6.5V, 1.2A, Ultra-Low Noise and Low Dropout LDO Regulator

Features

- Input Voltage Range: 1.1V to 6.5V
- Output Voltage Range: 0.8V to 5.5V
- ±1% Reference Voltage Accuracy
- Low Dropout Voltage: 65mV at 1.2A Typical
- Ultra-Low Nosie: 7μVRMS at 0.8V Output
- High PSRR: 35dB at 500kHz
- Programmable Soft-Start Time
- Stable with 10μF or Larger Value Ceramic Output Capacitors
- Power Good Indicator
- Thermal Shutdown
- Output Auto-Discharge in EN Shutdown
- Available in DFN3x3-8N Package

Application

- Wireless Infrastructure: FPGA, DSP
- High Performance Analog: ADC, DAC, VCO
- Noise Sensitive Imaging: CMOS Sensors

Description

The TMI6011 is a high output current, ultra-low noise, low dropout linear regulator that has 1.2A output current capability. It supports single input voltage with the range 1.1V to 6.5V.

With performance of low noise and high PSRR, TMI6011 could be used to power noise sensitive applications such as analog signal amplifiers, analog-to-digital converters, digital-to-analog converters and RF circuits. With performance of high output accuracy and programmable soft time, TMI6011 is also suitable for powering digital load application such as FPGA, DSP or ASIC device.

TMI6011 also could be control by external enable signal and it provides power good indicator for system power sequence control. The output noise could be enhanced by adding external bypass capacitor on SS pin.

TMI6011 is offered in the DFN3x3-8N package.

Typical Application

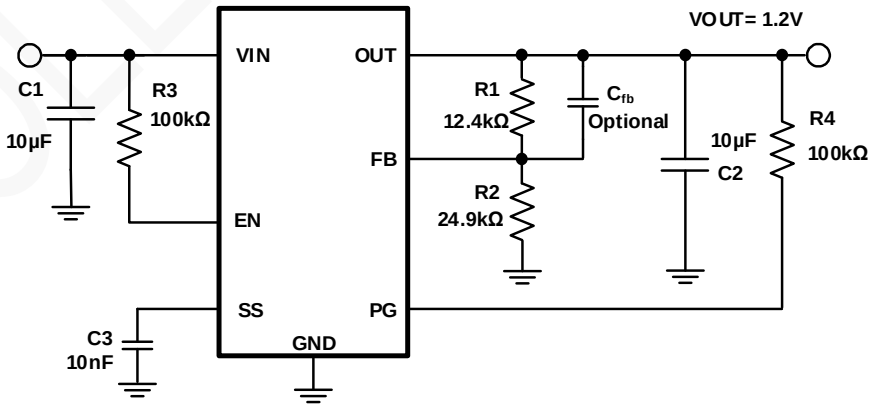
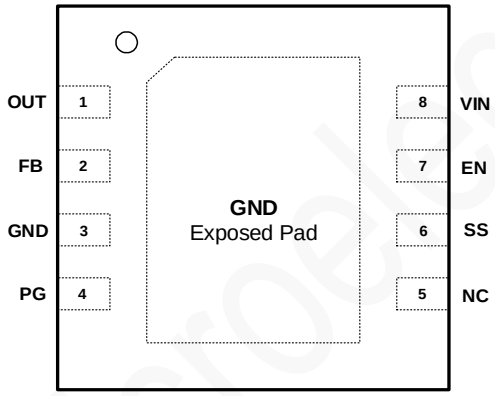


Figure 1. TMI6011 Typical Application Circuit

Absolute Maximum Ratings (Note 1)

Parameter	Min	Max	Unit
Input Supply Voltage, PG, EN	-0.3	7	V
Output Voltage	-0.3	V_{IN}+0.3	V
SS, FB Voltage	-0.3	3.6	V
Storage Temperature Range	-65	150	°C
Junction Temperature (Note2)	-40	150	°C
Power Dissipation	-	3.27	W
Lead Temperature (Soldering, 10s)	-	260	°C

Package



Top View

DFN3x3-8N

Top Marking: T6011/XXXXX (T6011: Device Code, XXXXX: Inside Code)

Order Information

Part Number	Package	Top Marking	Quantity/Reel
TMI6011	DFN3x3-8N	T6011 XXXXX	5000

TMI6011 devices are Pb-free and RoHS compliant.

Pin Functions

Pin	Name	Function
1	OUT	Output of the LDO. A 10μF or larger ceramic capacitor is required for stability.
2	FB	Output feedback voltage input. Connect FB to the center point of the external resistor divider.
3	GND	Ground pin.
4	PG	Power good indicator output.
5	NC	No connection. This pin must be floating in the application.
6	SS	This pin is the inner reference voltage. Connect this pin to GND with an external capacitor can reduce output noise and slow down the output voltage rise rate as the programmable soft-start function.
7	EN	Enable control input. Drive this pin to a logic-high to enable the IC. Drive to a logic-low to disable the IC and enter micro-power shutdown mode. Don't floating EN.
8	VIN	Power supply pin. A minimum 10μF ceramic capacitor or greater capacitance should be placed as close as possible from this pin to GND for better noise rejection.
9	Exposed Pad	Ground pin.

ESD Rating

Items	Description	Value	Unit
V_{ESD_HBM}	Human Body Model for all pins	±4000	V
V_{ESD_CDM}	Charged Device Model for all pins	±1000	V

JEDEC specification JS-001

Recommended Operating Conditions

Items	Description	Min	Max	Unit
Voltage Range	IN	1.1	6.5	V
T_J	Operating Junction Temperature	-40	125	°C

Thermal Resistance (Note3)

Items	Description	Value	Unit
θ_{JA}	Junction-to-ambient thermal resistance	30.5	°C/W
θ_{JC}	Junction-to-case(top) thermal resistance	7.5	°C/W
ψ_{JC}	Junction-to-case(top) characterization parameter	5	°C/W

Electrical Characteristics

V_{IN}=V_{OUT} + 0.3V, T_A = 25°C, unless otherwise noted.

Symbol	Parameter	Conditions	Min	Typ	Max	Units
Input Voltage						
V_{IN}	Input Voltage Range		1.1		6.5	V
V_{UVLO}	Input Under Voltage Lock Off			1.04	1.09	V
V_{UVLO_HYS}	UVLO Hysteresis			185		mV
I_{q_GND}	Ground Quiescent Current	V_{EN}=2V, I_{OUT}=1.2A		4		mA
I_{SD_GND}	Ground Shutdown Current	V_{IN}=6.5V, V_{EN}=0V		18		μA
PSRR	Power Supply Ripple Rejection	V_{IN}=4.2V, V_{OUT}=3.3V, I_{OUT}=1A, C_{SS}=C_{FB}=10nF, C_{OUT}=10μF, f=500kHz		35		dB
Enable						
V_{EN_H}	EN Pin High-Level Input Voltage	Enable device	1.1		6.5	V
V_{EN_L}	EN Pin Low-Level Input Voltage	Disable device	0		0.5	V
I_{EN}	EN Input Current	V_{EN}=V_{IN}=6.5V	-0.1		0.1	μA
Output Voltage						
V_{REF}	Reference Voltage Accuracy	V_{IN}=V_{OUT}+0.3V,	0.792	0.8	0.808	V
V_{LNR}	Output Line Regulation	V_{OUT}+0.3V<V_{IN}<6.5V, I_{OUT}=10mA		0.1		%/V
V_{LDR}	Output Load Regulation	1mA<I_{OUT}<1.2A, V_{IN}=1.4V, V_{OUT}=1.2V		0.08		%/A
V_{DROP}	Dropout Voltage (Note 4) at I_{OUT}=1.2A	V_{IN}=1.1V to 6.5V, I_{OUT} =1.2A V_{FB}= 0.8V - 3%		65		mV
V_{NOISE}	Output Noise Voltage	BW=10Hz to 100kHz, V_{IN}=1.4V, V_{OUT}=0.8V, C_{SS}=C_{FB}=10nF, C_{OUT}=10μF, I_{OUT}=1A		7		μV_{RMS}
V_{IT_PGOOD}	PGOOD Pin Threshold	For the direction PGOOD signal falling with decreasing VOUT	0.86x Vout	0.88 x Vout	0.91 x Vout	V
V_{PGOOD_HYS}	PGOOD Pin Hysteresis	For PGOOD signal rising		0.025 xVout		V
I_{PG_SK}	Power Good Sink Current	V_{FB} < 80% x V_{REF}			2	mA
V_{PG_LOW}	Power Good Low Level Output Voltage	V_{FB} > 95 x V_{REF}			0.4	V
R_{DIS}	Output Discharge Resistance			380		Ω
I_{SS}	SS Pin Charging Current	V_{SS} =0V		5		μA
Protection						
I_{LIMIT}	Output Current Limit	V_{OUT} = 90% V_{NOR}		1.9		A
T_{SD}	Thermal Shutdown Temperature (Note 5)			160		°C
T_{SDHYS}	Thermal Shutdown Hysteresis (Note 5)			20		°C

Note 1: Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.

Note 2: T_J is calculated from the ambient temperature T_A and power dissipation P_D according to the following formula: $T_J = T_A + P_D \times \theta_{JA}$.

Note 3: Measured on JESD51-7, 4-layer PCB.

Note 4: The dropout voltage is defined as V_{IN}-V_{OUT}, when V_{OUT} is 97% of the normal value of V_{OUT}.

Note 5: Guaranteed by design.

Block Diagram

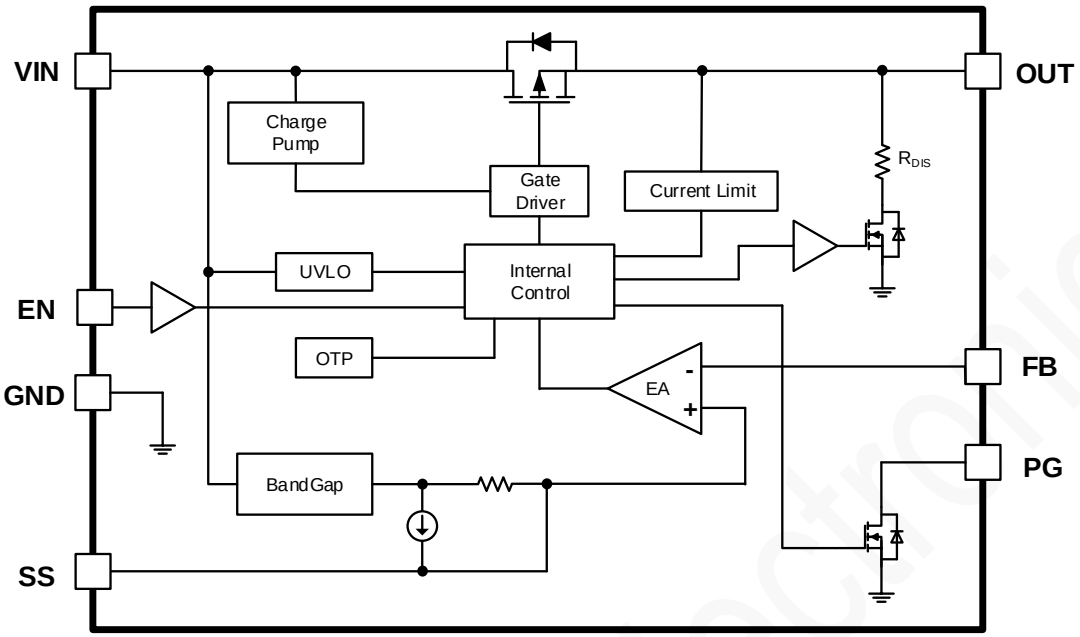


Figure 1. TMI6011 Block Diagram

Operation Description

Overview

The TMI6011 operates with single supply input ranging from 1.1V to 6.5V and capable to deliver 1.2A current to the output. The device features high PSRR and low noise provides a clean supply to the application.

A low-noise reference and error amplifier are included to reduce device noise. The C_{SS} capacitor filters the noise from the reference and feed-forward capacitor (C_{FB}) filters the noise from the error amplifier. The high power-supply rejection ratio (PSRR) of the TMI6011 minimize the coupling of input supply noise to the output.

Input Under Voltage Lockout

TMI6011 implement input under voltage lockout function to avoid mis-operation at low input voltages. When the input voltage is lower than input UVLO threshold with UVLO hysteresis, the device is shut down. The typical 185mV input UVLO hysteresis value of TMI6011 is useful to prevent device from abnormal switching caused by input voltage oscillation around UVLO threshold during input voltage power-up and power-down with high load condition.

Enable and Shutdown

The TMI6011 provides an EN pin, as an external chip enable control, to enable or disable the device. When V_{EN} voltage is below EN falling threshold voltage, the device turns the regulator off and enters the shutdown mode, while V_{EN} is above EN rising threshold voltage, the device turns the regulator on.

Programmable Soft-Start

The capacitor on SS pin can be used for output voltage soft start time programming and noise reduction. When EN and UVLO exceeds the respective threshold voltage, the TMI6011 active a soft-start circuit to charge the noise reduction capacitor (C_{SS}) and then the output voltage ramps up. The soft-start time can be calculated with the below equation:

$$t_{SS}=\frac{V_{REF}\times C_{SS}}{I_{SS}}$$

Power Good

The power-good circuit monitors the feedback pin voltage to indicate the status of the output voltage. The open drain PGOOD pin requires an external pull-up resistor to an external supply, any downstream device can receive power-good as a logic signal that can be used for sequencing. The pull-up resistor from 10kΩ to 100kΩ is recommended. Make sure that the external pull-up supply voltage results in a valid logic signal for the receiving device or devices.

Output Active Discharge

When the regulator is disabled, an internal 380Ω resister is connected between V_{OUT} and GND to discharge output capacitor C_{OUT}.

Current Limit

The TMI6011 includes a current limit circuit to monitor the gate voltage of the pass transistor to limit the output current. When the output current is higher than the over-current limit, the circuit will clamp the gate voltage of the pass transistor to limit the output current.

Thermal Shutdown

The TMI6011 monitors internal temperature. When the junction temperature exceeds 160°C, the over temperature protection (OTP) circuit turn off the pass transistor until the device is cooled down by 20°C. Then the pass transistor resumes. For continue operation, do not exceed absolute maximum junction temperature.

Output Voltage Setting

The output voltage of the TMI6011 can be set by external resistors to achieve different output target. Using external resistors, the output voltage is determined by the values of R1 and R2 as Figure 1. The values of R1 and R2 can be calculated with any voltage value via use the formula given in Equation:

$$V_{OUT}=0.8x\frac{R1+R2}{R2}$$

Table 1. Recommended Feedback-Resistor Values

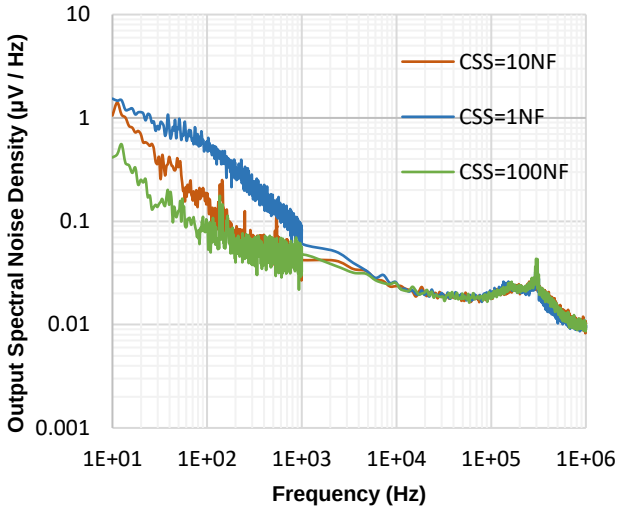
Output Voltage (V)	External Restive Divider Combinations	
	R1(kΩ)	R2(kΩ)
0.9	12.4	100
1	12.4	49.9
1.2	12.4	24.9
1.5	12.4	14.3
1.8	12.4	10
2.5	12.4	5.9
3.3	12.4	3.74
4.5	12.4	2.55
5	12.4	2.37

TYPICAL PERFORMANCE CHARACTERISTICS

C_{IN} =10μF, C_{OUT} =10μF, C_{SS}= 10nF, C_{FF}= 10nF

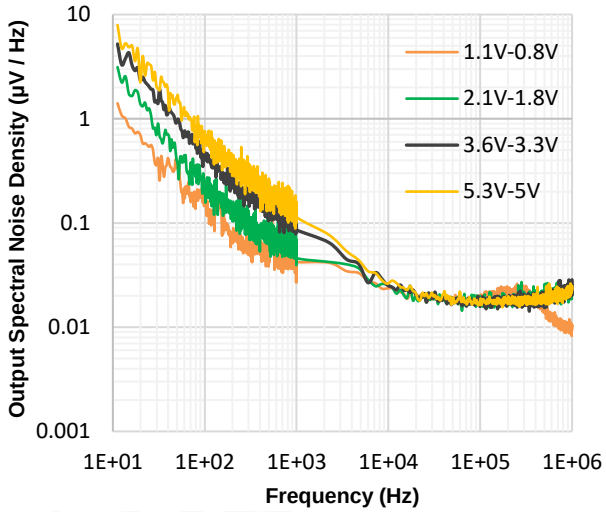
Output Noise vs. Frequency

V_{IN} =1.1V, I_{load}=1.2A



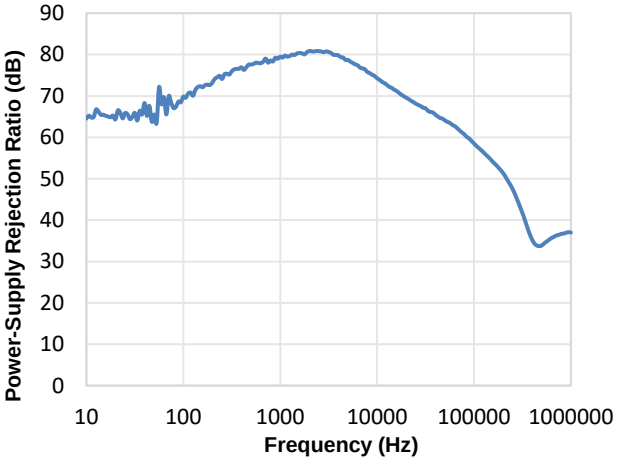
Output Noise vs. Frequency

C_{SS} = 10nF, I_{Load}=1.2A



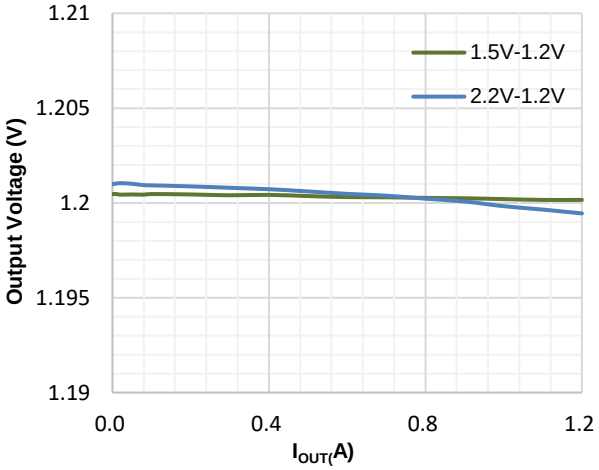
PSRR vs. Frequency

V_{OUT}=3.3V, C_{SS}=10nF



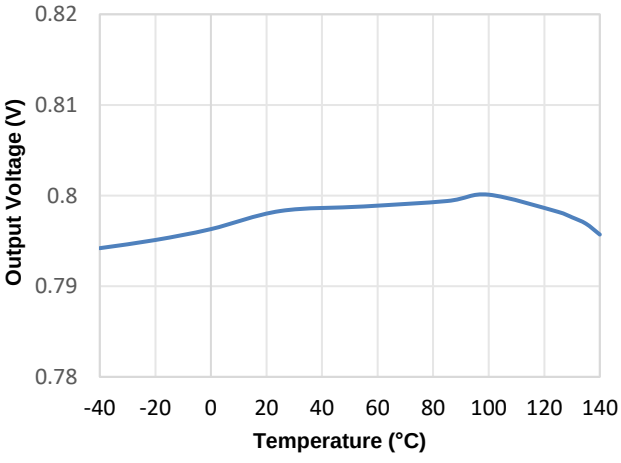
Output Voltage Vs. Iout

V_{OUT}=1.2V, C_{SS}=10nF



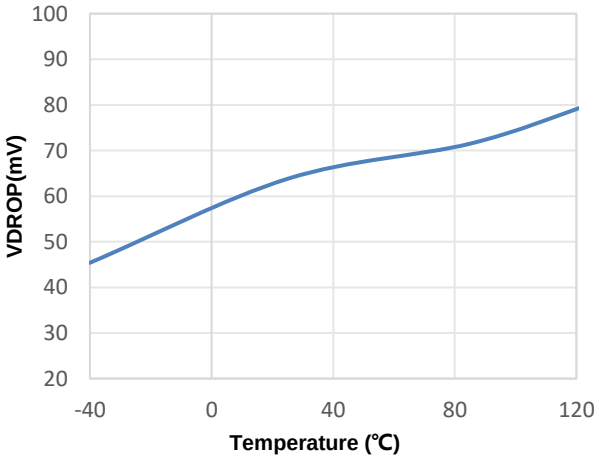
Output Voltage Vs. Temperature

V_{IN} =1.2V, C_{SS} = 10nF,I_{OUT}=1mA



Dropout Voltage Vs. Temperature

I_{OUT}=1.2A, V_{IN} =1.1V-6.5V

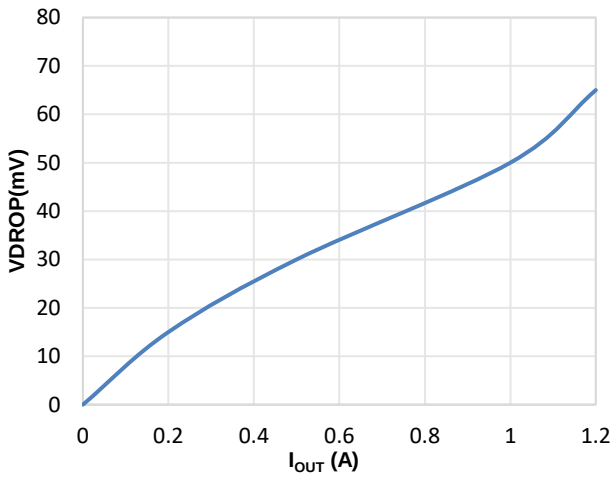


Typical Performance Characteristics (continued)

C_{IN} =10μF, C_{OUT} =10μF, C_{SS}= 10nF, C_{FF}= 10nF

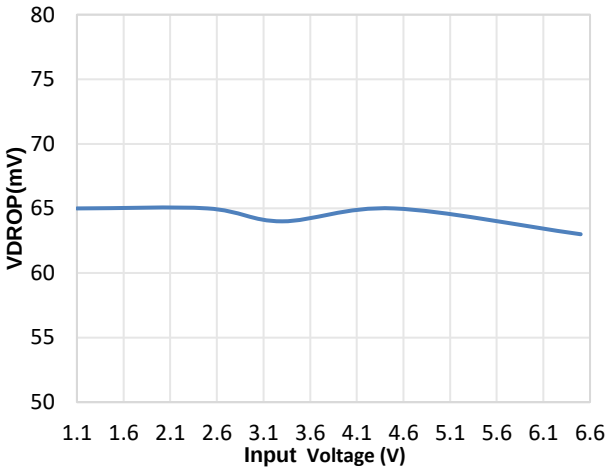
Dropout Voltage Vs. I_{OUT}

V_{IN} =1.1V-6.5V



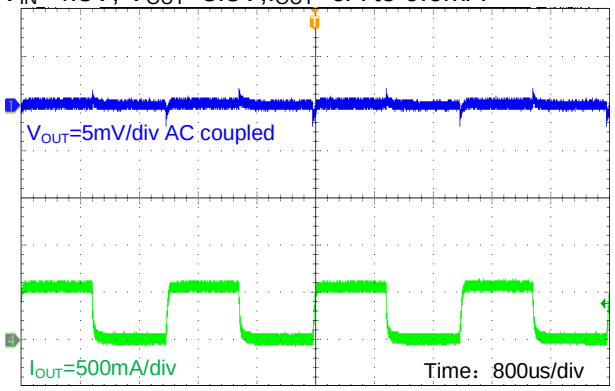
Dropout Voltage Vs. V_{IN}

I_{OUT}=1.2A



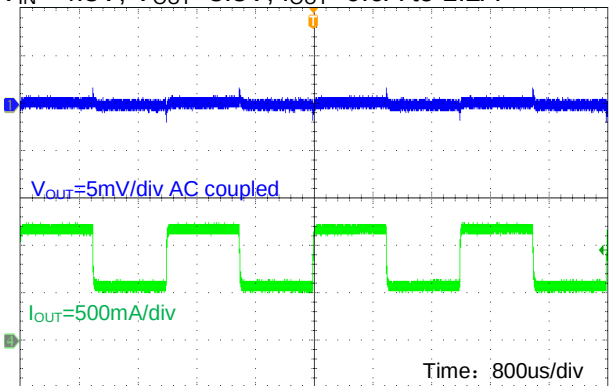
load Transient

V_{IN}=4.3V, V_{OUT}=3.3V,I_{OUT}=0A to 0.6mA



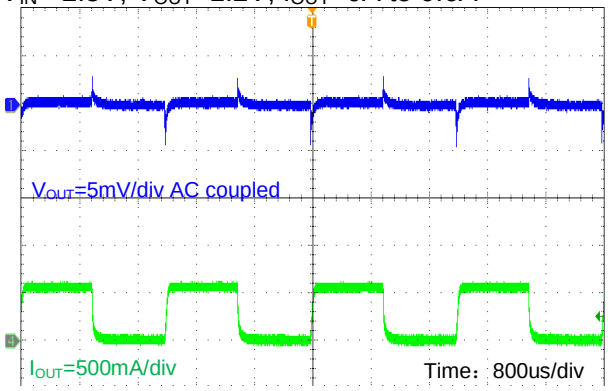
load Transient

V_{IN}= 4.3V, V_{OUT}=3.3V, I_{OUT}=0.6A to 1.2A



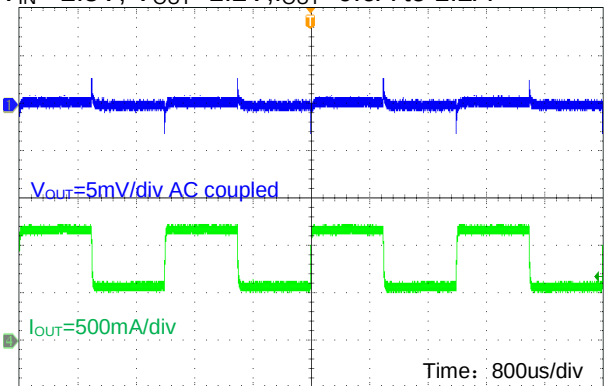
load Transient

V_{IN} =2.5V, V_{OUT}=1.2V, I_{OUT}=0A to 0.6A



load Transient

V_{IN}= 2.5V, V_{OUT}=1.2V,I_{OUT}=0.6A to 1.2A

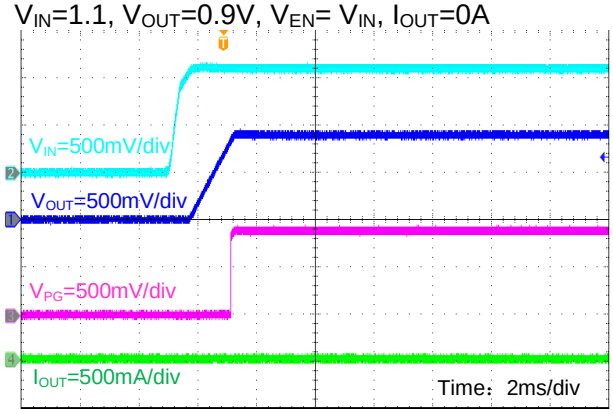


Typical Performance Characteristics (continued)

C_{IN} =10μF, C_{OUT} =10μF, C_{SS}= 10nF, C_{FF}= 10nF

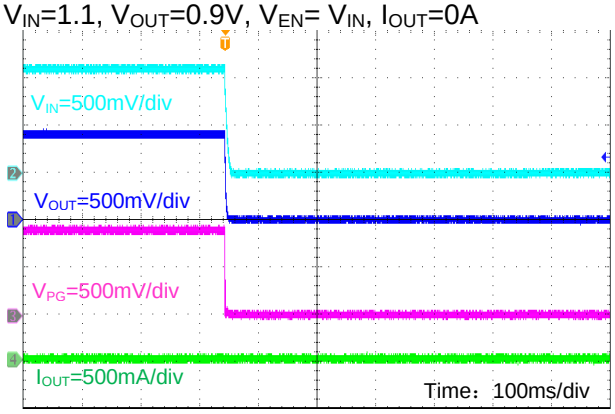
Input Power On

V_{IN}=1.1, V_{OUT}=0.9V, V_{EN}= V_{IN}, I_{OUT}=0A



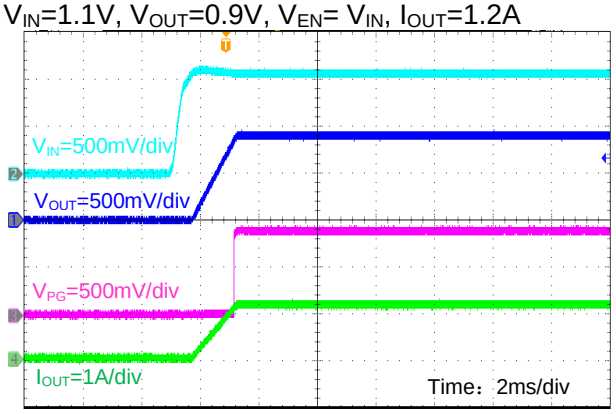
Input Power Down

V_{IN}=1.1, V_{OUT}=0.9V, V_{EN}= V_{IN}, I_{OUT}=0A



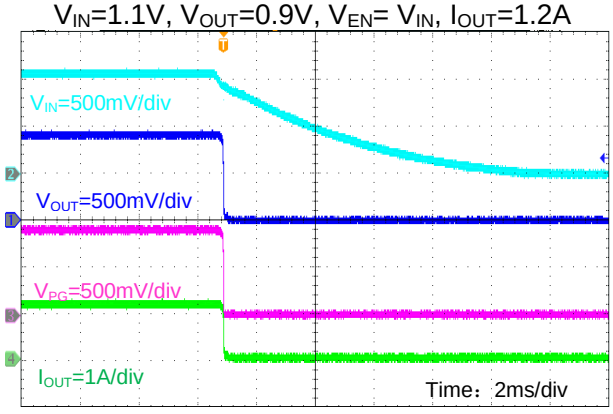
Input Power On

V_{IN}=1.1V, V_{OUT}=0.9V, V_{EN}= V_{IN}, I_{OUT}=1.2A



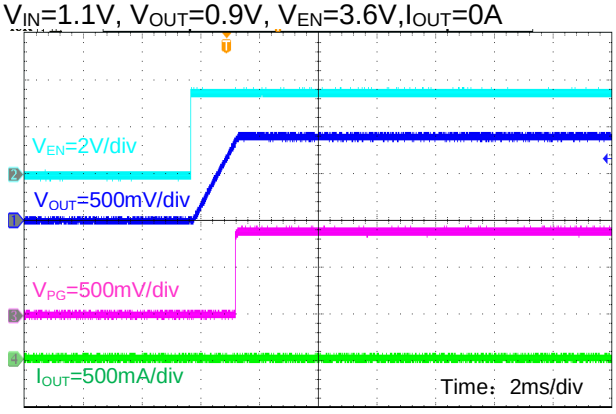
Input Power Down

V_{IN}=1.1V, V_{OUT}=0.9V, V_{EN}= V_{IN}, I_{OUT}=1.2A



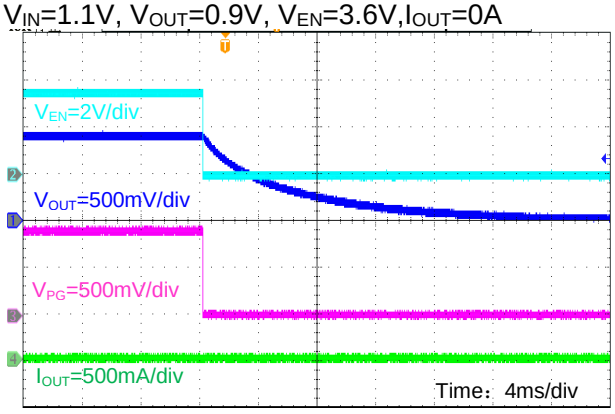
EN Power On

V_{IN}=1.1V, V_{OUT}=0.9V, V_{EN}=3.6V,I_{OUT}=0A



EN Power Down

V_{IN}=1.1V, V_{OUT}=0.9V, V_{EN}=3.6V,I_{OUT}=0A

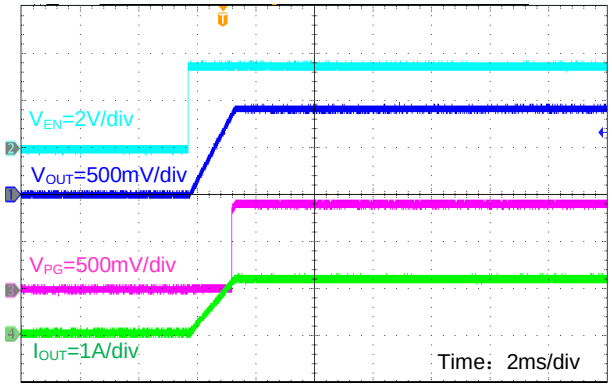


Typical Performance Characteristics (continued)

C_{IN} =10μF, C_{OUT} =10μF, C_{SS}= 10nF, C_{FF}= 10nF

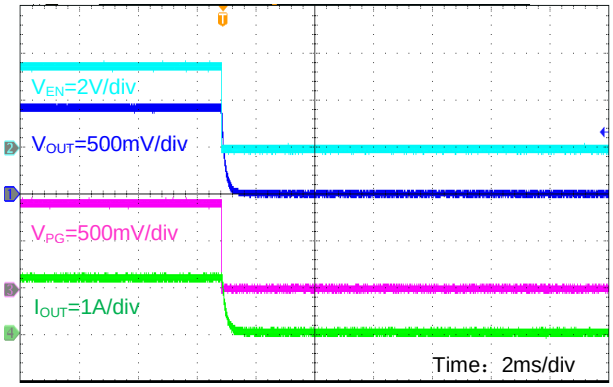
EN Power On

V_{IN}=1.1V, V_{OUT}=0.9V, V_{EN}=3.6V,I_{OUT}=1.2A



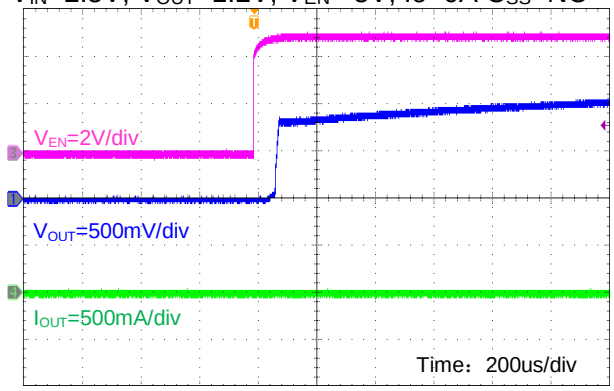
EN Power Down

V_{IN}=1.1V, V_{OUT}=0.9V, V_{EN}=3.6V,I_{OUT}=1.2A



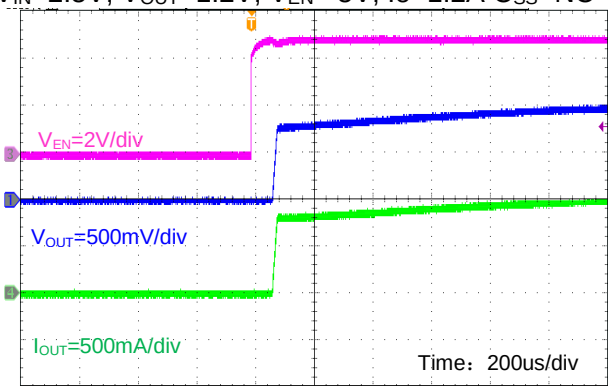
Start-Up Time and CNR/SS

V_{IN}=2.5V, V_{OUT}=1.2V, V_{EN}= 5V, Io=0A C_{SS}=NC



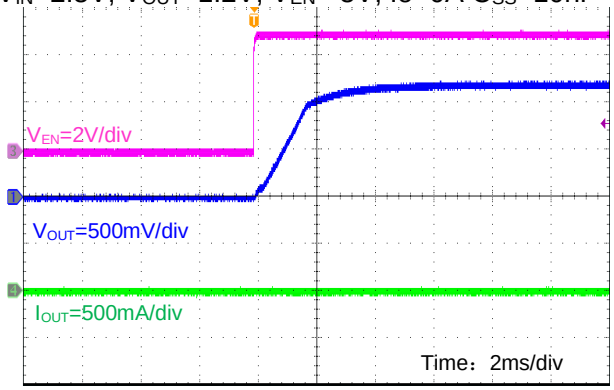
Start-Up Time and CNR/SS

V_{IN}=2.5V, V_{OUT}=1.2V, V_{EN}= 5V, Io=1.2A C_{SS}=NC



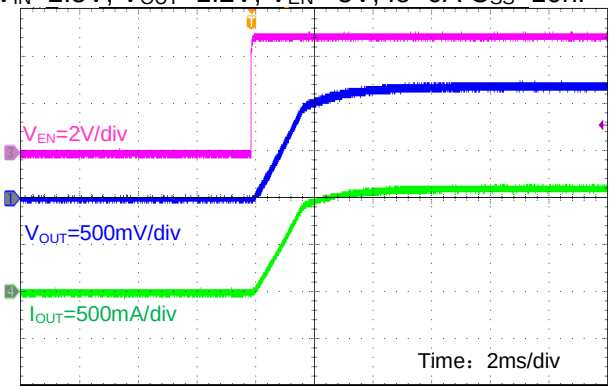
Start-Up Time and CNR/SS

V_{IN}=2.5V, V_{OUT}=1.2V, V_{EN}= 5V, Io=0A C_{SS}=10nF



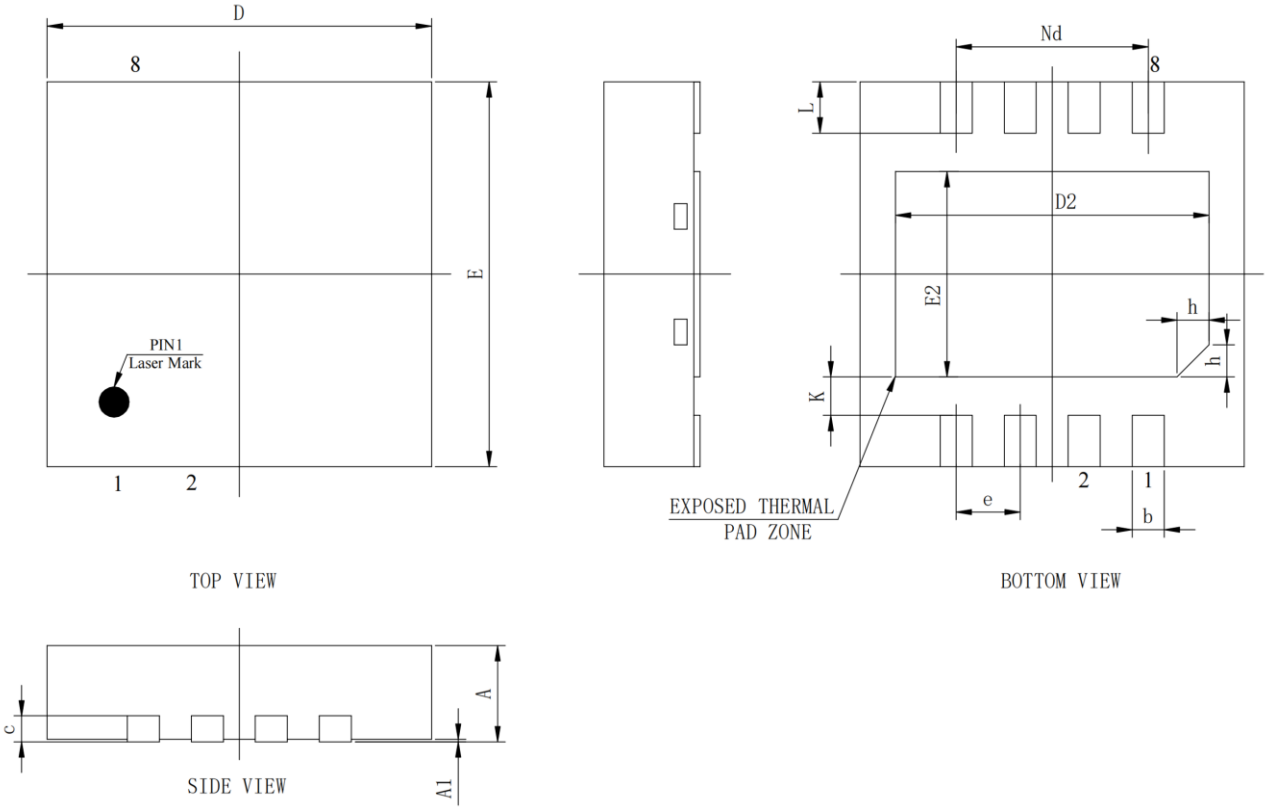
Start-Up Time and CNR/SS

V_{IN}=2.5V, V_{OUT}=1.2V, V_{EN}= 5V, Io=0A C_{SS}=10nF



Package Information

DFN3x3-8N



Unit: mm

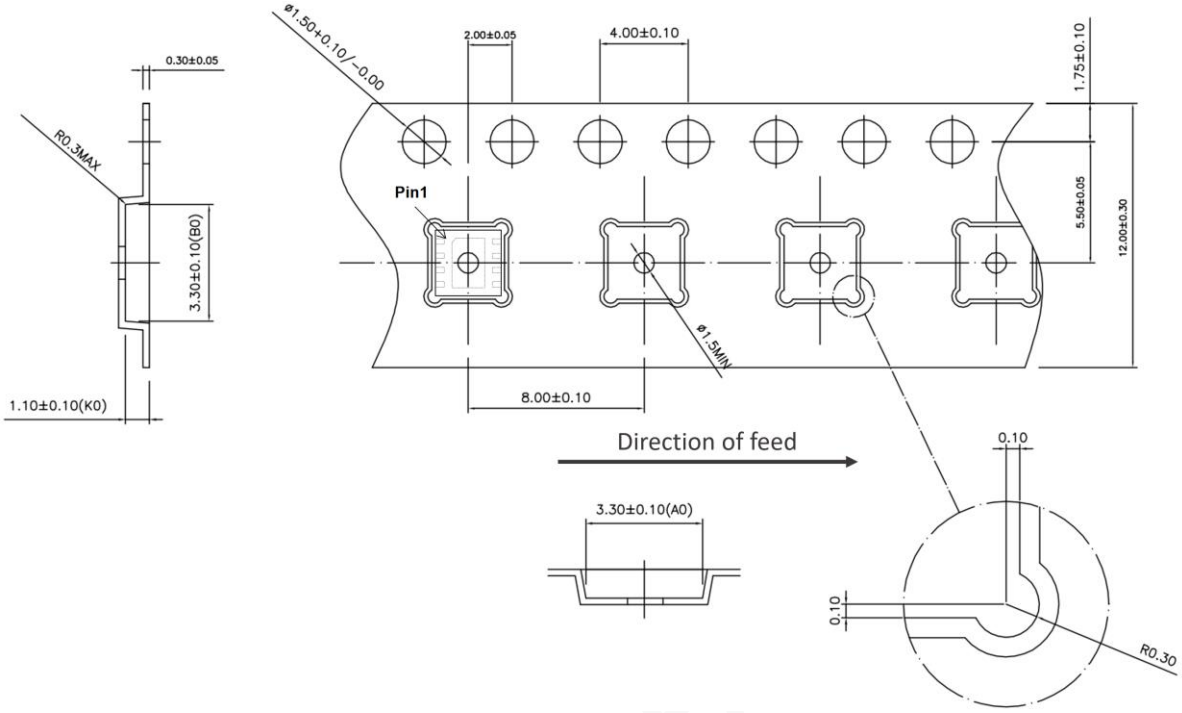
Symbol	Dimensions In Millimeters			Symbol	Dimensions In Millimeters		
	Min	Nom	Max		Min	Nom	Max
A	0.70	0.75	0.80	Nd	1.50 BSC		
A1	0	0.02	0.05	E	2.90	3.00	3.10
b	0.20	0.25	0.30	E2	1.50	1.60	1.70
c	0.203 REF			L	0.35	0.40	0.45
D	2.90	3.00	3.10	h	0.20	0.25	0.30
D2	2.35	2.45	2.55	K	0.30 REF		
e	0.50 BSC						

Note:

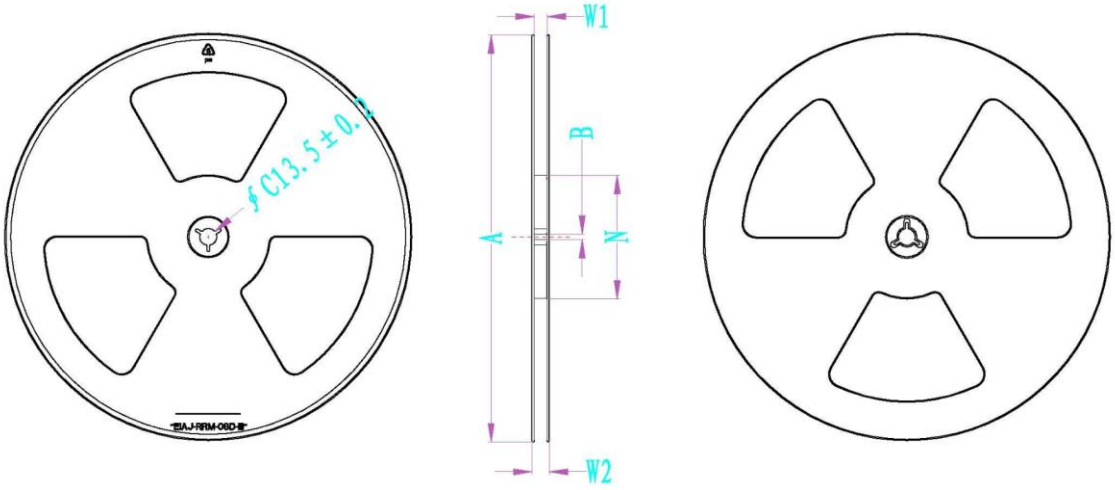
1) All dimensions are in millimeters.

Tape and Reel Information

TAPE DIMENSIONS: DFN3x3-8N



REEL DIMENSIONS: DFN3x3-8N



Unit: mm

Ø A	Ø C	B	W1	W2	N
330±1.0	13.5±0.2	4.7±0.5	13.4±0.5	17.4±0.5	100±0.5

Note:

1) All Dimensions are in Millimeter
2) Quantity of Units per Reel is 5000
3) MSL level is level 1.

Important Notification

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