# CS8363

# 3.3 V Dual Micropower Low Dropout Regulator with $\overline{\text{ENABLE}}$ and $\overline{\text{RESET}}$

The CS8363 is a precision Micropower dual voltage regulator with $\overline{\text{ENABLE}}$ and $\overline{\text{RESET}}$.

The 3.3 V standby output is accurate within ±2% while supplying loads of 100 mA. Quiescent current is low, typically 140 μA with a 300 μA load. The active $\overline{\text{RESET}}$ output monitors the 3.3 V standby output and is low during power−up and regulator dropout conditions. The $\overline{\text{RESET}}$ circuit includes hysteresis and is guaranteed to operate correctly with 1.0 V on the standby output.

The second output tracks the 3.3 V standby output through an external adjust lead, and can supply loads of 250 mA with a typical dropout voltage of 400 mV. The logic level lead $\overline{\text{ENABLE}}$ is used to control this tracking regulator output.

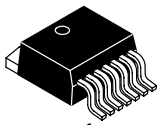
Both outputs are protected against overvoltage, short circuit, reverse battery and overtemperature conditions. The robustness and low quiescent current of the CS8363 makes it not only well suited for automotive microprocessor applications, but for any battery powered microprocessor applications.

### Features

- 2 Regulated Outputs
  - Standby Output 3.3 V ± 2%; 100 mA
  - Adjustable Tracking Output; 250 mA
- Low Dropout Voltage
- RESET for $V_{STBY}$
- ENABLE for $V_{TRK}$
- Low Quiescent Current
- Protection Features
  - Independent Thermal Shutdown
  - Short Circuit
  - 60 V Load Dump
  - Reverse Battery

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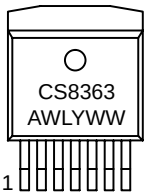
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**D²PAK−7**
**DPS SUFFIX**
**CASE 936AB**

Pin 1. $V_{STBY}$
2. $V_{IN}$
3. $V_{TRK}$
4. GND
5. Adj
6. $\overline{\text{ENABLE}}$
7. $\overline{\text{RESET}}$

### MARKING DIAGRAM




A = Assembly Location
WL, L = Wafer Lot
YY, Y = Year
WW, W = Work Week

### ORDERING INFORMATION*

| Device | Package | Shipping† |
|---|---|---|
| CS8363YDPS7 | D²PAK−7 | 50 Units/Rail |
| CS8363YDPSR7 | D²PAK−7 | 750 Tape & Reel |

*Contact your local sales representative for SO−16L package option.

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

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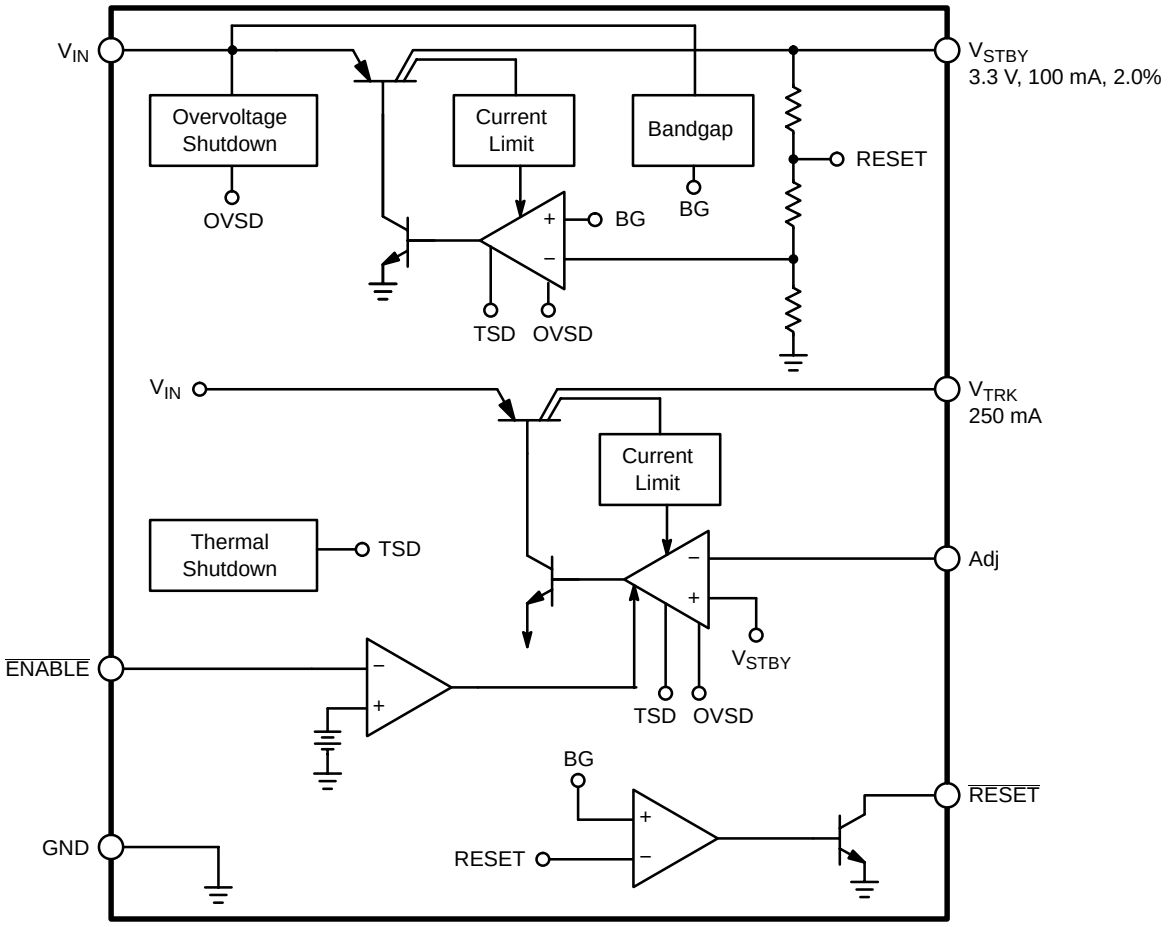



**Figure 1. Block Diagram. Consult Your Local Sales Representative for Positive ENABLE Option**

**ABSOLUTE MAXIMUM RATINGS***

| Rating | | Value | Unit |
|---|---|---|---|
| Supply Voltage, $V_{IN}$ | | −16 to 26 | V |
| Positive Transient Input Voltage, tr > 1.0 ms | | 60 | V |
| Negative Transient Input Voltage, T < 100 ms, 1.0 % Duty Cycle | | −50 | V |
| Input Voltage Range ($\overline{ENABLE}$, $\overline{RESET}$) | | −0.3 to 10 | V |
| Junction Temperature | | −40 to +150 | °C |
| Storage Temperature Range | | −55 to +150 | °C |
| ESD Susceptibility (Human Body Model) | | 2.0 | kV |
| Lead Temperature Soldering | Wave Solder (through hole styles only) Note 1<br>Reflow (SMD styles only) Note 2 | 260 peak<br>230 peak | °C<br>°C |

Maximum ratings are those values beyond which device damage can occur. Maximum ratings applied to the device are individual stress limit values (not normal operating conditions) and are not valid simultaneously. If these limits are exceeded, device functional operation is not implied, damage may occur and reliability may be affected.

1. 10 seconds max.
2. 60 seconds max above 183°C

*The maximum package power dissipation must be observed.

**ELECTRICAL CHARACTERISTICS** (6.0 V ≤ $V_{IN}$ ≤ 26 V, $I_{OUT1}$ = $I_{OUT2}$ = 100 μA, −40°C ≤ $T_A$ ≤ +125°C; unless otherwise stated.)

| Characteristic | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **Tracking Output ($V_{TRK}$)** | | | | | |
| $V_{TRK}$ Tracking Error ($V_{STBY}$ − $V_{TRK}$) | 6.0 V ≤ $V_{IN}$ ≤ 26 V, 100 μA ≤ $I_{TRK}$ ≤ 250 mA. Note 3 | −25 | − | +25 | mV |
| Adjust Pin Current, $I_{Adj}$ | Loop in Regulation | − | 1.5 | 5.0 | μA |
| Line Regulation | 6.0 V ≤ $V_{IN}$ ≤ 26 V. Note 3 | − | 5.0 | 50 | mV |
| Load Regulation | 100 μA ≤ $I_{TRK}$ ≤ 250 mA. Note 3 | − | 5.0 | 50 | mV |
| Dropout Voltage ($V_{IN}$ − $V_{TRK}$) | $I_{TRK}$ = 100 μA.<br>$I_{TRK}$ = 250 mA | −<br>− | 100<br>400 | 150<br>700 | mV<br>mV |
| Current Limit | $V_{IN}$ = 12 V, $V_{TRK}$ = 3.0 V | 275 | 500 | − | mA |
| Quiescent Current | $V_{IN}$ = 12 V, $I_{TRK}$ = 250 mA, No Load on $V_{STBY}$<br>$V_{IN}$ = 12 V, $I_{TRK}$ = 500 μA, $I_{STBY}$ = 100 μA | −<br>− | 25<br>145 | 50<br>220 | mA<br>μA |
| Reverse Current | $V_{TRK}$ = 3.3 V, $V_{IN}$ = 0 V | − | 200 | 1500 | μA |
| Ripple Rejection | f = 120 Hz, $I_{TRK}$ = 250 mA, 7.0 V ≤ $V_{IN}$ ≤ 17 V | 60 | 70 | − | dB |
| **Standby Output ($V_{STBY}$)** | | | | | |
| Output Voltage, $V_{STBY}$ | 4.5 V ≤ $V_{IN}$ ≤ 26 V, 100 μA ≤ $I_{STBY}$ ≤ 100 mA. | 3.234 | 3.3 | 3.366 | V |
| Line Regulation | 6.0 V ≤ $V_{IN}$ ≤ 26 V. | − | 5.0 | 50 | mV |
| Load Regulation | 100 μA ≤ $I_{STBY}$ ≤ 100 mA. | − | 5.0 | 50 | mV |
| Dropout Voltage ($V_{IN}$ − $V_{STBY}$) | $I_{STBY}$ = 100 μA, $V_{IN}$ = 4.2 V<br>$I_{STBY}$ = 100 mA, $V_{IN}$ = 4.2 V | −<br>− | −<br>− | 1.0<br>1.0 | V<br>V |
| Current Limit | $V_{IN}$ = 12 V, $V_{STBY}$ = 3.0 V | 125 | 200 | − | mA |
| Short Circuit Current | $V_{IN}$ = 12 V, $V_{STBY}$ = 0 V | 10 | 100 | − | mA |
| Quiescent Current | $V_{IN}$ = 12 V, $I_{STBY}$ = 100 mA, $I_{TRK}$ = 0 mA<br>$V_{IN}$ = 12 V, $I_{STBY}$ = 300 μA, $I_{TRK}$ = 0 mA | −<br>− | 10<br>140 | 20<br>200 | mA<br>μA |
| Reverse Current | $V_{STBY}$ = 3.3 V, $V_{IN}$ = 0 V | − | 100 | 200 | μA |
| Ripple Rejection | f = 120 Hz, $I_{STBY}$ = 100 mA, 7.0 V ≤ $V_{IN}$ ≤ 17 V | 60 | 70 | − | dB |
| **$\overline{\text{RESET}}$ $\overline{\text{ENABLE}}$ Functions** | | | | | |
| $\overline{\text{ENABLE}}$ Input Threshold | − | 0.8 | 1.2 | 2.0 | V |
| $\overline{\text{ENABLE}}$ Input Bias Current | $V_{ENABLE}$ = 0 V to 10 V | −10 | 0 | 10 | μA |
| $\overline{\text{RESET}}$ Hysteresis | − | 10 | 50 | 100 | mV |
| $\overline{\text{RESET}}$ Threshold Low ($V_{RL}$) | $V_{STBY}$ Decreasing, $V_{IN}$ > 4.5 V | 92.5 | 95 | 97.5 | %$V_{STBY}$ |
| $\overline{\text{RESET}}$ Leakage | − | − | − | 25 | μA |
| Output Voltage, Low ($V_{RLO}$) | 1.0 V ≤ $V_{STBY}$ ≤ $V_{RL}$, $R_{RST}$ = 10 kΩ | − | 0.1 | 0.4 | V |
| Output Voltage, Low ($V_{RPEAK}$) | $V_{STBY}$, Power Up, Power Down | − | 0.6 | 1.0 | V |
| $V_{IN}$ ($V_{RST}$ Low) | $V_{STBY}$ = 3.3 V | − | 4.0 | 4.5 | V |
| **Protection Circuitry (Both Outputs)** | | | | | |
| Independent Thermal Shutdown | $V_{STBY}$<br>$V_{TRK}$ | 150<br>150 | 180<br>165 | −<br>− | °C<br>°C |
| Overvoltage Shutdown | − | 30 | 34 | 38 | V |

3. $V_{TRK}$ connected to Adj lead. $V_{TRK}$ can be set to higher values by using an external resistor divider.

**PACKAGE PIN DESCRIPTION**

| PACKAGE PIN # | PIN SYMBOL | FUNCTION |
|---|---|---|
| D²PAK−7 | | |
| 1 | $V_{STBY}$ | Standby output voltage delivering 100 mA. |
| 2 | $V_{IN}$ | Input voltage. |
| 3 | $V_{TRK}$ | Tracking output voltage controlled by $\overline{\text{ENABLE}}$ delivering 250 mA. |
| 4 | GND | Reference ground connection. |
| 5 | Adj | Resistor divider from $V_{TRK}$ to Adj. Sets the output voltage on $V_{TRK}$. If tied to $V_{TRK}$, $V_{TRK}$ will track $V_{STBY}$. |
| 6 | $\overline{\text{ENABLE}}$ | Provides on/off control of the tracking output, active LOW. |
| 7 | $\overline{\text{RESET}}$ | CMOS compatible output lead that goes low whenever $V_{STBY}$ falls out of regulation. |

## CIRCUIT DESCRIPTION

### $\overline{\text{ENABLE}}$ Function

The $\overline{\text{ENABLE}}$ function switches the output transistor for $V_{TRK}$ on and off. When the $\overline{\text{ENABLE}}$ lead voltage exceeds 1.4 V (Typ), $V_{TRK}$ turns off. This input has several hundred millivolts of hysteresis to prevent spurious output activity during power−up or power−down.

### $\overline{\text{RESET}}$ Function

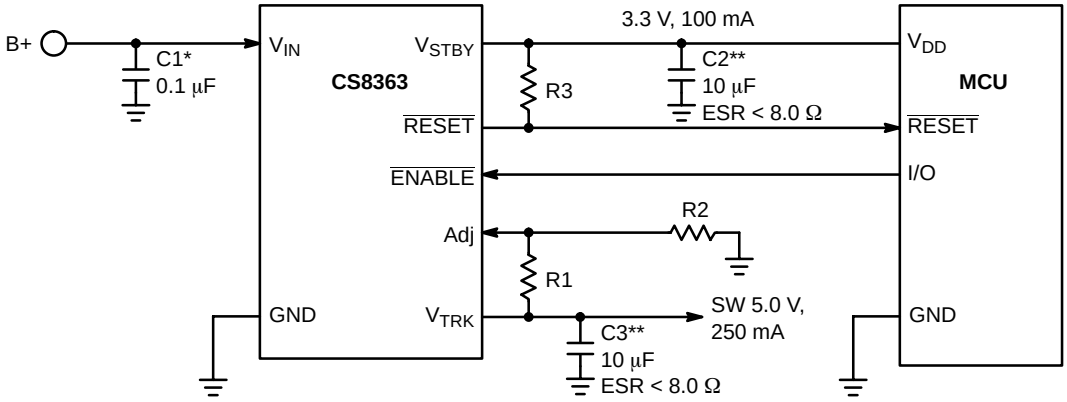
The $\overline{\text{RESET}}$ is an open collector NPN transistor, controlled by a low voltage detection circuit sensing the $V_{STBY}$ (3.3 V) output voltage. This circuit guarantees the $\overline{\text{RESET}}$ output stays below 1.0 V (0.1 V Typ) when $V_{STBY}$ is as low as 1.0 V to ensure reliable operation of microprocessor−based systems.

### $V_{TRK}$ Output Voltage

This output uses the same type of output device as $V_{STBY}$, but is rated for 250 mA. The output is configured as a tracking regulator of the standby output. By using the standby output as a voltage reference, giving the user an external programming lead (Adj lead), output voltages from 3.3 V to 20 V are easily realized. The programming is done with a simple resistor divider, and following the formula:

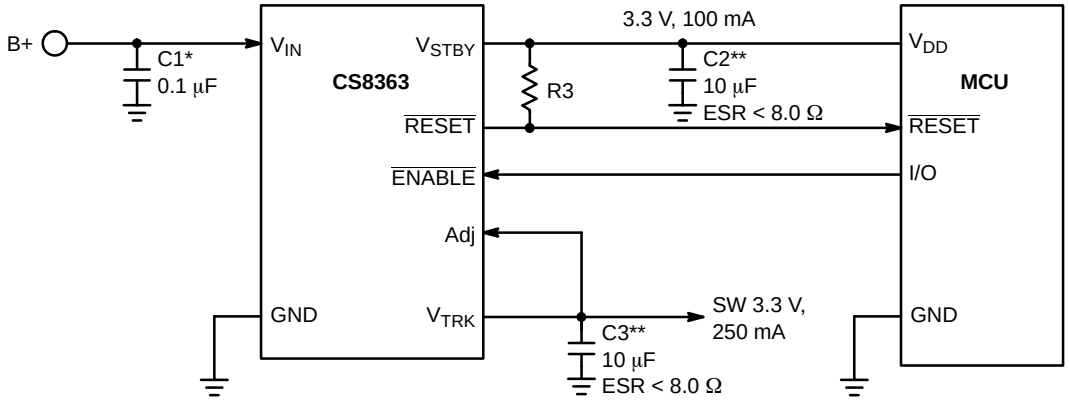
$$V_{TRK} = V_{STBY} \times (1 + R1/R2) + I_{Adj} \times R1$$

If another 3.3 V output is needed, simply connect the Adj lead to the $V_{TRK}$ output lead.




$V_{TRK}$ ~ $V_{STBY}$(1 + R1/R2)
For $V_{TRK}$ ~ 5.0 V, R1/R2 ~ 0.5
*C1 is required if regulator is located far from power supply filter.
**C2 and C3 are required for stability.

**Figure 2. Test and Application Circuit, 3.3 V, 5.0 V Regulator**




*C1 is required if regulator is located far from power supply filter.
**C2 and C3 are required for stability.

**Figure 3. Test and Application Circuit, Dual 3.3 V Regulator**

## APPLICATION NOTES

### External Capacitors

Output capacitors for the CS8363 are required for stability. Without them, the regulator outputs will oscillate. Actual size and type may vary depending upon the application load and temperature range. Capacitor effective series resistance (ESR) is also a factor in the IC stability. Worst−case is determined at the minimum ambient temperature and maximum load expected.

Output capacitors can be increased in size to any desired value above the minimum. One possible purpose of this would be to maintain the output voltages during brief conditions of negative input transients that might be characteristic of a particular system.

Capacitors must also be rated at all ambient temperatures expected in the system. To maintain regulator stability down to −40°C, capacitors rated at that temperature must be used.

More information on capacitor selection for SMART REGULATOR®s is available in the SMART REGULATOR application note, “Compensation for Linear Regulators,” document number SR003AN/D, available through the Literature Distribution Center or via our website at http://www.onsemi.com.

### Calculating Power Dissipation in a Dual Output Linear Regulator

The maximum power dissipation for a dual output regulator (Figure 4) is

$$P_{D(max)} = [V_{IN(max)} - V_{OUT1(min)}]I_{OUT1(max)} + [V_{IN(max)} - V_{OUT2(min)}]I_{OUT2(max)} + V_{IN(max)}I_Q \quad (1)$$

where:

$V_{IN(max)}$ is the maximum input voltage,

$V_{OUT1(min)}$ is the minimum output voltage from $V_{OUT1}$,

$V_{OUT2(min)}$ is the minimum output voltage from $V_{OUT2}$,

$I_{OUT1(max)}$ is the maximum output current, for the application,

$I_{OUT2(max)}$ is the maximum output current, for the application, and

$I_Q$ is the quiescent current the regulator consumes at both $I_{OUT1(max)}$ and $I_{OUT2(max)}$.

Once the value of $P_{D(max)}$ is known, the maximum permissible value of $R_{\theta JA}$ can be calculated:

$$R_{\Theta JA} = \frac{150^\circ C - T_A}{P_D} \quad (2)$$

The value of $R_{\theta JA}$ can be compared with those in the package section of the data sheet. Those packages with $R_{\theta JA}$’s less than the calculated value in equation 2 will keep the die temperature below 150°C.

In some cases, none of the packages will be sufficient to dissipate the heat generated by the IC, and an external heatsink will be required.

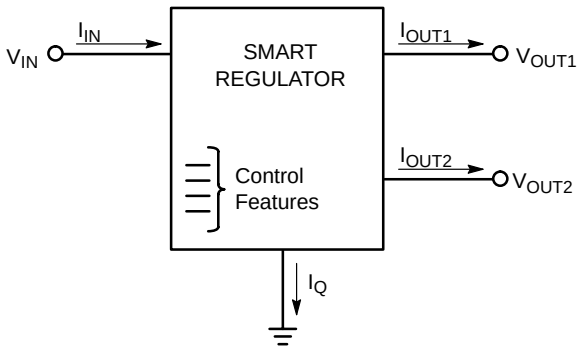



**Figure 4. Dual Output Regulator With Key Performance Parameters Labeled.**

**Heat Sinks**

A heat sink effectively increases the surface area of the package to improve the flow of heat away from the IC and into the surrounding air.

Each material in the heat flow path between the IC and the outside environment will have a thermal resistance. Like series electrical resistances, these resistances are summed to determine the value of $R_{\theta JA}$:

$$R_{\Theta JA} = R_{\Theta JC} + R_{\Theta CS} + R_{\Theta SA} \quad (3)$$

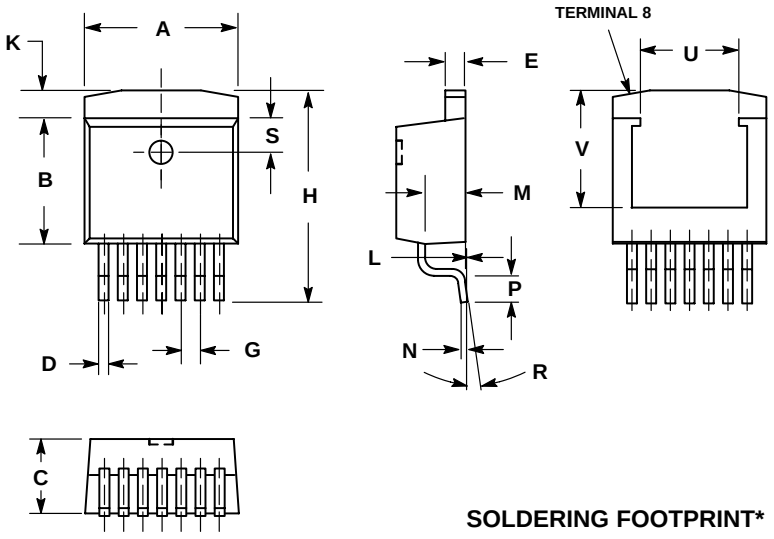
where:

$R_{\theta JC}$ = the junction−to−case thermal resistance,
$R_{\theta CS}$ = the case−to−heatsink thermal resistance, and
$R_{\theta SA}$ = the heatsink−to−ambient thermal resistance.

$R_{\theta JC}$ appears in the package section of the data sheet. Like $R_{\theta JA}$, it too is a function of package type. $R_{\theta CS}$ and $R_{\theta SA}$ are functions of the package type, heatsink and the interface between them. These values appear in heat sink data sheets of heat sink manufacturers.

## PACKAGE DIMENSIONS

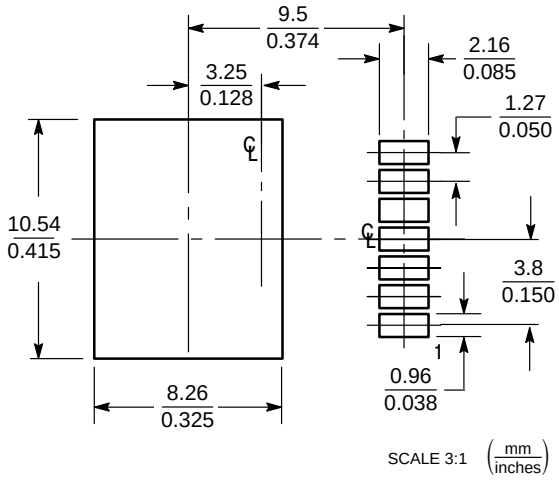
**D²PAK−7 (SHORT LEAD)**
**DPS SUFFIX**
CASE 936AB−01
ISSUE A




NOTES:
1. DIMENSIONS AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

| | INCHES | | MILLIMETERS | |
|---|---|---|---|---|
| DIM | MIN | MAX | MIN | MAX |
| A | 0.396 | 0.406 | 10.05 | 10.31 |
| B | 0.326 | 0.336 | 8.28 | 8.53 |
| C | 0.170 | 0.180 | 4.31 | 4.57 |
| D | 0.026 | 0.036 | 0.66 | 0.91 |
| E | 0.045 | 0.055 | 1.14 | 1.40 |
| G | 0.050 REF | | 1.27 REF | |
| H | 0.539 | 0.579 | 13.69 | 14.71 |
| K | 0.055 | 0.066 | 1.40 | 1.68 |
| L | 0.000 | 0.010 | 0.00 | 0.25 |
| M | 0.100 | 0.110 | 2.54 | 2.79 |
| N | 0.017 | 0.023 | 0.43 | 0.58 |
| P | 0.058 | 0.078 | 1.47 | 1.98 |
| R | 0 ° | 8 ° | 0 ° | 8 ° |
| S | 0.095 | 0.105 | 2.41 | 2.67 |
| U | 0.256 REF | | 6.50 REF | |
| V | 0.305 REF | | 7.75 REF | |

### SOLDERING FOOTPRINT*




*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

**PACKAGE THERMAL DATA**

| Parameter | | D²PAK−7 | Unit |
|---|---|---|---|
| $R_{\theta JC}$ | Typical | 3.5 | °C/W |
| $R_{\theta JA}$ | Typical | 10−50* | °C/W |

*Depending on thermal properties of substrate. $R_{\theta JA} = R_{\theta JC} + R_{\theta CA}$.

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**CS8363/D**

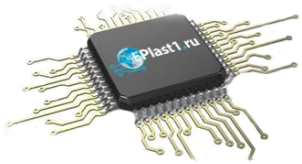
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