



# TDE1897C TDE1898C

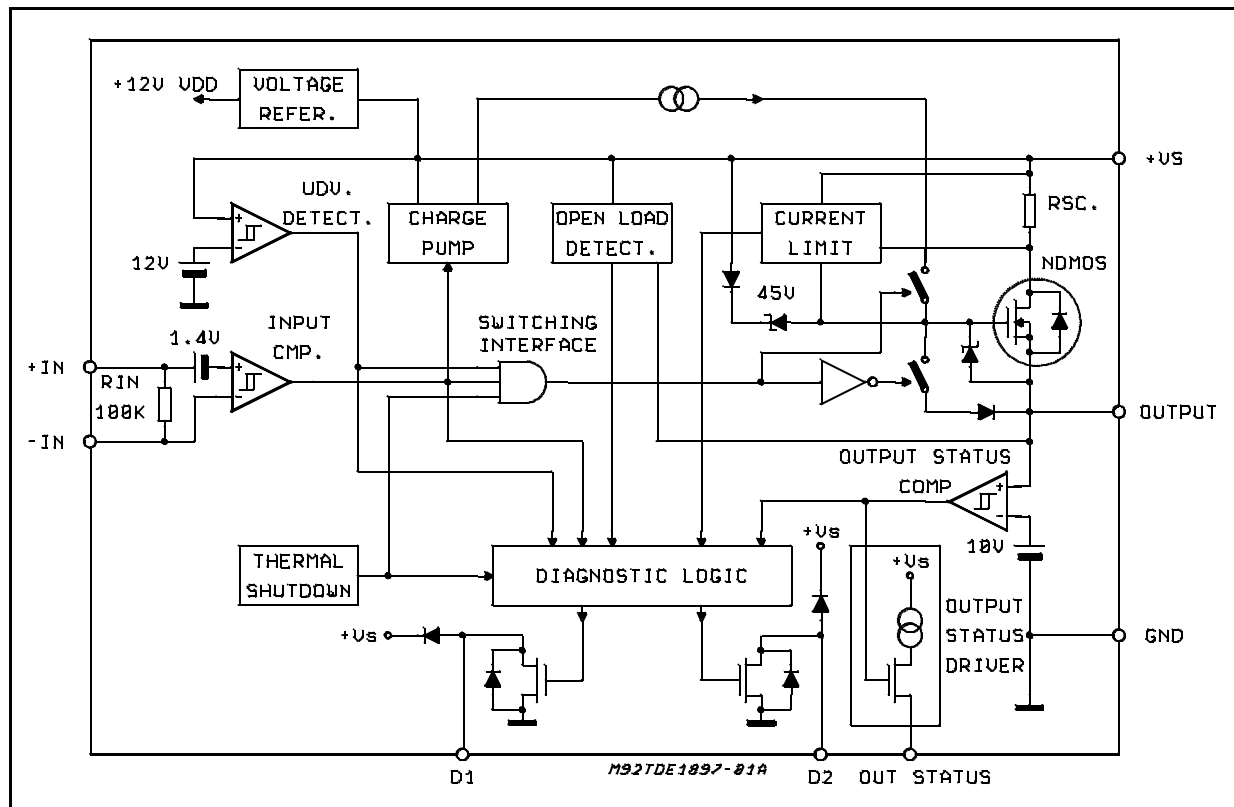
## 0.5A HIGH-SIDE DRIVER INDUSTRIAL INTELLIGENT POWER SWITCH

- 0.5A OUTPUT CURRENT
- 18V TO 35V SUPPLY VOLTAGE RANGE
- INTERNAL CURRENT LIMITING
- THERMAL SHUTDOWN
- OPEN GROUND PROTECTION
- INTERNAL NEGATIVE VOLTAGE CLAMPING TO  $V_S - 45V$  FOR FAST DEMAGNETIZATION
- DIFFERENTIAL INPUTS WITH LARGE COMMON MODE RANGE AND THRESHOLD HYSTERESIS
- UNDERVOLTAGE LOCKOUT WITH HYSTERESIS
- OPEN LOAD DETECTION
- TWO DIAGNOSTIC OUTPUTS
- OUTPUT STATUS LED DRIVER

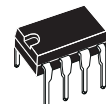
### DESCRIPTION

The TDE1897C/TDE1898C is a monolithic Intelligent Power Switch in Multipower BCD Technology.

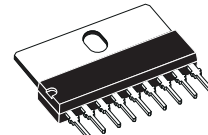
### BLOCK DIAGRAM



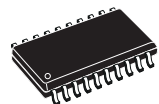
### MULTIPOWER BCD TECHNOLOGY



Minidip



SIP9



SO20

### ORDERING NUMBERS:

TDE1897CDP  
TDE1898CDP

TDE1898CSP

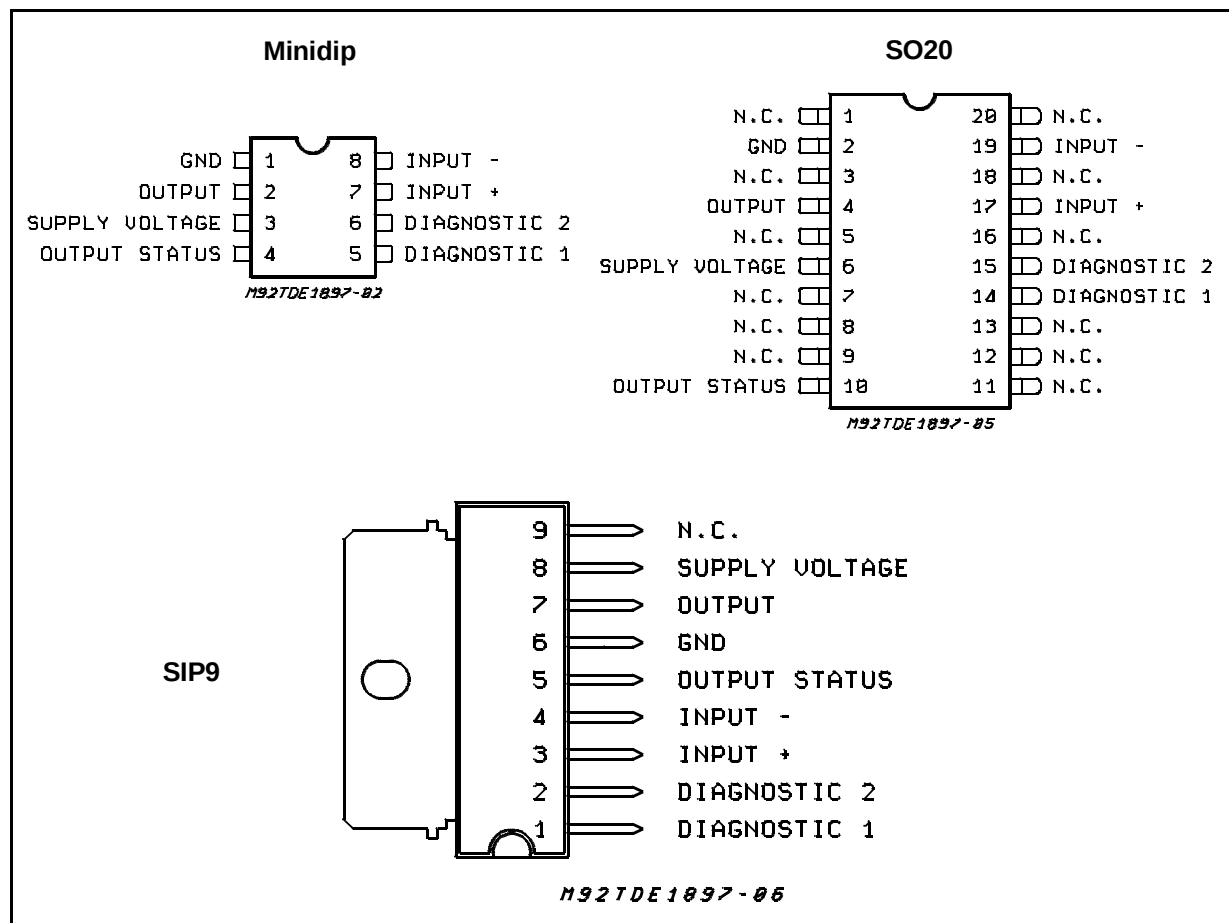
TDE1897CFP  
TDE1898CFP

ogy, for driving inductive or resistive loads. An internal Clamping Diode enables the fast demagnetization of inductive loads.

Diagnostic for CPU feedback and extensive use of electrical protections make this device inherently indistructible and suitable for general purpose industrial applications.

## TDE1897C - TDE1898C

### PIN CONNECTIONS (Top view)



### ABSOLUTE MAXIMUM RATINGS (Minidip pin reference)

| Symbol      | Parameter                                                                 | Value              | Unit             |
|-------------|---------------------------------------------------------------------------|--------------------|------------------|
| $V_S$       | Supply Voltage (Pins 3 - 1) ( $T_W < 10\text{ms}$ )                       | 50                 | V                |
| $V_S - V_O$ | Supply to Output Differential Voltage. See also $V_{CI}$ 3-2 (Pins 3 - 2) | internally limited | V                |
| $V_i$       | Input Voltage (Pins 7/8)                                                  | -10 to $V_S + 10$  | V                |
| $V_i$       | Differential Input Voltage (Pins 7 - 8)                                   | 43                 | V                |
| $I_i$       | Input Current (Pins 7/8)                                                  | 20                 | mA               |
| $I_O$       | Output Current (Pins 2 - 1). See also $I_{SC}$                            | internally limited | A                |
| $E_i$       | Energy from Inductive Load ( $T_J = 85^\circ\text{C}$ )                   | 200                | mJ               |
| $P_{tot}$   | Power Dissipation. See also THERMAL CHARACTERISTICS.                      | internally limited | W                |
| $T_{op}$    | Operating Temperature Range ( $T_{amb}$ )                                 | -25 to +85         | $^\circ\text{C}$ |
| $T_{stg}$   | Storage Temperature                                                       | -55 to 150         | $^\circ\text{C}$ |

### THERMAL DATA

| Symbol           | Description                         | Minidip | Sip | SO20 | Unit               |
|------------------|-------------------------------------|---------|-----|------|--------------------|
| $R_{th\ j-case}$ | Thermal Resistance Junction-case    | Max.    | 10  |      | $^\circ\text{C/W}$ |
| $R_{th\ j-amb}$  | Thermal Resistance Junction-ambient | Max.    | 100 | 70   | $^\circ\text{C/W}$ |

**ELECTRICAL CHARACTERISTICS** ( $V_S = 24V$ ;  $T_{amb} = -25$  to  $+85^\circ C$ , unless otherwise specified)

| Symbol          | Parameter                                                        | Test Condition                                                                        | Min.        | Typ.       | Max.       | Unit                     |
|-----------------|------------------------------------------------------------------|---------------------------------------------------------------------------------------|-------------|------------|------------|--------------------------|
| $V_{smin}$ 3    | Supply Voltage for Valid Diagnostics                             | $I_{diag} > 0.5mA$ @ $V_{dgl} = 1.5V$                                                 | 9           |            | 35         | V                        |
| $V_S$ 3         | Supply Voltage (operative)                                       |                                                                                       | 18          | 24         | 35         | V                        |
| $I_q$ 3         | Quiescent Current<br>$I_{out} = I_{os} = 0$                      | $V_{il}$<br>$V_{ih}$                                                                  |             | 2.5<br>4.5 | 4<br>7.5   | mA<br>mA                 |
| $V_{sth1}$      | Undervoltage Threshold 1                                         | (See fig. 1); $T_{amb} = 0$ to $+85^\circ C$                                          | 11          |            |            | V                        |
| $V_{sth2}$ 3    | Undervoltage Threshold 2                                         | (See fig. 1); $T_{amb} = 0$ to $+85^\circ C$                                          |             |            | 15.5       | V                        |
| $V_{shys}$      | Supply Voltage Hysteresis                                        | (See fig. 1); $T_{amb} = 0$ to $+85^\circ C$                                          | 0.4         | 1          | 3          | V                        |
| $I_{sc}$        | Short Circuit Current                                            | $V_S = 18$ to $35V$ ; $R_L = 1\Omega$                                                 | 0.75        |            | 1.5        | A                        |
| $V_{don}$ 3-2   | Output Voltage Drop                                              | @ $I_{out} = 625mA$ ; $T_j = 25^\circ C$<br>@ $I_{out} = 625mA$ ; $T_j = 125^\circ C$ |             | 250<br>400 | 425<br>600 | mV<br>mV                 |
| $I_{oslk}$ 2    | Output Leakage Current                                           | @ $V_i = V_{il}$ , $V_o = 0V$                                                         |             |            | 300        | $\mu A$                  |
| $V_{ol}$ 2      | Low State Out Voltage                                            | @ $V_i = V_{ih}$ ; $R_L = \infty$                                                     |             | 0.8        | 1.5        | V                        |
| $V_{cl}$ 3-2    | Internal Voltage Clamp ( $V_S - V_O$ )                           | @ $I_O = -500mA$                                                                      | 45          |            | 55         | V                        |
| $I_{old}$ 2     | Open Load Detection Current                                      | $V_i = V_{ih}$ ; $T_{amb} = 0$ to $+85^\circ C$                                       | 1           |            | 6          | mA                       |
| $V_{id}$ 7-8    | Common Mode Input Voltage Range (Operative)                      | $V_S = 18$ to $35V$ ,<br>$V_S = V_{id}$ 7-8 < $37V$                                   | -7          |            | 15         | V                        |
| $I_{ib}$ 7-8    | Input Bias Current                                               | $V_i = -7$ to $15V$ ; $-I_n = 0V$                                                     | -700        |            | 700        | $\mu A$                  |
| $V_{ith}$ 7-8   | Input Threshold Voltage                                          | $V+I_n > V-I_n$                                                                       | 0.8         | 1.4        | 2          | V                        |
| $V_{iths}$ 7-8  | Input Threshold Hysteresis Voltage                               | $V+I_n > V-I_n$                                                                       | 50          |            | 400        | mV                       |
| $R_{id}$ 7-8    | Diff. Input Resistance                                           | @ $0 < I_n < +16V$ ; $-I_n = 0V$<br>@ $-7 < I_n < 0V$ ; $-I_n = 0V$                   |             | 400<br>150 |            | K $\Omega$<br>K $\Omega$ |
| $I_{ilk}$ 7-8   | Input Offset Current                                             | $V+I_n = V-I_n$ + $I_i$ -20<br>$0V < V_i < 5.5V$ - $I_i$ -75                          | -20<br>-75  | -25        | +20        | $\mu A$<br>$\mu A$       |
|                 |                                                                  | $-I_n = GND$ + $I_i$ +10<br>$0V < V+I_n < 5.5V$ - $I_i$ -250                          | +10<br>-250 | -125       | +50        | $\mu A$<br>$\mu A$       |
|                 |                                                                  | $+I_n = GND$ + $I_i$ -100<br>$0V < V-I_n < 5.5V$ - $I_i$ -50                          | -100<br>-50 | -30<br>-15 |            | $\mu A$<br>$\mu A$       |
|                 |                                                                  |                                                                                       |             |            |            |                          |
| $V_{oth1}$ 2    | Output Status Threshold 1 Voltage                                | (See fig. 1)                                                                          |             |            | 12         | V                        |
| $V_{oth2}$ 2    | Output Status Threshold 2 Voltage                                | (See fig. 1)                                                                          | 9           |            |            | V                        |
| $V_{ohys}$ 2    | Output Status Threshold Hysteresis                               | (See fig. 1)                                                                          | 0.3         | 0.7        | 2          | V                        |
| $I_{osd}$ 4     | Output Status Source Current                                     | $V_{out} > V_{oth1}$ , $V_{os} = 2.5V$                                                | 2           |            | 4          | mA                       |
| $V_{osd}$ 3-4   | Active Output Status Driver Drop Voltage                         | $V_S - V_{os}$ @ $I_{os} = 2mA$ ;<br>$T_{amb} = -25$ to $85^\circ C$                  |             |            | 5          | V                        |
| $I_{oslk}$ 4    | Output Status Driver Leakage Current                             | $V_{out} < V_{oth2}$ , $V_{os} = 0V$<br>$V_S = 18$ to $35V$                           |             |            | 25         | $\mu A$                  |
| $V_{dgl}$ 5/6   | Diagnostic Drop Voltage                                          | $D1 / D2 = L$ @ $I_{diag} = 0.5mA$<br>$D1 / D2 = L$ @ $I_{diag} = 3mA$                |             |            | 250<br>1.5 | mV<br>V                  |
| $I_{dglk}$ 5/6  | Diagnostic Leakage Current                                       | $D1 / D2 = H$ @ $0 < V_{dg} < V_S$<br>$V_S = 15.6$ to $35V$                           |             |            | 25         | $\mu A$                  |
| $V_{fdg}$ 5/6-3 | Clamping Diodes at the Diagnostic Outputs. Voltage Drop to $V_S$ | @ $I_{diag} = 5mA$ ; $D1 / D2 = H$                                                    |             |            | 2          | V                        |

**Note**  $V_{il} \leq 0.8V$ ,  $V_{ih} \geq 2V$  @  $(V+I_n > V-I_n)$ ; Minidip pin reference.  
All test not dissipative.

## TDE1897C - TDE1898C

### SOURCE DRAIN NDMOS DIODE

| Symbol        | Parameter             | Test Condition                    | Min. | Typ. | Max. | Unit |
|---------------|-----------------------|-----------------------------------|------|------|------|------|
| $V_{fsd}$ 2-3 | Forward On Voltage    | @ $I_{fsd} = 625mA$               |      | 1    | 1.5  | V    |
| $I_{fp}$ 2-3  | Forward Peak Current  | $t = 10ms$ ; $d = 20\%$           |      |      | 2    | A    |
| $t_{rr}$ 2-3  | Reverse Recovery Time | $I_f = 625mA$ $di/dt = 25A/\mu s$ |      | 200  |      | ns   |
| $t_{fr}$ 2-3  | Forward Recovery Time |                                   |      | 50   |      | ns   |

### THERMAL CHARACTERISTICS (\*)

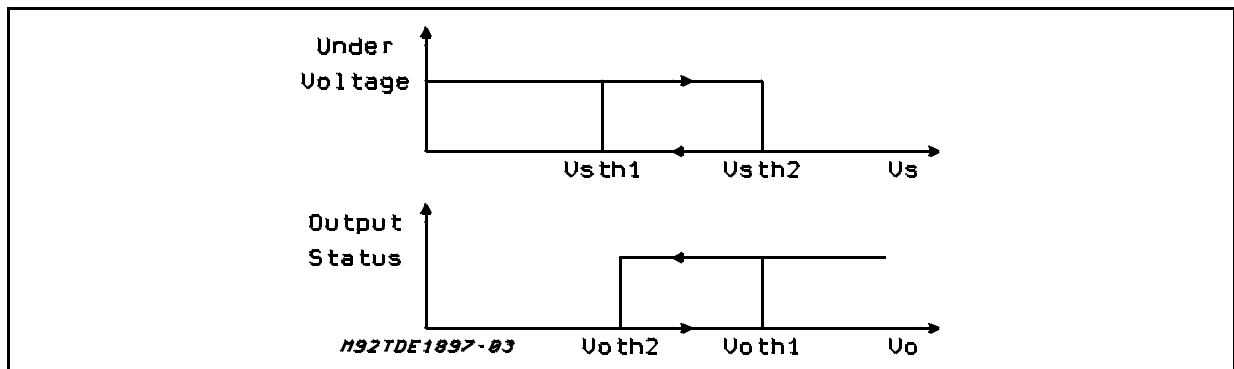
|                |                         |  |     |     |  |    |
|----------------|-------------------------|--|-----|-----|--|----|
| $\Theta_{Lim}$ | Junction Temp. Protect. |  | 135 | 150 |  | °C |
| $T_H$          | Thermal Hysteresis      |  |     | 30  |  | °C |

### SWITCHING CHARACTERISTICS ( $V_S = 24V$ ; $R_L = 48\Omega$ ) (\*)

|           |                                     |  |  |  |     |         |
|-----------|-------------------------------------|--|--|--|-----|---------|
| $t_{on}$  | Turn on Delay Time                  |  |  |  | 100 | $\mu s$ |
| $t_{off}$ | Turn off Delay Time                 |  |  |  | 20  | $\mu s$ |
| $t_d$     | Input Switching to Diagnostic Valid |  |  |  | 100 | $\mu s$ |

Note  $V_{il} \leq 0.8V$ ,  $V_{ih} \geq 2V$  @ ( $V_{in} > V_{in}$ ); Minidip pin reference. (\*) Not tested.

Figure 1



### DIAGNOSTIC TRUTH TABLE

| Diagnostic Conditions                                                                                                                          | Input           | Output | Diag1  | Diag2  |
|------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|--------|--------|--------|
| Normal Operation                                                                                                                               | L<br>H          | L<br>H | H<br>H | H<br>H |
| Open Load Condition ( $I_o < I_{old}$ )                                                                                                        | L<br>H          | L<br>H | H<br>L | H<br>H |
| Short to $V_S$                                                                                                                                 | L<br>H          | H<br>H | L<br>L | H<br>H |
| Short Circuit to Ground ( $I_o = I_{sc}$ ) (**)                                                                                                | <b>TDE1897C</b> | H      | <H (*) | H      |
|                                                                                                                                                | <b>TDE1898C</b> | H      | H<br>L | H<br>H |
| Output DMOS Open                                                                                                                               | L<br>H          | L<br>L | H<br>L | H<br>H |
| Overtemperature                                                                                                                                | L<br>H          | L<br>L | H<br>H | L<br>L |
| Supply Undervoltage ( $V_S < V_{sth1}$ in the falling phase of the supply voltage; $V_S < V_{sth2}$ in the rising phase of the supply voltage) | L<br>H          | L<br>L | L<br>L | L<br>L |

(\*) According to the intervention of the current limiting block.

(\*\*) A cold lamp filament, or a capacitive load may activate the current limiting circuit of the IPS, when the IPS is initially turned on. TDE1897 uses Diag2 to signal such condition, TDE1898 does not.

**APPLICATION INFORMATION****DEMAGNETIZATION OF INDUCTIVE LOADS**

An internal zener diode, limiting the voltage across the Power MOS to between 45 and 55V ( $V_{cl}$ ), provides safe and fast demagnetization of inductive loads without external clamping devices.

The maximum energy that can be absorbed from an inductive load is specified as 200mJ (at  $T_j = 85^\circ\text{C}$ ).

To define the maximum switching frequency three points have to be considered:

- 1) The total power dissipation is the sum of the On State Power and of the Demagnetization Energy multiplied by the frequency.
- 2) The total energy  $W$  dissipated in the device during a demagnetization cycle (fig. 2, 3) is:

$$W = V_{cl} \frac{L}{R_L} \left[ I_0 - \frac{V_{cl} - V_s}{R_L} \log \left( 1 + \frac{V_s}{V_{cl} - V_s} \right) \right]$$

Where:

$V_{cl}$  = clamp voltage;

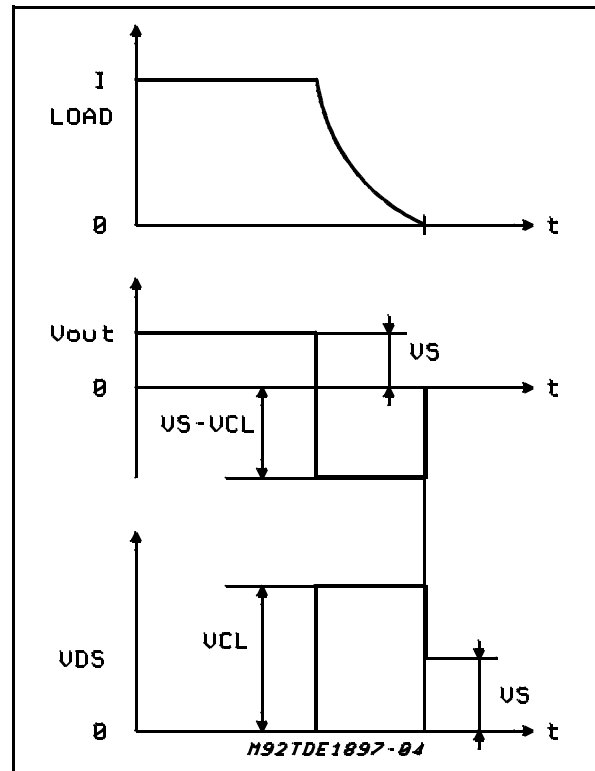
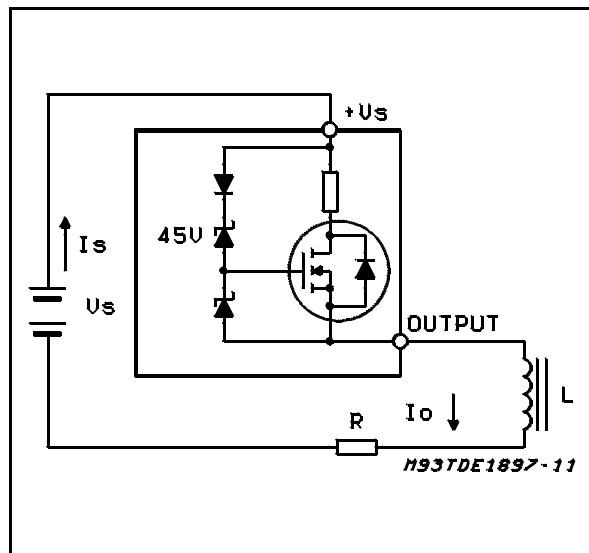
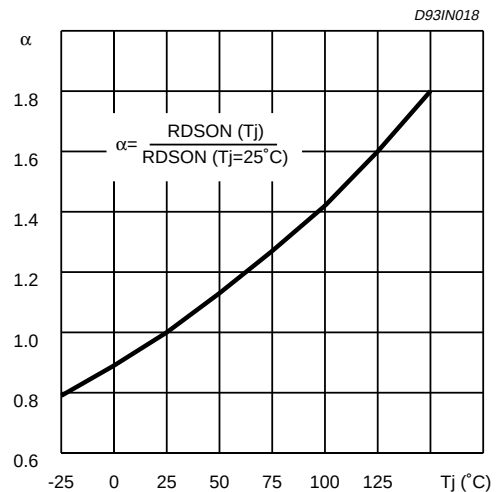
$L$  = inductive load;

$R_L$  = resistive load;

$V_s$  = supply voltage;

$I_0 = I_{LOAD}$

- 3) In normal conditions the operating Junction temperature should remain below  $125^\circ\text{C}$ .

**Figure 3: Demagnetization Cycle Waveforms****Figure 2: Inductive Load Equivalent Circuit****Figure 4: Normalized  $R_{DS(on)}$  vs. Junction Temperature**

## WORST CONDITION POWER DISSIPATION IN THE ON-STATE

In IPS applications the maximum average power dissipation occurs when the device stays for a long time in the ON state. In such a situation the internal temperature depends on delivered current (and related power), thermal characteristics of the package and ambient temperature.

At ambient temperature close to upper limit (+85°C) and in the worst operating conditions, it is possible that the chip temperature could increase so much to make the thermal shutdown procedure untimely intervene.

Our aim is to find the maximum current the IPS can withstand in the ON state without thermal shutdown intervention, related to ambient temperature. To this end, we should consider the following points:

- 1) The ON resistance  $R_{DS(on)}$  of the output NDMOS (the real switch) of the device increases with its temperature. Experimental results show that silicon resistivity increases with temperature at a constant rate, rising of 60% from 25°C to 125°C. The relationship between  $R_{DS(on)}$  and temperature is therefore:

$$R_{DS(on)} = R_{DS(on)0} (1 + k) (T_j - 25)$$

where:

$T_j$  is the silicon temperature in °C

$R_{DS(on)0}$  is  $R_{DS(on)}$  at  $T_j=25^\circ\text{C}$

$k$  is the constant rate ( $k = 4.711 \cdot 10^{-3}$ ) (see fig. 4).

- 2) In the ON state the power dissipated in the device is due to three contributes:

- a) power lost in the switch:  
 $P_{out} = I_{out}^2 \cdot R_{DS(on)}$  ( $I_{out}$  is the output current);
- b) power due to quiescent current in the ON state  $I_q$ , sunk by the device in addition to  $I_{out}$ :  $P_q = I_q \cdot V_s$  ( $V_s$  is the supply voltage);
- c) an external LED could be used to visualize the switch state (OUTPUT STATUS pin). Such a LED is driven by an internal current source (delivering  $I_{os}$ ) and therefore, if  $V_{os}$  is the voltage drop across the LED, the dissipated power is:  $P_{os} = I_{os} \cdot (V_s - V_{os})$ .

Thus the total ON state power consumption is given by:

$$P_{on} = P_{out} + P_q + P_{os} \quad (1)$$

In the right side of equation 1, the second and

the third element are constant, while the first one increases with temperature because  $R_{DS(on)}$  increases as well.

- 3) The chip temperature must not exceed  $\Theta_{Lim}$  in order to not lose the control of the device. The heat dissipation path is represented by the thermal resistance of the system device-board-ambient ( $R_{th}$ ). In steady state conditions, this parameter relates the power dissipated  $P_{on}$  to the silicon temperature  $T_j$  and the ambient temperature  $T_{amb}$ :

$$T_j - T_{amb} = P_{on} \cdot R_{th} \quad (2)$$

From this relationship, the maximum power  $P_{on}$  which can be dissipated without exceeding  $\Theta_{Lim}$  at a given ambient temperature  $T_{amb}$  is:

$$P_{on} = \frac{\Theta_{Lim} - T_{amb}}{R_{th}}$$

Replacing the expression (1) in this equation and solving for  $I_{out}$ , we can find the maximum current versus ambient temperature relationship:

$$I_{outx} = \sqrt{\frac{\frac{\Theta_{Lim} - T_{amb}}{R_{th}} - P_q - P_{os}}{R_{DS(on)x}}}$$

where  $R_{DS(on)x}$  is  $R_{DS(on)}$  at  $T_j=\Theta_{Lim}$ . Of course,  $I_{outx}$  values are top limited by the maximum operative current  $I_{outx}$  (500mA nominal).

From the expression (2) we can also find the maximum ambient temperature  $T_{amb}$  at which a given power  $P_{on}$  can be dissipated:

$$T_{amb} = \Theta_{Lim} - P_{on} \cdot R_{th} = \Theta_{Lim} - (I_{out}^2 \cdot R_{DS(on)x} + P_q + P_{os}) \cdot R_{th}$$

In particular, this relation is useful to find the maximum ambient temperature  $T_{ambx}$  at which  $I_{outx}$  can be delivered:

$$T_{ambx} = \Theta_{Lim} - (I_{outx}^2 \cdot R_{DS(on)x} + P_q + P_{os}) \cdot R_{th} \quad (4)$$

Referring to application circuit in fig. 5, let us consider the worst case:

- The supply voltage is at maximum value of industrial bus (30V instead of the 24V nominal value). This means also that  $I_{outx}$  rises of 25%

(625mA instead of 500mA).

- All electrical parameters of the device, concerning the calculation, are at maximum values.
- Thermal shutdown threshold is at minimum value.
- No heat sink nor air circulation ( $R_{th}$  equal to  $R_{thj-amb}$ ).

Therefore:

$V_s = 30V$ ,  $R_{DS(on)0} = 0.6\Omega$ ,  $I_q = 6mA$ ,  $I_{os} = 4mA$  @  $V_{os} = 2.5V$ ,  $\theta_{Lim} = 135^\circ C$

$R_{thj-amb} = 100^\circ C/W$  (Minidip);  $90^\circ C/W$  (SO20);  $70^\circ C/W$  (SIP9)

It follows:

$I_{outx} = 0.625mA$ ,  $R_{DS(on)x} = 1.006\Omega$ ,  $P_q = 180mW$ ,  $P_{os} = 110mW$

From equation 4, we can find:

$T_{ambx} = 66.7^\circ C$  (Minidip);  
 $73.5^\circ C$  (SO20);  
 $87.2^\circ C$  (SIP9).

Therefore, the IPS TDE1897/1898, although guaranteed to operate up to  $85^\circ C$  ambient temperature, if used in the worst conditions, can meet some limitations.

SIP9 package, which has the lowest  $R_{thj-amb}$ , can work at maximum operative current over the entire ambient temperature range in the worst conditions too. For other packages, it is necessary to consider some reductions.

With the aid of equation 3, we can draw a derating curve giving the maximum current allowable versus ambient temperature. The diagrams, computed using parameter values above given, are depicted in figg. 6 to 8.

If an increase of the operating area is needed, heat dissipation must be improved ( $R_{th}$  reduced) e.g. by means of air cooling.

**Figure 5:** Application Circuit.

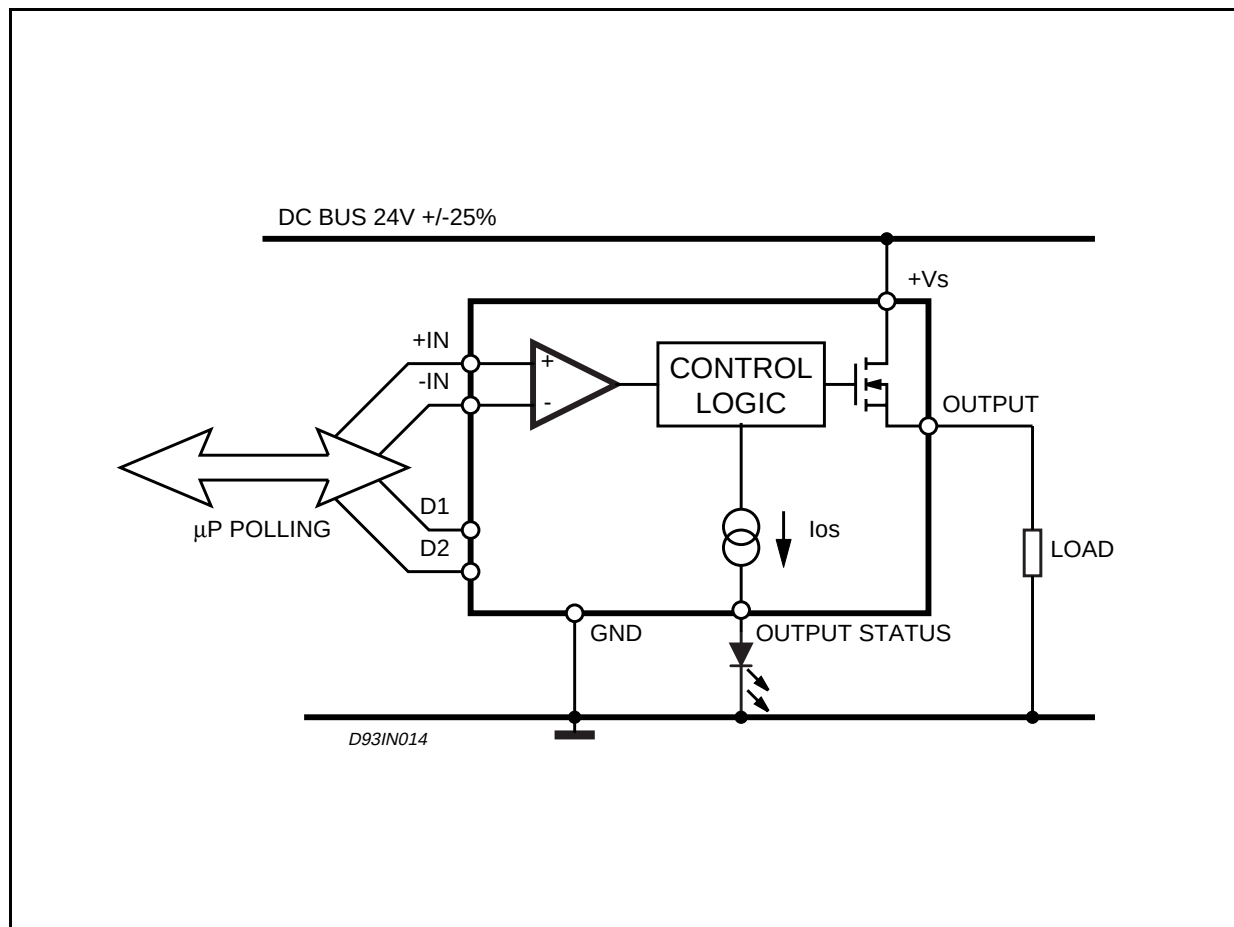


**Figure 6:** Max. Output Current vs. Ambient Temperature (Minidip Package,  $R_{th\ j-amb} = 100^{\circ}\text{C/W}$ )

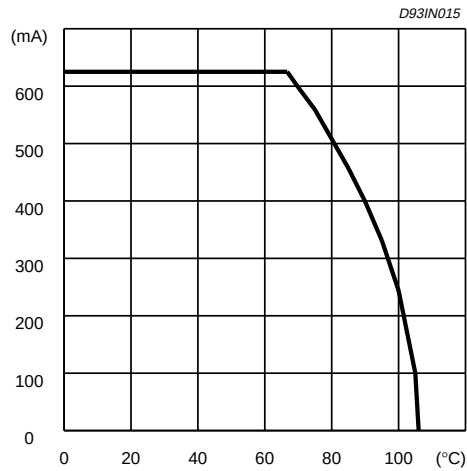


**Figure 7:** Max. Output Current vs. Ambient Temperature (SO20 Package,  $R_{th\ j-amb} = 90^{\circ}\text{C/W}$ )

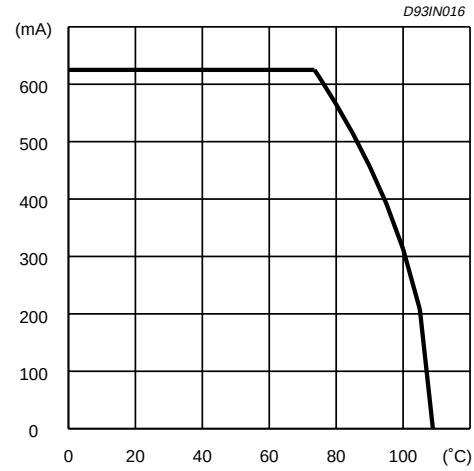
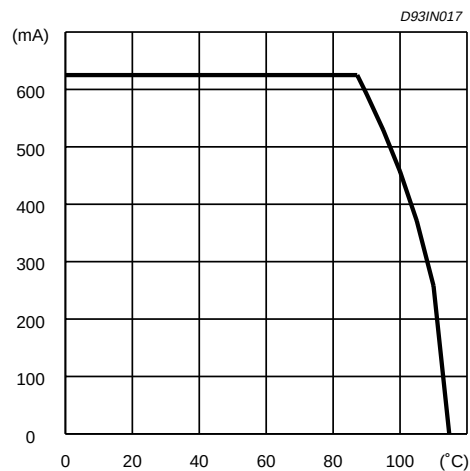
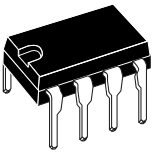


**Figure 8:** Max. Output Current vs. Ambient Temperature (SIP9 Package,  $R_{th\ j-amb} = 70^{\circ}\text{C/W}$ )

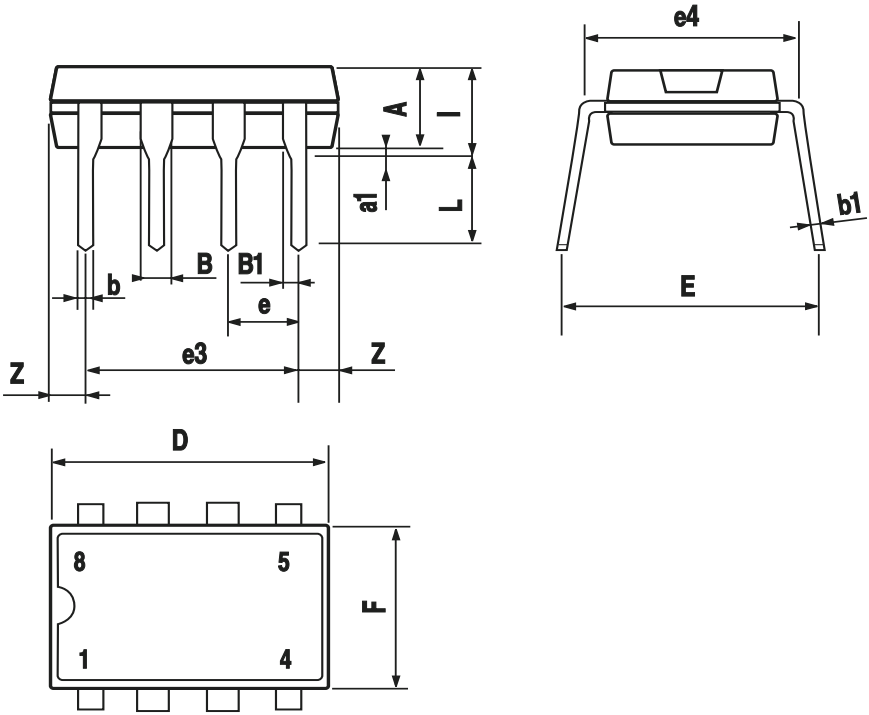


| DIM. | mm    |      |       | inch  |       |       |
|------|-------|------|-------|-------|-------|-------|
|      | MIN.  | TYP. | MAX.  | MIN.  | TYP.  | MAX.  |
| A    |       | 3.32 |       |       | 0.131 |       |
| a1   | 0.51  |      |       | 0.020 |       |       |
| B    | 1.15  |      | 1.65  | 0.045 |       | 0.065 |
| b    | 0.356 |      | 0.55  | 0.014 |       | 0.022 |
| b1   | 0.204 |      | 0.304 | 0.008 |       | 0.012 |
| D    |       |      | 10.92 |       |       | 0.430 |
| E    | 7.95  |      | 9.75  | 0.313 |       | 0.384 |
| e    |       | 2.54 |       |       | 0.100 |       |
| e3   |       | 7.62 |       |       | 0.300 |       |
| e4   |       | 7.62 |       |       | 0.300 |       |
| F    |       |      | 6.6   |       |       | 0.260 |
| I    |       |      | 5.08  |       |       | 0.200 |
| L    | 3.18  |      | 3.81  | 0.125 |       | 0.150 |
| Z    |       |      | 1.52  |       |       | 0.060 |

OUTLINE AND  
MECHANICAL DATA



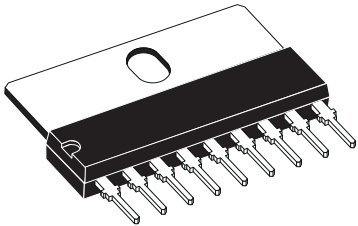
Minidip



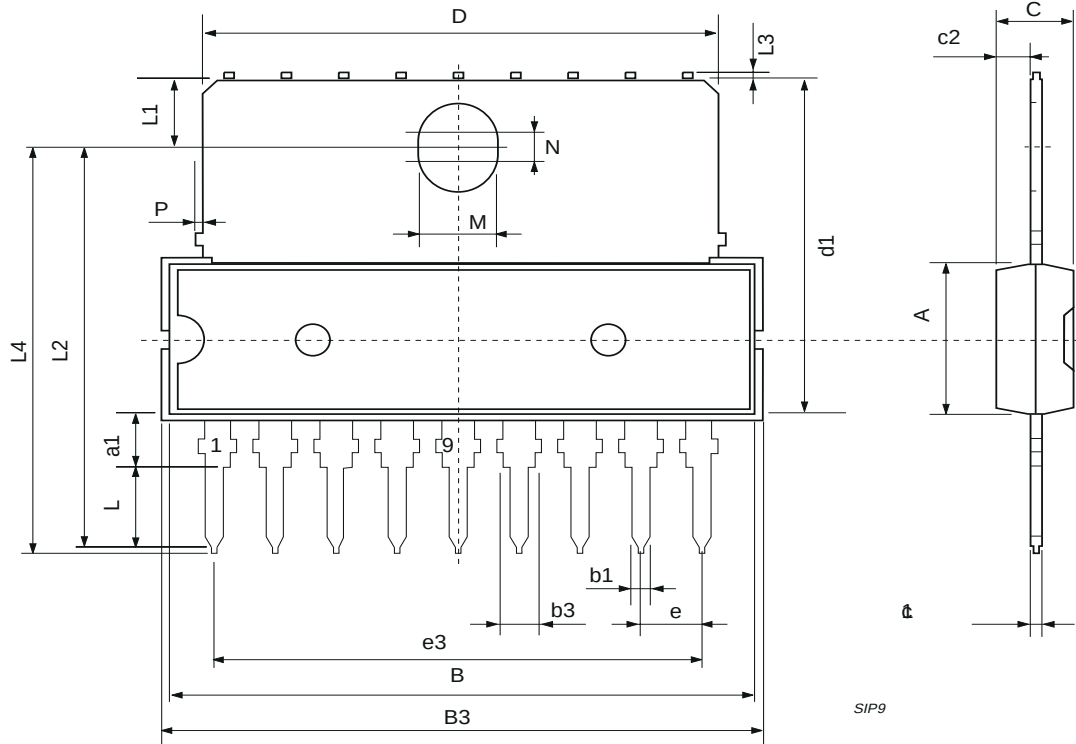
TDE1897C - TDE1898C

| DIM. | mm   |       |       | inch  |       |       |
|------|------|-------|-------|-------|-------|-------|
|      | MIN. | TYP.  | MAX.  | MIN.  | TYP.  | MAX.  |
| A    |      |       | 7.1   |       |       | 0.280 |
| a1   | 2.7  |       | 3     | 0.106 |       | 0.118 |
| B    |      |       | 23    |       |       | 0.90  |
| B3   |      |       | 24.8  |       |       | 0.976 |
| b1   |      | 0.5   |       |       | 0.020 |       |
| b3   | 0.85 |       | 1.6   | 0.033 |       | 0.063 |
| C    |      | 3.3   |       |       | 0.130 |       |
| c1   |      | 0.43  |       |       | 0.017 |       |
| c2   |      | 1.32  |       |       | 0.052 |       |
| D    |      |       | 21.2  |       |       | 0.835 |
| d1   |      | 14.5  |       |       | 0.571 |       |
| e    |      | 2.54  |       |       | 0.100 |       |
| e3   |      | 20.32 |       |       | 0.800 |       |
| L    | 3.1  |       |       | 0.122 |       |       |
| L1   |      | 3     |       | 0.118 |       |       |
| L2   |      | 17.6  |       |       | 0.693 |       |
| L3   |      |       | 0.25  |       |       | 0.010 |
| L4   | 17.4 |       | 17.85 | 0.685 |       | 0.702 |
| M    |      | 3.2   |       |       | 0.126 |       |
| N    |      | 1     |       |       | 0.039 |       |
| P    |      |       | 0.15  |       |       | 0.006 |

OUTLINE AND  
MECHANICAL DATA

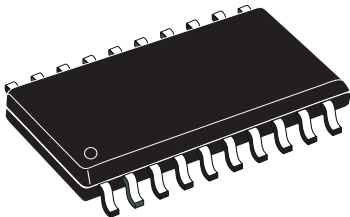


SIP9

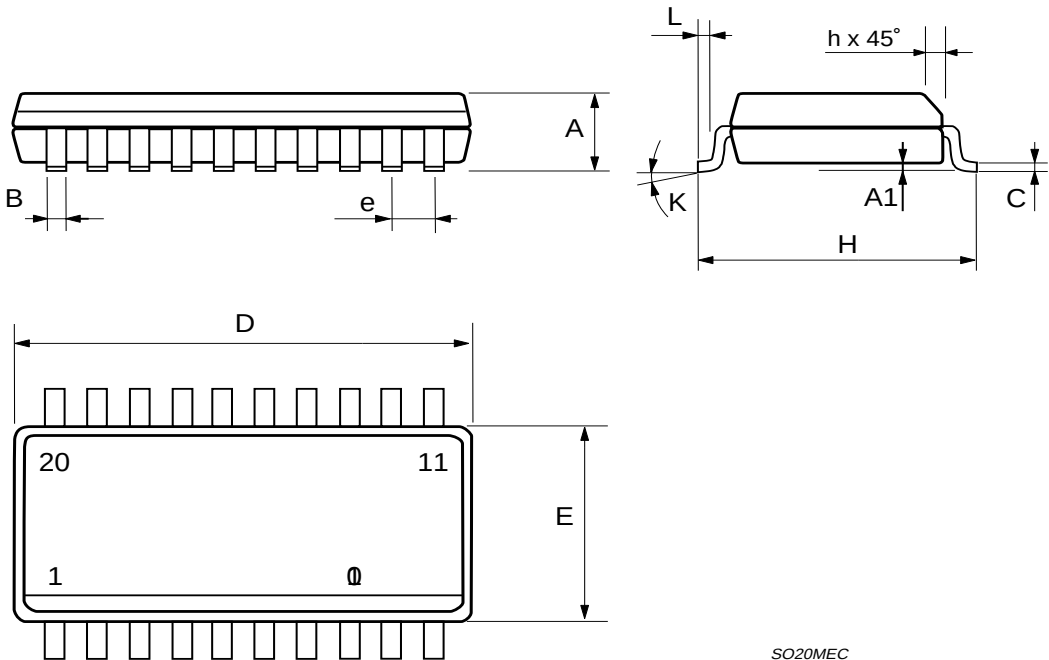


| DIM. | mm                 |      |       | inch  |       |       |
|------|--------------------|------|-------|-------|-------|-------|
|      | MIN.               | TYP. | MAX.  | MIN.  | TYP.  | MAX.  |
| A    | 2.35               |      | 2.65  | 0.093 |       | 0.104 |
| A1   | 0.1                |      | 0.3   | 0.004 |       | 0.012 |
| B    | 0.33               |      | 0.51  | 0.013 |       | 0.020 |
| C    | 0.23               |      | 0.32  | 0.009 |       | 0.013 |
| D    | 12.6               |      | 13    | 0.496 |       | 0.512 |
| E    | 7.4                |      | 7.6   | 0.291 |       | 0.299 |
| e    |                    | 1.27 |       |       | 0.050 |       |
| H    | 10                 |      | 10.65 | 0.394 |       | 0.419 |
| h    | 0.25               |      | 0.75  | 0.010 |       | 0.030 |
| L    | 0.4                |      | 1.27  | 0.016 |       | 0.050 |
| K    | 0° (min.)8° (max.) |      |       |       |       |       |

OUTLINE AND  
MECHANICAL DATA



SO20



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