4 POSCAP + 22μF*4 Ceramic



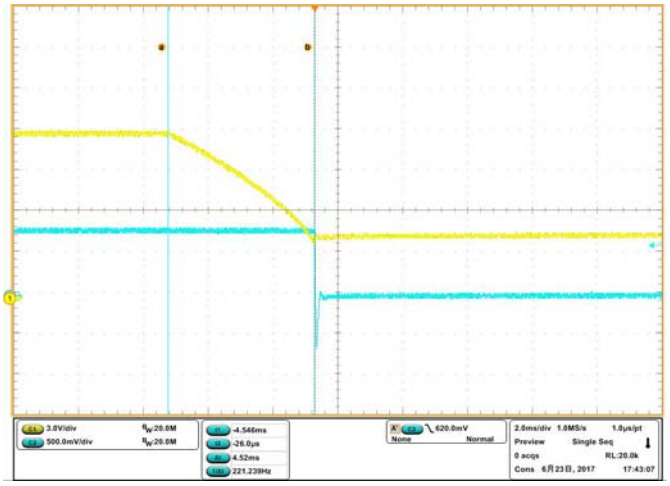
Noise V_{IN}=12V, I_O=135A, 20MHz Bandwidth



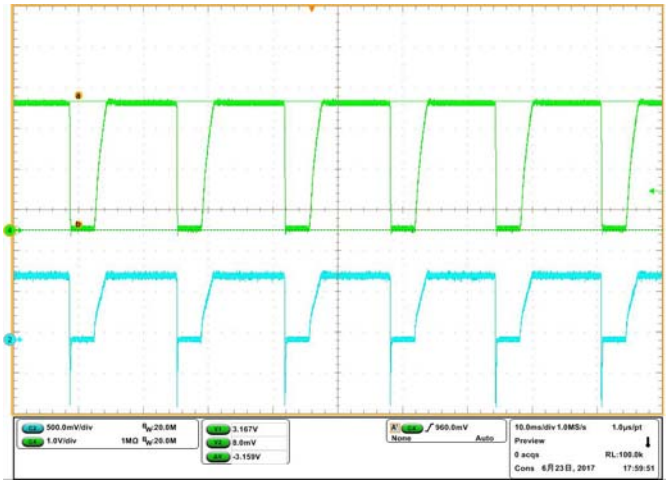
Transient Response V_{IN}=12V, Step from 65A~135A~65A
Blue: Output Current Green: Output Ripple



Start-up V_{IN}=12V, I_O=135A
Yellow: Input Voltage Blue: Output Voltage



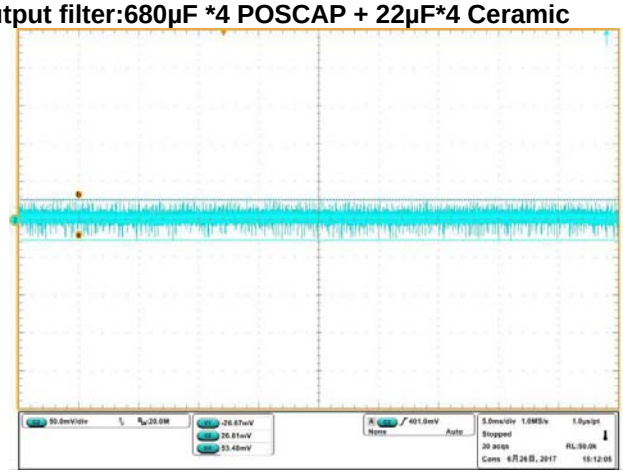
Shut-down V_{IN}=12V, I_O=135A
Yellow: Input Voltage Blue: Output Voltage



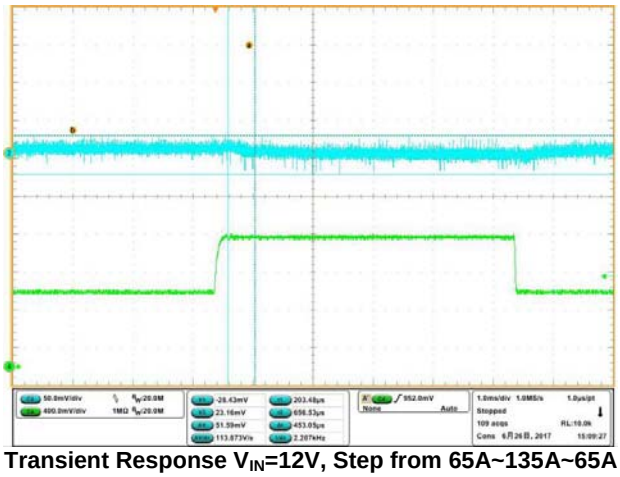
Short-Circuit Output VIN=12V
Blue: output Voltage Green: Load current

Typical Characteristics – output adjusted to 1.2V

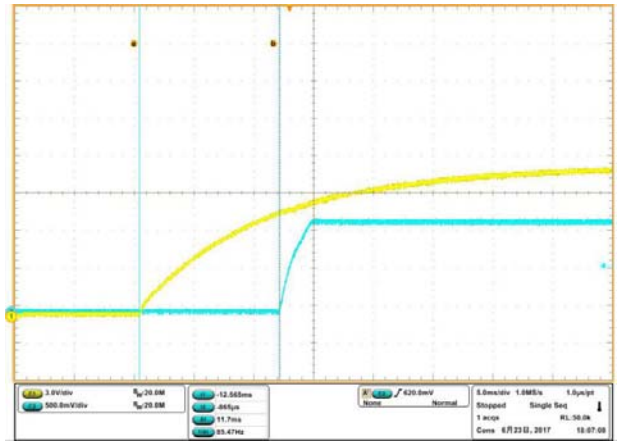
General conditions:
Input filter:330μF*4 AL-CAP;
Output filter:680μF *4 POSCAP + 22μF*4 Ceramic



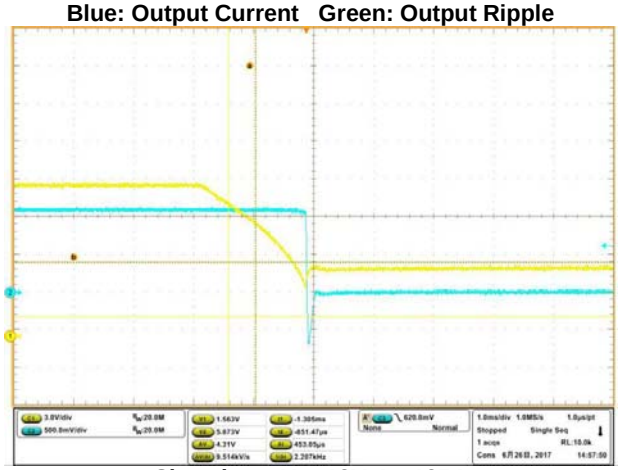
Noise V_{IN}=12V, I_O=135A, 20MHz Bandwidth



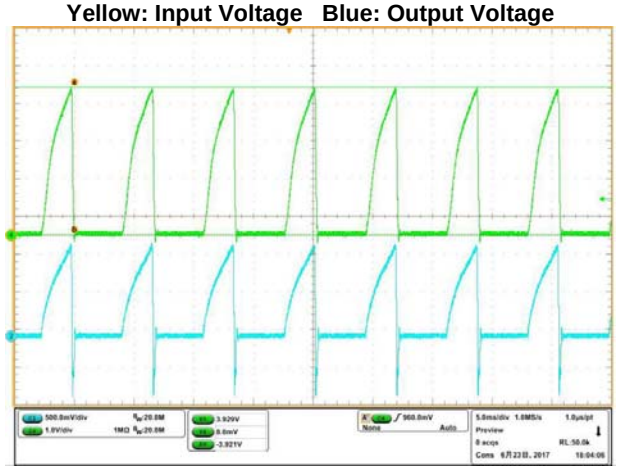
Transient Response V_{IN}=12V, Step from 65A~135A~65A
Blue: Output Current Green: Output Ripple



Start-up V_{IN}=12V, I_O=135A
Yellow: Input Voltage Blue: Output Voltage



Shut-down V_{IN}=12V, I_O=135A
Yellow: Input Voltage Blue: Output Voltage



Short-Circuit Output VIN=12V
Blue: output Voltage Green: Load current

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Typical Characteristics – output adjusted to 1.5V

General conditions:
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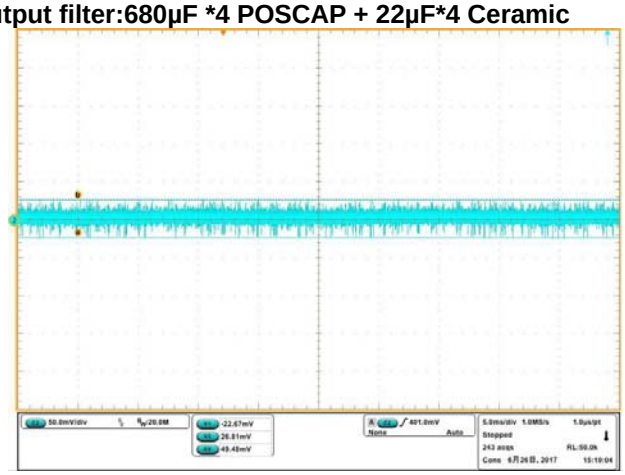
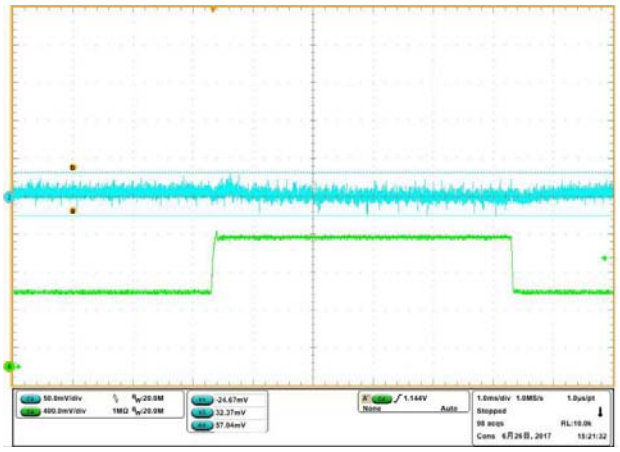
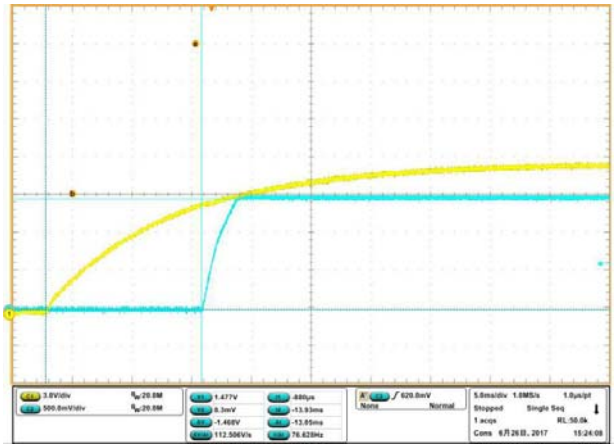
Output filter:680μF *4 POSCAP + 22μF*4 Ceramic



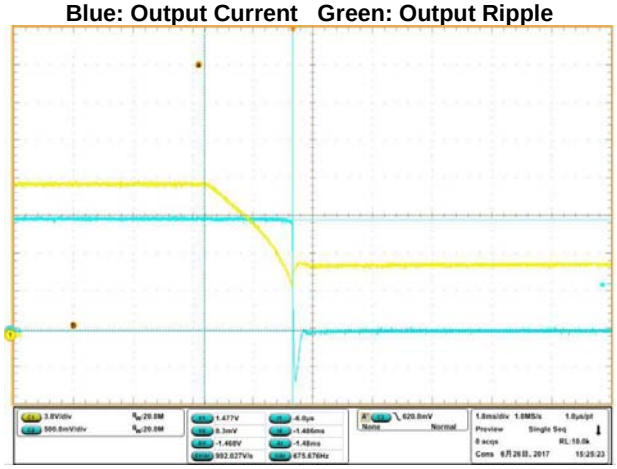
Noise V_{IN}=12V, I_O=135A, 20MHz Bandwidth



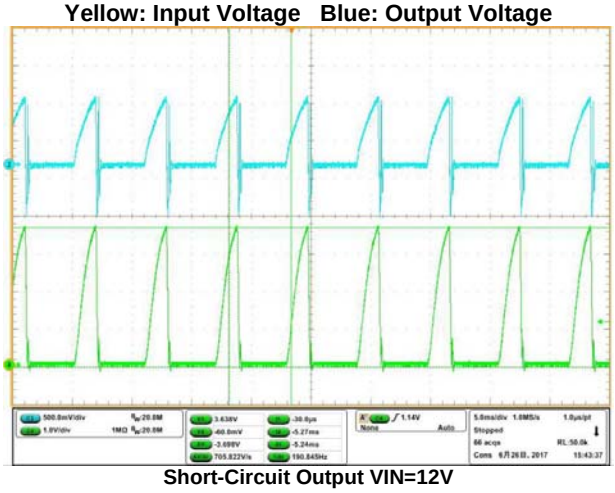
Transient Response V_{IN}=12V, Step from 65A~135A~65A
Blue: Output Current Green: Output Ripple



Start-up V_{IN}=12V, I_O=135A
Yellow: Input Voltage Blue: Output Voltage



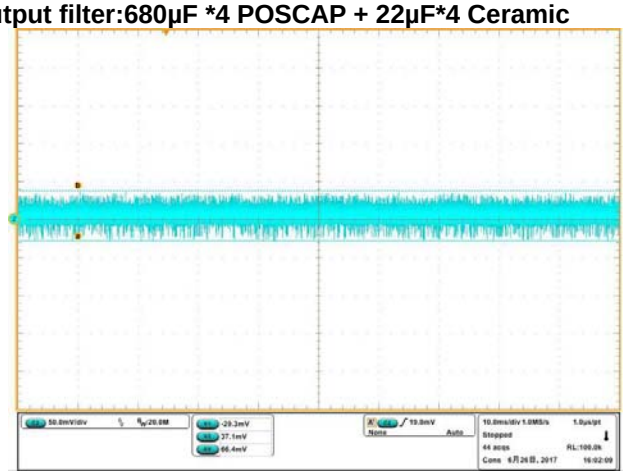
Shut-down V_{IN}=12V, I_O=135A
Yellow: Input Voltage Blue: Output Voltage



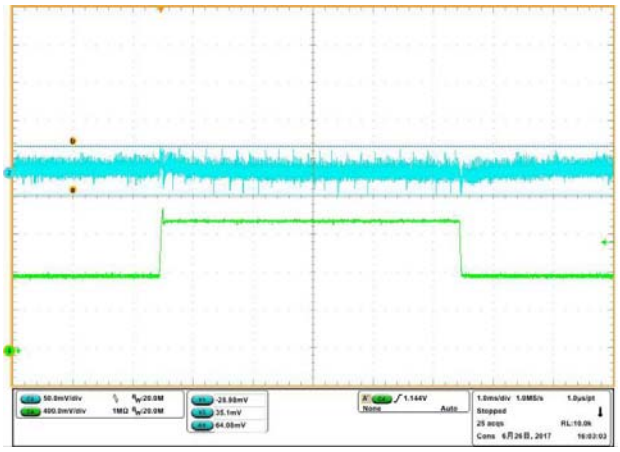
Short-Circuit Output VIN=12V
Blue: output Voltage Green: Load current

Typical Characteristics – output adjusted to 2V

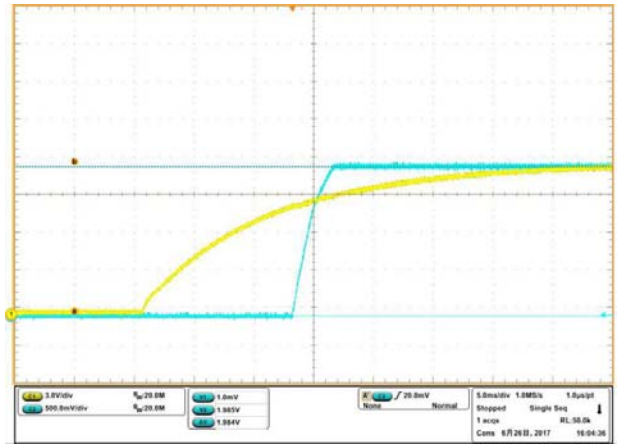
General conditions:
Input filter:330μF*4 AL-CAP;
Output filter:680μF *4 POSCAP + 22μF*4 Ceramic



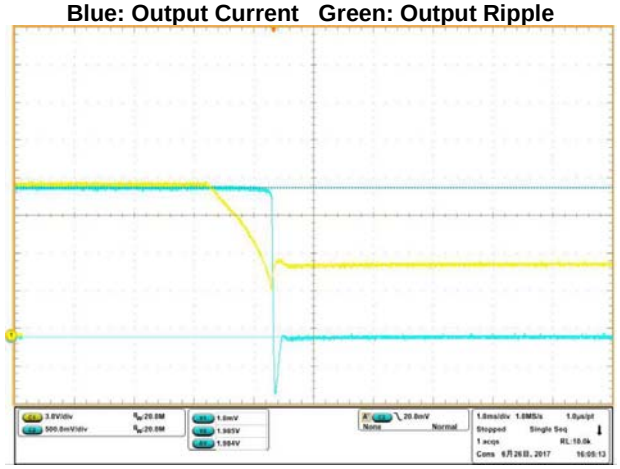
Noise V_{IN}=12V, I_O=135A, 20MHz Bandwidth



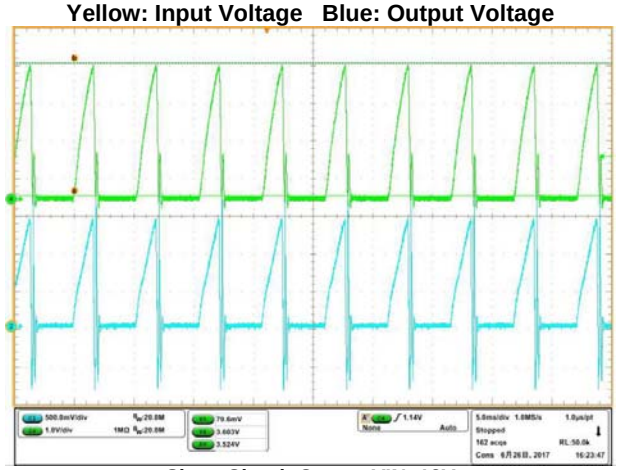
Transient Response V_{IN}=12V, Step from 65A~135A~65A
Blue: Output Current Green: Output Ripple



Start-up V_{IN}=12V, I_O=135A
Yellow: Input Voltage Blue: Output Voltage



Shut-down V_{IN}=12V, I_O=135A
Yellow: Input Voltage Blue: Output Voltage



Short-Circuit Output VIN=12V
Blue: output Voltage Green: Load current

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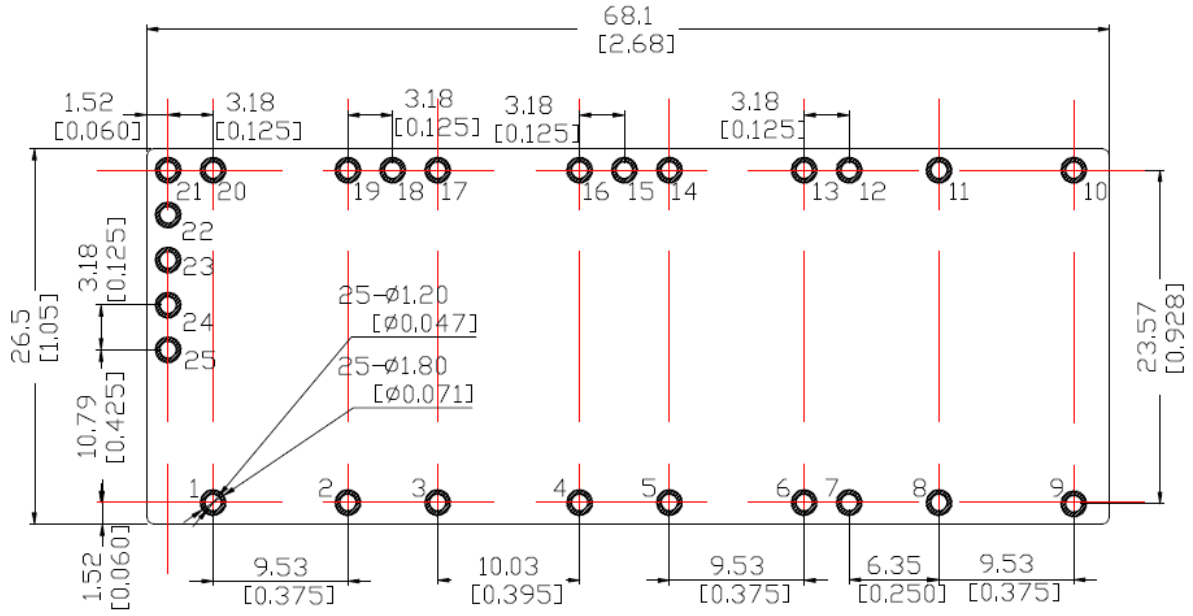
sales@union-pwr.com
www.union-pwr.com

Recommended Hole Pattern for Through-Hole part

Dimensions are in millimeters(inches)



Component-side footprint

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Application Notes

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