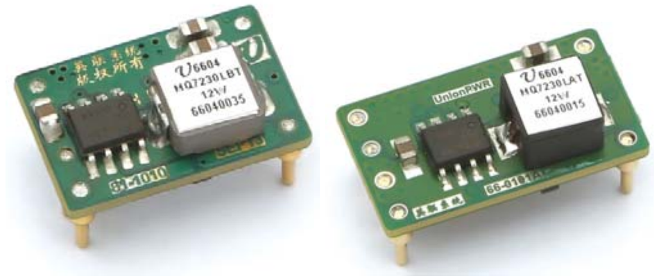
MQ7230LA/BT03

Non-isolated 3~3.6 or 4.5~5.5VDC input, 0.9~3.6V output, 6A DC-DC Converter



Features

- Wide operating voltage:
  - ☐ 03: 3V ~ 3.6V
  - ☐ 05: 4.5 ~ 5.5V
- Output Current up to 6A
- Output voltage ripple: 20mV$_{PP}$
- High Efficiency 94%
- Sequencing -- EZ-Tracking ™ (A only)
- Over current /short circuit protection
- Over-temperature protection
- Remote on/off control - Negative logic
- High reliability: designed to meet 5 million hour MTBF
- Minimal space on PCB:
  MQ7230 LAT:
  - ☐ 22.1 mm x 12.6mm x 8.0 mm or
  - ☐ 0.87 in x 0.5 in x 0.31 in
  MQ7230LBT:
  - ☐ 18.9 mm x 12.6 mm x6.4 mm or
  - ☐ 0.75 in x 0.5 in x 0.25 in

  No Derating to +75℃, natural convection
- UL/IEC/EN60950 compliant
- ROHS Compliant

Applications

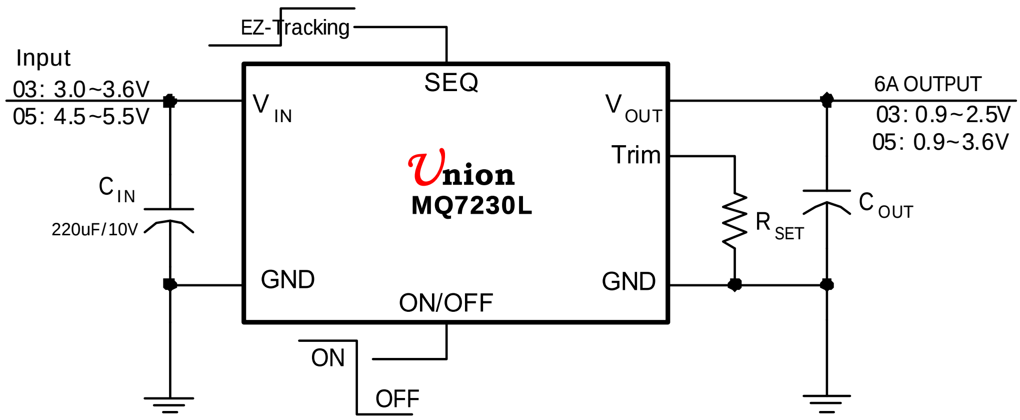
- ☐ Workstations, servers
- ☐ Desktop computers
- ☐ DSP applications
- ☐ Distributed power architectures
- ☐ Telecommunications equipment
- ☐ Data communications equipment
- ☐ Wireless communications equipment

Description

The MQ7230L Series Power Modules are non-isolated dc-dc converters that operate over a wide input voltage range of 3Vdc to 5.5Vdc and provide a precisely (2%) regulated dc output with industry standard POLA pin out. Such a module is suitable to application with 3.3V or 5V power supply bus. The modules have a maximum output current rating of 6A at a typical full-load efficiency over 93%. Standard features include remote on/off with negative logic and output voltage adjustment, over-current protection, over-temperature protection.

MQ7230L load 6A in a very small size. This improves PCB layout and system integration capability

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

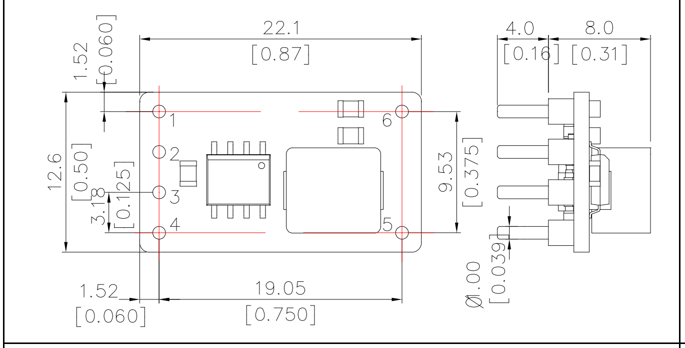


Performance Specifications (at TA=+25℃)

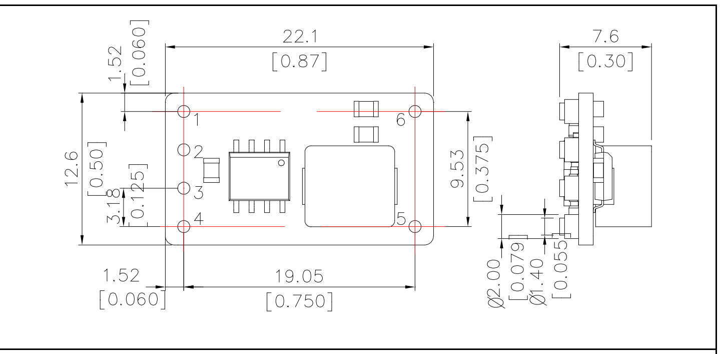
Model	Input V_{IN} Range (V)	Output				Efficiency (%)
		I_{OUT} (A)	Trim Range (V)	Regulation		
				Line (%)	Load (%)	
MQ7230LAT03	3~3.6	6	0.9V~2.5V	0.5	0.5	94
MQ7230LAT05	4.5~5.5	6	0.9V~3.6V	0.5	0.5	94
MQ7230LBT03	3~3.6	6	0.9V~2.5V	0.5	0.5	94
MQ7230LBT05	4.5~5.5	6	0.9V~3.6V	0.5	0.5	94

Mechanical Specifications

Dimensions are in mm (inches)

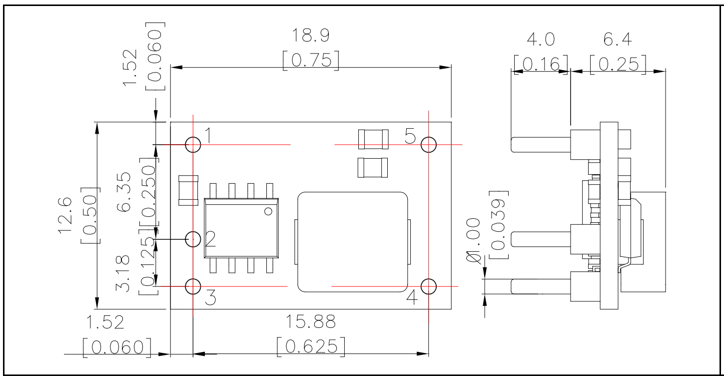


“A” Version

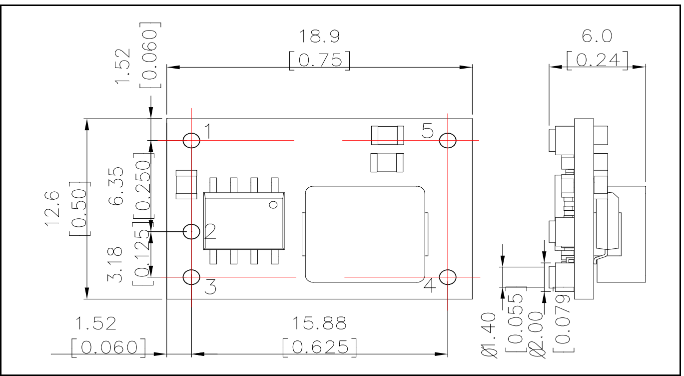


“A-S” Version

PIN	1	2	3	4	5	6
DESCRIPTION	GND	SEQ	V_{IN}	ON/OFF	TRIM	V_{OUT}



“B” Version



“B-S” Version

PIN	1	2	3	4	5
DESCRIPTION	GND	V_{IN}	ON/OFF	TRIM	V_{OUT}

Ordering Information

MQ7230LAT03

Union Microsystems Power module P/N

A: 6 pins B: 5 pins

Input Range:
03: 3~3.6V
05: 4.5~5.5V

T: Through Hole
S: SMT

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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	6	V
Storage Temperature	T_{STG}	-40	125	℃

MQ7230LA/BT03 Electrical Specifications: *(T_A=+25°C)*

Parameter	Condition	Symbol	Min	Typ	Max	Unit
Input Voltage Range		V_{IN}	3.0		3.6	V
Output Current		Io	0		6	A
Output Voltage Set point	100% load, $V_{IN}=V_{IN.MIN}$	ΔVo	-2		+2	%
Output Trim Range	***See Performance Specifications***					
Line Regulation						
Load Regulation						
Temperature Regulation	$T_A= T_{A.MIN}$ To $T_{A.MAX}$	-		0.4		$\%V_{O.SET}$
Output Ripple and Noise Voltage	Io=5A,0~20MHz（***Detail Please see Ripple Figures, Page 9~20***）					
Transient Response						

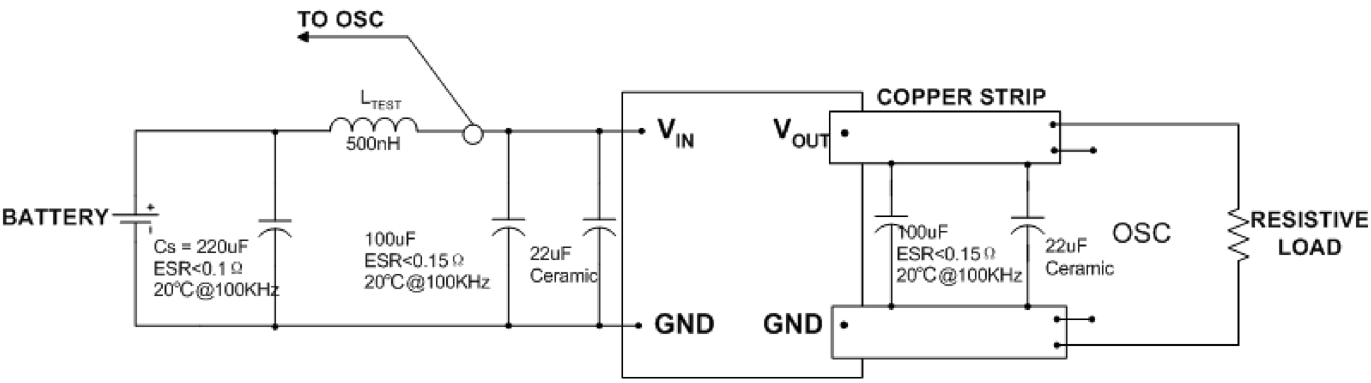
MQ7230LA/BT05 Electrical Specifications: *(T_A=+25°C)*

Parameter	Condition	Symbol	Min	Typ	Max	Unit
Input Voltage Range		V_{IN}	4.5		5.5	V
Output Current		Io	0		6	A
Output Voltage Set point	100% load, $V_{IN}=V_{IN.MIN}$	ΔVo	-2		+2	%
Output Trim Range	***See Performance Specifications***					
Line Regulation						
Load Regulation						
Temperature Regulation	$T_A= T_{A.MIN}$ To $T_{A.MAX}$	-		0.4		$\%V_{O.SET}$
Output Ripple and Noise Voltage	Io=5A,0~20MHz（***Detail Please see Ripple Figures, Page 9~20***）					
Transient Response						

General Specifications

Parameter	Condition	Symbol	Min	Typ	Max	Unit
Maximum Capacitive Load	5A resistive load + Aluminum capacitor			5000		µF
	5A resistive load +Sanyo POSCAP			1000		
Overcurrent Protection			6.8		10	A
Output short-circuit current (average)	All				2	A
Under Voltage Lockout Trip Level	Rising and falling V_{IN}, 3% hysteresis		1.95	2.05	2.15	V
Logic High (Module OFF)		V_{IH}	2		$V_{IN.MAX}$	V
Logic Low (Module ON)		V_{IL}	-0.7		0.3	V
Start-up Time	5A resistive load, no external output capacitors			1		mS
Switching Frequency		Fo		300		kHz
Operating Temperature	Natural convection, no forced air flow		-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

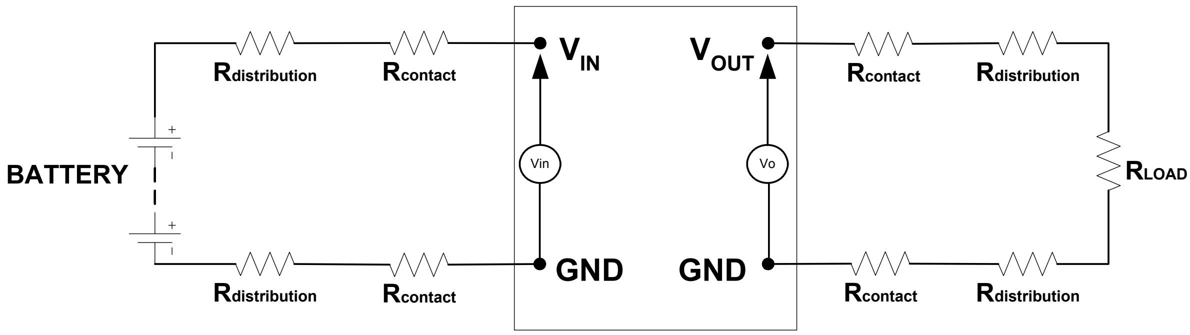
Test Configurations



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.

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Technical Notes

Input Voltage Range

The MQ7230L Series can be used in a wide variety of applications, esp. most of 3.3V or 5V power supply bus system. So, when system voltage transferred from 5V to 3.3V or vice versa, no redesign needed which simplifies design, speeds the time to market and adds flexibility to system.

Return Current Paths

The MQ7230L Series is non-isolated DC/DC converters. Their input and output shares same Common pins. To the extent possible with the intent of minimizing ground loops, input/output return current should be directed the Common pins as short as possible.

I/O Filtering

All the specifications of the MQ7230L Series are tested and specified without 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 MQ7230L 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.

MQ7230L'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 MQ7230L's Maximum Capacitive Load to avoid the module's protection condition in the start-up.

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 MQ7230L 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 module's maximum input current, 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

MQ7230L'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.

ON/OFF Control

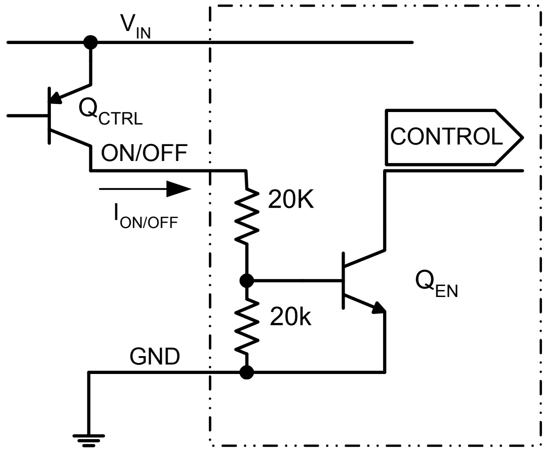

Fig1a. Remote ON/OFF Implementation with pull-up pnp transistor

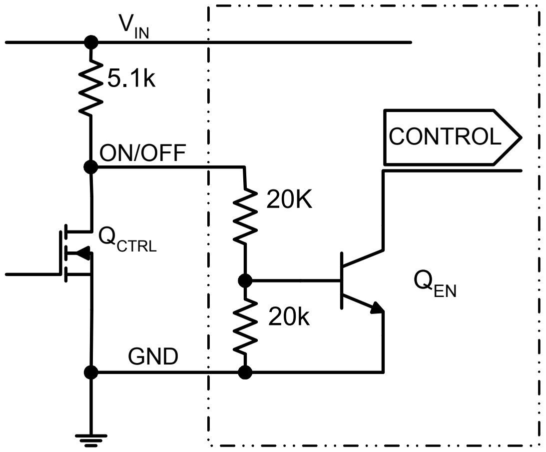

Fig1b, Remote ON/OFF Implementation with Open Collector/Drain transistor

The MQ7230L power modules feature an On/Off pin for remote On/Off operation. 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, connect an open collector pnp transistor between the On/Off pin and the VIN pin (See Figure 1a). During a logic-low when the transistor Q_{EN} inside power module is in the Off state, the power module is ON and the maximum Von/off of the module is 0.4 V. The maximum allowable leakage current of Q_{EN} when Von/off = 0.4V and VIN = 5.5V is 100uA. During a logic-high when Q_{EN} is in the active state, the power module is OFF. During this state VOn/Off = 2.5V to 5.5V and the maximum $I_{On/Off}$ = 1mA.

Remote On/Off can also be implemented using open collector/ drain logic devices with an external pull-up resistor. Figure1b shows the circuit configuration using this approach. 5.1k (+/- 5%) pull-up resistor is for proper operation of module function over the entire temperature range.

Output Overvoltage Protection

MQ7230L Series products do not incorporate output overvoltage protection. If the operating circuit requires protection against abnormal output voltage, voltage-limiting circuitry must be provided external to the power module.

Output Overcurrent Protection (OCP)

MQ7230L incorporates overcurrent and short circuit protection. If the load current exceeds the overcurrent protection setpoint, the MQ7230L's internal overcurrent-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 1~2A.

***Caution**: Be careful never to operate MQ7230L in a "heavy overload" condition that is between the rated output current and the overcurrent protection setpoint. This can cause permanent damage to the components.*

Output Voltage Trimming

MQ7230L's output voltage can be trimmed in certain ranges. Figure 3 shows the circuit used to program output voltage. See Performance Specifications for allowable trim ranges in detail. Also customized products are available.

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

for MQ7230LA/BT03: $$R_{TRIM} = \frac{8910}{V_O - 0.9} - 4990$$

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

For examples, to trim output to 1.5V, then

for MQ7230LA/BT03: $$R_{TRIM} = \frac{8910}{1.5 - 0.9} - 4990 = 9860$$

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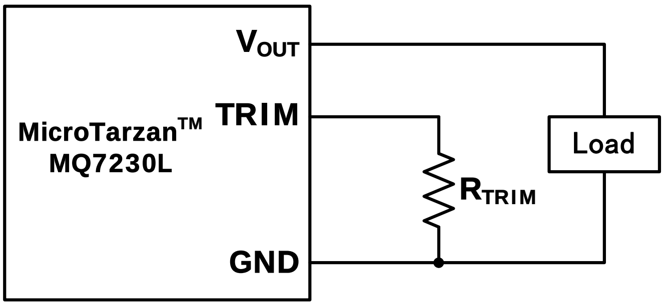


Fig3. Circuit configuration for programming output voltage using external resistor

For most common voltages, the required Trim resistors are as Table 1 and Table 2.

Preferred R_{TRIM} Values for most voltages of MQ7230LA/BT03

Desired Voltages (V)	R_{TRIM} (kΩ)
0.9	OPEN
1.0	82.5
1.2	24.3
1.5	9.76
1.8	4.87
2.5	0.576

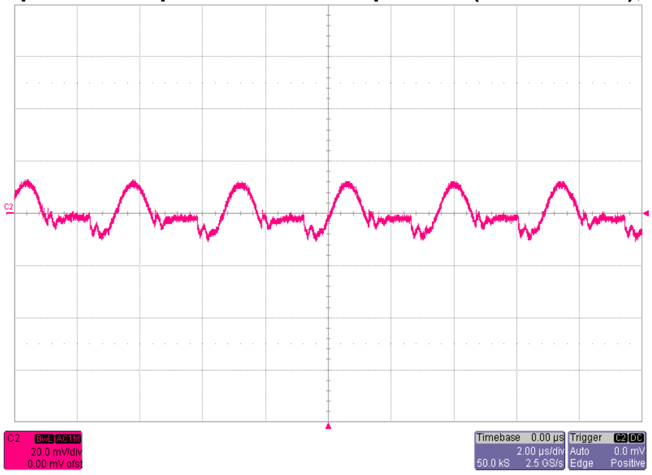
EZ-Track ("A" only)

1. The Track pin voltage must be allowed to rise above the modules' set-point voltage before the module can be regulate at its adjusted set-point voltage;
2. The *EZ-Track* function will track almost any voltage ramp during power up, and is compatible with ramp speeds of up to 1V/ms;
3. The module will not follow a voltage at its Track control input until it has completed its soft-start initialization. This takes about 10ms from the time that the module has sensed that a valid voltage has been applied its input. During this period, it is recommended that the Track pin be held at ground potential;
4. The absolute maximum voltage that may be applied to the Track pin is V_{in};
5. The module is capable of both sinking and sourcing current when following a voltage at its Track pin. Therefore startup into an output pre-bias is not supported during *EZ-Track* control;
6. The *EZ-Track* function can be disabled by connecting the Track pin to the input voltage (V_{in}). With *EZ-Track* disabled, the output voltage will rise at a quicker and more linear rate after input power is applied.

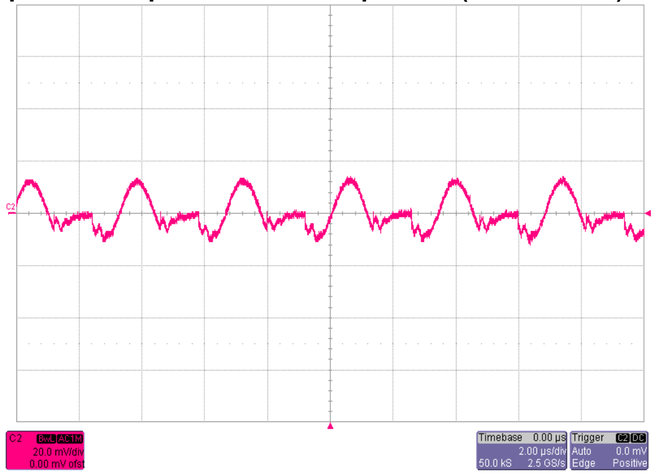
Typical Characteristics – output adjusted to 0.9V

General conditions:

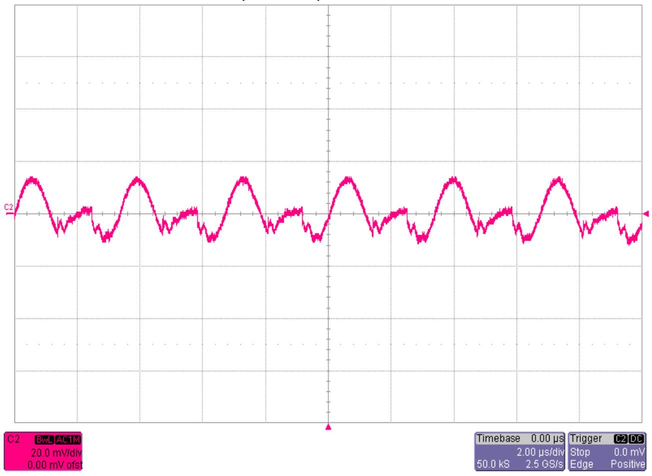
Input filter 22µF Ceramic + 100µF TAN (150mΩ ESR), Output filter 22µF Ceramic + 100µF TAN (150mΩ ESR)



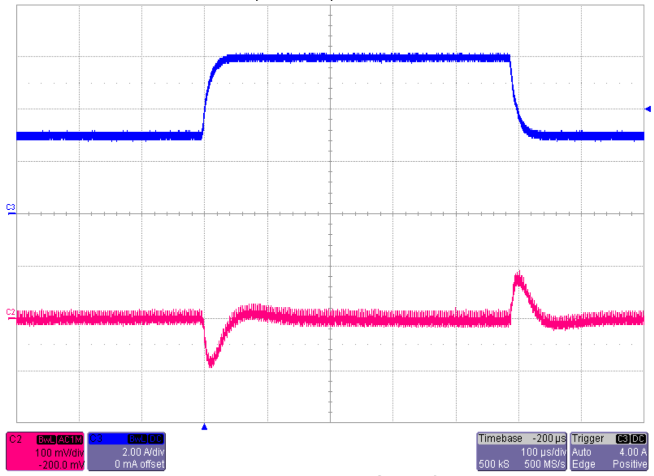
Noise V_{IN}=3V, I_O=6A, 5~20MHz Bandwidth



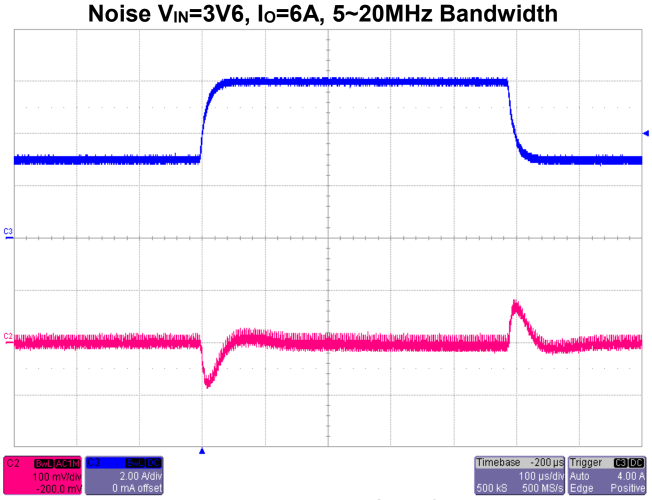
Noise V_{IN}=3V3, I_O=6A, 5~20MHz Bandwidth



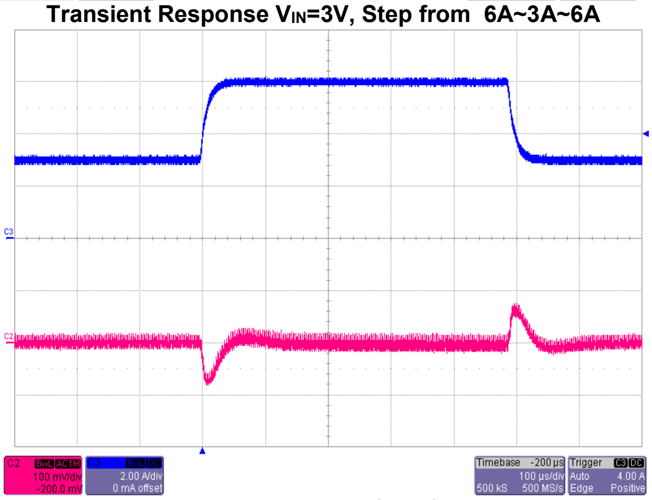
Noise V_{IN}=3V6, I_O=6A, 5~20MHz Bandwidth



Transient Response V_{IN}=3V, Step from 6A~3A~6A



Transient Response V_{IN}=3V3, Step from 6A~3A~6A



Transient Response V_{IN}=3V6, Step from 6A~3A~6A

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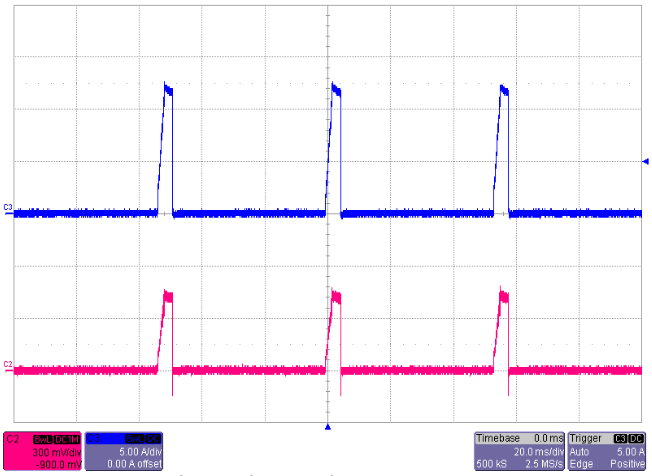
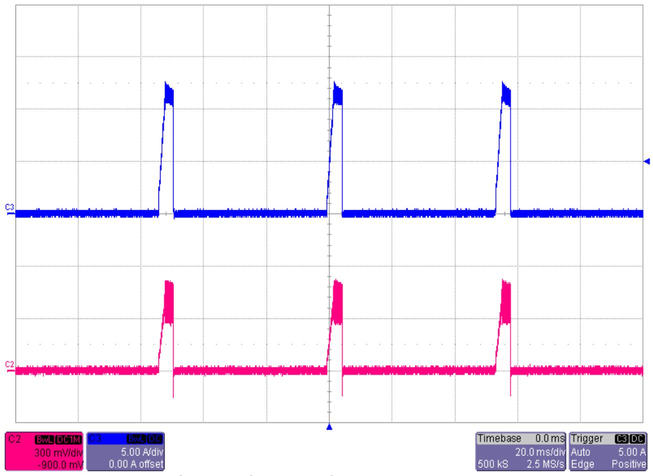
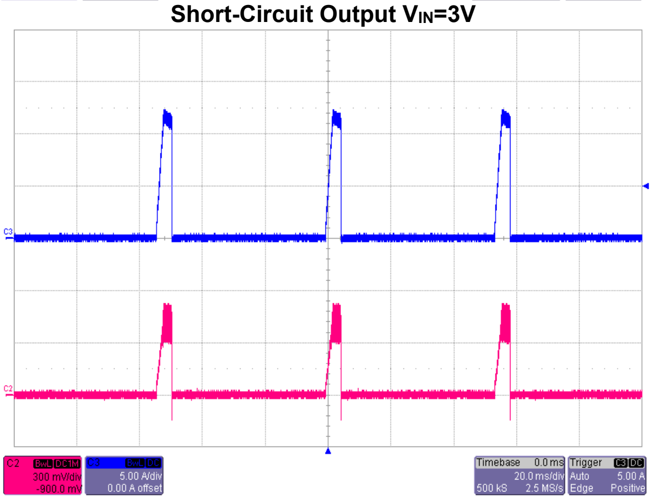


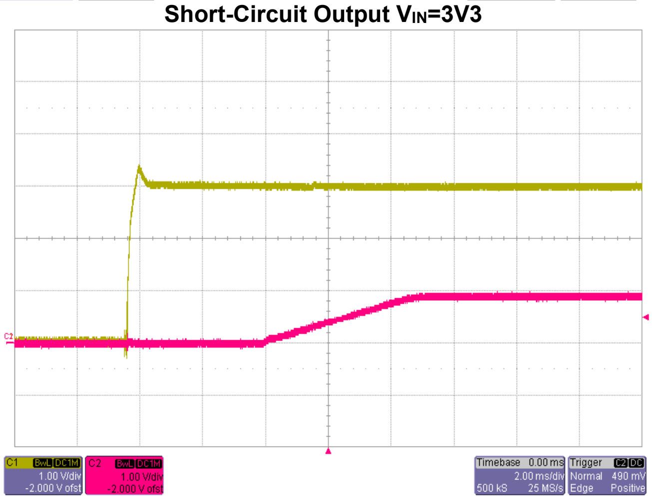
Short-Circuit Output V_{IN}=3V



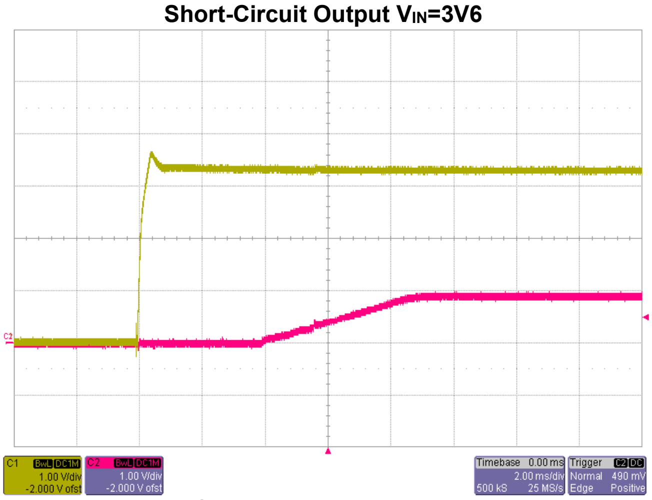
Short-Circuit Output V_{IN}=3V3



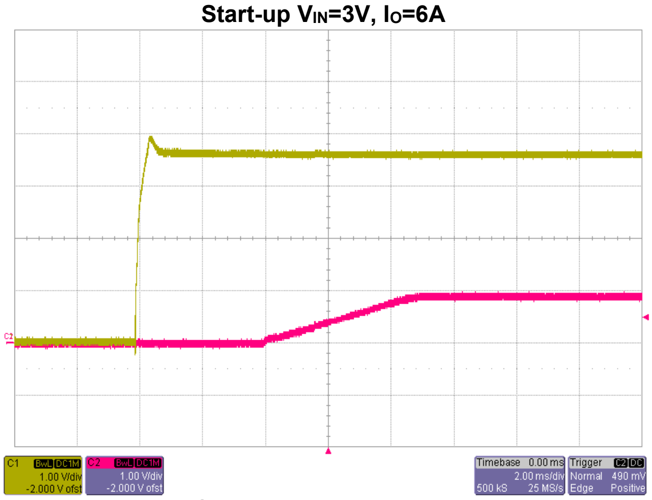
Short-Circuit Output V_{IN}=3V6



Start-up V_{IN}=3V, I_O=6A



Start-up V_{IN}=3V3, I_O=6A



Start-up V_{IN}=3V6, I_O=6A

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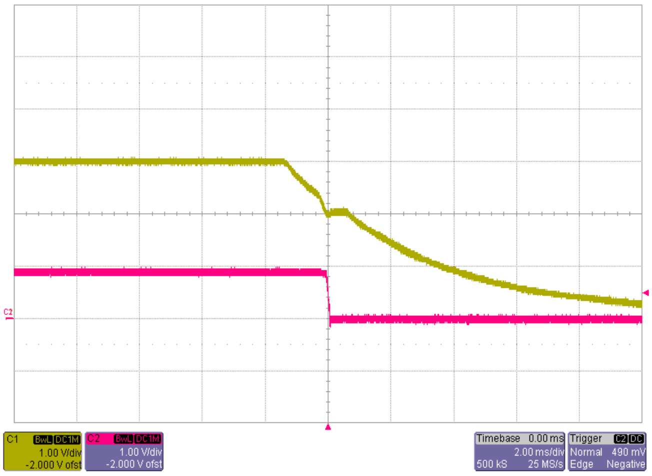
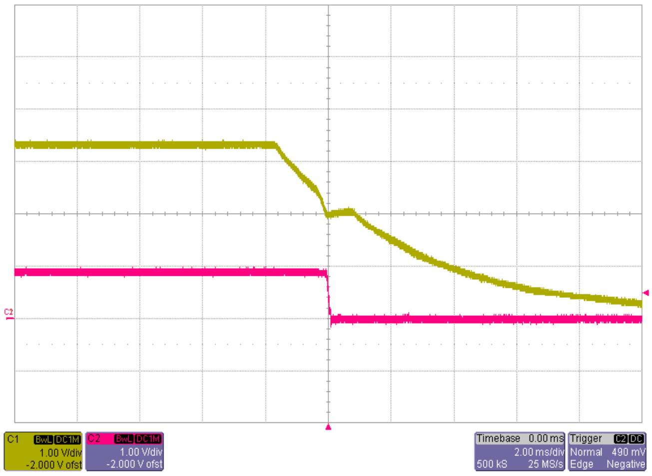
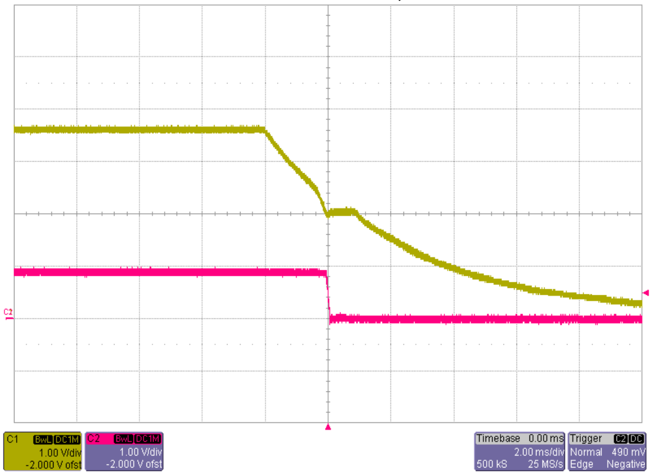


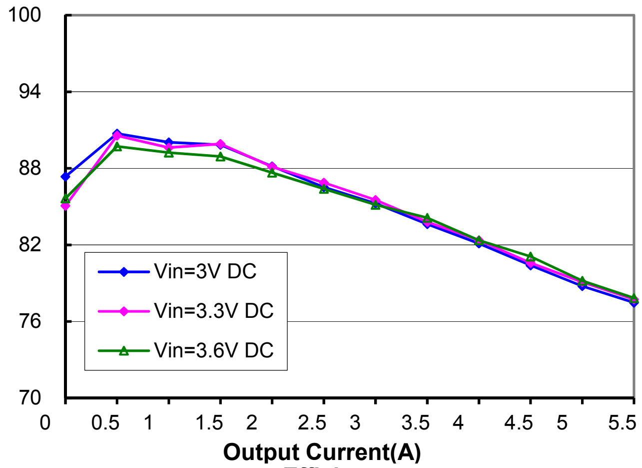
Power down V_{IN}=3V, I_O=6A



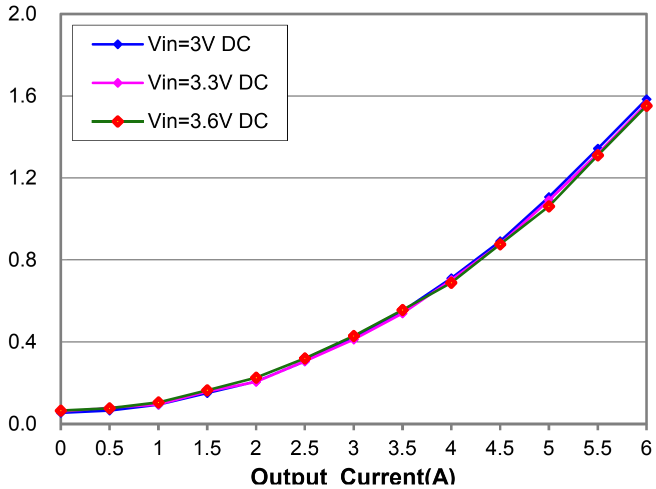
Power down V_{IN}=3V3, I_O=6A



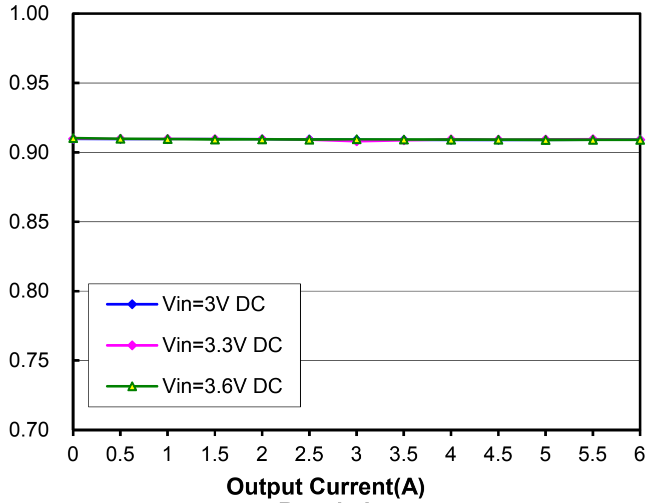
Power down V_{IN}=3V6, I_O=6A



Efficiency



Power Dissipation (W)



Regulation

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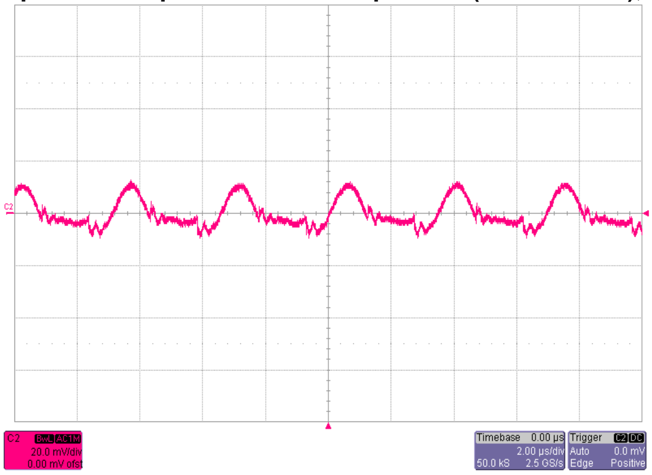
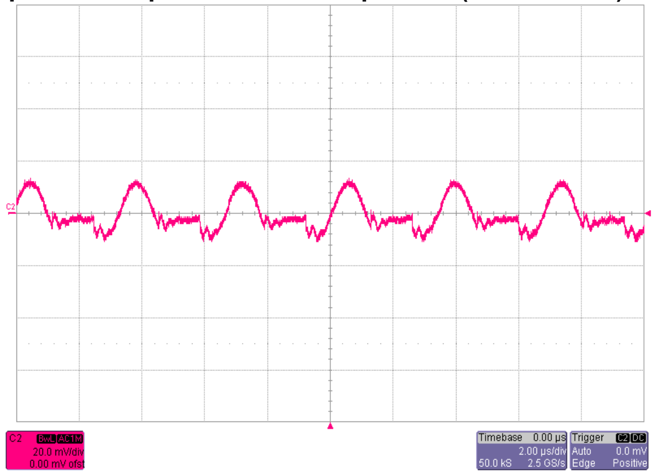
Typical Characteristics – output adjusted to 1V

General conditions:

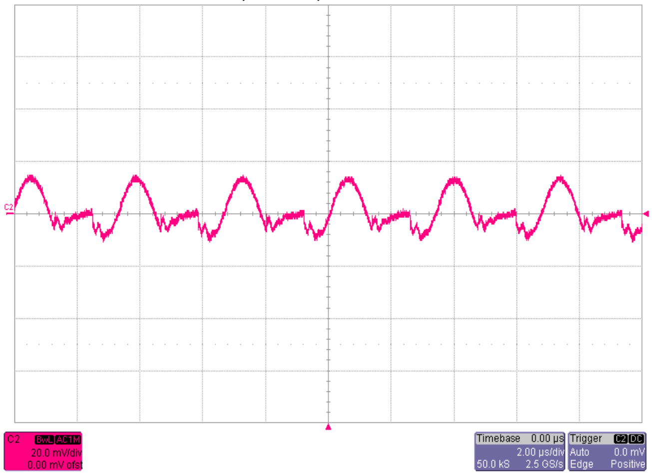
Input filter 22µF Ceramic + 100µF TAN (150mΩ ESR), Output filter 22µF Ceramic + 100µF TAN (150mΩ ESR)



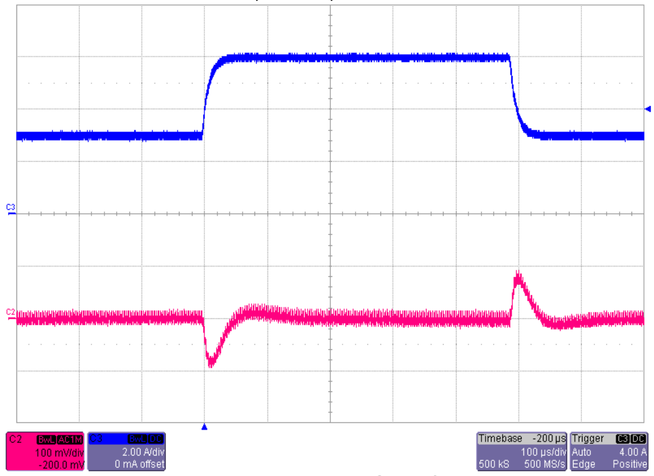
Noise V_{IN}=3V, I_O=6A, 5~20MHz Bandwidth



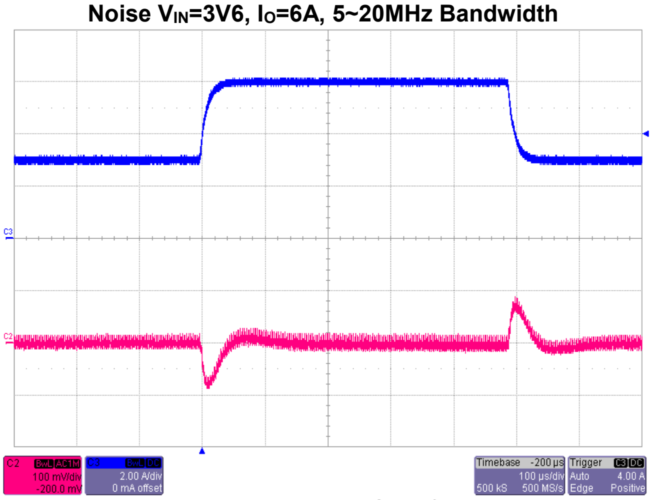
Noise V_{IN}=3V3, I_O=6A, 5~20MHz Bandwidth



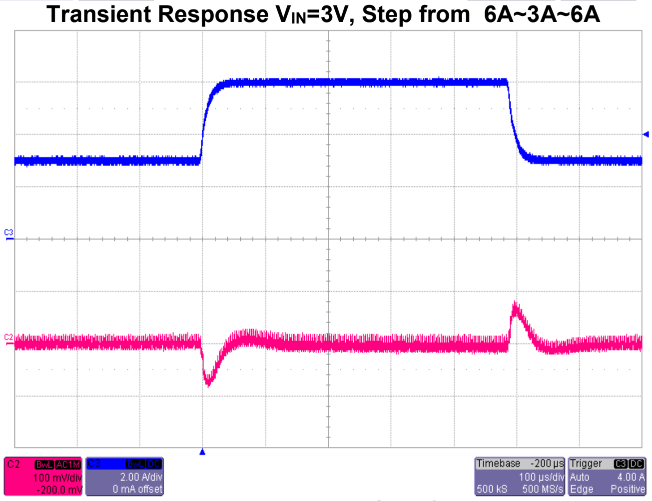
Noise V_{IN}=3V6, I_O=6A, 5~20MHz Bandwidth



Transient Response V_{IN}=3V, Step from 6A~3A~6A



Transient Response V_{IN}=3V3, Step from 6A~3A~6A



Transient Response V_{IN}=3V6, Step from 6A~3A~6A

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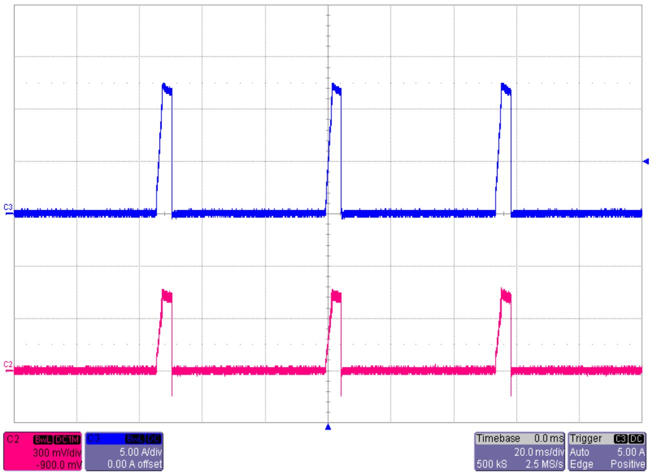
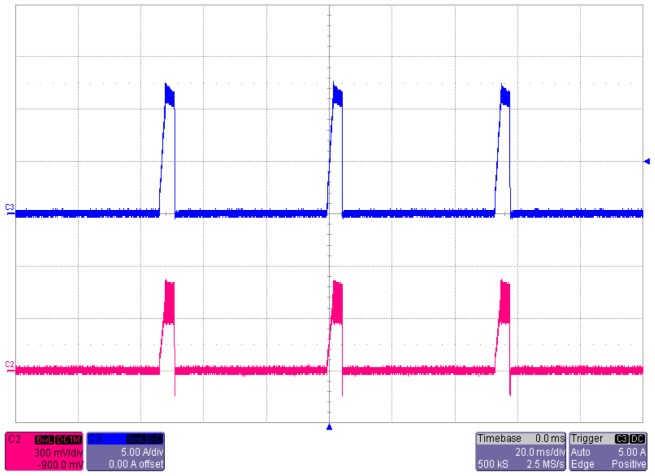
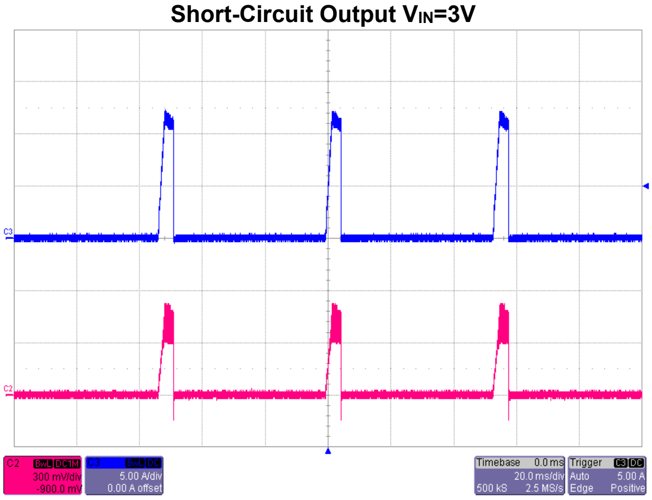


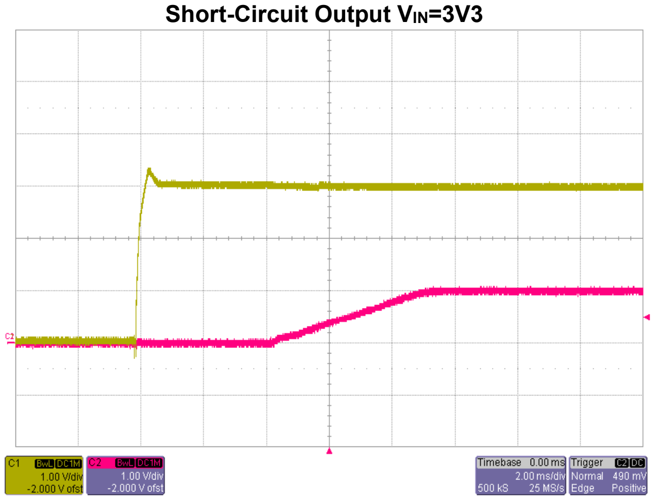
Short-Circuit Output V_{IN}=3V



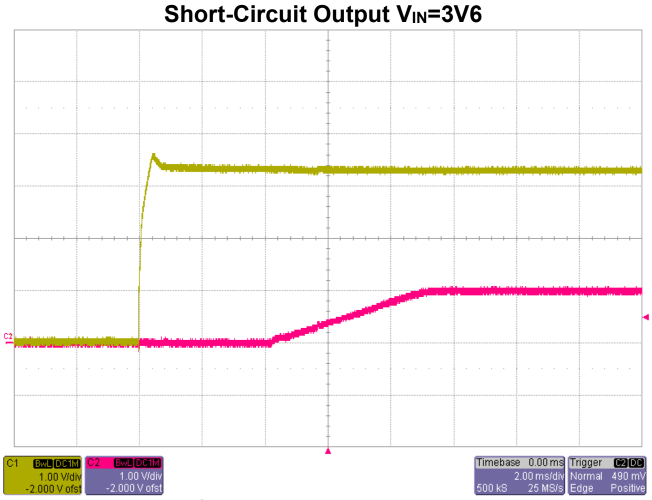
Short-Circuit Output V_{IN}=3V3



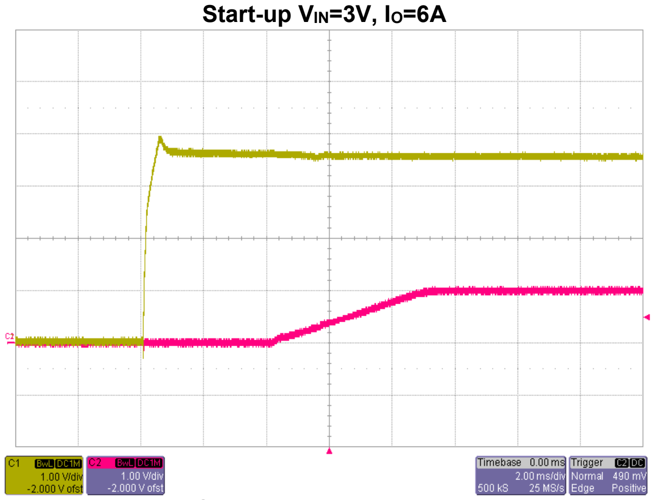
Short-Circuit Output V_{IN}=3V6



Start-up V_{IN}=3V, I_O=6A



Start-up V_{IN}=3V3, I_O=6A



Start-up V_{IN}=3V6, I_O=6A

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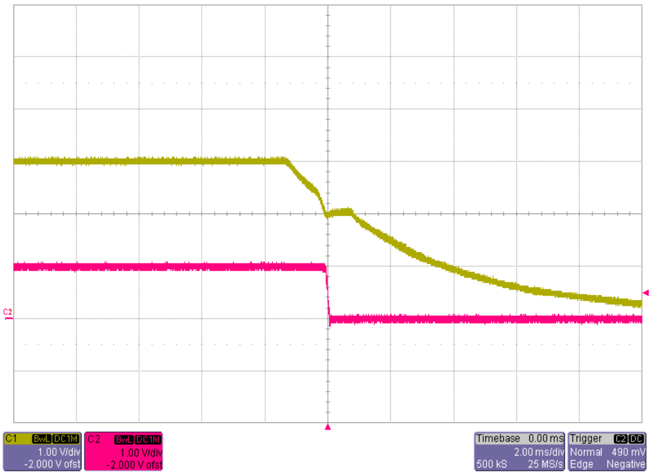
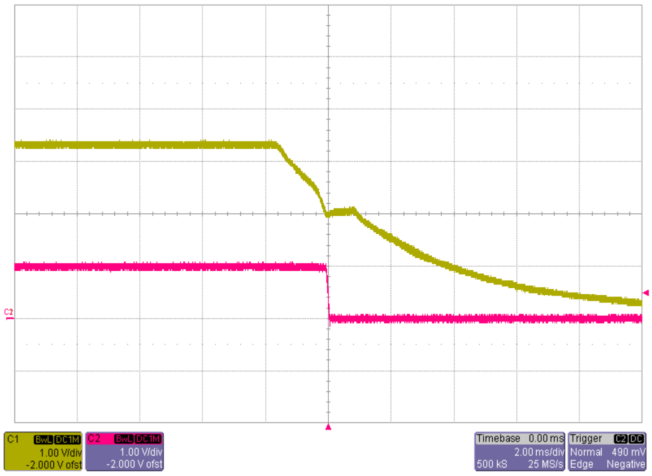
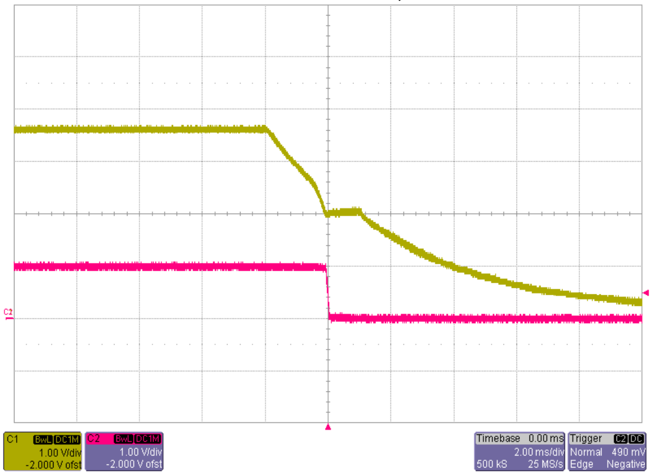


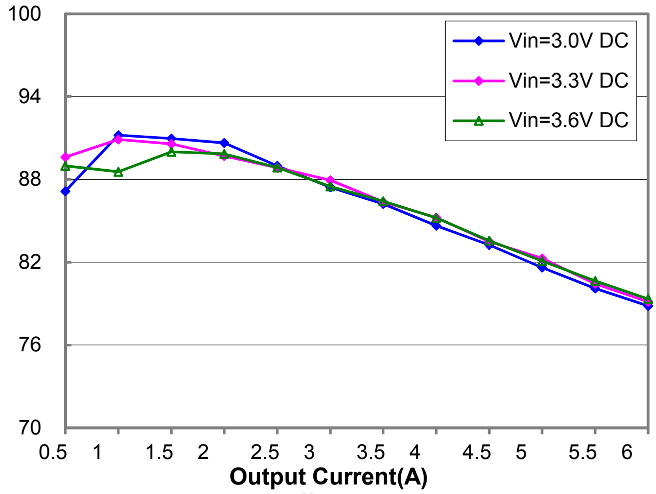
Power down V_{IN}=3V, I_O=6A



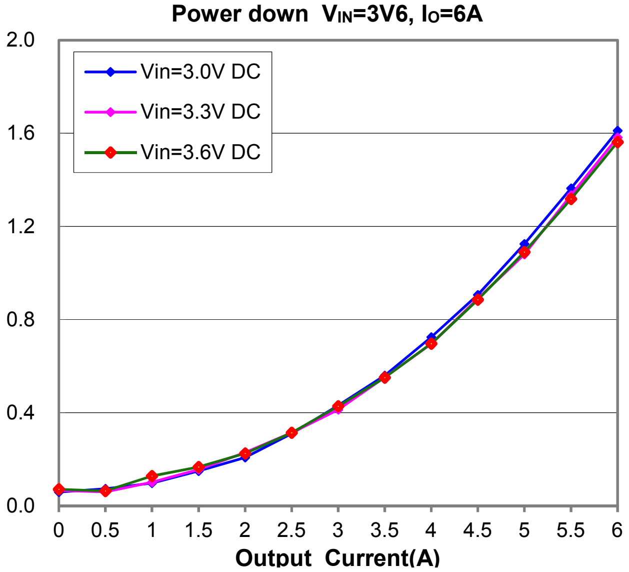
Power down V_{IN}=3V3, I_O=6A



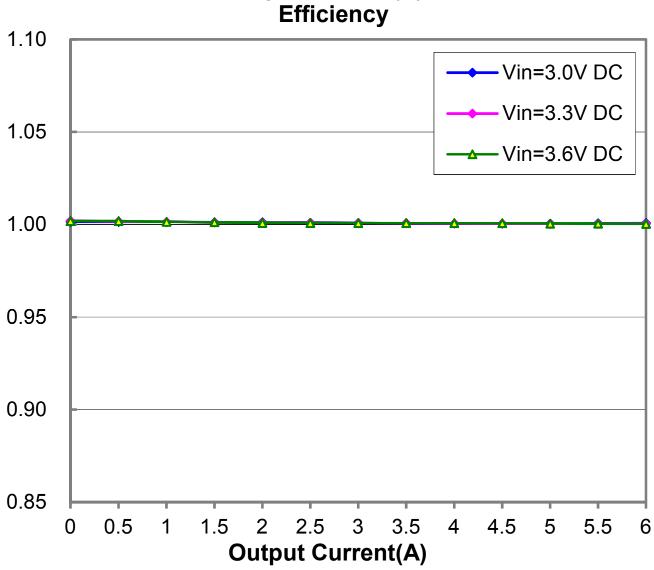
Power down V_{IN}=3V6, I_O=6A



Efficiency



Power Dissipation (W)



Regulation

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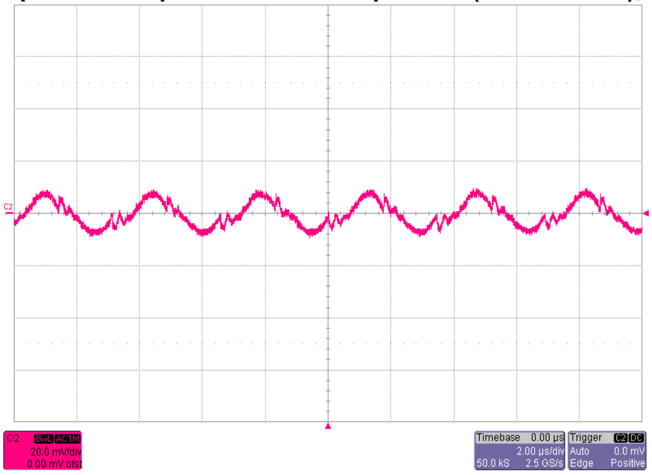
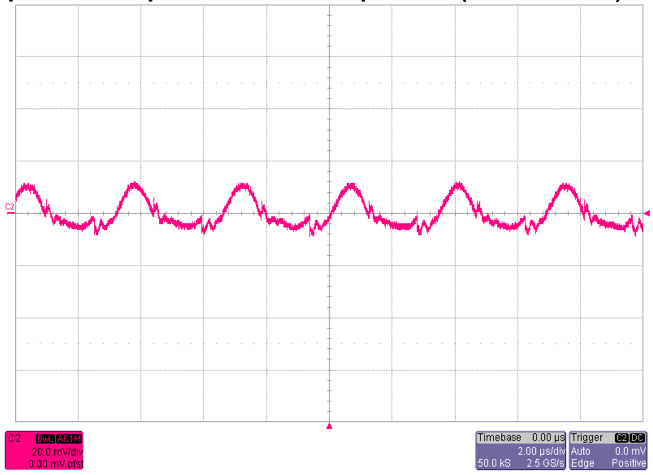
Typical Characteristics – output adjusted to 1.2V

General conditions:

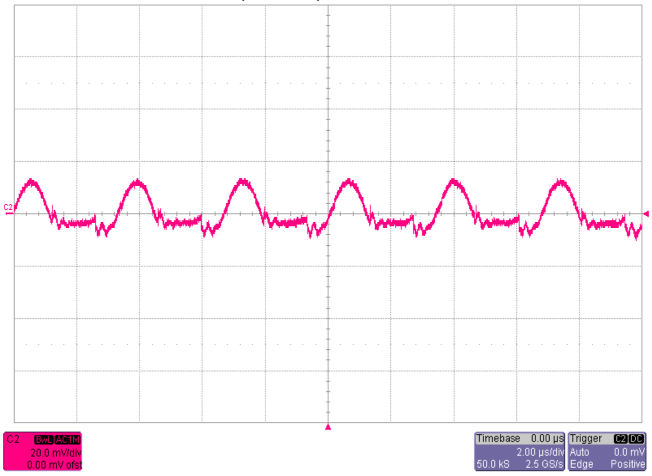
Input filter 22µF Ceramic + 100µF TAN (150mΩ ESR), Output filter 22µF Ceramic + 100µF TAN (150mΩ ESR)



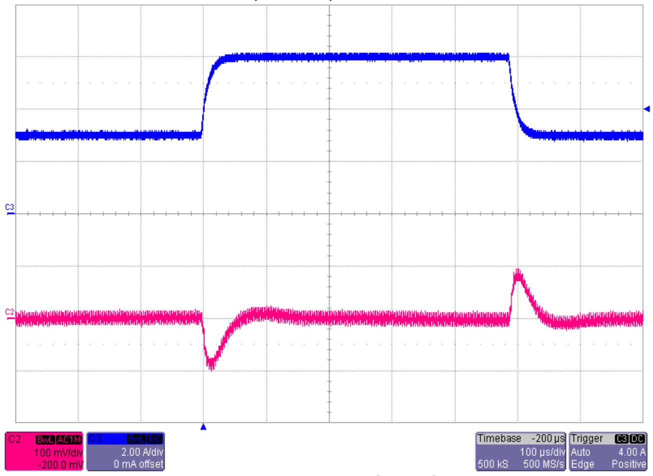
Noise V_{IN}=3V, I_O=6A, 5~20MHz Bandwidth



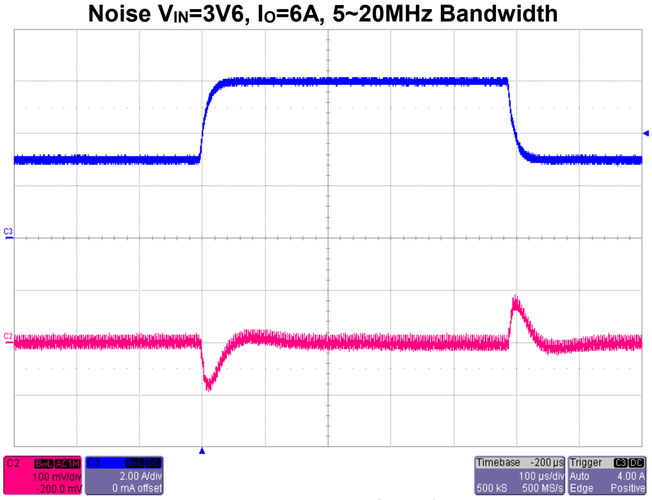
Noise V_{IN}=3V3, I_O=6A, 5~20MHz Bandwidth



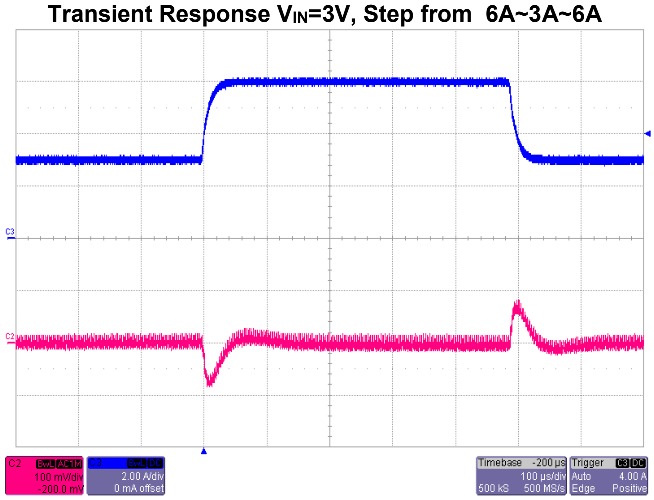
Noise V_{IN}=3V6, I_O=6A, 5~20MHz Bandwidth



Transient Response V_{IN}=3V, Step from 6A~3A~6A



Transient Response V_{IN}=3V3, Step from 6A~3A~6A



Transient Response V_{IN}=3V6, Step from 6A~3A~6A

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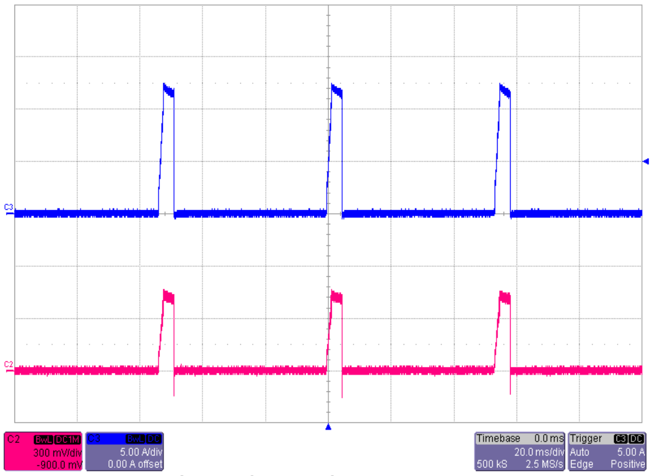
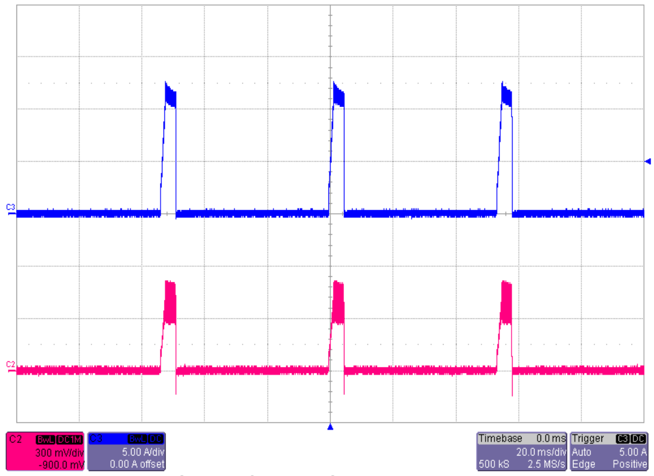
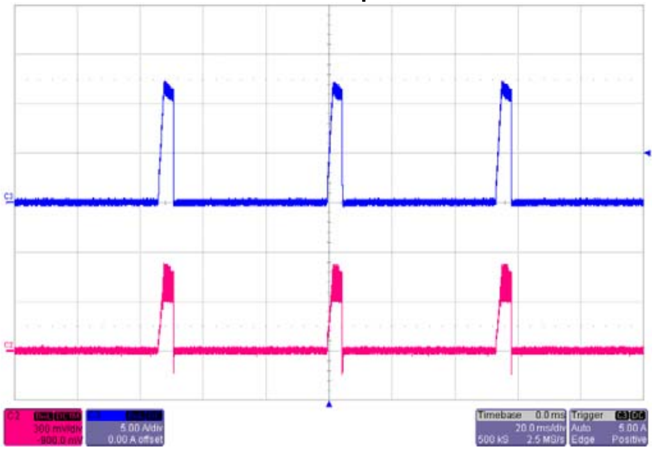


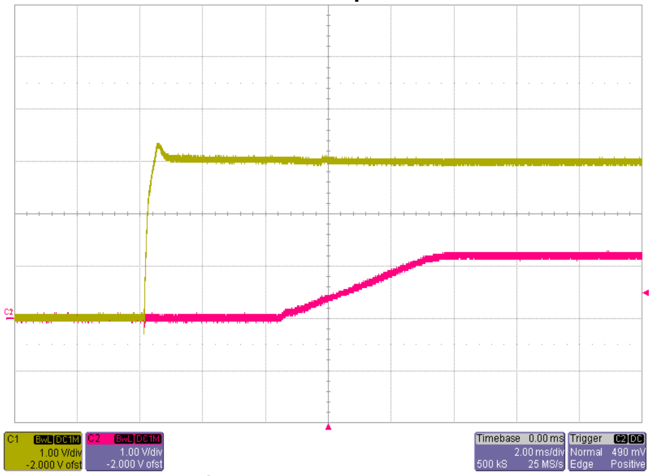
Short-Circuit Output V_{IN}=3V



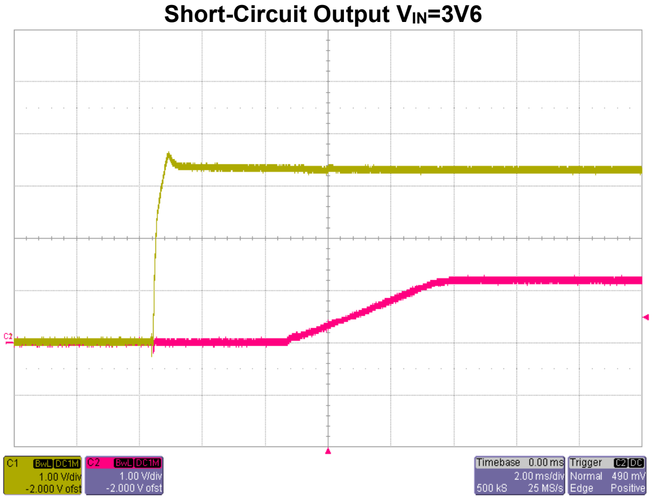
Short-Circuit Output V_{IN}=3V3



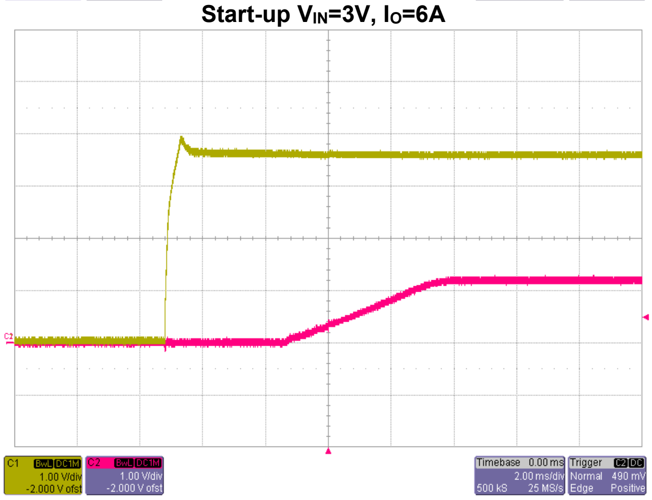
Short-Circuit Output V_{IN}=3V6



Start-up V_{IN}=3V, I_O=6A



Start-up V_{IN}=3V3, I_O=6A



Start-up V_{IN}=3V6, I_O=6A

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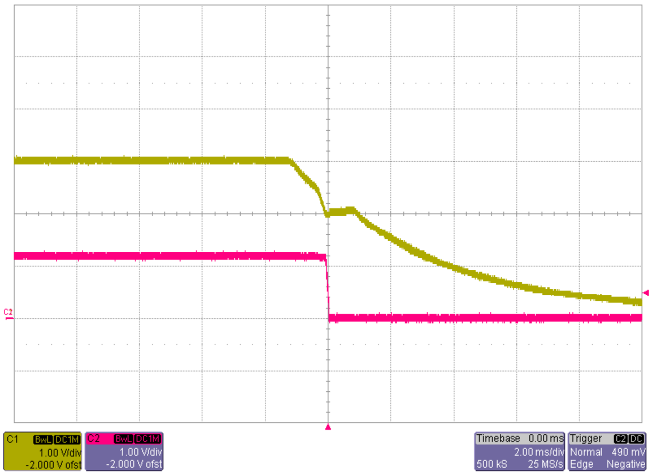
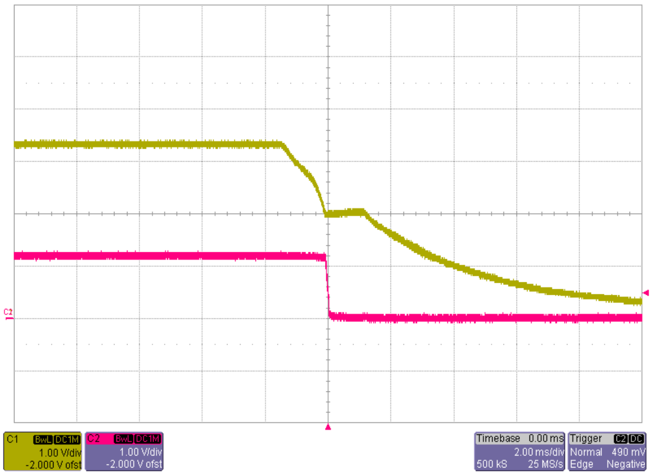
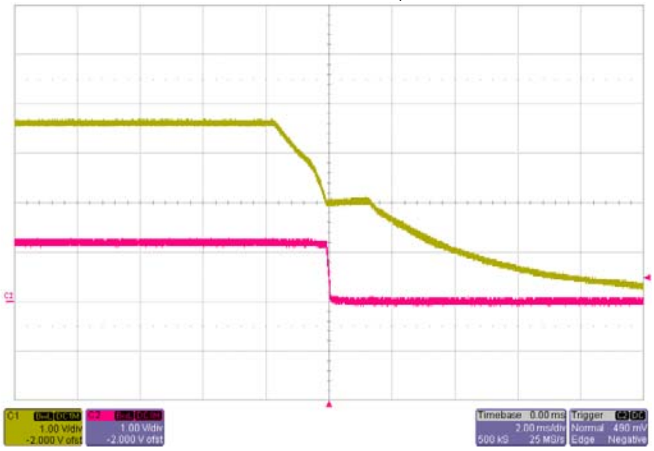


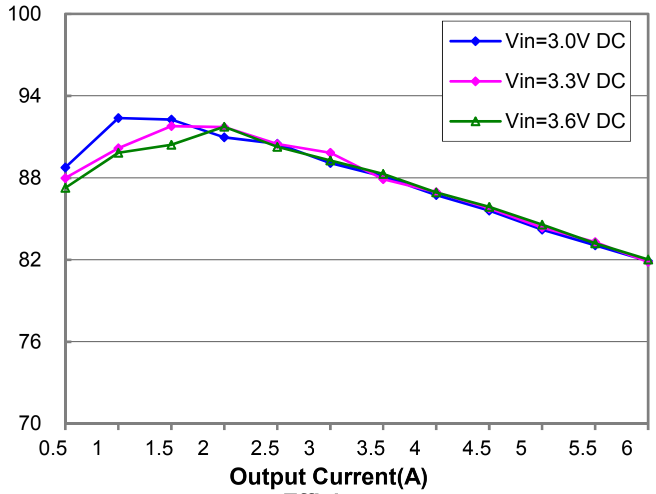
Power down V_{IN}=3V, I_O=6A



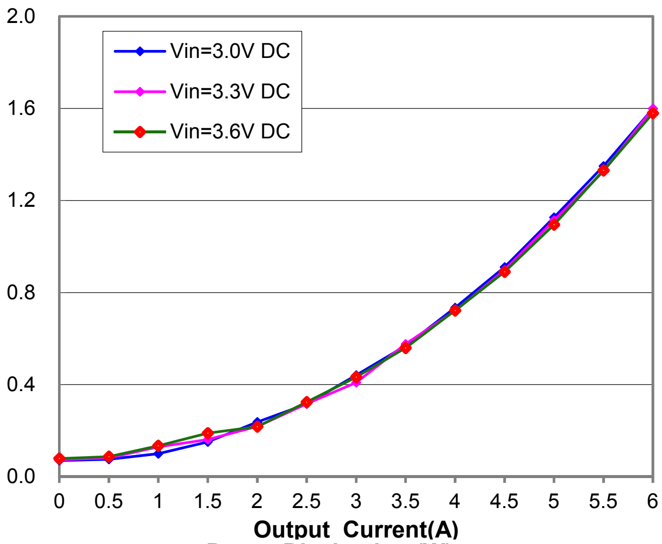
Power down V_{IN}=3V3, I_O=6A



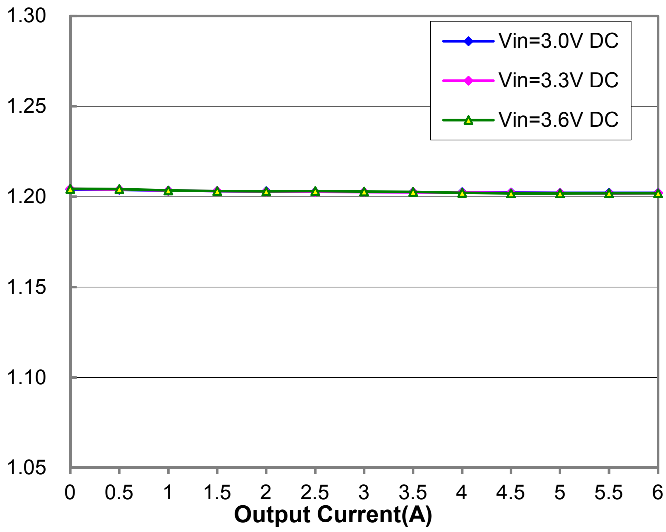
Power down V_{IN}=3V6, I_O=6A



Efficiency



Power Dissipation (W)



Regulation

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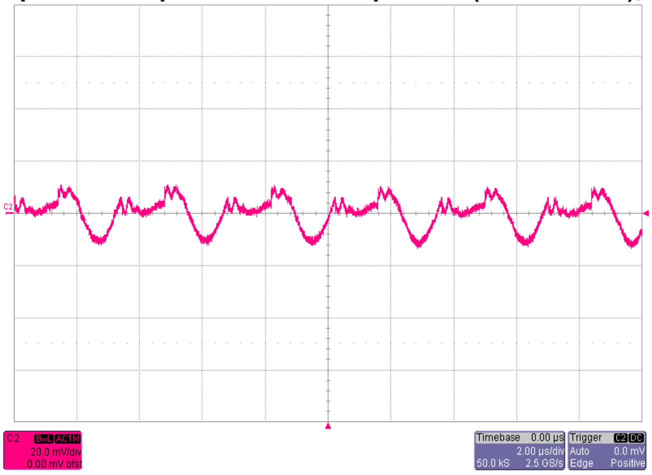
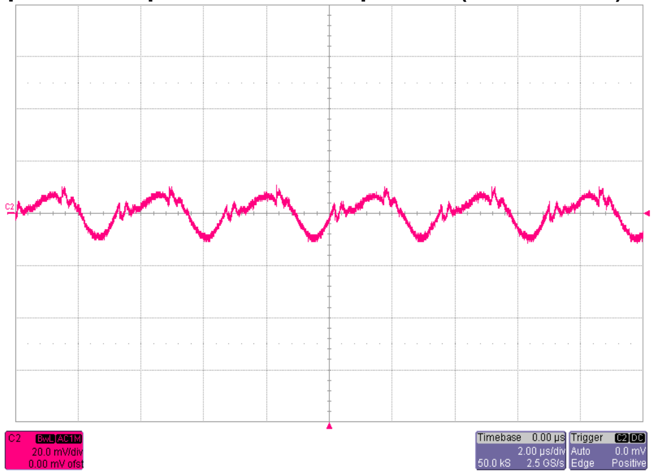
Typical Characteristics – output adjusted to 1.5V

General conditions:

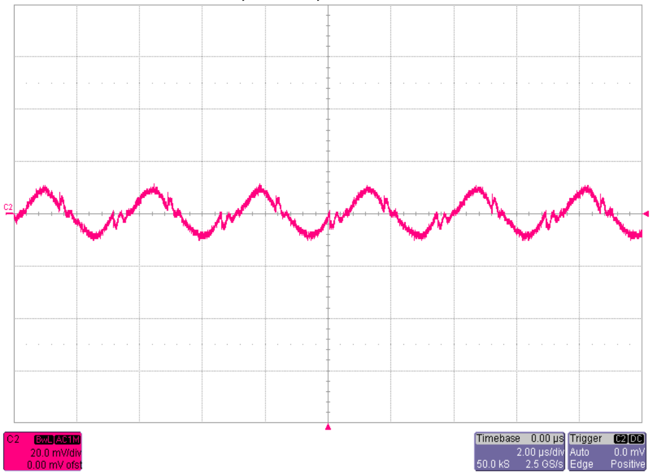
Input filter 22µF Ceramic + 100µF TAN (150mΩ ESR), Output filter 22µF Ceramic + 100µF TAN (150mΩ ESR)



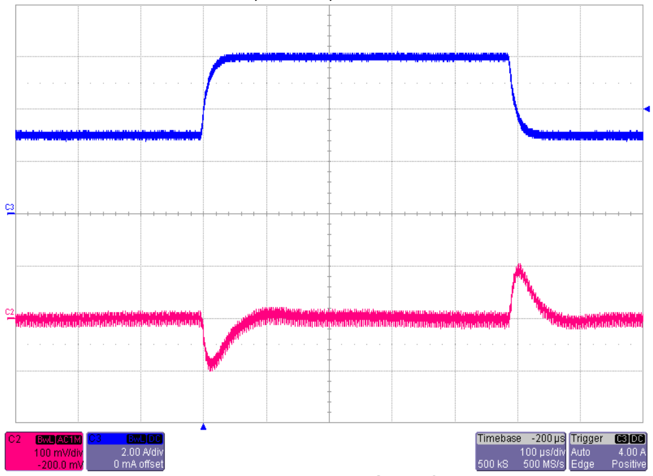
Noise V_{IN}=3V, I_O=6A, 5~20MHz Bandwidth



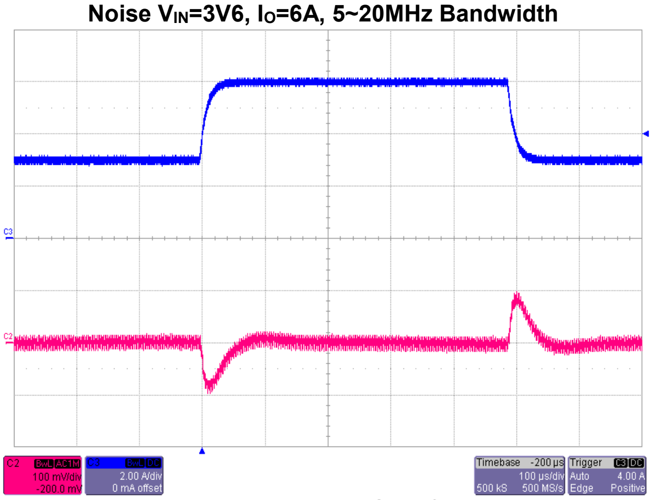
Noise V_{IN}=3V3, I_O=6A, 5~20MHz Bandwidth



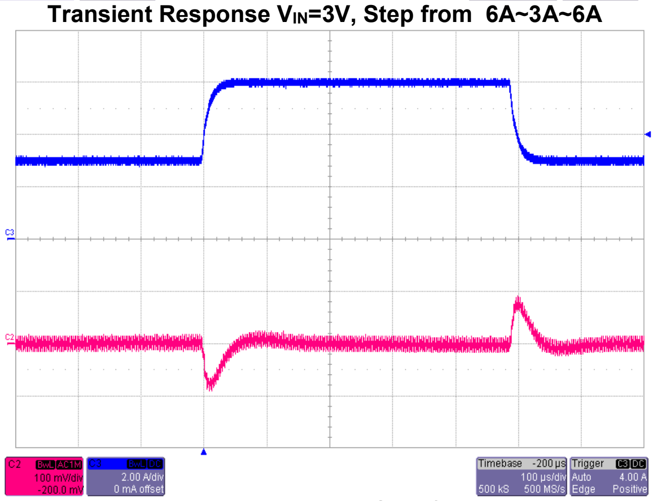
Noise V_{IN}=3V6, I_O=6A, 5~20MHz Bandwidth



Transient Response V_{IN}=3V, Step from 6A~3A~6A



Transient Response V_{IN}=3V3, Step from 6A~3A~6A



Transient Response V_{IN}=3V6, Step from 6A~3A~6A

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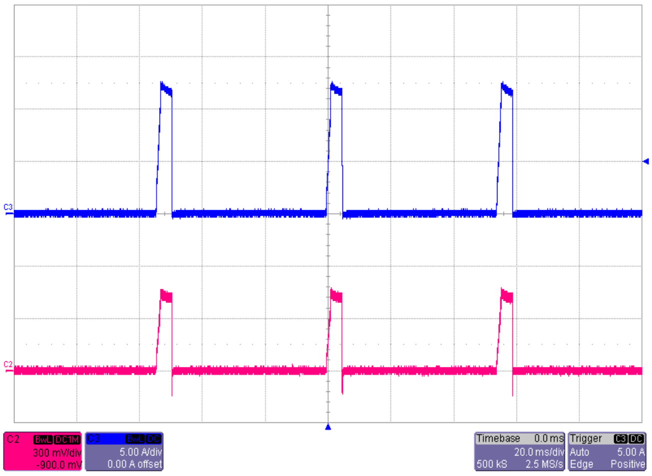
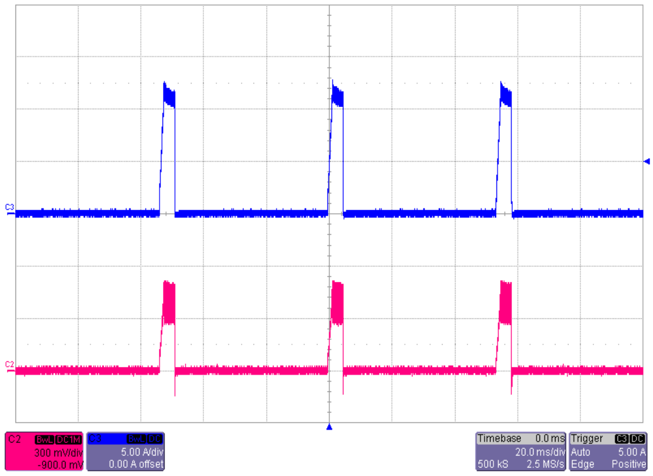
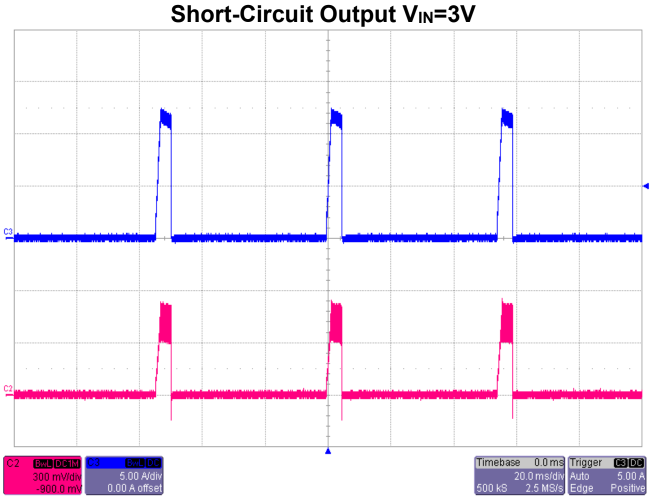


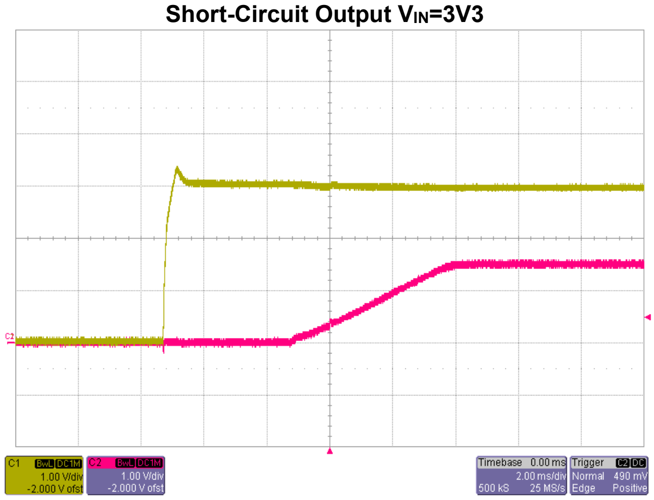
Short-Circuit Output V_{IN}=3V



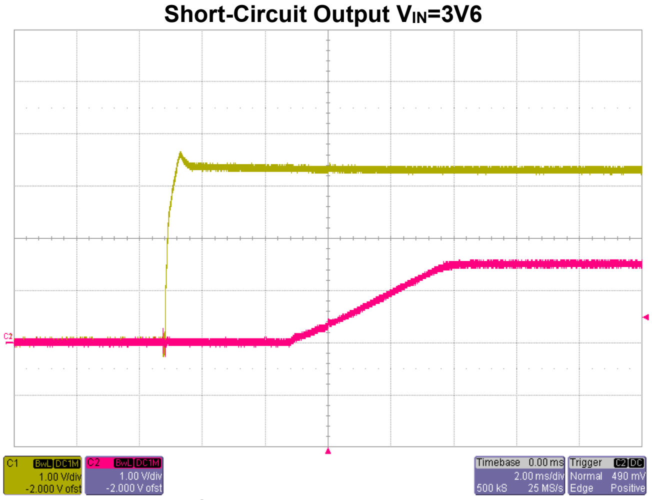
Short-Circuit Output V_{IN}=3V3



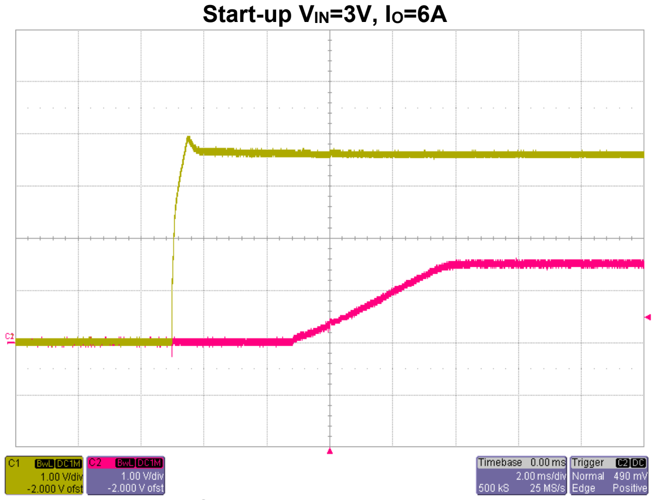
Short-Circuit Output V_{IN}=3V6



Start-up V_{IN}=3V, I_O=6A



Start-up V_{IN}=3V3, I_O=6A



Start-up V_{IN}=3V6, I_O=6A

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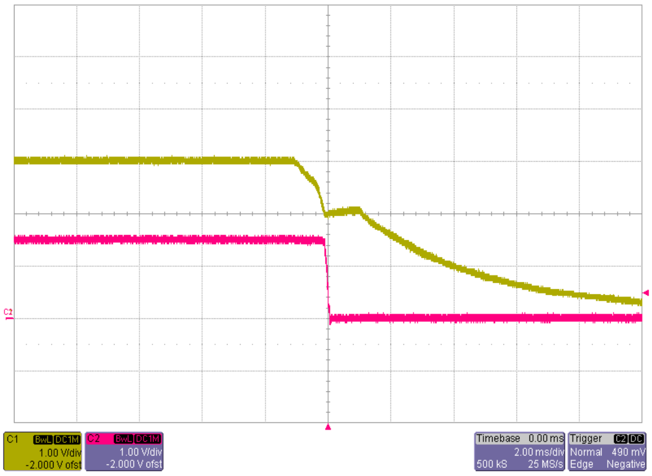
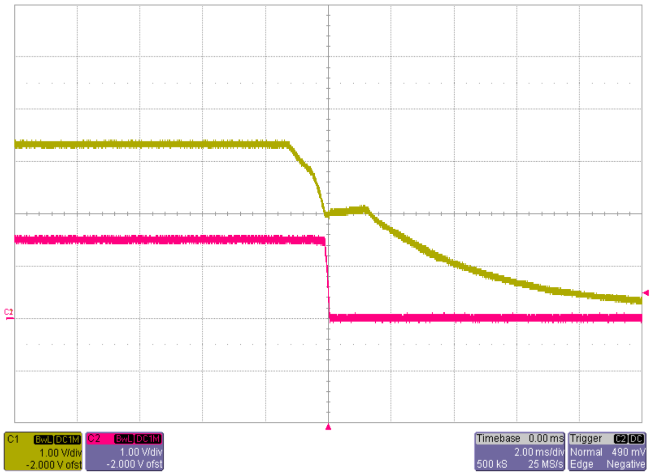
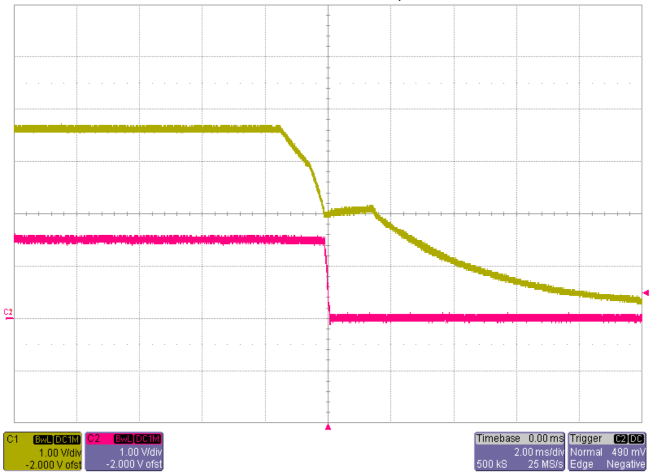


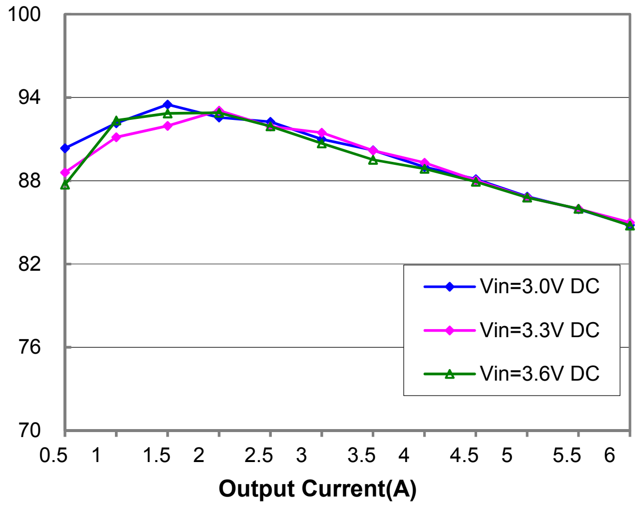
Power down V_{IN}=3V, I_O=6A



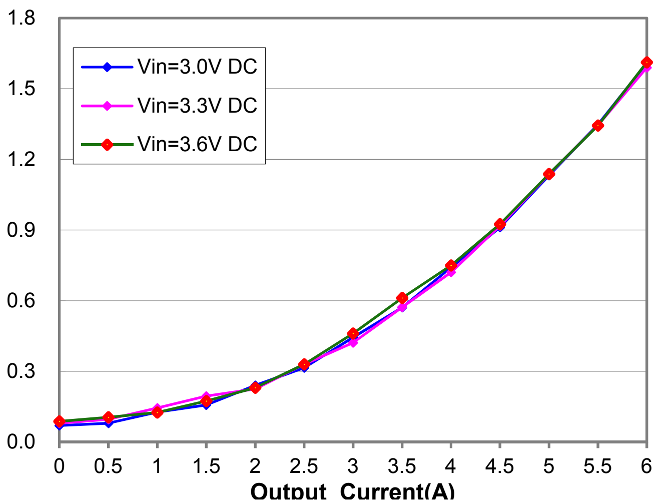
Power down V_{IN}=3V3, I_O=6A



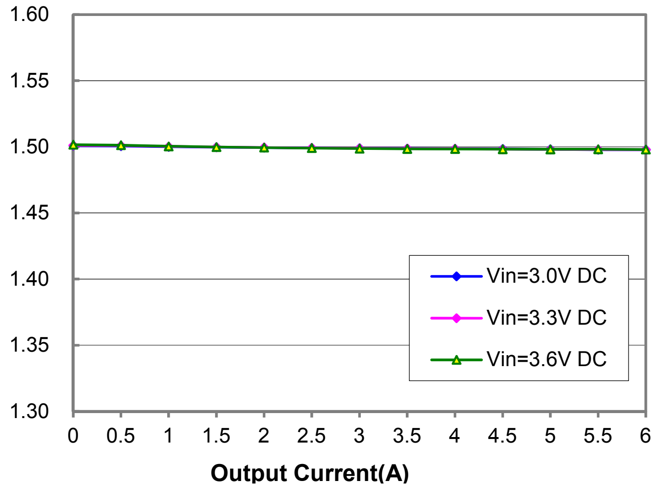
Power down V_{IN}=3V6, I_O=6A



Efficiency



Power Dissipation (W)



Regulation

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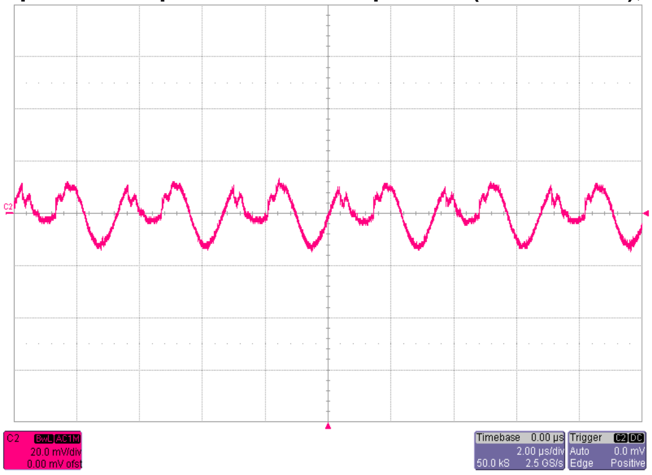
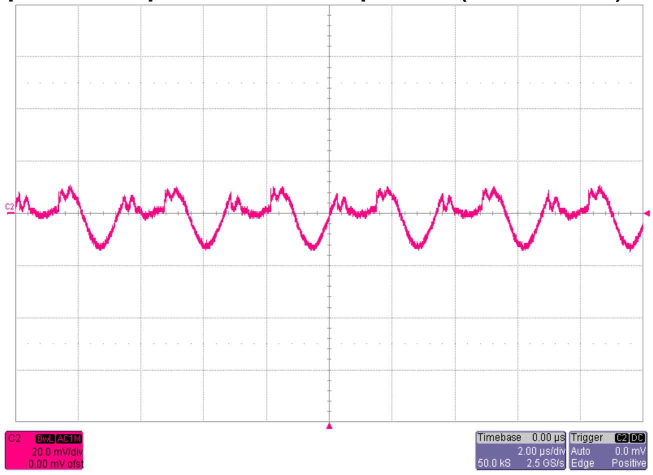
Typical Characteristics – output adjusted to1.8V

General conditions:

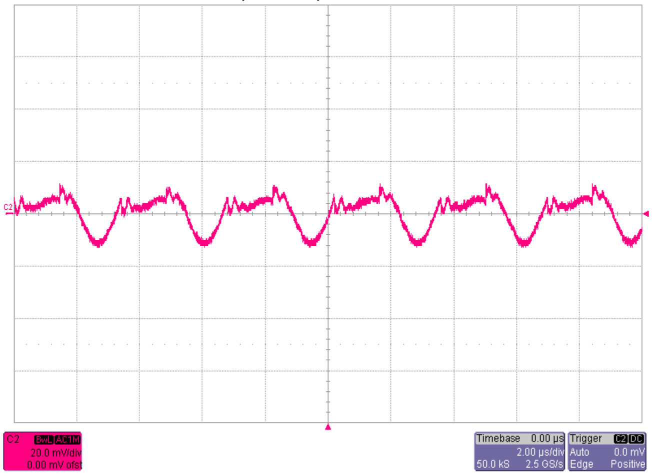
Input filter 22µF Ceramic + 100µF TAN (150mΩ ESR), Output filter 22µF Ceramic + 100µF TAN (150mΩ ESR)



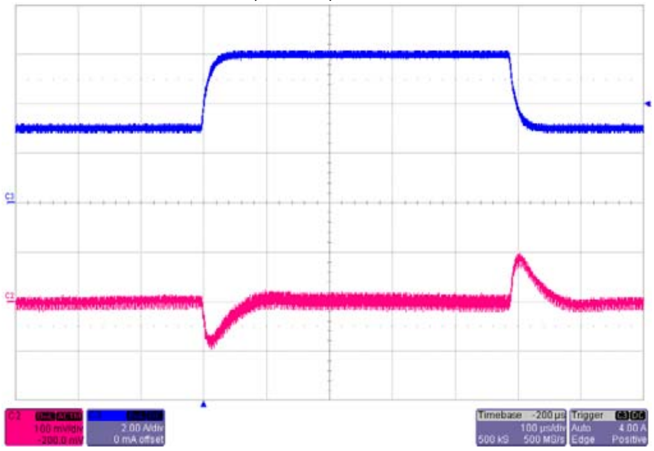
Noise V_{IN}=3V, I_O=6A, 5~20MHz Bandwidth



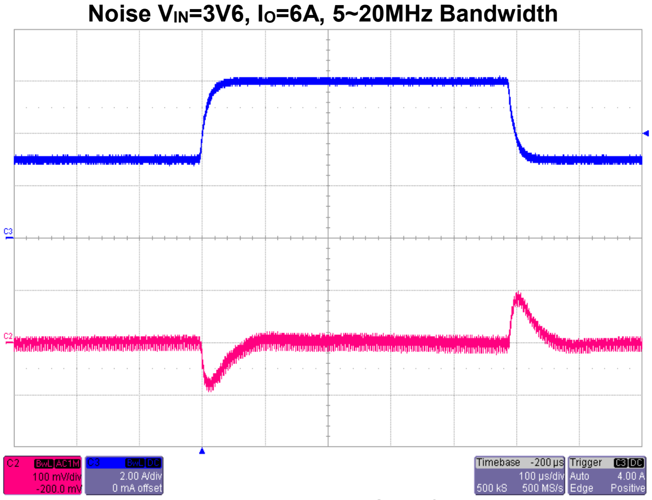
Noise V_{IN}=3V3, I_O=6A, 5~20MHz Bandwidth



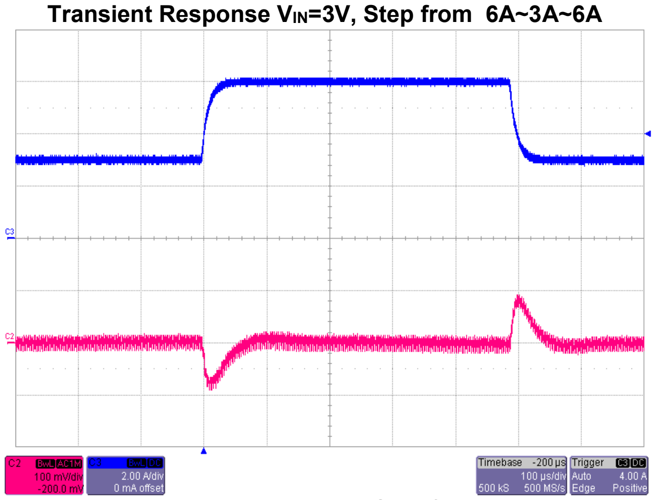
Noise V_{IN}=3V6, I_O=6A, 5~20MHz Bandwidth



Transient Response V_{IN}=3V, Step from 6A~3A~6A



Transient Response V_{IN}=3V3, Step from 6A~3A~6A



Transient Response V_{IN}=3V6, Step from 6A~3A~6A

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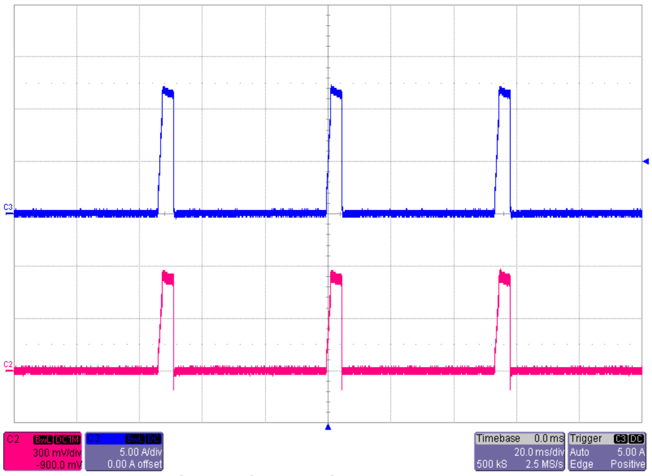
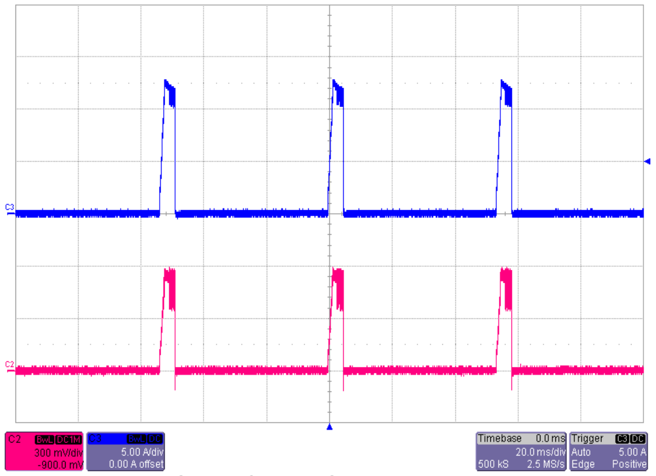
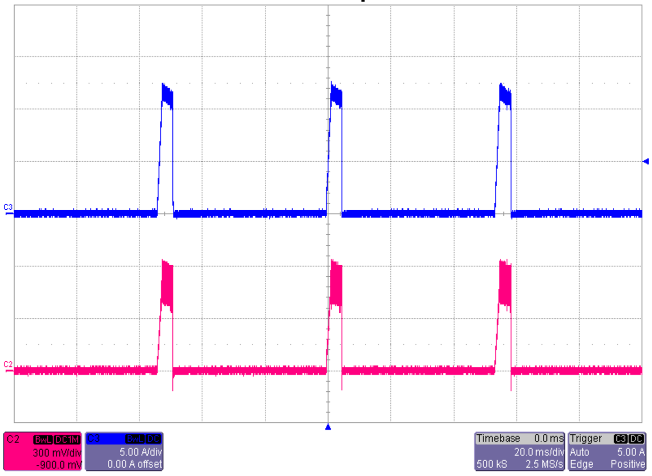


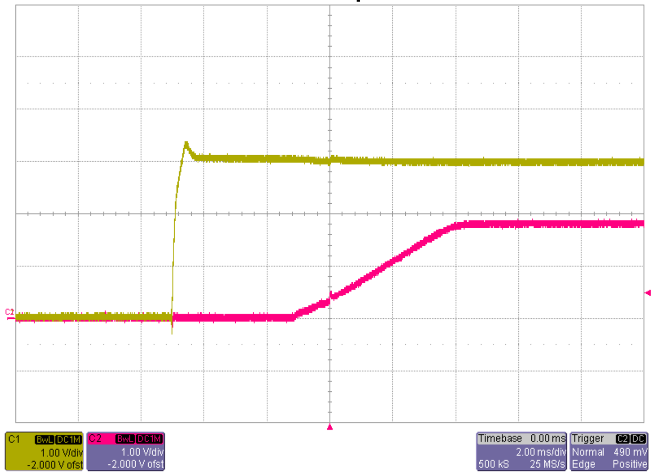
Short-Circuit Output V_{IN}=3V



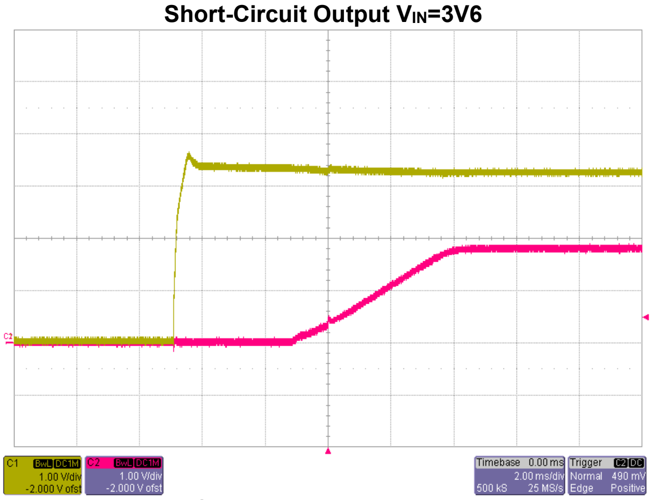
Short-Circuit Output V_{IN}=3V3



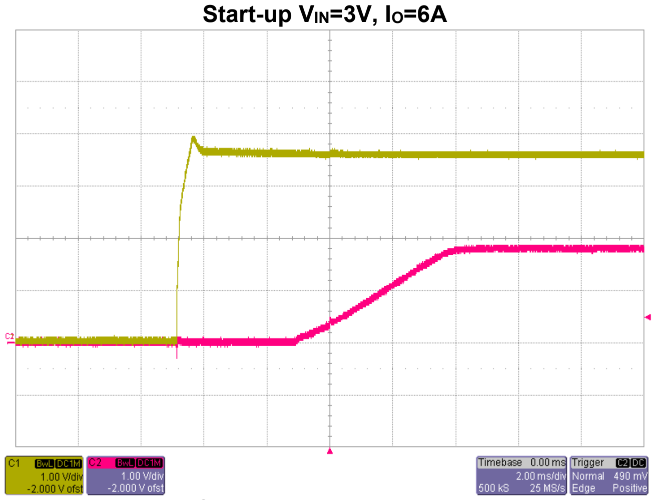
Short-Circuit Output V_{IN}=3V6



Start-up V_{IN}=3V, I_O=6A



Start-up V_{IN}=3V3, I_O=6A



Start-up V_{IN}=3V6, I_O=6A

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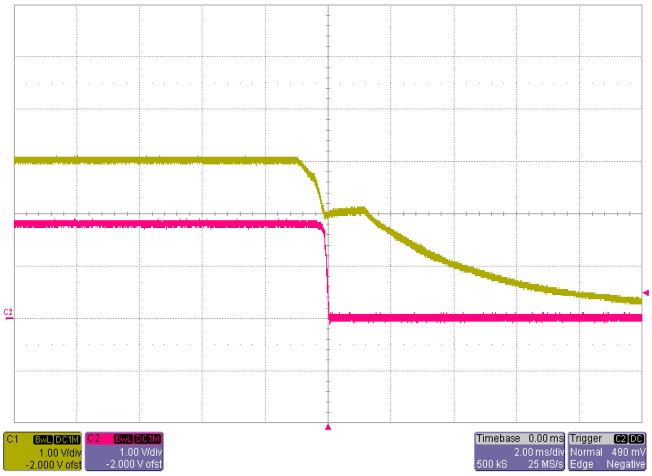
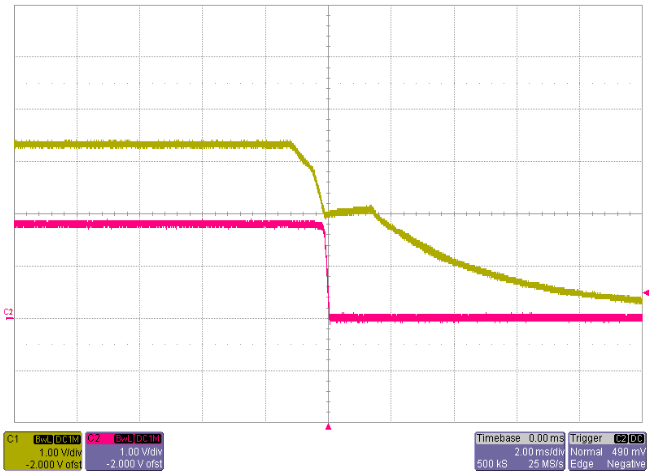
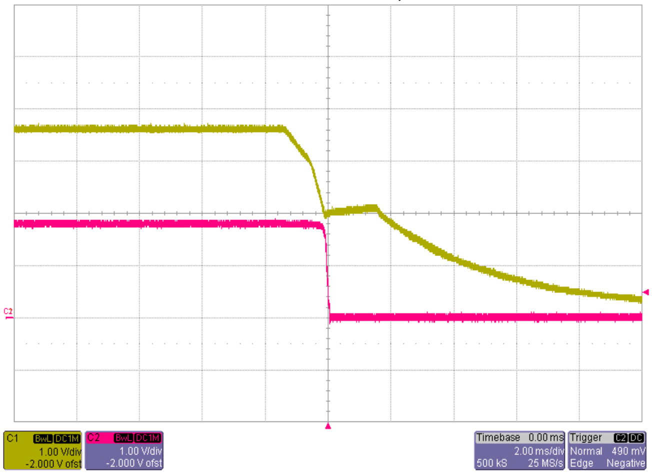


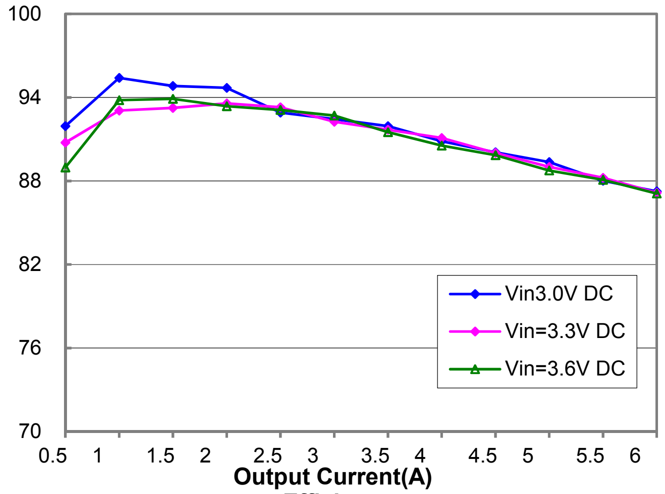
Power down V_{IN}=3V, I_O=6A



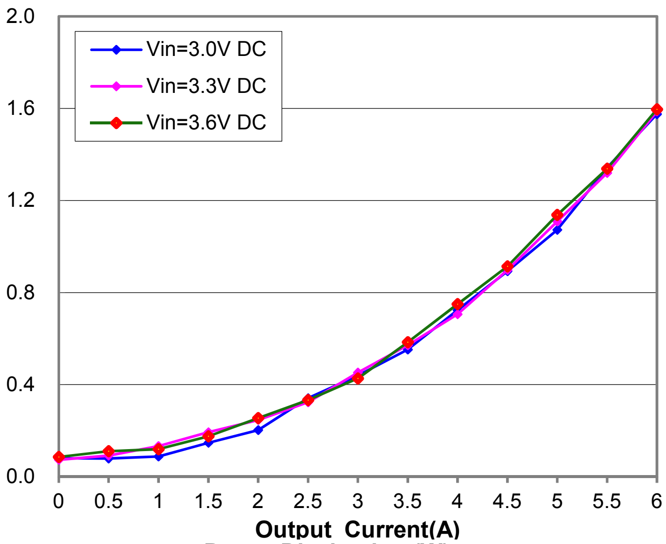
Power down V_{IN}=3V3, I_O=6A



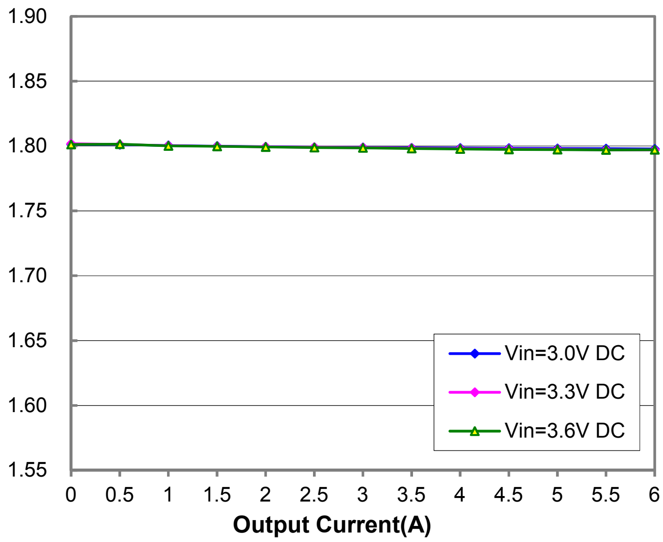
Power down V_{IN}=3V6, I_O=6A



Efficiency



Power Dissipation (W)



Regulation

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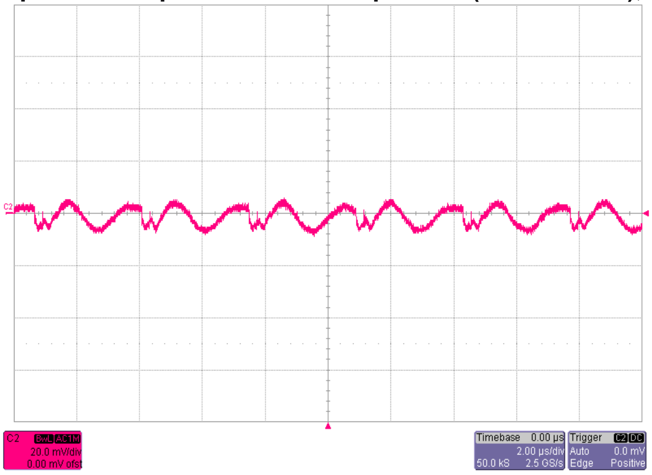
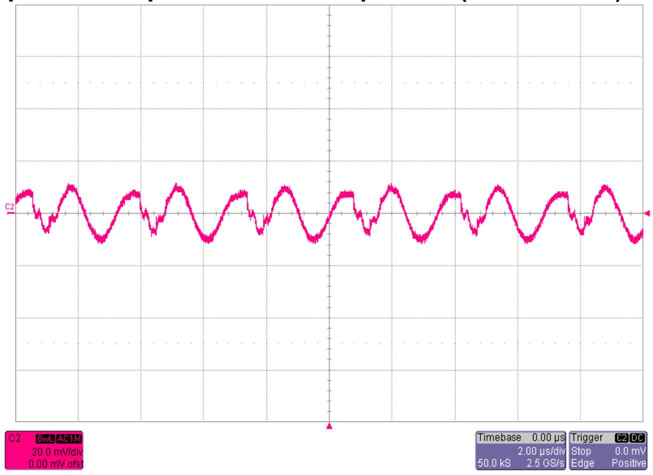
Typical Characteristics – output adjusted to2.5V

General conditions:

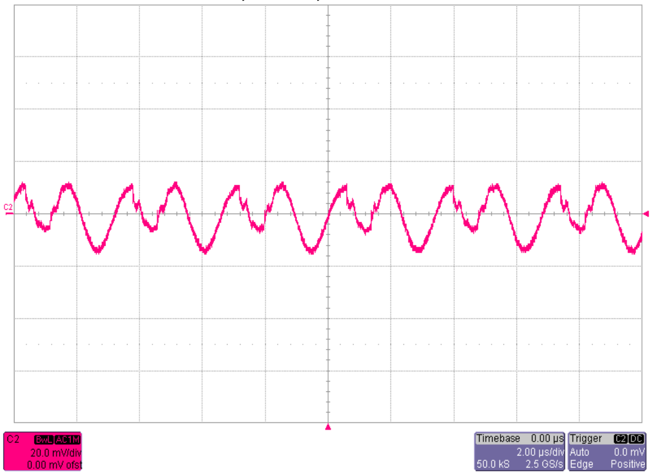
Input filter 22µF Ceramic + 100µF TAN (150mΩ ESR), Output filter 22µF Ceramic + 100µF TAN (150mΩ ESR)



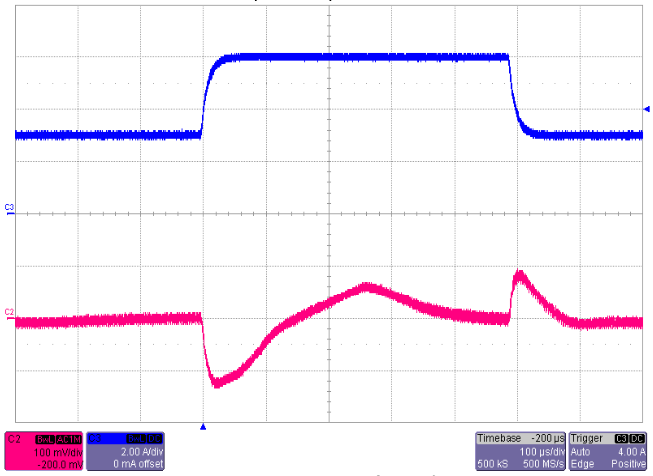
Noise V_{IN}=3V, I_O=6A, 5~20MHz Bandwidth



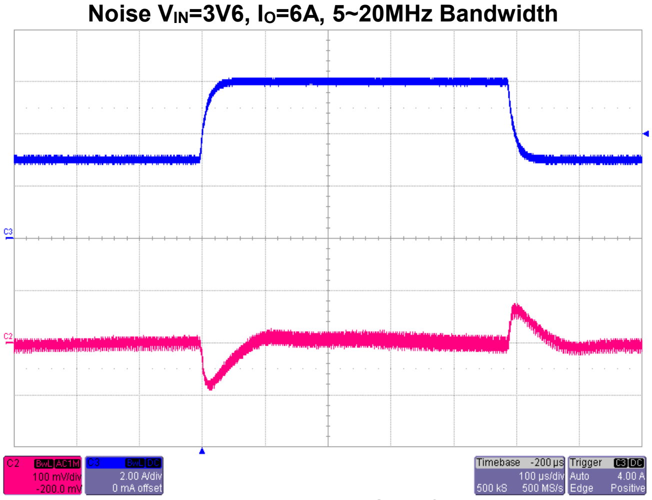
Noise V_{IN}=3V3, I_O=6A, 5~20MHz Bandwidth



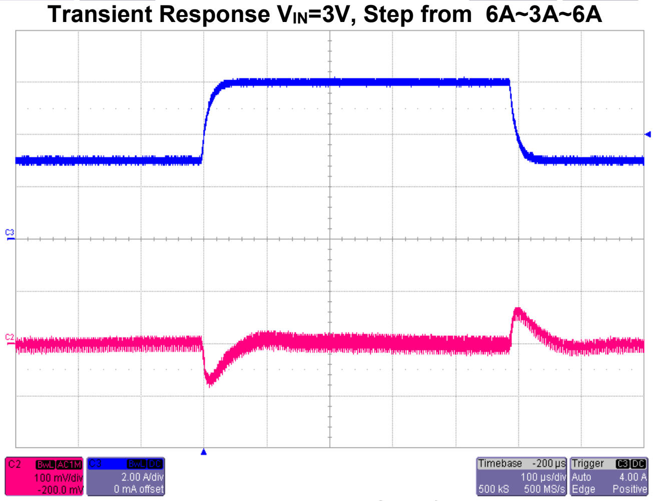
Noise V_{IN}=3V6, I_O=6A, 5~20MHz Bandwidth



Transient Response V_{IN}=3V, Step from 6A~3A~6A



Transient Response V_{IN}=3V3, Step from 6A~3A~6A



Transient Response V_{IN}=3V6, Step from 6A~3A~6A

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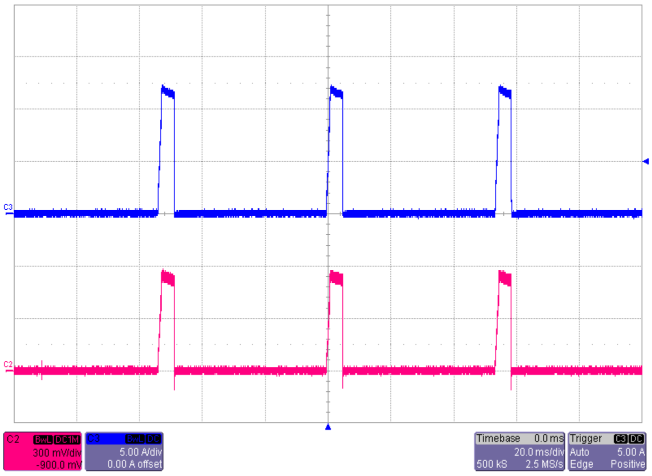
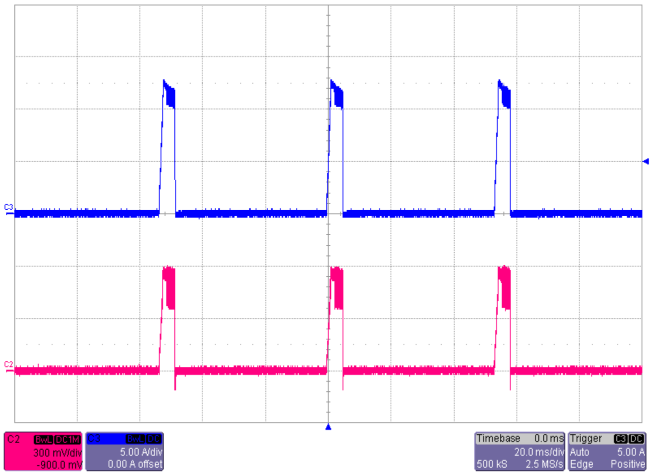
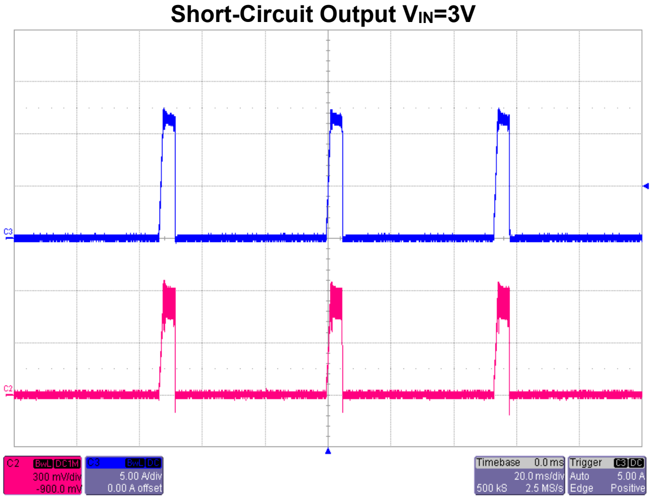


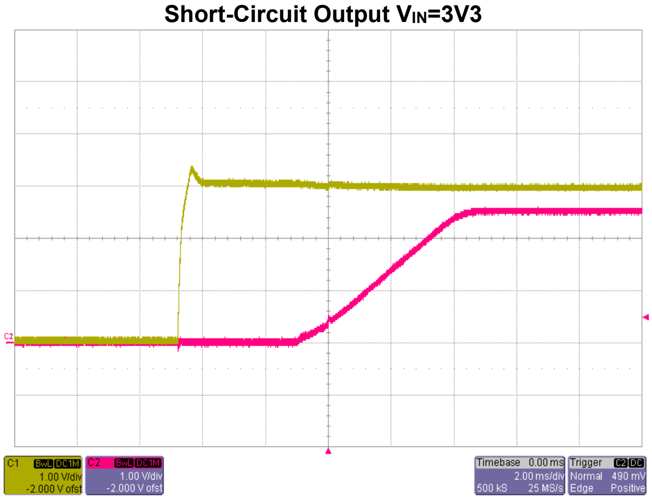
Short-Circuit Output V_{IN}=3V



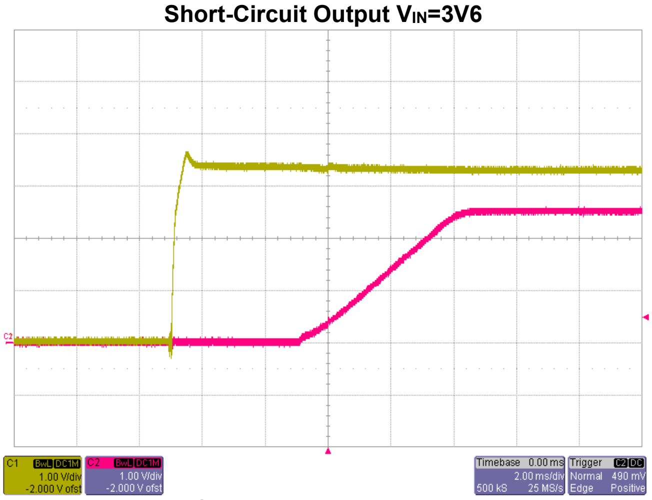
Short-Circuit Output V_{IN}=3V3



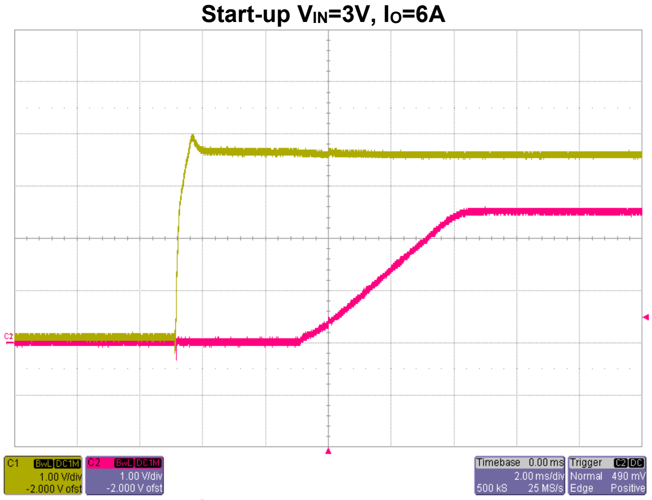
Short-Circuit Output V_{IN}=3V6



Start-up V_{IN}=3V, I_O=6A



Start-up V_{IN}=3V3, I_O=6A



Start-up V_{IN}=3V6, I_O=6A

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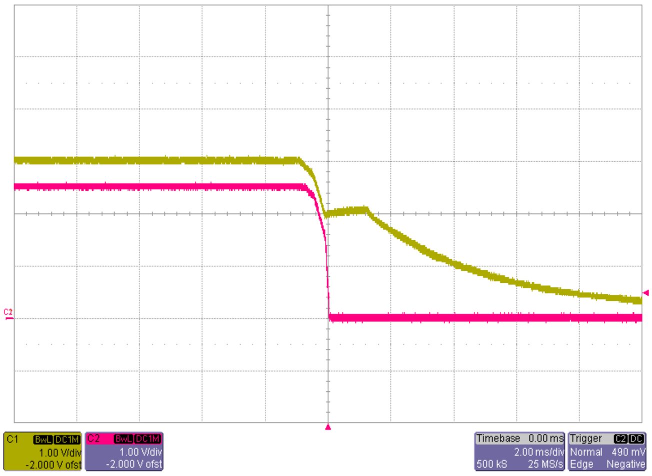
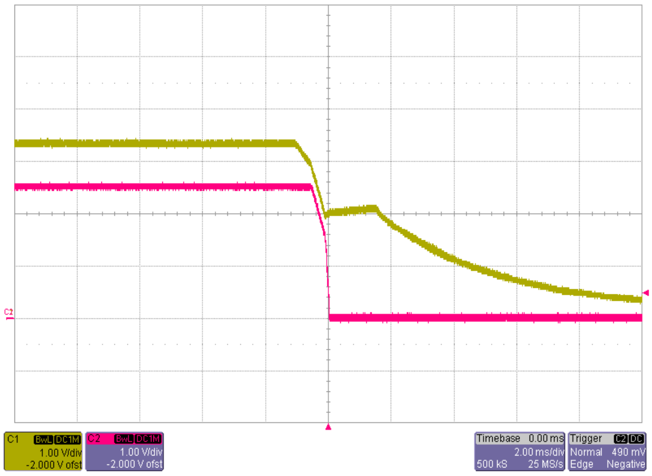
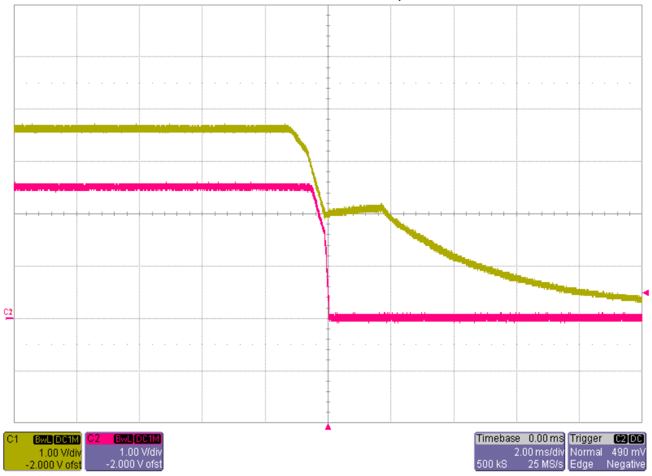


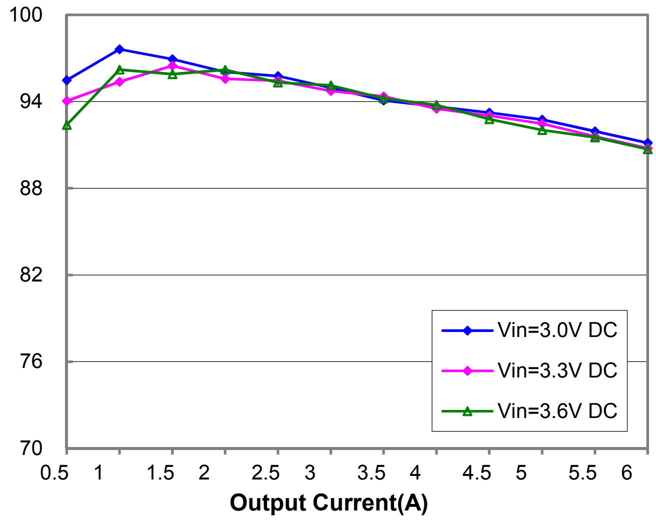
Power down V_{IN}=3V, I_O=6A



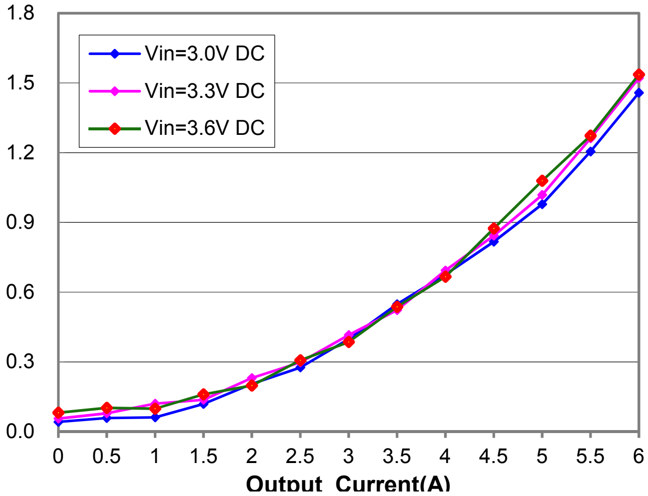
Power down V_{IN}=3V3, I_O=6A



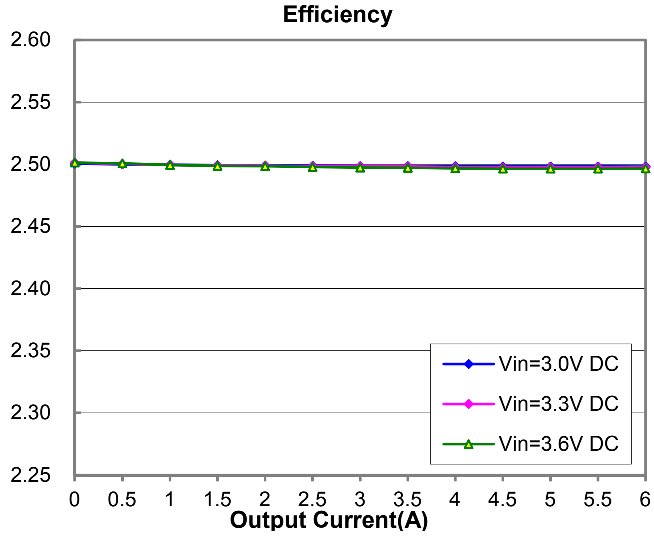
Power down V_{IN}=3V6, I_O=6A



Efficiency



Power Dissipation (W)



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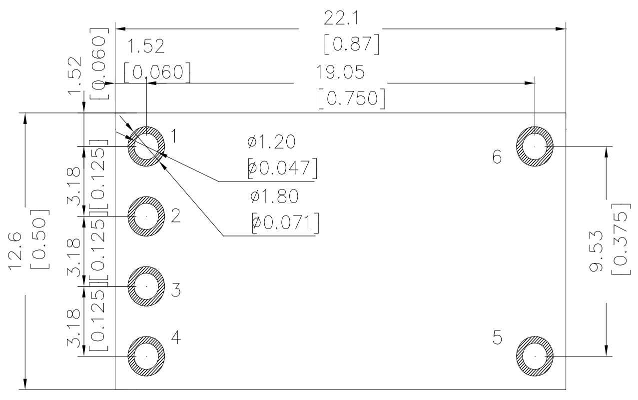
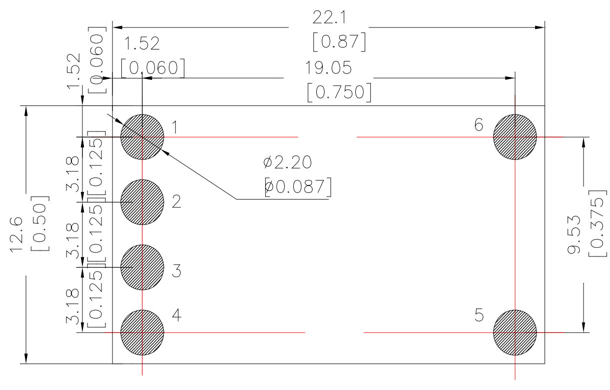
Recommended Hole Pattern for “AT” suffix

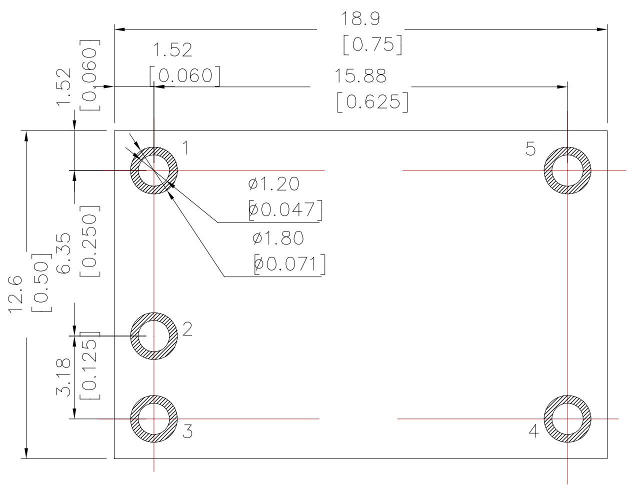
Dimensions are in millimeters (inches)



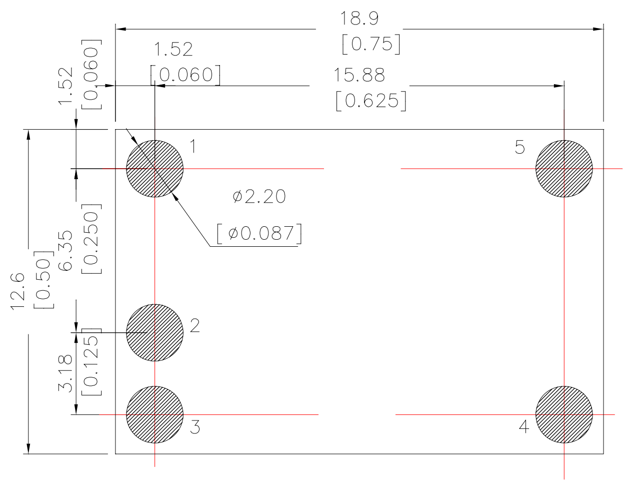
for “AT” suffix



for “AS” suffix



for “BT” suffix



for “BS” suffix

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Application Notes

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