LT1634

Micropower Precision Shunt Voltage Reference

FEATURES

- **Initial Voltage Accuracy: 0.05%**
- **Low Operating Current: 10µA**
- **Low Drift: 10ppm/°C Max**
- Less Than 1Ω Dynamic Impedance
- Available in 1.25V, 2.5V, 4.096V and 5V in SO-8 and TO-92 Packages
- 1.25V and 2.5V Available in MSOP Package
- Both Commercial and Industrial Temperature Range Parts Are Available

APPLICATIONS

- Portable Meters
- Precision Regulators
- A/D and D/A Converters
- Calibrators

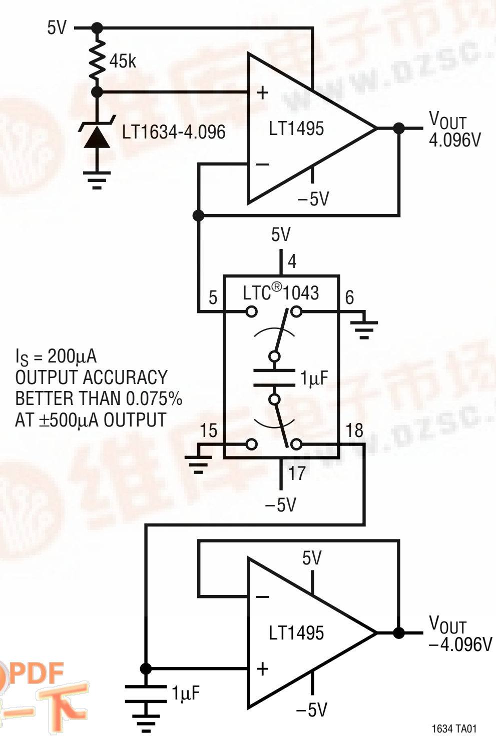
DESCRIPTION

The LT®1634 is a micropower, precision, shunt voltage reference. The bandgap reference uses trimmed precision thin film resistors to achieve 0.05% initial voltage accuracy. Improved curvature correction technique guarantees 10ppm/°C maximum temperature drift. Advances in design, processing and packaging techniques guarantee 10µA operation and low temperature cycling hysteresis. The LT1634 does not require an output compensation capacitor, but is stable with capacitive loads. Low dynamic impedance makes the LT1634 reference easy to use from unregulated supplies.

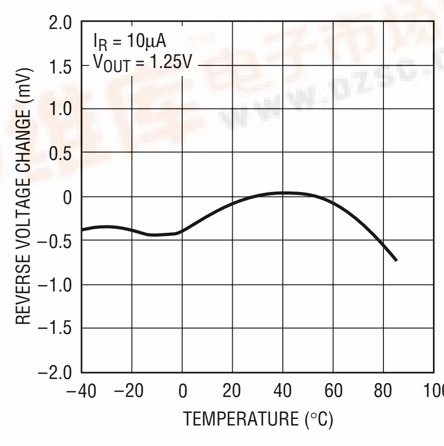
The LT1634 reference can be used as a high performance upgrade to the LM185/LM385, LT1004 and LT1034 where lower power and guaranteed temperature drift is required.

TYPICAL APPLICATION

Super Accurate ±4.096V Output References



Temperature Drift



ABSOLUTE MAXIMUM RATINGS

(Note 1)

Operating Current
- 1.25V 100mA
- 2.5V 50mA
- 4.096V, 5V 30mA

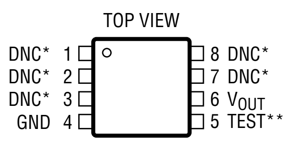
Forward Current 20mA

Operating Temperature Range
- Commercial .... 0°C to 70°C
- Industrial .... −40°C to 85°C

Storage Temperature Range (Note 1) ... −65°C to 150°C

Lead Temperature (Soldering, 10 sec) .... 300°C

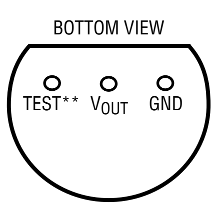
PACKAGE/ORDER INFORMATION



MS8 PACKAGE
8-LEAD PLASTIC MSOP

T_{JMAX} = 125°C, θ_{JA} = 250°C/W

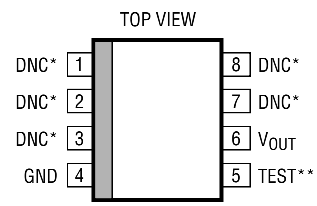
ORDER PART NUMBER	MS8 PART MARKING
LT1634BCMS8-1.25	LTCV
LT1634BCMS8-2.5	LTDF



Z PACKAGE
3-LEAD PLASTIC TO-92

T_{JMAX} = 125°C, θ_{JA} = 190°C/W

ORDER PART NUMBER
LT1634CCZ-1.25
LT1634CCZ-2.5
LT1634CCZ-4.096
LT1634CCZ-5



S8 PACKAGE
8-LEAD PLASTIC SO

T_{JMAX} = 125°C, θ_{JA} = 190°C/W

ORDER PART NUMBER	S8 PART MARKING
LT1634ACS8-1.25	1634A1
LT1634ACS8-2.5	1634A2
LT1634ACS8-4.096	1634A4
LT1634ACS8-5	1634A5
LT1634AIS8-1.25	634AI1
LT1634AIS8-2.5	634AI2
LT1634AIS8-4.096	634AI4
LT1634AIS8-5	634AI5
LT1634BCS8-1.25	1634B1
LT1634BCS8-2.5	1634B2
LT1634BCS8-4.096	1634B4
LT1634BCS8-5	1634B5
LT1634BIS8-1.25	634BI1
LT1634BIS8-2.5	634BI2
LT1634BIS8-4.096	634BI4
LT1634BIS8-5	634BI5

*Connected internally. Do Not Connect external circuitry to these pins.
**Connect to ground in user application.
Consult LTC Marketing for parts specified with wider operating temperature ranges.

AVAILABLE OPTIONS

TEMPERATURE	ACCURACY (%)	TEMPERATURE COEFFICIENT (ppm/°C)	PACKAGE TYPE		
			MS8	S8	Z
0°C to 70°C	0.05	10		LT1634ACS8-1.25 LT1634ACS8-2.5 LT1634ACS8-4.096 LT1634ACS8-5	
−40°C to 85°C	0.05	10		LT1634AIS8-1.25 LT1634AIS8-2.5 LT1634AIS8-4.096 LT1634AIS8-5	
0°C to 70°C	0.05	25	LT1634BCMS8-1.25 LT1634BCMS8-2.5	LT1634BCS8-1.25 LT1634BCS8-2.5 LT1634BCS8-4.096 LT1634BCS8-5	
−40°C to 85°C	0.05	25		LT1634BIS8-1.25 LT1634BIS8-2.5 LT1634BIS8-4.096 LT1634BIS8-5	
0°C to 70°C	0.20	25			LT1634CCZ-1.25 LT1634CCZ-2.5 LT1634CCZ-4.096 LT1634CCZ-5

1.25V ELECTRICAL CHARACTERISTICS

The ● denotes specifications which apply over the full operating temperature range, otherwise specifications are at T_A = 25°C. (Note 3)

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
Reverse Breakdown Voltage	LT1634ACS8/LT1634BCMS8/LT1634BCS8/ LT1634AIS8/LT1634BIS8 (I_R = 10µA)		1.24937 −0.05	1.250	1.25062 0.05	V %
	LT1634CCZ (I_R = 10µA)		1.24750 −0.20	1.250	1.25250 0.20	V %
	LT1634ACS8 (I_R = 10µA)	●	1.24849 −0.12	1.250	1.25149 0.12	V %
	LT1634AIS8 (I_R = 10µA)	●	1.24781 −0.175	1.250	1.25218 0.175	V %
	LT1634BCS8/LT1634BCMS8 (I_R = 10µA)	●	1.24718 −0.225	1.250	1.25281 0.225	V %
	LT1634BIS8 (I_R = 10µA)	●	1.24547 −0.362	1.250	1.25453 0.362	V %
	LT1634CCZ (I_R = 10µA)	●	1.24531 −0.375	1.250	1.25469 0.375	V %
Reverse Breakdown Change with Current (Note 4)	10µA ≤ I_R ≤ 2mA	 ●		0.25 0.30	1 2	mV mV
	2mA ≤ I_R ≤ 20mA	 ●		2 2	8 10	mV mV
Minimum Operating Current		●			7	µA
Temperature Coefficient (Note 8)	LT1634A, I_R = 10µA LT1634B/LT1634C, I_R = 10µA	● ●		4 10	10 25	ppm/°C ppm/°C
Reverse Dynamic Impedance (Note 5)	10µA ≤ I_R ≤ 2mA	 ●		0.125 0.150	0.5 1.0	Ω Ω
Low Frequency Noise (Note 6)	I_R = 10µA, 0.1Hz ≤ f ≤ 10Hz			10		$µV_{P-P}$
Hysteresis (Note 7)	ΔT = −40°C to 85°C ΔT = 0°C to 70°C			160 40		ppm ppm

2.5V ELECTRICAL CHARACTERISTICS

The ● denotes specifications which apply over the full operating temperature range, otherwise specifications are at T_A = 25°C. (Note 3)

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
Reverse Breakdown Voltage	LT1634ACS8/LT1634BCMS8/LT1634BCS8/ LT1634AIS8/LT1634BIS8 (I_R = 10µA)		2.49875 –0.05	2.500	2.50125 0.05	V %
	LT1634CCZ (I_R = 10µA)		2.49500 –0.20	2.500	2.50500 0.20	V %
	LT1634ACS8 (I_R = 10µA)	●	2.49700 –0.12	2.500	2.50300 0.12	V %
	LT1634AIS8 (I_R = 10µA)	●	2.49562 –0.175	2.500	2.50437 0.175	V %
	LT1634BCMS8/LT1634BCS8 (I_R = 10µA)	●	2.49437 –0.225	2.500	2.50562 0.225	V %
	LT1634BIS8 (I_R = 10µA)	●	2.49094 –0.362	2.500	2.50906 0.362	V %
	LT1634CCZ (I_R = 10µA)	●	2.49062 –0.375	2.500	2.50937 0.375	V %
Reverse Breakdown Change with Current (Note 4)	10µA ≤ I_R ≤ 2mA	 ●		0.30 0.40	1.5 3.0	mV mV
	2mA ≤ I_R ≤ 20mA	 ●		2 2	8 10	mV mV
Minimum Operating Current		●			8	µA
Temperature Coefficient (Note 8)	LT1634A, I_R = 10µA LT1634B/LT1634C, I_R = 10µA	● ●		4 10	10 25	ppm/°C ppm/°C
Reverse Dynamic Impedance (Note 5)	10µA ≤ I_R ≤ 2mA	 ●		0.15 0.20	0.75 1.50	Ω Ω
Low Frequency Noise (Note 6)	I_R = 10µA, 0.1Hz ≤ f ≤ 10Hz			15		μV_{P-P}
Hysteresis (Note 7)	ΔT = –40°C to 85°C ΔT = 0°C to 70°C			160 40		ppm ppm

4.096V ELECTRICAL CHARACTERISTICS

The ● denotes specifications which apply over the full operating temperature range, otherwise specifications are at T_A = 25°C. (Note 3)

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
Reverse Breakdown Voltage	LT1634ACS8/LT1634BCS8/ LT1634AIS8/LT1634BIS8 (I_R = 20µA)		4.09395 –0.05	4.096	4.09805 0.05	V %
	LT1634CCZ (I_R = 20µA)		4.08780 –0.20	4.096	4.10419 0.20	V %
	LT1634ACS8 (I_R = 20µA)	●	4.09108 –0.12	4.096	4.10091 0.12	V %
	LT1634AIS8 (I_R = 20µA)	●	4.08883 –0.175	4.096	4.10317 0.175	V %
	LT1634BCS8 (I_R = 20µA)	●	4.08678 –0.225	4.096	4.10522 0.225	V %
	LT1634BIS8 (I_R = 20µA)	●	4.08115 –0.362	4.096	4.11085 0.362	V %
	LT1634CCZ (I_R = 20µA)	●	4.08064 –0.375	4.096	4.11137 0.375	V %
Reverse Breakdown Change with Current (Note 4)	20µA ≤ I_R ≤ 2mA	 ●		0.3 0.4	1.5 3.0	mV mV
	2mA ≤ I_R ≤ 20mA	 ●		6 6	15 20	mV mV
Minimum Operating Current		●			15	µA

4.096V ELECTRICAL CHARACTERISTICS

The ● denotes specifications which apply over the full operating temperature range, otherwise specifications are at $T_A = 25°C$. (Note 3)

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
Temperature Coefficient (Note 8)	LT1634A, I_R = 20µA LT1634B/LT1634C, I_R = 20µA	● ●		4 10	10 25	ppm/°C ppm/°C
Reverse Dynamic Impedance (Note 5)	20µA ≤ I_R ≤ 2mA	 ●		0.15 0.20	0.75 1.50	Ω Ω
Low Frequency Noise (Note 6)	I_R = 20µA, 0.1Hz ≤ f ≤ 10Hz			30		$µV_{P-P}$
Hysteresis (Note 7)	ΔT = –40°C to 85°C ΔT = 0°C to 70°C			160 40		ppm ppm

5V ELECTRICAL CHARACTERISTICS

The ● denotes specifications which apply over the full operating temperature range, otherwise specifications are at $T_A = 25°C$. (Note 3)

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
Reverse Breakdown Voltage	LT1634ACS8/LT1634BCS8/ LT1634AIS8/LT1634BIS8 (I_R = 20µA)		4.99750 –0.05	5.000	5.00250 0.05	V %
	LT1634CCZ (I_R = 20µA)		4.99000 –0.20	5.000	5.01000 0.20	V %
	LT1634ACS8 (I_R = 20µA)	●	4.99400 –0.12	5.000	5.00600 0.12	V %
	LT1634AIS8 (I_R = 20µA)	●	4.99125 –0.175	5.000	5.00875 0.175	V %
	LT1634BCS8 (I_R = 20µA)	●	4.98875 –0.225	5.000	5.01125 0.225	V %
	LT1634BIS8 (I_R = 20µA)	●	498188 –0.362	5.000	5.01813 0.362	V %
	LT1634CCZ (I_R = 20µA)	●	4.98126 –0.375	5.000	5.01876 0.375	V %
Reverse Breakdown Change with Current (Note 4)	20µA ≤ I_R ≤ 2mA	 ●		0.3 0.4	1.5 3.0	mV mV
	2mA ≤ I_R ≤ 20mA	 ●		6 6	15 20	mV mV
Minimum Operating Current		●			15	µA
Temperature Coefficient (Note 8)	LT1634A, I_R = 20µA LT1634B/LT1634C, I_R = 20µA	● ●		4 10	10 25	ppm/°C ppm/°C
Reverse Dynamic Impedance (Note 5)	20µA ≤ I_R ≤ 2mA	 ●		0.15 0.20	0.75 1.50	Ω Ω
Low Frequency Noise (Note 6)	I_R = 20µA, 0.1Hz ≤ f ≤ 10Hz			35		$µV_{P-P}$
Hysteresis (Note 7)	ΔT = –40°C to 85°C ΔT = 0°C to 70°C			160 40		ppm ppm

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

Note 2: If the part is stored outside of the specific operating temperature range, the output may shift due to hysteresis.

Note 3: ESD (Electrostatic Discharge) sensitive device. Use proper ESD handling precautions.

Note 4: Output requires 0.1µF for operating current greater than 1mA.

Note 5: This parameter is guaranteed by "reverse breakdown change with current" test.

Note 6: Peak-to-peak noise is measured with a single highpass filter at 0.1Hz and 2-pole lowpass filter at 10Hz.

Note 7: Hysteresis in output voltage is created by package stress that differs depending on whether the IC was previously at a higher or lower temperature. Output voltage is always measured at 25°C but the IC is cycled to 85°C or –40°C before successive measurements. Hysteresis is roughly proportional to the square of the temperature change. Hysteresis is not normally a problem for operational temperature excursions where the instrument might be stored at high or low temperature.

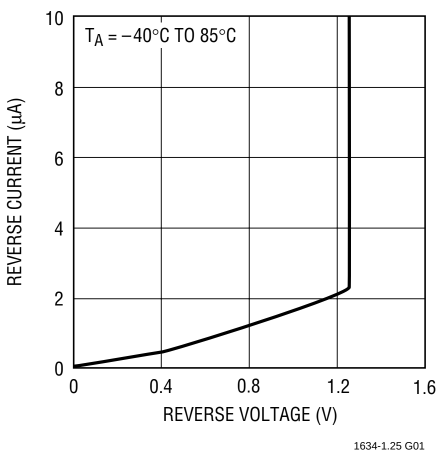
Note 8: Temperature coefficient is calculated from the minimum and maximum output voltage measured at T_{MIN}, Room and T_{MAX} as follows:

$$TC = (V_{OMAX} - V_{OMIN})/(T_{MAX} - T_{MIN})$$

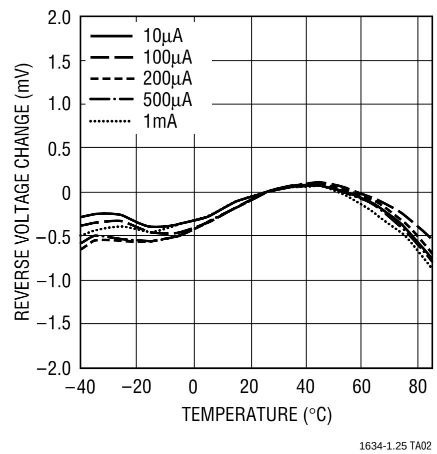
Incremental slope is also measured at 25°C.

1.25V TYPICAL PERFORMANCE CHARACTERISTICS

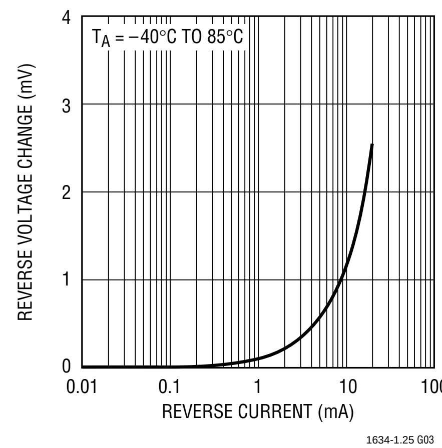
Reverse Characteristics



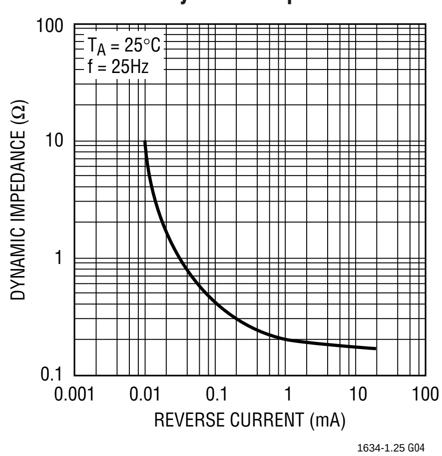
Temperature Drift



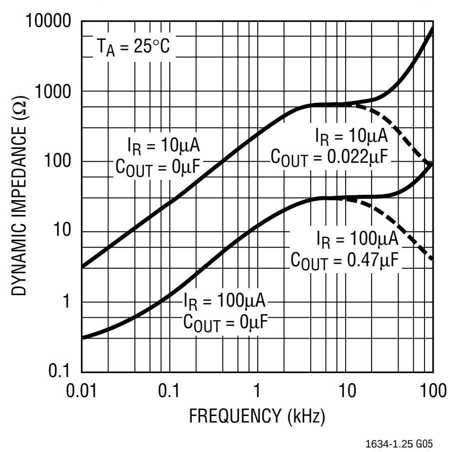
Reverse Voltage Change vs Current



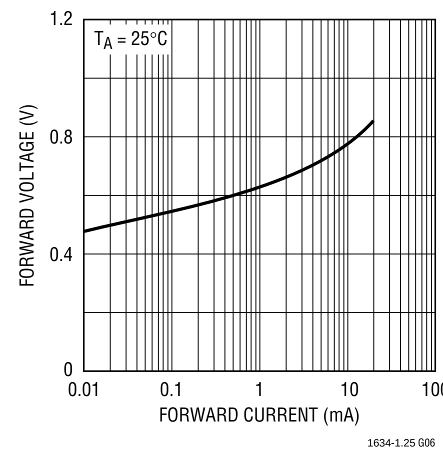
Reverse Dynamic Impedance



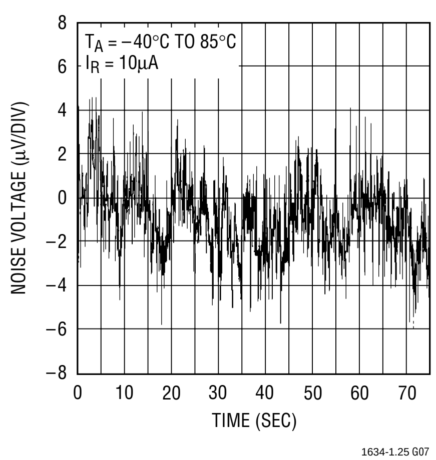
Dynamic Impedance vs Frequency



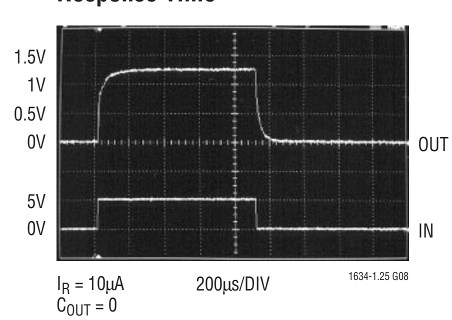
Forward Characteristics



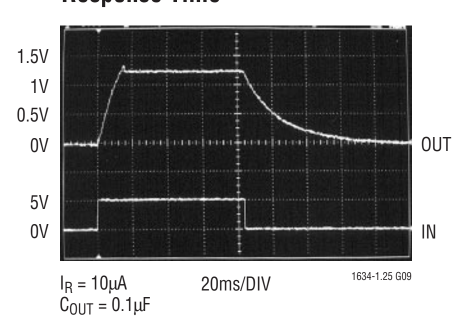
0.1Hz to 10Hz Noise



Response Time

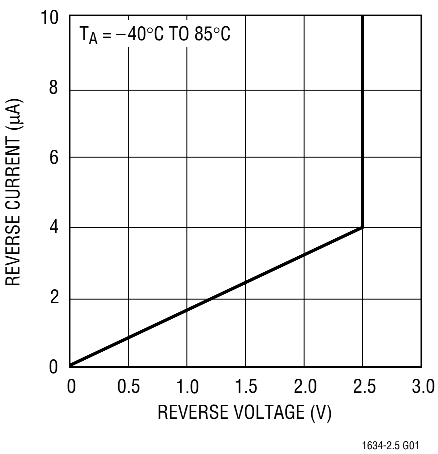


Response Time

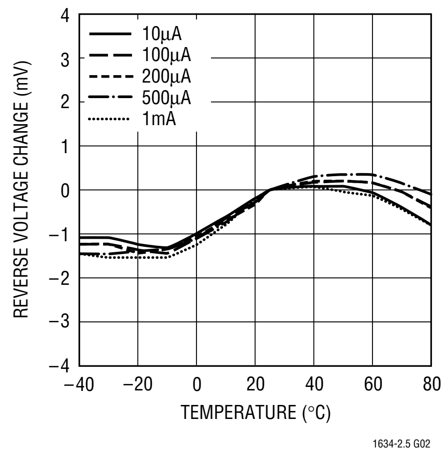


2.5V TYPICAL PERFORMANCE CHARACTERISTICS

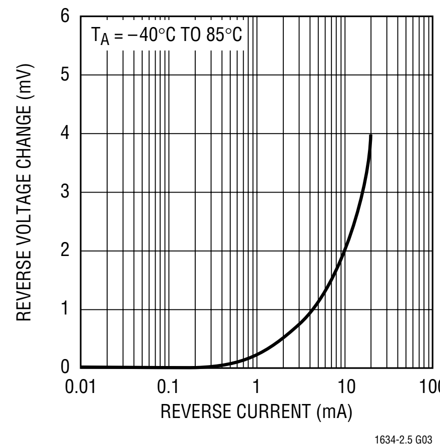
Reverse Characteristics



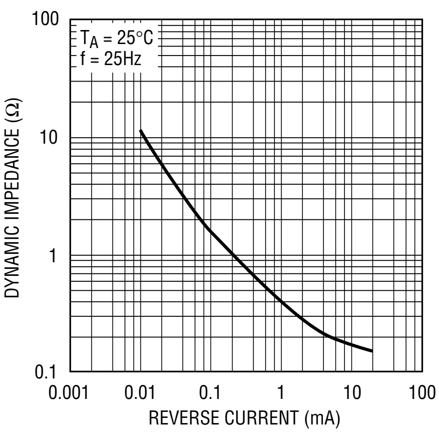
Temperature Drift



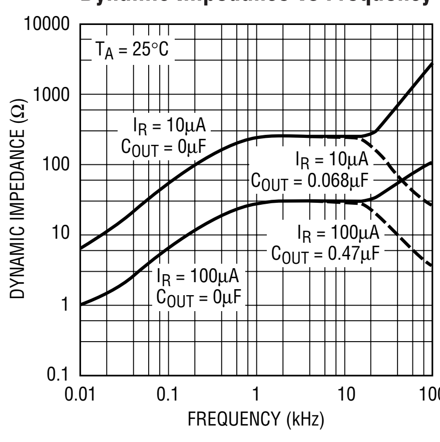
Reverse Voltage Change vs Current



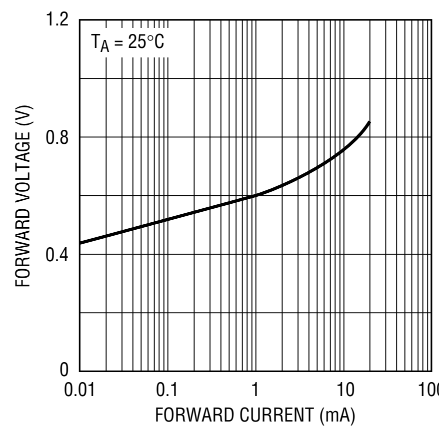
Reverse Dynamic Impedance



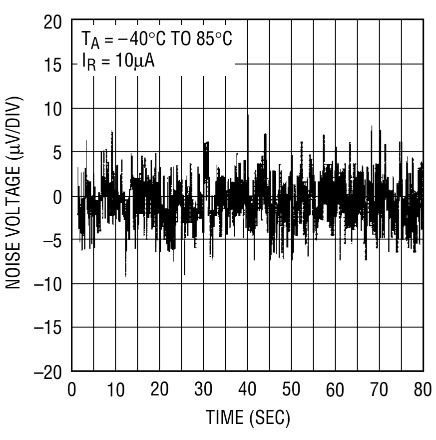
Dynamic Impedance vs Frequency



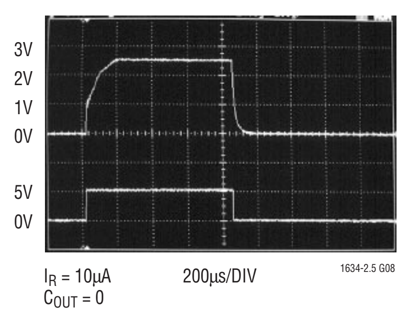
Forward Characteristics



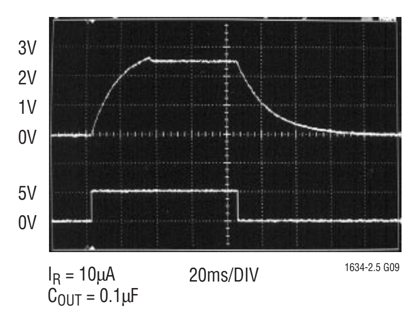
0.1Hz to 10Hz Noise



Response Time

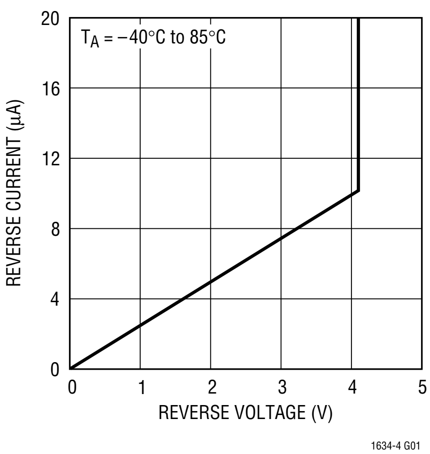


Response Time

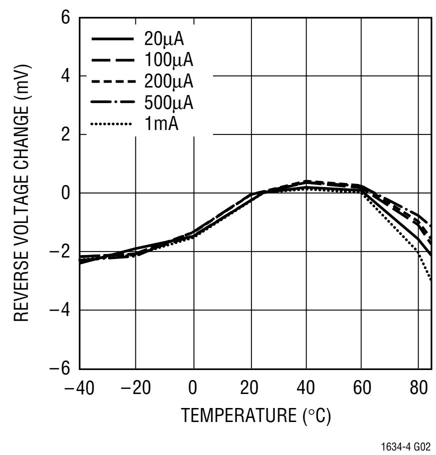


4.096V TYPICAL PERFORMANCE CHARACTERISTICS

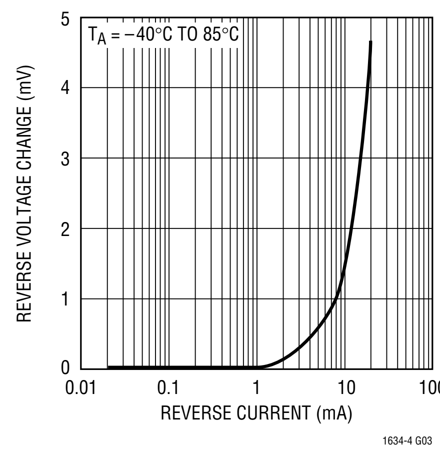
Reverse Characteristics



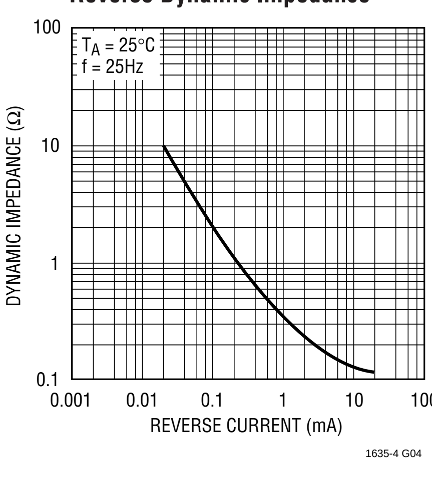
Temperature Drift



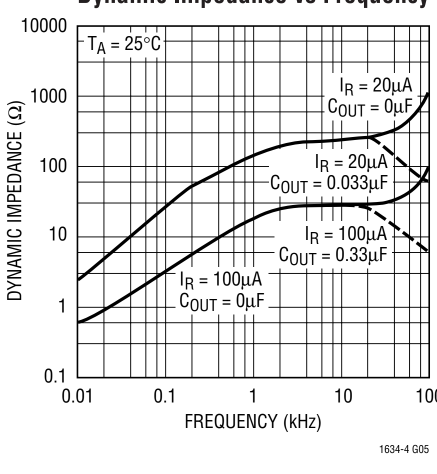
Reverse Voltage Change vs Current



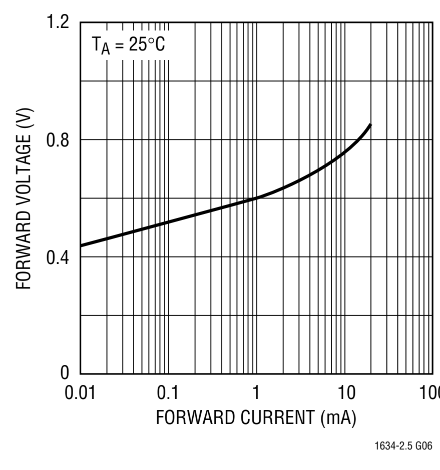
Reverse Dynamic Impedance



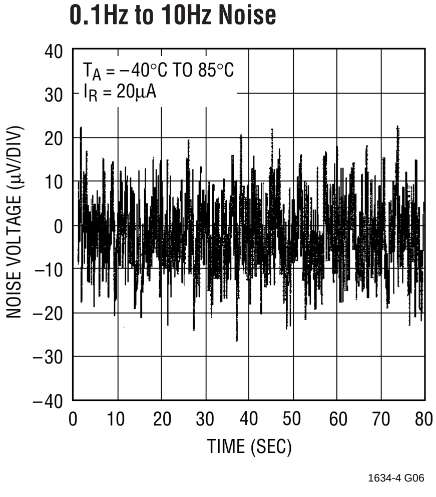
Dynamic Impedance vs Frequency



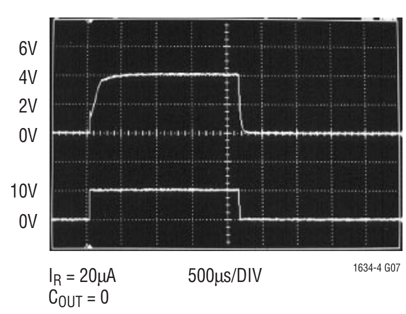
Forward Characteristics



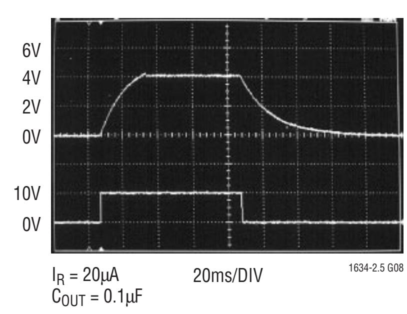
0.1Hz to 10Hz Noise



Response Time

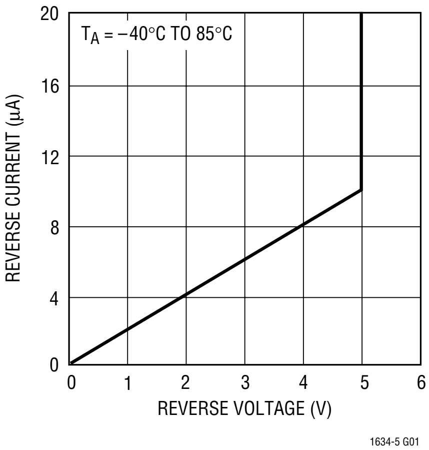


Response Time

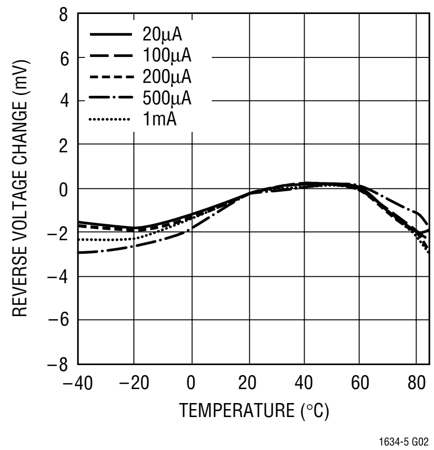


5V TYPICAL PERFORMANCE CHARACTERISTICS

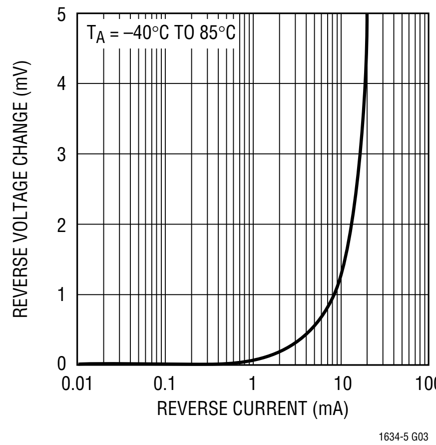
Reverse Characteristics



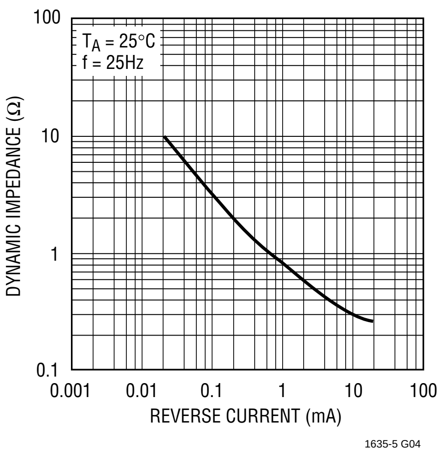
Temperature Drift



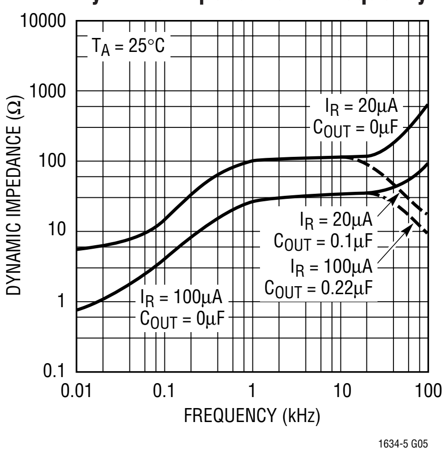
Reverse Voltage Change vs Current



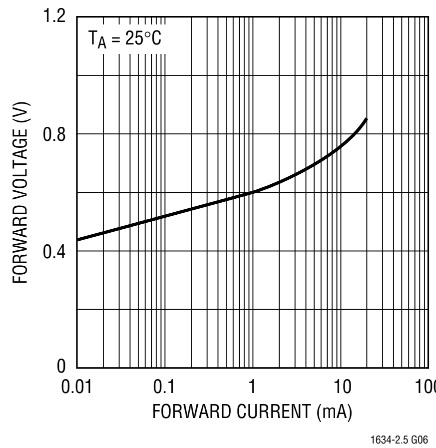
Reverse Dynamic Impedance



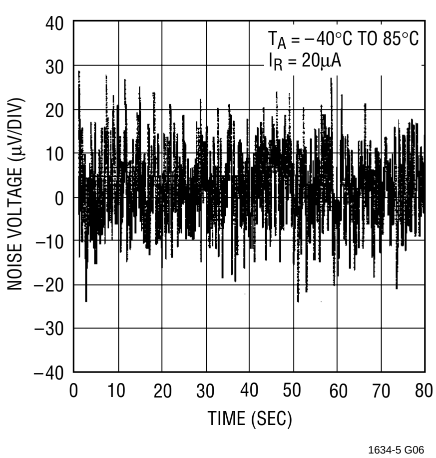
Dynamic Impedance vs Frequency



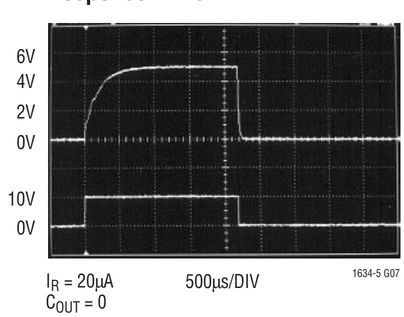
Forward Characteristics



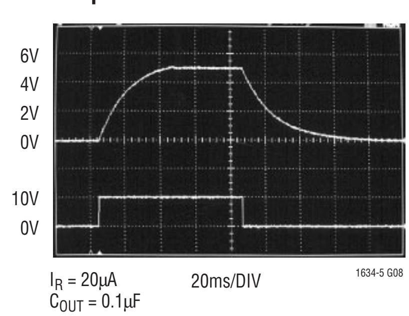
0.1Hz to 10Hz Noise



Response Time



Response Time



APPLICATIONS INFORMATION

The reverse characteristics of the LT1634 behave like a resistor in parallel with a Zener diode. This simple, well behaved characteristic is important to the proper operation of circuits like Figure 1. The adjustable output voltage reference depends upon positive feedback from the LT1495's output to start-up and regulate the bias current for the LT1634.

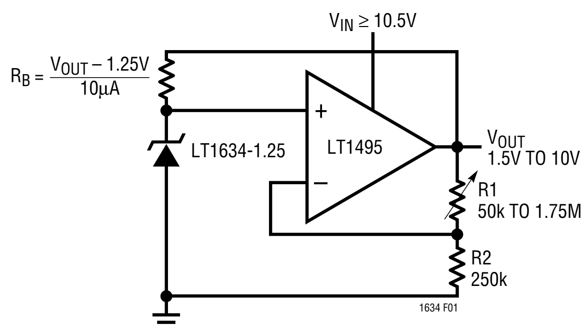
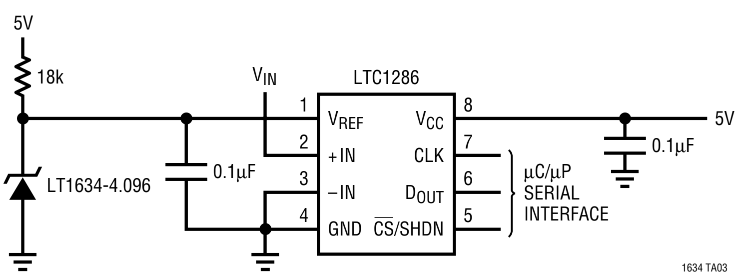


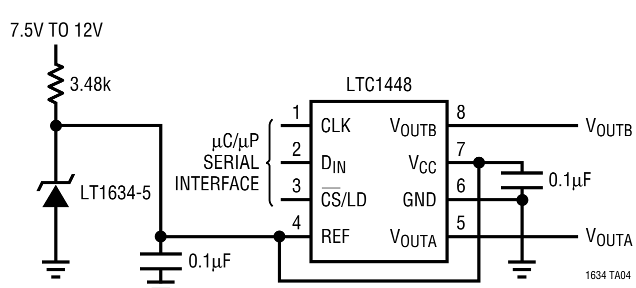
Figure 1. Adjustable Output Voltage Reference

TYPICAL APPLICATIONS

Reference for Micropower A/D Converter

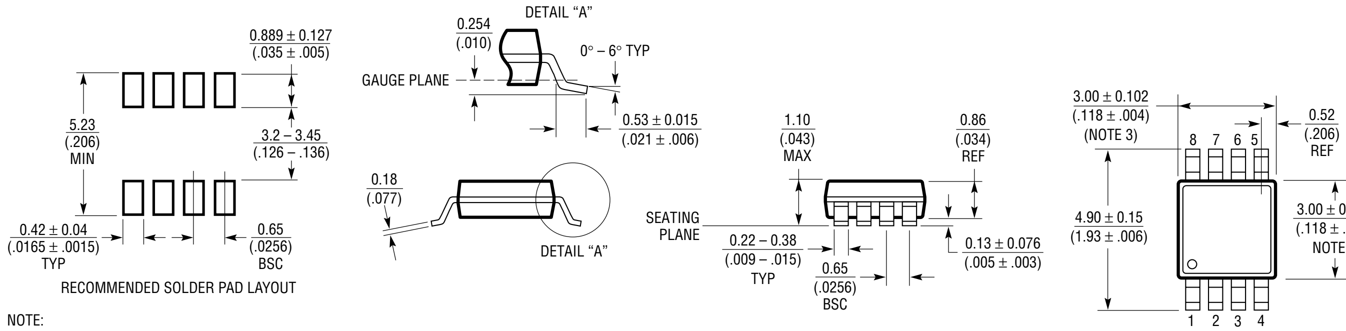


The LT1634-5 Generates the LTC1448 Dual 12-Bit DAC's Reference and Supply Voltage



PACKAGE DESCRIPTION

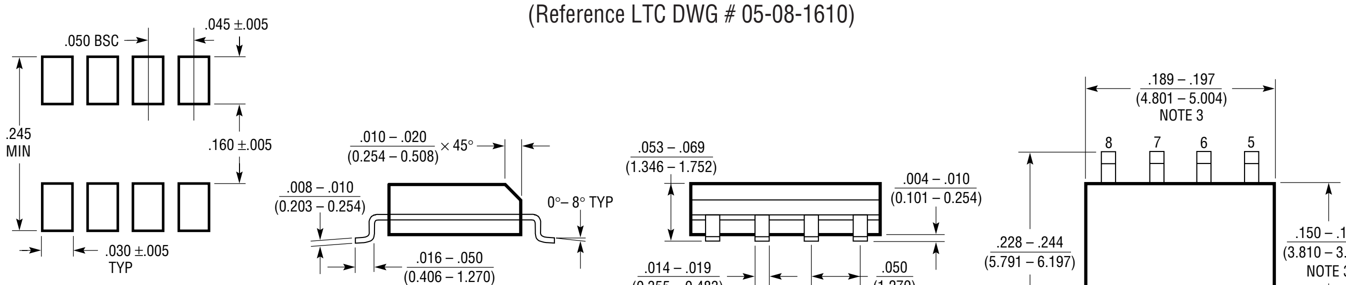
MS8 Package
8-Lead Plastic MSOP
(Reference LTC DWG # 05-08-1660)



NOTE:
1. DIMENSIONS IN MILLIMETER/(INCH)
2. DRAWING NOT TO SCALE
3. DIMENSION DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH, PROTRUSIONS OR GATE BURRS SHALL NOT EXCEED 0.152mm (.006") PER SIDE
4. DIMENSION DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSIONS. INTERLEAD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.152mm (.006") PER SIDE
5. LEAD COPLANARITY (BOTTOM OF LEADS AFTER FORMING) SHALL BE 0.102mm (.004") MAX

MSOP (MS8) 0802

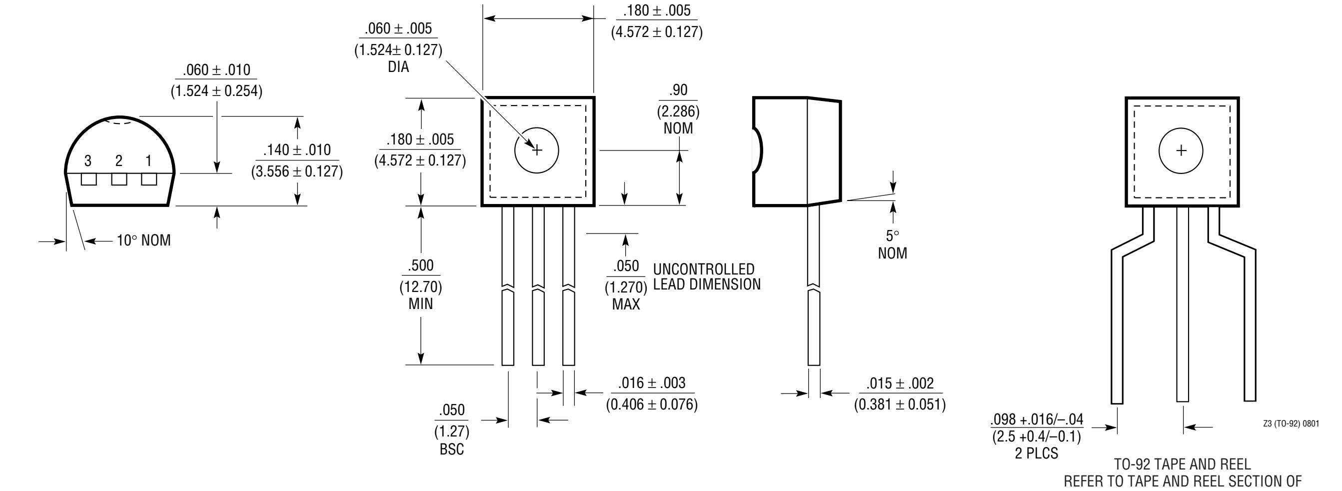
S8 Package
8-Lead Plastic Small Outline (Narrow 0.150 Inch)
(Reference LTC DWG # 05-08-1610)



NOTE:
1. DIMENSIONS IN INCHES / (MILLIMETERS)
2. DRAWING NOT TO SCALE
3. THESE DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS. MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED .006" (0.15mm)

S08 0303

Z Package
3-Lead Plastic TO-92 (Similar to TO-226)
(Reference LTC DWG # 05-08-1410)

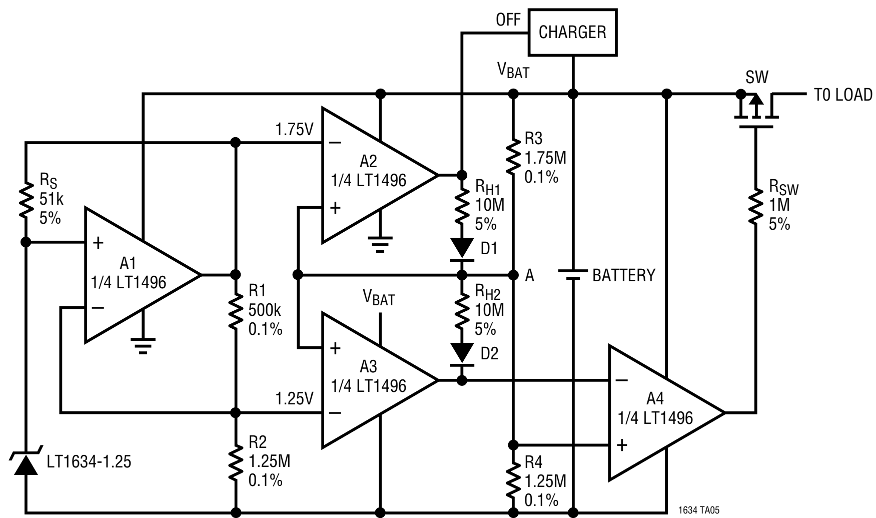


Z3 (TO-92) 0801

TO-92 TAPE AND REEL
REFER TO TAPE AND REEL SECTION OF
LTC DATA BOOK FOR ADDITIONAL INFORMATION

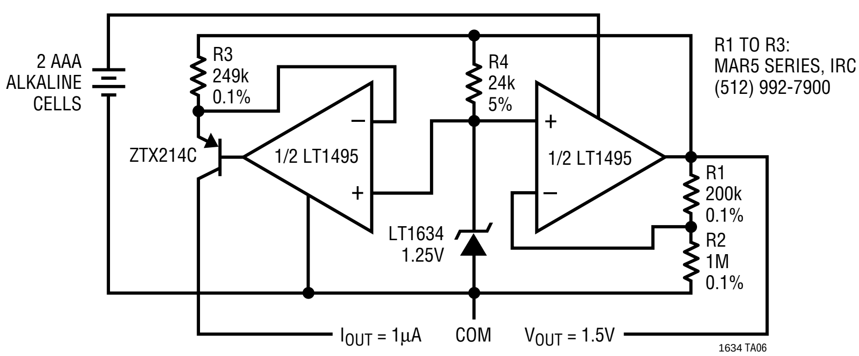
TYPICAL APPLICATIONS

Single Cell Li-Ion Battery Supervisory Circuit (I_Q = 20μA)



D1, D2: 1N458
R1 TO R4: CAR6 SERIES IRC (512) 992-7900

Micropower Voltage and Current Reference



RELATED PARTS

PART NUMBER	DESCRIPTION	COMMENTS
LTC1440	Micropower Comparator with Reference	3.7μA Max Supply Current, 1% 1.182V Reference, MSOP, PDIP and SO-8 Packages
LT1460	Micropower Series Reference	0.075% Max, 10ppm/°C Max Drift, 2.5V, 5V and 10V Versions, MSOP, PDIP, SO-8, SOT-23 and TO-92 Packages
LT1495	1.5μA Precision Rail-to-Rail Dual Op Amp	1.5μA Max Supply Current, 100pA Max I_{OS}
LTC1540	Nanopower Comparator with Reference	600nA Max Supply Current, 2% 1.182V Reference, MSOP and SO-8 Packages

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