The LTC® 1841/LTC1842/LTC1843 are ultralow power dual comparators with built-in reference (LTC1842/LTC1843). The comparators feature less than 5.7μA supply current over temperature, a 1.182V ±1% reference, programmable hysteresis and open-drain outputs that sink current. The reference output can drive a bypass capacitor of up to 0.01μF without oscillation.

The LTC1841 operates from a single 2V to 11V supply or a dual ±1V to ±5.5V supply. The LTC1842/LTC1843 operate from a single 2.5V to 11V supply or a dual ±1.25V to ±5.5V supply. The LTC1842/LTC1843 hysteresis is easily programmed by using two resistors and the HYST pin. The comparators’ input operates from the negative supply to within 1.3V of the positive supply. The comparators’ output stage can typically sink greater than 20mA. By eliminating the cross-conduction current that normally happens when the comparators change logic states, power supply glitches are eliminated.

The LTC1841/LTC1842/LTC1843 are available in SO-8 packages.
LTC1841/LTC1842/LTC1843

**ABSOLUTE MAXIMUM RATINGS**

(Note 1)

**Voltage**
- $V^+$ to $V^-$ ................................................ 12V to $-0.3V$
- $IN^+, IN^-, HYST$ ................. $(V^+ + 0.3V)$ to $(V^- - 0.3V)$
- REF ................................... $(V^+ + 0.3V)$ to $(V^- - 0.3V)$
- OUT ................................................ 12V to $(V^- - 0.3V)$

**Current**
- $IN^+, IN^-, HYST$ ................................................. 20mA
- REF ................................................................... 20mA
- OUT .................................................................. 50mA

**OUT Short-Circuit Duration** ($V^+ \leq 5.5V$) ...... Continuous

**Power Dissipation** ............................................. 500mW

**Operating Temperature Range**
- LTC1841C/LTC1842C/LTC1843C ........... $0^\circ C$ to $70^\circ C$
- LTC1841I/LTC1842I/LTC1843I ........... $-40^\circ C$ to $85^\circ C$

**Storage Temperature Range** .......... $-65^\circ C$ to $150^\circ C$

**Lead Temperature (Soldering, 10 sec)** .......... $300^\circ C$

**PACKAGE/ORDER INFORMATION**

<table>
<thead>
<tr>
<th>ORDER PART NUMBER</th>
<th>S8 PART MARKING</th>
</tr>
</thead>
<tbody>
<tr>
<td>LTC1841CS8</td>
<td>1841</td>
</tr>
<tr>
<td>LTC1841IS8</td>
<td>1841I</td>
</tr>
<tr>
<td>LTC1842CS8</td>
<td>1842</td>
</tr>
<tr>
<td>LTC1842IS8</td>
<td>1842I</td>
</tr>
<tr>
<td>LTC1843CS8</td>
<td>1843</td>
</tr>
<tr>
<td>LTC1843IS8</td>
<td>1843I</td>
</tr>
</tbody>
</table>

Consult factory for Military grade parts.

**ELECTRICAL CHARACTERISTICS**

$V^+ = 5V$, $V^- = 0V$, $T_A = 25^\circ C$ unless otherwise noted.

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>PARAMETER</th>
<th>CONDITIONS</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V^+$</td>
<td>Supply Voltage Range</td>
<td>LTC1841/LTC1842/LTC1843</td>
<td>2.0</td>
<td>11</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$I_{CC}$</td>
<td>Supply Current</td>
<td>HYST = REF (Note 2)</td>
<td>3.5</td>
<td>5.7</td>
<td>µA</td>
<td></td>
</tr>
</tbody>
</table>

**Comparator**

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>PARAMETER</th>
<th>CONDITIONS</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{OS}$</td>
<td>Comparator Input Offset Voltage</td>
<td>(Note 3)</td>
<td>±3</td>
<td>±10</td>
<td>mV</td>
<td></td>
</tr>
<tr>
<td>$I_{IN}$</td>
<td>Input Leakage Current ($IN^+, IN^-$)</td>
<td>$IN^+ = IN^- = 2.5V$ (LTC1841), $IN^+ = IN^- = V_{REF}$ (LTC1842/LTC1843)</td>
<td>±0.01</td>
<td>±1.0</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>$V_{IN}$</td>
<td>Comparator Input Voltage Range</td>
<td>$V^- \leq V^+ \leq 1.3V$</td>
<td>V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$PSRR$</td>
<td>Power Supply Rejection Ratio</td>
<td>$V^+ = 2V$ to $11V$ (LTC1841), $V^+ = 2.5V$ to $11V$ (LTC1842/LTC1843)</td>
<td>0.1</td>
<td>1</td>
<td>mV/V</td>
<td></td>
</tr>
<tr>
<td>$CMRR$</td>
<td>Common Mode Rejection Ratio</td>
<td>$V_{CM} = V^+ = V^- = 1.3V$</td>
<td>0.1</td>
<td>1</td>
<td>mV/V</td>
<td></td>
</tr>
<tr>
<td>$V_{Hyst}$</td>
<td>Hysteresis Input Voltage Range</td>
<td>LTC1842/LTC1843</td>
<td>$V_{REF} - 50mV$</td>
<td>$V_{REF}$</td>
<td>V</td>
<td></td>
</tr>
</tbody>
</table>
## ELECTRICAL CHARACTERISTICS

**V^+ = 5V, V^- = 0V, T_A = 25°C unless otherwise noted.**

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>PARAMETER</th>
<th>CONDITIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>IPD</td>
<td>Propagation Delay</td>
<td>C_OUT = 10pF, R_PULL-UP = 100kΩ Overdrive = 10mV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Overdrive = 100mV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>I_LEAK</td>
<td>Output Leakage Current</td>
<td>V_OUT = 12V (Note 2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>VOL</td>
<td>Output Low Voltage</td>
<td>I_O = 1.8mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Reference (LTC1842/LTC1843)

**V^+ = 3V, V^- = 0V, T_A = 25°C unless otherwise noted.**

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>PARAMETER</th>
<th>CONDITIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Power Supply</td>
<td></td>
</tr>
<tr>
<td></td>
<td>V^+ Supply Voltage Range</td>
<td>LTC1841</td>
</tr>
<tr>
<td></td>
<td></td>
<td>LTC1842/LTC1843</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td>I_CC Supply Current</td>
<td>HYST = REF (Note 2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.5</td>
</tr>
<tr>
<td></td>
<td>Comparator</td>
<td></td>
</tr>
<tr>
<td></td>
<td>V_OS Comparator Input Offset Voltage</td>
<td>(Note 3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±3</td>
</tr>
<tr>
<td></td>
<td>I_IN Input Leakage Current (IN^+, IN^-)</td>
<td>IN^+ = IN^- + 80mV (LTC1841), IN^+ = IN^- = V_REF (LTC1842/LTC1843)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±0.01</td>
</tr>
<tr>
<td></td>
<td>V_IN Comparator Input Voltage Range</td>
<td>V^-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V^+</td>
</tr>
<tr>
<td></td>
<td>PSRR Power Supply Rejection Ratio</td>
<td>V^+ = 2V to 11V (LTC1841), V^+ = 2.5V to 11V (LTC1842/LTC1843)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td>CMRR Common Mode Rejection Ratio</td>
<td>V_CM = V^- to (V^+ – 1.3V) LTC1841</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td>V_HYST Hysteresis Input Voltage Range</td>
<td>LTC1842/LTC1843</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V_REF – 50mV</td>
</tr>
<tr>
<td></td>
<td>IPD Propagation Delay</td>
<td>C_OUT = 10pF, R_PULL-UP = 100kΩ Overdrive = 10mV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Overdrive = 100mV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>I_LEAK Output Leakage Current</td>
<td>V_OUT = 12V (Note 2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>VOL Output Low Voltage</td>
<td>I_O = 0.8mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Reference (LTC1842/LTC1843)

**V^+ = 3V, V^- = 0V, T_A = 25°C unless otherwise noted.**

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>PARAMETER</th>
<th>CONDITIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reference Voltage</td>
<td>No Load</td>
</tr>
<tr>
<td></td>
<td></td>
<td>25°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0°C to 70°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>−40°C to 85°C</td>
</tr>
<tr>
<td></td>
<td>Load Regulation</td>
<td>I_SOURCE = 1mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I_SINK = 10µA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Voltage Noise</td>
<td>100Hz to 100kHz</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100</td>
</tr>
</tbody>
</table>

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

*Note 2: IN^+ = IN^- + 80mV, output is in high impedance state.*

*Note 3: V_CM = 1/2(V^+ – V^-) for LTC1841, V_CM = V_REF for LTC1842/LTC1843.*
TYPICAL PERFORMANCE CHARACTERISTICS

Comparator Response Time vs Input Overdrive, with $R_{\text{PULL-UP}} = 5k$

Comparator Short-Circuit Sink Current vs Supply Voltage

Comparator Response Time vs Load Capacitance with 100mV Input Overdrive

Comparator Response Time at Low Supply Voltage

Comparator Output Voltage Low vs Load Current
PIN FUNCTIONS

**OUT A (Pin 1):** Comparator A Open-Drain Output. Output can typically sink greater than 20mA.

**V– (Pin 2):** Negative Supply.

**IN A+ (Pin 3):** Noninverting Input of Comparator A. Input common mode range extends from V– to V+ – 1.3V. Input current is typically 10pA at 25°C.

**IN A– (Pin 4) (LTC1841):** Inverting Input of Comparator A. Input common mode range extends from V– to V+ – 1.3V. Input current is typically 10pA at 25°C.

**IN B+ (Pin 4) (LTC1842):** Noninverting Input of Comparator B. Input common mode range extends from V– to V+ – 1.3V. Input current is typically 10pA at 25°C.

**IN B– (Pin 4) (LTC1843):** Inverting Input of Comparator B. Input common mode range extends from V– to V+ – 1.3V. Input current is typically 10pA at 25°C.

**IN B– (Pin 5) (LTC1841):** Inverting Input of Comparator B. Input common mode range extends from V– to V+ – 1.3V. Input current is typically 10pA at 25°C.

**HYST (Pin 5) (LTC1842/LTC1843):** Hysteresis Input. Connect to REF if not used. Input voltage range is from VREF to VREF – 50mV.

**IN B+ (Pin 6) (LTC1841):** Noninverting Input of Comparator B. Input common mode range extends from V– to V+ – 1.3V. Input current is typically 10pA at 25°C.

**REF (Pin 6) (LTC1842/LTC1843):** Reference Output. 1.182V with respect to V–. Can typically source greater than 1mA and sink 10µA at 25°C. Can drive 0.01µF bypass capacitor without oscillation.

**V+ (Pin 7) (LTC1841):** Positive Supply. 2V to 11V.

**V+ (Pin 7) (LTC1842/LTC1843):** Positive Supply. 2.5V to 11V.

**OUT B (Pin 8):** Comparator B Open-Drain Output. Output can typically sink greater than 20mA.
The LTC1841/LTC1842/LTC1843 are dual micropower
comparators with a built-in 1.182V reference (LTC1842/
LTC1843). Features include programmable hysteresis,
wide supply voltage range (2V to 11V) and the ability for
the reference to drive up to a 0.01µF capacitor without
oscillation. The comparators' open-drain outputs can typi-
cally sink greater than 20mA and the supply current
glitches that normally occur when switching logic states
have been eliminated.

Power Supplies
The comparators operate from a single 2V to 11V (2.5V to
11V for LTC1842/LTC1843) or dual ±1V to ±5.5V supply
(±1.25V to ±5.5V for LTC1842/LTC1843). If the reference
output is required to source more than 1mA or the supply
source impedance is high, V+ should be bypassed with a
0.1µF capacitor.

Comparator Inputs
The comparators’ input can swing from the negative
supply V– to within 1.3V (max) of the positive supply V+.
The input can be forced 300mV below V– or above V+
without damage and the typical input leakage current is
only ±10pA.

Comparator Outputs
Each comparator output is an open-drain pull-down to V–
typically capable of sinking greater than 20mA. The low
output leakage current while in three-state mode allows a
high value pull-up resistor to be used. The open-drain
outputs can be wire OR-ed or used in level shifting
applications.

Voltage Reference
The internal bandgap reference has an output voltage of
1.182V referenced to V–. The reference accuracy is 1.5%
from –40°C to 85°C. It can typically source greater than
1mA and sink up to 10µA with a 5V supply. The reference
can drive a bypass capacitor of up to 0.01µF without
oscillation. By inserting a series resistor, capacitance
values up to 100µF can be used (Figure 1).

Figure 1. Damping the Reference Output

Figure 2 shows the resistor value required for different
capacitor values to achieve critical damping. Bypassing
the reference can help prevent false tripping of the com-
parators by preventing glitches on V+ or reference load
transients from disturbing the reference output voltage.

Figure 2. Damping Resistance vs Bypass Capacitor Value

Figure 3 shows the bypassed reference output with a
square wave applied to the V+ pin. Resistors R2 and R3 set
a 10mV hysteresis voltage band while R1 damps the
reference response. Note that the comparator output
doesn’t trip.
Hysteresis can be added to the LTC1842/LTC1843 by connecting a resistor (R1) between the REF and HYST pins and a second resistor (R2) from HYST to V- (Figure 4). The difference between the upper and lower threshold voltages, or hysteresis voltage band (V_{HB}), is equal to twice the voltage difference between the REF and HYST pins.

As more hysteresis is added, the upper threshold increases the same amount as the low threshold decreases. The maximum voltage allowed between REF and HYST pins is 50mV, producing a maximum hysteresis voltage band of 100mV. The hysteresis band may vary by up to 15%. If hysteresis is not wanted, the HYST pin should be shorted to REF. Acceptable values for I_{REF} range are from 0.1µA to 5µA. If 2.4M is chosen for R2, then the value of R1 is equal to the value of V_{HB}.

Window Detector

The LTC1843 is ideal for use as a micropower window detector as shown in Figure 5. The values of R1, R2 and R3 are selected for a 4.5V undervoltage threshold and a 5.5V overvoltage threshold. R4 and R5 set the hysteresis voltage. The following design procedure can be used to select the component values:

1. \( V_{THL} = 4.5V \)
2. \( V_{THH} = 5.5V \)
3. \( R3 = 1M \)
4. \( R2 = 62.2k \)
5. \( R4 = 2.4M \)
6. \( R5 = 10k \)
7. \( \text{The maximum voltage allowed between REF and HYST pins is 50mV, producing a maximum hysteresis voltage band of 100mV.} \)
8. \( \text{The hysteresis band may vary by up to} \ 15\%. \)
9. \( \text{If hysteresis is not wanted, the HYST pin should be shorted to REF. Acceptable values for} \ I_{REF} \ \text{range are from} \ 0.1\mu\text{A to} \ 5\mu\text{A.} \)
10. \( \text{If} \ 2.4M \ \text{is chosen for} \ R2, \ \text{then the value of} \ R1 \ \text{is equal to the value of} \ V_{HB}. \)
APPLICATIONS INFORMATION

1. Choose the required hysteresis voltage band and calculate values for R4 and R5 according to the formulas in the hysteresis section. In this example, ±5mV of hysteresis has been added at the comparator input \( V_H = V_{HB}/2 \). Note that the hysteresis apparent at \( V_{IN} \) will be larger because of the input resistor divider.

2. Select R1. The leakage current into IN B+ is under 1nA so the current through R1 should exceed 100nA, to ensure threshold accuracy. R1 values up to about 10M can be used, but values in the 100k to 1M range are usually easier to deal with. In this example choose \( R1 = 294k \).

3. Calculate \( R2 + R3 \). The overvoltage threshold should be set at 5.5V. The design equation is as follows:

\[
R2 + R3 = R1 \left( \frac{V_{UTH}}{V_{REF} + V_H} - 1 \right)
\]
\[
= 294k \left( \frac{5.5}{1.182 + 0.005} - 1 \right)
\]
\[
= 1.068M
\]

4. Calculate R2. The undervoltage threshold should be set at 4.5V. The design equation is as follows:

\[
R2 = (R1 + R2 + R3) \frac{V_{REF} - V_H}{V_{LTH}} - R1
\]
\[
= (294k + 1.068M) \frac{1.182 - 0.005}{4.5} - 294k
\]
\[
= 62.2k
\]

Choose \( R2 = 61.9k \) (1% standard value)

5. Calculate R3:

\[
R3 = (R2 + R3) - R2
\]
\[
= 1.068M - 61.9k
\]
\[
= 1.006M
\]

Choose \( R3 = 1M \) (1% standard value)

6. Verify the resistor values. The equations are as follows, evaluated for the above example:

Overvoltage threshold:

\[
V_{OTH} = \left( V_{REF} + V_H \right) \frac{R1 + R2 + R3}{R1}
\]
\[
= 5.474V
\]

Undervoltage threshold:

\[
V_{UTH} = \left( V_{REF} - V_H \right) \frac{R1 + R2 + R3}{R1 + R2}
\]
\[
= 4.484V
\]

where the hysteresis voltage \( V_H = \left( V_{REF} \left( \frac{R5}{R4} \right) \right) \)
Battery Switchover Circuit

WALL ADAPTER

9V

1N5818

1M

LTC1842

IN A

1.1M

IN B

562k

HYST

0.01µF

20k

130k

47k

2.4M

4-CELL BATTERY

LTC1842

OUT A

7

OUT B

8

LTC1474

STEP-DOWN REGULATOR

1M

1M

OUTPUT 3.3V

LBO
PACKAGE DESCRIPTION

Dimensions in inches (millimeters) unless otherwise noted.

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

*DIMENSION DOES NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.006" (0.152mm) PER SIDE
**DIMENSION DOES NOT INCLUDE INTERLEAD FLASH. INTERLEAD FLASH SHALL NOT EXCEED 0.010" (0.254mm) PER SIDE

Information furnished by Linear Technology Corporation is believed to be accurate and reliable. However, no responsibility is assumed for its use. Linear Technology Corporation makes no representation that the interconnection of its circuits as described herein will not infringe on existing patent rights.
TYPICAL APPLICATION

Low-Battery Load Disconnect and Charge Termination

RELATED PARTS

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>DESCRIPTION</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>LT®1178/LT1179</td>
<td>Dual/Quad 17µA Precision Single Supply Op Amps</td>
<td>70µV Max VDS, 5nA Max IBIAS</td>
</tr>
<tr>
<td>LT1351</td>
<td>Single 250µA, 3MHz, 200V/µs Op Amp with Shutdown</td>
<td>C-Load™ Op Amp Stable Driving Any Capacitive Load</td>
</tr>
<tr>
<td>LT1352/LT1353</td>
<td>Dual/Quad 250µA, 3MHz, 200V/µs Op Amps</td>
<td>C-Load Op Amps Stable Driving Any Capacitive Load</td>
</tr>
<tr>
<td>LTC1440/LTC1540</td>
<td>Micropower Comparator with 1% Reference</td>
<td>1.182V ±1% Reference, ±10mV (Max) Input Offset</td>
</tr>
<tr>
<td>LTC1441/LTC1442</td>
<td>Micropower Dual Comparator with 1% Reference</td>
<td>1.182V ±1% Reference (LTC1442)</td>
</tr>
<tr>
<td>LTC1443/LTC1444/LTC1445</td>
<td>Micropower Quad Comparator with 1% Reference</td>
<td>LTC1443 Has 1.182V Reference, LTC1444/LTC1445 Have 1.221V Reference and Adjustable Hysteresis</td>
</tr>
<tr>
<td>LTC1474</td>
<td>Low Quiescent Current High Efficiency Step-Down Switching Regulator</td>
<td>10µA Standby Current, 92% Efficiency, Space Saving 8-Pin MSOP Package</td>
</tr>
<tr>
<td>LT1495</td>
<td>1.5µA Max, Dual Precision Rail-to-Rail Input and Output Op Amp</td>
<td>375µV Max VDS, 250pA IBIAS, 25pA IOS</td>
</tr>
<tr>
<td>LT1521</td>
<td>300mA Low Dropout Regulator with Micropower Quiescent Current and Shutdown</td>
<td>0.5V Dropout Voltage, 12µA Quiescent Current, Adjustable Output 3V, 3.3V and 5V Fixed</td>
</tr>
<tr>
<td>LTC1541/LTC1542</td>
<td>Micropower Op Amp, Comparator and Reference</td>
<td>1.200V ±0.8% Reference (LTC1541) Op Amp Outputs Stable with 1000pF Load</td>
</tr>
<tr>
<td>LT1634</td>
<td>Micropower Precision Shunt Voltage Reference</td>
<td>1.25V Output, 10µA Operating Current, 0.1% Initial Accuracy 10ppm/°C Max Drift</td>
</tr>
</tbody>
</table>

C-Load is a trademark of Linear Technology Corporation.