

## TRIPLE IGBT/MOS DRIVER WITH CURRENT SENSE

- THREE POWER IGBT/MOS AND PULSE TRANSFORMER DRIVERS
- CURRENT SENSE COMPARATOR
- UNCOMMITTED OP-AMP
- 0.6 A PER CHANNEL PEAK OUTPUT CURRENT CAPABILITY
- LOW OUTPUT IMPEDANCE TYP:  $7\Omega$  AT 200mA
- CMOS/LSTTL COMPATIBLE INVERTING INPUT WITH HYSTERESIS
- 4V TO 16V SINGLE SUPPLY OPERATION
- LOW BIAS CURRENT TYP: 1.5mA
- ADJUSTABLE UNDERVOLTAGE LOCKOUT LEVEL
- STAND-BY MODE
- CHANNEL PARALLELING CAPABILITY

#### **DESCRIPTION**

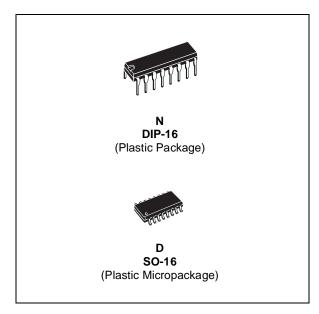
The TD310 is designed to drive one, two or three Power IGBT/MOS and has driving capability for pulse transformer. So it is perfectly suited to interface control IC with Power Switches in low side or half-bridge configuration.

TD310 includes a current sense comparator which inhibit the output drivers in case of overcurrent. An alarm output signals the even to a controller.

TD310 also includes an uncommitted op-amp which can be used for current measurement (as an amplifier before the A/D input of a microcontroller) of for other general purpose.

Programmable undervoltage lockout and standby mode make TD310 suitable for a large area of environment and application.

Typical applications are low side IGBT and power MOSFET drive in three phase systems, pulse transformer drive, and general purpose pulse drive.

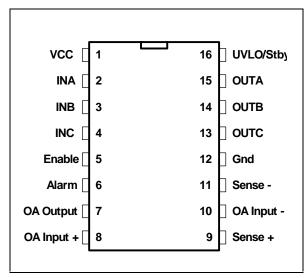


#### ORDER CODE

Part Number	Temperature Range	Package	
T art ivalliber	Temperature Range	N	D
TD310I	-40°C, +125°C	•	•

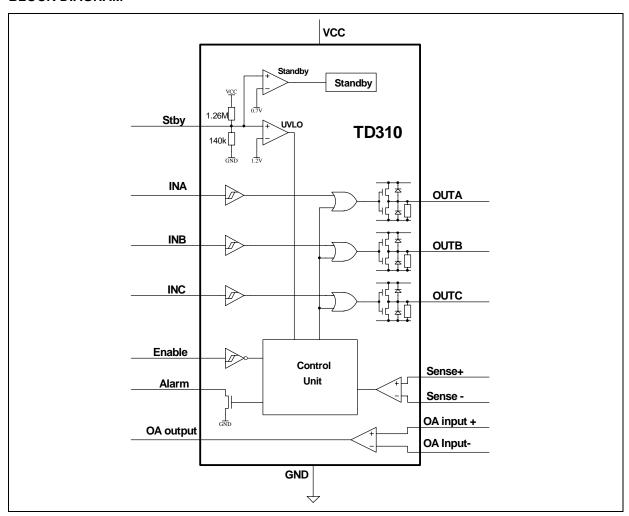
N = Dual in Line Package (DIP)
D = Small Outline Package (SO) - also available in Tape & Reel (DT)

#### PIN CONNECTIONS (top view)



December 2001 1/9

## **BLOCK DIAGRAM**



## **ABSOLUTE MAXIMUM RATINGS**

Symbol	Parameter	Value	Unit
V <sub>CC</sub>	Supply Voltage	18	V
V <sub>i</sub>	Input Voltage	0 to V <sub>CC</sub>	V
V <sub>is</sub>	Sense Input Voltage	-0.3 to V <sub>CC</sub>	V
T <sub>j</sub>	Operating Junction Temperature	-40 to 150	°C
T <sub>amb</sub>	Operating Ambient Temperature	-40 to 125	°C

### **OPERATING CONDITIONS**

Symbo	Parameter	Value	Unit
$V_{CC}$	Supply Voltage	4 to 16	V

#### **INSTRUCTION FOR USE**

- 1 The TD310 supply voltage must be decoupled with a  $1\mu F$  min. capacitor.
- 2 If the application involving TD310 requires maximum output current capability, this current must be pulsed: pulse width 1 $\mu$ sec, duty cycle 1% at  $T_{amb.}$

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## **ELECTRICAL CHARACTERISTICS**

 $V_{CC} = 15V$ ,  $T_{amb} = 25$ °C (unless otherwise specified)

	Symbol	Parameter	Min.	Тур.	Max.	Unit
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	I <sub>cc</sub>	Supply Current with Inputs in High State		1.5	2	mA
V <sub>IL</sub>   Low Input Voltage		NPUT (all inputs)				
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	V <sub>IH</sub>	High Input Voltage	2			V
II	$V_{IL}$	Low Input Voltage			0.8	V
Propagation Delay (10% input to 10% output)	I <sub>IH</sub>	High Input Current		10		pА
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	I <sub>IL</sub>	Low Input Current		10		pА
t <sub>dd</sub> Differential Delay Time Between Channels         20         ns           OUTPUT DRIVERS           V <sub>sod</sub> Sourcing Drop Voltage (A/B/C outputs) I <sub>source</sub> = 200mA         3         V           V <sub>sid</sub> Sinking Drop Voltage (A/B/C outputs) Isink = 200mA         5         V           V <sub>dem</sub> Demagnetizing Drop Voltage (A/B/C outputs) Idemag. = 100mA         2         V           Ropd         Output Pull Down Resistor         47         kΩ           ALARM OUTPUT         4         ALARM OUTPUT         5         35         mA           I <sub>s</sub> Low Level Sinking Current V <sub>O</sub> = 0.8V         5         35         mA         MA           I <sub>s</sub> High Level Sinking Current V <sub>O</sub> = 0.8V         1         1         μA           I <sub>s</sub> Hold Level Sinking Current V <sub>A</sub> 1         1         μA           I <sub>s</sub> Hold Level Sinking Current V <sub>A</sub> 1         1         μA           V <sub>i</sub> Input Offset Voltage         20         mV           SENSE INPUT         V <sub>i</sub> Input Offset Voltage         1         m           t <sub>s</sub> Input Offset Voltage         1         m         ms           t <sub>s</sub>		Output Delay Output Delay				ns
OUTPUT DRIVERS $V_{sod}$ Sourcing Drop Voltage (A/B/C outputs)         3         V $V_{sid}$ Sinking Drop Voltage (A/B/C outputs)         5         V $V_{dem}$ Demagnetizing Drop Voltage (A/B/C outputs)         2         V $V_{dem}$ Demagnetizing Drop Voltage (A/B/C outputs)         2         V $V_{dem}$ Output Pull Down Resistor         47         kΩ           ALARM OUTPUT         V         In Low Level Sinking Current         1         μA $V_{O} = 0.8V$ 5         35         mA           I high Level Sinking Current         1         μA $V_{O} = 0.8V$ 5         35         mA           I high Level Sinking Current         1         μA $V_{O} = 0.8V$ 5         35         mA           I high Level Sinking Current         1         μA $V_{O} = 0.8V$ 5         35         mA           I high Level Sinking Current         1         μA $V_{O} = 0.08V$ 5         35         mA           I high Level Sinking Current         1         mA $V_{O} = 0.08V$ 5	t <sub>li</sub>	Input Inhibiting Time		100		ns
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$				20		ns
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	OUTPUT	DRIVERS				
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	$V_{sod}$	$I_{\text{source}} = 200\text{mA}$			3	V
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	$V_{\text{sid}}$	Isink = 200mA			5	V
ALARM OUTPUT $I_s$ Low Level Sinking Current $V_O = 0.8V$ 5       35       mA $I_{sh}$ High Level Sinking Current that Alarm Output : Delay Time to Alarm Fall if Sense Input Triggered       1 $\mu$ A         SENSE INPUT       Vios Input Offset Voltage       20       mV $I_{sh}$ Inhibition Time if Sense Input Triggered       1       ms $I_s$ Delay Time to Output Fall if Sense Input Triggered All outputs inhibited       600       ns $I_s$ Inhibition Time of Sense Input       300       ns $I_s$ Vicm       Common Mode Input       0 to $V_{cc}^+ - 1.5$ V         OPERATIONAL AMPLIFIER       Vicm       0 to $V_{cc}^+ - 1.5$ V $I_{log}$ Input Offset Voltage       0 to $V_{cc}^+ - 1.5$ V $I_{log}$ Input Offset Voltage       0 to $V_{cc}^+ - 1.5$ V $I_{log}$ Input Offset Voltage       0 to $V_{cc}^+ - 1.5$ V $I_{log}$ <		Idemag. = 100mA			2	V
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$		·		47		kΩ
	ALARM	OUTPUT				
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	Is		5	35		mA
SENSE INPUT $V_{los}$ Input Offset Voltage       20       mV $t_{ai}$ Inhibition Time if Sense Input Triggered       1       ms $t_s$ Delay Time to Output Fall if Sense Input Triggered All outputs inhibited       300       ns $t_{si}$ Inhibition Time of Sense Input       300       ns $V_{shys}$ Sense Hysteresis       40       mV         OPERATIONAL AMPLIFIER $V_{icm}$ Common Mode Input Voltage Range       0 to $V_{CC}^+$ - 1.5       V $V_{io}$ Input Offset Voltage       10       mV         GBP       Gain Bandwidth Product       1       MHz $A_{vd}$ Open Loop Gain       60       dB         SR       Slew Rate at Unity Gain ( $R_L = 100k\Omega$ , $C_L = 100pF$ , $V_i = 3$ to 7V)       0.6 $V/\mu$ s         STAND-BY $V_{stdby}$ Standby Mode Threshold Voltage       0.3       1.1       V $I_{stdby}$ Standby Mode Supply Current       30 $\mu$ A         UNDER VOLTAGE LOCKOUT $I_{adj}$ Under Voltage Level Adjust Current       1 $\mu$ A/V $V_{std}$ Internal Stop Threshold (without	I <sub>sh</sub>	High Level Sinking Current			1	μΑ
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$					500	ns
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	SENSE I	NPUT				
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	V <sub>ios</sub>	Input Offset Voltage			20	mV
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	t <sub>Ai</sub>			1		ms
V <sub>shys</sub> Sense Hysteresis       40       mV         OPERATIONAL AMPLIFIER         V <sub>icm</sub> Common Mode Input Voltage Range       0 to $V_{CC}^+$ - 1.5       V         V <sub>io</sub> Input Offset Voltage       10       mV         GBP       Gain Bandwidth Product       1       MHz         A <sub>vd</sub> Open Loop Gain       60       dB         SR       Slew Rate at Unity Gain ( $R_L = 100k\Omega$ , $C_L = 100pF$ , $V_i = 3$ to $7V$ )       0.6       V/μs         STAND-BY         V <sub>stabby</sub> Standby Mode Threshold Voltage       0.3       1.1       V         I <sub>staby</sub> Standby Mode Supply Current       30       μA         UNDER VOLTAGE LOCKOUT       1       μΑ/V         V <sub>st1</sub> Internal Stop Threshold (without external adjustment)       10.7       13.3       V	t <sub>s</sub>				600	ns
OPERATIONAL AMPLIFIER $V_{icm}$ Common Mode Input Voltage Range         0 to $V_{CC}^+$ - 1.5         V $V_{io}$ Input Offset Voltage         10         mV           GBP         Gain Bandwidth Product         1         MHz $A_{vd}$ Open Loop Gain         60         dB           SR         Slew Rate at Unity Gain ( $R_L = 100kΩ$ , $C_L = 100pF$ , $V_i = 3 to 7V$ )         0.6 $V/μs$ STAND-BY $V_{stdby}$ Standby Mode Threshold Voltage         0.3         1.1 $V$ $I_{stdby}$ Standby Mode Supply Current         30 $μA$ UNDER VOLTAGE LOCKOUT         1 $μA/V$ $I_{adj}$ Under Voltage Level Adjust Current         1 $μA/V$ $V_{st1}$ Internal Stop Threshold (without external adjustment)         10.7         13.3 $V$	t <sub>si</sub>	Inhibition Time of Sense Input		300		ns
OPERATIONAL AMPLIFIER $V_{icm}$ Common Mode Input Voltage Range         0 to $V_{CC}^+$ - 1.5         V $V_{io}$ Input Offset Voltage         10         mV           GBP         Gain Bandwidth Product         1         MHz $A_{vd}$ Open Loop Gain         60         dB           SR         Slew Rate at Unity Gain ( $R_L = 100kΩ$ , $C_L = 100pF$ , $V_i = 3 to 7V$ )         0.6 $V/μs$ STAND-BY $V_{stdby}$ Standby Mode Threshold Voltage         0.3         1.1 $V$ $I_{stdby}$ Standby Mode Supply Current         30 $μA$ UNDER VOLTAGE LOCKOUT         1 $μA/V$ $I_{adj}$ Under Voltage Level Adjust Current         1 $μA/V$ $V_{st1}$ Internal Stop Threshold (without external adjustment)         10.7         13.3 $V$	$V_{shys}$	Sense Hysteresis		40		mV
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	OPERAT	IONAL AMPLIFIER				
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	V <sub>icm</sub>	Common Mode Input Voltage Range	0 t	o V <sub>CC</sub> + -	1.5	V
GBPGain Bandwidth Product1MHz $A_{vd}$ Open Loop Gain60dBSRSlew Rate at Unity Gain ( $R_L = 100kΩ$ , $C_L = 100pF$ , $V_i = 3 to 7V$ )0.6 $V/μs$ STAND-BY $V_{stdby}$ Standby Mode Threshold Voltage0.31.1 $V$ $I_{stdby}$ Standby Mode Supply Current30 $μA$ UNDER VOLTAGE LOCKOUT $I_{adj}$ Under Voltage Level Adjust Current1 $μA/V$ $V_{st1}$ Internal Stop Threshold (without external adjustment)10.713.3 $V$		Input Offset Voltage	1			mV
SR Slew Rate at Unity Gain ( $R_L = 100kΩ$ , $C_L = 100pF$ , $V_i = 3$ to 7V) 0.6 V/μs STAND-BY $V_{\text{Stdby}}$ Standby Mode Threshold Voltage 0.3 1.1 V $I_{\text{stdby}}$ Standby Mode Supply Current 30 μA  UNDER VOLTAGE LOCKOUT $I_{\text{adj}}$ Under Voltage Level Adjust Current 1 μA/V $V_{\text{st1}}$ Internal Stop Threshold (without external adjustment) 10.7 13.3 V		•	1	1		MHz
STAND-BY           V <sub>stdby</sub> Standby Mode Threshold Voltage         0.3         1.1         V           I <sub>stdby</sub> Standby Mode Supply Current         30         μA           UNDER VOLTAGE LOCKOUT           I <sub>adj</sub> Under Voltage Level Adjust Current         1         μA/V           V <sub>st1</sub> Internal Stop Threshold (without external adjustment)         10.7         13.3         V	A <sub>vd</sub>	Open Loop Gain	60			dB
$V_{stdby}$ Standby Mode Threshold Voltage 0.3 1.1 V $I_{stdby}$ Standby Mode Supply Current 30 μA UNDER VOLTAGE LOCKOUT $I_{adj}$ Under Voltage Level Adjust Current 1 μA/V $V_{st1}$ Internal Stop Threshold (without external adjustment) 10.7 13.3 V	SR	Slew Rate at Unity Gain ( $R_L = 100k\Omega$ , $C_L = 100pF$ , $V_i = 3 to 7V$ )		0.6		V/μs
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	STAND-I	ЗҮ	1		1	
$I_{stdby}$ Standby Mode Supply Current     30     μA       UNDER VOLTAGE LOCKOUT $I_{adj}$ Under Voltage Level Adjust Current     1     μA/V $V_{st1}$ Internal Stop Threshold (without external adjustment)     10.7     13.3     V	V <sub>stdby</sub>	Standby Mode Threshold Voltage	0.3		1.1	V
$ \begin{array}{c cccc} \textbf{UNDER VOLTAGE LOCKOUT} \\ I_{adj} & \textbf{Under Voltage Level Adjust Current} & 1 & \mu A/V \\ V_{st1} & \textbf{Internal Stop Threshold (without external adjustment)} & 10.7 & 13.3 & V \\ \end{array} $		Standby Mode Supply Current	1	30		μΑ
V <sub>st1</sub> Internal Stop Threshold (without external adjustment) 10.7 13.3 V		VOLTAGE LOCKOUT			1	
V <sub>st1</sub> Internal Stop Threshold (without external adjustment) 10.7 13.3 V	I <sub>adi</sub>	Under Voltage Level Adjust Current		1		μA/V
		Internal Stop Threshold (without external adjustment)	10.7		13.3	V
		Threshold Hysteresis		0.8		V



## **UVLO/stdby pin functioning modes**

Due to the wide supply voltage range of the TD310, the UVLO function (Under Voltage Lock Out) is externally adjustable by a resistor bridge.

The bridge rate can be calculated in relation with the expected UVLO protection level as follows:

$$V_{UVLO} \times \frac{R1}{R1 + R2} = 1.2V$$
 (where R1 is the lower resistor of the bridge)

The internal resistor sets the default UVLO value to 12V (\*) and might influence the external bridge rate if the values of the external resistors are too high. Moreover, the internal resistor ratio is accurate, but the the tolerance on the absolute value of each internal resistor (typically 140k and 1.26M) is about +/-20%. If an external bridge is used, we recommend to choose resistor values not greater than 10k.

The standby threshold value depends of the UVLO value as follows:

$$V_{stdbv} = {0.7}/{1.2} V_{UVLO}$$

Both UVLO and stdby functions can be inhibited by connecting the UVLO/stdby pin to  $V_{CC}^+$  via a pull up resistor (ex 150k $\Omega$ ).

The following table summarizes the functions of the TD310:

	Pin	16	9/11	5	2/3/4	15/14/13	6	7/8/10	Con-
	Config	UVLO/ stdby	Sense+/ Sense-	Enable	In A/B/C	Out A/B/C	Alarm	Op-Amp	sumption
			+>-	Х	Х	L	L		
Normal	1	Н	+ < -	Н	IN	ĪN	Н	OK	H (1.5mA)
			, ,	`			, ,		
Stdby	2		+>-	Х	X		L	HZ	L
Stuby	2	_	+ < -	^	^	_	Н	112	(30µA)
UVLO	3	М	Х	Х	Х	L	L	OK	Н

#### Configuration 1: UVLO/stdby = H

The TD310 is in a normal consumption state (1.5mA), the operational amplifier is normally functioning and the buffer outputs are determined by the sense comparator inputs, the enable inputs and the buffer inputs.

## Configuration 2: UVLO/stdby = L

The TD310 is in a low consumption state (standby mode  $30\mu$ A), the buffer outputs are set to low state and the operational amplifier is in high impedance state.

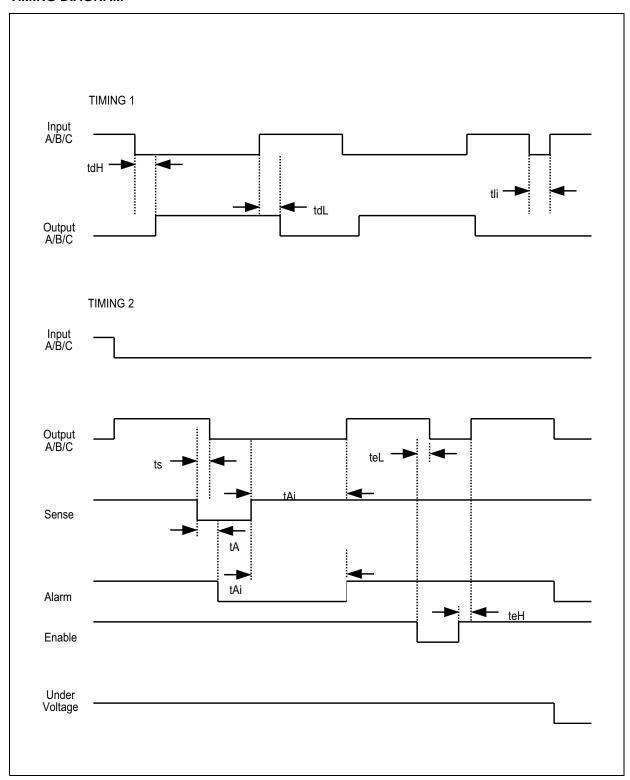
## Configuration 3: UVLO/stdby = M

The VCC supply voltage is between VUVLO and Vstdby (\*\*). The TD310 remains in a normal consumption state and the operational amplifier is normally functioning but the buffer outputs and the alarm pin are set to low state.

(\*) If the UVLO level remains unadjusted, it is recommended to bypass the UVLO/stdby pin with a 1nF capacitor.

(\*\*) If the supply voltage falls below  $V_{\mbox{stdby}}$ , the TD310 is set in standby mode (configuration 2).

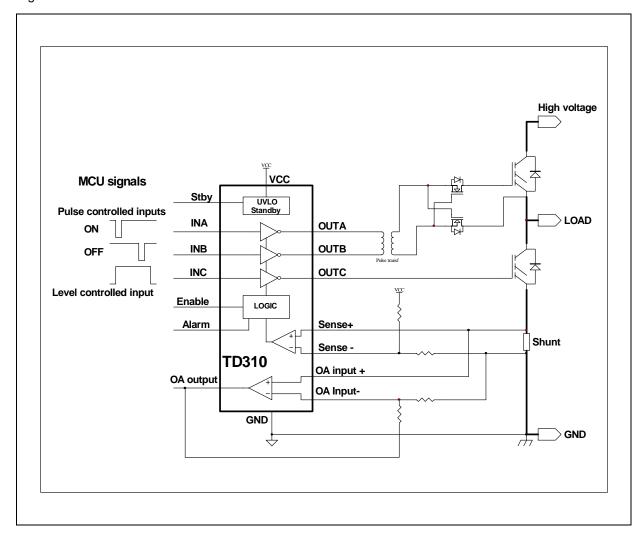
## **TIMING DIAGRAM**





## **TYPICAL APPLICATIONS**

Figure 1: HALF BRIDGE DRIVE IN THREE PHASE MOTOR SYSTEM



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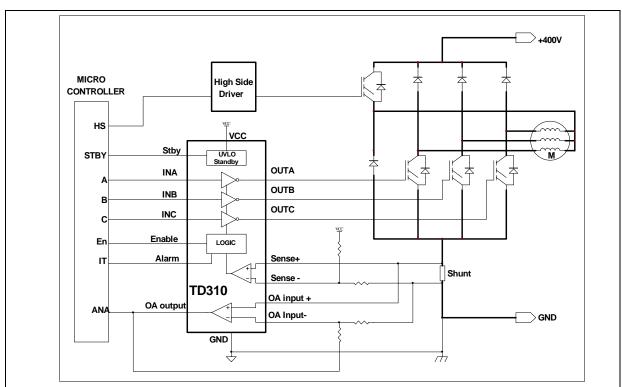
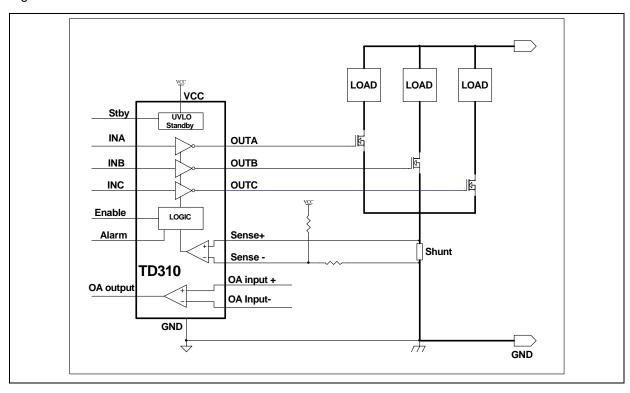


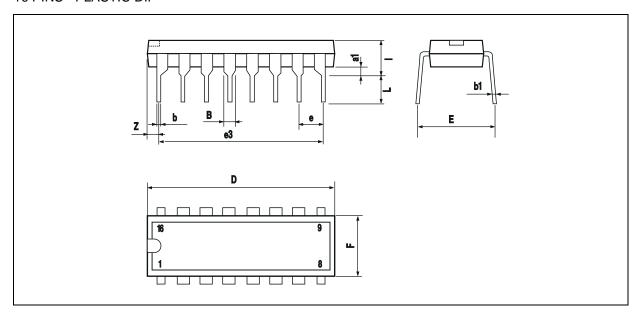
Figure 2 : THREE PHASE MOTOR LOW SIDE DRIVE

Figure 3 : LOW SIDE DRIVE



## PACKAGE MECHANICAL DATA

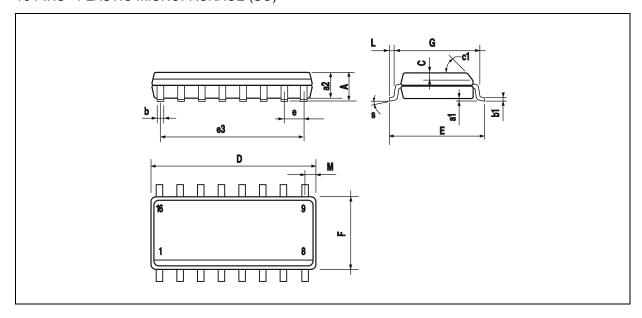
16 PINS - PLASTIC DIP



Dim.		Millimeters		Inches			
	Min.	Тур.	Max.	Min.	Тур.	Max.	
a1	0.51			0.020			
В	0.77		1.65	0.030		0.065	
b		0.5			0.020		
b1		0.25			0.010		
D			20			0.787	
E		8.5			0.335		
е		2.54			0.100		
e3		17.78			0.700		
F			7.1			0.280	
i			5.1			0.201	
L		3.3			0.130		
Z			1.27			0.050	

#### **PACKAGE MECHANICAL DATA**

16 PINS - PLASTIC MICROPACKAGE (SO)



Dim.		Millimeters		Inches				
	Min.	Тур.	Max.	Min.	Тур.	Max.		
Α			1.75			0.069		
a1	0.1		0.2	0.004		0.008		
a2			1.6			0.063		
b	0.35		0.46	0.014		0.018		
b1	0.19		0.25	0.007		0.010		
С		0.5			0.020			
c1			45°	(typ.)				
D	9.8		10	0.386		0.394		
E	5.8		6.2	0.228		0.244		
е		1.27			0.050			
e3		8.89			0.350			
F	3.8		4.0	0.150		0.157		
G	4.6		5.3	0.181		0.209		
L	0.5		1.27	0.020		0.050		
M			0.62			0.024		
S	8° (max.)							

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