

## LOW DROP VOLTAGE REGULATOR

### 1 FEATURES

- OPERATING DC SUPPLY VOLTAGE RANGE  
5.6V TO 31V
- LOW QUIESCENT CURRENT  
(6 $\mu$ A Typ. @ 25°C with Enable Low)
- HIGH PRECISION OUTPUT VOLTAGE (2%)
- LOW DROPOUT VOLTAGE LESS THAN 0.5V
- RESET CIRCUIT SENSING THE OUTPUT  
VOLTAGE DOWN TO 1V
- PROGRAMMABLE RESET PULSE DELAY  
WITH EXTERNAL CAPACITOR
- WATCHDOG
- PROGRAMMABLE WATCHDOG TIMER WITH  
EXTERNAL CAPACITOR
- THERMAL SHUTDOWN AND SHORT  
CIRCUIT PROTECTION
- AUTOMOTIVE TEMPERATURE RANGE  
(T<sub>j</sub> = -40°C TO 150°C)
- ENABLE INPUT FOR ENABLING/DISABLING  
THE VOLTAGE REGULATOR OUTPUT

Figure 1. Packages

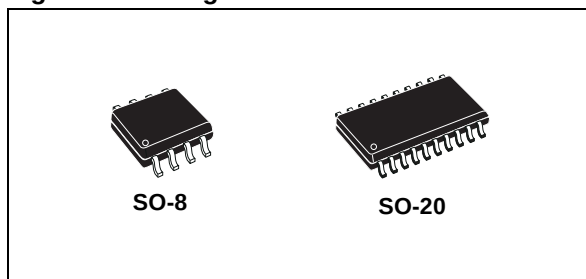


Table 1. Order Codes

| Part Number | Package           |
|-------------|-------------------|
| L4979D      | SO-8              |
| L4979MD     | SO-20             |
| L4979D13TR  | SO-8 Tape & Reel  |
| L4979MD13TR | SO-20 Tape & Reel |

Figure 2. Block Diagram

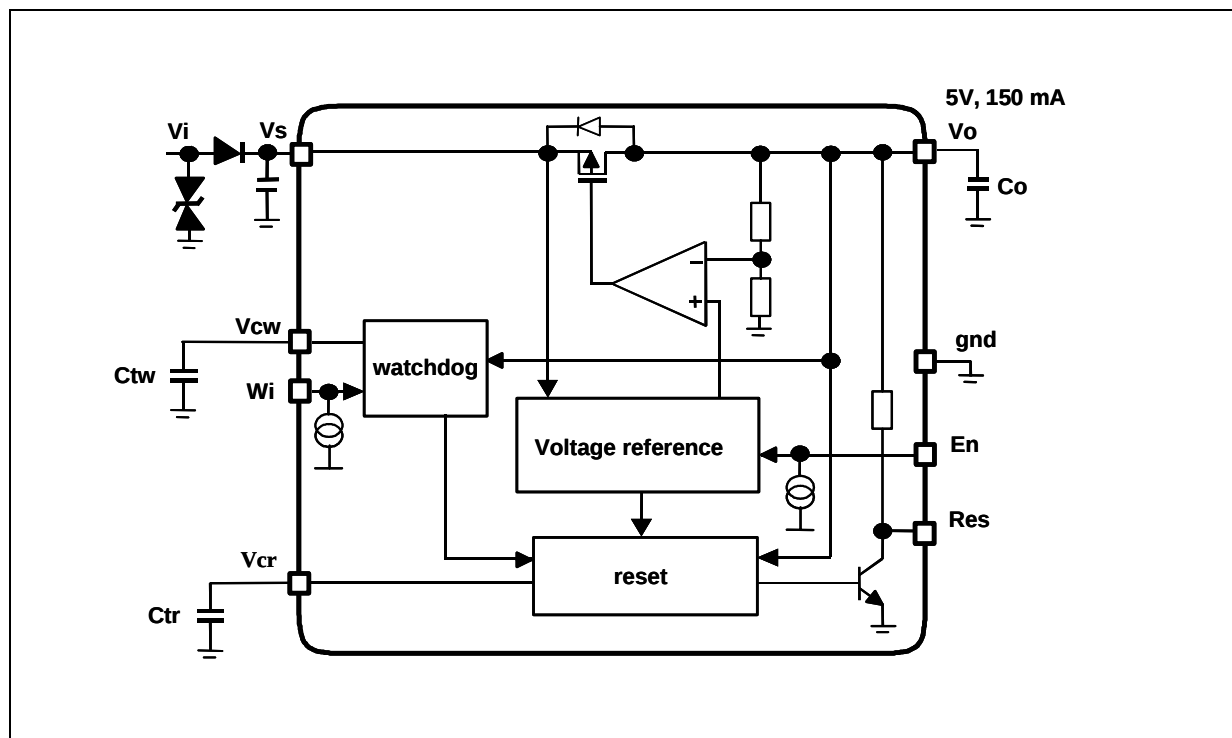
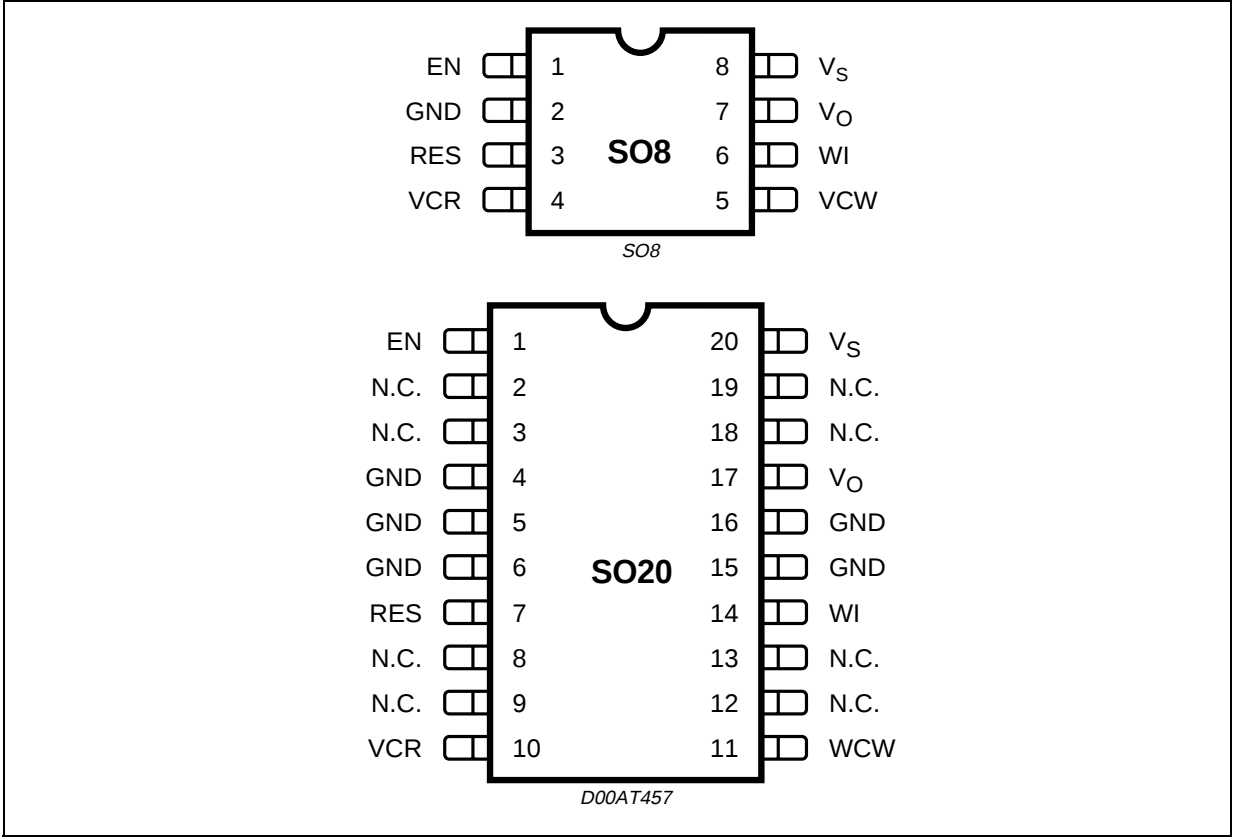


Table 2. Pin Function

| SO8<br>N° | SO20<br>N°                    | Pin<br>Name | Function                                                                                                                   |
|-----------|-------------------------------|-------------|----------------------------------------------------------------------------------------------------------------------------|
| 1         | 1                             | En          | Enable input<br>If high, regulator, watchdog and reset are operating. If low, regulator, watchdog and reset are shut down. |
| 2         | 4                             | gnd         | Ground reference                                                                                                           |
|           | 5,6,15,16                     | gnd         | Ground<br>These pins are to be connected to a heat spreader electrically grounded                                          |
| 3         | 7                             | Res         | Reset output.<br>It is pulled down when output voltage drops below Vo_th or frequency at Wi is too low.                    |
| 4         | 10                            | Vcr         | Reset timing adjust<br>A capacitor between Vcr pin and gnd sets the reset delay time (trd)                                 |
| 5         | 11                            | Vcw         | Watchdog timer adjust<br>A capacitor between Vcw pin and gnd sets the time response of the watchdog monitor.               |
| 6         | 14                            | Wi          | Watchdog input.<br>If the frequency at this input pin is too low, the Reset output is activated.                           |
| 7         | 17                            | Vo          | Voltage regulator output<br>Output capacitor >100nF is needed for regulator stability                                      |
| 8         | 20                            | Vs          | Supply voltage<br>Supply capacitor (e.g. 200nF) is needed for regulator stability.                                         |
|           | 2, 3, 8, 9, 12,<br>13, 18, 19 | N. C.       | not connected                                                                                                              |

Figure 3. Pins Connection (Top view)



**Table 3. Absolute Maximum Ratings**

| Symbol            | Parameter                            | Value                        | Unit |
|-------------------|--------------------------------------|------------------------------|------|
| V <sub>vsdc</sub> | DC supply voltage                    | -0.3 to 40                   | V    |
| I <sub>vsdc</sub> | Input current                        | internally limited           |      |
| V <sub>vo</sub>   | DC output voltage                    | -0.3 to 6                    | V    |
| I <sub>vo</sub>   | DC output current                    | internally limited           |      |
| V <sub>wi</sub>   | Watchdog input voltage               | -0.3 to V <sub>vo</sub> +0.3 | V    |
| V <sub>od</sub>   | Open drain output voltage (RES)      | -0.3 to V <sub>vo</sub> +0.3 | V    |
| I <sub>od</sub>   | Open drain output current (RES)      | internally limited           |      |
| V <sub>cr</sub>   | Reset delay voltage                  | -0.3 to V <sub>vo</sub> +0.3 | V    |
| V <sub>cw</sub>   | Watchdog delay voltage               | -0.3 to V <sub>vo</sub> +0.3 | V    |
| V <sub>en</sub>   | Enable input voltage                 | -0.3 to 40                   | V    |
| T <sub>j</sub>    | Junction temperature                 | -40 to 150                   | °C   |
| VESD              | ESD voltage level (HBM-MIL STD 883C) | ±2                           | kV   |

Note: 1. Maximum ratings are absolute ratings; exceeding any one of these values may cause permanent damage to the integrated circuit.

**Table 4. Thermal Data**

| Symbol                | Parameter                              | SO8        | SO16+2+2 | Unit |
|-----------------------|----------------------------------------|------------|----------|------|
| R <sub>th j-amb</sub> | Thermal resistance Junction to Ambient | 130 to 180 | 50 to 80 | °C/W |

**Table 5. Electrical Characteristics**

(V<sub>s</sub> = 5.6V to 31V, T<sub>j</sub> = -40°C to +150°C unless otherwise specified)

| Pin                             | Symbol            | Parameter                                 | Test Condition                                                                    | Min. | Typ. | Max. | Unit |
|---------------------------------|-------------------|-------------------------------------------|-----------------------------------------------------------------------------------|------|------|------|------|
| <b>GENERAL</b>                  |                   |                                           |                                                                                   |      |      |      |      |
| V <sub>s</sub> , V <sub>o</sub> | I <sub>q</sub>    | Quiescent current                         | V <sub>s</sub> = 13.5V, I <sub>o</sub> =150mA, enable high<br>all I/O currents=0  |      | 1.5  | 3    | mA   |
| V <sub>s</sub> , V <sub>o</sub> | I <sub>q</sub>    | Quiescent current                         | V <sub>s</sub> = 13.5V, I <sub>o</sub> = 0mA, enable high<br>all I/O currents = 0 |      | 100  | 200  | μA   |
| V <sub>s</sub> , V <sub>o</sub> | I <sub>q</sub>    | Quiescent current                         | V <sub>s</sub> = 13.5V, I <sub>o</sub> = 0mA, enable low<br>all I/O currents = 0  |      | 6    | 20   | μA   |
|                                 | T <sub>w</sub>    | Thermal protection temperature            |                                                                                   | 150  |      | 190  | °C   |
|                                 | T <sub>w_hy</sub> | Thermal protection temperature hysteresis |                                                                                   |      | 10   |      | °C   |

Table 5: Electrical Characteristics (continued)

| Pin                             | Symbol             | Parameter                                   | Test Condition                                                    | Min.                              | Typ.                              | Max.                               | Unit |
|---------------------------------|--------------------|---------------------------------------------|-------------------------------------------------------------------|-----------------------------------|-----------------------------------|------------------------------------|------|
| <b>VOLTAGE REGULATOR</b>        |                    |                                             |                                                                   |                                   |                                   |                                    |      |
| V <sub>O</sub>                  | V <sub>O_ref</sub> | Output voltage                              | V <sub>S</sub> = 5.6 to 31V<br>I <sub>O</sub> = 1 to 150mA        | 4.90                              | 5.00                              | 5.10                               | V    |
| V <sub>O</sub>                  | I <sub>short</sub> | Output short circuit current <sup>(1)</sup> | V <sub>S</sub> = 13.5V                                            | 150                               | 280                               | 400                                | mA   |
| V <sub>O</sub>                  | I <sub>lim</sub>   | Output current limitation <sup>(1)</sup>    | V <sub>S</sub> = 13.5V                                            | 150                               | 320                               | 500                                | mA   |
| V <sub>S</sub> , V <sub>O</sub> | V <sub>line</sub>  | Line regulation voltage                     | V <sub>S</sub> = 5.6 to 31V<br>I <sub>O</sub> = 1 to 150mA        |                                   |                                   | 25                                 | mV   |
| V <sub>O</sub>                  | V <sub>load</sub>  | Load regulation voltage                     | I <sub>O</sub> = 1 to 150mA                                       |                                   |                                   | 25                                 | mV   |
| V <sub>S</sub> , V <sub>O</sub> | V <sub>dp</sub>    | Drop voltage                                | I <sub>O</sub> = 150mA                                            |                                   | 200                               | 400                                | mV   |
| V <sub>S</sub> , V <sub>O</sub> | SVR                | Ripple rejection <sup>(2)</sup>             | f <sub>r</sub> = 100 Hz                                           | 55                                |                                   |                                    | dB   |
| <b>RESET</b>                    |                    |                                             |                                                                   |                                   |                                   |                                    |      |
| R <sub>es</sub>                 | V <sub>res_l</sub> | Reset output low voltage                    | R <sub>ext</sub> = 5kΩ to V <sub>O</sub> ,<br>V <sub>O</sub> > 1V |                                   |                                   | 0.4                                | V    |
| R <sub>es</sub>                 | I <sub>res_h</sub> | Reset output high leakage current           | V <sub>res</sub> = 5V                                             |                                   |                                   | 1                                  | μA   |
| R <sub>es</sub>                 | R <sub>p_u</sub>   | Internal Pull up resistance                 | with respect to V <sub>O</sub>                                    | 12                                | 25                                | 50                                 | kΩ   |
| R <sub>es</sub>                 | V <sub>O_th</sub>  | Reset threshold voltage                     | V <sub>S</sub> = 5.6 to 31V<br>I <sub>O</sub> = 1 to 150mA        | 6%<br>below<br>V <sub>O_ref</sub> | 8%<br>below<br>V <sub>O_ref</sub> | 10%<br>below<br>V <sub>O_ref</sub> |      |
| V <sub>cr</sub>                 | V <sub>rhth</sub>  | Reset timing high threshold                 | V <sub>S</sub> = 13.5V                                            | 44%<br>V <sub>O_ref</sub>         | 47%<br>V <sub>O_ref</sub>         | 50%<br>V <sub>O_ref</sub>          |      |
| V <sub>cr</sub>                 | V <sub>rlth</sub>  | Reset timing low threshold                  | V <sub>S</sub> = 13.5V                                            | 10%<br>V <sub>O_ref</sub>         | 13%<br>V <sub>O_ref</sub>         | 16%<br>V <sub>O_ref</sub>          |      |
| V <sub>cr</sub>                 | I <sub>cr</sub>    | Charge current                              | V <sub>S</sub> = 13.5V                                            | 8                                 | 17                                | 30                                 | μA   |
| V <sub>cr</sub>                 | I <sub>dr</sub>    | Discharge current                           | V <sub>S</sub> = 13.5V                                            | 8                                 | 17                                | 30                                 | μA   |
| R <sub>es</sub>                 | t <sub>rr_2</sub>  | Reset delay time <sup>(3)</sup>             | V <sub>O</sub> = V <sub>O_th</sub> -100mV                         | 100                               | 250                               | 700                                | μs   |
| R <sub>es</sub>                 | t <sub>rd</sub>    | Reset pulse delay                           | V <sub>S</sub> = 13.5V, C <sub>tr</sub> = 1nF                     | 65                                |                                   | 150                                | ms   |
| <b>WATCHDOG</b>                 |                    |                                             |                                                                   |                                   |                                   |                                    |      |
| W <sub>i</sub>                  | V <sub>ih</sub>    | Input high voltage                          | V <sub>S</sub> = 13.5V                                            | 3.5                               |                                   |                                    | V    |
| W <sub>i</sub>                  | V <sub>il</sub>    | Input low voltage                           | V <sub>S</sub> = 13.5V                                            |                                   |                                   | 1.5                                | V    |
| W <sub>i</sub>                  | V <sub>ih</sub>    | Input hysteresis                            | V <sub>S</sub> = 13.5V                                            |                                   | 300                               |                                    | mV   |
| W <sub>i</sub>                  | I <sub>i</sub>     | Pull down current                           | V <sub>S</sub> = 13.5V                                            |                                   | 10                                | 20                                 | μA   |
| V <sub>cw</sub>                 | V <sub>whth</sub>  | High threshold                              | V <sub>S</sub> = 13.5V                                            | 2.20                              | 2.35                              | 2.50                               | V    |
| V <sub>cw</sub>                 | V <sub>wlth</sub>  | Low threshold                               | V <sub>S</sub> = 13.5V                                            | 0.50                              | 0.65                              | 0.80                               | V    |

**ELECTRICAL CHARACTERISTICS** (continued)

| Pin           | Symbol       | Parameter                 | Test Condition               | Min. | Typ. | Max. | Unit    |
|---------------|--------------|---------------------------|------------------------------|------|------|------|---------|
| $V_{CW}$      | $I_{CWC}$    | Charge current            | $V_S = 13.5V, V_{CW} = 0.1V$ | 4    | 7.5  | 14   | $\mu A$ |
| $V_{CW}$      | $I_{CWD}$    | Discharge current         | $V_S = 13.5V, V_{CW} = 2.5V$ | 1.0  | 2.4  | 4.5  | $\mu A$ |
| $V_{CW}$      | $T_{Wop}$    | Watchdog period           | $V_S = 13.5V, C_{TW} = 47nF$ | 25   | 50   | 90   | ms      |
| $R_{ES}$      | $t_{Wol}$    | Watchdog output low time  | $V_S = 13.5V, C_{TW} = 47nF$ | 6    | 10   | 22   | ms      |
| <b>ENABLE</b> |              |                           |                              |      |      |      |         |
| $E_n$         | $V_{en\_l}$  | Enable input low voltage  |                              |      |      | 1    | V       |
| $E_n$         | $V_{en\_h}$  | Enable input high voltage |                              | 3    |      |      | V       |
| $E_n$         | $V_{en\_hy}$ | Enable input hysteresis   |                              | 700  | 1000 | 1100 | mV      |
| $E_n$         | $I_{leak}$   | Pull down current         | $E_n = 5V$                   | 2    | 10   | 20   | $\mu A$ |

Note: 1. see fig4 (behavior of output current versus regulated voltage  $V_o$ )

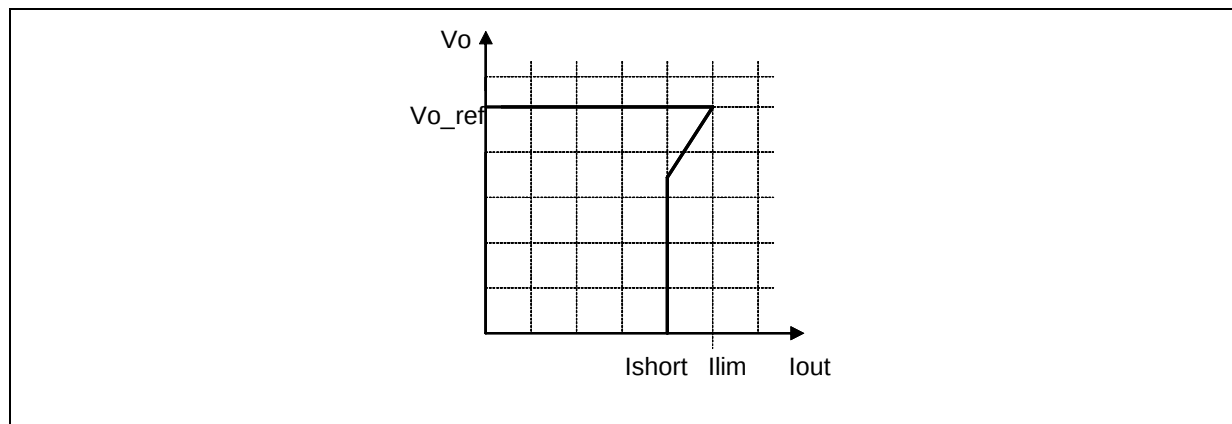
2. guaranteed by design

3. When  $V_o$  becomes lower than 4V, the reset reaction time decreases down to 2 $\mu s$  assuring a faster reset condition in this particular case.

**2 VOLTAGE REGULATOR**

The voltage regulator uses a p-channel MOS transistor as a regulating element. With this structure a low drop-out voltage at current up to 150mA is achieved. The output voltage is regulated up to transient input supply voltage of 40V. No functional interruption due to over-voltage pulses is generated. The high precision of the output voltage is obtained with a pre-trimmed reference voltage. A short circuit protection to GND is provided.

**Figure 4. Behavior of output current versus regulated voltage  $V_o$  (see a.m. Note 1)**

**3 RESET**

The reset circuit monitors the output voltage  $V_o$ . If the output voltage drops below  $V_{o\_th}$  then  $R_{es}$  becomes low with a delay time  $t_{rr}$ . Real  $t_{rr}$  value changes as a non-linear function of  $\Delta(V_{o\_th} - \bar{V}_o)$ . The reset low signal is guaranteed for an output voltage  $V_o$  greater than 1V.

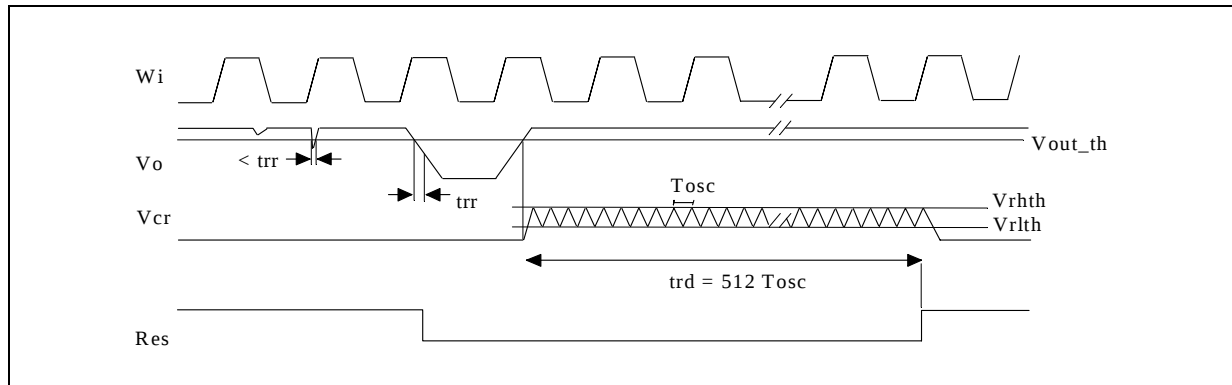
When the output voltage becomes higher than  $V_{o\_th}$  then  $R_{es}$  goes high with a delay  $t_{rd}$ . This delay is obtained by 512 periods of an oscillator (see fig. 5). The oscillator period is given by:

$$T_{osc} = \frac{[(V_{rth} - V_{rlth}) \cdot C_{tr}]}{I_{cr}} + \frac{[(V_{rth} - V_{rlth}) \cdot C_{tr}]}{I_{dr}}$$

and reset pulse delay  $t_{rd}$  is given by:

$$t_{rd} = 512 \times T_{osc}$$

**Figure 5. Reset Time Diagram.**



## 4 WATCHDOG

The watchdog input  $W_i$  monitors a connected microcontroller. If pulses are missing, the reset output  $Res$  is set to low. The pulse sequence time can be set within a wide range through the external capacitor  $C_{tw}$ . The watchdog circuit discharges the capacitor  $C_{tw}$  with the constant current  $I_{cwd}$ . If the lower threshold  $V_{wlth}$  is reached, a watchdog reset is generated. To prevent this reset, the microcontroller must generate a positive edge during the discharge of the capacitor before the voltage has reached the threshold  $V_{wlth}$ . In order to calculate the minimum time  $T_{dis}$  during which the microcontroller must generate the positive edge, the following equation can be used:

$$(V_{whth} - V_{wlth}) \times C_{tw} = I_{cwd} \times T_{dis}$$

Each  $W_i$  positive edge switches the current source from discharging to charging; the same happens when the lower  $V_{wlth}$  threshold is reached. When the voltage reaches the upper threshold  $V_{whth}$  the current switches from charging to discharging. The result is a saw tooth voltage at the watchdog timer capacitor  $C_{tw}$ .

**Figure 6. Watchdog time diagram**

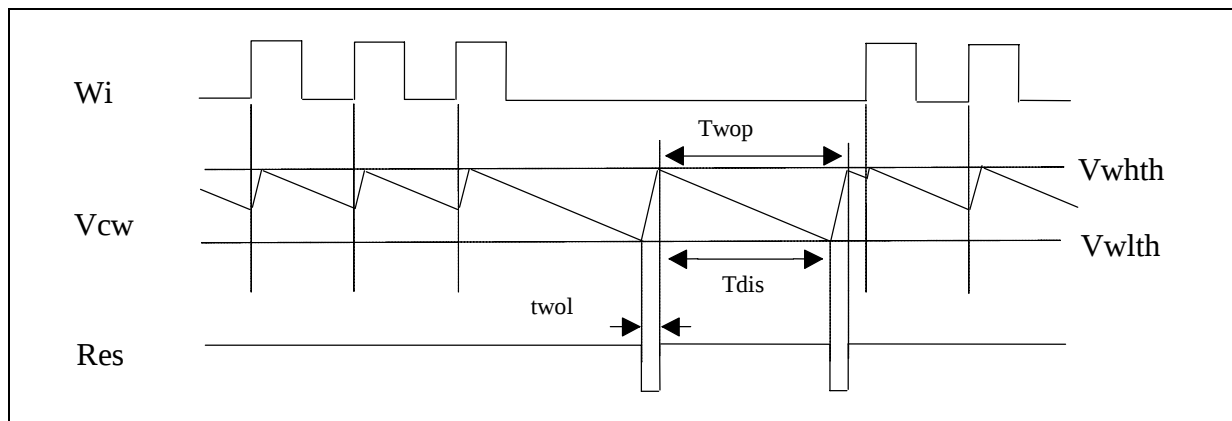
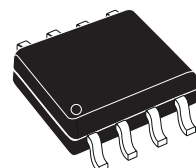


Figure 7. SO-8 Mechanical Data &amp; Package Dimensions

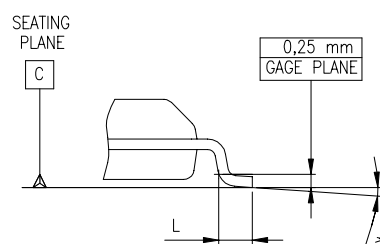
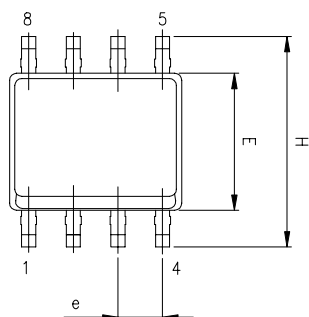
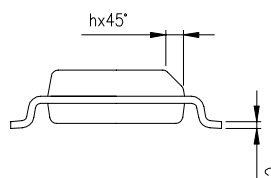
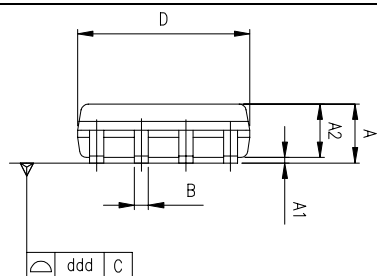
| DIM.             | mm                   |      |      | inch  |       |       |
|------------------|----------------------|------|------|-------|-------|-------|
|                  | MIN.                 | TYP. | MAX. | MIN.  | TYP.  | MAX.  |
| A                | 1.35                 |      | 1.75 | 0.053 |       | 0.069 |
| A1               | 0.10                 |      | 0.25 | 0.004 |       | 0.010 |
| A2               | 1.10                 |      | 1.65 | 0.043 |       | 0.065 |
| B                | 0.33                 |      | 0.51 | 0.013 |       | 0.020 |
| C                | 0.19                 |      | 0.25 | 0.007 |       | 0.010 |
| D <sup>(1)</sup> | 4.80                 |      | 5.00 | 0.189 |       | 0.197 |
| E                | 3.80                 |      | 4.00 | 0.15  |       | 0.157 |
| e                |                      | 1.27 |      |       | 0.050 |       |
| H                | 5.80                 |      | 6.20 | 0.228 |       | 0.244 |
| h                | 0.25                 |      | 0.50 | 0.010 |       | 0.020 |
| L                | 0.40                 |      | 1.27 | 0.016 |       | 0.050 |
| k                | 0° (min.), 8° (max.) |      |      |       |       |       |
| ddd              |                      |      | 0.10 |       |       | 0.004 |

Note: (1) Dimensions D does not include mold flash, protrusions or gate burrs.  
Mold flash, protrusions or gate burrs shall not exceed 0.15mm (.006inch) in total (both side).

## OUTLINE AND MECHANICAL DATA



## SO-8

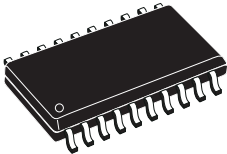


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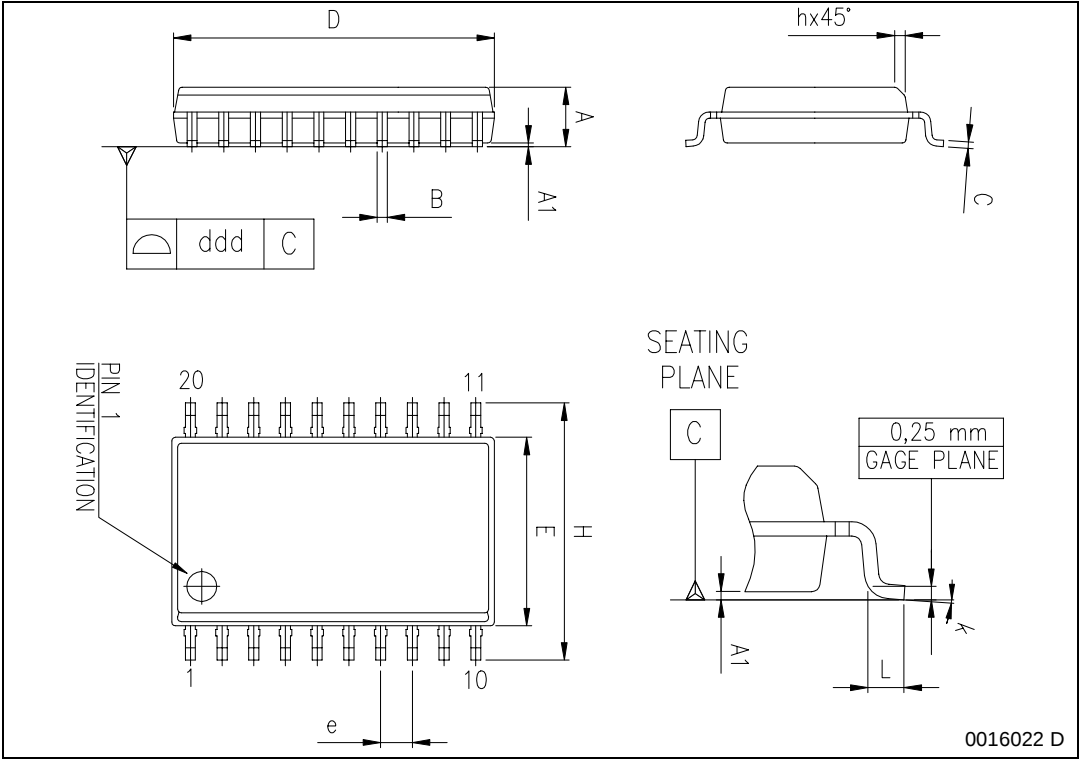
Figure 8. SO-20 Mechanical Data & Package Dimensions

| DIM.                                                                                                                                            | mm                   |      |       | inch  |       |       |
|-------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|------|-------|-------|-------|-------|
|                                                                                                                                                 | MIN.                 | TYP. | MAX.  | MIN.  | TYP.  | MAX.  |
| A                                                                                                                                               | 2.35                 |      | 2.65  | 0.093 |       | 0.104 |
| A1                                                                                                                                              | 0.10                 |      | 0.30  | 0.004 |       | 0.012 |
| B                                                                                                                                               | 0.33                 |      | 0.51  | 0.013 |       | 0.200 |
| C                                                                                                                                               | 0.23                 |      | 0.32  | 0.009 |       | 0.013 |
| D (1)                                                                                                                                           | 12.60                |      | 13.00 | 0.496 |       | 0.512 |
| E                                                                                                                                               | 7.40                 |      | 7.60  | 0.291 |       | 0.299 |
| e                                                                                                                                               |                      | 1.27 |       |       | 0.050 |       |
| H                                                                                                                                               | 10.0                 |      | 10.65 | 0.394 |       | 0.419 |
| h                                                                                                                                               | 0.25                 |      | 0.75  | 0.010 |       | 0.030 |
| L                                                                                                                                               | 0.40                 |      | 1.27  | 0.016 |       | 0.050 |
| k                                                                                                                                               | 0° (min.), 8° (max.) |      |       |       |       |       |
| ddd                                                                                                                                             |                      |      | 0.10  |       |       | 0.004 |
| (1) "D" dimension does not include mold flash, protusions or gate burrs. Mold flash, protusions or gate burrs shall not exceed 0.15mm per side. |                      |      |       |       |       |       |

OUTLINE AND MECHANICAL DATA



SO20



**Table 6. Revision History**

| Date         | Revision | Description of Changes                                                                                                                                                                |
|--------------|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| June 2004    | 3        | Changed the values of the parameter "Reset timing high/low threshold.                                                                                                                 |
| July 2004    | 4        | Pin Connection SO-20 changed.<br>Changed some textes in the Features and table 2.<br>Changed some values in the tables 3, 4 and 5.<br>Changed some textes in the sections 2, 3 and 4. |
| October 2004 | 5        | Changed from Product Preview to final datasheet.                                                                                                                                      |

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