TD350

Advanced IGBT/MOSFET Driver

- **0.75A min gate drive**
- **Negative gate drive ability**
- **Input compatible with pulse transformer or optocoupler**
- **Separate sink and source outputs for easy gate drive**
- **Two steps turn-off with adjustable level and delay**
- **Miller clamp feature**
- **Desaturation protection**
- **Fault status output**
- **UVLO protection**
- **2kV ESD protection**

DESCRIPTION

TD350 is an advanced gate driver for IGBT and power MOSFET. Control and protection functions are included and allow the design of high reliability systems.

APPLICATIONS

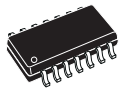
- **1200V 3-Phase Inverter**
- **Motor Control**

ORDER CODE

Part Number	Temperature Range	Package
		D
TD350I	-40, +125°C	•

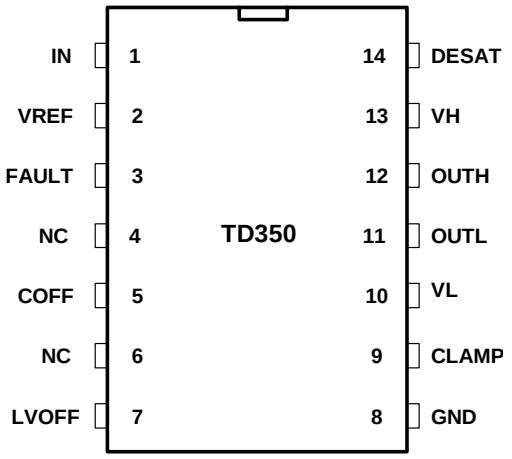
Note: **D =** Small Outline Package (SO) - also available in Tape & Reel (DT)

PACKAGE REFERENCE

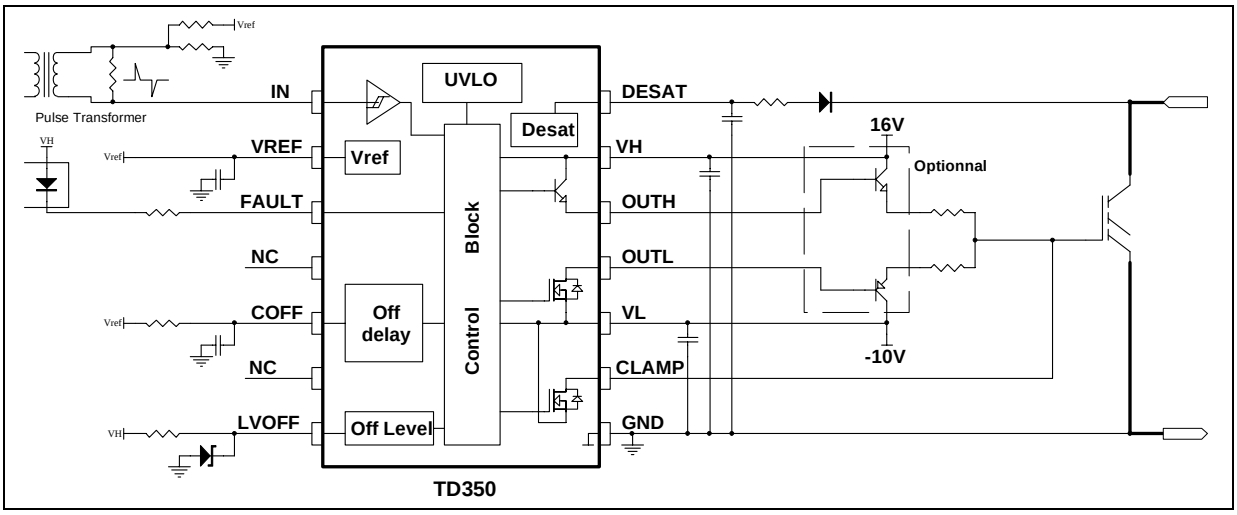


D
SO14
(Plastic MicroPackage)

PIN CONNECTIONS (top view)



1 BLOCK DIAGRAM



PIN DESCRIPTION

Name	Pin Number	Type	Function
IN	1	Analog input	Input
VREF	2	Analog output	+5V reference voltage
FAULT	3	Digital output	Fault status output
NC	4	Not connected	
COFF	5	Timing capacitor	Turn off delay
NC	6	Not connected	
LVOFF	7	Analog input	Turn off level
GND	8	Power supply	Signal ground
CLAMP	9	Analog output	Miller clamp
VL	10	Power supply	Negative supply
OUTL	11	Analog output	Gate drive output (sink)
OUTH	12	Analog output	Gate drive output (source)
VH	13	Power supply	Positive supply
DESAT	14	Analog input	Desaturation protection

2 ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
VHL	Maximum Supply Voltage (VH - VL)	28	V
VH	Maximum VH voltage vs. GND	28	V
VL	Minimum VL voltage vs. GND	-12	V
Vout	Voltage on OUTH, OUTL, CLAMP pins	VL-0.3 to VH+0.3	V
Vdes	Voltage on DESAT, FAULT, LVOFF pin	-0.3 to VH+0.3	V
Vter	Voltage on other pins (IN, COFF, VREF)	-0.3 to 7	V
Pd	Power dissipation	500	mW
Tstg	Storage temperature	-55 to 150	°C
Tj	Maximum Junction Temperature	150	°C
Rhja	Thermal Resistance Junction-Ambient	125	°C/W
Rhjc	Thermal Resistance Junction-Case	22	°C/W
ESD	Electrostatic discharge	2	kV

Operating conditions

Symbol	Parameter	Value	Unit
VH	Positive Supply Voltage vs. GND	UVLO to 26	V
VL	Negative Supply Voltage vs. GND	0 to -10	V
VH-VL	Maximum Total Supply Voltage	26	V
Toper	Operating Free Air Temperature Range	-40 to 125	°C

3 ELECTRICAL CHARACTERISTICS

T_{amb} = -20 to 125°C, VH=16V, VL=-10V (unless otherwise specified)

Symbol	Parameter	Test Condition	Min	Typ	Max	Unit
Input						
Vton	IN turn-on threshold voltage		0.8	1.0		V
Vtoff	IN turn-off threshold voltage			4.0	4.2	V
tonmin	Minimum pulse width		100	135	220	ns
Iinp	IN Input current				1	µA
Voltage reference - Note 1						
Vref	Voltage reference	T=25°C Tmin<T<Tmax	4.85 4.77	5.00	5.15 5.22	V V
Iref	Maximum output current		10			mA
Desaturation protection						
Vdes	Desaturation threshold		6.5	7.2	7.9	V
Ides	Source current			250		µA
Fault output						
tfault	Delay for fault detection				500	ns
VFL	FAULT low voltage	Ifsink=10mA			1	V
Clamp						
Vtclamp	CLAMP pin voltage threshold			2.0		V
VCL	Clamp low voltage at Icsink=500mA	T=25°C Tmin<T<Tmax			VL+2.5 VL+3.0	V V
Off Delay						
Vtdel	Voltage threshold		2.35	2.50	2.65	V
Rdel	Discharge resistor	I=1mA			500	Ω
Off Levels						
Iblvoff	LVOFF peak input current (sink)	LVOFF=12V		120	200	µA
Violv	Offset voltage	LVOFF=12V	-0.3	-0.15	0	V
Outputs						
VOL1	Output low voltage at Iosink=20mA				VL+0.35	V
VOL2	Output low voltage at Iosink=200mA	T=25°C Tmin<T<Tmax			VL+1.0 VL+1.5	V V
VOL3	Output low voltage at Iosink=500mA	T=25°C Tmin<T<Tmax			VL+2.5 VL+3.0	V V
VOH1	Output high voltage 1	Iosource=20mA	VH-2.5			V
VOH2	Output high voltage 2	Iosource=200mA	VH-3.0			V
VOH3	Output high voltage 3	Iosource=500mA	VH-4.0			V
tr	Rise time	CL=1nF, 10% to 90% VL=0 VL=-10V			 130 175	 ns ns
tf	Fall time (2 step turn-off disabled)	CL=1nF, 90% to 10% VL=0 VL=-10V			 75 90	 ns ns
tpd	Input to output propagation delay at turn-on (2 step delay disabled)	10% output change	270		800	ns
Δtw	Input to output pulse distortion	10% output change	10	60	110	ns
Under Voltage Lockout (UVLO)						
UVLOH	UVLO top threshold		10	11	12	V
UVLOL	UVLO bottom threshold		9	10	11	V
Vhyst	UVLO hysteresis	UVH-UVL	0.5	1		V
Supply current						
Iin	Quiescent current	output=0V, no load			5	mA

Note: 1.Recommended capacitor range on VREF pin is 10nF to 100nF.

4 FUNCTIONAL DESCRIPTION

4.1 Input

The input is compatible with optocouplers or pulse transformers. The input is triggered by the signal edge and allows the use of low-sized, low-cost pulse transformer. Input is active low (output is high when input is low) to ease the use of optocoupler. When driven by a pulse transformer, the input pulse (positive and negative) width must be larger than the minimum pule width t_{onmin}.

4.2 Voltage reference

A voltage reference is used to create accurate timing for the two-level turn-off with external resistor and capacitor.

4.3 Desaturation protection

Desaturation protection ensures the protection of the IGBT in the event of overcurrent. When the DESAT voltage goes higher that 7V, the output is driven low (with 2-level turn-off if applicable). The FAULT output is activated. The FAULT state is exited at the next rising edge of IN input.

A programmable blanking time is used to allow enough time for IGBT saturation. Blanking time is provided by an internal current source and external capacitor.

DESAT input can also be used with an external comparator for overcurrent or over temperature detection.

4.4 Active Miller clamp:

A Miller clamp allows the control of the Miller current during a high dV/dt situation and can avoid the use of a negative supply voltage.

During turn-off, the gate voltage is monitored and the clamp output is activated when gate voltage goes below 2V (relative to GND). The clamp voltage is VL+3V max for a Miller current up to 500mA. The clamp is disabled when the IN input is triggered again.

4.5 Two level turn-off

The two-level turn-off is used to increase the reliability of the application.

During turn-off, gate voltage can be reduced to a programmable level in order to reduce the IGBT current (in the event of over-current). This action avoids both dangerous overvoltage across the IGBT, and RBSOA problems, especially at short circuit turn-off.

Turn-off (T_a) delay is programmable through an external resistor and capacitor for accurate timing.

Turn-off delay (T_a) is also used to delay the input signal to prevent distortion of input pulse width.

4.6 Minimum ON time

In order to ensure the proper operation of the 2-level turn-off function, the input ON time (T_{win}) must be greater than the T_{winmin} value:

$$T_{winmin}=T_a+2*R_{del}*C_{off}$$

R_{del} is the internal discharge resistor and C_{off} is the external timing capacitor.

Input signals smaller than Ta are ignored. Input signals larger than T_{winmin} are transmitted to the output stage after the T_a delay with minimum width distortion ($\Delta T_w=T_{wout}-T_{win}$).

For an input signal width T_{win} between T_a and T_{winmin}, the output width T_{wout} is reduced below T_{win} (pulse distortion) and the IGBT could be partially turned on. These input signals should be avoided during normal operation.

4.7 Output

The output stage is able to sink/source 1.5A (0.75A min. over full temperature range). Separated sink and source outputs allow independent gate charge and discharge control without an extra external diode.

4.8 Fault status output

Fault output is used to signal a fault event (desaturation, UVLO) to a controller. The fault pin is designed to drive an optocoupler.

4.9 Undervoltage protection

Undervoltage detection protects the application in the event of a low VH supply voltage (during start-up or a fault situation). During undervoltage, the OUTH pin is open and the OUTL pin is driven low (active pull-down for VH>2V, passive pull-down for VH<2V). Fault output signals the undervoltage state and is reset only when undervoltage state disappears.

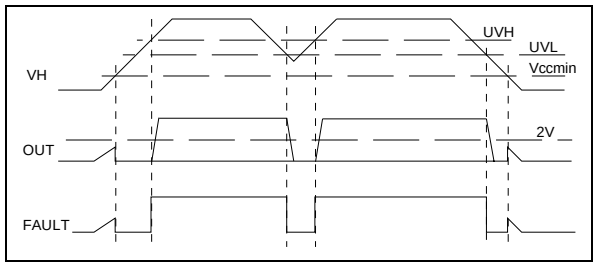
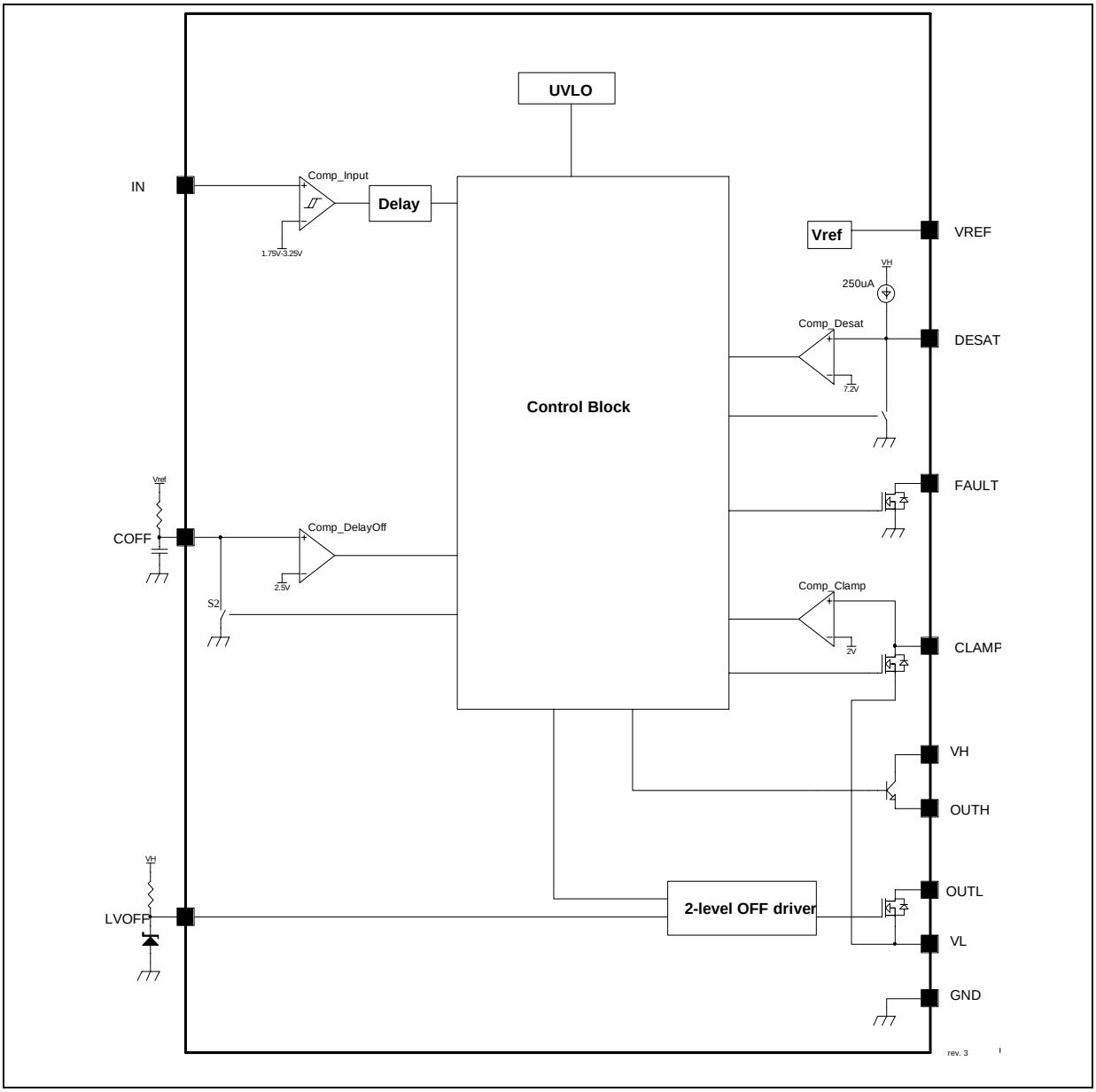
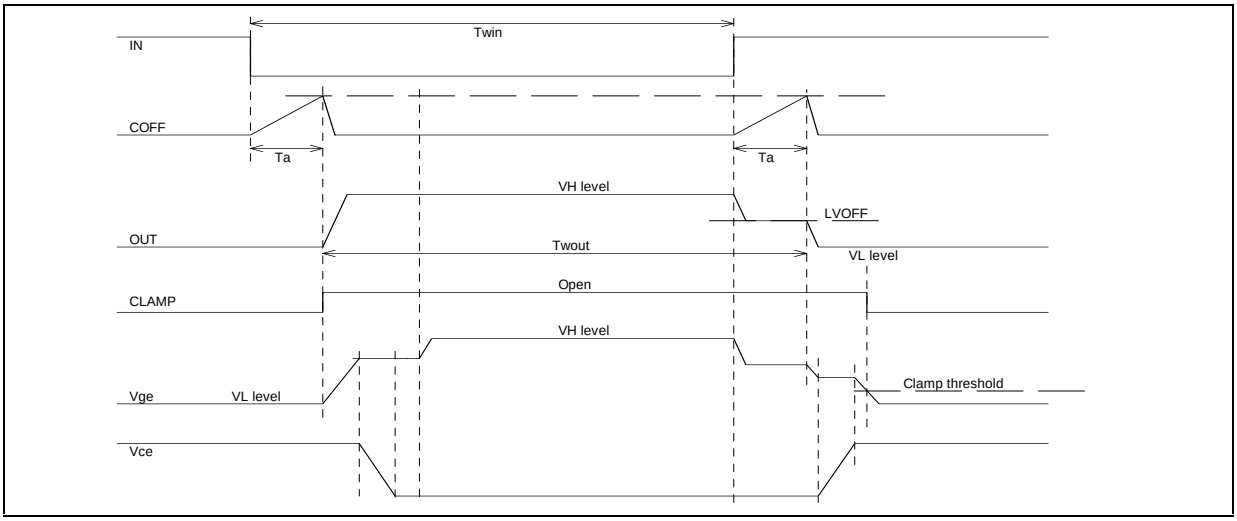


Fig. 1: Detailed Internal Schematic

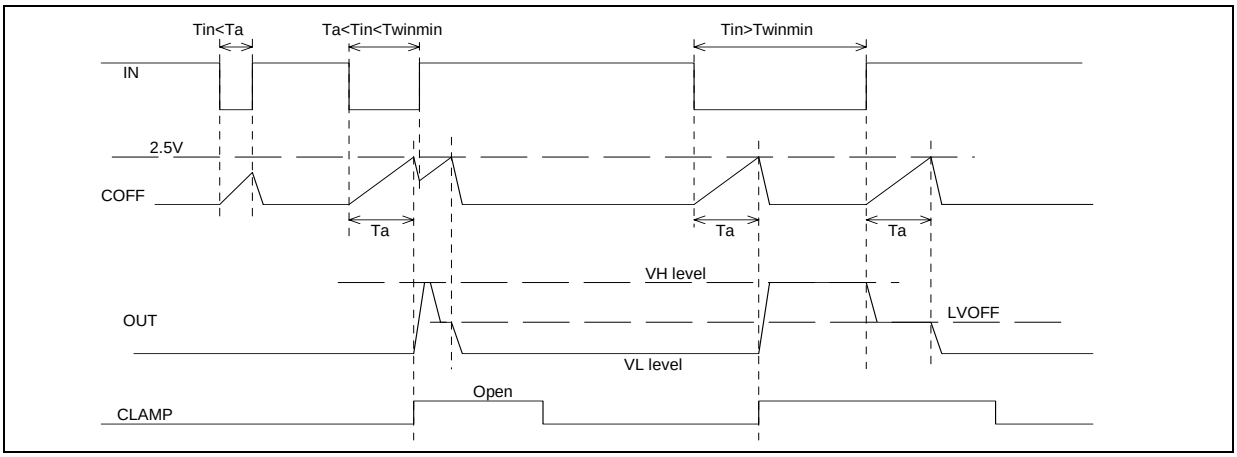


5 TIMING DIAGRAMS

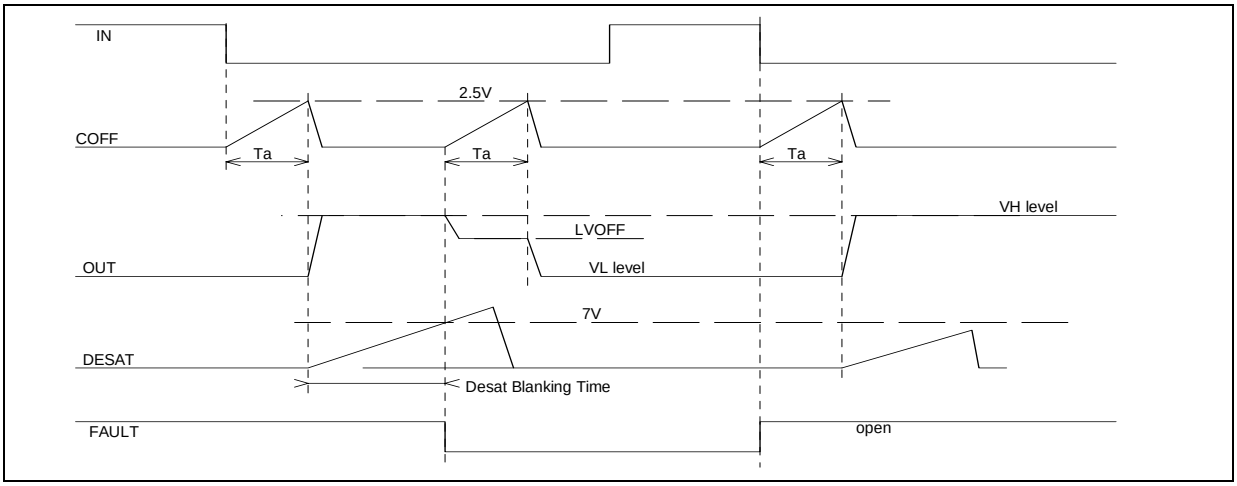
Turn-on and turn-off



Minimum ON time



Desaturation fault



6 TYPICAL PERFORMANCE CURVES

Fig. 2: Supply Current vs Temperature

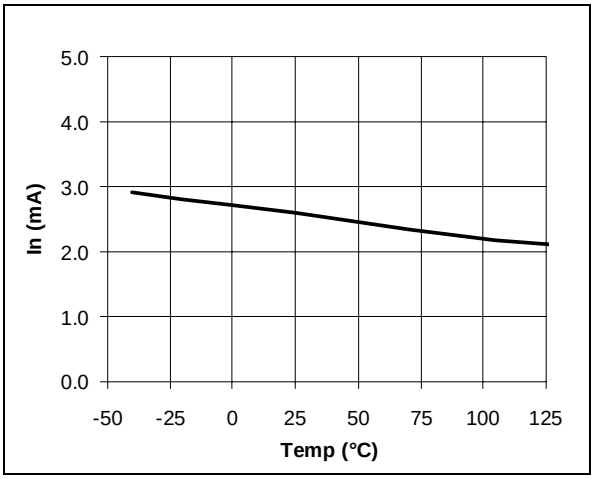


Fig. 3: Low Level Output Voltage vs Temp.

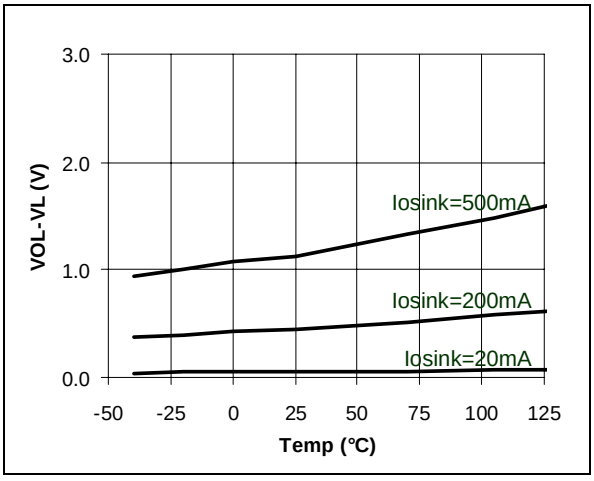


Fig. 4: Desaturation Threshold vs Temperature

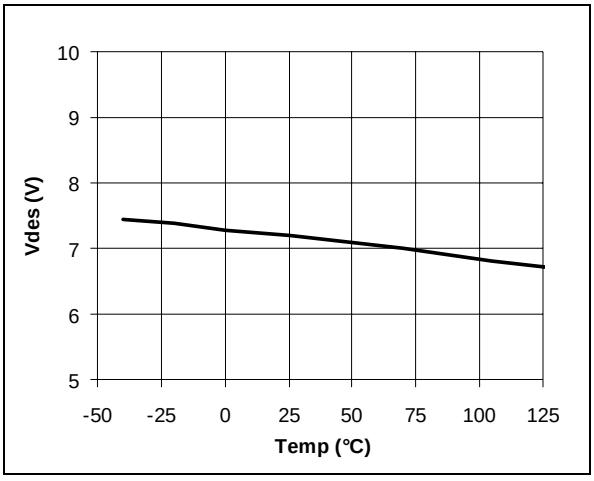


Fig. 5: Voltage Reference vs Temperature

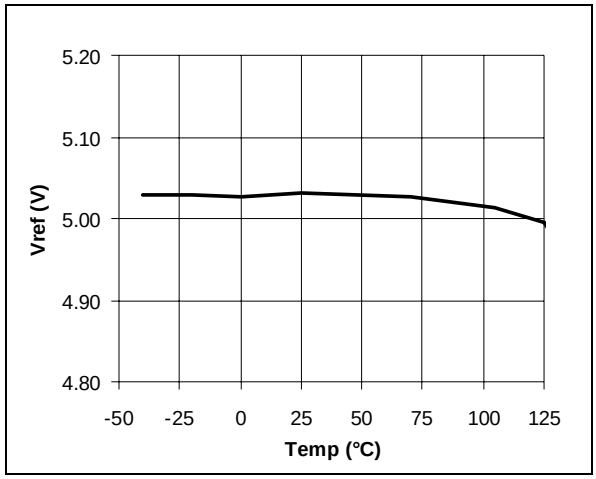


Fig. 6: High Level Output voltage vs Temp.

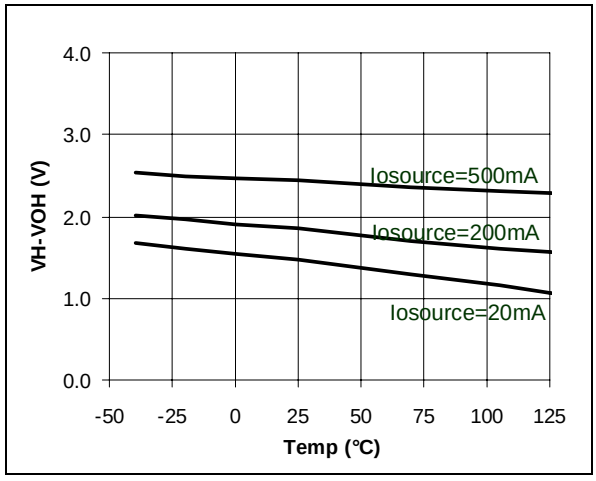
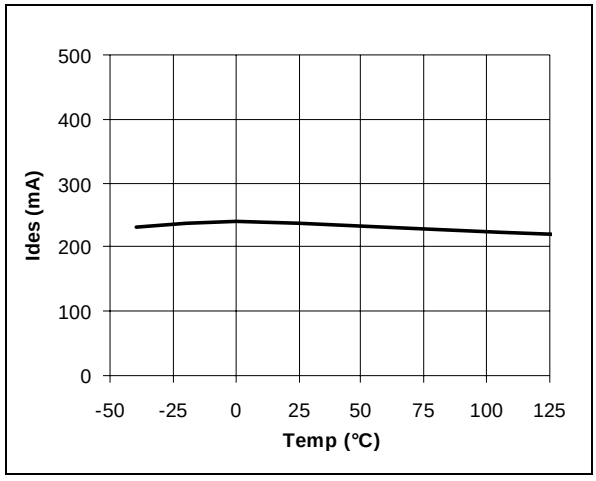
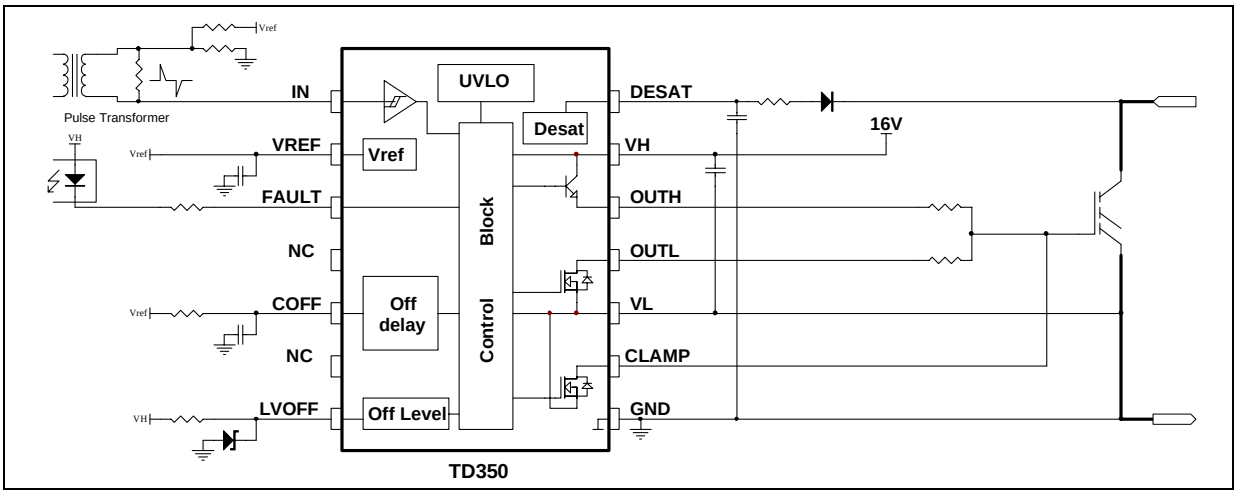


Fig. 7: Desaturation Source Current vs Temp.

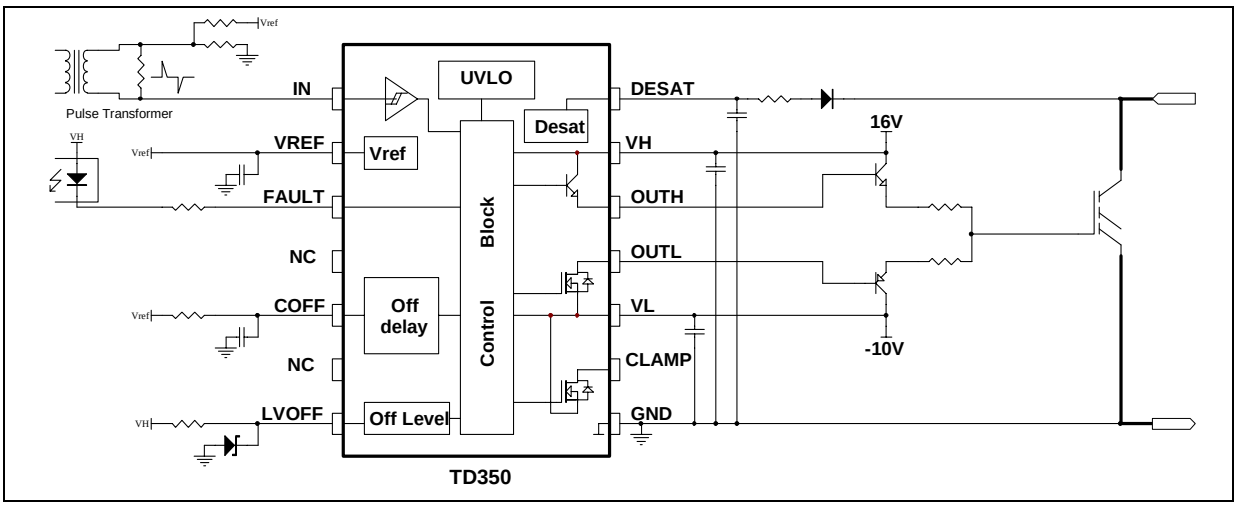


7 APPLICATION DIAGRAMS

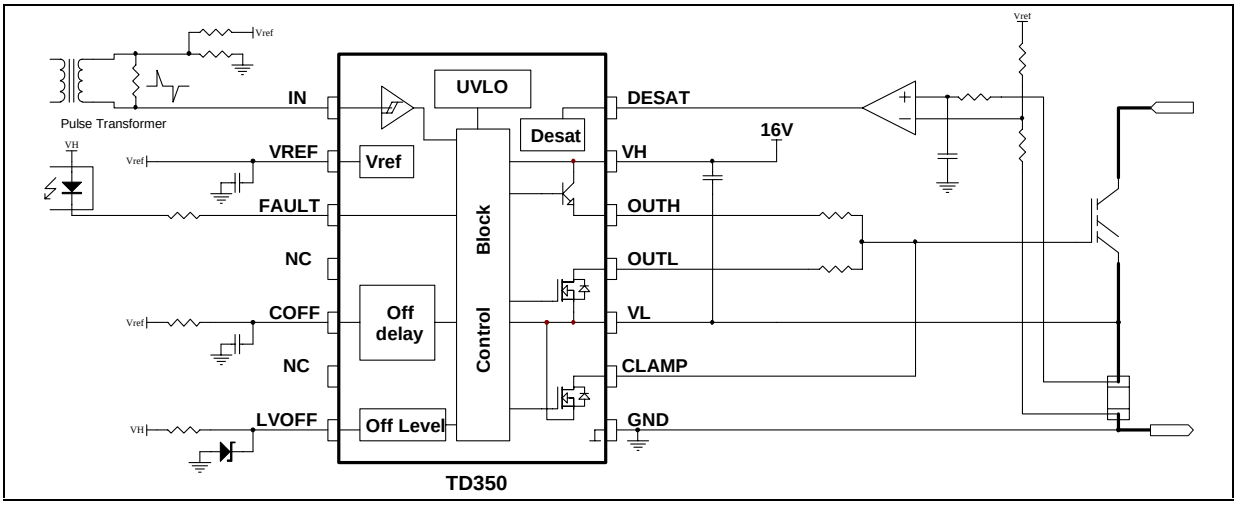
Single supply IGBT drive with active Miller clamp



Large IGBT drive with negative gate drive



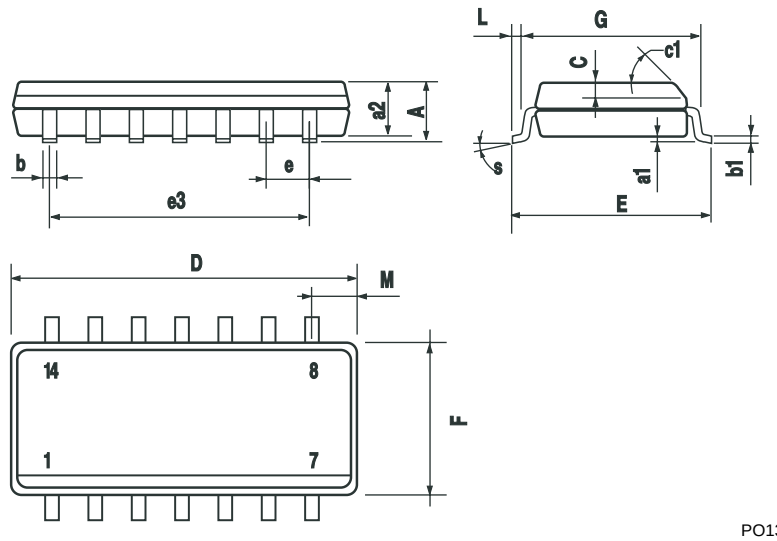
Use of DESAT input for direct overcurrent detection



8 PACKAGE MECHANICAL DATA

SO-14 MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A			1.75			0.068
a1	0.1		0.2	0.003		0.007
a2			1.65			0.064
b	0.35		0.46	0.013		0.018
b1	0.19		0.25	0.007		0.010
C		0.5			0.019	
c1	45° (typ.)					
D	8.55		8.75	0.336		0.344
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		7.62			0.300	
F	3.8		4.0	0.149		0.157
G	4.6		5.3	0.181		0.208
L	0.5		1.27	0.019		0.050
M			0.68			0.026
S	8° (max.)					



PO13G