LTP7293
3A output, Low Vin, Low Noise Linear Regulator

General Description

The LTP7293 is a low V_{IN}, low noise linear regulator with typical 30 mV ultra-low dropout voltage. The LTP7293 could support very low input voltage supply range from 1.1 V to 1.98 V with no external bias supply required. It is also designed to support both fixed output voltage and adjustable output voltage range from 0.5 V to 1.5 V.

Excellent power supply rejection ratio (PSRR) and low noise performance can limit the phase noise and clock jitter generated by the power supply, together with 3 A maximum output current capability and connecting a capacitor to SS pin to program soft-start time externally, it makes LTP7293 ideal power supply for mainly two types of applications---One is digital-loads, such as Field-programmable gate array (FPGA) and digital signal processor (DSP) supplies. The other is for noise sensitive applications, such as RF transceivers, high performance Serializer / DeSerializer (Serdes), analog-to-digital converter (ADC) and digital-to-analog (DAC) circuits.

The LTP7293 is available in 3 mm × 3 mm QFN-16L packages. It is rated over −40℃ to +125℃ extended industrial temperature range.

Features and Benefits

- 3 A maximum output current
- Low input voltage range: 1.1 V to 1.98 V, with no external bias supply required
- Flexible Output voltage options:
  - Fixed output voltage range: V_{OUT_FIXED} = 0.5 V to 1.5 V
  - Adjustable output voltage range: V_{OUT_ADJ} = 0.5 V to 1.5 V
- Ultra-low noise: 2.2 µV rms, 100 Hz to 100 kHz
- Low dropout voltage: 60 mV typical at 3 A load
- ±1.5 % fixed output voltage accuracy over line, load, and temperature
- Excellent PSRR:
  - 65 dB typical at 10 kHz
  - 55 dB typical at 100 kHz
- Excellent load/line transient response
- Enable and Soft start (SS) control
- Power-good (PG) output
- 3 mm × 3 mm QFN-16L package

Applications

- Digital loads: CPU, ASIC, FPGA, DSP, CPLD
- RF transceivers, high performance Serializer/DESerializer (Serdes), analog-to-digital converter (ADC) and digital-to-analog (DAC) circuits.
- Medical and healthcare
- Industrial and instrumentation

Table of Content

Ordering Information(1)

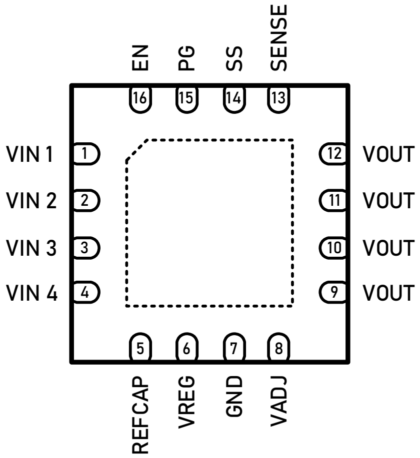
Part Number	Output Voltage	Package Type	Quantity	ECO Class(2)	Mark Code(3)
LTP7293XF16/R6	Adjustable	QFN3×3-16L	3 000	Green (RoHS & no Sb/Br)	L23A
LTP7293-09XF16/R6	0.9 V	QFN3×3-16L	3 000	Green (RoHS & no Sb/Br)	2309
LTP7293-095XF16/R6	0.95 V	QFN3×3-16L	3 000	Green (RoHS & no Sb/Br)	L095
LTP7293-10XF16/R6	1.0 V	QFN3×3-16L	3 000	Green (RoHS & no Sb/Br)	2310
LTP7293-11XF16/R6	1.1 V	QFN3×3-16L	3 000	Green (RoHS & no Sb/Br)	2311
LTP7293-12XF16/R6	1.2 V	QFN3×3-16L	3 000	Green (RoHS & no Sb/Br)	2312
LTP7293-125XF16/R6	1.25 V	QFN3×3-16L	3 000	Green (RoHS & no Sb/Br)	L125
LTP7293-13XF16/R6	1.3 V	QFN3×3-16L	3 000	Green (RoHS & no Sb/Br)	2313
LTP7293-15XF16/R6	1.5 V	QFN3×3-16L	3 000	Green (RoHS & no Sb/Br)	2315

(1) Please contact to your Linearin representative for the latest availability information and product content details.

(2) Eco Class - The planned eco-friendly classification: Pb-Free (RoHS) or Green (RoHS & Halogen Free).

Pin Configuration (Top View)

LTP7293
QFN3×3-16L



Symbol	LTP7293, QFN3×3-16L	Description
VIN	1, 2, 3, 4	Input Supply Pin. Bypass VIN to GND with a 10µF or greater capacitor. Note that all four VIN pins must be connected to the source supply.
REFCAP	5	Reference Filter Capacitor. Connect a 1µF capacitor from the REFCAP pin to ground. Do not connect a load to ground.
VREG	6	Regulated Input Supply to LDO Amplifier. Bypass VREG to GND with a 1 µF or greater capacitor. Do not connect a load to ground.
GND	7	Ground.
VADJ	8	Adjustable Voltage Pin for the Adjustable Output Option. Connect a 10 kΩ external resistor between the VADJ pin and ground to set the output voltage to 1.5 V. For the fixed output option, leave this pin floating.
VOUT	9, 10, 11, 12	Output Voltage Pin. Bypass VOUT to GND with a 10 µF or greater capacitor. Note that all four VOUT pins must be connected to the load.
SENSE	13	Sense Input. The SENSE pin measures the actual output voltage at the load and feeds it to the error amplifier. Connect VSENSE as close to the load as possible to minimize the effect of IR voltage drop between VOUT and the load.
SS	14	Soft Start Pin. A 10 nF capacitor connected to the SS pin and ground sets the start-up time to xxx ms.
PG	15	Power-Good Output. This open-drain output requires an external pull-up resistor.
EN	16	Enable Input. Drive the EN pin high to turn on the regulator. Drive the EN pin low to turn off the regulator. For automatic startup, connect the EN pin to the VIN pin.

Limiting Value

Parameter	Absolute Maximum Rating
V_{IN} to GND	−0.3 V to +2.16 V
EN to GND	−0.3 V to + V_{IN}
VOUT, SENSE, VREG, RECAP, VADJ, SS to GND	−0.3 V to + V_{IN}
PG to GND	−0.3 V to + 5.5 V
Storage Temperature Range, T_{stg}	−65 °C to +150 °C
Junction Temperature, T_J	150 °C
Lead Temperature Range (Soldering 10 sec)	260 °C

ESD Ratings

Parameter	Level	UNIT
Human body model (HBM), per ESDA/JEDEC JS-001-2017 (1)	TBD	V
Charged device model (CDM), per ESDA/JEDEC JS-002-2018 (2)	TBD	V

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process. Manufacturing with less than 500-V HBM is possible if necessary precautions are taken.

(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process. Manufacturing with less than 250-V CDM is possible if necessary precautions are taken.

Thermal Information

Thermal Metric		Package	Value	Unit
θ_{JA}	Thermal Resistance	QFN3×3-16L	65	℃/W

Electrical Characteristics

V_{IN} = V_{OUT} + 0.2 V or V_{IN} = 1.1 V, whichever is greater, I_{LOAD} = 10 mA, C_{IN} = 10 µF, C_{OUT} = 10 µF, C_{REF} = 1 µF, C_{REG} = 1 µF, T_A = 25 ℃, Minimum and maximum limits at T_J = −40 ℃ to +125 ℃, unless otherwise noted.

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
INPUT SUPPLY VOLTAGE AND CURRENT						
Input supply voltage range	V_{IN}	T_A = −40 to +125 ℃	1.1		1.98	V
Operating supply current	I_{GND}	I_{OUT} = 0 µA		4.5	8	mA
		I_{OUT} = 10 mA		4.9	8	mA
		I_{OUT} = 100 mA		5.5	8.5	mA
		I_{OUT} = 3 A		12	16	mA
Shutdown current	I_{SD}	EN = GND, T_A = −40 to +85 ℃, V_{IN} = (V_{OUT}+0.2) to 1.98 V			180	µA
		T_A = +85 to +125 °C, V_{IN} = (V_{OUT}+0.2) to 1.98 V			800	µA
Power supply rejection ratio	PSRR	I_{OUT} = 3 A, modulated V_{IN}, 10 kHz, V_{OUT} =1.3 V, V_{IN} =1.7 V		65		dB
		I_{OUT} = 3 A, modulated V_{IN}, 100 kHz, V_{OUT} =1.3 V, V_{IN} =1.7 V		55		dB
		I_{OUT} = 3 A, modulated V_{IN}, 1 MHz, V_{OUT} =1.3 V, V_{IN} =1.7 V		30		dB
		I_{OUT} = 3 A, modulated V_{IN}, 10 kHz, V_{OUT} =0.9 V, V_{IN} =1.3 V		60		dB
		I_{OUT} = 3 A, modulated V_{IN}, 100 kHz, V_{OUT} =0.9 V, V_{IN} =1.3 V		55		dB
		I_{OUT} = 3 A, modulated V_{IN}, 1 MHz, V_{OUT} =0.9 V, V_{IN} =1.3 V		28		dB
OUTPUT VOLTAGE AND CURRENT						
Output voltage range	V_{OUT_FIXED}	T_A = 25 ℃	0.5		1.5	V
	V_{OUT_ADJ}	T_A = 25 ℃	0.5		1.5	V
Fixed output voltage accuracy	V_{OUT}	I_{OUT} = 100 mA, T_A = 25 ℃	−0.5		0.5	%
		10 mA < I_{OUT} < 3 A, V_{IN} = (V_{OUT} +0.2) to 1.98 V, T_A = 0 to 85 ℃	−1		1.5	%
		10 mA < I_{OUT} < 3 A, V_{IN} = (V_{OUT} +0.2) to 1.98 V	−1.5		1.5	%
V_{ADJ} current	I_{ADJ}	T_A = 25 ℃, V_{IN} = (V_{OUT}+0.2) to 1.98 V		50		µA
Line regulation	$\Delta V_{OUT} / \Delta V_{IN}$	V_{IN} = (V_{OUT}+0.2) to 1.98 V	−0.2		0.2	%/V
Current limit threshold	I_{LIMIT}		3.3	4	5	A
Load regulation	$\Delta V_{OUT} / \Delta I_{OUT}$	I_{OUT} = 10 mA to 3 A		0.12	0.45	%/A
Adjustable output voltage gain factor	A_D	T_A = 25 ℃, V_{IN} = (V_{OUT}+0.2) to 1.98 V	2.95	3	3.055	
Dropout voltage	V_{DO}	I_{OUT} = 100 mA, V_{OUT} ≥1.2 V		30		mV
		I_{OUT} = 3 A, V_{OUT} ≥1.2 V		60		mV
NOISE						
Output noise voltage	V_N	10 Hz to 100 kHz, V_{OUT} =1.5 V, V_{IN} =1.7 V, C_{REF} = 10 µF		2.2		µV rms
		10 Hz to 100 kHz, V_{OUT} =1.5 V, V_{IN} =1.7 V, C_{REF} = 4.7 µF		3.2		µV rms
		10 Hz to 100 kHz, V_{OUT} =1.5 V, V_{IN} =1.7 V, C_{REF} = 2.2 µF		5.7		µV rms

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Output noise voltage	V_N	10 Hz to 100 kHz, V_{OUT} =1.5 V, V_{IN} =1.7 V, C_{REF} = 1 µF		10		µV rms
POWER GOOD, ENABLE AND SOFT START						
Soft start current	I_{ss}	1.1 V ⩽ V_{IN} ⩽ 1.98 V		10		µA
Power good threshold	V_{PG_LOW}	1.1 V ⩽ V_{IN} ⩽ 1.98 V, I_{PG} ⩽ 1 mA			0.35	V
	PG_{FALL}	1.1 V ⩽ V_{IN} ⩽ 1.98 V		−7.5		%
	PG_{RISE}	1.1 V ⩽ V_{IN} ⩽ 1.98 V		−5		%
EN pin high level input voltage	$V_{IH(EN)}$			650		mV
EN pin low level input voltage	$V_{IL(EN)}$			590		mV
Input logic hysteresis	EN_{HYS}			60		mV
UNDER VOLTAGE LOCKOUT						
Input voltage rising	$UVLO_{RISE}$	T_A = −40 to +85 °C		1.05		V
Input voltage falling	$UVLO_{FALL}$	T_A = −40 to +85 °C		0.95		V
Hysteresis	$UVLO_{HYS}$			80		mV

Typical Characteristics

At T_A = 25℃, V_{IN} = 1.5 V and V_{OUT} = 1.3 V, unless otherwise noted.

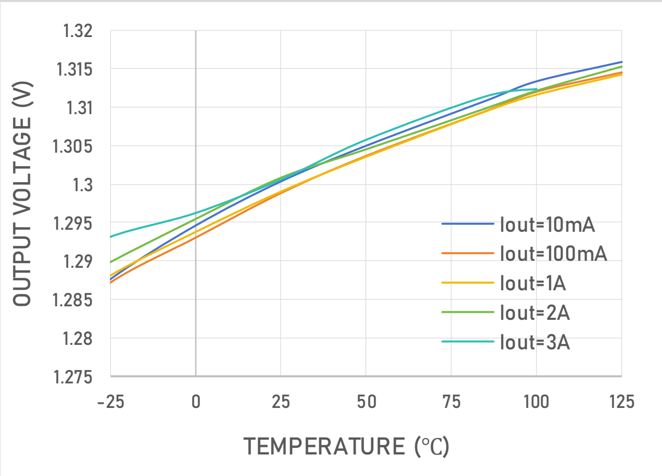


Figure 1. Output Voltage vs Temperature

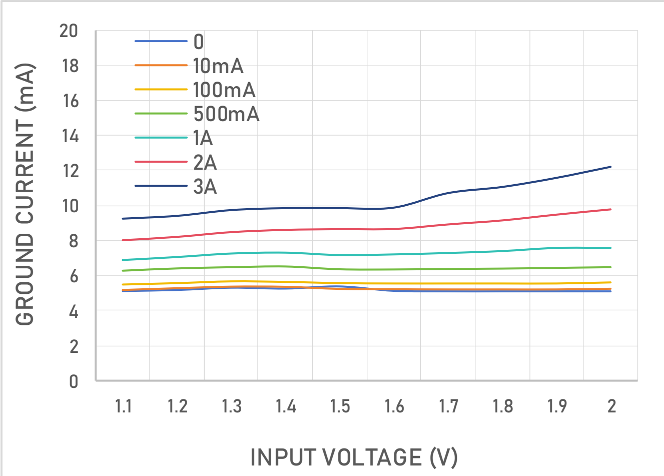


Figure 2. Input voltage vs Ground Current

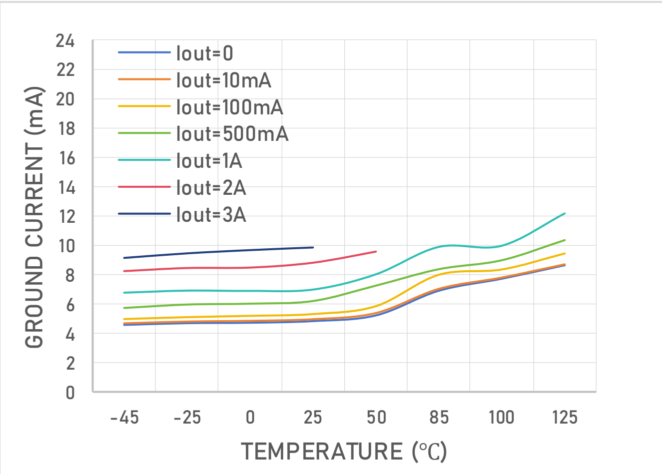


Figure 3. Ground Current vs Temperature

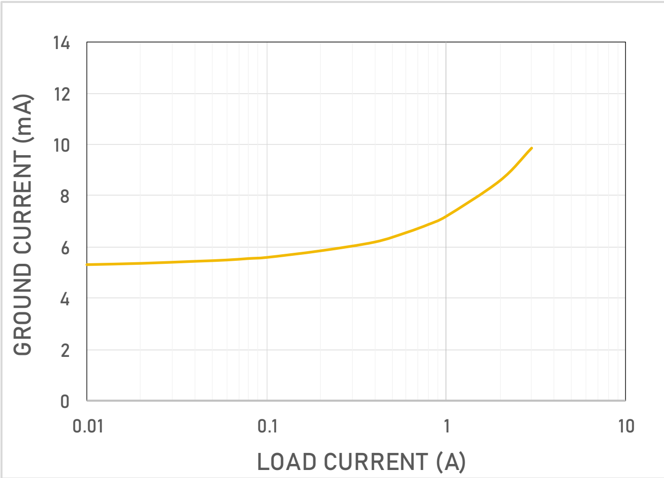


Figure 4. Ground Current vs Load Current

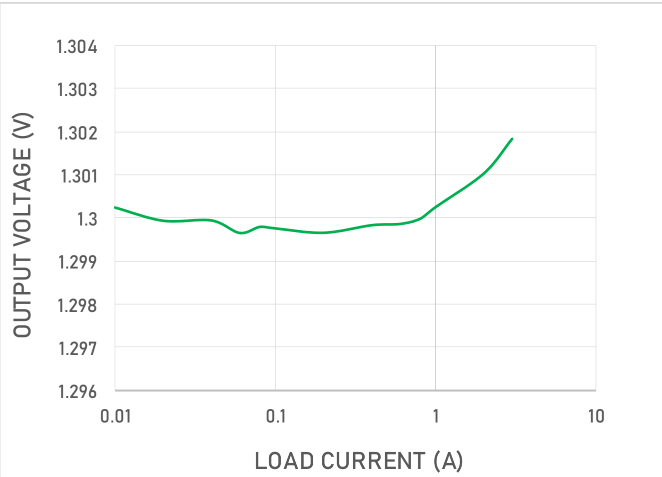


Figure 5. Output Voltage vs Load Current

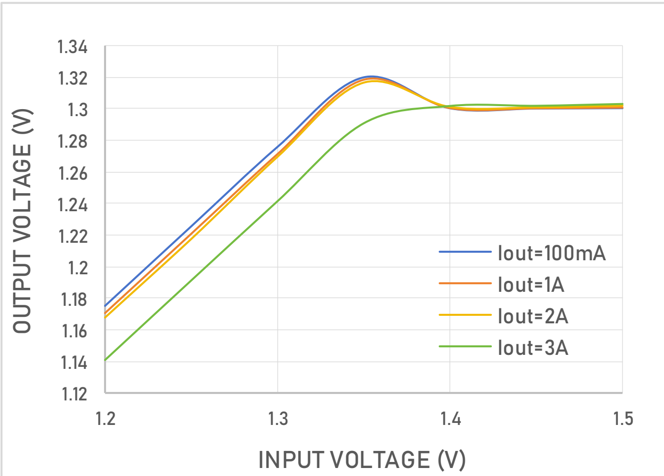


Figure 6. Output Voltage vs Input Voltage

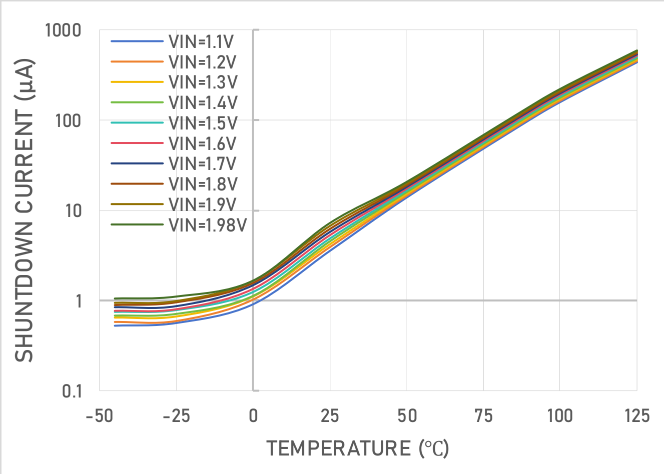


Figure 7. Shutdown Current vs Temperature

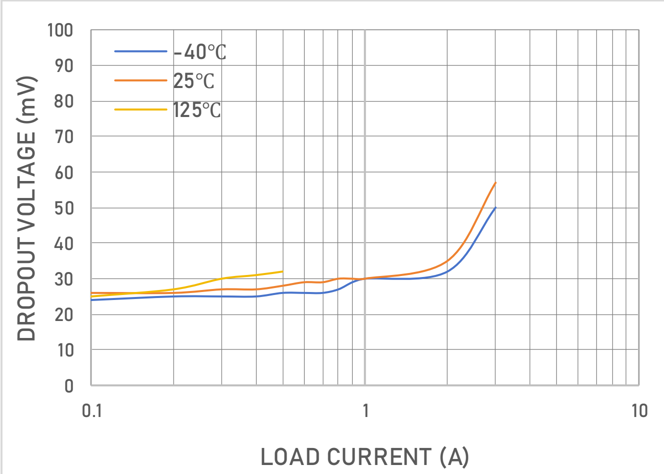


Figure 8. Dropout Voltage vs Load Current

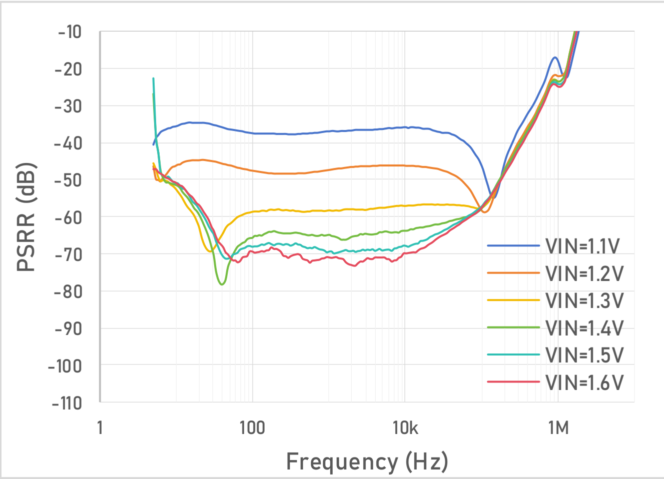


Figure 9. PSRR vs Frequency for Various input voltage , V_{OUT} =0.9 V, Load current = 3 A

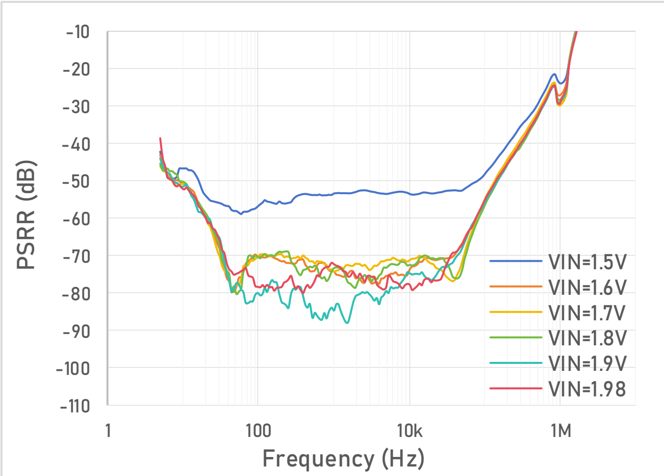


Figure 10. PSRR vs Frequency for Various input voltage , V_{OUT} =1.3 V, Load current = 3 A

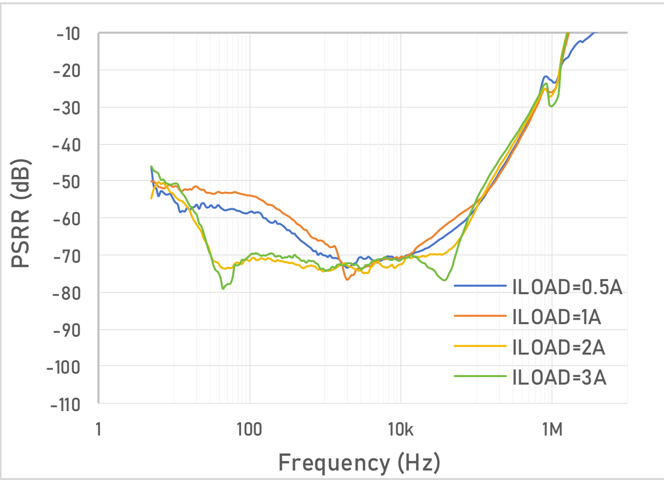


Figure 11. PSRR vs Frequency for Various loads, V_{OUT} =1.3 V, V_{OUT} =1.7 V

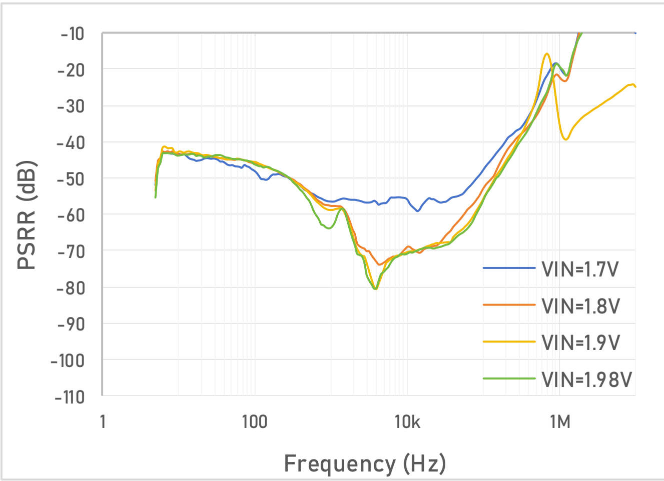


Figure 12. PSRR vs Frequency for Various input voltage , V_{OUT} =1.5 V, Load current = 3 A

Detailed Description

The LTP7293 is a low dropout linear regulator. The device operates from 1.1 V to 1.98 V input to provide up to 3 A of output current. It also has features such as high PSRR and excellent line and load transient response using 10 µF ceramic output capacitor. The LTP7293 is available in output voltages from 0.9 V to 1.5 V for a fixed output, and adjustable output voltages can be set from 0.5 V to 1.5 V.

The LTP7293 has EN pin to control the V_{OUT}. When EN is high, V_{OUT} turns on, When EN is low, V_{OUT} turns off. Connect EN to V_{IN} for automatic startup.

Soft start function

The LTP7293 supports programmable soft start function. With soft start function, it is helpful to reduce the inrush current when system startup and providing voltage sequencing. To implement soft start, connect a ceramic capacitor from SS to GND. At startup, a 10 µA current source charges this capacitor. The voltage at SS limits the LTP7293 start-up output voltage, just providing a smooth ramp-up to the nominal output voltage. To calculate the start-up time for the fixed output and adjustable output, use the following equations:

$$t_{START\text{-}UP\_FIXED} = t_{DELAY} + V_{REF} \times (C_{SS} / I_{SS}) \quad (1)$$

$$t_{START\text{-}UP\_ADJ} = t_{DELAY} + V_{REF} \times (C_{SS} / I_{SS}) \quad (2)$$

Notes:

t_{DELAY} is a fixed delay of 100 µs.

V_{REF} is the soft start capacitance from SS to GND.

I_{SS} is the current sourced from SS (10 µA).

V_{ADJ} is the voltage at VADJ pin equal to R_{ADJ} x I_{ADJ}.

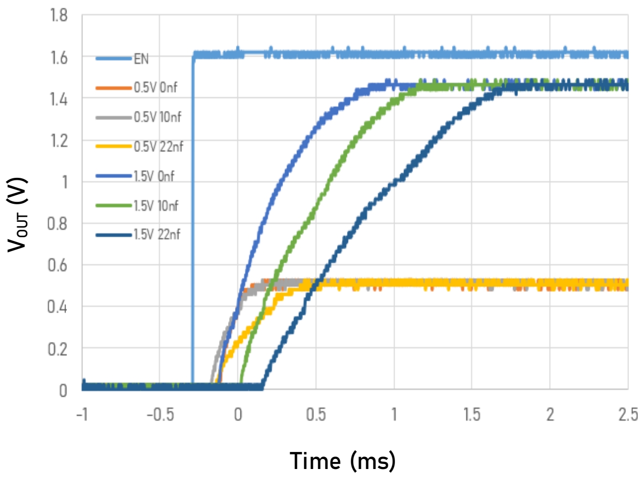


Figure 13. V_{OUT} Adjustable with SS vs Time

Adjustable output voltage

The output voltage of LTP7293 can be set from 0.5 V to 1.5 V. Connect R_{ADJ} from VADJ pin to ground to set the output voltage. To calculate the output voltage, use the following equation:

$V_{OUT} = A_D \times (R_{ADJ} \times I_{ADJ})$

Notes:

A_D is the gain factor with a typical value of 3.0 between the VADJ pin and VOUT pin.

I_{ADJ} is the 50 µA constant current out of the VADJ pin.

Power-Good (PG) function

The LTP7293 has a power-good pin (PG) to indicate the status of the output. PG pin is an open-drain output which requests an external pull-up resistor that can be connected to V_{IN} or V_{OUT}. If the device is in shut-down mode, current-limit mode, or thermal shut-down, or if output voltage falls below 90% of the nominal voltage, PG will transitions low quickly. During soft start, the rising threshold of the power-good signal is 95% of the nominal output voltage.

The open-drain output is held low when the LTP7293 has sufficient input voltage to turn on the internal PG transistor. An optional soft start delay can be detected. The PG transistor is terminated via a pull-up resistor to V_{IN} or V_{OUT}.

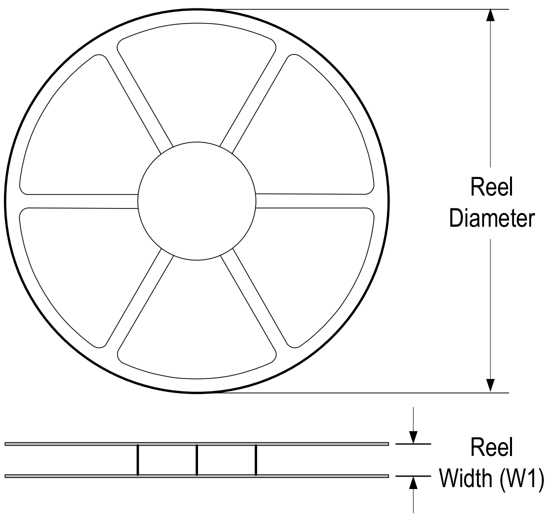
Power-good accuracy is 92.5% of the nominal regulator output voltage when this voltage is rising, with 95% trip point when this voltage is falling.

Regulator input voltage brownouts or glitches trigger a power no good if V_{OUT} falls below 92.5%.

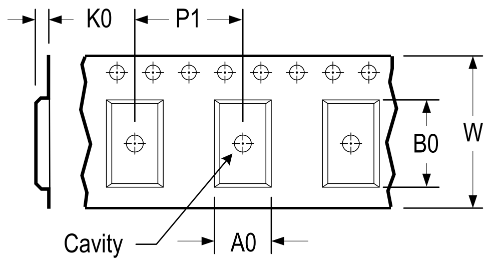
A normal power-down triggers a power good when V_{OUT} is at 95%.

Tape and Reel Information

REEL DIMENSIONS

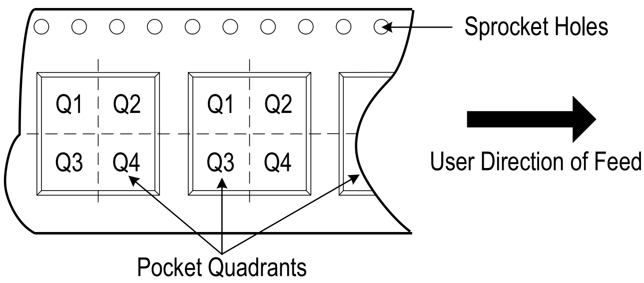


TAPE DIMENSIONS



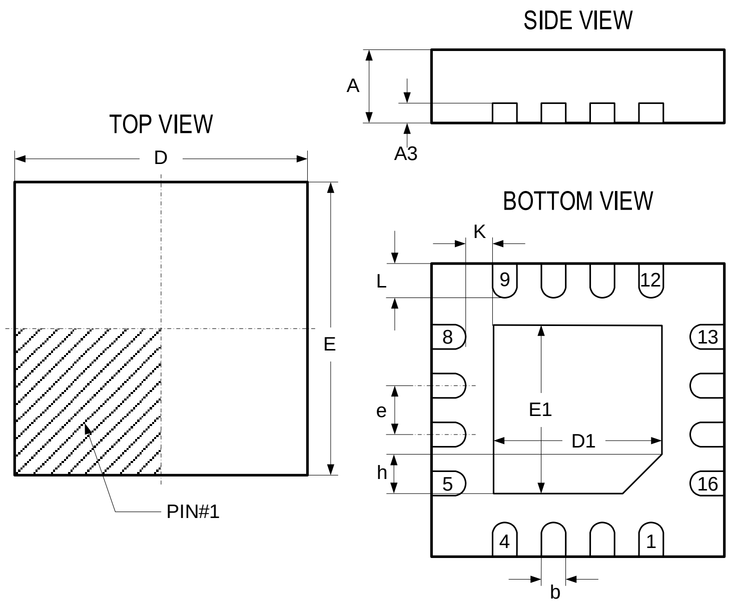
A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

QUADRANT ASSIGNMENTS FOR PIN 1 ORIETATION IN TAPE



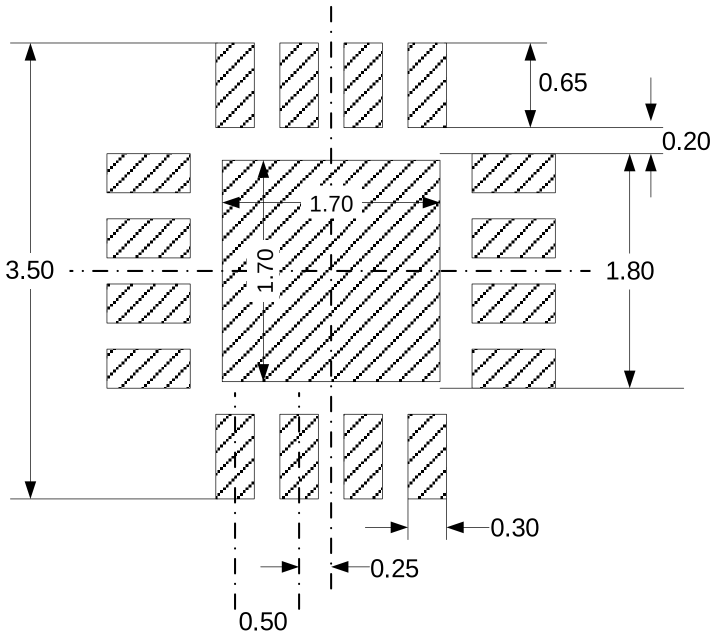
Package Outlines

DIMENSIONS, QFN3×3-16L



<table>
<tr><th rowspan="2">Symbol</th><th colspan="3">Millimeters</th></tr>
<tr><th>Min.</th><th>Nom.</th><th>Max.</th></tr>
<tr><td>A</td><td>0.70</td><td>0.75</td><td>0.80</td></tr>
<tr><td>A3</td><td colspan="3">0.210 REF.</td></tr>
<tr><td>b</td><td>0.20</td><td>0.25</td><td>0.30</td></tr>
<tr><td>D</td><td>2.90</td><td>3.00</td><td>3.10</td></tr>
<tr><td>D1</td><td>1.60</td><td>1.65</td><td>1.70</td></tr>
<tr><td>E</td><td>2.90</td><td>3.00</td><td>3.10</td></tr>
<tr><td>E1</td><td>1.60</td><td>1.65</td><td>1.70</td></tr>
<tr><td>e</td><td colspan="3">0.50 BSC.</td></tr>
<tr><td>h</td><td>0.20</td><td>0.25</td><td>0.30</td></tr>
<tr><td>K</td><td>0.225</td><td>0.275</td><td>0.325</td></tr>
<tr><td>L</td><td>0.35</td><td>0.40</td><td>0.45</td></tr>
</table>

RECOMMENDED SOLDERING FOOTPRINT, QFN 3×3-16L



Important Notice

Linearin is a global fabless semiconductor company specializing in advanced high-performance high-quality analog/mixed-signal IC products and sensor solutions. The company is devoted to the innovation of high performance, analog-intensive sensor front-end products and modular sensor solutions, applied in multi-market of medical & wearable devices, smart home, sensing of IoT, intelligent industrial & smart factory (industry 4.0), and automotives. Linearin's product families include widely-used standard catalog products, solution-based application specific standard products (ASSPs) and sensor modules that help customers achieve faster time-to-market products. Go to http://www.linearin.com for a complete list of Linearin product families.

For additional product information, or full datasheet, please contact with the Linearin's Sales Department or Representatives.