



# Pulse-Load Battery Monitor

## Description

The CS2516 is designed for use in battery powered medical, security, or environmental systems where prior notification of impending power source failure is a requirement. The IC effectively provides continuous monitoring of battery condition by pulse-sampling the system voltage at predetermined intervals. Low standby current permits unswitched connection to the battery with minimal impact on operating life. The ability to load the battery during the test pulse provides assurance that sufficient reserve capacity exists to operate critical system components.

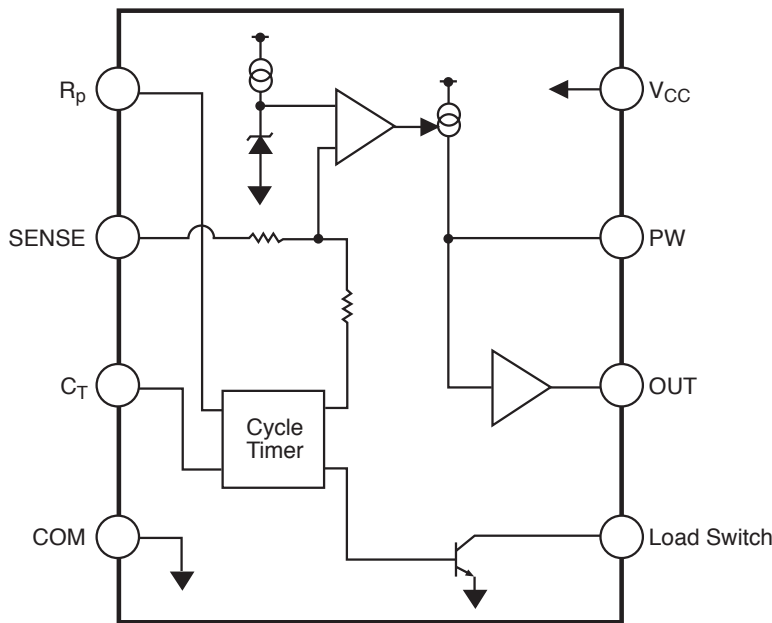
The CS2516 contains an internal timer that generates a 1.0 millisecond test pulse once each 33 seconds (both times are typical). The load switch transistor conducts only during the test pulse, and can sink up to 50mA directly. An

external transistor can be added to increase the load current capability. Should, during the test pulse, the sense terminal voltage fall below the threshold level determined by the internal (synthesized) temperature compensated zener diode, the comparator will permit a charging current to flow out of PW. This pin is also the input of a Schmitt trigger that in turn drives the output transistor. Collectively, the charge current and trigger, in conjunction with an external RC network, operate as a "pulse-stretcher" to provide output "ON" times that are a multiple of the sampling time. This feature permits low battery alarm devices or visible annunciators to be driven directly by the IC. The maximum permissible output current is 30mA.

## Features

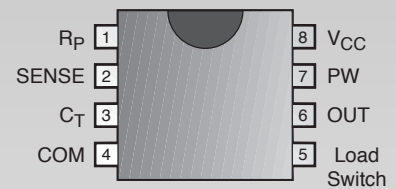
- Adjustable Battery Sense from 7 to 12 Volts
- Pulse Loads Battery at up to 50mA
- Standby Current Under 10µA
- Test Period, Rate and Load Adjustable
- On Chip 15mA Output Driver

## Block Diagram



## Package Options

8L PDIP and 8L SO



### Absolute Maximum Ratings

Supply Voltage ( $V_{CC}$ ).....	0 to 14V
$R_p$ Input Voltage .....	-0.5 to $V_{CC}$
SENSE, $C_T$ , PW, Output and Load Switch.....	-0.5 to 8V
Load Current.....	50mA
Output Current .....	30mA
Storage Temperature.....	-40 to +150°C
Lead Temperature Soldering: Wave Solder (through hole styles only).....	10 sec. max, 260°C peak
Reflow (SMD styles only) .....	60 sec. max above 183°C, 230°C peak

**Electrical Characteristics:  $V_{CC} = 9V$ ,  $R_p = 9.1 M\Omega$ ,  $C_T = 4.7\mu F$ ,  $C_{pw} = 0.1\mu F$ ,  $R_{pw} = 10M\Omega$ ,  
 $0^\circ \leq T_A \leq 85^\circ$  unless otherwise specified.**

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>■ <math>V_{CC}</math></b>					
Operating Voltage			9	12	V
Standby Current			4	10	$\mu A$
<b>■ Cycle Timer</b>					
Charge Current	$V_{C_T} = 0V$ , $6V \leq V_{CC} \leq 12V$	-1.70	-1.20	-0.48	$\mu A$
	$2V \leq V_{C_T} < 7.5V$	-0.77	-0.74	-0.71	$\mu A$
Discharge Current	$V_{C_T} = 8.8V$	8.0	20.0	25.0	mA
	$V_{C_T} = 2.0V$	1.1	3.0	3.6	mA
Discharge Impedance	$4.6V < V_{C_T} < 8.0V$		440		$\Omega$
Upper Charge Threshold	$-0.48\mu A < I_{C_T} < -1.70\mu A$	7.0	8.0	9.0	V
Lower Charge Threshold	$-0.48\mu A < I_C < -1.70\mu A$	0.5	1.0	3.0	V
Lower Discharge Threshold	$1.1mA < I_C < 25mA$	2.0	4.6	6.0	V
<b>■ Load Switch</b>					
“ON” Voltage	$I_{Load\ Switch} = 50mA$		0.3	0.5	V
“OFF” Current	$V_{Load\ Switch} = 12V$			1.0	$\mu A$
<b>■ Sense Input</b>					
Threshold Voltage		6.3	6.7	7.1	V
Threshold Temp Coefficient	$0^\circ C < T_A < 85^\circ C$		150		ppm/ $^\circ C$
Active Impedance		5.0	8.5	12.0	k $\Omega$
<b>■ Pulse Stretcher</b>					
Source Current	$V_{SENSE} = 6.3V$ , $V_{PW} = 0V$	-950	-550	-250	$\mu A$
	$V_{CC} = V_{SENSE} = 6.3V$ , $V_{PW} = 0V$	-300	-250	-200	$\mu A$
Schmitt Upper Threshold		2.25	2.50	2.75	V
Hysteresis		0.60	1.00	1.40	V
Input Bias Current	$V_{SENSE} = 7.1V$ , $V_{PW} = 1.2V$			1.00	$\mu A$
<b>■ Output Switch</b>					
“ON” Voltage	$V_{PW} = 3V$ ; $I_{OUT} = 15mA$		0.1	0.5	V
“OFF” Current	$V_{PW} = 0V$ ; $V_{OUT} = 12V$			1.0	$\mu A$

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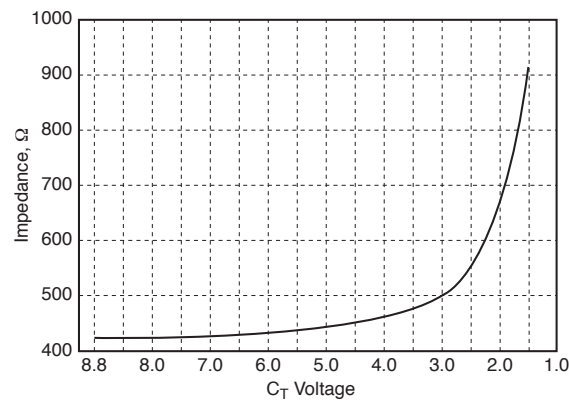
PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>Recommended Component Values</b>					
R <sub>P</sub> Program Resistor		1.0		9.1	MΩ
C <sub>T</sub> Cycle Timer Capacitor		4.7		22.0	μF
C <sub>PW</sub> Pulse Stretcher Capacitor		0.01		0.10	μF
R <sub>PW</sub> Pulse Stretcher Resistor		1		10	MΩ

### Package Pin Description

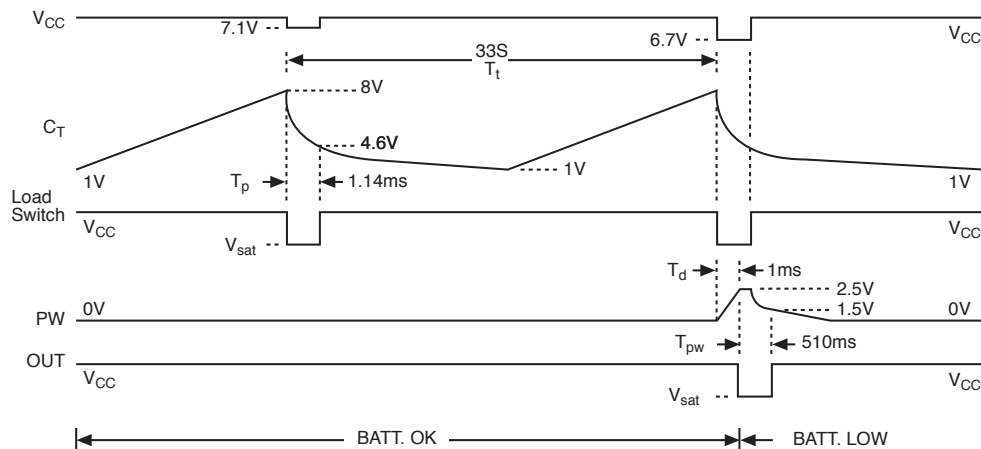
PACKAGE PIN #	PIN SYMBOL	FUNCTION
<b>8L PDIP &amp; SO Narrow</b>		
1	R <sub>P</sub>	Test period programming resistor.
2	SENSE	Voltage sense comparator input.
3	C <sub>T</sub>	Test period, duration programming capacitor.
4	COM	Common negative
5	Load Switch	Collector of pulse loading NPN transistor.
6	OUT	Alarm Pulse width-stretcher output
7	PW	Output pulse-width programming RC.
8	V <sub>CC</sub>	Power source.

### Typical Performance Characteristics

C<sub>T</sub> Discharge Impedance vs C<sub>T</sub> Voltage (Typ +25°C)



### Timing Diagram



**Program and Standby Currents:**  $I_P = \frac{V_{CC}}{R_P} = \frac{9V}{9.1m\Omega} \approx 1\mu A$  Standby Current =  $4I_P = 4\mu A$  (typ.)

**Cycle Timer Period:**  $T_t = \frac{V_T C_T}{I_P} = \frac{7C_T}{1\mu A} = \frac{7 \times 4.7\mu F}{1\mu A} \approx 33sec.$ ,

where  $V_t$  = Upper Charge Threshold - Lower Charge Threshold (7V typ.)

**Test Pulse Width:**  $T_p = R_d C_T \times \ln(V_p) \approx 242C_T \approx 242 \times 4.7\mu F \approx 1.14ms$

where  $R_d$  is the dynamic cycle timer discharge impedance (440 $\Omega$  typ.)

and  $V_p = \frac{\text{Upper Charge Threshold}}{\text{Lower Discharge Threshold}}$  [ $\ln(V_p) = 0.55$  typ.]

**Pulse Stretcher: Delay Time:**  $T_D = \frac{V_d C_{PW}}{I_{src}} = \frac{2.5C_{PW}}{250\mu A} = \frac{2.5 \times 0.1\mu F}{250\mu A} \approx 1ms$

where  $V_d$  = Schmitt Trigger Upper Threshold (2.5V typ.)

and  $I_{src}$  = Typical source current at the PW pin at the nominal low battery sense threshold of 6.7V.

Pulse Width:  $T_p = C_{PW} R_{PW} \ln(V_S) \approx 0.51 \times 0.1\mu F \times 10m\Omega \approx 510ms$ .

and  $V_S = \frac{\text{Schmitt Trigger Upper Threshold}}{\text{Schmitt Trigger Hysteresis}}$  [ $\ln(V_S) = 0.51$  typ.]

### Applications Information

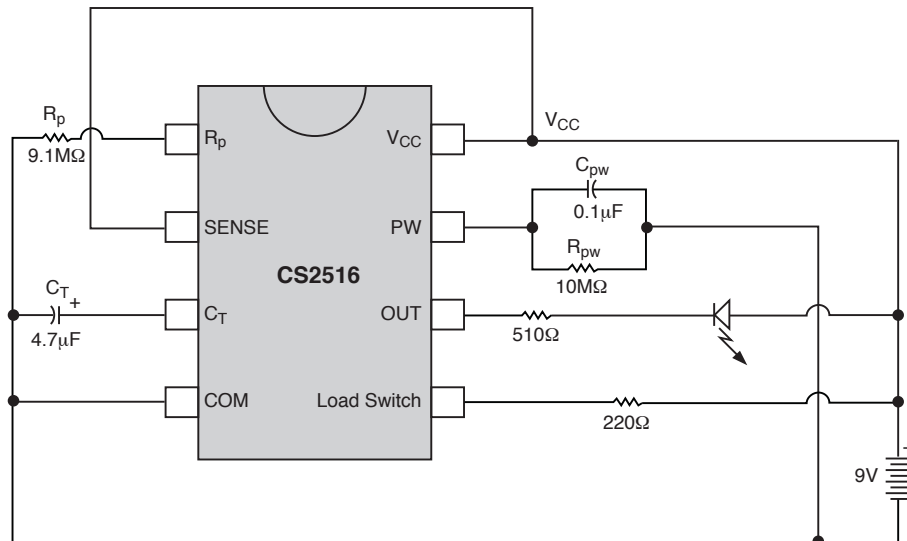
The value of  $R_p$  affects standby current, operating current, and the test cycle period. The recommended value is  $(V+/1\mu A)$  where  $V+$  is the fresh battery voltage. Higher values of  $R_p$  are not recommended. Minimum recommended value is  $(V+/10\mu A)$  which will increase both the standby and operating currents by 10X and reduce the test cycle period by the same factor; the test pulse width will be unaffected.

The value of  $C_t$  affects both the test cycle period and the test pulse width. Of critical importance is the selection of a low leakage type capacitor; if leakage current exceeds the cycle timer charge current, the timer will not operate.

The pulse stretcher components  $R_{PW}$  and  $C_{PW}$  should be selected such that the delay timer to charge  $C_{PW}$  is shorter than the test pulse width programmed by  $C_t$  to guarantee operation of the Output. The output is an open-collector transistor which may be used to drive an indicator device directly or to interface to logic family devices.

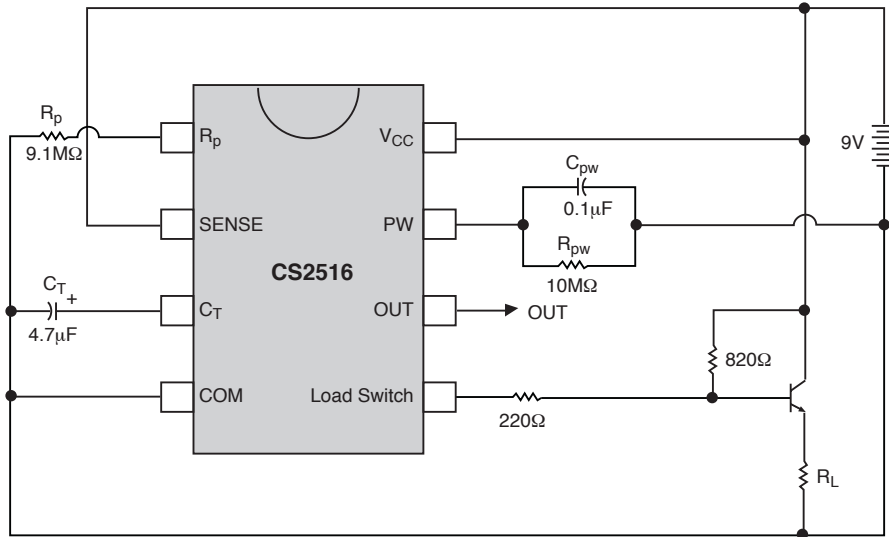
The SENSE input typical 8.5k $\Omega$  input impedance appears only during the test pulse; otherwise the SENSE input is in a high impedance state. The effective low battery threshold voltage can be modified (increased only) by means of a voltage divider placed across the load resistor. This technique can also be used to effectively reduce the threshold tolerance band.

### Typical Application Circuit

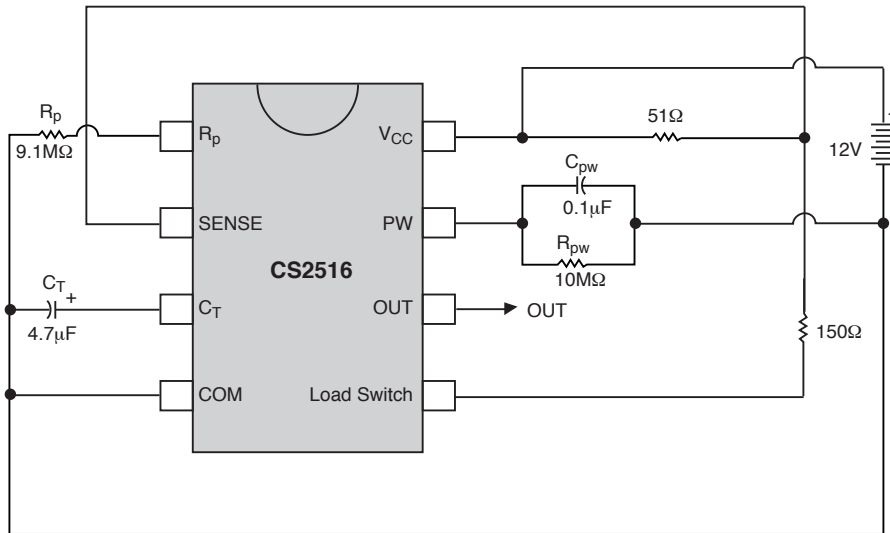


## Increased Pulse-Load Current Capability

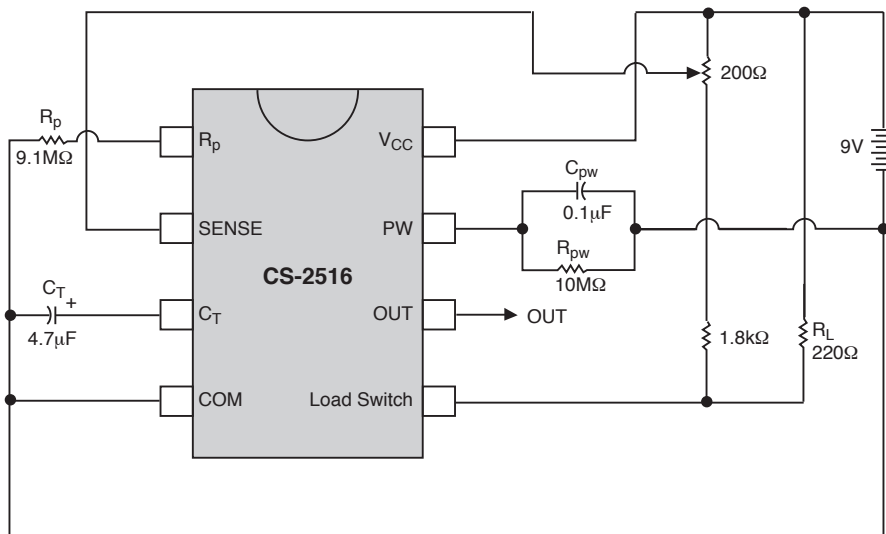
CS2516



## 12V Battery Application with 9V Threshold



## Adjustable Sense Threshold



**Package Specification**

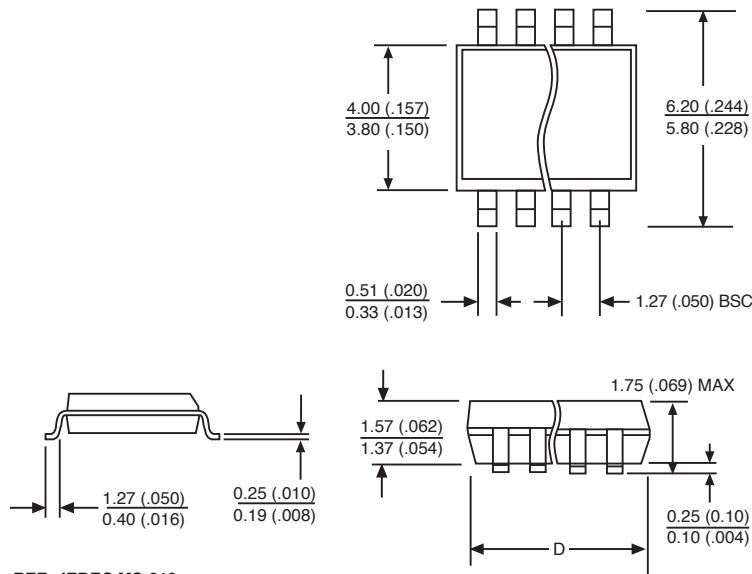
**PACKAGE DIMENSIONS IN mm (INCHES)**

Lead Count	D			
	Metric		English	
	Max	Min	Max	Min
8L PDIP	10.16	9.02	.400	.355
8L SOIC	5.00	4.80	.197	.189

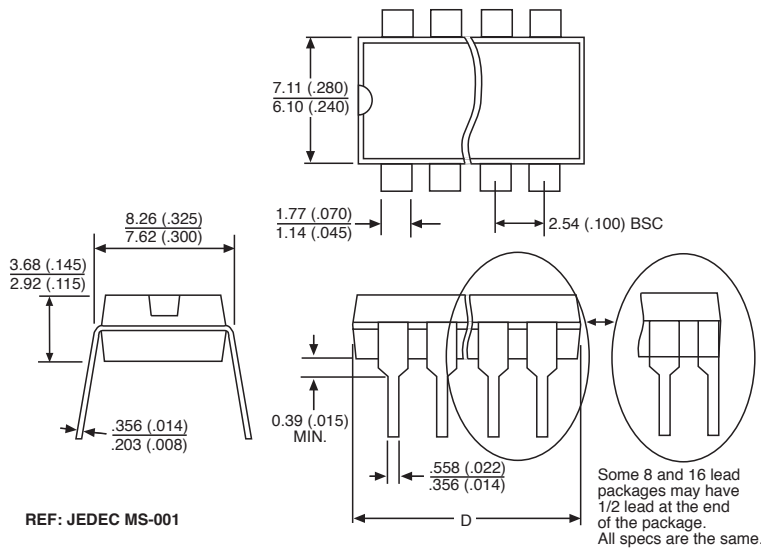
**PACKAGE THERMAL DATA**

Thermal Data		8L PDIP	8L SO	
$R\theta_{JC}$	typ	52	45	$^{\circ}\text{C}/\text{W}$
$R\theta_{JA}$	typ	100	165	$^{\circ}\text{C}/\text{W}$

**Surface Mount Narrow Body (D); 150 mil wide**



**Plastic DIP (N); 300 mil wide**



**Ordering Information**

Part Number	Description
CS2516KN8	8 Lead PDIP
CS2516KD8	8 Lead SOIC
CS2516KDR8	8 Lead SOIC (tape & reel)

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