



500mA Low-Dropout Linear Regulator in MSOP Package

Preliminary Technical Data

ADP1715/ADP1716

FEATURES

- 16 Fixed Output Voltage Options from 0.75V to 3.3V
- Adjustable Output Voltage from 0.8V to 5V
- Wide 2.5V to 5.5V Input Voltage Range
- Low Dropout Voltage:
 - 250 mV @500mA
- ±1% Initial Accuracy
- High PSRR (60dB @1kHz)
- 1µA Shutdown Current
- Adjustable Soft-Start Option Available
- Output Voltage Tracking Option Available
- Optimized for Small Ceramic Capacitors
- Thermal Overload Protection
- Short Circuit Protection
- Small Thermally-Enhanced MSOP Package

APPLICATIONS

- Telecom Equipment
- Network Equipment
- DSP/FPGA/Microprocessor Supplies
- Instrumentation Equipment/Data Acquisition Systems

GENERAL DESCRIPTION

The ADP1715/16 is a 500mA low-dropout linear regulator that uses an advanced, proprietary architecture to provide high power supply rejection ratio (PSRR) and excellent line and load transient response with just a small 2.2µF ceramic output capacitor. Supply current in shutdown mode is reduced to less than 1µA.

Three versions of this part are available: one with fixed output voltage and variable soft-start, one with fixed output voltage and output voltage tracking, and one with adjustable output voltage and fixed soft start. The fixed output voltage is internally set to one of sixteen values between 0.75V and 3.3V while the adjustable output voltage can be set between 0.8V and 5.0V by an external voltage divider from OUT to ADJ. The variable soft-start uses an external capacitor at SS to control the output voltage ramp while the internal soft-start uses a 3pF capacitor to give a constant 24µs ramp. Tracking limits the output voltage to the at-or-below voltage at the TRK pin.

The ADP1715/16 is available in a thermally-enhanced MSOP package, making it a very compact solution for applications requiring up to 500mA of output current in a small, low-profile footprint.

TYPICAL APPLICATION CIRCUIT

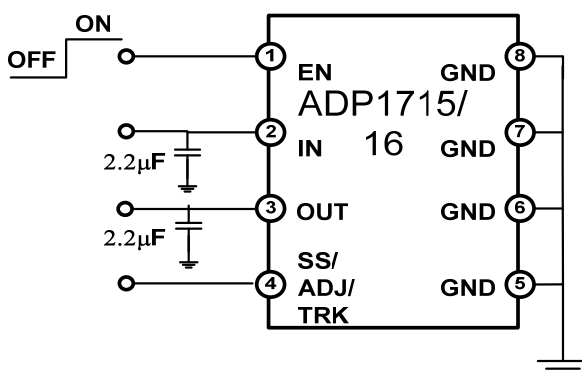
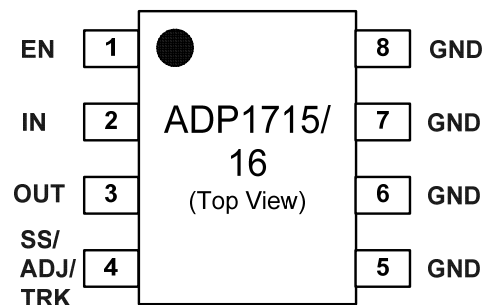


Figure 1. ADP1715/16 typical operation circuit

PIN CONFIGURATION



Rev. PrA

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One Technology Way, P.O. Box 9106, Norwood, MA 02062-9106, U.S.A.
 Tel: 781.329.4700 www.analog.com
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ADP1715/16 TARGET SPECIFICATIONS

Table 1. Electrical Characteristics

$V_{IN} = 5V$, $I_{OUT} = 100mA$, $C_{LOAD} = 2.2\mu F$, $T_A = 25^\circ C$, **BOLD** values indicate spec applies over $T_J = -40^\circ C$ to $125^\circ C$, unless otherwise noted.

Parameter	Conditions	Min	Typ	Max	Unit
Input Voltage		2.5		5.5	V
Operating Supply Current	100uA		80	90	μA
	100mA				
	500mA				
Shutdown Supply Current	EN = GND		0.1	1.0	μA
Fixed Output Voltage Accuracy	$I_{OUT} = 10mA$	-1		+1	%
	$10mA < I_{OUT} < 500mA$	-2		+2	%
	$10mA < I_{OUT} < 500mA$, $T_A = -40^\circ C$ to $85^\circ C$	-3		+3	%
ADJ Regulation Voltage	$I_{OUT} = 10mA$	792	800	808	mV
	$10mA < I_{OUT} < 500mA$	784		816	mV
ADJ Input Bias Current	$V_{ADJ} = V_{OUT}$				nA
Line Regulation	$V_{IN} = (V_{OUT} + 0.5V)$ to $5.5V$, $I_{OUT} = 1mA$	-0.15	0	+0.15	%/V
Load Regulation	$10mA < I_{OUT} < 500mA$		0.01	0.04	%/A
Dropout Voltage (Note 1)	$I_{OUT} = 100mA$		125	250	mV
	$I_{OUT} = 500mA$		250		
Current Limit Threshold	$V_{OUT} = 0.9 \times V_{OUT(NOM)}$	550	TBD	850	mA
Thermal Shutdown Temperature	Typical Thermal Hysteresis = $15^\circ C$		150		$^\circ C$
SS Source Current	ADP1715 Only, SS = GND	0.8	1	1.2	μA
SS Pull Up Voltage	ADP1715, (Not to be included in final data sheet, design spec only)	1.0		1.5	V
SS Pull Down Resistance	ADP1715, EN = GND (Not to be included on final data sheet, design spec only)	12			Ω
TRK to OUT Accuracy	ADP1716-XX Only, $V_{TRK} = 0.5 \times V_{OUT(NOM)}$	-50	0	50	mV
EN Input High	$2.5V \leq V_{IN} \leq 5.5V$	1.8			V
EN Input Low	$2.5V \leq V_{IN} \leq 5.5V$			0.8	V
EN Input Leakage Current	EN = IN or GND	-0.1	0	+0.1	μA
PSRR	1kHz, $I_{OUT} = 500mA$		60		dB
Output Noise			TBD		μV_{rms}

Notes:

1. Dropout voltage is defined as the input to output voltage differential when the input voltage is set to the nominal output voltage. Applies for output voltages above 2.5V only.

ABSOLUTE MAXIMUM RATINGS

Table 2 Absolute Maximum Ratings (at 25°C, unless otherwise noted)

Parameter	Rating
IN, OUT, EN, TRK, ADJ, SS to GND	6 V
OUT to IN	-0.3V to ($V_{IN} + 0.3V$)
Maximum Output Current	TBD
Storage Temperature Range	-65°C to +150°C
Operating Junction Temperature Range	-40°C to +125° C
Maximum Junction Temperature	150°C
Lead Temperature Range (Soldering, 10sec)	300°C

Table 3 Thermal Resistance

Package Type	θ_{JA} ¹	Unit
8-lead Thermally Enhanced MSOP	TBD	°C/W

¹ θ_{JA} is specified for the worst-case conditions, i.e., θ_{JA} is specified for device soldered in circuit board for surface mount packages.

ESD CAUTION

ESD (electrostatic discharge) sensitive device. Electrostatic charges as high as 4000 V readily accumulate on the human body and test equipment and can discharge without detection. Although these products feature proprietary ESD protection circuitry, permanent damage may occur on devices subjected to high energy electrostatic discharges. Therefore, proper ESD precautions are recommended to avoid performance degradation or loss of functionality.

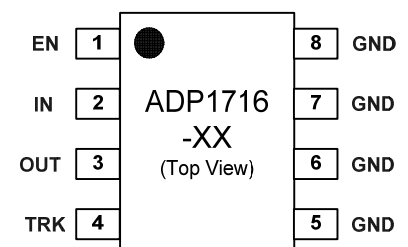
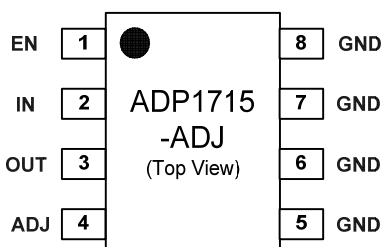
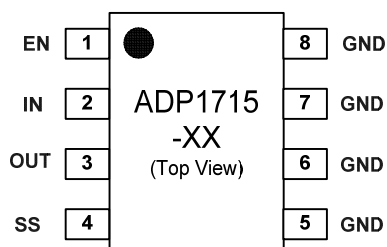


PIN DESCRIPTION

Table 4. Pin numbers are Preliminary and Subject To Change)

Pin Number	ADP1715		ADP1716	Description
	-XXX	-ADJ		
2	IN	IN	IN	Power Source Input. IN is the source input to the LDO. Connect the input voltage to IN. Bypass IN to GND with a 2.2 μ F or greater capacitor.
3	OUT	OUT	OUT	Regulated Voltage Output. OUT is the output voltage of the LDO. Bypass OUT to GND with a 2.2 μ F or greater capacitor
1	EN	EN	EN	Enable Input. The ADP1715/16 is turned on/off by the state of EN. Drive EN high to turn on the LDO, drive it low to turn it off. For automatic startup, connect EN to IN.
4	SS			Soft-Start Control Input. Connect a capacitor from SS to GND to set the soft-start period. A 10nF capacitor sets the soft-start period to 8ms. If not used, the part will have a fixed startup ramp of 24 μ s.
		ADJ		Adjustable Output Voltage Control Input. A resistive voltage divider from OUT to ADJ sets the output voltage for adjustable output voltage versions. These parts will have a fixed startup ramp of 24 μ s.
			TRK	Tracking Input. A voltage applied to TRK limits the output voltage. To force the output voltage to track an external signal, drive TRK with that signal. If not used, connect TRK to IN.
5, 6, 7, 8	GND	GND	GND	Ground.

PIN CONFIGURATIONS:



TYPICAL PERFORMANCE CHARACTERISTICS

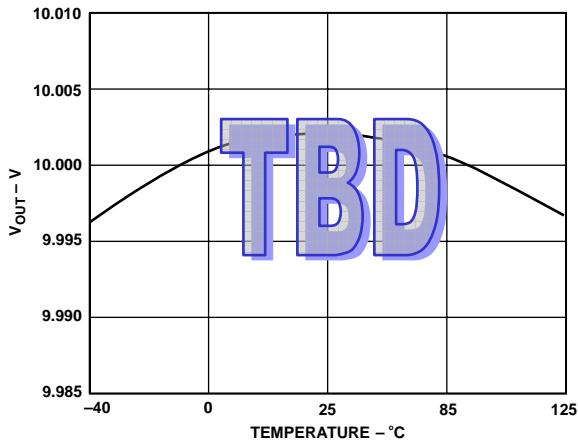


Figure 1. Output Voltage vs. Load Current

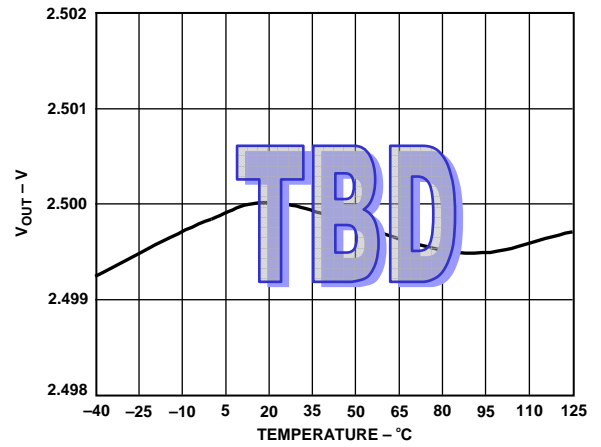


Figure 3. Output Voltage vs. Temperature

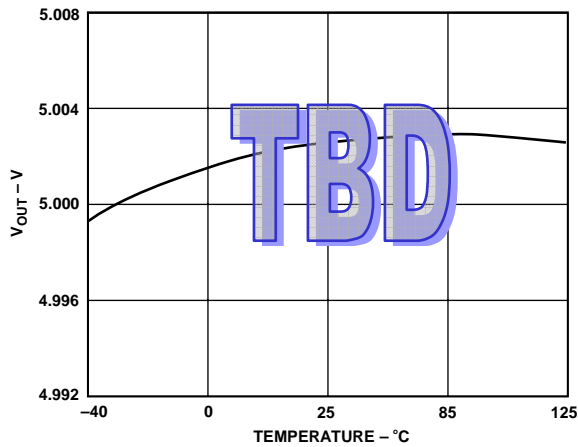


Figure 2. Ground Current vs. Input Voltage

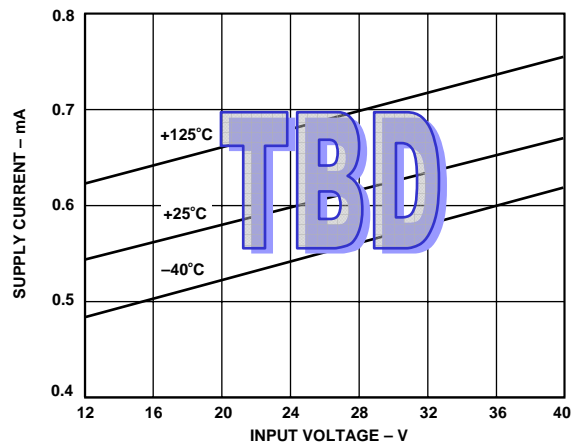


Figure 4. Ground Current vs. Load Current

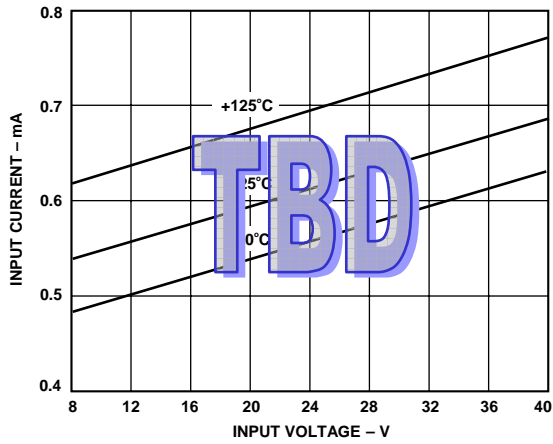


Figure 5. Ground Current vs., Temperature

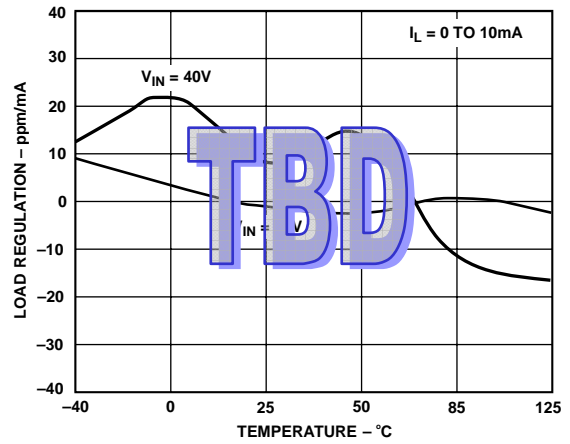


Figure 7. Dropout Voltage vs. Load Current

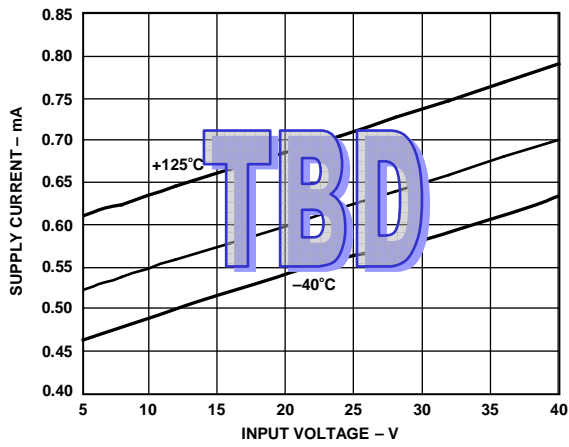


Figure 6. PSRR vs. Frequency

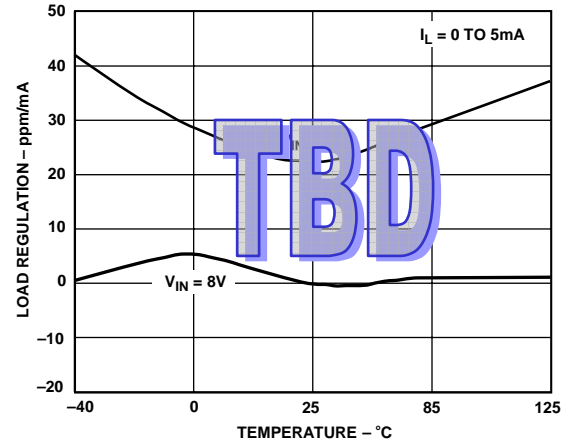


Figure 8. Load Transient Response

THEORY OF OPERATION

Introduction

The ADP1715/16 is a low-dropout linear regulator that uses an advanced, proprietary architecture to provide high power supply rejection ratio (PSRR) and excellent line and load transient response with just a small 2.2 μ F ceramic output capacitor. Supply current in shutdown mode is reduced to 1 μ A.

Three versions are available: one with fixed output voltage and soft-start, one with fixed output voltage and output voltage tracking, and one with adjustable output voltage. The fixed output voltage is internally set to one of sixteen values between 0.75V and 3.3V. The adjustable output voltage is set between 0.8V and 5.0V by an external voltage divider from OUT to ADJ. The soft-start uses an external capacitor at SS to control the output voltage ramp. In the case of the adjustable version, ADP1715-ADJ, the soft-start is controlled by an internal 3pF capacitor, limiting the output voltage ramp-up period to approximately 24 μ s. Tracking limits the output voltage to the at-or-below the voltage at TRK.

The ADP1715/16 is available in a thermally-enhanced MSOP package, making it a very compact solution for applications requiring up to 500mA in a small, low-profile footprint.

Soft-start Function (ADP1715)

For applications that require a controlled startup, the ADP1715 provides a programmable soft-start function. Programmable soft-start is useful for reducing inrush current upon startup and for providing voltage sequencing. To implement soft-start, connect a capacitor from SS to GND. Upon startup, a 1 μ A current source charges the capacitor. The ADP1715 startup output voltage is limited by the voltage at SS, providing a smooth ramp up to the nominal output voltage. The soft-start time is calculated by $T_{SS} = V_{REF} \times (C_{SS}/I_{SS})$, where T_{SS} is the soft-start period, V_{REF} is the 0.8V reference voltage, C_{SS} is the soft-start capacitance from SS to GND, and I_{SS} is the current sourced from SS (1 μ A). Note that when the ADP1715 is disabled, the soft-start capacitor is discharged to GND through an internal 100 Ω resistor.

In the case of the adjustable output version, there is no pin for soft-start, so the function is switched to an internal 3pF capacitor. This sets the soft-start ramp-up period to approximately 24 μ s. Using the suggested 2.2 μ F output capacitor, the resulting input inrush current is approximately 460mA, which is less than the maximum 500mA load current.

Voltage Tracking Function (ADP1716)

For applications that require voltage tracking, the ADP1716 provides a TRK pin. The ADP1716's output voltage is not allowed to exceed the voltage on the TRK pin, allowing control of the output voltage of the ADP1716 by another voltage rail in the system. The ADP1716's tracking function is always enabled, hence if the voltage applied to TRK pin drops below

the output voltage at any time, the ADP1716's output tracks it down. This ensures that the ADP1716 provides proper voltage tracking under startup and shutdown as well as under fault conditions.

The ADP1716 is only available in the fixed output voltage version. A voltage divider is present from TRK to the error amplifier input whose divider ratio is equal to the divider from OUT to the error amplifier. This sets the output voltage equal to the tracking voltage. Both divider ratios are set by post-package trim depending on the desired output voltage.

Output Capacitor Selection

The ADP1715/16 is optimized for operation with small ceramic capacitors. For output voltages, $V_{OUT} \geq 2V$, the ADP1715/16 operates with just 2.2 μ F of output capacitance. For output voltages below 1.8V, additional output capacitance may be required. Ceramic capacitors are manufactured with a variety of dielectrics, each with different behavior over temperature and applied voltage. When choosing your capacitor be sure to choose a dielectric adequate to ensure the minimum capacitance over the necessary temperature range.

Thermal Protection and Current Limit

The ADP1715/16 contains internal current limiting to protect itself and its loads during overload and short-circuit conditions. In addition to current limiting, this device contains automatic thermal overload protection circuitry to provide additional protection under continuous short-circuit conditions.

Adjustable Output Voltage

The ADP1715-ADJ's output voltage is adjustable over a 0.8V to 5.0V range. The output voltage is set by connecting a resistive voltage divider from OUT to ADJ. The output voltage is calculated using the equation $V_{OUT} = 0.8V(1 + R_{TOP}/R_{BOTTOM})$ where R_{TOP} is the resistor from OUT to ADJ and R_{BOTTOM} is the resistor from ADJ to GND. The maximum bias current into ADJ is 100nA, so for less than 0.1% error due to the bias current, use values less than 12k Ω for R_{BOTTOM} .

Shutdown

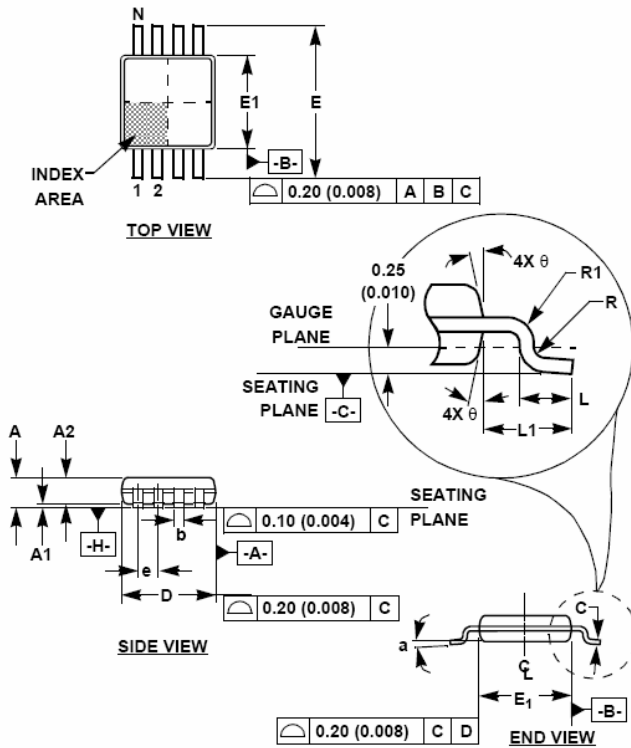
The ADP1715/16 includes a low power shutdown state entered by driving EN to GND. In shutdown, power consumption is 1 μ A. When the ADP1715-XX is disabled, the soft-start capacitor C_{SS} is discharged to GND with a 100 Ω resistance.

Package and Power Dissipation

The ADP1715/16 use a thermally-enhanced MSOP package, which achieves a respectable **TBD** $^{\circ}C/W$ for such a small footprint.

OUTLINE DIMENSIONS

Mini Small Outline Plastic Packages (MSOP)



M8.118 (JEDEC MO-187AA) 8 LEAD MINI SMALL OUTLINE PLASTIC PACKAGE

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN	MAX	MIN	MAX	
A	0.037	0.043	0.94	1.10	-
A1	0.002	0.006	0.05	0.15	-
A2	0.030	0.037	0.75	0.95	-
b	0.010	0.014	0.25	0.36	9
c	0.004	0.008	0.09	0.20	-
D	0.116	0.120	2.95	3.05	3
E1	0.116	0.120	2.95	3.05	4
e	0.026 BSC		0.65 BSC		-
E	0.187	0.199	4.75	5.05	-
L	0.016	0.028	0.40	0.70	6
L1	0.037 REF		0.95 REF		-
N	8		8		7
R	0.003	-	0.07	-	-
R1	0.003	-	0.07	-	-
θ	5°	15°	5°	15°	-
α	0°	6°	0°	6°	-

Rev. 2 01/03

NOTES:

1. These package dimensions are within allowable dimensions of JEDEC MO-187BA.
2. Dimensioning and tolerancing per ANSI Y14.5M-1994.
3. Dimension "D" does not include mold flash, protrusions or gate burrs and are measured at Datum Plane. Mold flash, protrusion and gate burrs shall not exceed 0.15mm (0.006 inch) per side.
4. Dimension "E1" does not include interlead flash or protrusions and are measured at Datum Plane. [-H-] Interlead flash and protrusions shall not exceed 0.15mm (0.006 inch) per side.
5. Formed leads shall be planar with respect to one another within 0.10mm (0.004) at seating Plane.
6. "L" is the length of terminal for soldering to a substrate.
7. "N" is the number of terminal positions.
8. Terminal numbers are shown for reference only.
9. Dimension "b" does not include dambar protrusion. Allowable dambar protrusion shall be 0.08mm (0.003 inch) total in excess of "b" dimension at maximum material condition. Minimum space between protrusion and adjacent lead is 0.07mm (0.0027 inch).
10. Datums [-A-] and [-B-] to be determined at Datum plane [-H-].
11. Controlling dimension: MILLIMETER. Converted inch dimensions are for reference only.

ORDERING GUIDE

TABLE 5

ADP1715/16	Output Voltage	Variable Soft-start Option	Tracking Option	Package Description	Package Option	Top Mark ¹	No. of Parts per Reel	Temperature Range
	V _o (V)							(°C)
ADP1715-075	0.75V	Yes	No	8-lead MSOP	RN	TBD	TBD	-40°C to +125°C
ADP1715-080	0.80V	Yes	No	8-lead MSOP	RN	TBD	TBD	-40°C to +125°C
ADP1715-085	0.85V	Yes	No	8-lead MSOP	RN	TBD	TBD	-40°C to +125°C
ADP1715-090	0.90V	Yes	No	8-lead MSOP	RN	TBD	TBD	-40°C to +125°C
ADP1715-095	0.95V	Yes	No	8-lead MSOP	RN	TBD	TBD	-40°C to +125°C
ADP1715-100	1.00V	Yes	No	8-lead MSOP	RN	TBD	TBD	-40°C to +125°C
ADP1715-105	1.05V	Yes	No	8-lead MSOP	RN	TBD	TBD	-40°C to +125°C
ADP1715-110	1.10V	Yes	No	8-lead MSOP	RN	TBD	TBD	-40°C to +125°C
ADP1715-115	1.15V	Yes	No	8-lead MSOP	RN	TBD	TBD	-40°C to +125°C
ADP1715-120	1.20V	Yes	No	8-lead MSOP	RN	TBD	TBD	-40°C to +125°C
ADP1715-130	1.30V	Yes	No	8-lead MSOP	RN	TBD	TBD	-40°C to +125°C
ADP1715-150	1.50V	Yes	No	8-lead MSOP	RN	TBD	TBD	-40°C to +125°C
ADP1715-180	1.80V	Yes	No	8-lead MSOP	RN	TBD	TBD	-40°C to +125°C
ADP1715-250	2.50V	Yes	No	8-lead MSOP	RN	TBD	TBD	-40°C to +125°C
ADP1715-300	3.00V	Yes	No	8-lead MSOP	RN	TBD	TBD	-40°C to +125°C
ADP1715-330	3.30V	Yes	No	8-lead MSOP	RN	TBD	TBD	-40°C to +125°C
ADP1715-ADJ	0.8V to 5.0V	No	No	8-lead MSOP	RN	TBD	TBD	-40°C to +125°C
ADP1716-075	0.75V	No	Yes	8-lead MSOP	RN	TBD	TBD	-40°C to +125°C
ADP1716-080	0.80V	No	Yes	8-lead MSOP	RN	TBD	TBD	-40°C to +125°C
ADP1716-085	0.85V	No	Yes	8-lead MSOP	RN	TBD	TBD	-40°C to +125°C
ADP1716-090	0.90V	No	Yes	8-lead MSOP	RN	TBD	TBD	-40°C to +125°C
ADP1716-095	0.95V	No	Yes	8-lead MSOP	RN	TBD	TBD	-40°C to +125°C
ADP1716-100	1.00V	No	Yes	8-lead MSOP	RN	TBD	TBD	-40°C to +125°C
ADP1716-105	1.05V	No	Yes	8-lead MSOP	RN	TBD	TBD	-40°C to +125°C
ADP1716-110	1.10V	No	Yes	8-lead MSOP	RN	TBD	TBD	-40°C to +125°C
ADP1716-115	1.15V	No	Yes	8-lead MSOP	RN	TBD	TBD	-40°C to +125°C
ADP1716-120	1.20V	No	Yes	8-lead MSOP	RN	TBD	TBD	-40°C to +125°C
ADP1716-130	1.30V	No	Yes	8-lead MSOP	RN	TBD	TBD	-40°C to +125°C
ADP1716-150	1.50V	No	Yes	8-lead MSOP	RN	TBD	TBD	-40°C to +125°C
ADP1716-180	1.80V	No	Yes	8-lead MSOP	RN	TBD	TBD	-40°C to +125°C
ADP1716-250	2.50V	No	Yes	8-lead MSOP	RN	TBD	TBD	-40°C to +125°C
ADP1716-300	3.00V	No	Yes	8-lead MSOP	RN	TBD	TBD	-40°C to +125°C
ADP1716-330	3.30V	No	Yes	8-lead MSOP	RN	TBD	TBD	-40°C to +125°C