MIC2951

150 mA Low-Dropout Voltage Regulator

Features

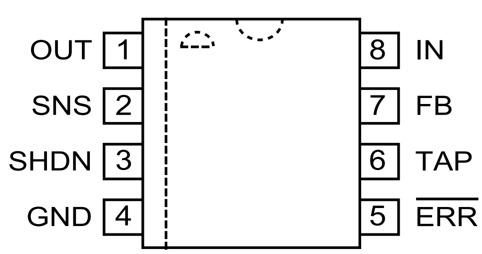
- High Accuracy 3.3V, 4.85V, or 5V, Guaranteed 150 mA Output
- Extremely Low Quiescent Current
- Low-Dropout Voltage
- Extremely Tight Load and Line Regulation
- Very Low Temperature Coefficient
- Use as Regulator or Reference
- Needs Only 1.5 µF for Stability
- Current and Thermal Limiting
- Unregulated DC Input Can Withstand –20V Reverse Battery and +60V Positive Transients
- Error Flag Warns of Output Dropout
- Logic-Controlled Electronic Shutdown
- Output Programmable from 1.24 to 29V

Applications

- Automotive Electronics
- Voltage Reference
- Avionics
- Cellular Telephones
- Battery Powered Equipment
- SMPS Post-Regulator
- High Efficiency Linear Power Supplies

Package Type

MIC2951
DIP (N)*, SOIC (M)*, MSOP (MM)*
(Top View)



* Pb-Free

General Description

The MIC2951 is a “bulletproof” micropower voltage regulator with very low dropout voltage (typically 40 mV at light loads and 250 mV at 100 mA), and very low quiescent current. Like its predecessor, the LP2951, the quiescent current of the MIC2951 increases only slightly in dropout, which prolongs the battery life. The MIC2951 is pin-for-pin compatible with the LP2951, but offers a lower dropout, lower quiescent current, reverse battery, and automotive load dump protection.

The key additional features and protection offered include higher output current (150 mA), positive transient protection for up to 60V (load dump), and the ability to survive an unregulated input voltage transient of –20V below ground (reverse battery).

The plastic DIP, SOIC, and MSOP versions offer system functions such as programmable output voltage and logic controlled shutdown.

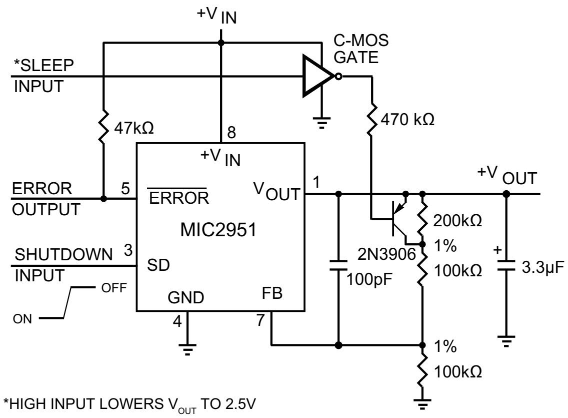
These system functions also include an error flag output that warns of a low output voltage, which is often due to failing batteries on the input. This may also be used as a power-on reset. A logic-compatible shutdown input is also available which enables the regulator to be switched on and off. This part may also be pin-strapped for a 5V output, or programmed from 1.24V to 29V with the use of two external resistors.

The MIC2951 is available as an -02 or -03 version.

The MIC2951 has a tight initial tolerance (0.5% typical), a very low output voltage temperature coefficient, which allows use as a low-power voltage reference, and extremely good load and line regulation (0.04% typical). This greatly reduces the error in the overall circuit and is the result of careful design techniques and process control.

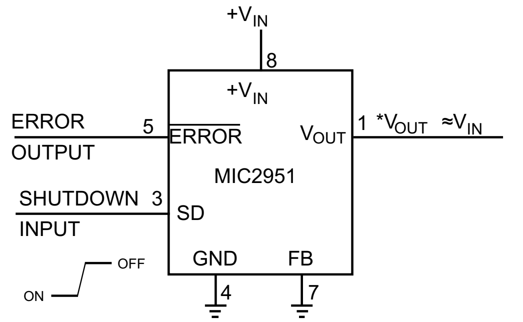
Typical Application Circuits

5V Regulator with 2.5V Sleep Function



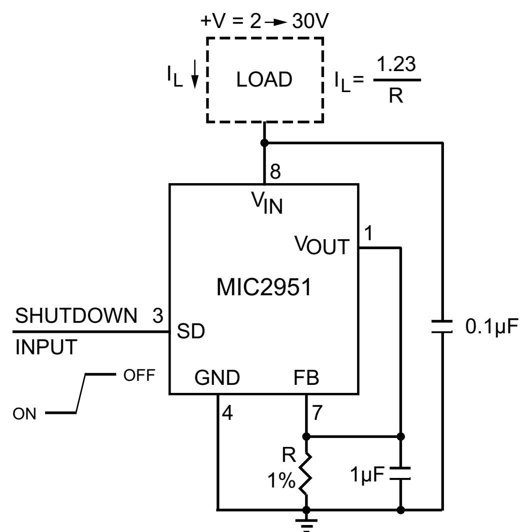
*HIGH INPUT LOWERS V_{OUT} TO 2.5V

Wide Input Voltage Range Current Limiter

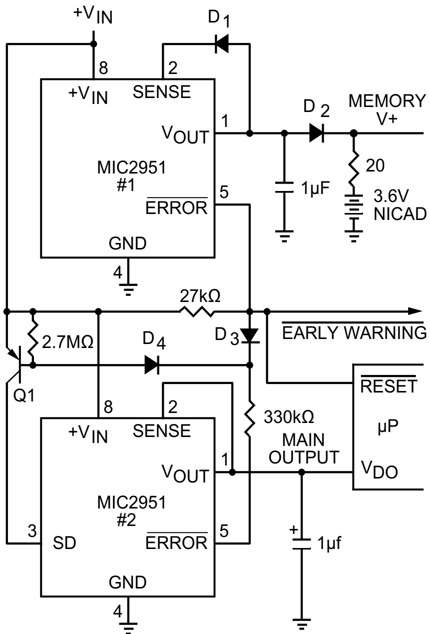


*MINIMUM INPUT-OUTPUT VOLTAGE RANGES FROM 40 mV TO 400 mV, DEPENDING ON LOAD CURRENT. CURRENT LIMIT IS TYPICALLY 160 mA.

Low Drift Current Source



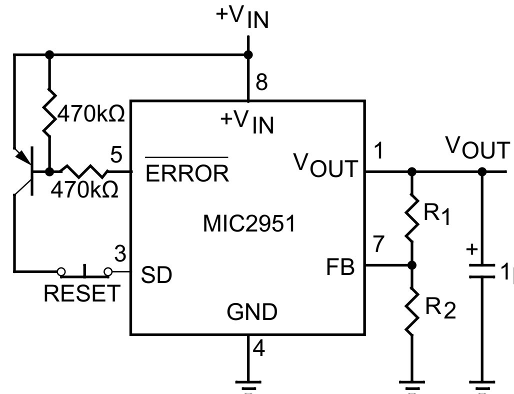
Regulator with Early Warning and Auxiliary Output



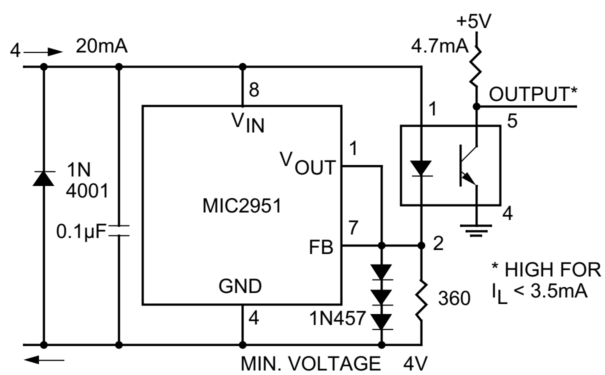
- EARLY WARNING FLAG ON LOW INPUT VOLTAGE
- MAIN OUTPUT LATCHES OFF AT LOWER INPUT VOLTAGES
- BATTERY BACKUP ON AUXILIARY OUTPUT

OPERATION: REG. #1'S V_{OUT} IS PROGRAMMED ONE DIODE DROP ABOVE 5 V. ITS ERROR FLAG BECOMES ACTIVE WHEN $V_{IN} \leq 5.7$ V. WHEN V_{IN} DROPS BELOW 5.3 V, THE ERROR FLAG OF REG. #2 BECOMES ACTIVE AND VIA Q1 LATCHES THE MAIN OUTPUT OFF. WHEN V_{IN} AGAIN EXCEEDS 5.7 V REG. #1 IS BACK IN REGULATION AND THE EARLY WARNING SIGNAL RISES, UNLATCHING REG. #2 VIA D3.

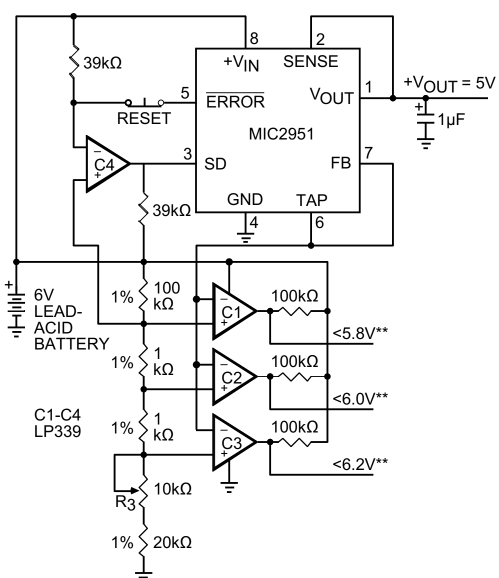
Latch Off When Error Flag Occurs



Open Circuit Detector for 4 mA to 20 mA Current Loop

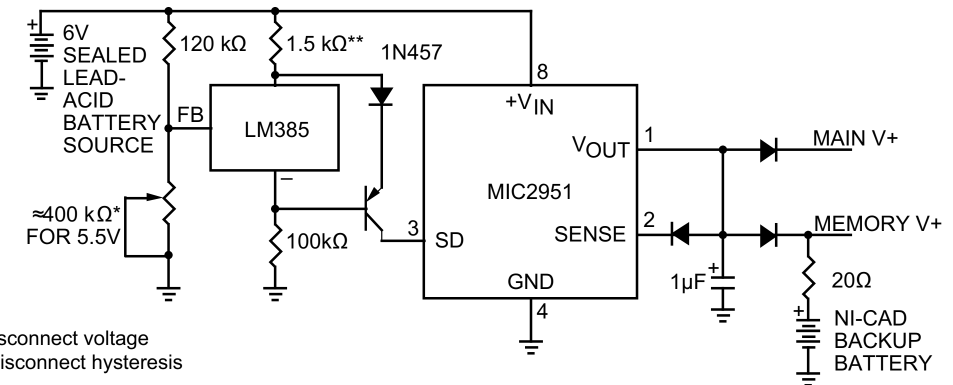


Regulator with State-of-Charge Indicator



C1 TO C4 ARE COMPARATORS (LP339 OR EQUIVALENT)
*OPTIONAL LATCH OFF WHEN DROP OUT OCCURS. ADJUST R3 FOR C2 SWITCHING WHEN V_{IN} IS 6.0V
**OUTPUTS GO LOW WHEN V_{IN} DROPS BELOW DESIGNATED THRESHOLDS.

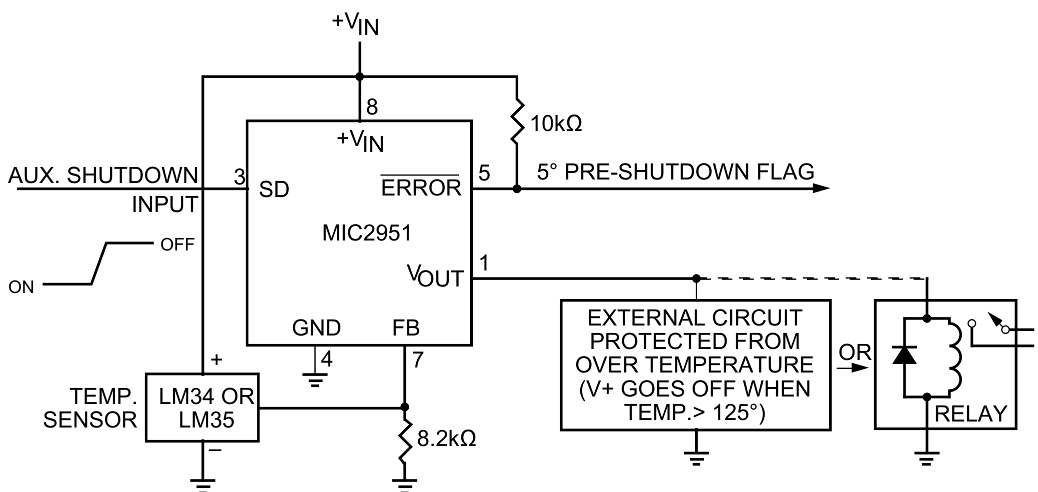
Low Battery Disconnect



* Sets disconnect voltage
** Sets disconnect hysteresis

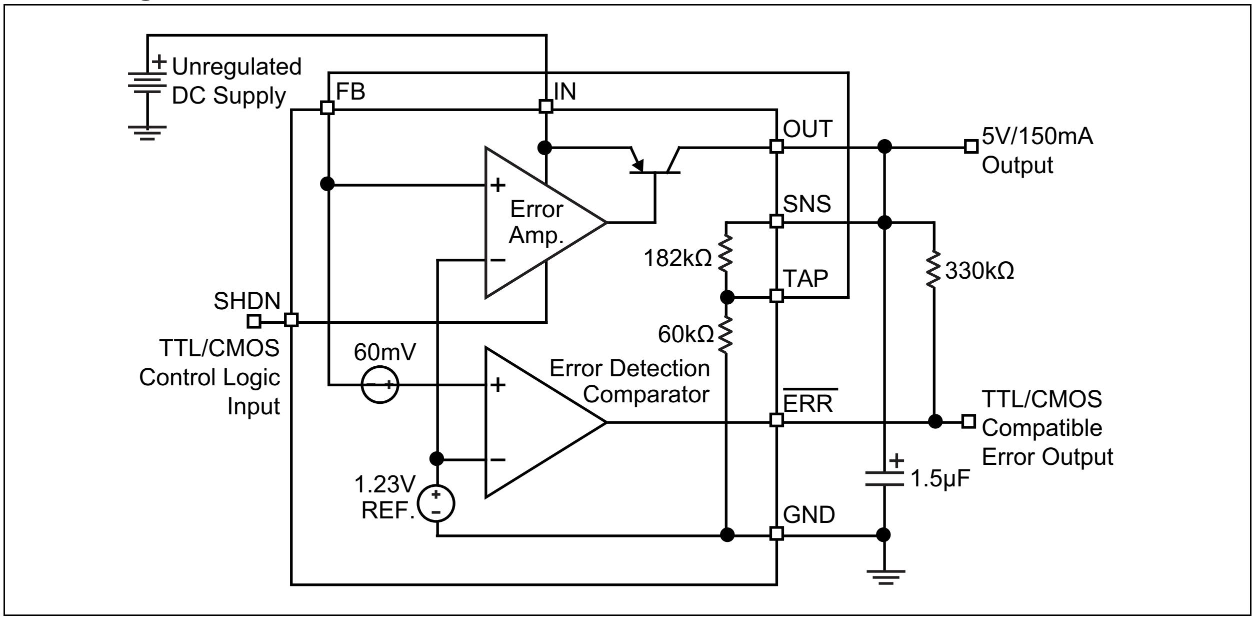
For values shown, Regulator shuts down when V_{IN} < 5.5 V and turns on again at 6.0 V. Current drain in disconnected mode is 150 µA.

System Overtemperature Protection Circuit



LM34 for 125°F Shutdown
LM35 for 125°C Shutdown

Block Diagram



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

Input Voltage, V_{IN} (Note 1) .... –20V to +60V
Feedback Input Voltage, V_{FB} (Note 2, Note 3) .... –1.5V to +26V
Shutdown Input Voltage, V_{SHDN} (Note 2) .... –0.3V to +30V
Power Dissipation P_D (Note 4) .... Internally Limited
ESD .... Note 5

Operating Ratings ††

Input Supply Voltage, V_{IN} .... +2.0V to +30V

† Notice: Exceeding the absolute maximum rating may damage the device.

†† Notice: The device is not guaranteed to function outside its operating rating.

Note 1: The maximum positive supply voltage of 60V must be of limited duration (≤100 ms) and duty cycle (≤1%). The maximum continuous supply voltage is 30V.

2: When used in dual-supply systems where the output terminal sees loads returned to a negative supply, the output voltage should be diode-clamped to ground.

3: $V_{SHDN} \geq 2V$, $V_{IN} \leq 30V$, $V_{OUT} = 0$, with the FB pin connected to TAP.

4: The thermal resistance of the 8-pin DIP (N) package is 105°C/W junction-to-ambient when soldered directly to a PC board. Junction-to-ambient thermal resistance for the SOIC (M) package is 160°C/W. Junction-to-ambient thermal resistance for the MSOP (MM) is 250°C/W.

5: Device is ESD sensitive. Handling precautions are recommended.

ELECTRICAL CHARACTERISTICS

Electrical Characteristics: Unless otherwise indicated, V_{IN} = 6V; I_L = 100 µA; C_L = 1 µF; T_J = 25°C, **bold** values indicate –40°C ≤ TJ ≤ +125°C.

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Output Voltage T_J = 25°C	V_{OUT}	4.975	5.000	5.025	V	MIC2951-02 (±0.5%)
		4.950	5.000	5.050	V	MIC2951-03 (±1%)
		3.267	3.300	3.333	V	MIC2951-3.3 (±1%)
		4.802	4.850	4.899	V	MIC2951-4.8 (±1%)
Output Voltage –25°C ≤ T_J ≤ +85°C	V_{OUT}	4.950	—	5.050	V	MIC2951-02 (±0.5%)
		4.925	—	5.075	V	MIC2951-03 (±1%)
		3.251	—	3.350	V	MIC2951-3.3 (±1%)
		4.777	—	4.872	V	MIC2951-4.8 (±1%)
Output Voltage Over Full Temperature Range –40°C to +125°C	V_{OUT}	**4.940**	—	**5.060**	V	MIC2951-02 (±0.5%)
		4.900	—	**5.100**	V	MIC2951-03 (±1%)
		3.234	—	**3.366**	V	MIC2951-3.3 (±1%)
		4.753	—	**4.947**	V	MIC2951-4.8 (±1%)

Note 1: V_{SHDN} ≥ 2V, V_{IN} ≤ 30V, V_{OUT} = 0, with the FB pin connected to TAP.

2: Additional conditions for 8-pin devices are V_{FB} = 5V, TAP and OUT connected to SNS (V_{OUT} = 5V) and V_{SHDN} ≤ 0.8V.

3: Output or reference voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

4: Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered in the specification for thermal regulation.

5: Line regulation for the MIC2951 is tested at 150°C for I_L = 1 mA. For I_L = 100 µA and T_J = 125°C, line regulation is guaranteed by design to 0.2%. See Typical Performance Curves for line regulation versus temperature and load current.

6: Dropout voltage is defined as the input to output differential at which the output voltage drops 100 mV below its nominal value measured at 1V differential. At very low values of programmed output voltage, the minimum input supply voltage of 2V (2.3V over temperature) must be taken into account.

7: Thermal regulation is defined as the change in output voltage at a time “t” after a change in power dissipation is applied, excluding load or line regulation effects. Specifications are for a 50 mA load pulse at V_{IN} = 30V (1.25W pulse) for t = 10 ms.

8: $V_{REF} \le V_{OUT} \le (V_{IN} - 1\ V)$, 2.3V ≤ V_{IN} ≤ 30V, 100 µA < I_L ≤ 150 mA, $T_J \le T_{JMAX}$.

9: Comparator thresholds are expressed in terms of a voltage differential at the FB terminal below the nominal reference voltage measured at 6V input. To express these thresholds in terms of output voltage change, multiply by the error amplifier gain = V_{OUT}/V_{REF} = (R1 + R2)/R2. For example, at a programmed output voltage of 5V, the error output is guaranteed to go low when the output drops by 95 mV x 5V/1.235V = 384 mV. Thresholds remain constant as a percent of V_{OUT} as V_{OUT} is varied, with the dropout warning occurring at typically 5% below nominal, 7.5% guaranteed.

10: Specification for packaged product only.

ELECTRICAL CHARACTERISTICS (CONTINUED)

Electrical Characteristics: Unless otherwise indicated, V_{IN} = 6V; I_L = 100 µA; C_L = 1 µF; T_J = 25°C, **bold** values indicate –40°C ≤ TJ ≤ +125°C.

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Output Voltage Over Load Variation	V_{OUT}	**4.930**	—	**5.070**	V	MIC2951-02 (±0.5%), 100 µA ≤ I_L ≤ 150 mA, $T_J \le T_{J(max)}$
		4.880	—	**5.120**	V	MIC2951-03 (±1%), 100 µA ≤ I_L ≤ 150 mA, $T_J \le T_{J(max)}$
		3.221	—	**3.379**	V	MIC2951-3.3 (±1%), 100 µA ≤ I_L ≤ 150 mA, $T_J \le T_{J(max)}$
		4.733	—	**4.967**	V	MIC2951-4.8 (±1%), 100 µA ≤ I_L ≤ 150mA, $T_J \le T_{J(max)}$
Output Voltage Temperature Coefficient	$\Delta V_{OUT}/\Delta T$	—	**20**	**100**	ppm/°C	MIC2951-02 (±0.5%), (Note 3)
		—	**50**	**150**	ppm/°C	MIC2951-03 (±1%), (Note 3)
		—	**50**	**150**	ppm/°C	MIC2951-3.3 (±1%), (Note 3)
		—	50	150	ppm/°C	MIC2951-4.8 (±1%), (Note 3)

Note 1: V_{SHDN} ≥ 2V, V_{IN} ≤ 30V, V_{OUT} = 0, with the FB pin connected to TAP.

2: Additional conditions for 8-pin devices are V_{FB} = 5V, TAP and OUT connected to SNS (V_{OUT} = 5V) and V_{SHDN} ≤ 0.8V.

3: Output or reference voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

4: Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered in the specification for thermal regulation.

5: Line regulation for the MIC2951 is tested at 150°C for I_L = 1 mA. For I_L = 100 µA and T_J = 125°C, line regulation is guaranteed by design to 0.2%. See Typical Performance Curves for line regulation versus temperature and load current.

6: Dropout voltage is defined as the input to output differential at which the output voltage drops 100 mV below its nominal value measured at 1V differential. At very low values of programmed output voltage, the minimum input supply voltage of 2V (2.3V over temperature) must be taken into account.

7: Thermal regulation is defined as the change in output voltage at a time "t" after a change in power dissipation is applied, excluding load or line regulation effects. Specifications are for a 50 mA load pulse at V_{IN} = 30V (1.25W pulse) for t = 10 ms.

8: $V_{REF} \le V_{OUT} \le (V_{IN} – 1\text{ V})$, 2.3V ≤ V_{IN} ≤ 30V, 100 µA < I_L ≤ 150 mA, $T_J \le T_{JMAX}$.

9: Comparator thresholds are expressed in terms of a voltage differential at the FB terminal below the nominal reference voltage measured at 6V input. To express these thresholds in terms of output voltage change, multiply by the error amplifier gain = V_{OUT}/V_{REF} = (R1 + R2)/R2. For example, at a programmed output voltage of 5V, the error output is guaranteed to go low when the output drops by 95 mV x 5V/1.235V = 384 mV. Thresholds remain constant as a percent of V_{OUT} as V_{OUT} is varied, with the dropout warning occurring at typically 5% below nominal, 7.5% guaranteed.

10: Specification for packaged product only.

ELECTRICAL CHARACTERISTICS (CONTINUED)

Electrical Characteristics: Unless otherwise indicated, V_{IN} = 6V; I_L = 100 µA; C_L = 1 µF; T_J = 25°C, **bold** values indicate –40°C ≤ TJ ≤ +125°C.

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Line Regulation	$\Delta V_{OUT}/V_{OUT}$	—	0.03	0.10	%	MIC2951-02 (±0.5%), (Note 4, 5)
		—	—	**0.20**	%	
		—	0.04	0.20	%	MIC2951-03 (±1%), (Note 4, 5)
		—	—	**0.40**	%	
		—	0.04	0.20	%	MIC2951-3.3 (±1%), (Note 4, 5)
		—	—	**0.40**	%	
		—	0.04	0.20	%	MIC2951-4.8 (±1%), (Note 4, 5)
		—	—	**0.40**	%	
Load Regulation	$\Delta V_{OUT}/V_{OUT}$	—	0.04	0.10	%	MIC2951-02 (±0.5%), 100 µA ≤ I_L ≤ 150 mA, (Note 4)
		—	—	**0.20**	%	
		—	0.10	0.20	%	MIC2951-03 (±1%), 100 µA ≤ I_L ≤ 150 mA, (Note 4)
		—	—	**0.30**	%	
		—	0.10	0.20	%	MIC2951-3.3 (±1%), 100 µA ≤ I_L ≤ 150 mA, (Note 4)
		—	—	**0.30**	%	
		—	0.10	0.20	%	MIC2951-4.8 (±1%), 100 µA ≤ I_L ≤ 150 mA, (Note 4)
		—	—	**0.30**	%	

Note 1: V_{SHDN} ≥ 2V, V_{IN} ≤ 30V, V_{OUT} = 0, with the FB pin connected to TAP.

2: Additional conditions for 8-pin devices are V_{FB} = 5V, TAP and OUT connected to SNS (V_{OUT} = 5V) and V_{SHDN} ≤ 0.8V.

3: Output or reference voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

4: Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered in the specification for thermal regulation.

5: Line regulation for the MIC2951 is tested at 150°C for I_L = 1 mA. For I_L = 100 µA and T_J = 125°C, line regulation is guaranteed by design to 0.2%. See Typical Performance Curves for line regulation versus temperature and load current.

6: Dropout voltage is defined as the input to output differential at which the output voltage drops 100 mV below its nominal value measured at 1V differential. At very low values of programmed output voltage, the minimum input supply voltage of 2V (2.3V over temperature) must be taken into account.

7: Thermal regulation is defined as the change in output voltage at a time "t" after a change in power dissipation is applied, excluding load or line regulation effects. Specifications are for a 50 mA load pulse at V_{IN} = 30V (1.25W pulse) for t = 10 ms.

8: V_{REF} ≤ V_{OUT} ≤ (V_{IN} – 1 V), 2.3V ≤ V_{IN} ≤ 30V, 100 µA < I_L ≤ 150 mA, T_J ≤ T_{JMAX}.

9: Comparator thresholds are expressed in terms of a voltage differential at the FB terminal below the nominal reference voltage measured at 6V input. To express these thresholds in terms of output voltage change, multiply by the error amplifier gain = V_{OUT} /V_{REF} = (R1 + R2)/R2. For example, at a programmed output voltage of 5V, the error output is guaranteed to go low when the output drops by 95 mV x 5V/1.235V = 384 mV. Thresholds remain constant as a percent of V_{OUT} as V_{OUT} is varied, with the dropout warning occurring at typically 5% below nominal, 7.5% guaranteed.

10: Specification for packaged product only.

ELECTRICAL CHARACTERISTICS (CONTINUED)

Electrical Characteristics: Unless otherwise indicated, V_{IN} = 6V; I_L = 100 µA; C_L = 1 µF; T_J = 25°C, **bold** values indicate –40°C ≤ TJ ≤ +125°C.

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Dropout Voltage	V_{DO}	—	40	80	mV	MIC2951-02/-03, I_L = 100 µA, (Note 6)
		—	—	**140**	mV	
		—	250	300	mV	MIC2951-02/-03, I_L = 100 mA, (Note 6)
		—	300	450	mV	MIC2951-02/-03, I_L = 150 mA, (Note 6)
		—	—	**600**	mV	
		—	40	80	mV	MIC2951-3.3 (±1%), I_L = 100 µA, (Note 6)
		—	—	**150**	mV	
		—	250	350	mV	MIC2951-3.3 (±1%), I_L = 100 mA, (Note 6)
		—	320	450	mV	MIC2951-3.3 (±1%), I_L = 150 mA, (Note 6)
		—	—	**600**	mV	
		—	40	80	mV	MIC2951-4.8 (±1%), I_L = 100 µA, (Note 6)
		—	—	**140**	mV	
		—	250	300	mV	MIC2951-4.8 (±1%), I_L = 100 mA, (Note 6)
		—	320	450	mV	MIC2951-4.8 (±1%), I_L = 150 mA, (Note 6)
		—	—	**600**	mV	

Note 1: V_{SHDN} ≥ 2V, V_{IN} ≤ 30V, V_{OUT} = 0, with the FB pin connected to TAP.

2: Additional conditions for 8-pin devices are V_{FB} = 5V, TAP and OUT connected to SNS (V_{OUT} = 5V) and V_{SHDN} ≤ 0.8V.

3: Output or reference voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

4: Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered in the specification for thermal regulation.

5: Line regulation for the MIC2951 is tested at 150°C for I_L = 1 mA. For I_L = 100 µA and T_J = 125°C, line regulation is guaranteed by design to 0.2%. See Typical Performance Curves for line regulation versus temperature and load current.

6: Dropout voltage is defined as the input to output differential at which the output voltage drops 100 mV below its nominal value measured at 1V differential. At very low values of programmed output voltage, the minimum input supply voltage of 2V (2.3V over temperature) must be taken into account.

7: Thermal regulation is defined as the change in output voltage at a time "t" after a change in power dissipation is applied, excluding load or line regulation effects. Specifications are for a 50 mA load pulse at V_{IN} = 30V (1.25W pulse) for t = 10 ms.

8: $V_{REF} \le V_{OUT} \le (V_{IN} - 1\ V)$, 2.3V ≤ V_{IN} ≤ 30V, 100 µA < I_L ≤ 150 mA, $T_J \le T_{JMAX}$.

9: Comparator thresholds are expressed in terms of a voltage differential at the FB terminal below the nominal reference voltage measured at 6V input. To express these thresholds in terms of output voltage change, multiply by the error amplifier gain = V_{OUT}/V_{REF} = (R1 + R2)/R2. For example, at a programmed output voltage of 5V, the error output is guaranteed to go low when the output drops by 95 mV x 5V/1.235V = 384 mV. Thresholds remain constant as a percent of V_{OUT} as V_{OUT} is varied, with the dropout warning occurring at typically 5% below nominal, 7.5% guaranteed.

10: Specification for packaged product only.

ELECTRICAL CHARACTERISTICS (CONTINUED)

Electrical Characteristics: Unless otherwise indicated, V_{IN} = 6V; I_L = 100 µA; C_L = 1 µF; T_J = 25°C, **bold** values indicate –40°C ≤ TJ ≤ +125°C.

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Ground Current	I_{GND}	—	120	180	µA	MIC2951-02/-03, I_L = 100 µA
		—	—	**300**	µA	
		—	1.7	2.5	mA	MIC2951-02/-03, I_L = 100 mA
		—	—	**3.5**	mA	
		—	4	6	mA	MIC2951-02/-03, I_L = 150 mA
		—	—	**8**	mA	
		—	100	180	µA	MIC2951-3.3 (±1%), I_L = 100 µA
		—	—	**300**	µA	
		—	1.7	2.5	mA	MIC2951-3.3 (±1%), I_L = 100 mA
		—	4	6	mA	MIC2951-3.3 (±1%), IL = 150 mA
		—	—	**10**	mA	
		—	120	180	µA	MIC2951-4.8 (±1%), I_L = 100 µA
		—	—	**300**	µA	
		—	1.7	2.5	mA	MIC2951-4.8 (±1%), I_L = 100 mA
		—	—	**3.5**	mA	
		—	4	6	mA	MIC2951-4.8 (±1%), I_L = 150 mA
		—	—	**8**	mA	

Note 1: $V_{SHDN} \geq 2V$, $V_{IN} \leq 30V$, $V_{OUT} = 0$, with the FB pin connected to TAP.

2: Additional conditions for 8-pin devices are V_{FB} = 5V, TAP and OUT connected to SNS (V_{OUT} = 5V) and $V_{SHDN} \leq 0.8V$.

3: Output or reference voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

4: Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered in the specification for thermal regulation.

5: Line regulation for the MIC2951 is tested at 150°C for I_L = 1 mA. For I_L = 100 µA and T_J = 125°C, line regulation is guaranteed by design to 0.2%. See Typical Performance Curves for line regulation versus temperature and load current.

6: Dropout voltage is defined as the input to output differential at which the output voltage drops 100 mV below its nominal value measured at 1V differential. At very low values of programmed output voltage, the minimum input supply voltage of 2V (2.3V over temperature) must be taken into account.

7: Thermal regulation is defined as the change in output voltage at a time "t" after a change in power dissipation is applied, excluding load or line regulation effects. Specifications are for a 50 mA load pulse at V_{IN} = 30V (1.25W pulse) for t = 10 ms.

8: $V_{REF} \leq V_{OUT} \leq (V_{IN} - 1\ V)$, $2.3V \leq V_{IN} \leq 30V$, $100\ µA < I_L \leq 150\ mA$, $T_J \leq T_{JMAX}$.

9: Comparator thresholds are expressed in terms of a voltage differential at the FB terminal below the nominal reference voltage measured at 6V input. To express these thresholds in terms of output voltage change, multiply by the error amplifier gain = V_{OUT}/V_{REF} = (R1 + R2)/R2. For example, at a programmed output voltage of 5V, the error output is guaranteed to go low when the output drops by 95 mV x 5V/1.235V = 384 mV. Thresholds remain constant as a percent of V_{OUT} as V_{OUT} is varied, with the dropout warning occurring at typically 5% below nominal, 7.5% guaranteed.

10: Specification for packaged product only.

ELECTRICAL CHARACTERISTICS (CONTINUED)

Electrical Characteristics: Unless otherwise indicated, V_{IN} = 6V; I_L = 100 µA; C_L = 1 µF; T_J = 25°C, **bold** values indicate –40°C ≤ TJ ≤ +125°C.

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Dropout Ground Current	I_{GND_DO}	—	280	350	µA	MIC2951-02/-03, V_{IN} = 4.5V, I_L = 100 µA
		—	—	**400**	µA	
		—	150	350	µA	MIC2951-3.3 (±1%), V_{IN} = 3.0V, I_L = 100 µA
		—	—	**400**	µA	
		—	280	350	µA	MIC2951-4.8 (±1%), V_{IN} = 4.3V, I_L = 100 µA
		—	—	**400**	µA	
Current Limit	I_{LIM}	—	300	400	mA	V_{OUT} = 0V
		—	—	**450**	mA	
Thermal Regulation	$\Delta V_{OUT}/\Delta P_D$	—	0.05	0.20	%/W	Note 7
Output Noise	e_{no}	—	430	—	μV_{RMS}	10 Hz to 100 kHz, C_L = 1.5 µF
		—	160	—	μV_{RMS}	10 Hz to 10 kHz, C_L = 200 µF
		—	100	—	μV_{RMS}	10 Hz to 100 kHz, C_L = 3.3 µF, 0.01 µF bypass Feedback to Output

Note 1: V_{SHDN} ≥ 2V, V_{IN} ≤ 30V, V_{OUT} = 0, with the FB pin connected to TAP.

2: Additional conditions for 8-pin devices are V_{FB} = 5V, TAP and OUT connected to SNS (V_{OUT} = 5V) and V_{SHDN} ≤ 0.8V.

3: Output or reference voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

4: Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered in the specification for thermal regulation.

5: Line regulation for the MIC2951 is tested at 150°C for I_L = 1 mA. For I_L = 100 µA and T_J = 125°C, line regulation is guaranteed by design to 0.2%. See Typical Performance Curves for line regulation versus temperature and load current.

6: Dropout voltage is defined as the input to output differential at which the output voltage drops 100 mV below its nominal value measured at 1V differential. At very low values of programmed output voltage, the minimum input supply voltage of 2V (2.3V over temperature) must be taken into account.

7: Thermal regulation is defined as the change in output voltage at a time “t” after a change in power dissipation is applied, excluding load or line regulation effects. Specifications are for a 50 mA load pulse at V_{IN} = 30V (1.25W pulse) for t = 10 ms.

8: $V_{REF} \le V_{OUT} \le (V_{IN} - 1\ V)$, 2.3V ≤ V_{IN} ≤ 30V, 100 µA < I_L ≤ 150 mA, $T_J \le T_{JMAX}$.

9: Comparator thresholds are expressed in terms of a voltage differential at the FB terminal below the nominal reference voltage measured at 6V input. To express these thresholds in terms of output voltage change, multiply by the error amplifier gain = V_{OUT}/V_{REF} = (R1 + R2)/R2. For example, at a programmed output voltage of 5V, the error output is guaranteed to go low when the output drops by 95 mV x 5V/1.235V = 384 mV. Thresholds remain constant as a percent of V_{OUT} as V_{OUT} is varied, with the dropout warning occurring at typically 5% below nominal, 7.5% guaranteed.

10: Specification for packaged product only.

ELECTRICAL CHARACTERISTICS (CONTINUED)

Electrical Characteristics: Unless otherwise indicated, V_{IN} = 6V; I_L = 100 µA; C_L = 1 µF; T_J = 25°C, **bold** values indicate –40°C ≤ TJ ≤ +125°C.

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Reference Voltage	V_{REF}	1.210	1.235	1.250	V	MIC2951-02 (±0.5%)
		1.200	—	**1.260**	V	
		1.210	1.235	1.260	V	MIC2951-03 (±1%)
		1.200	—	**1.270**	V	
		1.210	1.235	1.260	V	MIC2951-3.3 (±1%)
		1.200	—	**1.270**	V	
		1.210	1.235	1.260	V	MIC2951-4.8 (±1%)
		1.200	—	**1.270**	V	
Reference Voltage	V_{REF}	**1.190**	—	**1.270**	V	MIC2951-3.3 (±%) (Note 8)
		1.185	—	**1.285**	V	MIC2951-4.8 (±1%) (Note 8)
		1.185	—	**1.285**	V	MIC2951-3.3 (±1%) (Note 8)
		1.185	—	**1.285**	V	MIC2951-4.8 (±1%) (Note 8)
Feedback Bias Current	I_{FB}	—	20	40	nA	—
		—	—	**60**	nA	—
Reference Voltage Temperature Coefficient	V_{REF_TC}	—	20	—	ppm/°C	MIC2951-02 (±0.5%), (Note 3)
		—	50	—	ppm/°C	MIC2951-03 (±1%), (Note 3)
		—	**50**	—	ppm/°C	MIC2951-3.3 (±1%), (Note 3)
		—	50	—	ppm/°C	MIC2951-4.8 (±1%), (Note 3)

Note 1: V_{SHDN} ≥ 2V, V_{IN} ≤ 30V, V_{OUT} = 0, with the FB pin connected to TAP.

2: Additional conditions for 8-pin devices are V_{FB} = 5V, TAP and OUT connected to SNS (V_{OUT} = 5V) and V_{SHDN} ≤ 0.8V.

3: Output or reference voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

4: Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered in the specification for thermal regulation.

5: Line regulation for the MIC2951 is tested at 150°C for I_L = 1 mA. For I_L = 100 µA and T_J = 125°C, line regulation is guaranteed by design to 0.2%. See Typical Performance Curves for line regulation versus temperature and load current.

6: Dropout voltage is defined as the input to output differential at which the output voltage drops 100 mV below its nominal value measured at 1V differential. At very low values of programmed output voltage, the minimum input supply voltage of 2V (2.3V over temperature) must be taken into account.

7: Thermal regulation is defined as the change in output voltage at a time "t" after a change in power dissipation is applied, excluding load or line regulation effects. Specifications are for a 50 mA load pulse at V_{IN} = 30V (1.25W pulse) for t = 10 ms.

8: $V_{REF} \le V_{OUT} \le (V_{IN} - 1\ V)$, 2.3V ≤ V_{IN} ≤ 30V, 100 µA < I_L ≤ 150 mA, $T_J \le T_{JMAX}$.

9: Comparator thresholds are expressed in terms of a voltage differential at the FB terminal below the nominal reference voltage measured at 6V input. To express these thresholds in terms of output voltage change, multiply by the error amplifier gain = V_{OUT} /V_{REF} = (R1 + R2)/R2. For example, at a programmed output voltage of 5V, the error output is guaranteed to go low when the output drops by 95 mV x 5V/1.235V = 384 mV. Thresholds remain constant as a percent of V_{OUT} as V_{OUT} is varied, with the dropout warning occurring at typically 5% below nominal, 7.5% guaranteed.

10: Specification for packaged product only.

ELECTRICAL CHARACTERISTICS (CONTINUED)

Electrical Characteristics: Unless otherwise indicated, V_{IN} = 6V; I_L = 100 µA; C_L = 1 µF; T_J = 25°C, **bold** values indicate –40°C ≤ TJ ≤ +125°C.

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Feedback Bias Current Temperature Coefficient	I_{FB_TC}	—	0.1	—	nA/°C	—
Error Comparator Flag Output Leakage Current	I_{ERR_LEAK}	—	0.01	1.00	µA	V_{OH} = 30V
		—	—	**2.00**	µA	
Error Comparator Flag Output Low Voltage Flag	V_{ERR_LOW}	—	150	250	mV	V_{IN} = 4.5V, I_{OL} = 200 µA
		—	—	**400**	mV	
Error Comparator Flag Upper Threshold Voltage	$V_{ERR\_HIGH\_TH}$	40	60	—	mV	Note 9
		25	—	—	mV	
Error Comparator Lower Threshold Voltage	$V_{ERR\_LOW\_TH}$	—	75	95	mV	Note 9
		—	—	**140**	mV	
Error Comparator Hysteresis	V_{ERR_HYST}	—	15	—	mV	Note 9

Note 1: V_{SHDN} ≥ 2V, V_{IN} ≤ 30V, V_{OUT} = 0, with the FB pin connected to TAP.

2: Additional conditions for 8-pin devices are V_{FB} = 5V, TAP and OUT connected to SNS (V_{OUT} = 5V) and V_{SHDN} ≤ 0.8V.

3: Output or reference voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

4: Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered in the specification for thermal regulation.

5: Line regulation for the MIC2951 is tested at 150°C for I_L = 1 mA. For I_L = 100 µA and T_J = 125°C, line regulation is guaranteed by design to 0.2%. See Typical Performance Curves for line regulation versus temperature and load current.

6: Dropout voltage is defined as the input to output differential at which the output voltage drops 100 mV below its nominal value measured at 1V differential. At very low values of programmed output voltage, the minimum input supply voltage of 2V (2.3V over temperature) must be taken into account.

7: Thermal regulation is defined as the change in output voltage at a time “t” after a change in power dissipation is applied, excluding load or line regulation effects. Specifications are for a 50 mA load pulse at V_{IN} = 30V (1.25W pulse) for t = 10 ms.

8: $V_{REF} \le V_{OUT} \le (V_{IN} – 1\ V)$, 2.3V ≤ V_{IN} ≤ 30V, 100 µA < I_L ≤ 150 mA, $T_J \le T_{JMAX}$.

9: Comparator thresholds are expressed in terms of a voltage differential at the FB terminal below the nominal reference voltage measured at 6V input. To express these thresholds in terms of output voltage change, multiply by the error amplifier gain = V_{OUT} /V_{REF} = (R1 + R2)/R2. For example, at a programmed output voltage of 5V, the error output is guaranteed to go low when the output drops by 95 mV x 5V/1.235V = 384 mV. Thresholds remain constant as a percent of V_{OUT} as V_{OUT} is varied, with the dropout warning occurring at typically 5% below nominal, 7.5% guaranteed.

10: Specification for packaged product only.

ELECTRICAL CHARACTERISTICS (CONTINUED)

Electrical Characteristics: Unless otherwise indicated, V_{IN} = 6V; I_L = 100 µA; C_L = 1 µF; T_J = 25°C, **bold** values indicate –40°C ≤ TJ ≤ +125°C.

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Shutdown Input Logic Voltage	V_{SHDN}	—	1.3	—	V	MIC2951-02 (±0.5%)
		—	—	**0.7**	V	Low
		2.0	—	—	V	High
		—	1.3	—	V	MIC2951-03 (±1%)
		—	—	**0.7**	V	Low
		2.0	—	—	V	High
		—	1.3	—	V	MIC2951-3.3 (±1%)
		—	—	**0.7**	V	Low
		2.0	—	—	V	High
		—	1.3	—	V	MIC2951-4.8 (±1%)
		—	—	**0.7**	V	Low
		2.0	—	—	V	High
Shutdown Input Current	I_{SHDN}	—	30	50	µA	$V_{SHUTDOWN}$ = 2.4V
		—	—	**100**	µA	
		—	450	600	µA	$V_{SHUTDOWN}$ = 30V
		—	—	**750**	µA	
Regulator Output Current in Shutdown	I_{OUT_SHDN}	—	3	10	µA	Note 1
		—	—	**20**	µA	

Note 1: V_{SHDN} ≥ 2V, V_{IN} ≤ 30V, V_{OUT} = 0, with the FB pin connected to TAP.

2: Additional conditions for 8-pin devices are V_{FB} = 5V, TAP and OUT connected to SNS (V_{OUT} = 5V) and V_{SHDN} ≤ 0.8V.

3: Output or reference voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

4: Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered in the specification for thermal regulation.

5: Line regulation for the MIC2951 is tested at 150°C for I_L = 1 mA. For I_L = 100 µA and T_J = 125°C, line regulation is guaranteed by design to 0.2%. See Typical Performance Curves for line regulation versus temperature and load current.

6: Dropout voltage is defined as the input to output differential at which the output voltage drops 100 mV below its nominal value measured at 1V differential. At very low values of programmed output voltage, the minimum input supply voltage of 2V (2.3V over temperature) must be taken into account.

7: Thermal regulation is defined as the change in output voltage at a time "t" after a change in power dissipation is applied, excluding load or line regulation effects. Specifications are for a 50 mA load pulse at V_{IN} = 30V (1.25W pulse) for t = 10 ms.

8: $V_{REF} \le V_{OUT} \le (V_{IN} - 1\text{ V})$, 2.3V ≤ V_{IN} ≤ 30V, 100 µA < I_L ≤ 150 mA, $T_J \le T_{JMAX}$.

9: Comparator thresholds are expressed in terms of a voltage differential at the FB terminal below the nominal reference voltage measured at 6V input. To express these thresholds in terms of output voltage change, multiply by the error amplifier gain = V_{OUT} /V_{REF} = (R1 + R2)/R2. For example, at a programmed output voltage of 5V, the error output is guaranteed to go low when the output drops by 95 mV x 5V/1.235V = 384 mV. Thresholds remain constant as a percent of V_{OUT} as V_{OUT} is varied, with the dropout warning occurring at typically 5% below nominal, 7.5% guaranteed.

10: Specification for packaged product only.

TEMPERATURE SPECIFICATIONS (Note 1)

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Temperature Ranges						
Lead Temperature	—	—	—	+260	°C	Soldering, 5s
Junction Operating Temperature	T_J	–40	—	+125	°C	—
Storage Temperature Range	T_A	–65	—	+150	°C	—
Package Thermal Resistances						
Thermal Resistance, SOIC-8Ld	θ_{JA}	—	**TBD**	—	°C/W	
Thermal Resistance, PDIP-8Ld	θ_{JA}	—	**TBD**	—	°C/W	

Note 1: The maximum allowable power dissipation is a function of ambient temperature, the maximum allowable junction temperature and the thermal resistance from junction to air (i.e., T_A, T_J, θ_{JA}). Exceeding the maximum allowable power dissipation will cause the device operating junction temperature to exceed the maximum +125°C rating. Sustained junction temperatures above +125°C can impact the device reliability.

2.0 TYPICAL PERFORMANCE CURVES

Note:	The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only. The performance characteristics listed herein are not tested or guaranteed. In some graphs or tables, the data presented may be outside the specified operating range (e.g., outside specified power supply range) and therefore outside the warranted range.

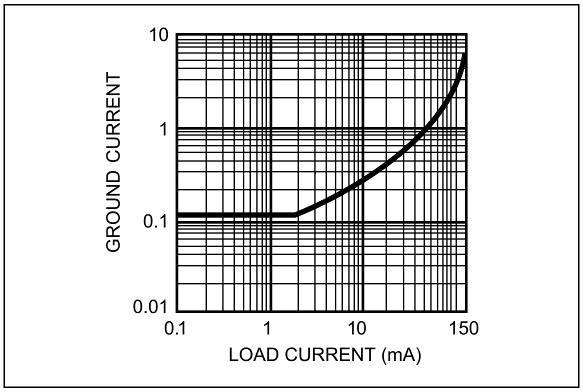


FIGURE 2-1: *Ground Pin Current vs. Load Current.*

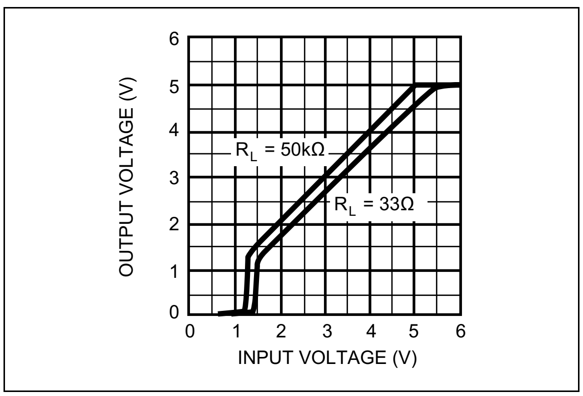


FIGURE 2-2: *Dropout Characteristics.*

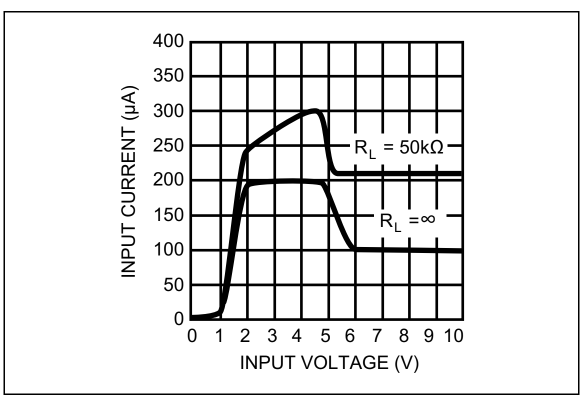


FIGURE 2-3: *Input Current vs. Input Votlage.*

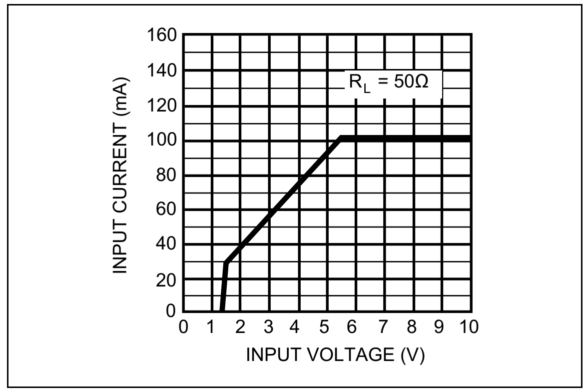


FIGURE 2-4: *Input Current vs. Input Voltage.*

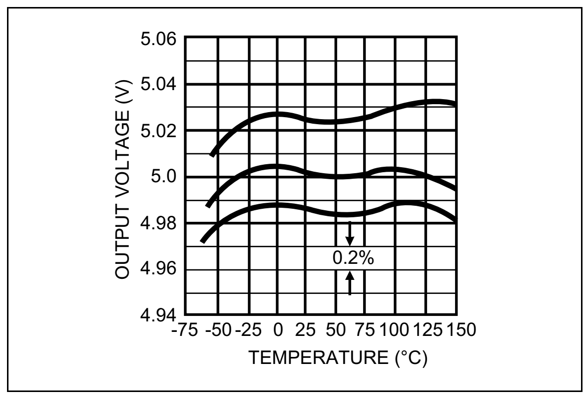


FIGURE 2-5: *Output Voltage vs. Temperature of 3 Representative Units.*

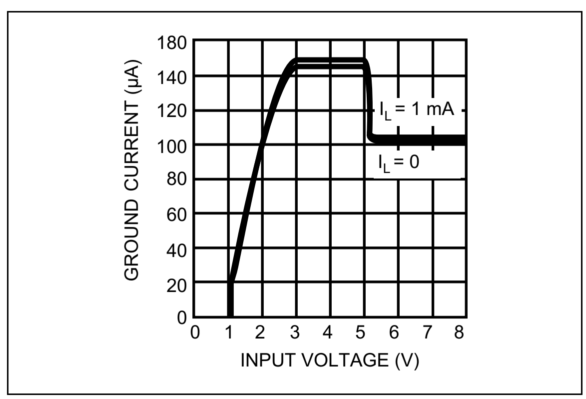


FIGURE 2-6: *Ground Pin Current vs. Input Voltage.*

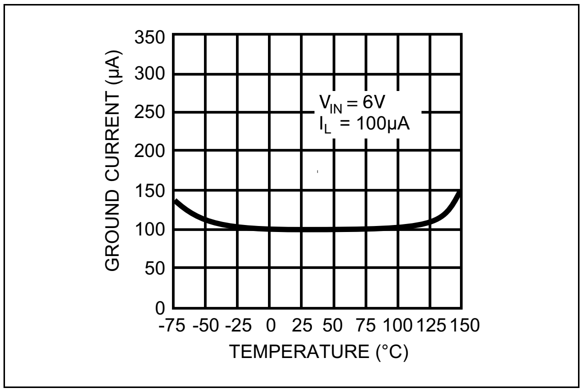


FIGURE 2-7: *Ground Pin Current vs. Temperature.*

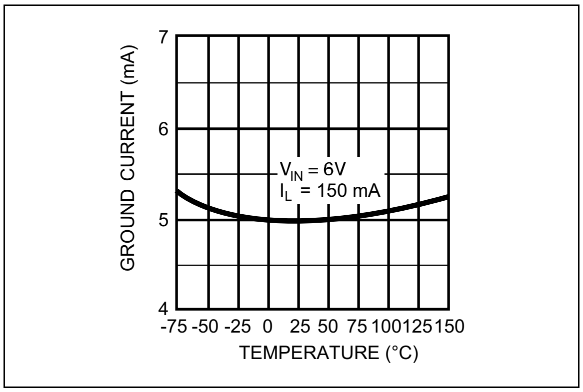


FIGURE 2-8: *Ground Pin Current vs. Temperature.*

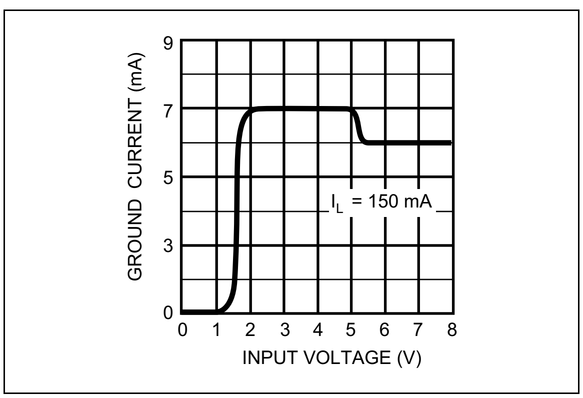


FIGURE 2-9: *Ground Pin Current vs. Input Voltage.*

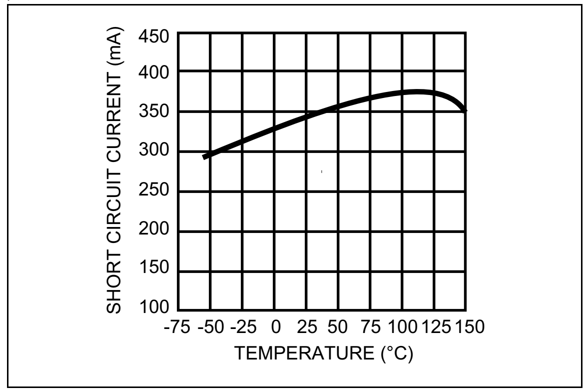


FIGURE 2-10: *Short Circuit Current vs Temperature.*

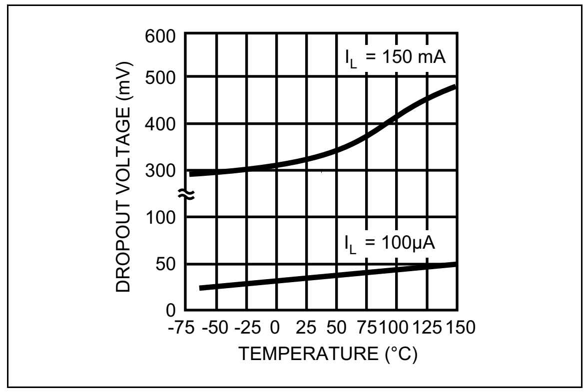


FIGURE 2-11: *Dropout Voltage vs. Temperature.*

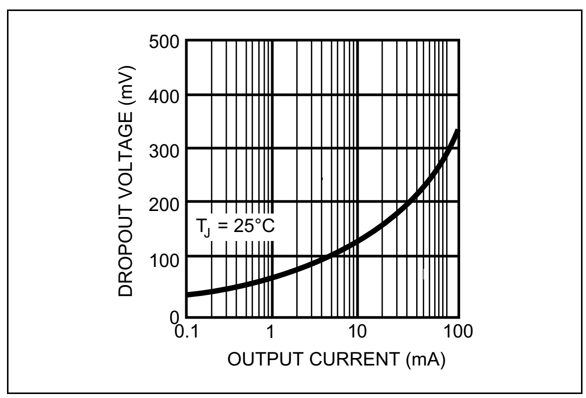


FIGURE 2-12: *Dropout Voltage vs. Load Current.*

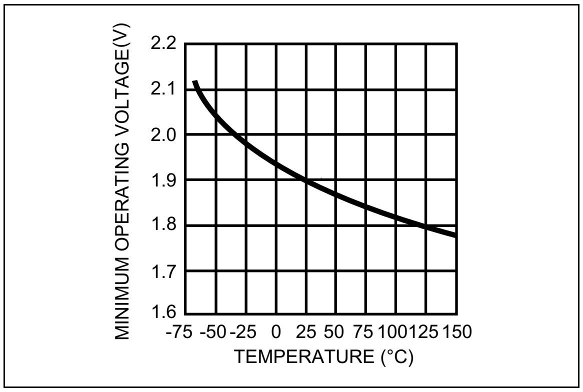


FIGURE 2-13: *Minimum Operating Voltage vs. Temperature.*

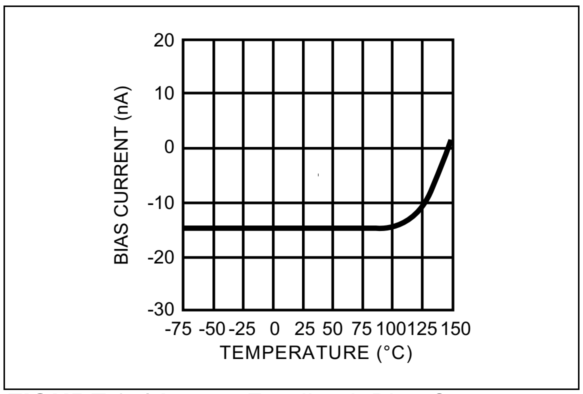


FIGURE 2-14: *Feedback Bias Current vs. Temperature.*

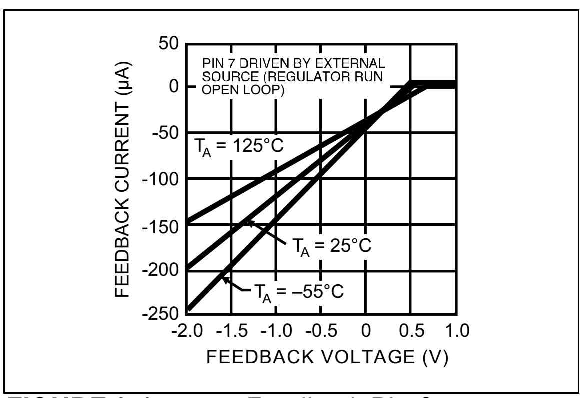


FIGURE 2-15: *Feedback Pin Current vs. Feedback Voltage.*

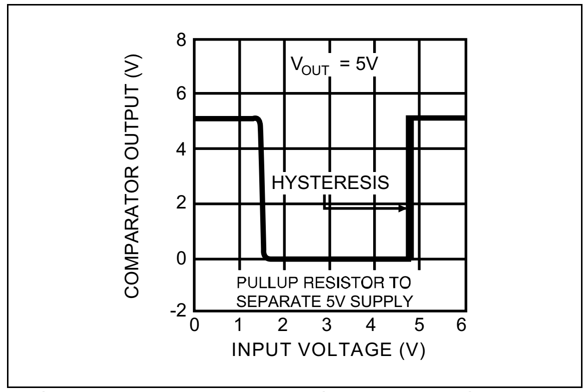


FIGURE 2-16: *Error Comparator Output vs. Input Voltage.*

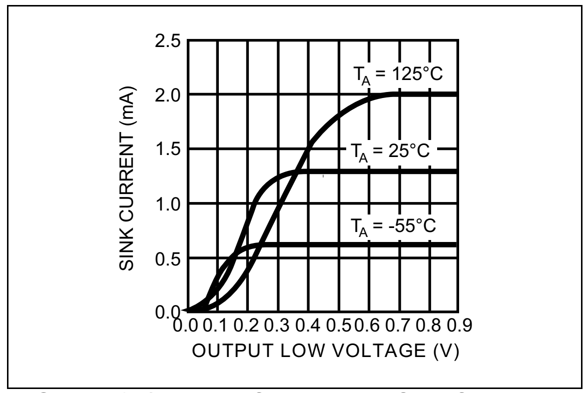


FIGURE 2-17: *Comparator Sink Current vs. Output Low Voltage.*

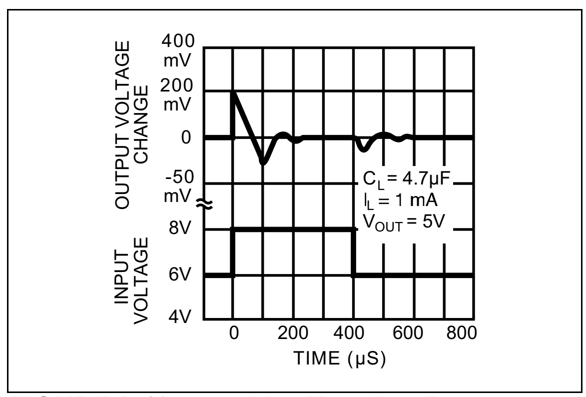


FIGURE 2-18: *Line Transient Response.*

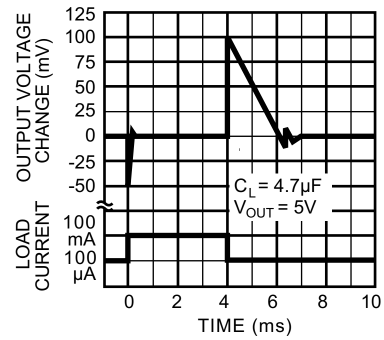


FIGURE 2-19: *Load Transient Response.*

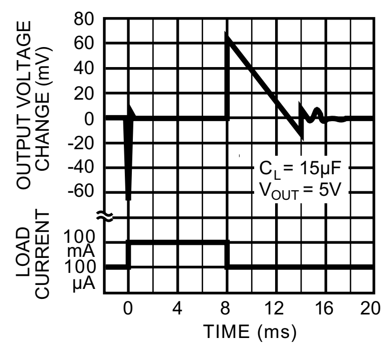


FIGURE 2-20: *Load Transient Response.*

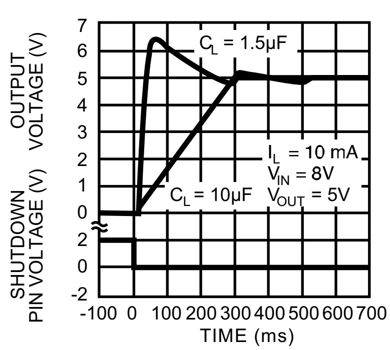


FIGURE 2-21: *Start-Up from SHDN.*

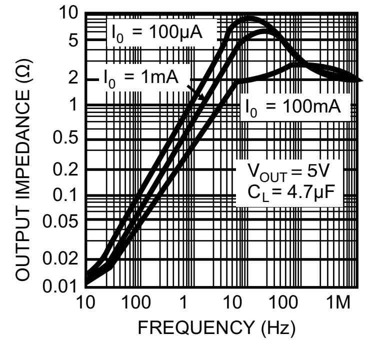


FIGURE 2-22: *Output Impedance.*

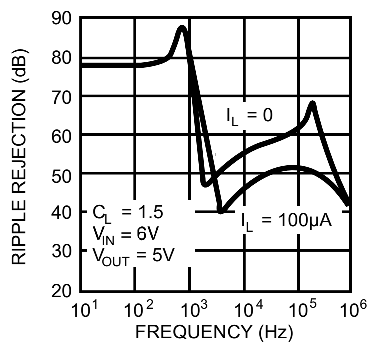


FIGURE 2-23: *Power Supply Ripple Rejection.*

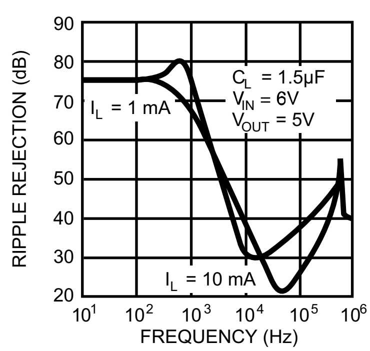


FIGURE 2-24: *Power Supply Ripple Rejection.*

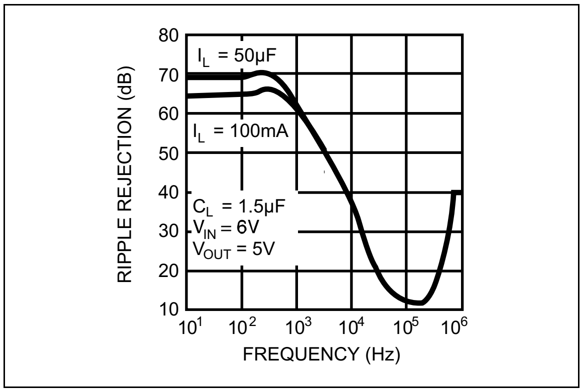


FIGURE 2-25: *Power Supply Ripple Rejection.*

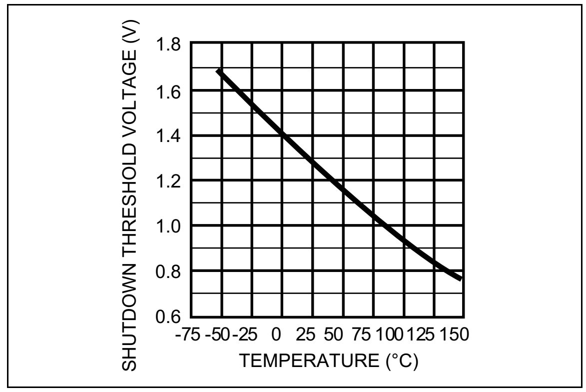


FIGURE 2-28: *Shutdown Threshold Voltage vs. Temperature.*

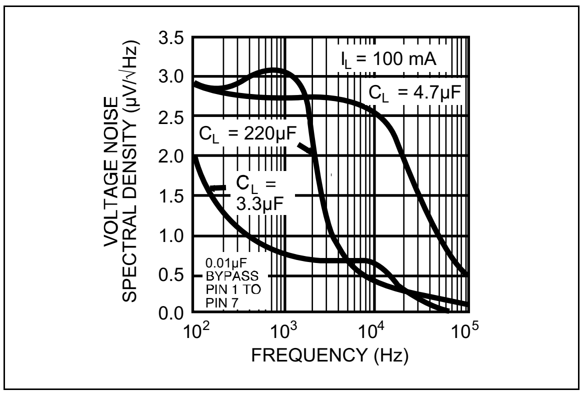


FIGURE 2-26: *Output Noise.*

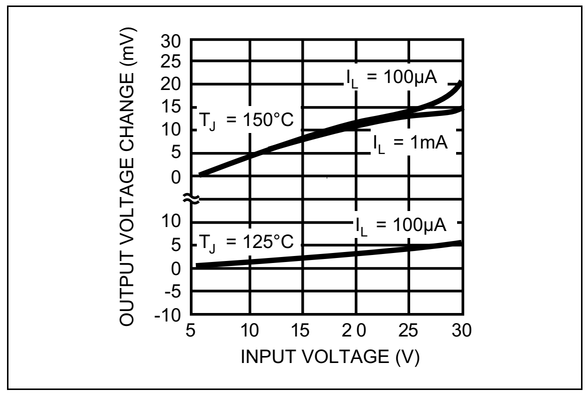


FIGURE 2-29: *Line Regulation.*

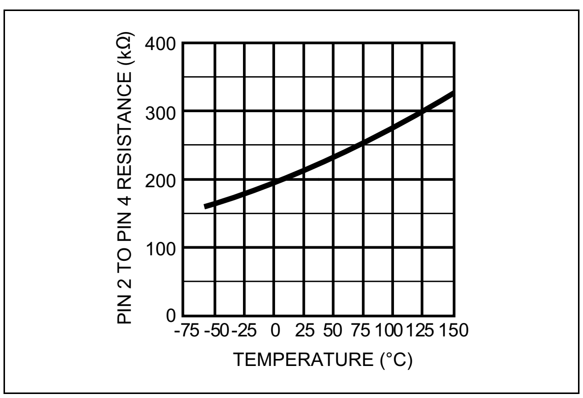


FIGURE 2-27: *Divider Resistance vs. Temperature.*

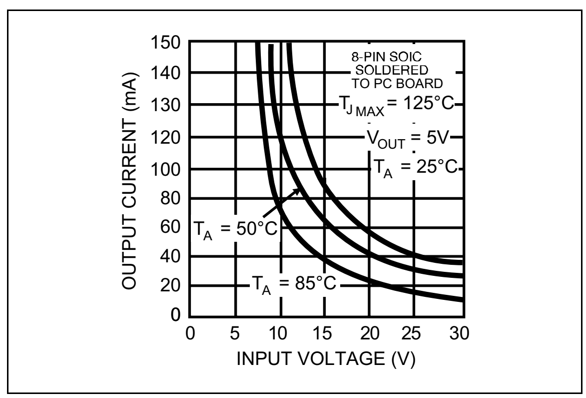


FIGURE 2-30: *Maximum Rated Output Current vs. Input Voltage.*

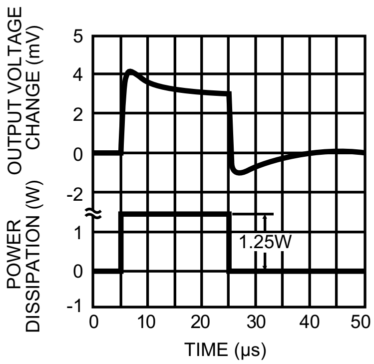


FIGURE 2-31: *Thermal Response.*

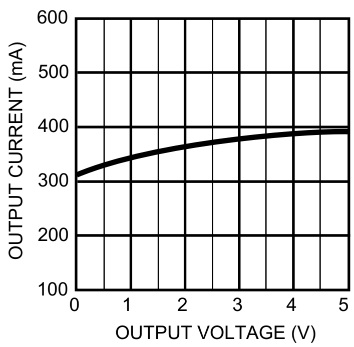


FIGURE 2-32: *Foldback Current Limiting.*

3.0 PIN DESCRIPTIONS

The descriptions of the pins are listed in Table 3-1.

TABLE 3-1: PIN FUNCTION TABLE

Pin Number	Pin Name	Description
1	OUT	Regulated Output.
2	SNS	Sense (Input): Output-voltage sensing end of internal voltage divider for fixed 5V operation. Not used in adjustable configuration.
3	SHDN	Shutdown/Enable (Input): TTL compatible input. High = shutdown, low or open = enable.
4	GND	Ground.
5	$\overline{\text{ERR}}$	Error Flag (Output): Active low, open-collector output (low = error, floating = normal).
6	TAP	3.3V/4.85V/5V Tap: Output of internal voltage divider when the regulator is configured for fixed operation. Not used in adjustable configuration.
7	FB	Feedback (Input): 1.235V feedback from internal voltage divider's TAP (for fixed operation) or external resistor network (adjustable configuration).
8	IN	Unregulated Supply Input.

4.0 APPLICATION CIRCUITS AND ISSUES

4.1 Automotive Applications

The MIC2951 is ideally suited for automotive applications for a variety of reasons. It will operate over a wide range of input voltages, have very low dropout voltages (40 mV at light loads), and very low quiescent currents. These features are necessary for use in battery powered systems, such as automobiles. It is also a “bulletproof” device; with the ability to survive both reverse battery (negative transients up to 20V below ground), and load dump (positive transients up to 60V) conditions. A wide operating temperature range with low temperature coefficients is yet another reason to use this versatile regulator in automotive designs.

4.2 External Capacitors

A 1.5 µF (or greater) capacitor is required between the MIC2951 output and ground to prevent oscillations due to instability. Most types of tantalum or aluminum electrolytics will be adequate; film types will work, but are costly and therefore not recommended. Many aluminum electrolytics have electrolytes that freeze at about –30°C, so solid tantalums are recommended for operation below –25°C. The important parameters of the capacitor are an effective series resistance of about 5Ω or less and a resonant frequency above 500 kHz. The value of this capacitor may be increased without limit.

At lower values of output current, less output capacitance is required for output stability. The capacitor can be reduced to 0.5 µF for current below 10 mA or 0.15 µF for currents below 1 mA. Using the regulator at voltages below 5V runs the error amplifier at lower gains so that more output capacitance is needed. For the worst-case situation of a 150 mA load at 1.23V output (Output shorted to Feedback) a 5 µF (or greater) capacitor should be used.

The MIC2950 will remain stable and in regulation with no load in addition to the internal voltage divider, unlike many other voltage regulators. This is especially important in CMOS RAM keep-alive applications. When setting the output voltage of the MIC2951 with external resistors, a minimum load of 1 µA is recommended.

A 0.1 µF capacitor should be placed from the MIC2951 input to ground if there is more than 10 inches of wire between the input and the AC filter capacitor or if a battery is used as the input.

Stray capacitance to the MIC2951 Feedback terminal (pin 7) can cause instability. This may especially be a problem when using high value external resistors to set the output voltage. Adding a 100 pF capacitor between Output and Feedback and increasing the output capacitor to at least 3.3 µF will remedy this.

4.3 Error Detection Comparator Output

A logic low output will be produced by the comparator whenever the MIC2951 output falls out of regulation by more than approximately 5%. This figure is the comparator’s built-in offset of about 60mV divided by the 1.235V reference voltage. (Refer to the Block Diagram). This trip level remains “5% below normal” regardless of the programmed output voltage of the MIC2951. For example, the error flag trip level is typically 4.75V for a 5V output or 11.4V for a 12V output. The out of regulation condition may be due either to low input voltage, current limiting, thermal limiting, or overvoltage on input (over 40V).

Figure 4-1 is a timing diagram depicting the /ERROR signal and the regulated output voltage as the MIC2951 input is ramped up and down. The /ERROR signal becomes valid (low) at about 1.3V input. It goes high at about 5V input (the input voltage at which V_{OUT} = 4.75 for 5.0V applications). Since the MIC2951’s dropout voltage is load-dependent (see curve in Typical Performance Curves), the input voltage trip point (about 5V) will vary with the load current. The output voltage trip point does not vary with load.

The error comparator has an open-collector output which requires an external pull-up resistor. Depending on system requirements, this resistor may be returned to the output or some other supply voltage. In determining a value for this resistor, note that while the output is rated to sink 200 µA, this sink current adds to battery drain in a low battery condition. Suggested values range from 100 kΩ to 1 MΩ. The resistor is not required if this output is unused.

4.4 Programming the Output Voltage

The MIC2951 may be pin-strapped for 5V (or 3.3V or 4.85V) using its internal voltage divider by tying Pin 1 (output) to Pin 2 (sense) and Pin 7 (feedback) to Pin 6 (5V Tap). Alternatively, it may be programmed for any output voltage between its 1.235V reference and its 30V maximum rating. Taking into account the dropout voltage, the maximum output voltage recommended is 29V. An external pair of resistors is required, as shown in Figure 4-2.

The complete equation for the output voltage is shown in Equation 4-1.

EQUATION 4-1:

$$V_{OUT} = V_{REF} \times \left\{1 + \frac{R_1}{R_2}\right\} + I_{FB}R_1$$

Where:

V_{REF}	=	The nominal 1.235 reference voltage
I_{FB}	=	The feedback pin bias current, nominally –20 nA

The minimum recommended load current of 1 µA forces an upper limit of 1.2 MΩ on the value of R2, if the regulator must work with no load (a condition often found in CMOS in standby), I_{FB} will produce a 2% typical error in V_{OUT} which may be eliminated at room temperature by trimming R1. For better accuracy, choosing R2 = 100 kΩ reduces this error to 0.17% while increasing the resistor program current to 12 µA.

4.5 Reducing Output Noise

In some applications it may be advantageous to reduce the AC noise present at the output. One method is to reduce the regulator bandwidth by increasing the size of the output capacitor. This method is relatively inefficient, as increasing the capacitor from 1 µF to 220 µF only decreases the noise from 430 µV to 160 µV RMS for a 100 kHz bandwidth at 5V output.

Noise can be reduced fourfold by a bypass capacitor across R1, since it reduces the high frequency gain from 4 to unity. Choose from either Equation 4-2 or about 0.01 µF.

EQUATION 4-2:

$$C_{BYPASS} = \frac{1}{2\pi R_1 \bullet 200Hz}$$

When doing this, the output capacitor must be increased to 3.3 µF to maintain stability. These changes reduce the output noise from 430 µV to 100 µV_{rms} for a 100 kHz bandwidth at 5V output. With the bypass capacitor added, noise no longer scales with output voltage so that improvements are more dramatic at higher output voltages.

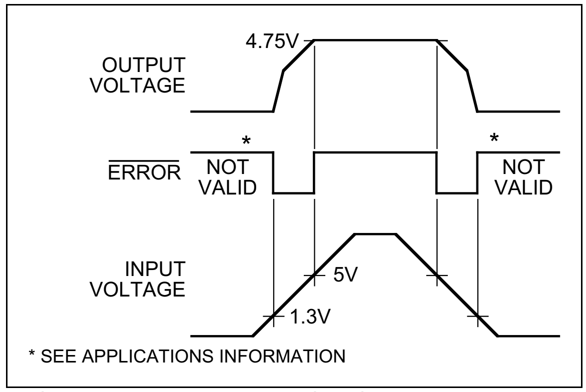


FIGURE 4-1: *ERROR Output Timing.*

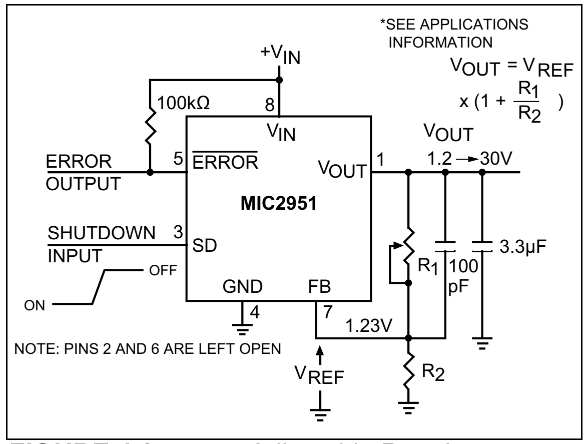


FIGURE 4-2: *Adjustable Regulator.*

5.0 SCHEMATIC DIAGRAM

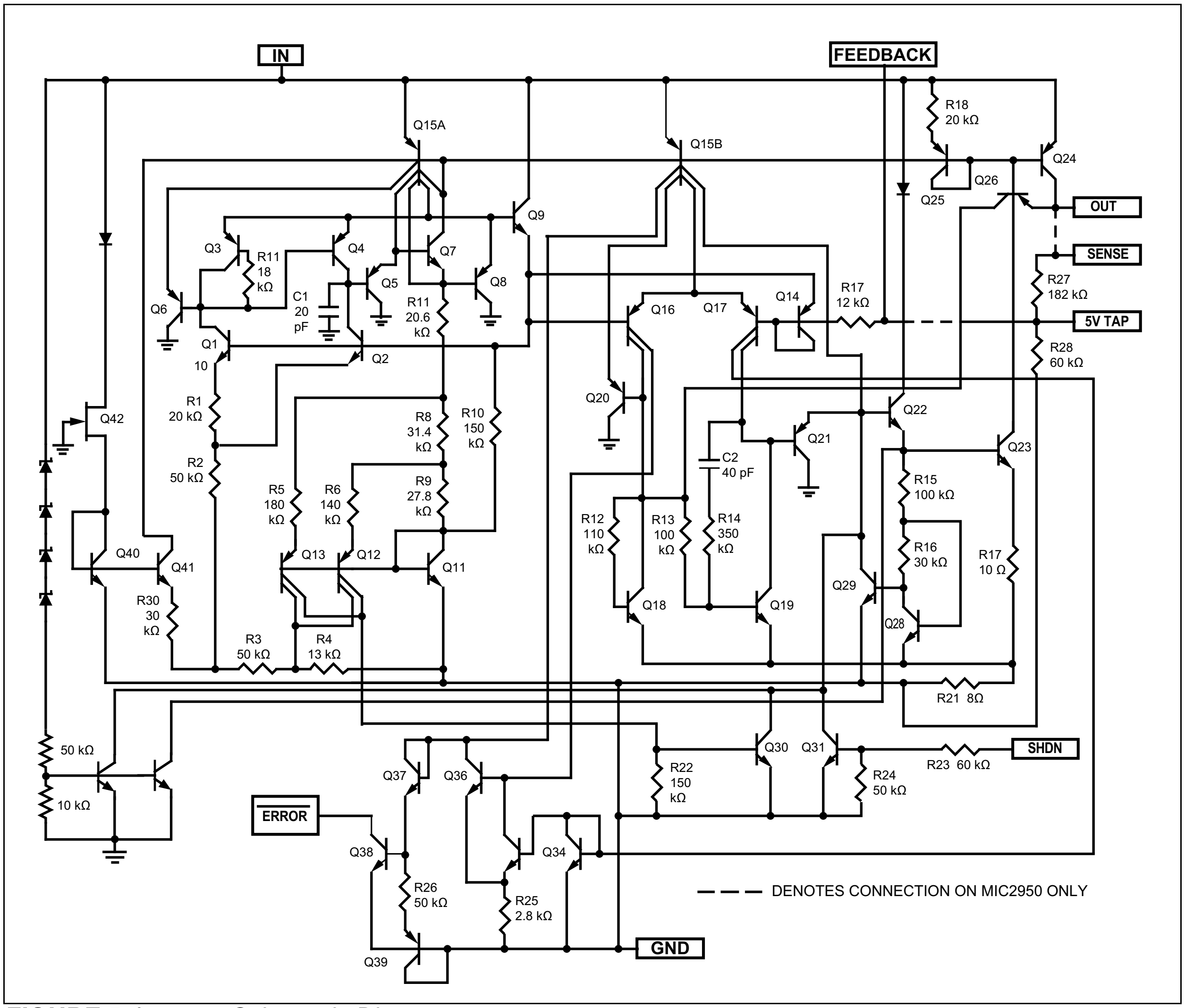
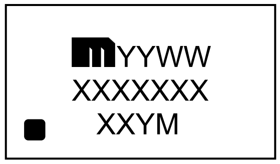


FIGURE 5-1: *Schematic Diagram.*

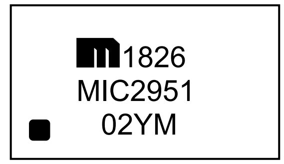
6.0 PACKAGING INFORMATION

6.1 Package Marking Information

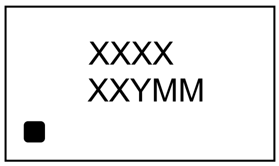
8-Lead SOIC*



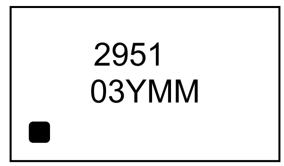
Example



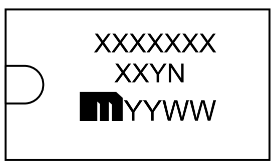
8-Lead MSOP*



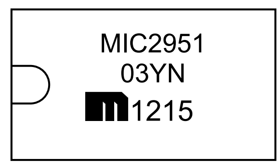
Example



8-Lead PDIP*



Example



Legend:	XX...X	Product code or customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week ‘01’)
	NNN	Alphanumeric traceability code
	(e3)	Pb-free JEDEC® designator for Matte Tin (Sn)
	*	This package is Pb-free. The Pb-free JEDEC designator ((e3)) can be found on the outer packaging for this package.
	●, ▲, ▼	Pin one index is identified by a dot, delta up, or delta down (triangle mark).

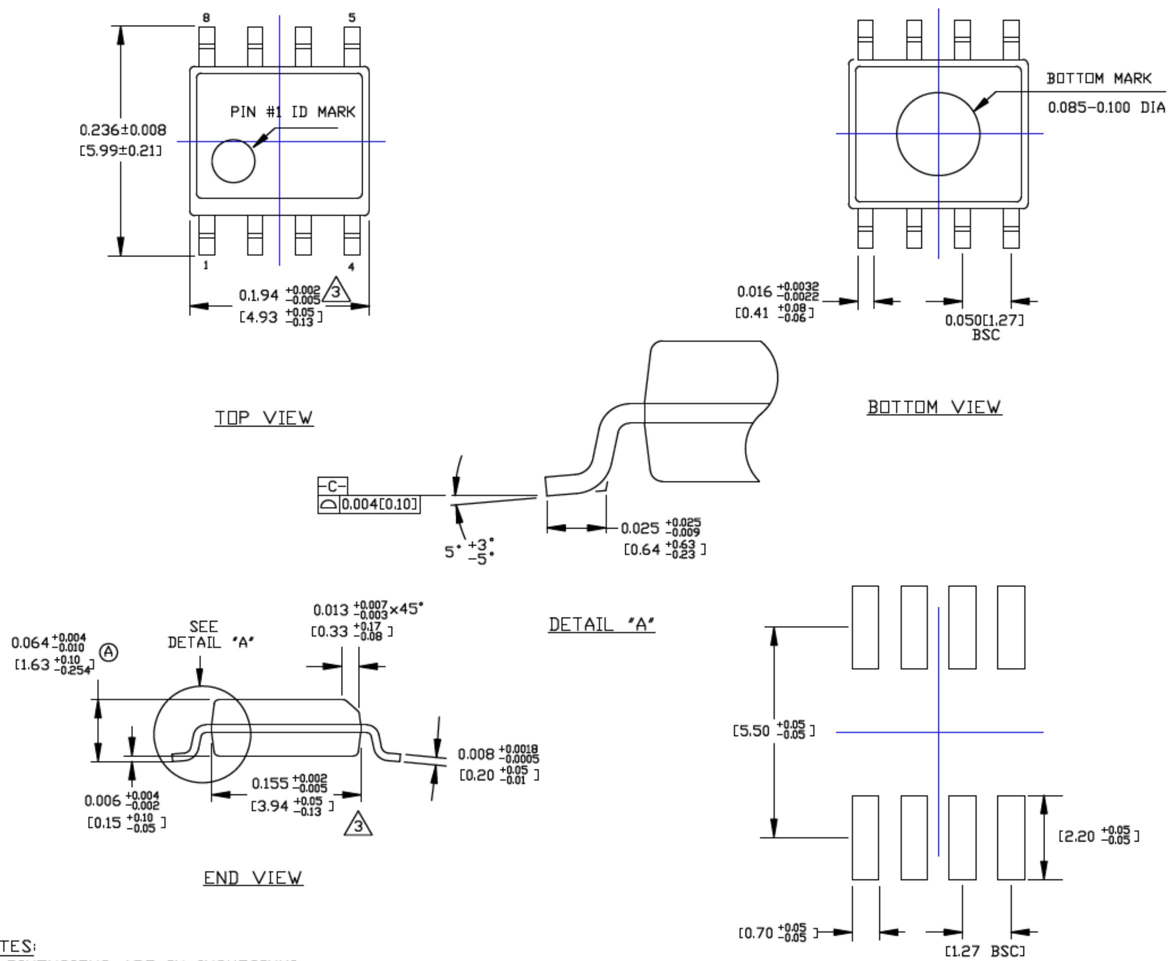
Note: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information. Package may or may not include the corporate logo.

Underbar (_) and/or Overbar (‾) symbol may not be to scale.

8-Lead SOICN Package Outline & Recommended Land Pattern

TITLE
8 LEAD SOICN PACKAGE OUTLINE & RECOMMENDED LAND PATTERN

DRAWING #	SOICN-8LD-PL-1	**UNIT**	INCH [MM]



RECOMMENDED LAND PATTERN

NOTES:
1. DIMENSIONS ARE IN INCHES[MM].
2. CONTROLLING DIMENSION: INCHES.
3. DIMENSION DOES NOT INCLUDE MOLD FLASH OR PROTRUSIONS, EITHER OF WHICH SHALL NOT EXCEED 0.010[0.25] PER SIDE.

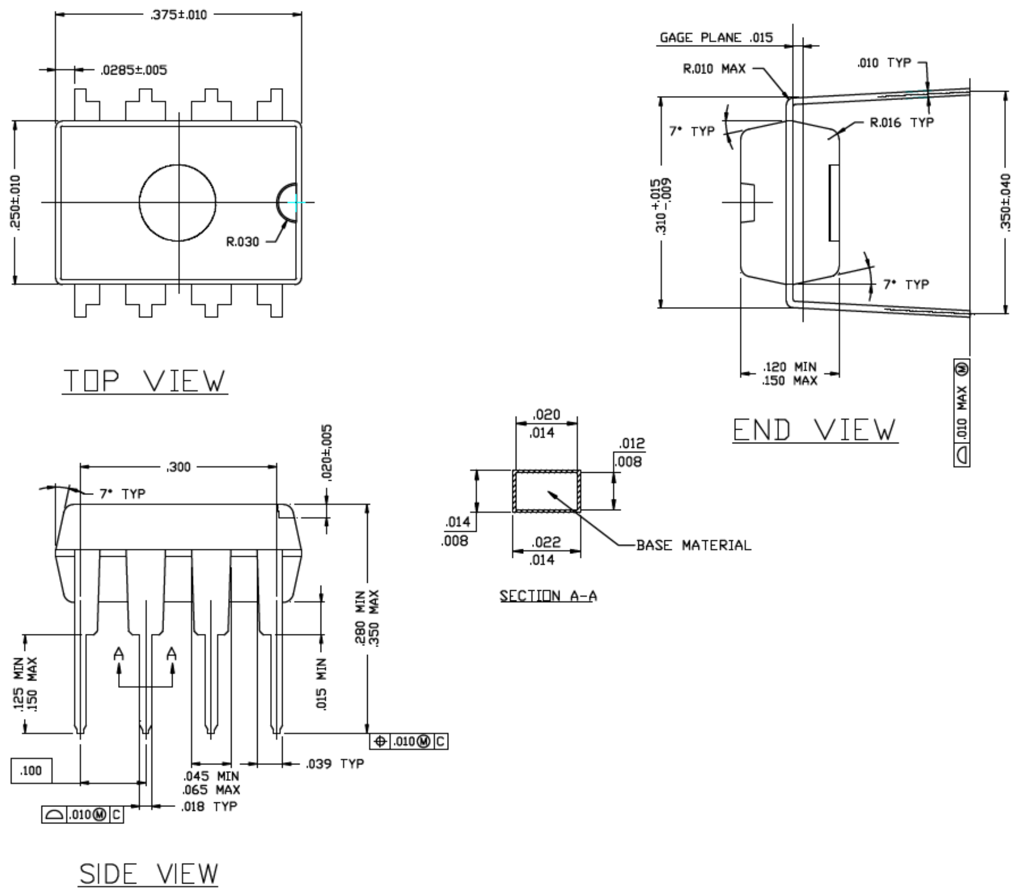
Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging.

8-Lead Plastic DIP Package Outline & Recommended Land Pattern

TITLE

8 LEAD PDIP PACKAGE OUTLINE & RECOMMENDED LAND PATTERN

DRAWING #	PDIP-8LD-PL-1	**UNIT**	INCH
Lead Frame	Copper	**Lead Finish**	Matte Tin

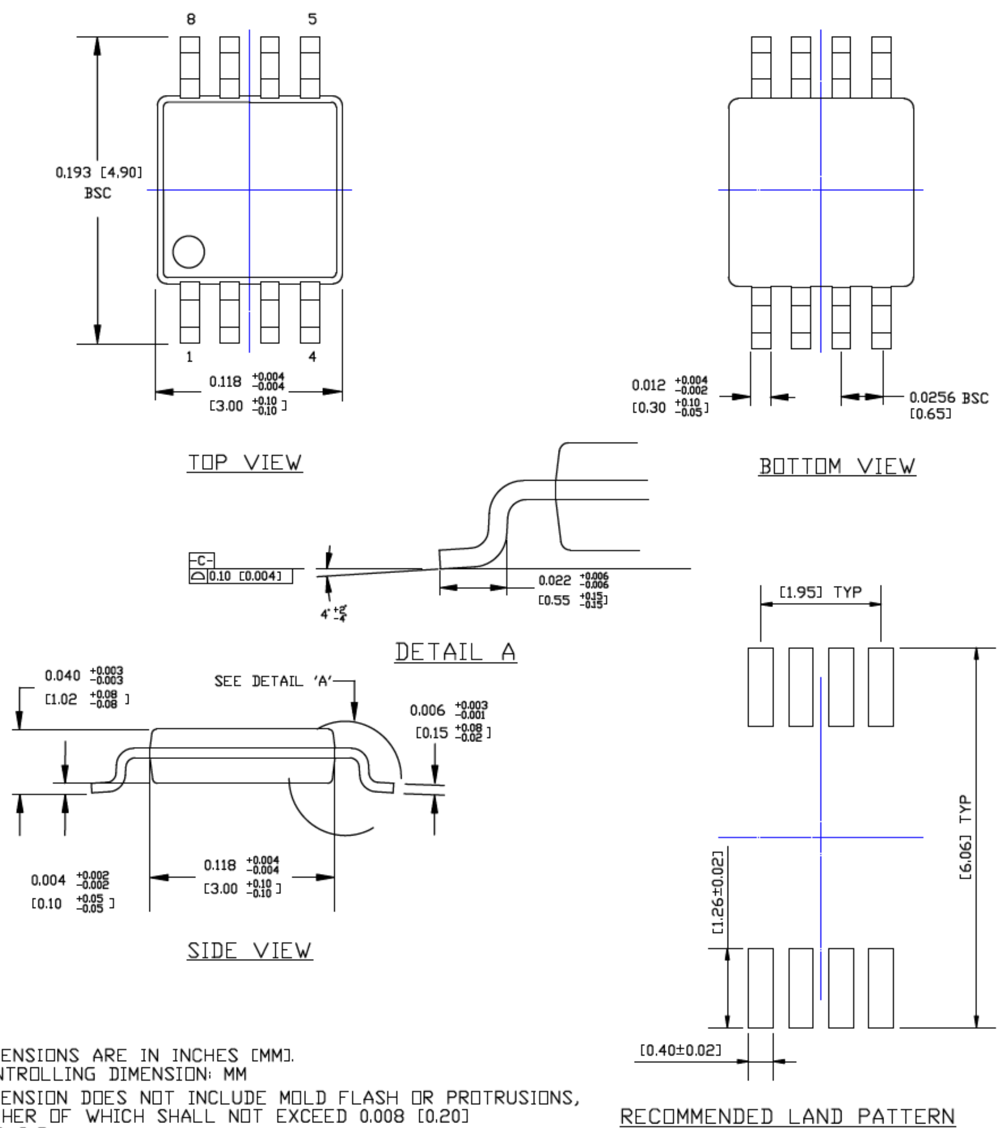


Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging.

8-Lead MSOP Package Outline & Recommended Land Pattern

TITLE
8 LEAD MSOP PACKAGE OUTLINE & RECOMMENDED LAND PATTERN

DRAWING #	MSOP-8LD-PL-1	**UNIT**	INCH [MM]



NOTES:
1. DIMENSIONS ARE IN INCHES [MM].
2. CONTROLLING DIMENSION: MM
3. (△) DIMENSION DOES NOT INCLUDE MOLD FLASH OR PROTRUSIONS, EITHER OF WHICH SHALL NOT EXCEED 0.008 [0.20] PER SIDE.

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging.

APPENDIX A: REVISION HISTORY

Revision A (November 2020)

- Converted Micrel document MIC2951 to Microchip data sheet template DS20006447A.
- Minor grammatical text changes throughout.
- Removed all reference to MIC2950 which has been EOL.

NOTES:

PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, contact your local Microchip representative or sales office.

PART NO.	-XX	X	XX	-XX
Device	Voltage Specification Range	Temperature Range	Package	Media Type

Device:	MIC2951:	150 mA Low-Dropout Voltage Regulator
Output and Reference Voltage Specification Range:	02 = 5.0V ±0.5% 03 = 5.0V ±1.0%	
Temperature Range:	Y = –40°C to +125°C (RoHS Compliant)	
Packages:	M = 8-Lead SOIC MM = 8-Lead MSOP N = 8-Lead Plastic DIP	
Media Type:	<blank>= 95/Tube (SOIC option) <blank>= 100/Tube (MSOP option) <blank>= 50/Tube (PDIP option) TR = 2500/Reel (All package options)	

Examples:

a) MIC2951-02YM: MIC2951, 5.0V ±0.5% Voltage Specification Range, –40°C to +125°C Temp. Range, 8-Lead SOIC, 95/Tube

b) MIC2951-03YN: MIC2951, 5.0V ±1.0% Voltage Specification Range, –40°C to +125°C Temp. Range, 8-Lead PDIP, 50/Tube

c) MIC2951-03YMM: MIC2951, 5.0V ±1.0% Voltage Specification Range, –40°C to +125°C Temp. Range, 8-Lead MSOP, 100/Tube

d) MIC2951-02YM-TR: MIC2951, 5.0V ±0.5% Voltage Specification Range, –40°C to +125°C Temp. Range, 8-Lead SOIC, 2,500/Reel

e) MIC2951-03YMM-TR: MIC2951, 5.0V ±1.0% Voltage Specification Range, –40°C to +125°C Temp. Range, 8-Lead MSOP, 2,500/Reel

Note 1: Tape and Reel identifier only appears in the catalog part number description. This identifier is used for ordering purposes and is not printed on the device package. Check with your Microchip Sales Office for package availability with the Tape and Reel option.

NOTES:

Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specifications contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is secure when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods being used in attempts to breach the code protection features of the Microchip devices. We believe that these methods require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Attempts to breach these code protection features, most likely, cannot be accomplished without violating Microchip's intellectual property rights.
- Microchip is willing to work with any customer who is concerned about the integrity of its code.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of its code. Code protection does not mean that we are guaranteeing the product is "unbreakable." Code protection is constantly evolving. We at Microchip are committed to continuously improving the code protection features of our products. Attempts to break Microchip's code protection feature may be a violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyrighted work, you may have a right to sue for relief under that Act.

For information regarding Microchip's Quality Management Systems, please visit www.microchip.com/quality.

Trademarks

ISBN: 978-1-5224-7157-8

Worldwide Sales and Service

AMERICAS

Corporate Office
2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 480-792-7200
Fax: 480-792-7277
Technical Support:
http://www.microchip.com/support
Web Address:
www.microchip.com

Atlanta
Duluth, GA
Tel: 678-957-9614
Fax: 678-957-1455

Austin, TX
Tel: 512-257-3370

Boston
Westborough, MA
Tel: 774-760-0087
Fax: 774-760-0088

Chicago
Itasca, IL
Tel: 630-285-0071
Fax: 630-285-0075

Dallas
Addison, TX
Tel: 972-818-7423
Fax: 972-818-2924

Detroit
Novi, MI
Tel: 248-848-4000

Houston, TX
Tel: 281-894-5983

Indianapolis
Noblesville, IN
Tel: 317-773-8323
Fax: 317-773-5453
Tel: 317-536-2380

Los Angeles
Mission Viejo, CA
Tel: 949-462-9523
Fax: 949-462-9608
Tel: 951-273-7800

Raleigh, NC
Tel: 919-844-7510

New York, NY
Tel: 631-435-6000

San Jose, CA
Tel: 408-735-9110
Tel: 408-436-4270

Canada - Toronto
Tel: 905-695-1980
Fax: 905-695-2078

ASIA/PACIFIC

Australia - Sydney
Tel: 61-2-9868-6733

China - Beijing
Tel: 86-10-8569-7000

China - Chengdu
Tel: 86-28-8665-5511

China - Chongqing
Tel: 86-23-8980-9588

China - Dongguan
Tel: 86-769-8702-9880

China - Guangzhou
Tel: 86-20-8755-8029

China - Hangzhou
Tel: 86-571-8792-8115

China - Hong Kong SAR
Tel: 852-2943-5100

China - Nanjing
Tel: 86-25-8473-2460

China - Qingdao
Tel: 86-532-8502-7355

China - Shanghai
Tel: 86-21-3326-8000

China - Shenyang
Tel: 86-24-2334-2829

China - Shenzhen
Tel: 86-755-8864-2200

China - Suzhou
Tel: 86-186-6233-1526

China - Wuhan
Tel: 86-27-5980-5300

China - Xian
Tel: 86-29-8833-7252

China - Xiamen
Tel: 86-592-2388138

China - Zhuhai
Tel: 86-756-3210040

ASIA/PACIFIC

India - Bangalore
Tel: 91-80-3090-4444

India - New Delhi
Tel: 91-11-4160-8631

India - Pune
Tel: 91-20-4121-0141

Japan - Osaka
Tel: 81-6-6152-7160

Japan - Tokyo
Tel: 81-3-6880- 3770

Korea - Daegu
Tel: 82-53-744-4301

Korea - Seoul
Tel: 82-2-554-7200

Malaysia - Kuala Lumpur
Tel: 60-3-7651-7906

Malaysia - Penang
Tel: 60-4-227-8870

Philippines - Manila
Tel: 63-2-634-9065

Singapore
Tel: 65-6334-8870

Taiwan - Hsin Chu
Tel: 886-3-577-8366

Taiwan - Kaohsiung
Tel: 886-7-213-7830

Taiwan - Taipei
Tel: 886-2-2508-8600

Thailand - Bangkok
Tel: 66-2-694-1351

Vietnam - Ho Chi Minh
Tel: 84-28-5448-2100

EUROPE

Austria - Wels
Tel: 43-7242-2244-39
Fax: 43-7242-2244-393

Denmark - Copenhagen
Tel: 45-4485-5910
Fax: 45-4485-2829

Finland - Espoo
Tel: 358-9-4520-820

France - Paris
Tel: 33-1-69-53-63-20
Fax: 33-1-69-30-90-79

Germany - Garching
Tel: 49-8931-9700

Germany - Haan
Tel: 49-2129-3766400

Germany - Heilbronn
Tel: 49-7131-72400

Germany - Karlsruhe
Tel: 49-721-625370

Germany - Munich
Tel: 49-89-627-144-0
Fax: 49-89-627-144-44

Germany - Rosenheim
Tel: 49-8031-354-560

Israel - Ra'anana
Tel: 972-9-744-7705

Italy - Milan
Tel: 39-0331-742611
Fax: 39-0331-466781

Italy - Padova
Tel: 39-049-7625286

Netherlands - Drunen
Tel: 31-416-690399
Fax: 31-416-690340

Norway - Trondheim
Tel: 47-7288-4388

Poland - Warsaw
Tel: 48-22-3325737

Romania - Bucharest
Tel: 40-21-407-87-50

Spain - Madrid
Tel: 34-91-708-08-90
Fax: 34-91-708-08-91

Sweden - Gothenberg
Tel: 46-31-704-60-40

Sweden - Stockholm
Tel: 46-8-5090-4654

UK - Wokingham
Tel: 44-118-921-5800
Fax: 44-118-921-5820

02/28/20