TelCom
Semiconductor, Inc.

EVALUATION
KIT
AVAILABLE

TC43

LINEAR BUILDING BLOCK – VOLTAGE REFERENCE, DUAL OP AMP, DUAL COMPARATOR WITH SHUTDOWN MODE

FEATURES

- **Combines Two Op Amps, Two Comparators and a Voltage Reference into a Single Package**
- **Optimized for Single Supply Operation**
- **Small Package .... 16-Pin SOIC or DIP (Narrow)**
- **Ultra Low Input Bias Current ...... Less than 100pA**
- **Low Quiescent Current .... 10μA, 5μA in Shutdown Mode**
- **Reference and One Comparator Remain Active in Shutdown to Provide Supervisory Functions**

APPLICATIONS

- **Power Supply Circuits**
- **Embedded Systems**
- **Instrumentation**
- **Portable Equipment**
- **Consumer Products**
- **Replacements for Discrete Components**

GENERAL DESCRIPTION

The TC43 is a mixed-function device combining two general purpose op amps, two general purpose comparators and a voltage reference in a single 16-pin package.

This increased integration allows the user to replace two or three packages, saving space, lowering supply current, and increasing system performance. A Shutdown input, $\overline{SHDN}$, disables the op amps and one of the comparators, placing their outputs in a high-impedance state. The reference and one comparator stay active in Shutdown Mode. Standby power consumption is typically 5μA.

The TC43 is designed specifically for operation from a single supply, however, operation from dual supplies is also possible, and the power supply current drain is independent of the magnitude of the power supply voltage.

Packaged in a 16-pin narrow SOIC (0.150 wide) or 16-pin DIP, the TC43 is ideal for applications requiring high integration, small size and low power.

FUNCTIONAL BLOCK DIAGRAM
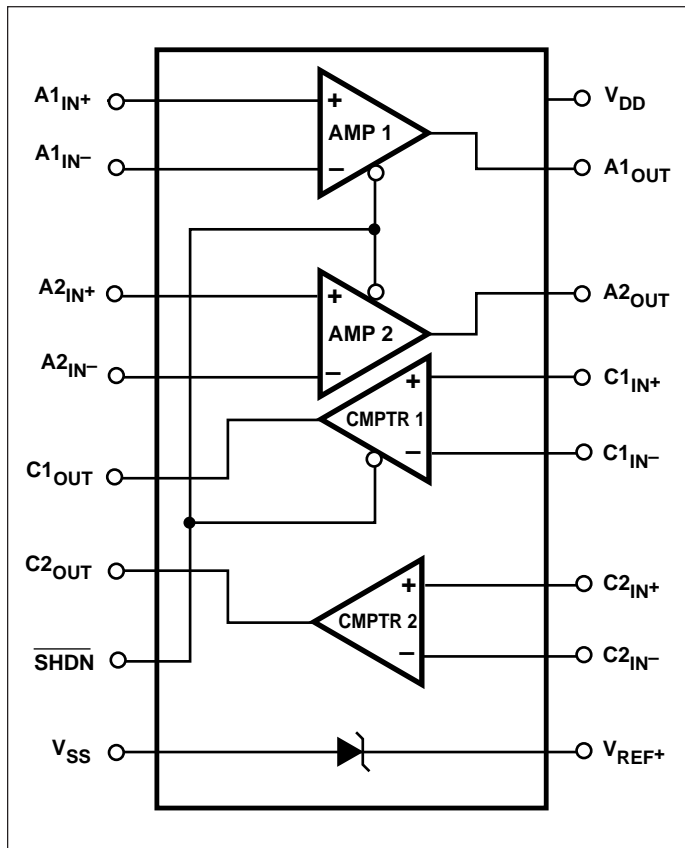
PIN CONFIGURATIONS (DIP and SOIC)
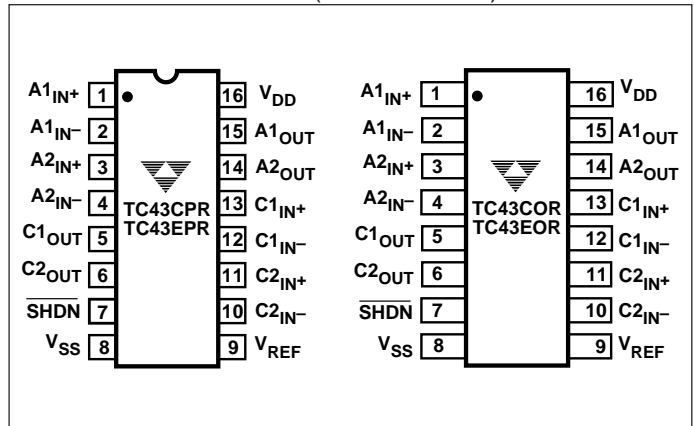
ORDERING INFORMATION

Part No.	Package	Temp. Range
TC43COR	16-Pin SOIC (Narrow)	0°C to +70°C
TC43CPR	16-Pin Plastic DIP (Narrow)	0°C to +70°C
TC43EOR	16-Pin SOIC (Narrow)	– 40°C to +85°C
TC43EPR	16-Pin Plastic DIP (Narrow)	– 40°C to +85°C
TC43EV	*Evaluation Kit for TC43*	

TC43

ABSOLUTE MAXIMUM RATINGS*

Supply Voltage 6V

Package Power Dissipation ($T_A \leq 70°C$)

    PDIP 840mW

    SOIC (Narrow) 700mW

Voltage on Any Pin:

    (With Respect to GND) ....(V_{SS} – 0.3V) to (V_{DD} +0.3V)

Operating Temperature Range:

    C Suffix .... 0°C to +70°C

    E Suffix .... – 40°C to + 85°C

Storage Temperature Range .... – 65°C to +150°C

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

* Static-sensitive device. Unused devices must be stored in conductive material. Protect devices from static discharge and static fields. Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to Absolute Maximum Rating Conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS: T_A = Over Operating Temperature Range, V_{DD} = 5.0V ±10%, V_{SS} = 0V, $\overline{SHDN}$ = V_{DD}, unless otherwise specified.

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{DD}	Supply Voltage		1.8	—	5.5	V
I_Q	Supply Current, Operating	All Outputs Open	—	10	15	µA
I_{SHDN}	Supply Current, Shutdown Mode	All Outputs Open (Note 1)	—	5	8	µA
Shutdown Input						
V_{IH}	Input High Voltage		80% V_{DD}	—	—	V
V_{IL}	Input Low Voltage		—	—	20% V_{DD}	V
I_{IL}	Input Current		—	—	1	µA
Op Amps						
T_{SEL}	Select Time (V_{OUT} from $\overline{SHDN}$ = V_{IH})		—	2	—	msec
T_{DESEL}	Deselect Time (HI-Z from $\overline{SHDN}$ = V_{IL})		—	5	—	µsec
A_{VOL}	Large Signal Voltage Gain	C_L = 100pF, R_L = 47kΩ	—	100	—	dB
V_{ICMR}	Common Mode Input Voltage Range	1.8 < V_{DD} < 5.5V	V_{SS}	—	V_{DD} – 1.0	V
V_{OS}	Input Offset Voltage	V_{CM} = (V_{DD} – V_{SS})/2	–10	±1.0	+10	mV
I_B	Input Bias Current		—	50	—	pA
$V_{OS (DRIFT)}$	Average Input Offset Voltage Drift		—	30	—	µV/°C
GBWP	Gain-Bandwidth Product		4	7	—	kHz
SR	Slew Rate	Gain = 1, V_{IN} = 4.0$_{P-P}$ C_L = 100pF, R_L = 1MΩ to V_{SS}	—	2	—	V/msec
V_{OUT}	Output Signal Swing	R_L = 47kΩ	V_{SS} + .20	—	V_{DD} – .15	V
CMRR	Common Mode Rejection Ratio		—	80	—	dB
PSRR	Power Supply Rejection Ratio	(4.5V to 5.5V)	—	80	—	dB
R_{OUT}(SD)	Output Resistance in Shutdown	SHDN = V_{SS}	20	—	—	MΩ
C_{OUT}(SD)	Output Capacitance in Shutdown	SHDN = V_{SS} (Note 5)	—	40	55	pF
I_{SRC}	DC Output Source Current	V_{IN} = V_{DD} Output Shorted to V_{SS} (Note 2)	3	8	20	mA
I_{SINK}	DC Output Sink Current	V_{IN} = V_{SS} Output Shorted to V_{DD} (Note 2)	0.6	1.2	5	mA
Comparators						
T_{SEL}	CMPTR1 Select Time (V_{OUT} from $\overline{SHDN}$ = V_{IH})		—	5	—	µsec

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ELECTRICAL CHARACTERISTICS: (Cont.) T_A = Over Operating Temperature Range, V_{DD} = 5.0V ±10%, V_{SS} = 0V, $\overline{SHDN}$ = V_{DD}, unless otherwise specified.

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
Comparators (Cont.)						
T_{DESEL}	CMPTR1 Deselect time (HI-Z from $\overline{SHDN}$ = V_{IL})	—	—	5	—	μsec
V_{IN}	Differential Input Voltage Range	Both V_{INS} > = V_{SS}	—	—	V_{DD}	V
$V_{IN(CM)}$	Input Common Mode Voltage Range	Note 3, 5	V_{SS}	—	V_{DD}	V
V_{OS}	Input Offset Voltage	V_{CM} = (V_{DD} − V_{SS})/2	− 10	—	+10	mVDC
I_B	Input Bias Current	IN+ or IN−	—	50	—	pA
V_{OH}	Output High Voltage	R_L = 10kΩ to V_{SS}, 1.8 < V_{DD} < 5.5V	V_{DD} − 0.3	—	—	V
V_{OL}	Output Low Voltage	R_L = 10kΩ to V_{DD} 1.8 < V_{DD} < 5.5V	—	—	0.3	V
I_{OH}	Output Source Current (Continuous)	V_{IN} (+) = V_{DD}, V_{IN} (−) = V_{SS} V_{DD} = 1.8V, Output Shorted to V_{SS}	1.3	3	8	mA
I_{OL}	Output Sink Current (Continuous)	V_{IN} (−) = V_{DD}, V_{IN} (+) = V_{SS} V_{DD} = 1.8V, Output Shorted to V_{DD}	2.5	6	15	mA
t_{PD1}	Response Time	100mV Overdrive (Note 4)	—	15	—	μsec
t_{PD2}	Response Time	10mV Overdrive (Note 4)	—	60	—	μsec
$R_{OUT}(SD)$	Output Resistance in Shutdown	$\overline{SHDN}$ = V_{SS}	20	—	—	MΩ
$C_{OUT}(SD)$	Output Capacitance in Shutdown	$\overline{SHDN}$ = V_{SS} (Note 5)	—	3	5	pF
Voltage Reference						
V_{REF}	Reference Voltage	No Load	1.152	1.200	1.248	V
	Load Regulation	0mA < I_{SOURCE} < 5mA V_{DD} = 5V, T_A = 25°C	—	− 300	—	μV/mA
$C_{L(REF)}$	Load Capacitance		—	—	100	pF
N_{VREF}	Voltage Noise	100Hz to 100kHz	—	100	—	μV$_{RMS}$

NOTES: 1. The reference and one comparator remain active in SHUTDOWN mode.
2. Op Amp configured as a voltage follower (inverting input connected to output; signal applied to non-inverting input).
3. Input common-mode voltage should not be allowed to go negative by more than 0.3V.
4. V_{DD} = 5.0V; C_L = 100pF.
5. Guaranteed by Design

DETAILED DESCRIPTION

The TC43 is the first of a series of very low power, Linear Building Block products targeted at low voltage, single supply applications. The TC43 minimum operating voltage is 1.8V and maximum supply current is only 15μA (fully enabled). It combines two comparators, two op amps and a voltage reference in a single package. A shutdown mode is incorporated for easy adaptation to system power management schemes. During shutdown, all but one comparator and the voltage reference are disabled (i.e. powered down and with their respective outputs at high impedance). The "still awake" comparator and voltage reference can be used as wake-up timer, power supply monitor, LDO controller or other continuous duty circuit function.

Operational Amplifiers

Both op amps have rail-to-rail outputs, and an input common range that includes ground. Input offset voltage is 1.0mV and input bias current is only 50pA. The outputs are protected against short circuits. Both op amps are disabled (powered down and outputs at high impedance) during shutdown.

Comparators

Both comparators feature complimentary outputs with current sinking capability of 2.5mA. Inputs and outputs are rail-to-rail. Comparator CMPTR1 is disabled (powered down and outputs at high impedance) during shutdown. CMPTR2 remains fully enabled during shutdown.

TC43

Voltage Reference

A 4% tolerance, internally biased, 1.20V voltage reference is included in the TC43. It has a push-pull output capable of sourcing 5mA or sinking 200µA. The voltage reference remains fully enabled during shutdown.

Shutdown Input

$\overline{SHDN}$ at V_{IL} disables both op amps and one comparator. The $\overline{SHDN}$ input cannot be allowed to float; when not used, connect to V_{DD}.

TYPICAL APPLICATIONS

The TC43 lends itself to a wide variety of applications, particularly in battery-powered systems. It typically finds application in power management, processor supervisory, and interface circuitry.

Wake-up Timer

Many microcontrollers have a low power "sleep" mode that significantly reduces their supply current. Typically, the microcontroller is placed in this mode via a software instruction, and returns to a fully enabled state upon reception of an external signal ("wake-up"). The wake-up signal is usually supplied by a hardware timer. Most system applications demand that this timer have a long duration (typically seconds or minutes), and consume as little supply current as possible.

The circuit shown in Figure 1 is a wake-up timer made from comparator CMPTR2. (CMPTR2 is used because the wake-up timer must operate when SHDN is active.) Capaci-
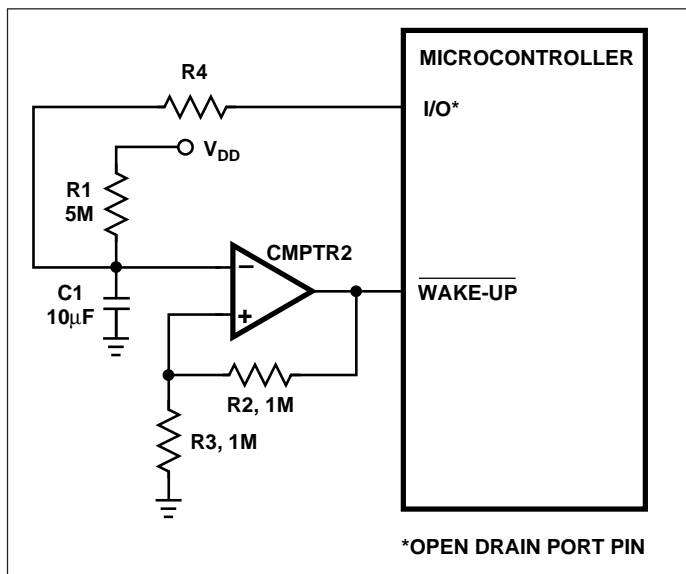
tor C1 charges through R1 until a voltage equal to $V_{DD}/2$ is reached, at which point the $\overline{WAKE}$ is driven active. Upon wake-up, the microcontroller resets the timer by forcing a logic low on a dedicated, open drain I/O port pin. This discharges C1 through R4 (the value of R4 is chosen to limit maximum current sunk by the I/O port pin). With a 3V supply, the circuit as shown consumes typically 8µA and furnishes a nominal timer duration of 25 seconds.

Precision Battery Monitor

Figure 2 is a precision battery low/battery dead monitoring circuit. Typically, the battery low output warns the user that a battery dead condition is eminent. Battery dead typically initiates a forced shutdown to prevent operation at low internal supply voltages (which can cause unstable system operation).

The circuit of Figure 2 uses a single TC43 (one Op Amp unused) and only 7 external resistors. AMP 1 is a simple buffer while CMPTR1 and CMPTR2 provide precision voltage detection using Vr as a reference. Resistors R2 and R4 set the detection threshold for $\overline{BATT\ LOW}$ while resistors R1 and R7 set the detection threshold for $\overline{BATT\ FAIL}$. The component values shown assert $\overline{BATT\ LOW}$ at 2.2V (typical) and $\overline{BATT\ FAIL}$ at 2.0V (typical). Total current consumed by this circuit is typically 22µA at 3V.

DUAL LDO with Shutdown

Figure 3 shows a portion of a TC43 configured as a dual low drop regulator with shutdown. AMP1 and AMP2 are independent error amplifiers that use Vr as a reference. Resistors RA and RB set the feedback around the amplifier and therefore determine the output voltage setting (please see equation in the figure). RA and RB can have large ohmic values (i.e. 100's of KΩ) to minimize supply current.

Using the 2N2222 output transistors as shown, these regulators exhibit low dropout operation. For example, with $V_{OUT} = 3.0V$, the typical drop out voltage is only 50mV at an output current of 50mA. The unused comparators can be used in conjunction with this circuit as power-on reset or low voltage detectors for a complete LDO solution at a very low installed cost.

EVALUATION KIT

The TC43EV consists of a four inch by six inch pre-wired application circuit board. Pre-configured circuits include a pulse width modulator, wake-up timer, function generator, and others. On-board current meter terminals, voltage regulator and a user-prototyping area speed circuit development. Please contact your local TelCom Semiconductor representative for more information.
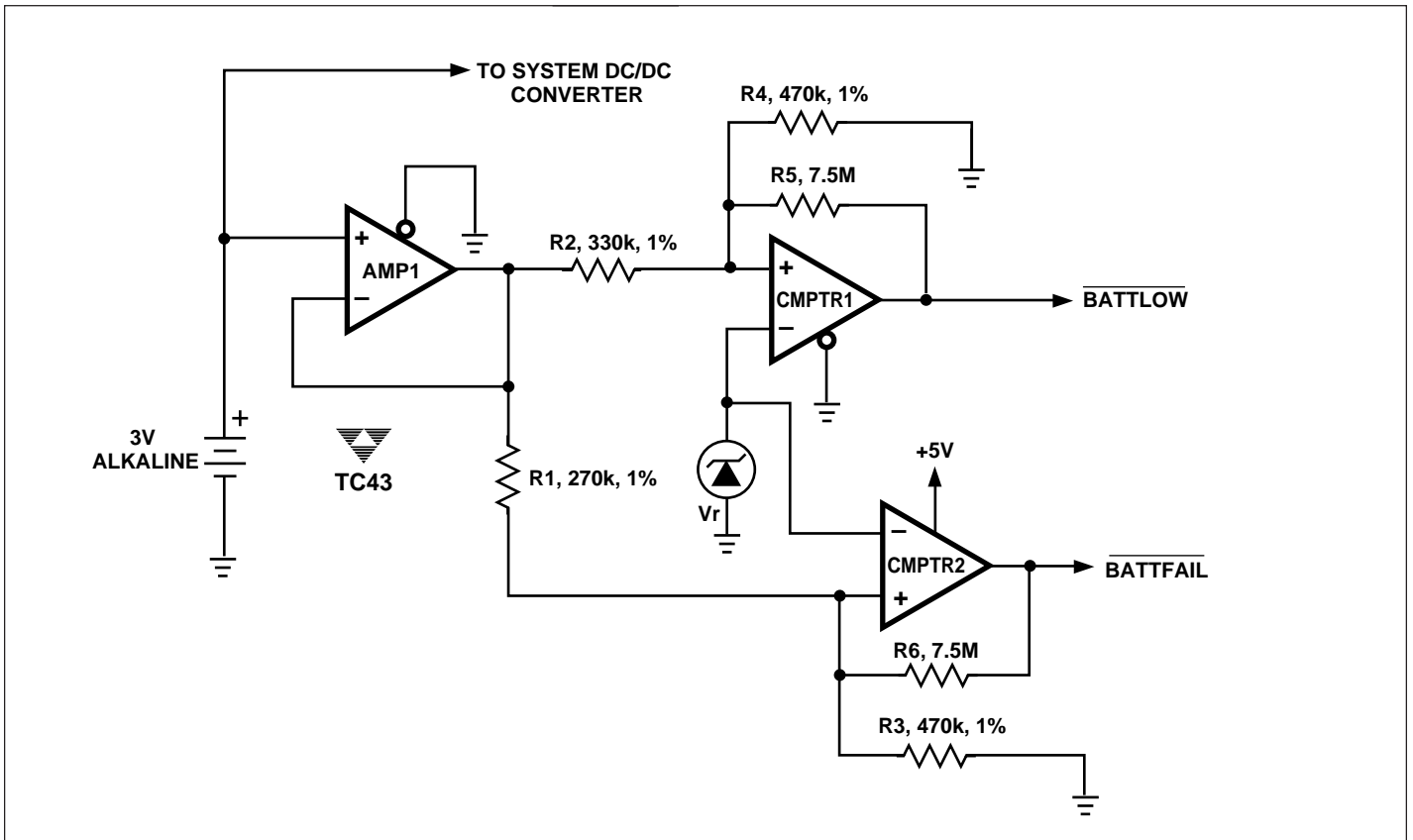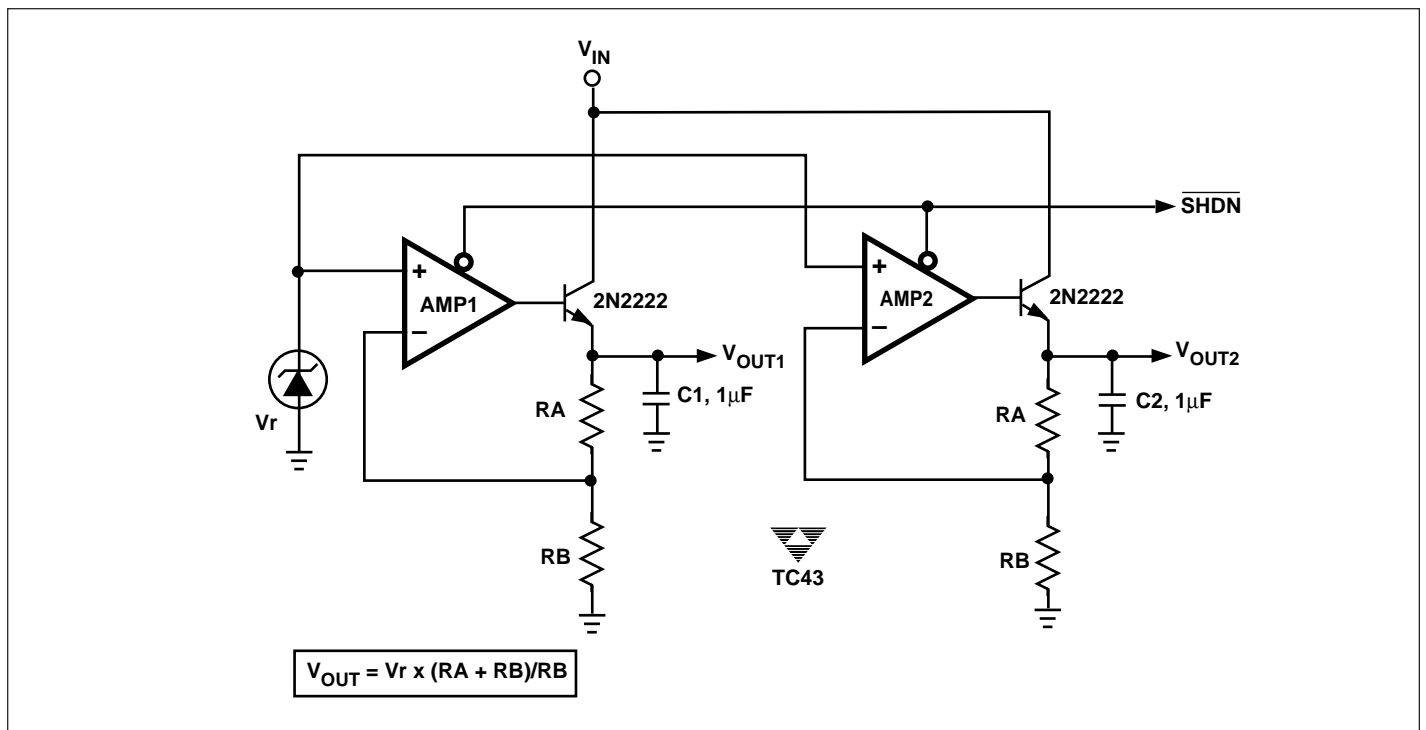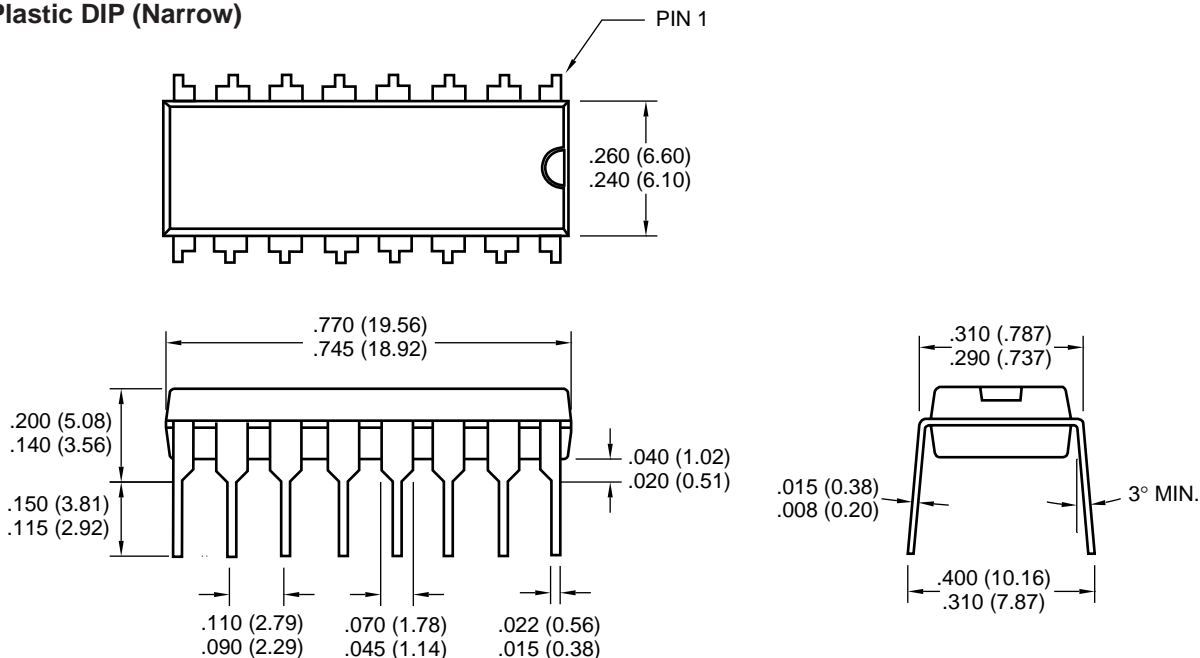

Figure 1. Wake-Up Timer

Figure 2. Precision Battery Monitor

$$V_{OUT} = Vr \times (RA + RB)/RB$$

Figure 3. Dual Low Dropout Regulator

LINEAR BUILDING BLOCK –
VOLTAGE REFERENCE, DUAL OP AMP,
DUAL COMPARATOR WITH SHUTDOWN MODE

TC43

PACKAGE DIMENSIONS

16-Pin Plastic DIP (Narrow)

PIN 1

.260 (6.60)
.240 (6.10)

.770 (19.56)
.745 (18.92)

.200 (5.08)
.140 (3.56)

.150 (3.81)
.115 (2.92)

.040 (1.02)
.020 (0.51)

.110 (2.79)
.090 (2.29)

.070 (1.78)
.045 (1.14)

.022 (0.56)
.015 (0.38)

.310 (.787)
.290 (.737)

.015 (0.38)
.008 (0.20)

3° MIN.

.400 (10.16)
.310 (7.87)

16-Pin SOIC (Narrow)

PIN 1

.157 (3.99)
.150 (3.81)

.244 (6.20)
.228 (5.79)

.050 (1.27) TYP

.394 (10.00)
.385 (9.78)

.069 (1.75)
.053 (1.35)

.018 (0.46)
.014 (0.36)

.010 (0.25)
.004 (0.10)

8°
MAX.

.050 (1.27)
.016 (0.40)

.010 (0.25)
.007 (0.18)
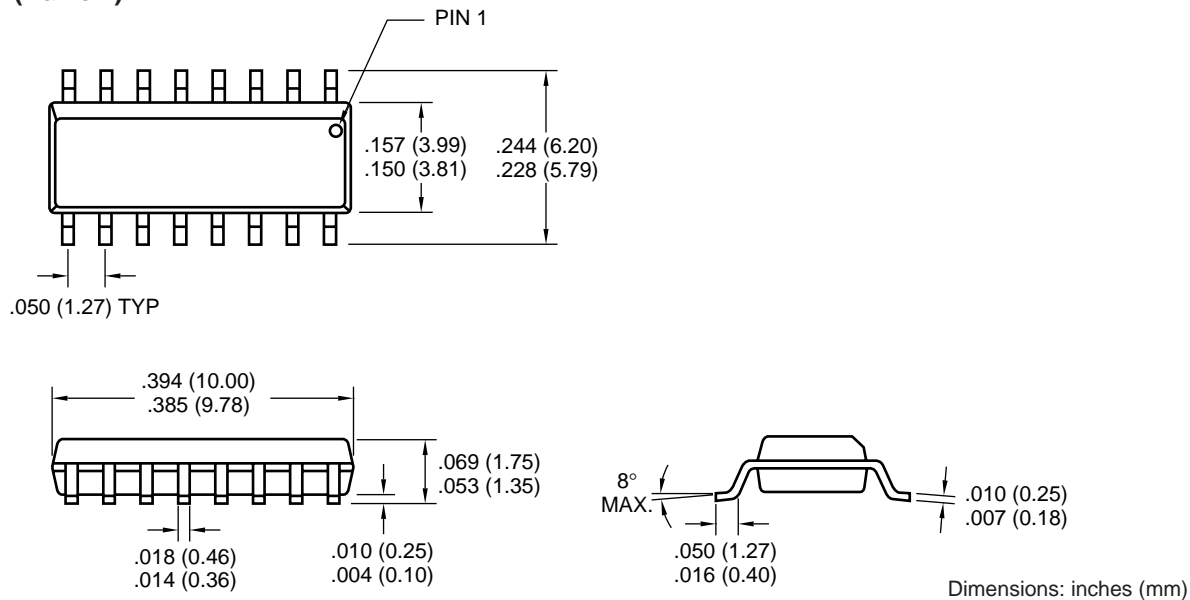
Dimensions: inches (mm)

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