50 mA, High Voltage, Micropower Linear Regulator

Data Sheet

ADP1720-EP

FEATURES

- Wide input voltage range: 4 V to 28 V
- Maximum output current: 50 mA
- Low light load current
  - 28 µA at 0 µA load
  - 35 µA at 100 µA load
- Low shutdown current: 0.7 µA
- Low dropout voltage: 275 mV @ 50 mA load
- Initial accuracy: ±0.5%
- Accuracy over line, load, and temperature: ±2%
- Stable with small 1 µF ceramic output capacitor
- Fixed 3.3 V and 5.0 V output voltage options
- Adjustable output voltage option: 1.225 V to 5.0 V
- Current limit and thermal overload protection
- Logic controlled enable
- Space-saving MSOP package

ENHANCED PRODUCT FEATURES

Enhanced processing (EP) for –55°C to +125°C operation

APPLICATIONS

- DC-to-dc post regulation
- PCMCIA regulation
- Keep-alive power in portable equipment
- Industrial applications
- Aeronautic and military operating temperature environment

TYPICAL APPLICATION CIRCUITS

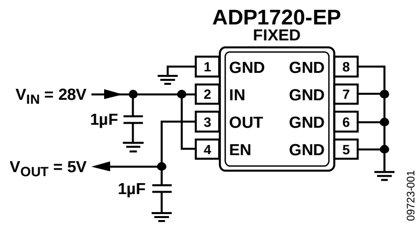

Figure 1. ADP1720-EP with Fixed Output Voltage, 5.0 V

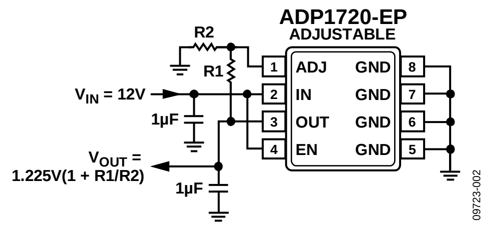

Figure 2. ADP1720-EP with Adjustable Output Voltage, 1.225 V to 5.0 V

GENERAL DESCRIPTION

The ADP1720-EP is a high voltage, micropower, low dropout linear regulator. Operating over a very wide input voltage range of 4 V to 28 V, the ADP1720-EP can provide up to 50 mA of output current. With just 28 µA of quiescent supply current and a micropower shutdown mode, this device is ideal for applications that require low quiescent current.

The ADP1720-EP is available in fixed output voltages of 3.3 V and 5.0 V. An adjustable version is also available, which allows the output to be set anywhere between 1.225 V and 5.0 V. An enable function that allows external circuits to turn on and turn off the ADP1720 output is available. For automatic startup, the enable (EN) pin can be connected directly to the input rail.

The ADP1720-EP is optimized for stable operation with small 1 µF ceramic output capacitors, allowing for good transient performance while occupying minimal board space.

The ADP1720-EP operates from –55°C to +125°C and uses current limit protection and thermal overload protection circuits to prevent damage to the device in adverse conditions.

Available in a small MSOP package, the ADP1720-EP provides a compact solution with low thermal resistance.

Additional application and technical information can be found in the ADP1720 data sheet.

Rev. A

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TABLE OF CONTENTS

REVISION HISTORY

6/12—Rev. 0 to Rev. A

Changes to Ordering Guide 12

2/11—Revision 0: Initial Version

SPECIFICATIONS

V_{IN} = 12 V, I_{OUT} = 100 μA, C_{IN} = C_{OUT} = 1 μF, T_A = 25°C, unless otherwise noted.

Table 1.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
INPUT VOLTAGE RANGE	V_{IN}	T_J = −55°C to +125°C	4		28	V
OPERATING SUPPLY CURRENT	I_{GND}	I_{OUT} = 0 μA		28		μA
		I_{OUT} = 0 μA, V_{IN} = V_{OUT} + 0.5 V or 4 V (whichever is greater), T_J = −55°C to +125°C			80	μA
		I_{OUT} = 100 μA		35		μA
		I_{OUT} = 100 μA, V_{IN} = V_{OUT} + 0.5 V or 4 V (whichever is greater), T_J = −55°C to +125°C			120	μA
		I_{OUT} = 1 mA		74		μA
		I_{OUT} = 1 mA, V_{IN} = V_{OUT} + 0.5 V or 4 V (whichever is greater), T_J = −55°C to +125°C			340	μA
		I_{OUT} = 10 mA		300		μA
		I_{OUT} = 10 mA, V_{IN} = V_{OUT} + 0.5 V or 4 V (whichever is greater), T_J = −55°C to +125°C			900	μA
		100 μA < I_{OUT} < 50 mA, V_{IN} = V_{OUT} + 0.5 V or 4 V (whichever is greater), T_J = −55°C to +125°C		1185	2115	μA
SHUTDOWN CURRENT	I_{GND-SD}	EN = GND		0.7		μA
		EN = GND, T_J = −55°C to +125°C			1.7	μA
OUTPUT						
Fixed Output Voltage Accuracy	V_{OUT}	I_{OUT} = 100 μA	−0.5		+0.5	%
		100 μA < I_{OUT} < 50 mA	−1		+1	%
		100 μA < I_{OUT} < 50 mA, T_J = −55°C to +125°C	−2		+2	%
Adjustable Output[1] Voltage Accuracy	V_{OUT}	I_{OUT} = 100 μA	1.2188	1.2250	1.2311	V
		100 μA < I_{OUT} < 50 mA	1.2127		1.2372	V
		100 μA < I_{OUT} < 50 mA, T_J = −55°C to +125°C	1.2005		1.2495	V
Noise (10 Hz to 100 kHz)	OUT_{NOISE}	V_{OUT} = 1.6 V, C_{OUT} = 1 μF		146		μV rms
		V_{OUT} = 1.6 V, C_{OUT} = 10 μF		124		μV rms
		V_{OUT} = 5 V, C_{OUT} = 1 μF		340		μV rms
		V_{OUT} = 5 V, C_{OUT} = 10 μF		266		μV rms
REGULATION						
Line Regulation	$\Delta V_{OUT}/\Delta V_{IN}$	V_{IN} = (V_{OUT} + 0.5 V) to 28 V, T_J = −55°C to +125°C	−0.02		+0.02	%/V
Load Regulation[2]	$\Delta V_{OUT}/\Delta I_{OUT}$	1 mA < I_{OUT} < 50 mA		0.001		%/mA
		1 mA < I_{OUT} < 50 mA, T_J = −55°C to +125°C			0.005	%/mA
DROPOUT VOLTAGE[3]	$V_{DROPOUT}$	I_{OUT} = 10 mA		55		mV
		I_{OUT} = 10 mA, T_J = −55°C to +125°C			105	mV
		I_{OUT} = 50 mA		275		mV
		I_{OUT} = 50 mA, T_J = −55°C to +125°C			480	mV
START-UP TIME[4]	$t_{START-UP}$			200		μs
CURRENT LIMIT THRESHOLD[5]	I_{LIMIT}		55	90	140	mA
THERMAL CHARACTERISTICS						
Thermal Shutdown Threshold	TS_{SD}	T_J rising		150		°C
Thermal Shutdown Hysteresis	TS_{SD-HYS}			15		°C
EN CHARACTERISTICS						
EN Input						
Logic High	V_{IH}	4 V ≤ V_{IN} ≤ 28 V	1.8			V
Logic Low	V_{IL}	4 V ≤ V_{IN} ≤ 28 V			0.4	V
Leakage Current	$V_{I-LEAKAGE}$	EN = GND		0.1	1	μA
		EN = IN		0.5	1	μA
ADJ INPUT BIAS CURRENT (ADP1720-EP ADJUSTABLE)	ADJ_{I-BIAS}			30	100	nA

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
POWER SUPPLY REJECTION RATIO	PSRR	f = 120 Hz, V_{IN} = 8 V, V_{OUT} = 1.6 V		−90		dB
		f = 1 kHz, V_{IN} = 8 V, V_{OUT} = 1.6 V		−80		dB
		f = 10 kHz, V_{IN} = 8 V, V_{OUT} = 1.6 V		−60		dB
		f = 120 Hz, V_{IN} = 8 V, V_{OUT} = 5 V		−83		dB
		f = 1 kHz, V_{IN} = 8 V, V_{OUT} = 5 V		−70		dB
		f = 10 kHz, V_{IN} = 8 V, V_{OUT} = 5 V		−50		dB

[1] Accuracy when OUT is connected directly to ADJ. When OUT voltage is set by external feedback resistors, absolute accuracy in adjust mode depends on the tolerances of resistors used.
[2] Based on an end-point calculation using 1 mA and 50 mA loads. See Figure 6 for typical load regulation performance for loads less than 1 mA.
[3] Dropout voltage is defined as the input-to-output voltage differential when the input voltage is set to the nominal output voltage. This applies only for output voltages above 4 V.
[4] Start-up time is defined as the time between the rising edge of EN to OUT being at 95% of its nominal value.
[5] Current limit threshold is defined as the current at which the output voltage drops to 90% of the specified typical value. For example, the current limit for a 5.0 V output voltage is defined as the current that causes the output voltage to drop to 90% of 5.0 V, or 4.5 V.

ABSOLUTE MAXIMUM RATINGS

Table 2.

Parameter	Rating
IN to GND	−0.3 V to +30 V
OUT to GND	−0.3 V to IN or +6 V (whichever is less)
EN to GND	−0.3 V to +30 V
ADJ to GND	−0.3 V to +6 V
Storage Temperature Range	−65°C to +150°C
Operating Junction Temperature Range	−55°C to +125°C
Soldering Conditions	JEDEC J-STD-020

Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

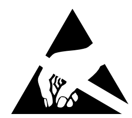
THERMAL RESISTANCE

θ_{JA} is specified for the worst-case conditions, that is, a device soldered in a circuit board for surface-mount packages.

Table 3. Thermal Resistance

Package Type	θ_{JA}	θ_{JC}	Unit
8-Lead MSOP	246	66	°C/W

ESD CAUTION



ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

PIN CONFIGURATIONS AND FUNCTION DESCRIPTIONS

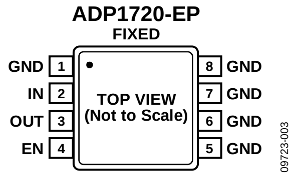


Figure 3. 8-Lead MSOP Pin Configuration—Fixed Output Voltage

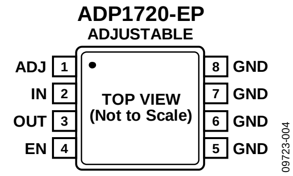


Figure 4. 8-Lead MSOP Pin Configuration—Adjustable Output Voltage

Table 4. Pin Function Descriptions

Pin No.			
Fixed	**Adjustable**	**Mnemonic**	**Description**
1	N/A	GND	This pin is internally connected to ground.
N/A	1	ADJ	Adjust. A resistor divider from OUT to ADJ sets the output voltage.
2	2	IN	Regulator Input Supply. Bypass IN to GND with a 1 μF or greater capacitor.
3	3	OUT	Regulated Output Voltage. Bypass OUT to GND with a 1 μF or greater capacitor.
4	4	EN	Enable Input. Drive EN high to turn on the regulator; drive it low to turn off the regulator. For automatic startup, connect EN to IN.
5	5	GND	Ground.
6	6	GND	Ground.
7	7	GND	Ground.
8	8	GND	Ground.

TYPICAL PERFORMANCE CHARACTERISTICS

V_{IN} = 12 V, V_{OUT} = 5 V, I_{OUT} = 100 μA, C_{IN} = C_{OUT} = 1 μF, T_A = 25°C, unless otherwise noted.

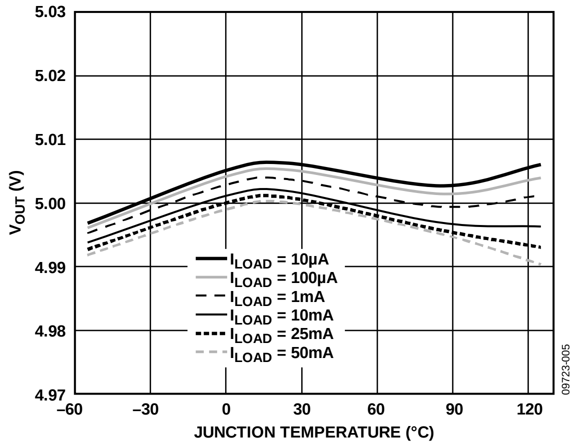


Figure 5. Output Voltage vs. Junction Temperature

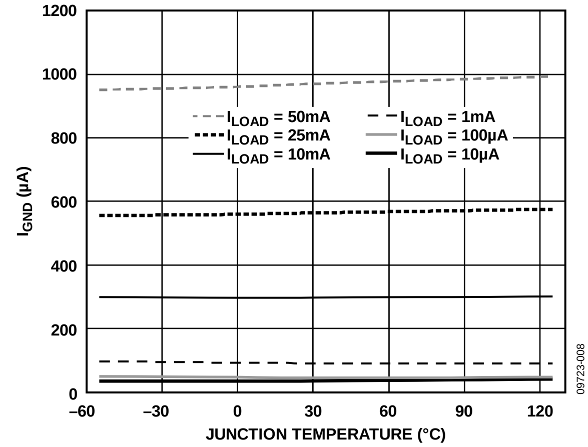


Figure 8. Ground Current vs. Junction Temperature

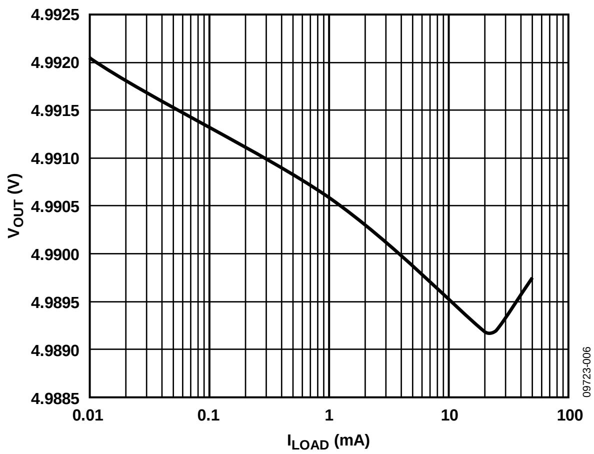


Figure 6. Output Voltage vs. Load Current

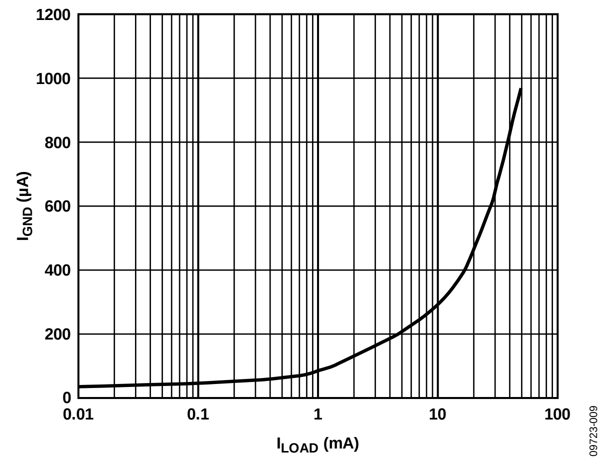


Figure 9. Ground Current vs. Load Current

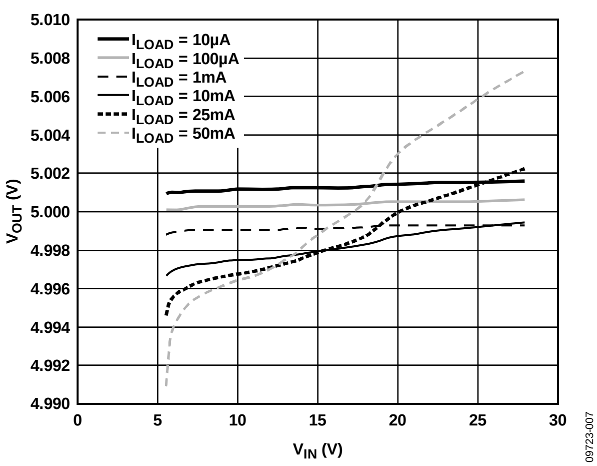


Figure 7. Output Voltage vs. Input Voltage

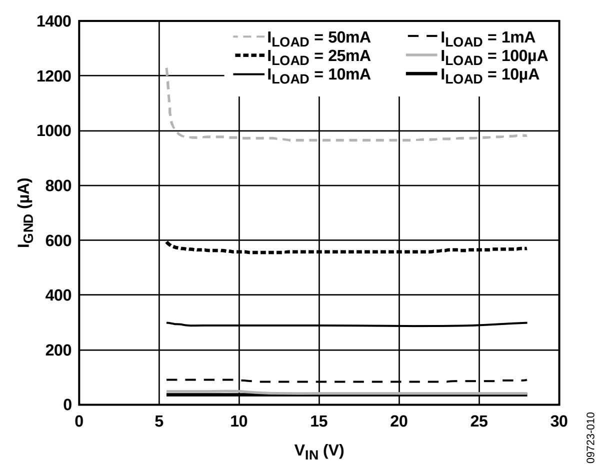


Figure 10. Ground Current vs. Input Voltage

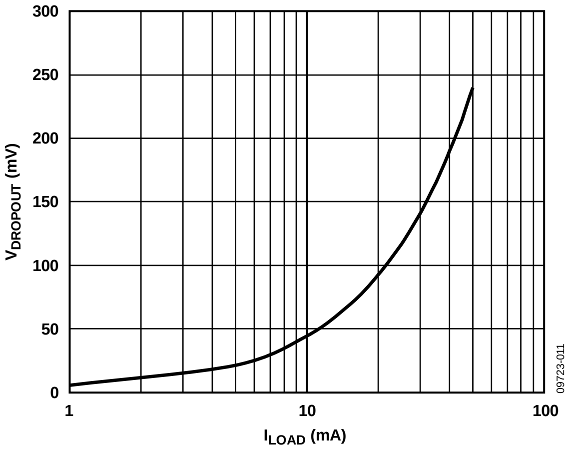


Figure 11. Dropout Voltage vs. Load Current

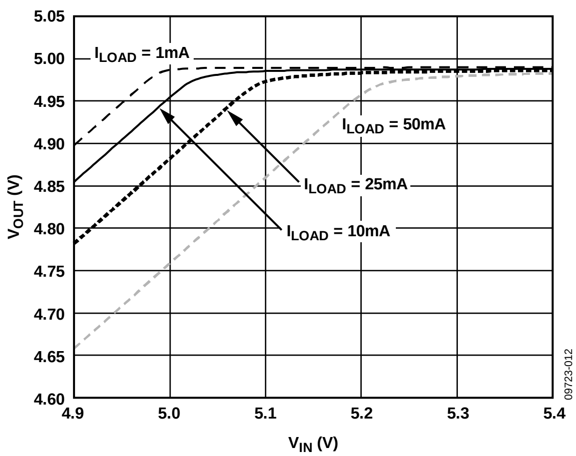


Figure 12. Output Voltage vs. Input Voltage (in Dropout)

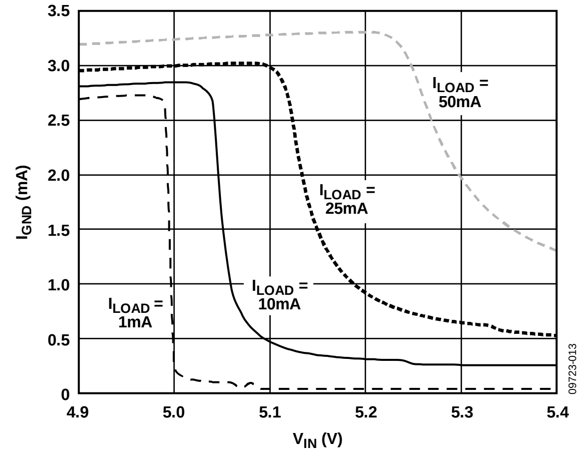


Figure 13. Ground Current vs. Input Voltage (in Dropout)

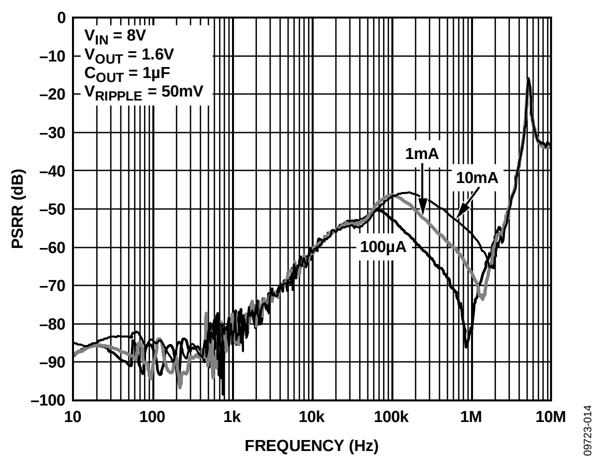


Figure 14. Power Supply Rejection Ratio vs. Frequency (1.6 V Adjustable Output)

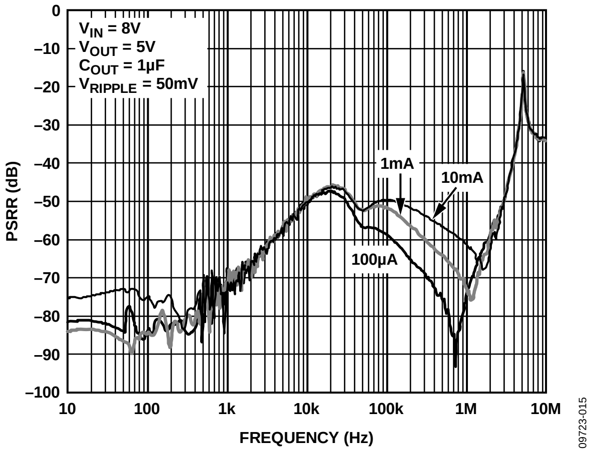


Figure 15. Power Supply Rejection Ratio vs. Frequency (5.0 V Fixed Output)

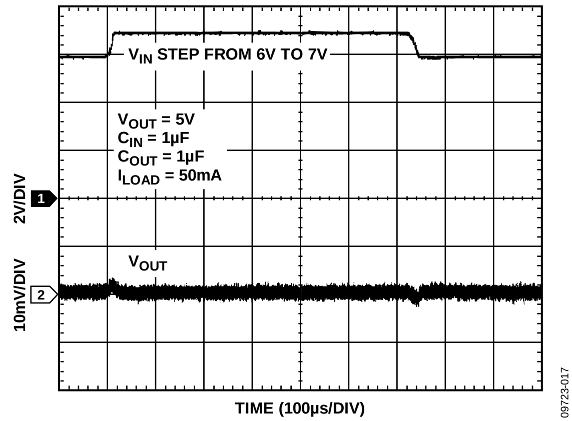


Figure 17. Line Transient Response

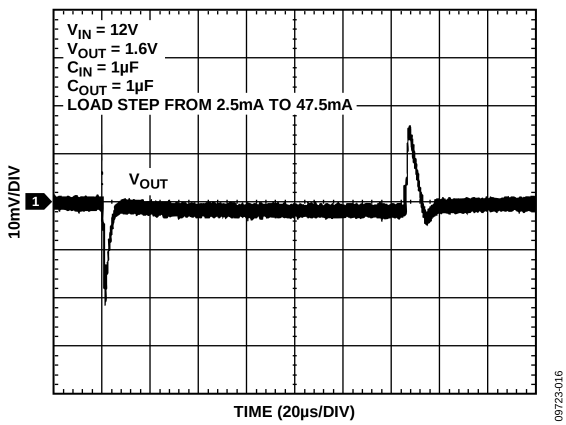


Figure 16. Load Transient Response

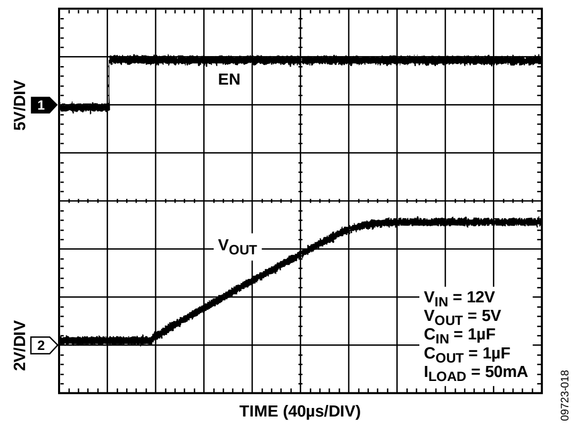


Figure 18. Start-Up Time

APPLICATIONS INFORMATION

THERMAL CONSIDERATIONS

To guarantee reliable operation, the junction temperature of the ADP1720-EP must not exceed 125°C. To ensure that the junction temperature stays below this maximum value, the user needs to be aware of the parameters that contribute to junction temperature changes. These parameters include ambient temperature, power dissipation in the power device, and thermal resistances between the junction and ambient air (θ_{JA}). The θ_{JA} number is dependent on the package assembly compounds used and the amount of copper to which the GND pins of the package are soldered on the PCB. Table 5 shows typical θ_{JA} values of the 8-lead MSOP package for various PCB copper sizes.

Table 5. Typical θ_{JA} Values for ADP1720-EP

Copper Size (mm^2)	θ_{JA} (°C/W)
25	246
50	216
100	186
300	178
500	169

The junction temperature of the ADP1720-EP can be calculated from the following equation:

$$T_J = T_A + (P_D \times \theta_{JA}) \quad (3)$$

where:
T_A is the ambient temperature.
P_D is the power dissipation in the die, given by

$$P_D = [(V_{IN} - V_{OUT}) \times I_{LOAD}] + (V_{IN} \times I_{GND}) \quad (4)$$

where:
I_{LOAD} is the load current.
I_{GND} is the ground current.
V_{IN} and V_{OUT} are input and output voltages, respectively.

Power dissipation due to ground current is quite small and can be ignored. Therefore, the junction temperature equation simplifies to the following:

$$T_J = T_A + \{[(V_{IN} - V_{OUT}) \times I_{LOAD}] \times \theta_{JA}\} \quad (5)$$

As shown in Equation 5, for a given ambient temperature, input-to-output voltage differential, and continuous load current, there exists a minimum copper size requirement for the PCB to ensure that the junction temperature does not rise above 125°C. Figure 19 to Figure 24 show junction temperature calculations for different ambient temperatures, load currents, V_{IN} to V_{OUT} differentials, and areas of PCB copper for the ADP1720-EP.

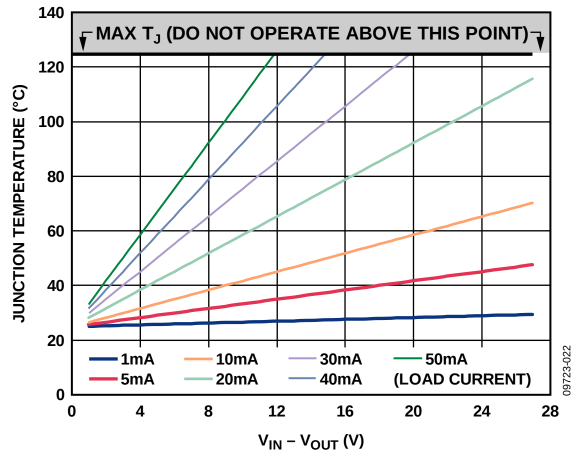


Figure 19. 500 mm^2 of PCB Copper, T_A = 25°C

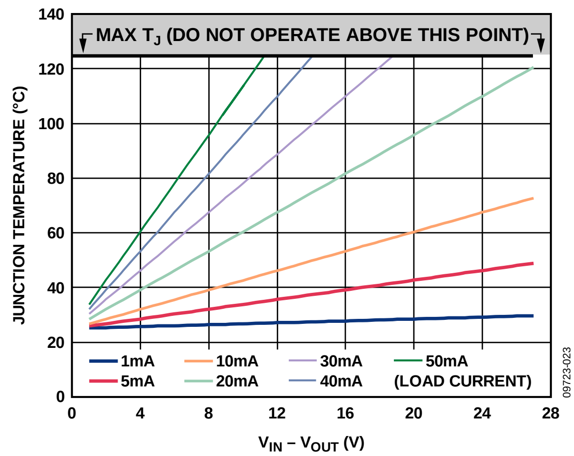


Figure 20. 300 mm^2 of PCB Copper, T_A = 25°C

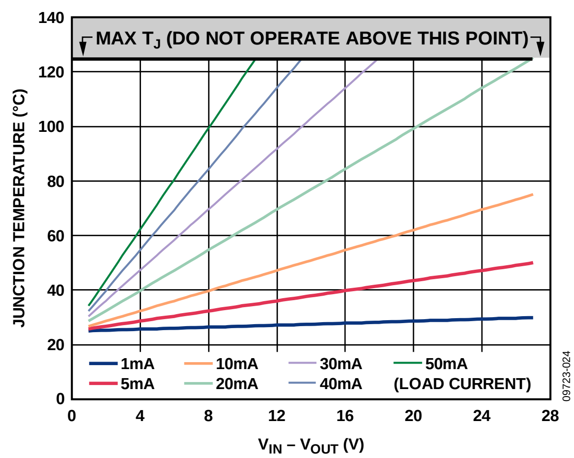


Figure 21. 100 mm^2 of PCB Copper, T_A = 25°C

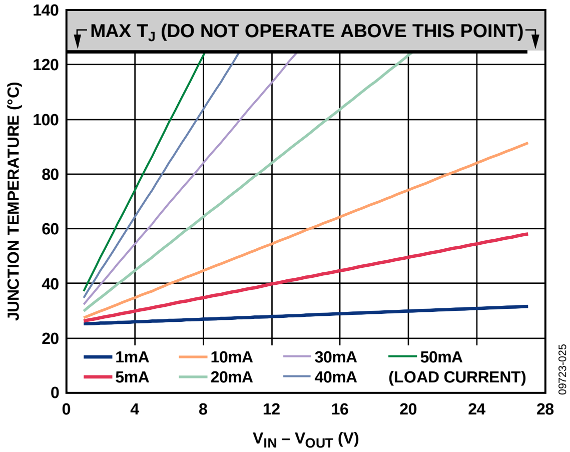


Figure 22. 25 mm² of PCB Copper, T_A = 25°C

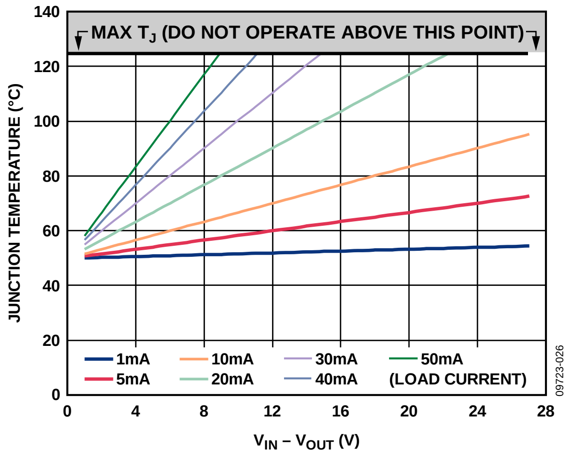


Figure 23. 500 mm² of PCB Copper, T_A = 50°C

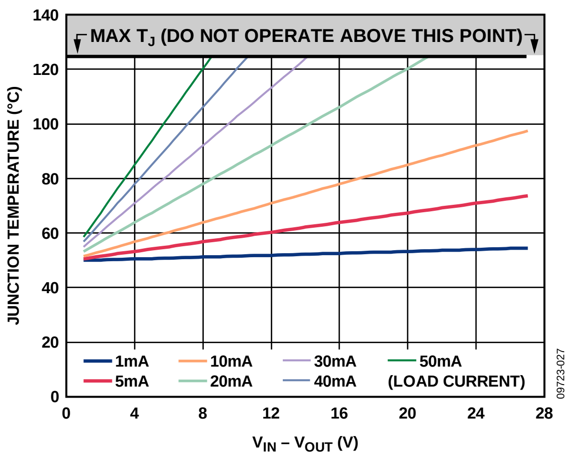


Figure 24. 300 mm² of PCB Copper, T_A = 50°C

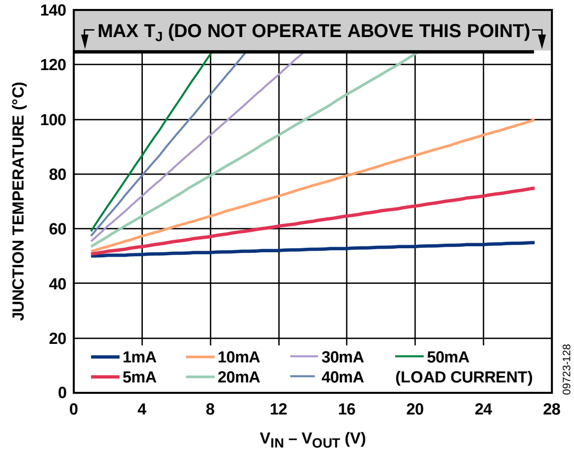


Figure 25. 100 mm2 of PCB Copper, TA = 50°C

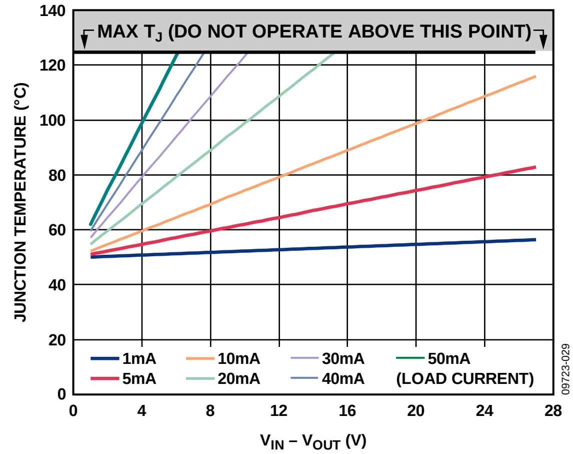


Figure 26. 25 mm2 of PCB Copper, TA = 50°C

OUTLINE DIMENSIONS

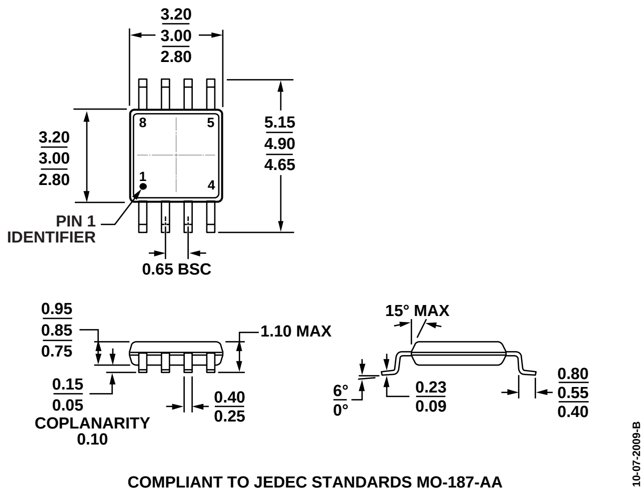


Figure 27. 8-Lead Mini Small Outline Package [MSOP]
(RM-8)
Dimensions shown in millimeters

ORDERING GUIDE

Model[1]	Temperature Range	Output Voltage (V)	Package Description	Package Option	Branding
ADP1720TRMZ5-EP	−55°C to +125°C	5	8-Lead MSOP	RM-8	LKU
ADP1720TRMZ5-EP-R7	−55°C to +125°C	5	8-Lead MSOP	RM-8	LKU
ADP1720TRMZ3.3-EP	−55°C to +125°C	3.3	8-Lead MSOP	RM-8	LKT
ADP1720TRMZ3.3-EPR7	−55°C to +125°C	3.3	8-Lead MSOP	RM-8	LKT
ADP1720TRMZ-EP	−55°C to +125°C	1.225 to 5	8-Lead MSOP	RM-8	LG2
ADP1720TRMZ-EP-R7	−55°C to +125°C	1.225 to 5	8-Lead MSOP	RM-8	LG2

[1] Z = RoHS Compliant Part.

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