REGULATION CONTROL CIRCUIT LBR FAMILY

T-58-11-13

Description

The Regulation Control Circuit LBR Family consists of integrated circuits which provide three useful power supply function (see Applications) in the same package: a voltage regulator, a precision 1.25 V reference, and a high-speed comparator. Each device accepts an unregulated dc supply voltage ranging from 4 V to 26 V and provides two fixed outputs: a 1.25 V reference voltage, common to each device code in this family; and a customer specified regulation voltage, ranging from 2 V to 24 V, fixed at time of manufacture. Refer to Ordering Information (last page) for a detailed coding description.

These devices are available in 16-pin packages (Functional Diagram) which allow a designer to customize several circuit configurations. These devices are also available in 8-pin packages (Functional Diagram) with a fixed configuration.

Features

Voltage Regulator

- Fixed values between 2 V and 24 V (±1%)
- Less than 1% change over combined temperature and supply voltage ranges:
  $-40°C \leq T_A \leq +100°C$
  $4\ V \leq V+ \leq 26\ V$

High-Speed Comparator

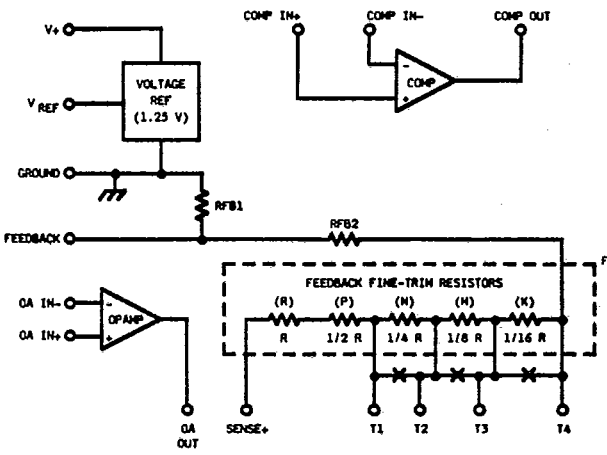
- Referenced to 1.25 V
- Propagation delay < 150 ns
- Input offset < 5 mV (−40 to +100°C).
- Output loading to 10 mA maximum

Precision Low-Voltage Reference

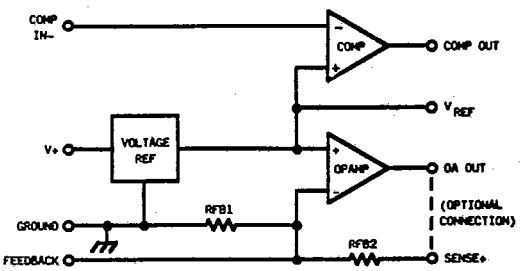
- 1.25 V (±1%) from 4- to 26-Volt Supply
- Temperature coefficient
  < 50 ppm/°C (−40 to +100°C)
- 4-Volt minimum V+ operation
  (−40 to +100°C)
- Capacitive operation to 100 pF maximum
- Current loading to ≤ 10 mA
- Excellent power supply rejection ratio
  (PSRR) 70 dB @ dc; 40 dB @ 1 MHz
- Fast transient start-up time

Functional Diagrams

16-Pin Package



8-Pin Package



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Pin Diagrams (See Notes 1 & 2 on page 5.)

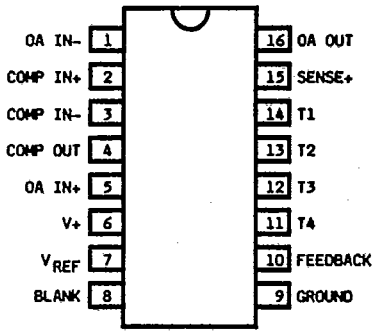

Figure 1. 16-Pin Surface Mount (SOJ)

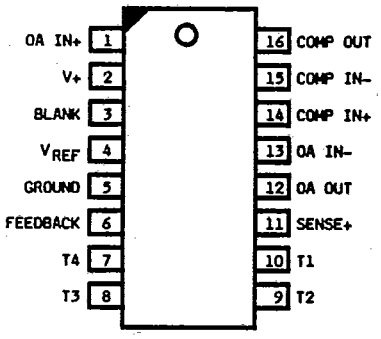

Figure 2. 16-Pin Plastic DIP

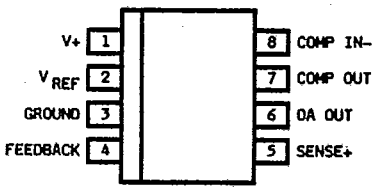

Figure 3. 8-Pin Surface Mount (SOIC)

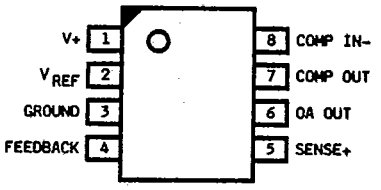

Figure 4. 8-Pin Plastic DIP

Pin Descriptions (See Notes 1 & 2 on page 5.)

Pin No.	Name	Description
6	V+	Supply Voltage (4 to 26 V)
8	BLANK	This pin may be used as a tie-point for external components. Maximum Voltage = 30 V
9	GROUND	Circuit common (not necessarily system or physical ground).
7	VREF	1.25 V Reference Output
3	COMP IN –	Inverting Comparator Input
2	COMP IN +	Non-Inverting Comparator Input. Connected to VREF on 8-Pin Packages.
4	COMP OUT	Comparator Output, Open Collector. Requires pull-up resistor.
1	OA IN –	Inverting Op-Amp Input. Connected to FEEDBACK on 8-Pin Packages.
5	OA IN +	Non-Inverting Op-Amp Input. Connected to VREF on 8-Pin Packages.
16	OA OUT	Op-Amp Output.
10	FEEDBACK	Connection to feedback resistors. Connected to OA IN – on 8-Pin Packages.
15	SENSE +	Positive Sense Node. Normally connected to OA OUT in regulator applications.
14 13 12 11	T1 T2 T3 T4 (See Functional Diagram)	These trim links are normally factory trimmed as required to provide the desired voltage regulator output. However, some applications may require additional fine-tuned trimming to account for offset voltages in customer systems. Devices can be ordered which are trimmed to a value within several mV of a customer's desired value. The customer is then responsible for final trimming. (This option not available in 8-Pin Packages.)

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Maximum Ratings

At 25 °C

Stresses exceeding the values listed under Maximum Ratings may cause permanent damage to the device. This is an absolute stress rating only. Functional operation of the device at these or any other conditions in excess of those indicated in the operational sections of this data sheet is not implied. Exposure to maximum-rating conditions for extended periods of time may adversely affect device reliability.

Rating	Value	Unit
Power-Supply Voltage (V+)	30	V
Ambient Operating Temperature Range	−40 to +100	°C
Storage Temperature	−55 to +125	°C
Pin Soldering Temperature (t = 15 s max.)	300	°C

Electrical Characteristics

(T_A = 25 °C unless otherwise specified)

Characteristic and Conditions	Min	Typ	Max	Unit
Total Circuit				
Power-Supply Voltage Range (V+)	3.5	—	26	V
Standby Current Drain (V+ = 29 V) (Note 3)				
T_A = 25°C	—	3.7	4.5	mA
T_A = 100°C	—	4.0	—	mA
Line Impedance (4 V ≤ V + ≤ 26 V)	—	230	—	kΩ
Voltage Regulator				
Available V_{SENSE} Range (Note 4)	2	—	24	V
V+ minus V_{SENSE} (Note 5)	1.4	—	24	V
V_{SENSE} Set Point	−1	±0.3	+1	%
V_{SENSE} Load Regulation (0 mA ≤ I_{SENSE} ≤ 10 mA) (Note 5)				
T_A = 25°C	—	±0.05	±0.2	%
−40°C ≤ T_A ≤ 100°C	—	±0.15	—	%
Temperature Coefficient of V_{SENSE} Over V+ Range (−40°C ≤ T_A ≤ +100°C; 4V ≤ V+ ≤ 26 V)	—	±.002	—	%/°C
Precision Low-Voltage Reference				
V_{REF}, Set Point V+ = 4 V to 26 V	1.238	1.250 (±.005)	1.262	V
I_{REF} Operating Current	—	—	10	mA
V_{REF} Voltage Change (−40°C ≤ T_A ≤ +100°C; I_{REF} = 10 mA)	—	±.0035	±.005	%/°C
		or		
	—	±35	±50	ppm/°C
V_{REF} Line Regulation (Note 6) 4 V ≤ V+ ≤ 26 V; I_{REF} = 10 mA)	—	3	6	mV
V_{REF} Load Regulation (0 ≤ I_{REF} ≤ 10 mA)	—	3	8	mV
V_{REF} Temperature Regulation (−40°C ≤ T_A ≤ +100°C; I_{REF} = 10 mA)	—	3	—	mV

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Electrical Characteristics
(Continued)

Characteristic and Conditions	Min	Typ	Max	Unit
Precision Low-Voltage Reference (Continued)				
Supply Voltage (V+) Start-Up (Note 7) ($-40°C \le T_A + 100°C$; I_{REF} = 10 mA)	4	—	—	V
Power-Supply Rejection Ratio				
(Load Capacitance = 100 pF) dc	—	70	—	dB
1 MHz	—	40	—	dB
Transient start-Up Time (Load Capacitance = 100 pF)				
I_{REF} = 1 mA	—	2	—	μs
I_{REF} = 5 mA	—	15	—	μs
I_{REF} = 10 mA	—	150	—	μs
V_{REF} RMS Noise Voltage (10 Hz ≤ f ≤ 10 kHz)	—	5	—	μVrms
High-Speed Comparator				
Input Offset Voltage ($-40°C \le T_A \le +100°C$)	—	±1	±5	mV
Input Bias Current	—	300	900	nA
Output Sink Current	—	—	10	mA
Output Saturation Voltage				
(Output Sink Current = 10 mA)				
(V_{IN} + = 250 mV overdrive), T_A = 25°C	—	235	500	mV
$-40°C \le T_A + 100°C$	—	< 350	—	mV
(Output Sink Current = 5 mA)				
(V_{IN} + = 250 mV overdrive), T_A = 25°C	—	130	400	mV
$-40°C \le T_A \le +100°C$	—	< 150	—	mV
Transient Response Times				
(Logic Low = 0 V; Logic High = 2.5 V,				
Output Reference = 1.4 V)				
Propagation Dely (Low-to-High)	—	105	—	ns
Propagation Delay (High-to-Low)	—	25	—	ns
Rise Time (10% to 90%)	—	20	—	ns
Fall Time (90% to 10%)	—	50	—	ns
Output Leakage Current	—	1	10	μA
Differential Input Voltage	—	—	±6	V
Operational Amplifier				
Input Offset Voltage	—	±1.0	±5.0	mV
Output Voltage Swing (R_L = 2kΩ)				
$V_{IN}-$ = 0.5 V, V_{HIGH}	(V+) − 1.5	(V+) − 0.8	—	V
$V_{IN}-$ = 1.5 V, V_{LOW}	—	+1.6	+1.65	V
Input Bias Current	—	550	—	nA
Output Source Current				
($V_{IN}-$ = 0 V; R_L = 100Ω)	—	31	—	mA

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Electrical Characteristics
(Continued)

Characteristic and Conditions	Min	Typ	Max	Unit
Operational Amplifier				
Output Sink Current (V_{IN-} = 2.25 V; R_L = 100Ω; $V_{OUT} \leq$ 1.65 V)	—	35	—	mA
Common-Mode Voltage Range High (Note 8) Low	— —	(V+) − 2.5 GND	— —	V V
Power-Supply Rejection Ratio (DC)	—	100	—	dB
Unity Gain Frequency (C_C = C_{int})	—	3.0	—	MHz
Slew Rate (Gain = 10 to 100; C_C = C_{int})	—	11	—	V/μs

Notes:

1. When certain pins are not being used, they should be connected as follows for the 8-Pin devices:
   a. COMP IN − to GND (when comparator is not used)
   b. OA OUT to FEEDBACK (when Op-Amp is not used)
   c. SENSE + should float (when Op-Amp is not used)
2. When certain pins are not used, they should be connected as follows for the 16-Pin devices:
   a. When the comparator is not used, connect COMP IN + to V_{REF} and COMP IN − to GND.
   b. When the Op-Amp is not used, connect OA OUT to OA IN − and OA IN + to V_{REF}.
3. This characteristic excludes the current flowing in the feedback resistors. Feedback current must be calculated for each voltage regulator value.
4. Specific available V_{SENSE} output levels are listed with Ordering Information on the last page.
5. OA OUT is connected to SENSE +.
6. OA OUT is disconnected from SENSE +.
7. This is the minimum supply voltage which is required to assure that V_{REF} has stabilized at any specific temperature within the specified temperature range.
8. Supply voltage (V+) minus a nominal 2.5 V yields high CMVR.

Characteristic Curves

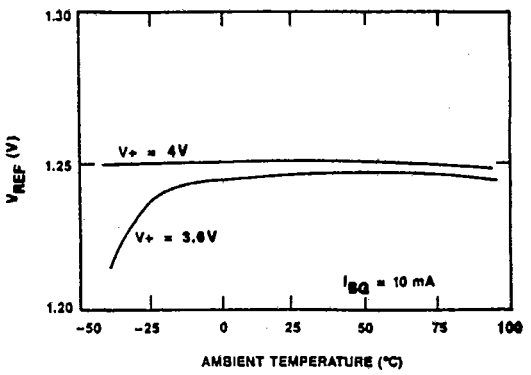

Figure 5. Precision Low-Voltage Reference Start-Up Characteristics

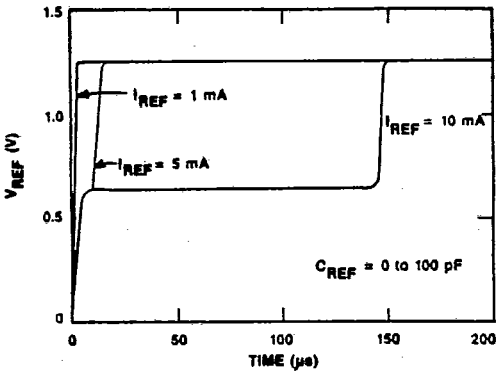

Figure 6. Precision Low-Voltage Reference Transient Start-Up Time

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Characteristic Curves
(Continued)

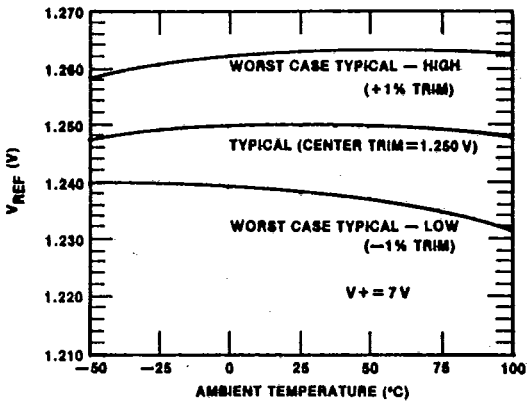

Figure 7. Precision Low-Voltage Reference Temperature Characteristics

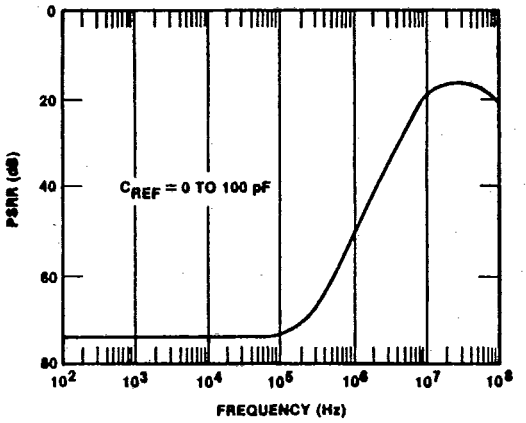

Figure 8. Precision Low-Voltage Reference Power Supply Rejection Ratio Frequency Characteristics

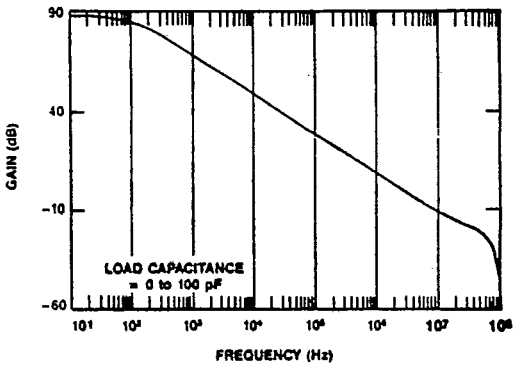

Figure 9. Op-Amp Open Loop Gain

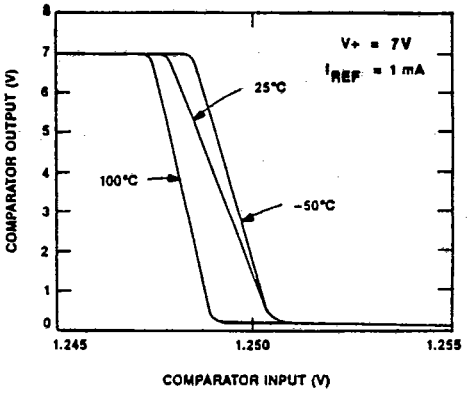

Figure 10. Typical Comparator DC Transfer Characteristics vs Temperature

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Characteristic Curves
(Continued)

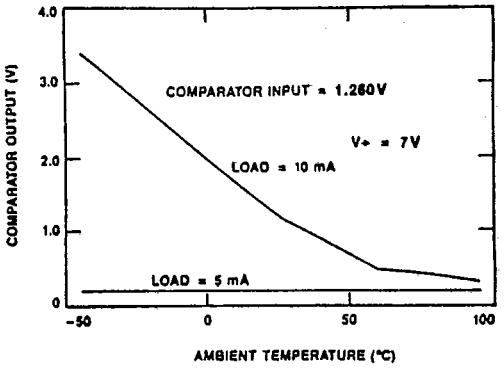

Figure 11. Typical Temperature Characteristics Comparator Output Voltage vs Comparator Input Overdrive of 10 mV

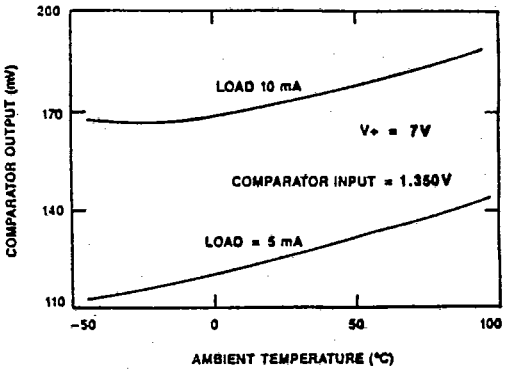

Figure 12. Typical Temperature Characteristics Comparator-Output Voltage vs Comparator Input Overdrive of 100 mV

Applications

The regulation control devices are used in power-supply applications where the simultaneous use of all three functions (voltage regulator, high-speed comparator, precision low-voltage reference) is a common practice.

Figure 13 shows an application which uses all three functions:

The regulator output (Pins 5 and 6 are connected) can be used in dc-dc Converter applications (see Figure 14), current regulation circuits, precision current limiting, etc.

The comparator (Pins 7 and 8) is configured as an alarm indicator circuit. The alarm indicator can be configured as either a visual indicator (LED), a logic output, or both.

The 1.25 V reference output (Pin 2) has many potential applications. Figure 13 shows one application where a programmable shutdown circuit is formed in conjunction with resistors R1 through R4, and an external comparator. The shutdown output controls a circuit which can shut down line voltages which exceed predetermined values.

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Applications
(Continued)

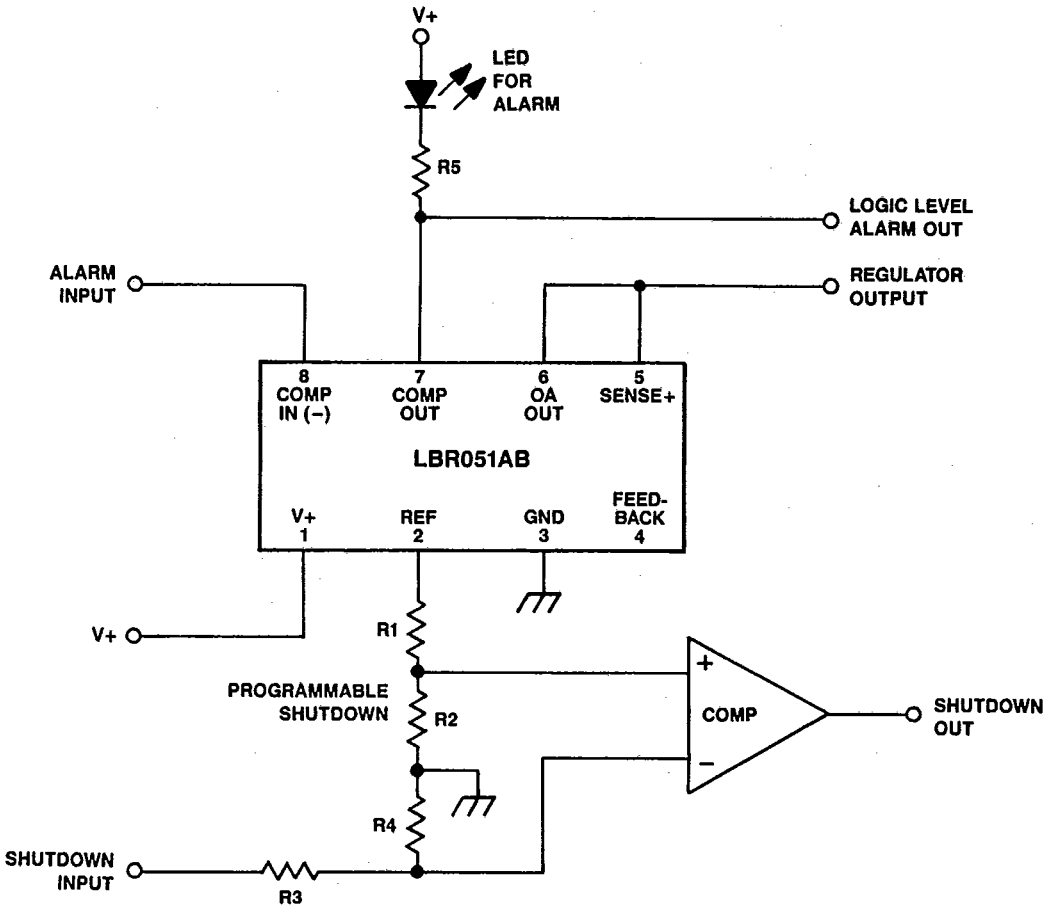
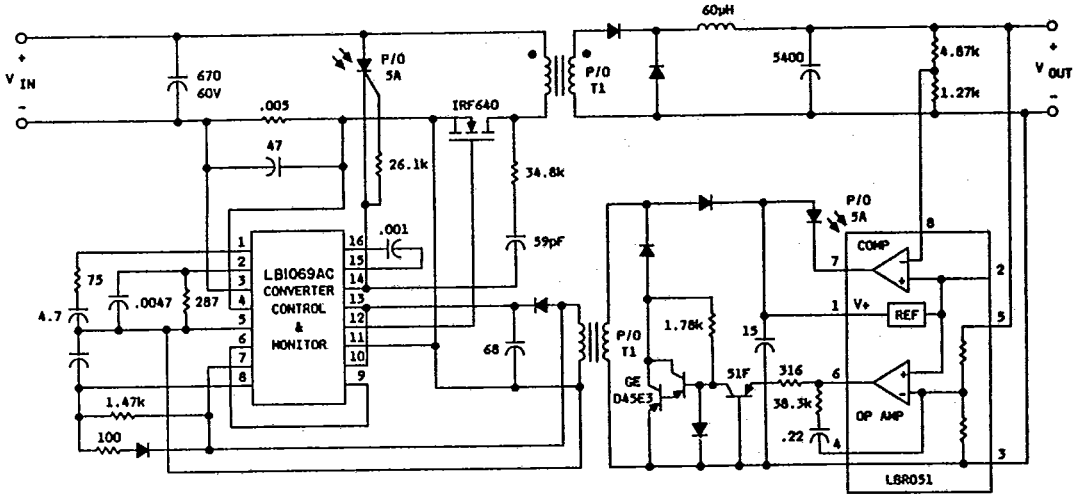


Figure 13. Regulation Control General Application Diagram

Applications
(Continued)

Figure 14 shows the LBR051, a 5.1 V regulation control device, as it is used in a dc-dc Converter application. This application is a 48 V to 5 V, 20 amp converter, and features high-voltage shutdown and current limiting.



Note: Unless otherwise specified, resistor values are in ohms and capacitor values are in microfarads.

Figure 14. DC-DC Converter Application

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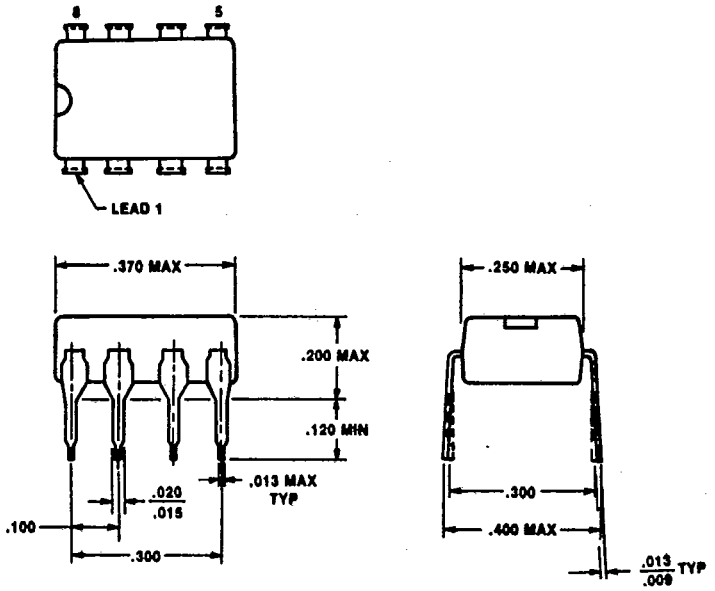
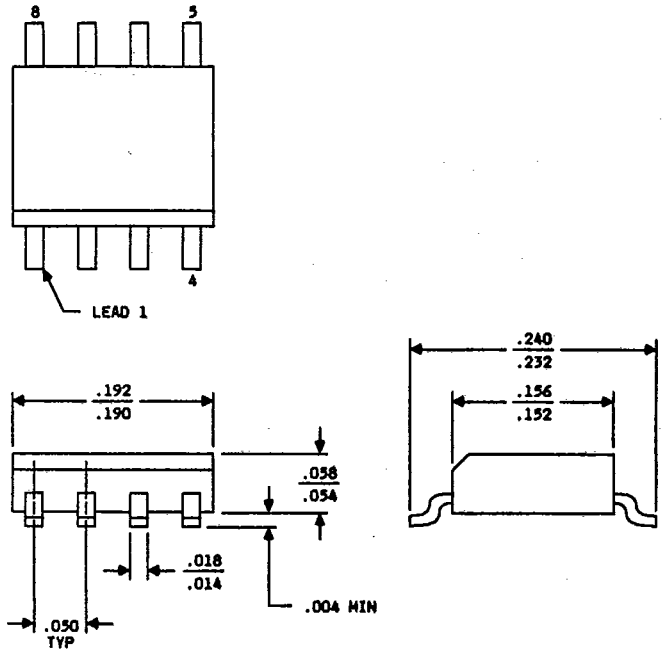
Outline Drawings
(Dimensions in Inches)

8-Pin DIP



8-Pin



REGULATION CONTROL CIRCUIT LBR FAMILY

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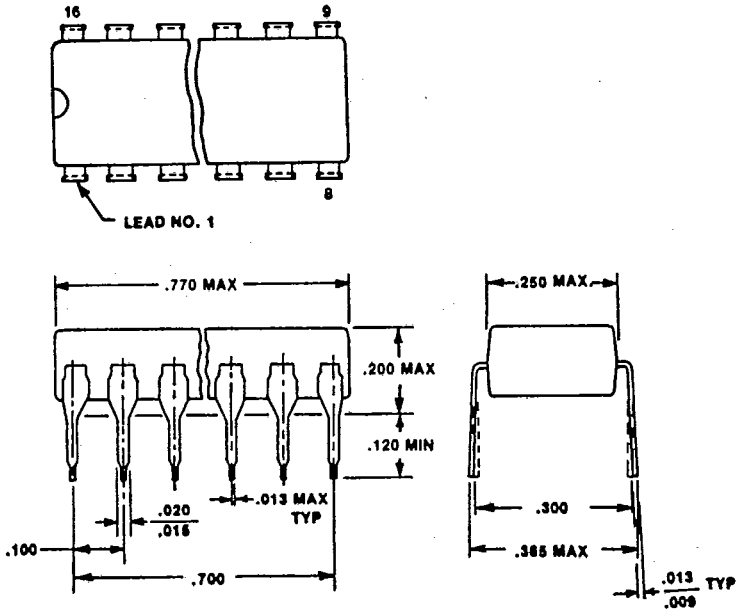
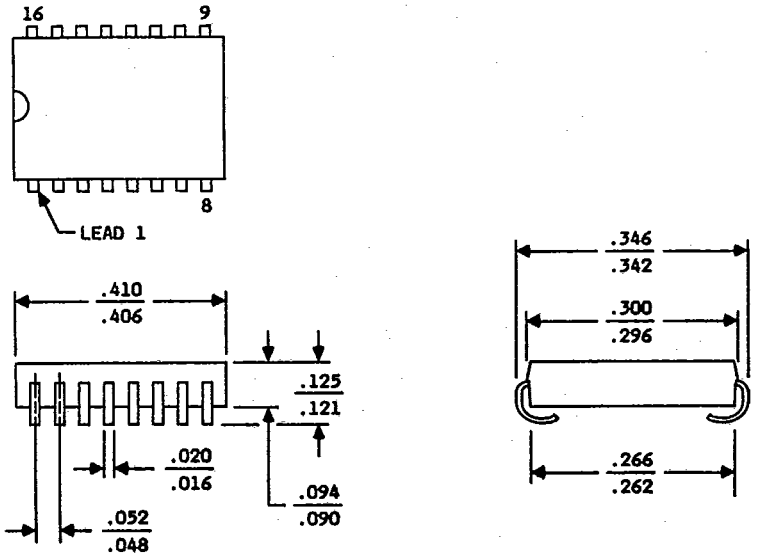
Outline Drawings
(Dimensions in Inches)

16-Pin DIP



16-Pin SOJ



REGULATION CONTROL CIRCUIT LBR FAMILY

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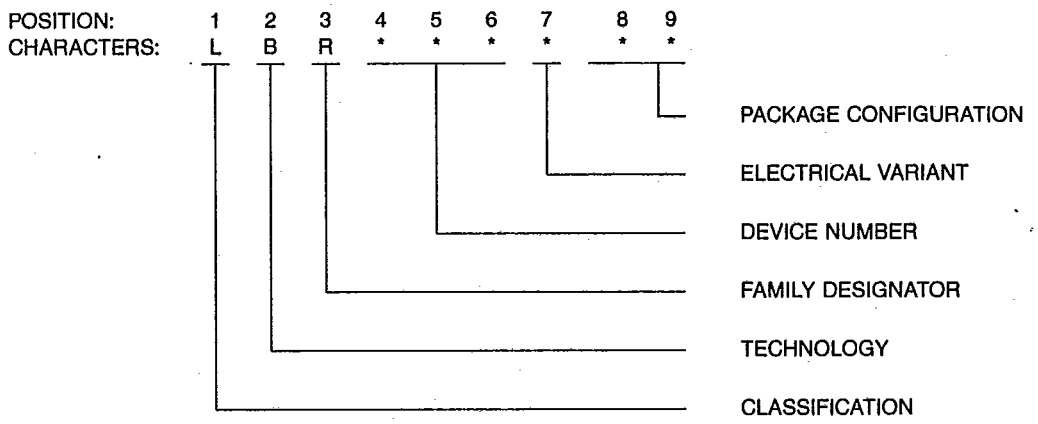
Ordering Information

The Regulation Control Circuit Family is coded as follows:



Classification (Position 1): L = Linear

Technology (Position 2): B = Complementary Bipolar Integrated Circuit (CBIC)

Family Designator (Position 3): Regulation Control Circuit Family

Device Number (Positions 4, 5, 6): The device number is also the voltage value of the regulator function for this device. A decimal point shall be understood to exist between positions 5 and 6.

Example: 022 = 2.2 V
220 = 22.0 V

Electrical Variants (Position 7): A = ±1% Regulator Voltage①
B = ±1.5% Regulator Voltage
C = ±2% Regulator Voltage
D = ±0.5% Regulator Voltage

Package Configuration (Positions 8; 9):

A = Wafer (8-Pad Chip) Unthinned	K = 16-Pin SOJ (Surface Mount)
AA = Wafer (8-Pad Chip) Thinned	S = 8-Pin SOIC (Surface Mount)
B = 8-Pin DIP	X = Wafer (16-Pad Chip) Unthinned
C = 16-Pin DIP	XA = Wafer (16-Pad Chip) Thinned

①Regulator voltage output is SENSE+ connected to OA OUT.