MAX603, MAX604

5V/3.3V or Adjustable, Low-Dropout, Low-I_Q, 500mA Linear Regulators

Industry's Smallest 500mA LDO in SO-8 Footprint Handles Up to 1.8W Power Dissipation

Description

The MAX603/MAX604 low-dropout, low quiescent current, linear regulators supply 5V, 3.3V, or an adjustable output for currents up to 500mA. They are available in a 1.8W SO package. Typical dropouts are 320mV at 5V and 500mA, or 240mV at 3.3V and 200mA. Quiescent currents are 15µA typ and 35µA max. Shutdown turns off all circuitry and puts the regulator in a 2µA off mode. A unique protection scheme limits reverse currents when the input voltage falls below the output. Other features include foldback current limiting and thermal overload protection.

The output is preset at 3.3V for the MAX604 and 5V for the MAX603. In addition, both devices employ Dual Mode™ operation, allowing user-adjustable outputs from 1.25V to 11V using external resistors. The input voltage supply range is 2.7V to 11.5V.

The MAX603/MAX604 feature a 500mA P-channel MOSFET pass transistor. This transistor allows the devices to draw less than 35µA over temperature, independent of the output current. The supply current remains low because the P-channel MOSFET pass transistor draws no base currents (unlike the PNP transistors of conventional bipolar linear regulators). Also, when the input-to-output voltage differential becomes small, the internal P-channel MOSFET does not suffer from excessive base current losses that occur with saturated PNP transistors.

Key Features

Applications / Uses

- 500mA Output Current, with Foldback Current Limiting
- High-Power (1.8W) 8-Pin SO Package
- Dual Mode™ Operation: Fixed or Adjustable Output from 1.25V to 11V
- Large Input Range (2.7V to 11.5V)
- Internal 500mA P-Channel Pass Transistor
- 15µA Typical Quiescent Current
- 2µA (Max) Shutdown Mode
- Thermal Overload Protection
- Reverse-Current Protection

1.25V to 11V Adjustable Regulators
5V and 3.3V Regulators
Automotive Electronics
Pagers and Cell Phones
Portable Instrumentation
Solar-Powered Instruments

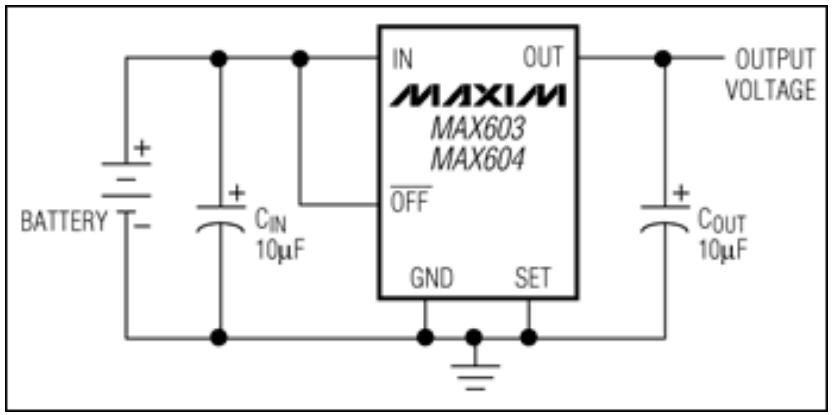
Key Specifications: Linear Regulators

Part Number	Regulators per Pkg.	Min. V_{IN} (V)	Max. V_{IN} (V)	Preset V_{OUT} (V)	Min. Adjustable V_{OUT} (V)	Max. Adjustable V_{OUT} (V)	Typ. $V_{DROPOUT}$@ Rated I_{LOAD} (V)	Rated I_{LOAD} (mA)	Max. I_{CC} (µA)	Low Battery/ Power Fail Output	Watchdog	Reverse Battery Protection	Package	Operating Temp. Range (°C)	
MAX603	1	2.7	11.5	5.0	1.3	11.5	0.32	500	50	No	No	No	CDIP/8 PDIP/8 SOIC/8	0 to +70	
MAX604				3.3			0.6		35					-40 to +85 0 to +70	

See All Linear Regulators (145)

Notes:
**This pricing is BUDGETARY, for comparing similar parts. Prices are in U.S. dollars and subject to change. Quantity pricing may vary substantially and international prices may differ due to local duties, taxes, fees, and exchange rates. For volume-specific prices and delivery, please see the price and availability page or contact an authorized distributor.

Diagram



Typical Operating Circuit

Application Notes

Application Note 751: Linear Regulators in Portable Applications - MAX603, MAX604
Application Note 921: Variable, Linear Current Source Operates On 5V - MAX603

Evaluation Kits

none

Reliability Reports

Show FIT data for:
Reliability Report: MAX604xxA.pdf

Request Reliability Report for:

Software / Models

none

Ordering Information

Notes:

1. Other options and links for purchasing parts are listed at:
2. Didn't Find What You Need? Ask our applications engineers. Expert assistance in finding parts, usually within one business day.
3. Part number suffixes: T or T&R = tape and reel; + = RoHS/lead-free; # = RoHS/lead-exempt. More: SeeFull Data Sheet or Part Naming Conventions.
4. * Some packages have variations, listed on the drawing. "PkgCode/Variation" tells which variation the product uses. Note that "+", "#", "-" in the part number suffix describes RoHS status. Package drawings may show a different suffix character.

Devices: 1-28 of 28

MAX603	Free Sample	Buy	Package: TYPE PINS FOOTPRINT DRAWING CODE/VAR *	Temp	RoHS/Lead-Free? Materials Analysis
MAX603MJA			CDIP;8 pin; Dwg: 21-0045 (PDF) Use pkgcode/variation: J8-3*	-55°C to +125°C	See data sheet
MAX603C/D					See data sheet

MAX603CPA+			PDIP;8 pin; Dwg: 21-0043 (PDF) Use pkgcode/variation: P8+3*	0°C to +70°C	RoHS/Lead-Free: Lead Free Materials Analysis
MAX603EPA+			PDIP;8 pin; Dwg: 21-0043 (PDF) Use pkgcode/variation: P8+3*	-40°C to +85°C	RoHS/Lead-Free: Lead Free Materials Analysis
MAX603CPA			PDIP;8 pin; Dwg: 21-0043 (PDF) Use pkgcode/variation: P8-3*	0°C to +70°C	RoHS/Lead-Free: No Materials Analysis
MAX603EPA			PDIP;8 pin; Dwg: 21-0043 (PDF) Use pkgcode/variation: P8-3*	-40°C to +85°C	RoHS/Lead-Free: No Materials Analysis
MAX603CSA+T			SOIC;8 pin; Dwg: 21-0041 (PDF) Use pkgcode/variation: S8+7F*	0°C to +70°C	RoHS/Lead-Free: Lead Free Materials Analysis
MAX603CSA+			SOIC;8 pin; Dwg: 21-0041 (PDF) Use pkgcode/variation: S8+7F*	0°C to +70°C	RoHS/Lead-Free: Lead Free Materials Analysis
MAX603CSA-T			SOIC;8 pin; Dwg: 21-0041 (PDF) Use pkgcode/variation: S8-7F*	0°C to +70°C	RoHS/Lead-Free: No Materials Analysis
MAX603CSA			SOIC;8 pin; Dwg: 21-0041 (PDF) Use pkgcode/variation: S8-7F*	0°C to +70°C	RoHS/Lead-Free: No Materials Analysis
MAX603ESA-T			SOIC;8 pin; Dwg: 21-0041 (PDF) Use pkgcode/variation: S8-7F*	-40°C to +85°C	RoHS/Lead-Free: No Materials Analysis
MAX603ESA			SOIC;8 pin; Dwg: 21-0041 (PDF) Use pkgcode/variation: S8-7F*	-40°C to +85°C	RoHS/Lead-Free: No Materials Analysis
MAX603ESA+T			SOIC;8 pin; Dwg: 21-0041 (PDF) Use pkgcode/variation: S8+7F*	-40°C to +85°C	RoHS/Lead-Free: Lead Free Materials Analysis
MAX603ESA+			SOIC;8 pin; Dwg: 21-0041 (PDF) Use pkgcode/variation: S8+7F*	-40°C to +85°C	RoHS/Lead-Free: Lead Free Materials Analysis
MAX604	**Free Sample**	**Buy**	**Package: TYPE PINS FOOTPRINT DRAWING CODE/VAR ***	**Temp**	**RoHS/Lead-Free? Materials Analysis**
MAX604MJA			CDIP;8 pin; Dwg: 21-0045 (PDF) Use pkgcode/variation: J8-3*	-55°C to +125°C	See data sheet

MAX604C/D					See data sheet
MAX604CPA+			PDIP;8 pin; Dwg: 21-0043 (PDF) Use pkgcode/variation: P8+3*	0°C to +70°C	RoHS/Lead-Free: Lead Free Materials Analysis
MAX604EPA+			PDIP;8 pin; Dwg: 21-0043 (PDF) Use pkgcode/variation: P8+3*	-40°C to +85°C	RoHS/Lead-Free: Lead Free Materials Analysis
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MAX604EPA			PDIP;8 pin; Dwg: 21-0043 (PDF) Use pkgcode/variation: P8-3*	-40°C to +85°C	RoHS/Lead-Free: No Materials Analysis
MAX604CSA+			SOIC;8 pin; Dwg: 21-0041 (PDF) Use pkgcode/variation: S8+7F*	0°C to +70°C	RoHS/Lead-Free: Lead Free Materials Analysis
MAX604CSA+T			SOIC;8 pin; Dwg: 21-0041 (PDF) Use pkgcode/variation: S8+7F*	0°C to +70°C	RoHS/Lead-Free: Lead Free Materials Analysis
MAX604CSA			SOIC;8 pin; Dwg: 21-0041 (PDF) Use pkgcode/variation: S8-7F*	0°C to +70°C	RoHS/Lead-Free: No Materials Analysis
MAX604CSA-T			SOIC;8 pin; Dwg: 21-0041 (PDF) Use pkgcode/variation: S8-7F*	0°C to +70°C	RoHS/Lead-Free: No Materials Analysis
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5V/3.3V or Adjustable, Low-Dropout, Low I_Q, 500mA Linear Regulators

General Description

The MAX603/MAX604 low-dropout, low quiescent current, linear regulators supply 5V, 3.3V, or an adjustable output for currents up to 500mA. They are available in a 1.8W SO package. Typical dropouts are 320mV at 5V and 500mA, or 240mV at 3.3V and 200mA. Quiescent currents are 15µA typ and 35µA max. Shutdown turns off all circuitry and puts the regulator in a 2µA off mode. A unique protection scheme limits reverse currents when the input voltage falls below the output. Other features include foldback current limiting and thermal overload protection.

The output is preset at 3.3V for the MAX604 and 5V for the MAX603. In addition, both devices employ Dual Mode™ operation, allowing user-adjustable outputs from 1.25V to 11V using external resistors. The input voltage supply range is 2.7V to 11.5V.

The MAX603/MAX604 feature a 500mA P-channel MOSFET pass transistor. This transistor allows the devices to draw less than 35µA over temperature, independent of the output current. The supply current remains low because the P-channel MOSFET pass transistor draws no base currents (unlike the PNP transistors of conventional bipolar linear regulators). Also, when the input-to-output voltage differential becomes small, the internal P-channel MOSFET does not suffer from excessive base current losses that occur with saturated PNP transistors.

Applications

5V and 3.3V Regulators
1.25V to 11V Adjustable Regulators
Battery-Powered Devices
Pagers and Cellular Phones
Portable Instruments
Solar-Powered Instruments

Features

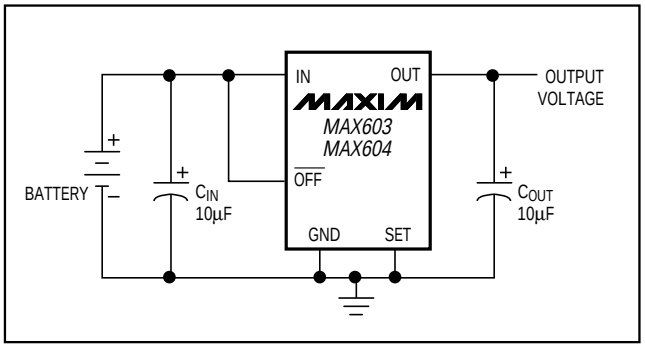
- **500mA Output Current, with Foldback Current Limiting**
- **High-Power (1.8W) 8-Pin SO Package**
- **Dual Mode™ Operation: Fixed or Adjustable Output from 1.25V to 11V**
- **Large Input Range (2.7V to 11.5V)**
- **Internal 500mA P-Channel Pass Transistor**
- **15µA Typical Quiescent Current**
- **2µA (Max) Shutdown Mode**
- **Thermal Overload Protection**
- **Reverse-Current Protection**

Ordering Information

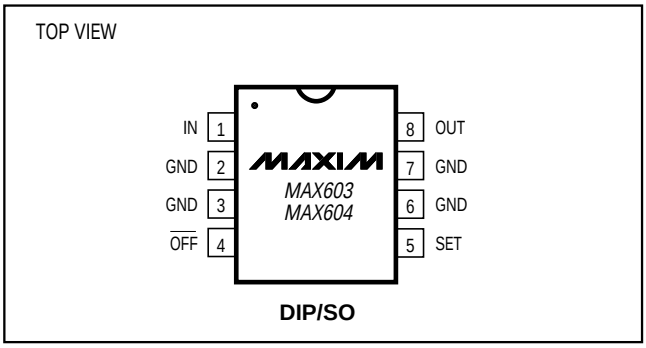
PART	TEMP. RANGE	PIN-PACKAGE
MAX603CPA	0°C to +70°C	8 Plastic DIP
MAX603CSA	0°C to +70°C	8 SO
MAX603C/D	0°C to +70°C	Dice*
MAX603EPA	-40°C to +85°C	8 Plastic DIP
MAX603ESA	-40°C to +85°C	8 SO
MAX603MJA	-55°C to +125°C	8 CERDIP**
MAX604CPA	0°C to +70°C	8 Plastic DIP
MAX604CSA	0°C to +70°C	8 SO
MAX604C/D	0°C to +70°C	Dice*
MAX604EPA	-40°C to +85°C	8 Plastic DIP
MAX604ESA	-40°C to +85°C	8 SO
MAX604MJA	-55°C to +125°C	8 CERDIP**

** Dice are tested at T_A = +25°C, DC parameters only.*
*** Contact factory for availability.*

Typical Operating Circuit



Pin Configuration



™ Dual Mode is a trademark of Maxim Integrated Products.

5V/3.3V or Adjustable, Low-Dropout, Low I_Q, 500mA Linear Regulators

ABSOLUTE MAXIMUM RATINGS

Supply Voltage (IN or OUT to GND).....-0.3V to +12V
Output Short-Circuit Duration .....1 min
Continuous Output Current.....600mA
SET, $\overline{OFF}$ Input Voltages .....-0.3V to the greater of (IN + 0.3V) or (OUT + 0.3V)
Continuous Power Dissipation (T_A = +70°C)
Plastic DIP (derate 9.09mW/°C above +70°C) 727mW
SO (derate 23.6mW/°C above +70°C).....1.8W
CERDIP (derate 8.00mW/°C above +70°C).....640mW

Operating Temperature Ranges
MAX60_C_A.....0°C to +70°C
MAX60_E_A.....-40°C to +85°C
MAX60_MJA .....-55°C to +125°C
Junction Temperature.....+150°C
Storage Temperature Range .....-65°C to +160°C
Lead Temperature (soldering, 10sec) .....+300°C

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

(V_{IN} = 6V (MAX603) or 4.3V (MAX604), C_{IN} = C_{OUT} = 10µF, $\overline{OFF}$ = V_{IN}, SET = GND, T_J = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_J = +25°C.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Input Voltage	V_{IN}	SET = OUT, R_L = 1kΩ	MAX60_C	2.7		11.5	V
			MAX60_E	2.9		11.5	
			MAX60_M	3.0		11.5	
Output Voltage (Note 2)	V_{OUT}	I_{OUT} = 20µA to 500mA, 6.0V < V_{IN} < 11.5V	MAX603	4.75	5.00	5.25	V
		I_{OUT} = 20µA to 300mA, 4.3V < V_{IN} < 11.5V	MAX604	3.15	3.30	3.45	
Load Regulation	ΔV_{LDR}	I_{OUT} = 1mA to 500mA	MAX603C/E		60	100	mV
			MAX603M			150	
		I_{OUT} = 1mA to 300mA	MAX604		30	100	
Line Regulation	ΔV_{LNR}	(V_{OUT} + 0.5V) ≤ V_{IN} ≤ 11.5V, I_{OUT} = 25mA			7	40	mV
Dropout Voltage (Note 3)	ΔV_{DO}	I_{OUT} = 200mA	MAX603		130	220	mV
		I_{OUT} = 500mA			320	550	
		I_{OUT} = 200mA	MAX604		240	410	
		I_{OUT} = 400mA			480	820	
Quiescent Current	I_Q	3.0V ≤ V_{IN} ≤ 11.5V, SET = OUT	MAX60_C/E		15	35	µA
			MAX60_M			40	
OFF Quiescent Current	$I_{Q\ OFF}$	$\overline{OFF}$ ≤ 0.4V, R_L = 1kΩ, (V_{OUT} + 1V) ≤ V_{IN} ≤ 11.5V	MAX60_C		0.01	2	µA
			MAX60_E			10	
			MAX60_M			20	
Minimum Load Current	$I_{OUT\ MIN}$	V_{IN} = 11.5V, SET = OUT	MAX60_C			2	µA
			MAX60_E			6	
			MAX60_M			20	
Foldback Current Limit (Note 4)	I_{LIM}	V_{OUT} < 0.8V			350		mA
		V_{OUT} > 0.8V and V_{IN} - V_{OUT} > 0.7V			1200		
Thermal Shutdown Temperature	T_{SD}				160		°C
Thermal Shutdown Hysteresis	ΔT_{SD}				10		°C

ELECTRICAL CHARACTERISTICS (continued)

(V_{IN} = 6V (MAX603) or 4.3V (MAX604), C_{IN} = C_{OUT} = 10µF, $\overline{OFF}$ = V_{IN}, SET = GND, T_J = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_J = +25°C.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Reverse-Current Protection Threshold (Note 5)	ΔV_{RTH}	V_{OUT} = 4.5V	MAX603		6	20	mV
		V_{OUT} = 3.0V	MAX604		6	20	
Reverse Leakage Current	I_{RVL}	V_{IN} = 0V, V_{OUT} = 4.5V (MAX603) V_{OUT} = 3.0V (MAX604)	MAX60_C		0.01	10	µA
			MAX60_E			20	
			MAX60_M			100	
Start-Up Overshoot	V_{OSH}	R_L = 1kΩ, C_{OUT} = 10µF, $\overline{OFF}$ rise time ≤ 1µs			2		$\%V_{OUT}$
Time Required to Exit Shutdown	t_{START}	V_{IN} = 9V, R_L = 18Ω, $V_{\overline{OFF}}$ switched from 0V to V_{IN}, time from 0% to 95% of V_{OUT}			200		µs
Dual-Mode SET Threshold	$V_{SET\ TH}$	For internal feedback			80	30	mV
		For external feedback		150	80		
SET Reference Voltage	V_{SET}	SET = OUT, R_L = 1kΩ		1.16	1.20	1.24	V
SET Input Leakage Current	I_{SET}	V_{SET} = 1.5V or 0V			±0.01	±10	nA
OUT Leakage Current	$I_{OUT\ LKG}$	V_{IN} = 11.5V, V_{OUT} = 2V, SET = OUT	MAX60_C		0.01	2	µA
			MAX60_E			6	
			MAX60_M			20	
$\overline{OFF}$ Threshold Voltage	$V_{IL\ \overline{OFF}}$	Off				0.4	V
	$V_{IH\ \overline{OFF}}$	On, SET = OUT, V_{IN} = 4V		2.0			
		On, SET = OUT, V_{IN} = 6V		3.0			
		On, SET = OUT, V_{IN} = 11.5V		4.0			
$\overline{OFF}$ Input Leakage Current	$I_{\overline{OFF}}$	$V_{\overline{OFF}}$ = V_{IN} or GND			±0.01	±10	nA
Output Noise (Note 6)	e_n	10Hz to 10kHz, SET = OUT, R_L = 1kΩ, C_{OUT} = 10µF			250		μV_{RMS}

Note 1: Electrical specifications are measured by pulse testing and are guaranteed for a junction temperature (T_J) equal to the operating temperature range. C and E grade parts may be operated up to a T_J of +125°. Expect performance similar to M grade specifications. For T_J between +125°C and +150°C, the output voltage may drift more.

Note 2: (V_{IN} - V_{OUT}) is limited to keep the product (I_{OUT} x (V_{IN} - V_{OUT})) from exceeding the package power dissipation limits.

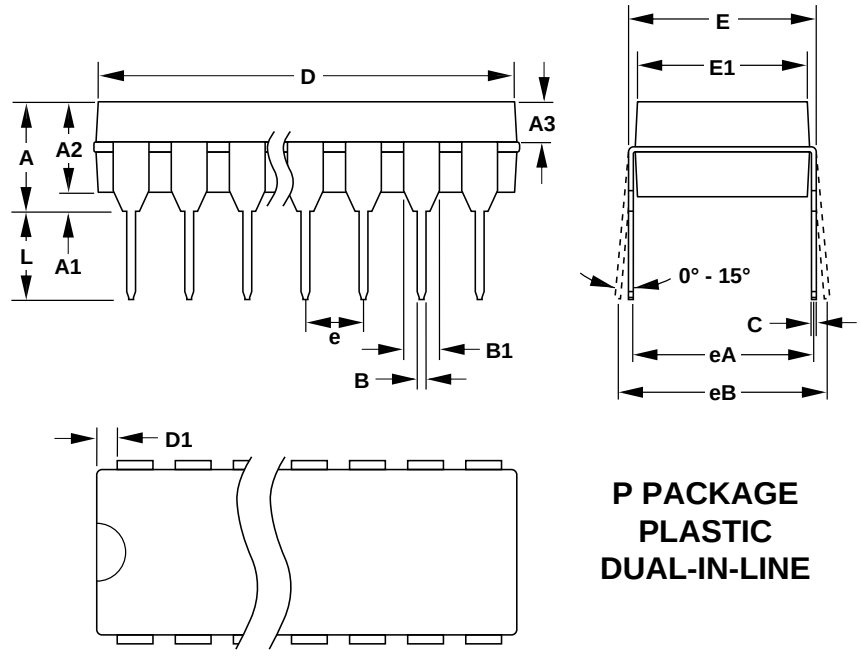
Note 3: Dropout Voltage is (V_{IN} - V_{OUT}) when V_{OUT} falls to 100mV below its nominal value at V_{IN} = V_{OUT} + 2V. For example, the MAX603 is tested by measuring the V_{OUT} at V_{IN} = 7V, then V_{IN} is lowered until V_{OUT} falls 100mV below the measured value. The difference (V_{IN} - V_{OUT}) is then measured and defined as ΔV_{DO}.

Note 4: Foldback Current Limit was characterized by pulse testing to remain below the maximum junction temperature.

Note 5: The Reverse-Current Protection Threshold is the output/input differential voltage (V_{OUT} - V_{IN}) at which reverse-current protection switchover occurs and the pass transistor is turned off.

Note 6: Noise is tested using a bandpass amplifier with two poles at 10Hz and two poles at 10kHz.

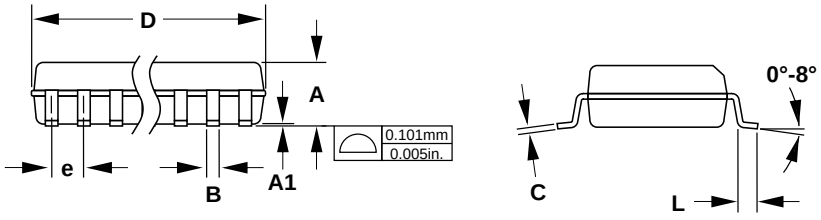
Package Information



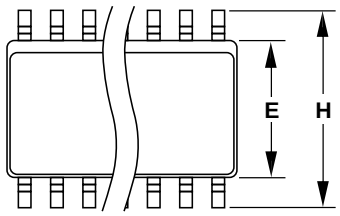
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	–	0.200	–	5.08
A1	0.015	–	0.38	–
A2	0.125	0.175	3.18	4.45
A3	0.055	0.080	1.40	2.03
B	0.016	0.022	0.41	0.56
B1	0.045	0.065	1.14	1.65
C	0.008	0.012	0.20	0.30
D1	0.005	0.080	0.13	2.03
E	0.300	0.325	7.62	8.26
E1	0.240	0.310	6.10	7.87
e	0.100	–	2.54	–
eA	0.300	–	7.62	–
eB	–	0.400	–	10.16
L	0.115	0.150	2.92	3.81

P PACKAGE
PLASTIC
DUAL-IN-LINE

DIM	PINS	INCHES		MILLIMETERS	
		MIN	MAX	MIN	MAX
D	8	0.348	0.390	8.84	9.91
D	14	0.735	0.765	18.67	19.43
D	16	0.745	0.765	18.92	19.43
D	18	0.885	0.915	22.48	23.24
D	20	1.015	1.045	25.78	26.54
D	24	1.14	1.265	28.96	32.13



DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.053	0.069	1.35	1.75
A1	0.004	0.010	0.10	0.25
B	0.014	0.019	0.35	0.49
C	0.007	0.010	0.19	0.25
E	0.150	0.157	3.80	4.00
e	0.050		1.27	
H	0.228	0.244	5.80	6.20
L	0.016	0.050	0.40	1.27



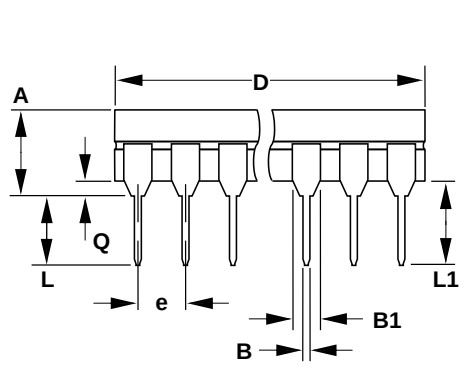
S PACKAGE
SMALL
OUTLINE

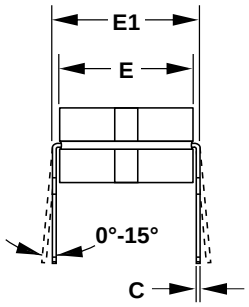
DIM	PINS	INCHES		MILLIMETERS	
		MIN	MAX	MIN	MAX
D	8	0.189	0.197	4.80	5.00
D	14	0.337	0.344	8.55	8.75
D	16	0.386	0.394	9.80	10.00

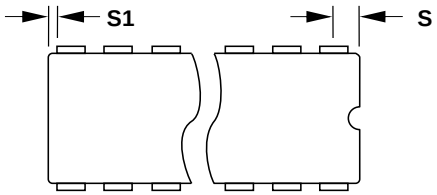
21-0041A

5V/3.3V or Adjustable, Low-Dropout, Low I_Q, 500mA Linear Regulators

Package Information (continued)







J PACKAGE
(0.300 in.)
CERDIP
DUAL-IN-LINE

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	–	0.200	–	5.08
B	0.014	0.023	0.36	0.58
B1	0.038	0.065	0.97	1.65
C	0.008	0.015	0.20	0.38
E	0.220	0.310	5.59	7.87
E1	0.290	0.320	7.37	8.13
e	0.100		2.54	
L	0.125	0.200	3.18	5.08
L1	0.150	–	3.81	–
Q	0.015	0.070	0.38	1.78
S	–	0.098	–	2.49
S1	0.005	–	0.13	–

DIM	PINS	INCHES		MILLIMETERS	
		MIN	MAX	MIN	MAX
D	8	–	0.405	–	10.29
D	14	–	0.785	–	19.94
D	16	–	0.840	–	21.34
D	18	–	0.960	–	24.38
D	20	–	1.060	–	26.92
D	24	–	1.280	–	32.51