MegaTarzan™ MQ7286PL

Non-isolated 4.5~14.4VDC input, 0.6~2.0V output, 40A DC-DC Converter

Features

- Wide operating voltage:
  - 4.5V ~ 14.4V
- Output voltage programmable via external resistor
  - 0.6V ~ 2.0V
- Output Current up to 40A
- Power Good signal
- Output voltage ripple: 20mVpp
- High Efficiency 93%
- Fixed switching frequency with capability of external synchronization.
- Over current /Short circuit protection (Hiccup)
- Over-temperature protection
- Remote on/off control – negative or positive
- High reliability: designed to meet 5 million hour MTBF
- Output voltage remote sense compensation
- Minimal space on PCB:
  - 33.0mm x 13.5mm x 10.9mm or
  - 1.30in x 0.53in x 0.43in
- Wide operating temperature range (-40°C to 85°C)
- Design to meet UL/IEC/EN60950
- RoHS Compliant

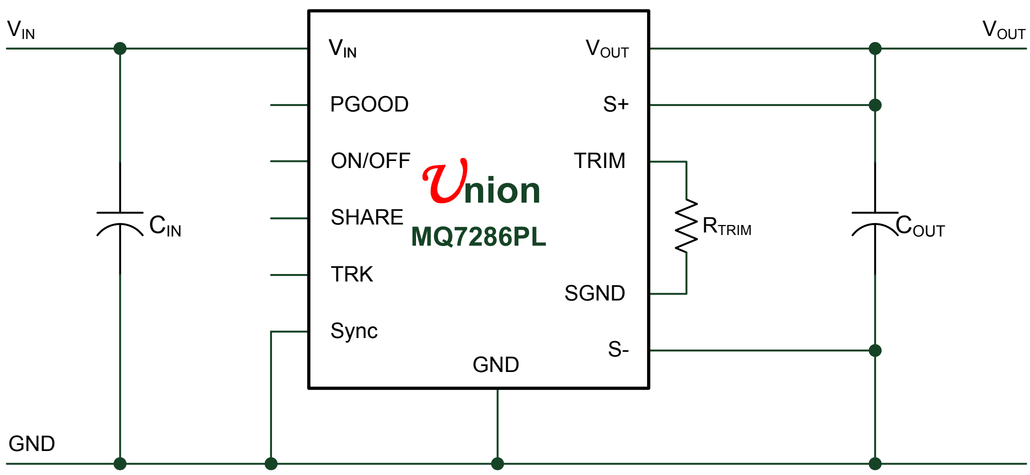
Applications

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

Description

The ***MegaTarzan™*** MQ7286PL2 Series Power Modules are non-isolated dc-dc converters that operate over a wide input voltage range of 4.5Vdc to 14.4Vdc and provide a precisely 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 40A at typical full-load efficiency over 91.5%. Default features include remote on/off with positive logic and output voltage adjustment, over-current protection, over-temperature protection. Option features include positive or negative logic mode.

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



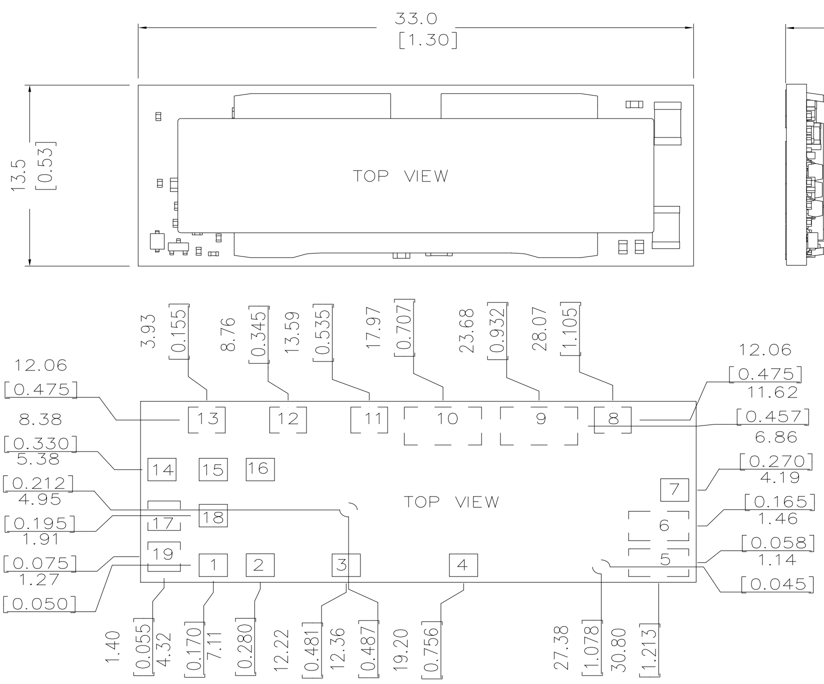
Performance Specifications (at T_A=+25℃)

Model	Input V_{IN} Range (V)	Output				Efficiency (%)
		I_{OUT} (A)	Trim Range (V)	Regulation		
				Line (%)	Load (%)	
MQ7286PL2	4.5~14.4	40	0.6V ~ 2.0V	0.5	0.5	91.5

Mechanical Specifications

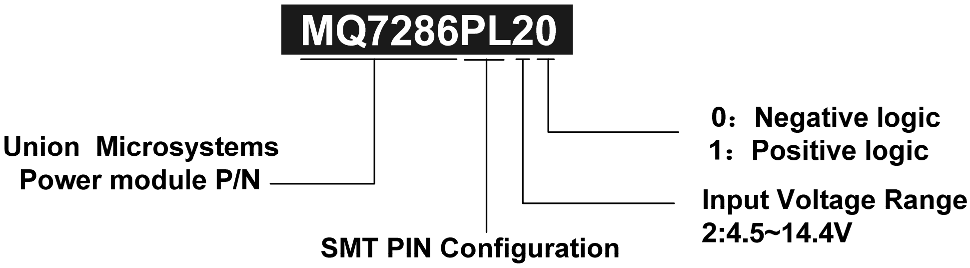
Dimensions are in millimeters (inches)

Tolerances: x.x mm±0.5mm (x.xx in ±0.02 in); x.xx mm±0.25mm (x.xxx in ±0.01 in)



Pin	Description
1	NA
2	NA
3	NA
4	PGOOD
5	Vin
6	GND
7	SYNC
8	TRK
9	GND
10	Vout
11	TRIM
12	S+
13	SHARE
14	S-
15	NA
16	NA
17	GND
18	SGND
19	ON/OFF

Ordering Information



For examples:

MQ7286PL20 means MQ7286PL in SMT pin, input voltage 4.5~14.4V, output voltage 0.6V~2.0V, negative logic control

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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	15	V
Storage Temperature	T_{STG}	-55	125	℃

MQ7286PL Electrical Specifications: *(T_A=+25°C)*

Parameter	Condition		Symbol	Min	Typ	Max	Unit
Input Voltage Range			V_{IN}	4.5	12	14.4	V
Maximum Input current	V_{IN}=4.5V to 14.4V, I_O=$I_{O,\ max}$		$I_{IN,max}$			24	A
Input No Load Current	V_{IN} = 12Vdc, I_O = 0A, module enabled	Vo=0.6V	$I_{IN,No\ load}$		55		mA
		Vo=2.0V			105		
Input Stand-by Current	V_{IN} = 12Vdc, module disabled		$I_{IN,stand-by}$		12.5		mA
Inrush Transient			I^2t			1	A^2S
Input Reflected Ripple Current, peak-to-peak	5Hz to 20MHz, 1μH source impedance; V_{IN} =0 to 14.4V, I_O= I_{Omax} ;See Test Configurations				90		mApp
Output Current			Io	0		40	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=40A,0~20MHz（***Detail Please see corresponding figure***）						
Transient Response							

General Specifications

Parameter		Condition	Symbol	Min	Typ	Max	Unit
Maximum Capacitive Load		40A resistive load + Solid Electrolytic capacitor ESR⩾2mΩ			8500		μF
Over current Protection		All		50		65	A
Over Temperature Protection		All	T_{ref}		117		℃
Output short-circuit current (average)		All				3	A
Forced Load Share Accuracy					10		%
Under Voltage Lockout Trip Level		Rising and falling V_{IN}, 3% hysteresis		4.1		4.4	V
Positive Logic	Logic High (Module ON)		V_{IH}	V_{IN}-0.7		$V_{IN.MAX}$	V
	Logic Low (Module OFF)		V_{IL}	-0.7		V_{IN}-1.4	V
Negative Logic	Logic High (Module OFF)		V_{IH}	3		$V_{IN.MAX}$	V
	Logic Low (Module ON)		V_{IL}	-0.7		1.2	V
Start-up Time		40A resistive load, no external output capacitors			2	5	mS
Switching Frequency			Fo		400		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

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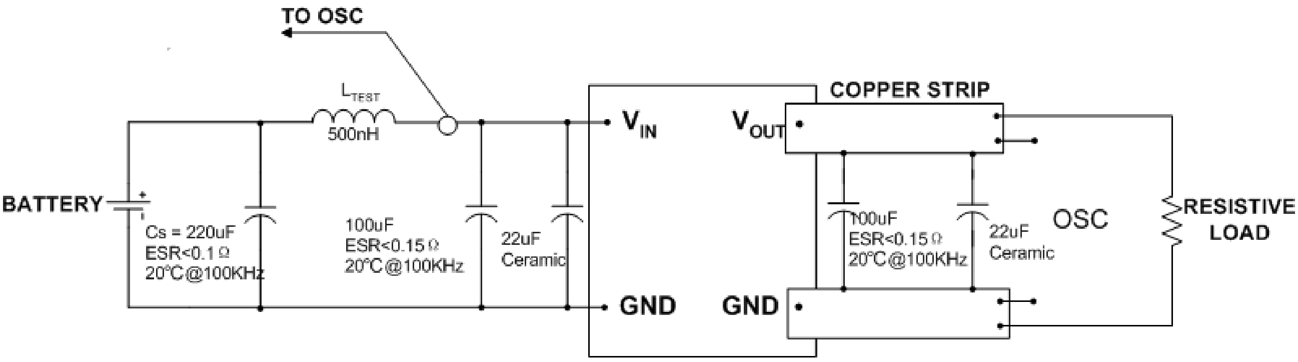
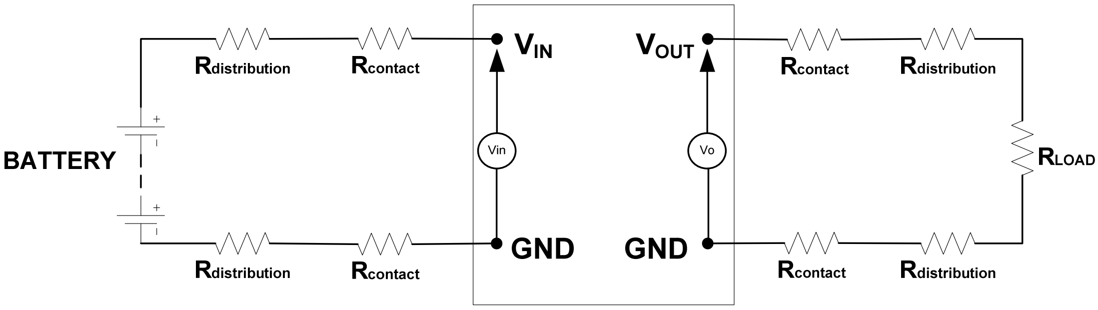
Test Configurations



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.



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 MQ7286PL 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 MQ7286PL Series are non-isolated DC/DC converters. Their two Common pins (pins 6 and 9) 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 6 (also referred to as---Input or Input Return), and output return current should be directed through pin 9 (also referred to as---Output or Output Return) as short as possible.

I/O Filtering

All the specifications of the MQ7286PL 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 MQ7286PL and selected for bulk capacitance (at appropriate frequencies), low ESR, and high rms-ripple-current ratings. All external capacitors should have

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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.

MQ7286PL'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 MQ7286PL'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 MQ7286PL 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 fast-blow 20A fuses.
2. Both input traces must be capable of carrying a current of 1.5 times the value of the fuse without opening.

Safety Considerations

MQ7286PL'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

MQ7286PL Power Modules offer a positive output sense function on pin VS+. 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 MQ7286PL's specified rating. Therefore:

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

ON/OFF Control

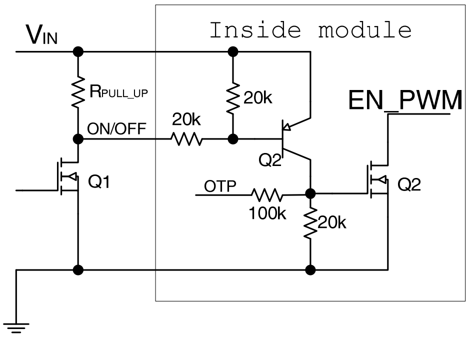

Fig1a. Remote ON/OFF Implementation with pull-up transistor for positive logic control

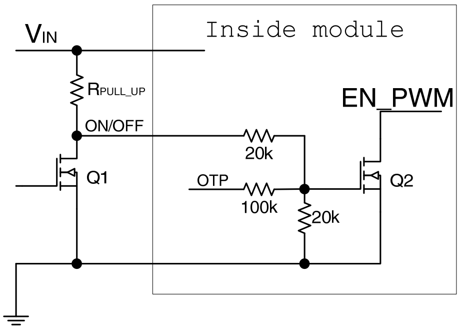

Fig1b, Remote ON/OFF Implementation with Open Collector/Drain transistor for negative logic control

The MQ7286PL power modules feature an On/Off pin for remote On/Off operation with optional negative or 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 1a~1b. 20k pull-up resistor for positive logic will be suitable, 5.11k will be reasonable value for negative logic control.

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Output Over voltage Protection

MQ7286PL 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)

MQ7286PL incorporates over current and short circuit protection. If the load current exceeds the over current protection set point, the MQ7286PL'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 3A.

Caution*：*Be careful never to operate MQ7286PL in a "heavy overload" condition that is between the rated output current and the over current protection set point. This can cause permanent damage to the components.

Over temperature Protection (OTP)

To ensure MQ7286PL's reliability and avoid damaging its internal components，MQ7286PL 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 120℃, the over temperature protection circuit will release and the module will automatically recover from shutdown. To avoid permanently damaging components, the surface temperature of MQ7286PL's power components, esp. of the MOSFET (T_{REF} in Fig2) should be ensured below 125℃.

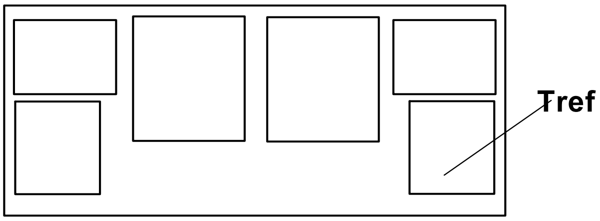

Fig2, Temperature Reference Point

Note*：*The over temperature protection may be issued when MQ7286PL operates in a "heavy overload" condition for a long time. Thus, the airflow should be improved.

Output Voltage Trimming

MQ7286PL's output voltage can be trimmed in certain ranges. See Figure 3 for the 2 programming methods. See Performance Specifications for allowable trim ranges in detail. Also customized products are offered.

Trim with external resistor (Fig3), the equation as below,

$$R_{TRIM} = \frac{12000}{V_O - 0.6}$$

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

For examples, to trim output to 1.5V, then

$$R_{TRIM} = \frac{12000}{1.5 - 0.6} = 13333$$

So, choose R_{TRIM} = 13.3kΩ

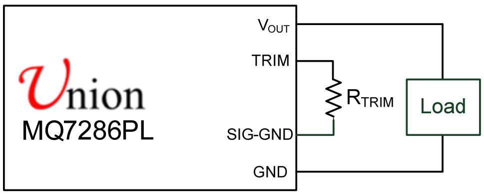

Fig3. Circuit configuration for programming output voltage using external resistor

***Caution** – Do not connect SIG-GND to GND elsewhere in the layout*

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For most common voltages, the required Trim resistors are as Table 1.

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

Desired Voltages (V)	R_{TRIM} (kΩ)
0.6	Open
0.9	40
1.0	30
1.2	20
1.5	13.3
1.8	10
2.0	8.57

Active Load Sharing

For addition power requirements, the MQ7286PL2 power module is also available in parallel operation. Up to five modules can be configured in parallel with active load sharing.

To implement paralleling, the following conditions must be satisfied.

- All modules connected in parallel must be frequency synchronized where they are switching at the same frequency. This is done by using the sync function of the module and connecting to an external frequency source. Modules can be interleaved to reduce input ripple/filtering requirements.
- The share pins of all units in parallel must be connected together .the path of these connections should be as direct as possible.
- The remote sense connections to all modules should be made that to same points for the output, i.e. all VS+ and VS- terminals for all modules are connected to the power bus at the same points.

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 90% of the sum of the individual converters. As an example, for a system of three MQ7286PL2 converters in parallel, the total current drawn should be less that 90% of (3x 40A), i.e. less than 108A.
- 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.
- If the Sequencing function is being used to start-up and shut down modules and the module is being held to 0V by the tracking signal then there may be small deviations on the module output. This is due to controller duty cycle limitations encountered in trying to hold the voltage down near 0V.
- The share bus is not designed for redundant operation and the system will be non-functional upon 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 restart is ensured, the system may never properly restart since different converters will try to restart at different times causing an overload condition and subsequent shutdown. 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.

When not using the active load share feature, share pins should be left unconnected.

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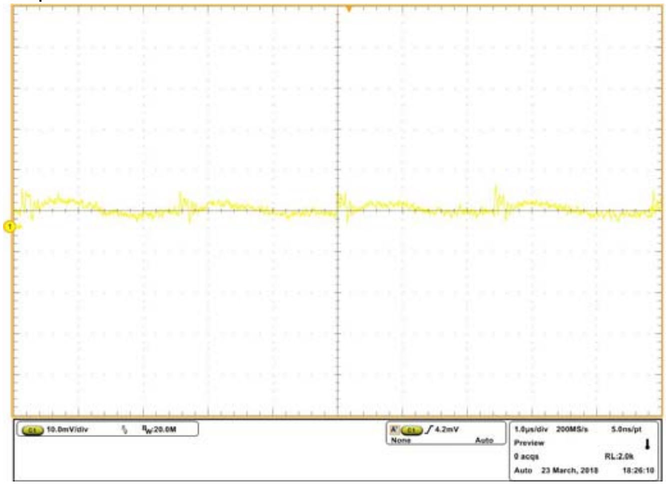
Typical Characteristics – output adjusted to 0.6V

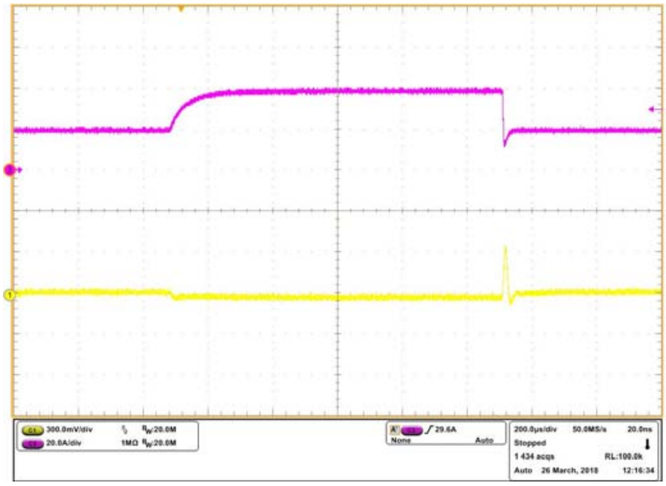
General conditions:

Input filter：270uF/25V*1 Solid Electrolytic CAP+10uF/25V*4 ceramic;

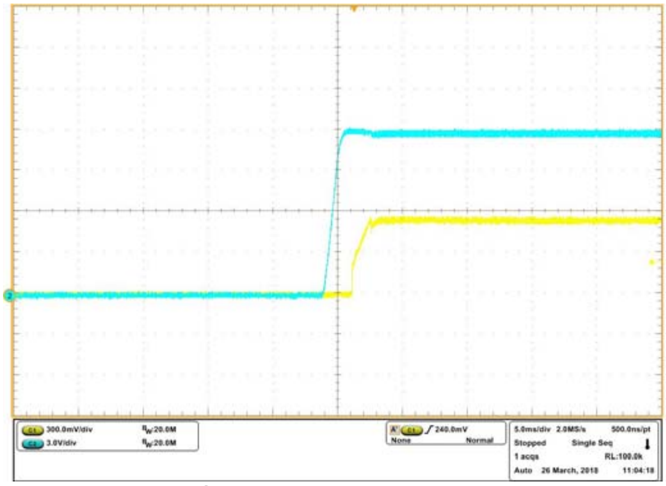
Output filter：47uF/6.3V*6 ceramic



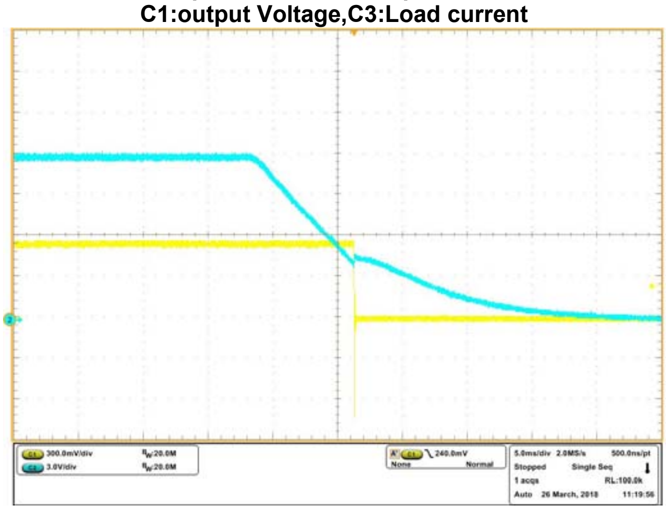
Noise V_{IN}=12V, I_O=40A, 5~20MHz Bandwidth



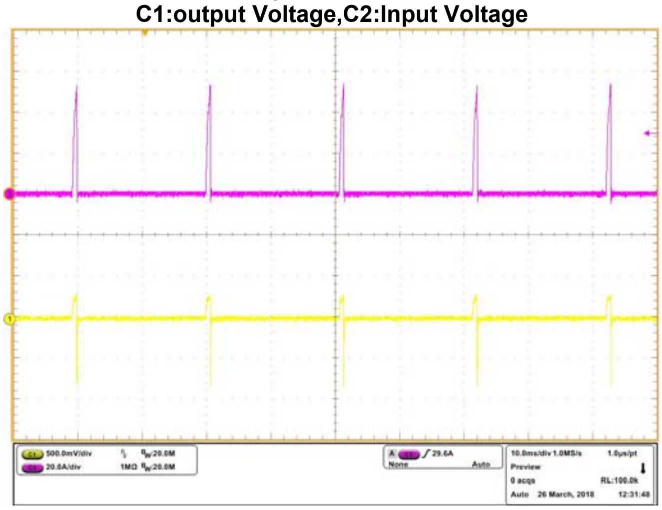
Transient Response V_{IN}=12V, Step from20A~40A~20A
C1:output Voltage,C3:Load current



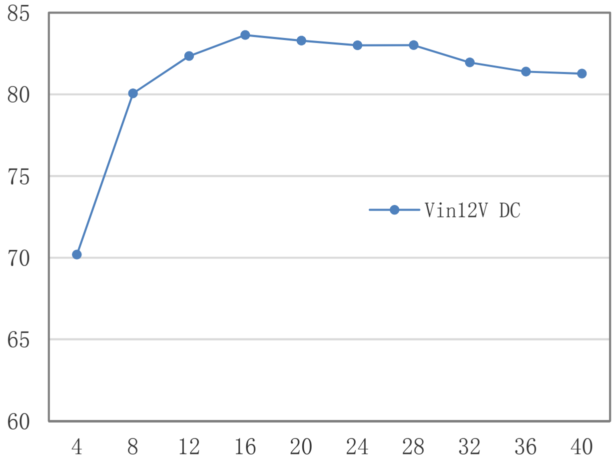
Start-up V_{IN}=12V, I_O=40A
C1:output Voltage,C2:Input Voltage



Power Down, V_{IN}=12V, I_O=40A
C1:output Voltage,C2:Input Voltage



Short-Circuit Output V_{IN}=12V
C1:output Voltage,C3:Load current



Efficiency

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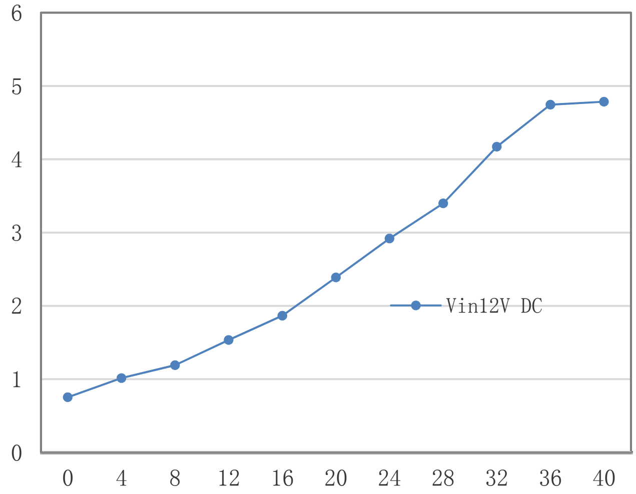
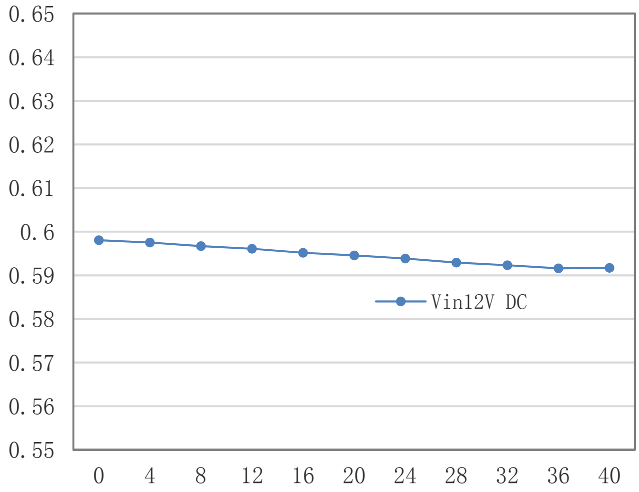
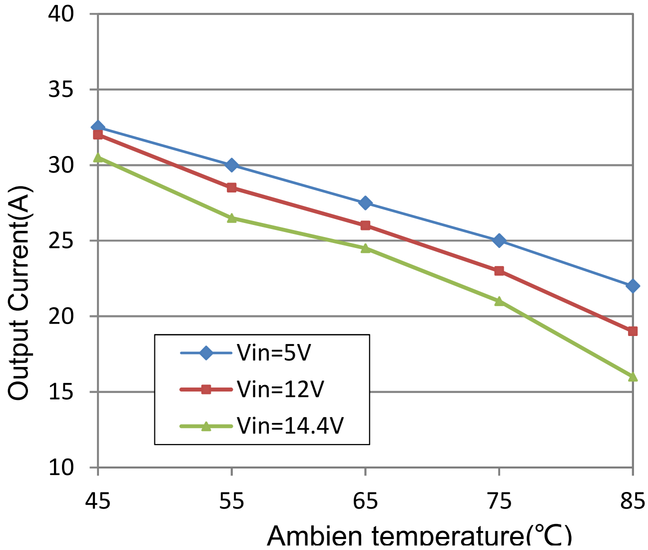


Power Dissipation (W)



Regulation
Output voltage vs. Load Current



Derating

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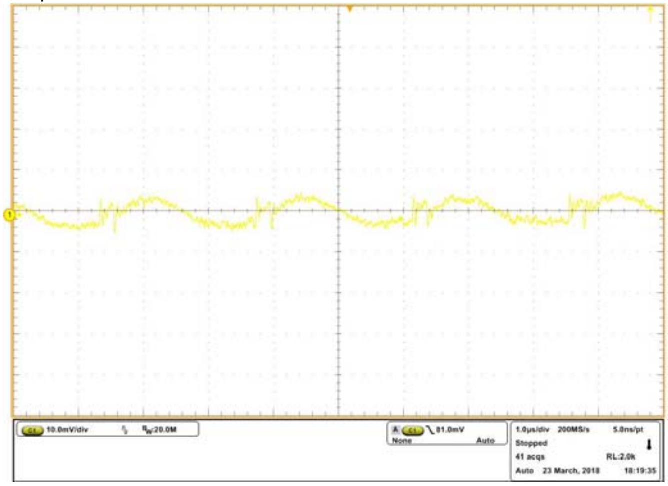
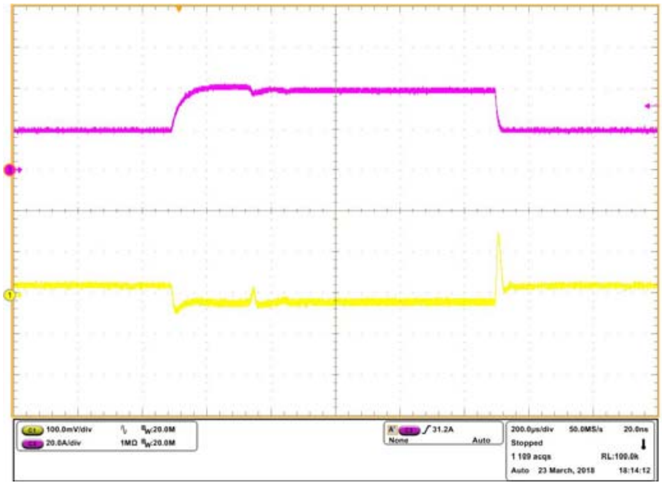
Typical Characteristics – output adjusted to 0.9V

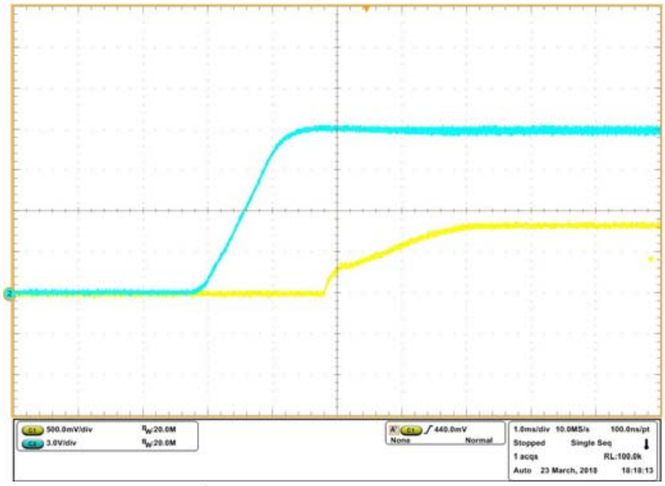
General conditions:
Input filter：270uF/25V*1 Solid Electrolytic CAP+10uF/25V*4 ceramic;
Output filter：47uF/6.3V*6 ceramic



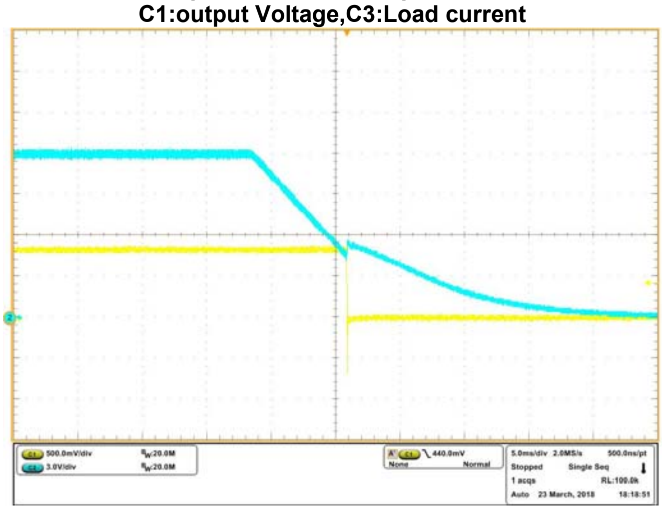
Noise V_{IN}=12V, I_O=40A, 5~20MHz Bandwidth



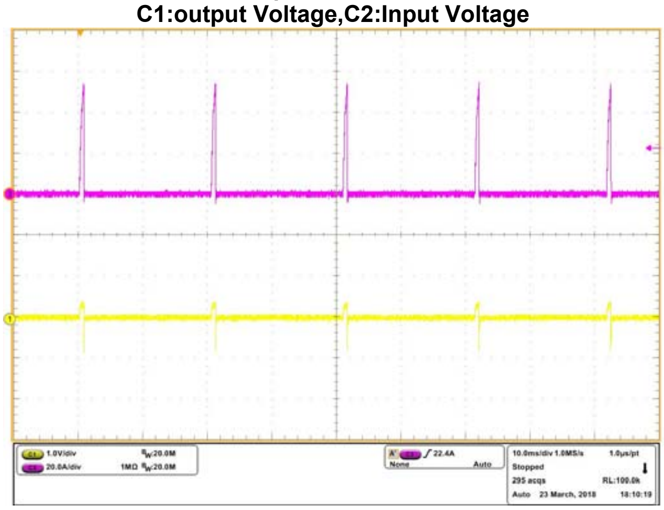
Transient Response V_{IN}=12V, Step from20A~40A~20A
C1:output Voltage,C3:Load current



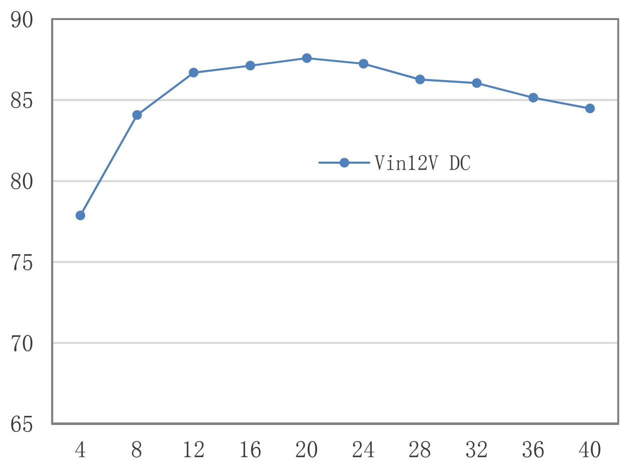
Start-up V_{IN}=12V, I_O=40A
C1:output Voltage,C2:Input Voltage



Power Down, V_{IN}=12V, I_O=40A
C1:output Voltage,C2:Input Voltage



Short-Circuit Output V_{IN}=12V
C1:output Voltage,C3:Load current



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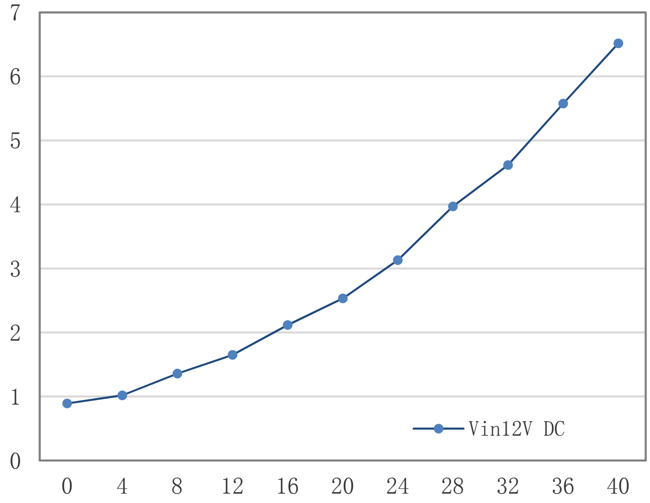
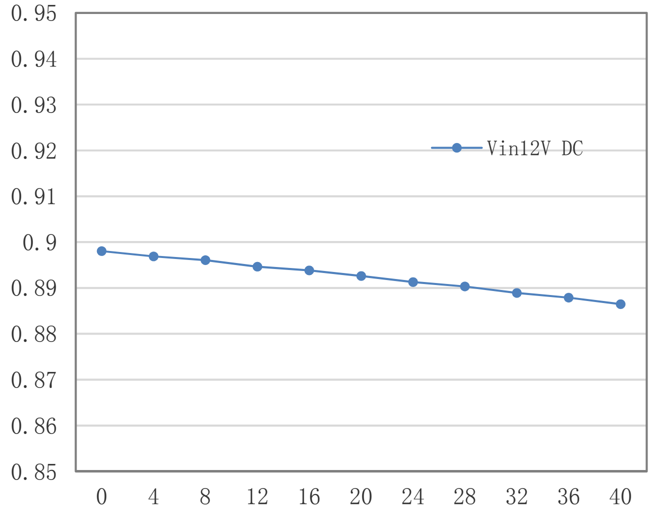
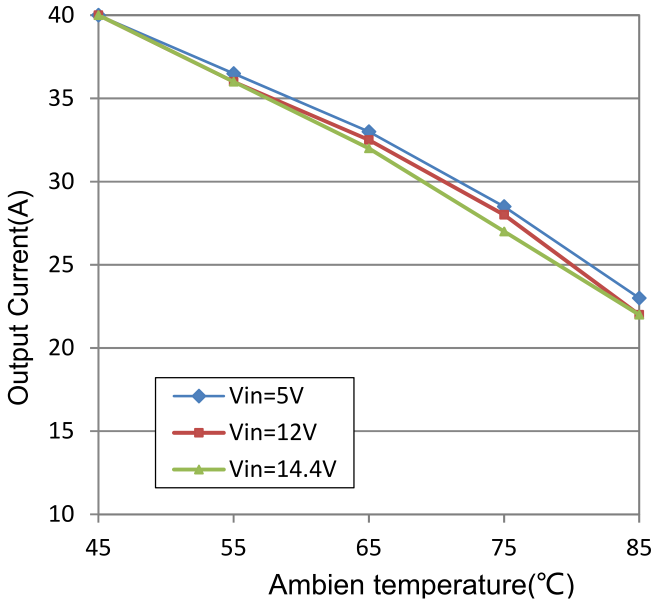


Power Dissipation (W)



Regulation
Output voltage vs. Load Current



Derating

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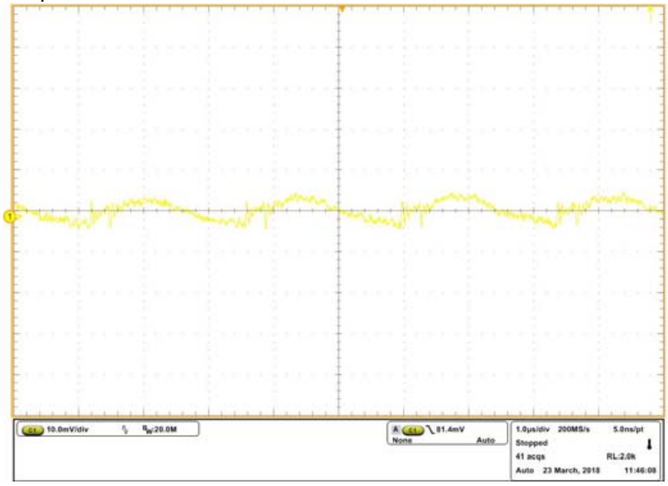
Typical Characteristics – output adjusted to 1.2V

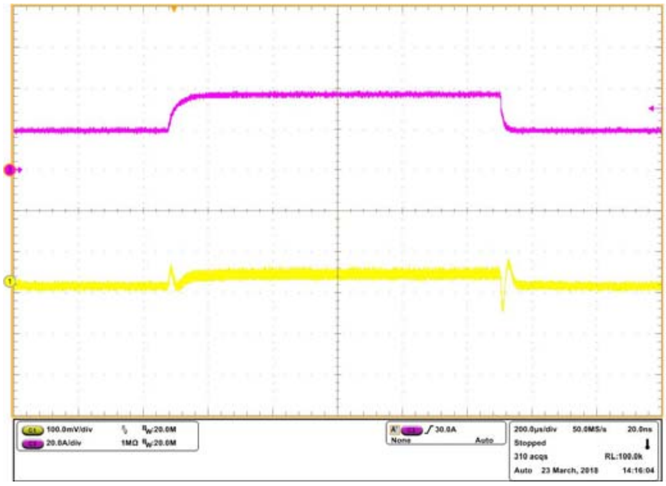
General conditions:

Input filter：270uF/25V*1 Solid Electrolytic CAP+10uF/25V*4 ceramic;

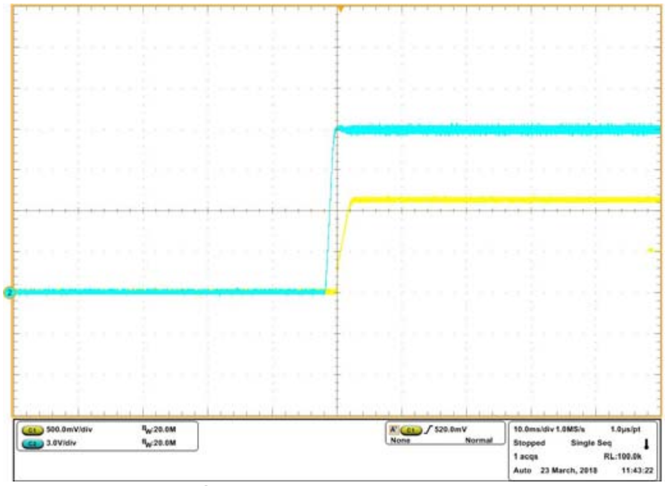
Output filter：47uF/6.3V*6 ceramic



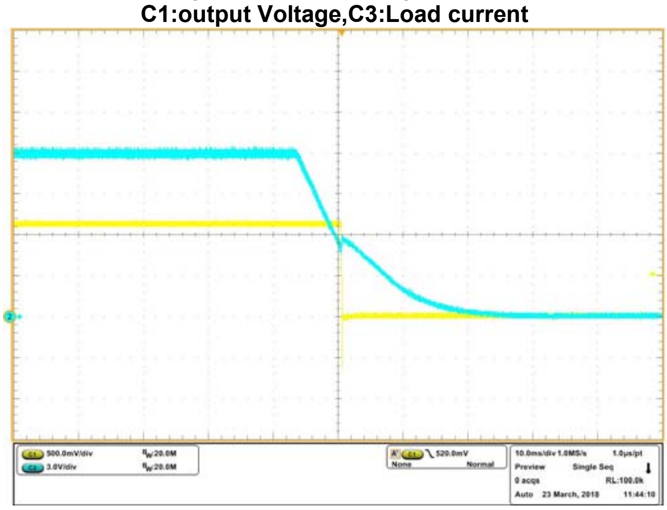
Noise V_{IN}=12V, I_O=40A, 5~20MHz Bandwidth



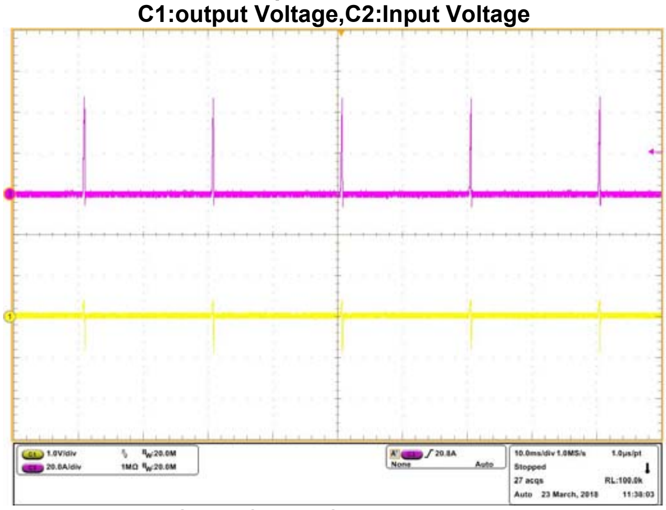
Transient Response V_{IN}=12V, Step from20A~40A~20A
C1:output Voltage,C3:Load current



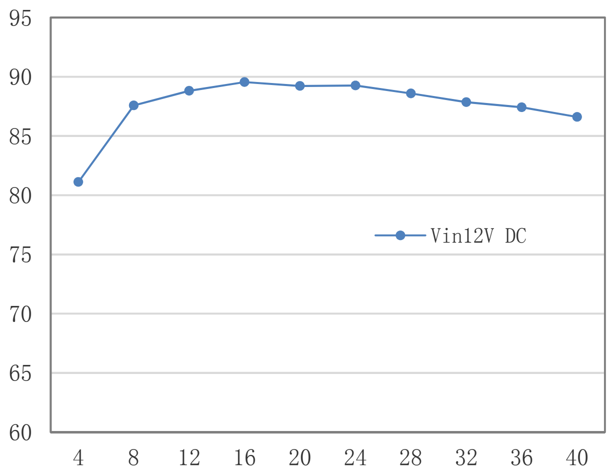
Start-up V_{IN}=12V, I_O=40A
C1:output Voltage,C2:Input Voltage



Power Down, V_{IN}=12V, I_O=40A
C1:output Voltage,C2:Input Voltage



Short-Circuit Output V_{IN}=12V
C1:output Voltage,C3:Load current



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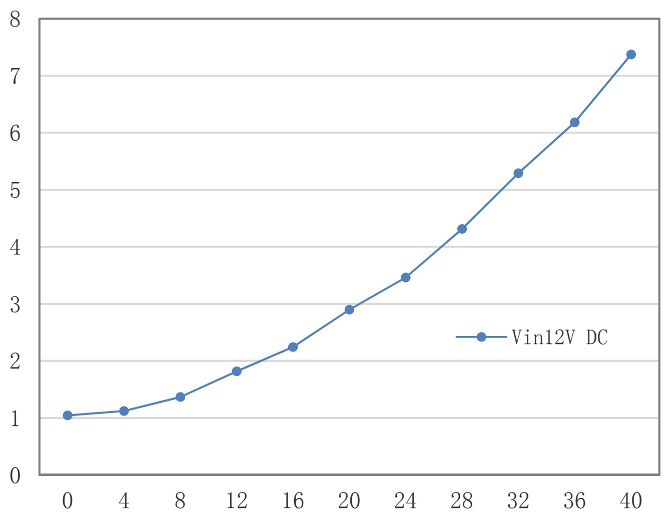
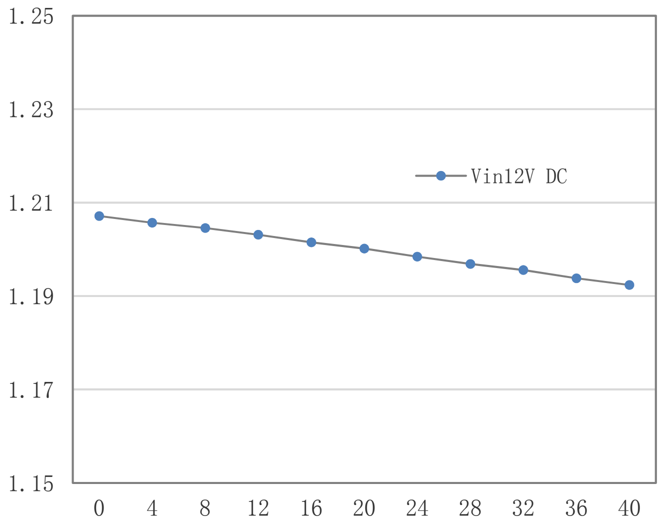
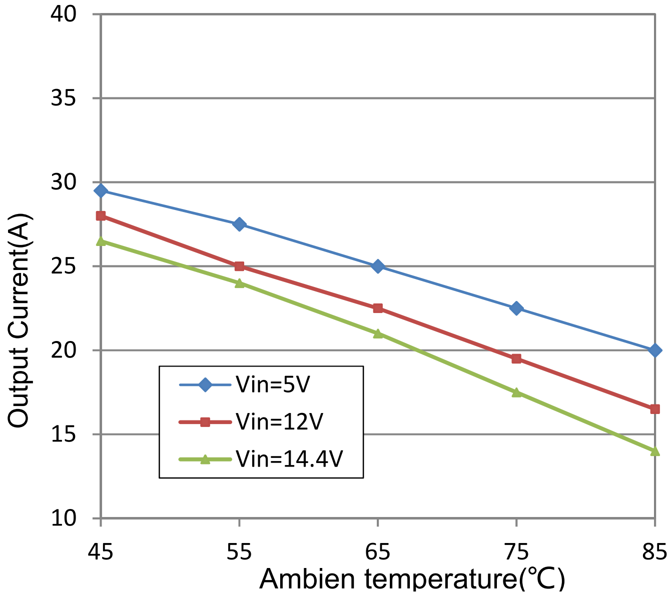


Power Dissipation (W)



Regulation
Output voltage vs. Load Current



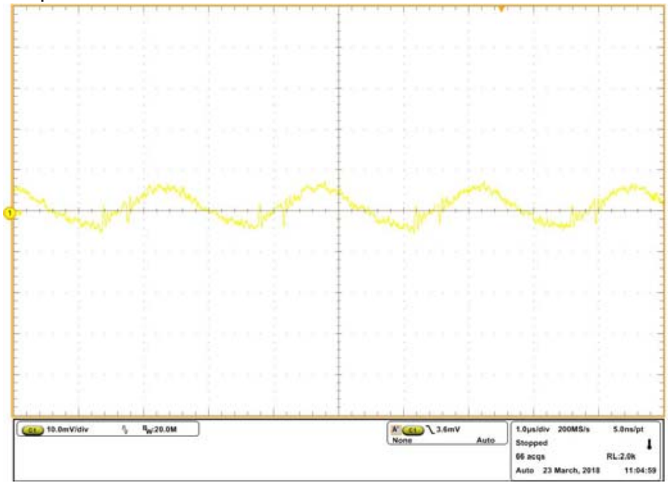
Derating

Typical Characteristics – output adjusted to 1.5V

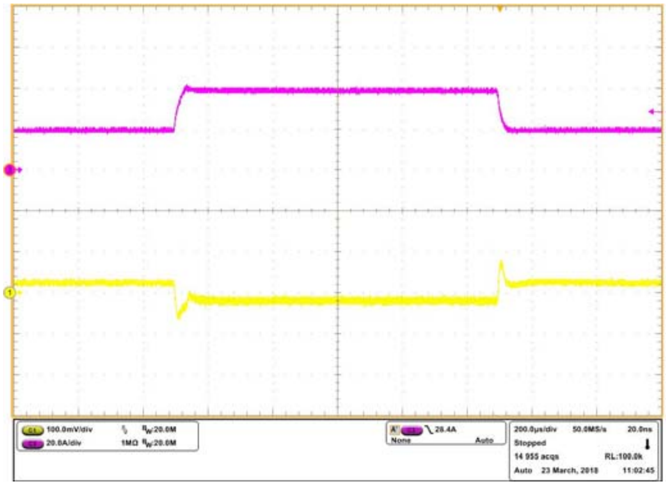
General conditions:

Input filter ：270uF/25V*1 Solid Electrolytic CAP+10uF/25V*4 ceramic;

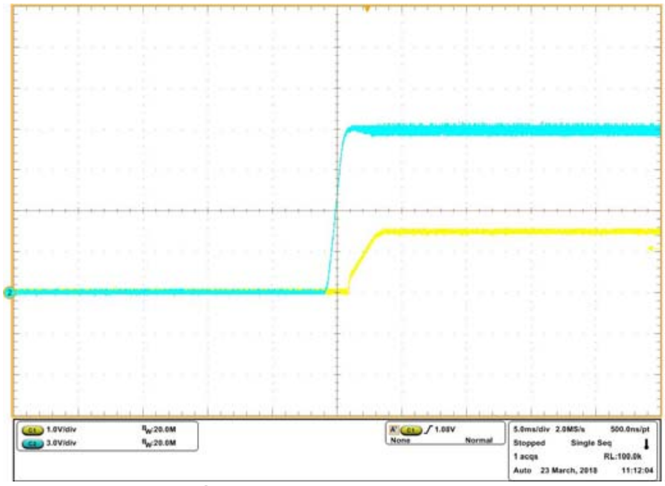
Output filter：47uF/6.3V*6 ceramic



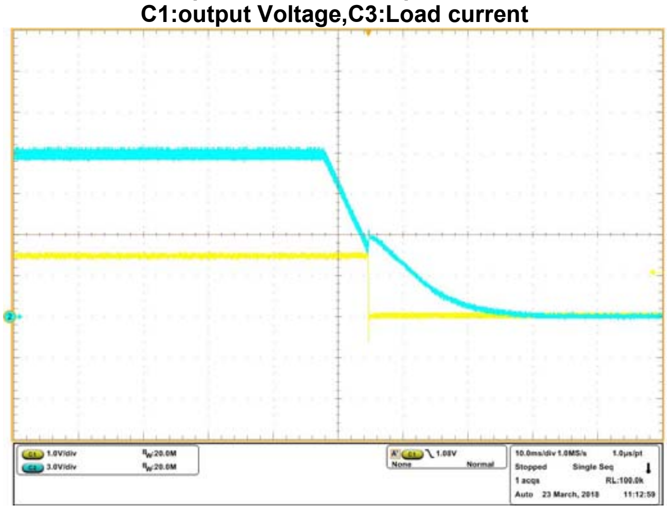
Noise V_{IN}=12V, I_O=40A, 5~20MHz Bandwidth



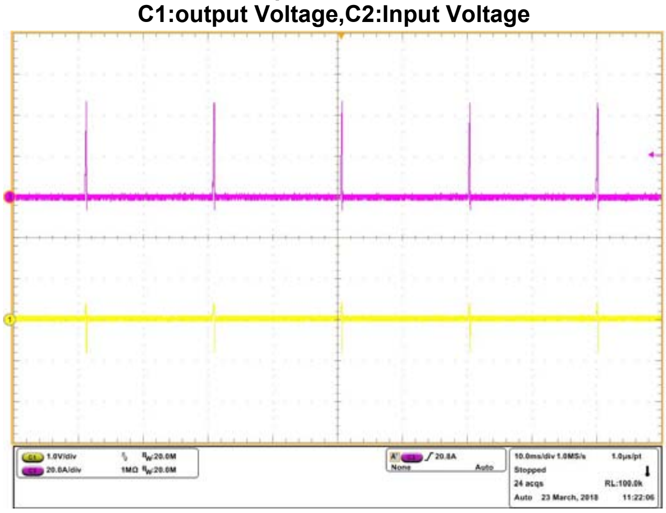
Transient Response V_{IN}=12V, Step from20A~40A~20A
C1:output Voltage,C3:Load current



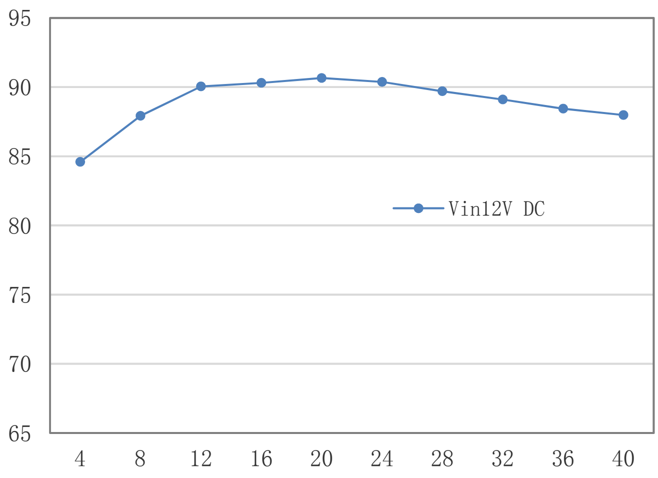
Start-up V_{IN}=12V, I_O=40A
C1:output Voltage,C2:Input Voltage



Power Down, V_{IN}=12V, I_O=40A
C1:output Voltage,C2:Input Voltage



Short-Circuit Output V_{IN}=12V
C1:output Voltage,C3:Load current



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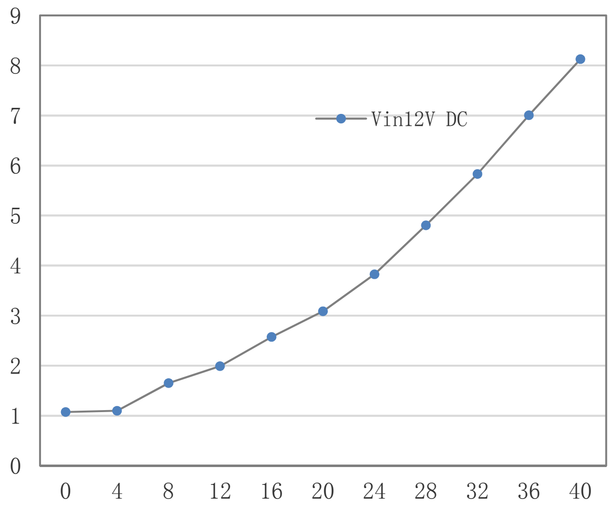
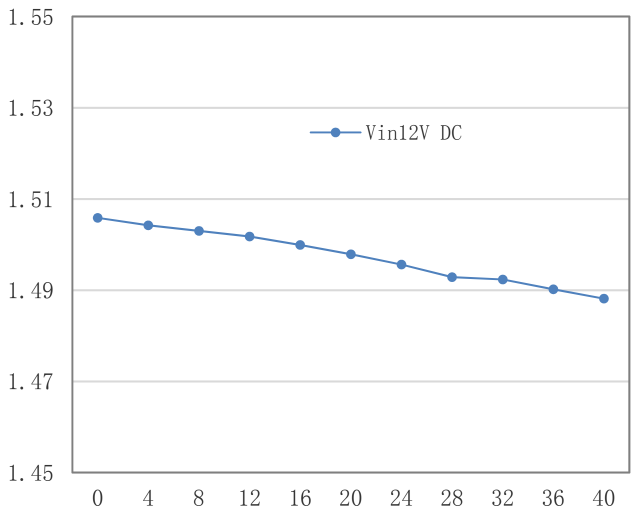


Power Dissipation (W)



Regulation
Output voltage vs. Load Current

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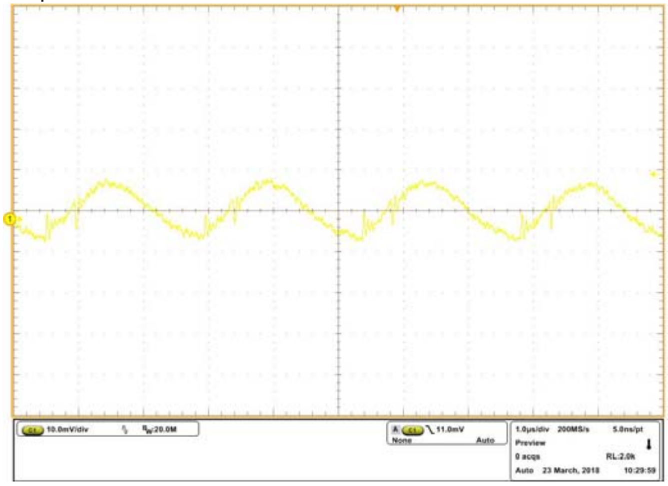
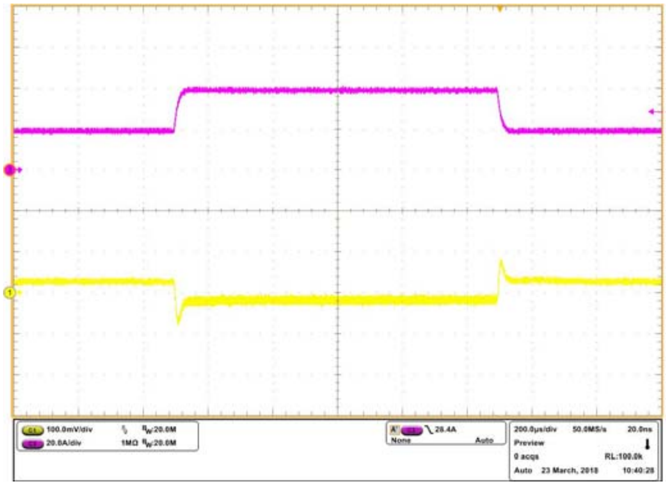
Typical Characteristics – output adjusted to 1.8V

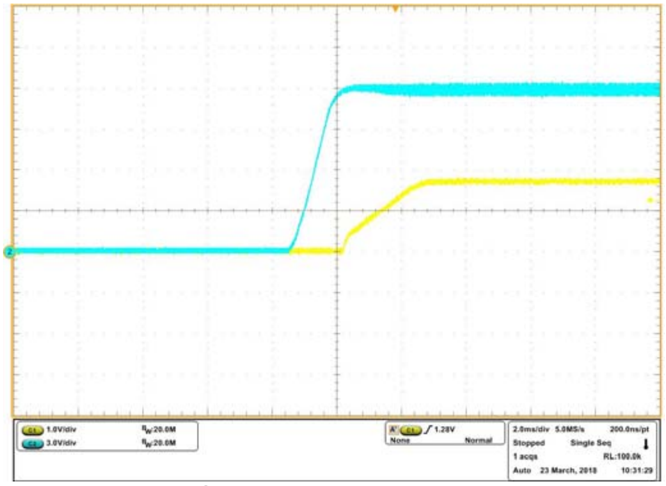
General conditions:
Input filter ：270uF/25V*1 Solid Electrolytic CAP+10uF/25V*4 ceramic;
Output filter：47uF/6.3V*6 ceramic



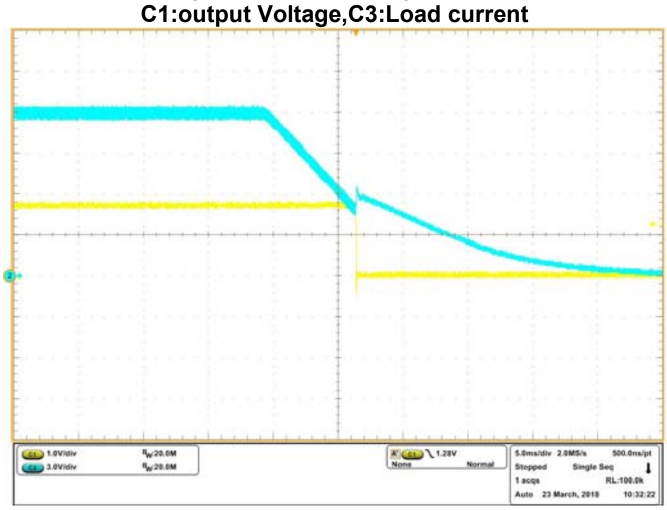
Noise V_{IN}=12V, I_O=40A, 5~20MHz Bandwidth



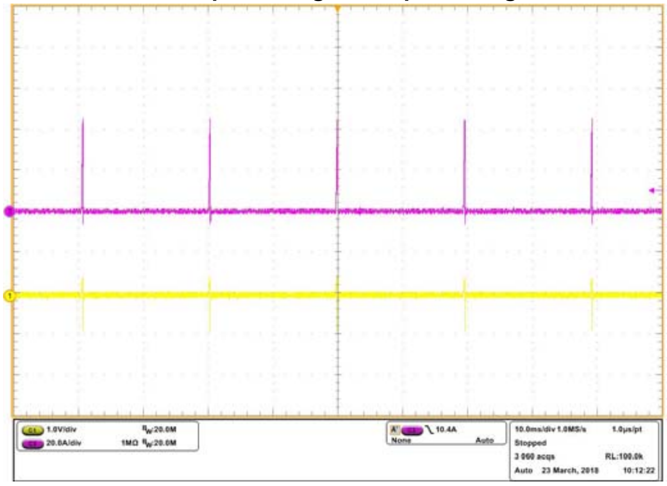
Transient Response V_{IN}=12V, Step from20A~40A~20A
C1:output Voltage,C3:Load current



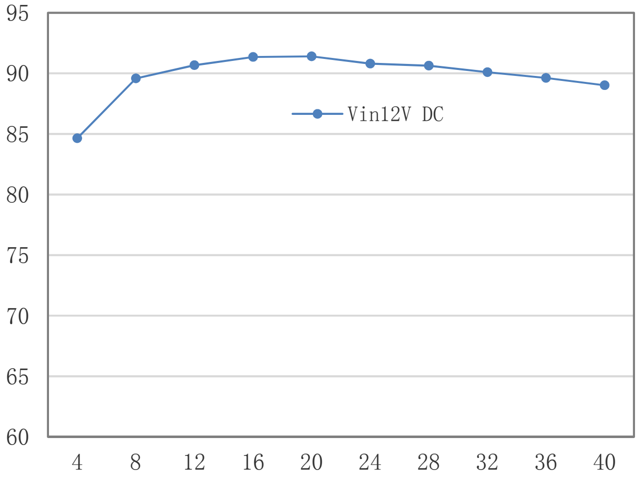
Start-up V_{IN}=12V, I_O=40A
C1:output Voltage,C2:Input Voltage



Power Down, V_{IN}=12V, I_O=40A
C1:output Voltage,C2:Input Voltage



Short-Circuit Output V_{IN}=12V
C1:output Voltage,C3:Load current



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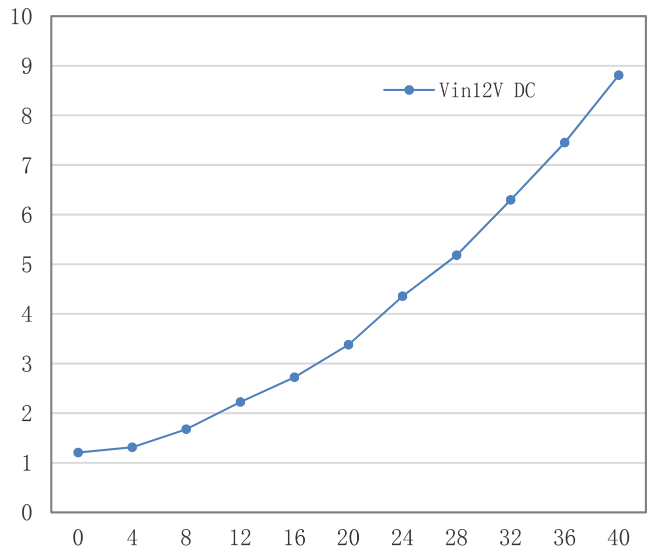
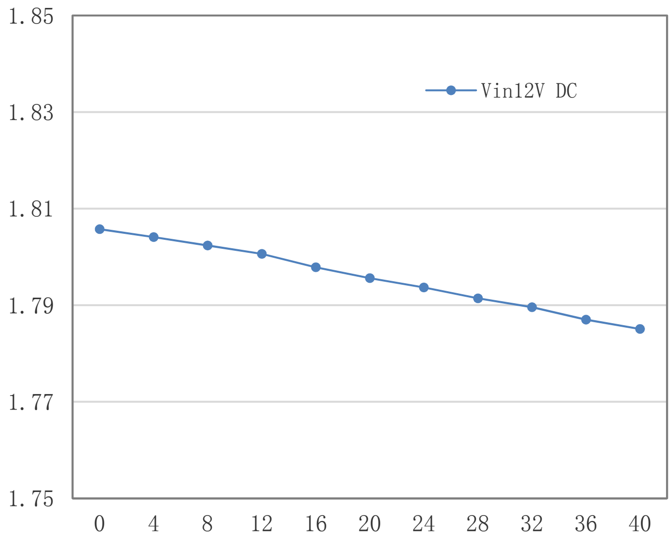


Power Dissipation (W)



Regulation
Output voltage vs. Load Current

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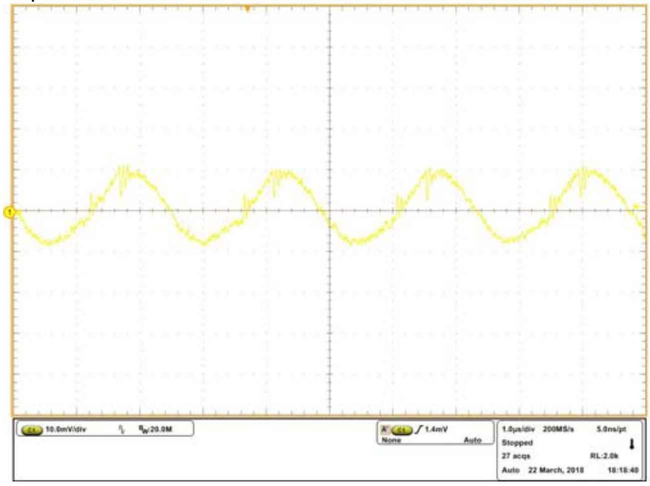
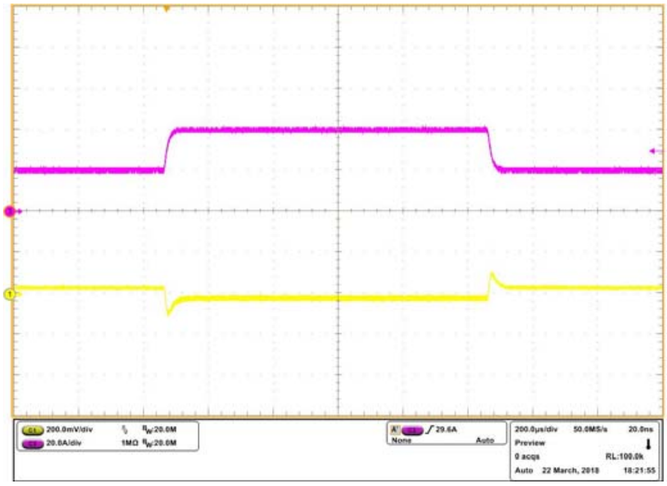
Typical Characteristics – output adjusted to 2.0V

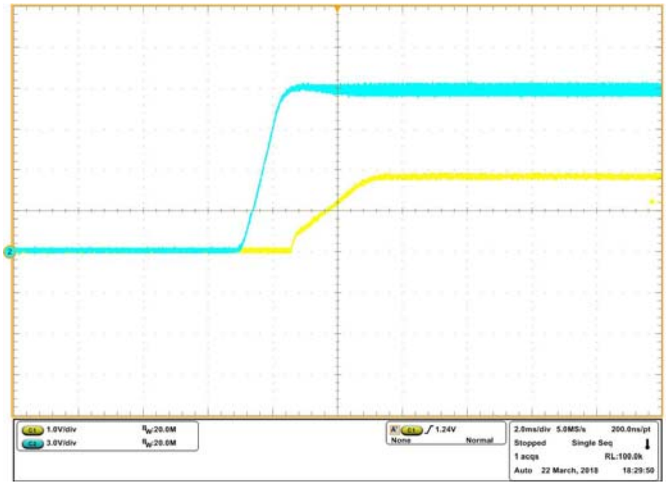
General conditions:
Input filter：270uF/25V*1 Solid Electrolytic CAP+10uF/25V*4 ceramic;
Output filter：47uF/6.3V*6 ceramic



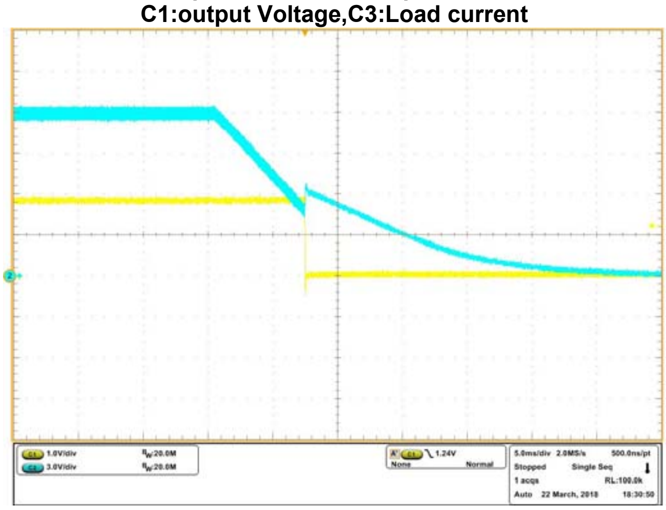
Noise V_{IN}=12V, I_O=40A, 5~20MHz Bandwidth



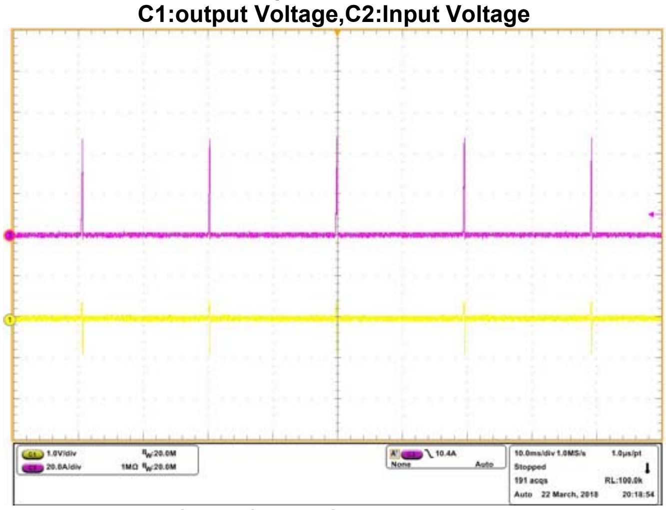
Transient Response V_{IN}=12V, Step from20A~40A~20A
C1:output Voltage,C3:Load current



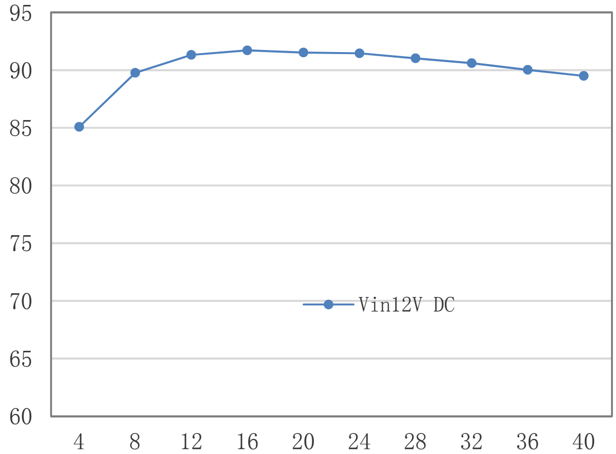
Start-up V_{IN}=12V, I_O=40A
C1:output Voltage,C2:Input Voltage



Power Down, V_{IN}=12V, I_O=40A
C1:output Voltage,C2:Input Voltage



Short-Circuit Output V_{IN}=12V
C1:output Voltage,C3:Load current



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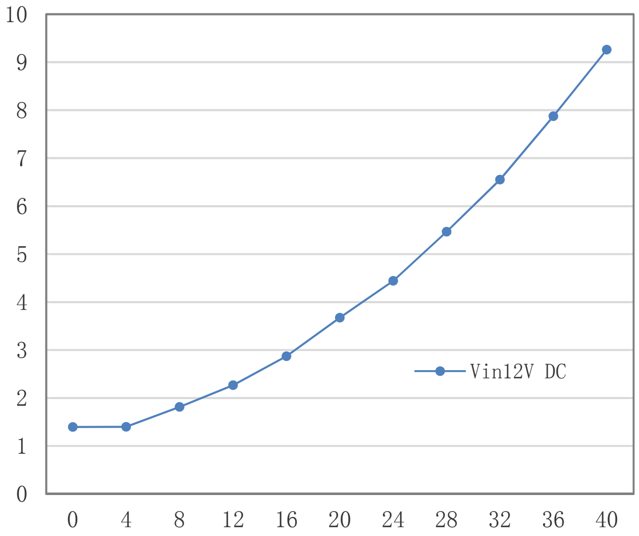
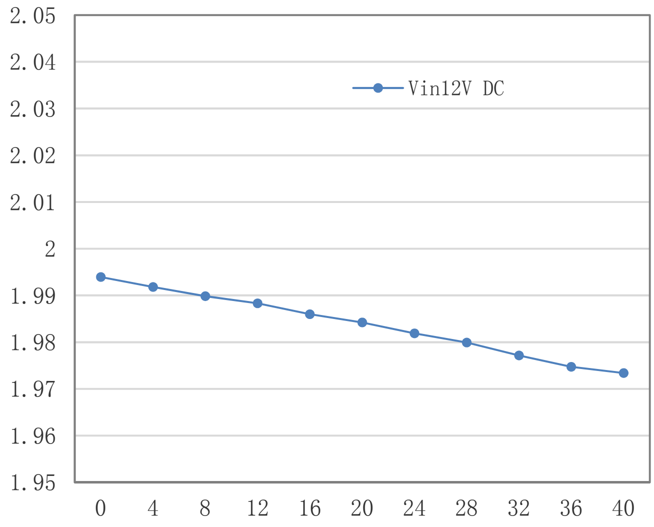
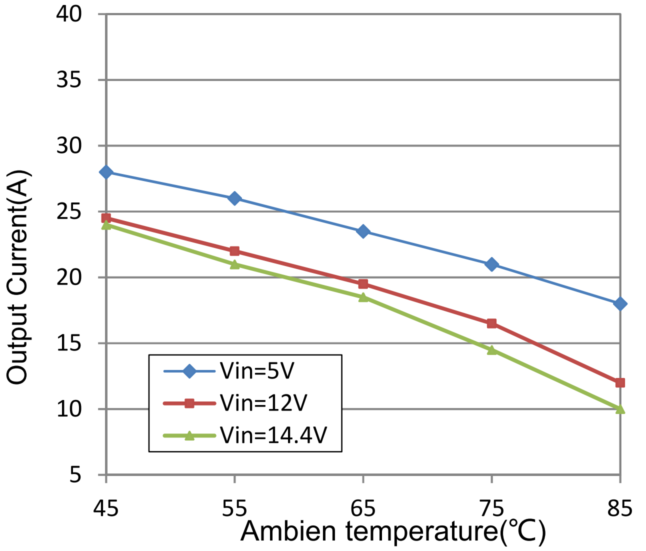


Power Dissipation (W)



Regulation

Output voltage vs. Load Current



Derating

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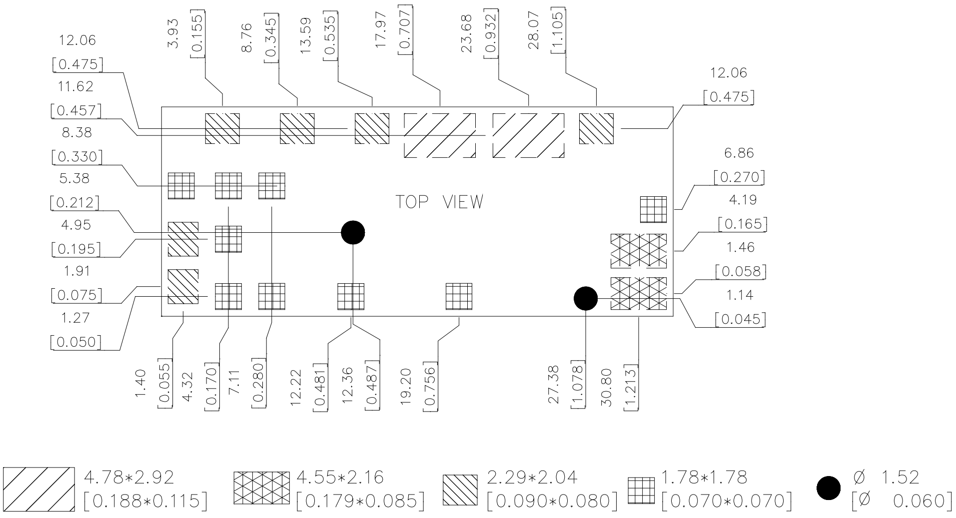
Recommended Hole Pattern

Dimensions are in millimeters (inches)



COMPONENT-SIDE FOOTPRINT

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Application Notes

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