

# HA13703A

## IPIC™ High Side Inductive Load Driver

Preliminary



### Description

(IPIC: Intelligent Power IC)

HA13703A is high side power driver IC with protectors and diagnostic function. The device is especially designed to switch inductive loads.

### Functions

- Power MOS source follower output (4 A)
- With over voltage shut down circuit (OVSD)
- With over current protector circuit (OCSD)
- With over temperature shut down circuit (OTSD)
- With diagnostic circuit and status output
- With fail safe function under input open circuit condition
- With low voltage inhibit circuit (LVI)
- With output negative voltage clamp circuit

### Features

- Protected against 60 V load dump condition
- Low  $R_{ON}$  (0.1  $\Omega$  typ)
- Wide operating supply voltage range ( $V_{DD} = 7\text{ V to }25\text{ V}$ )
- High sustaining voltage ( $-15\text{ V}$ )
- Protected against reverse supply voltage ( $-13\text{ V}$ )
- Protected against short circuit condition
- Suitable switching speed to have high speed operation and low EMI
- Input compatible with TTL, LS-TTL, or 5 V CMOS
- Protected against electrostatic discharge (2 kV min at 100 pF/1.5 k $\Omega$ )

### Pin Arrangement

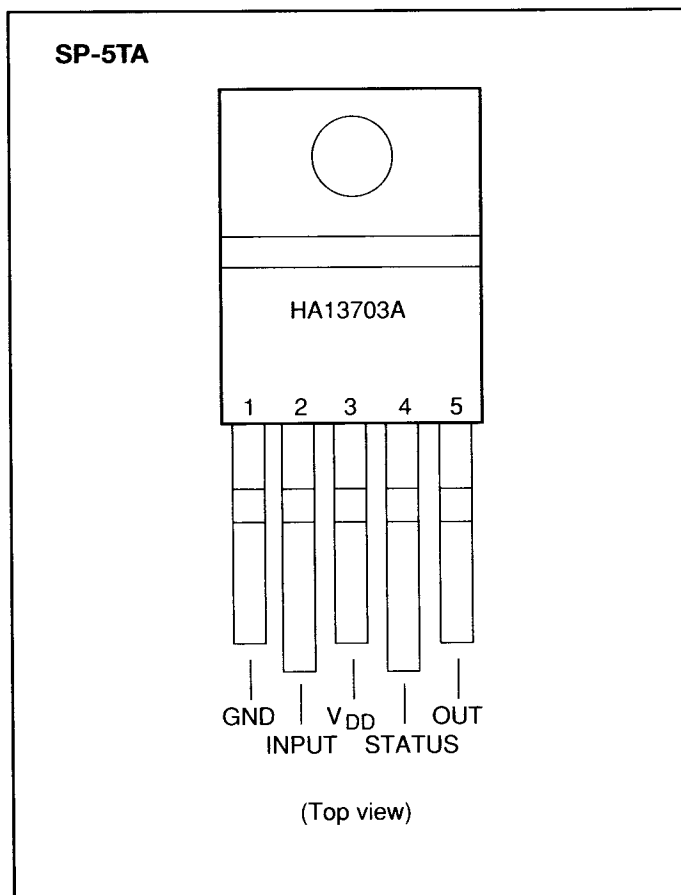


Figure 1 Pin Arrangement

### Ordering Information

Type No.	Package
HA13703A	SP-5TA

Block Diagram

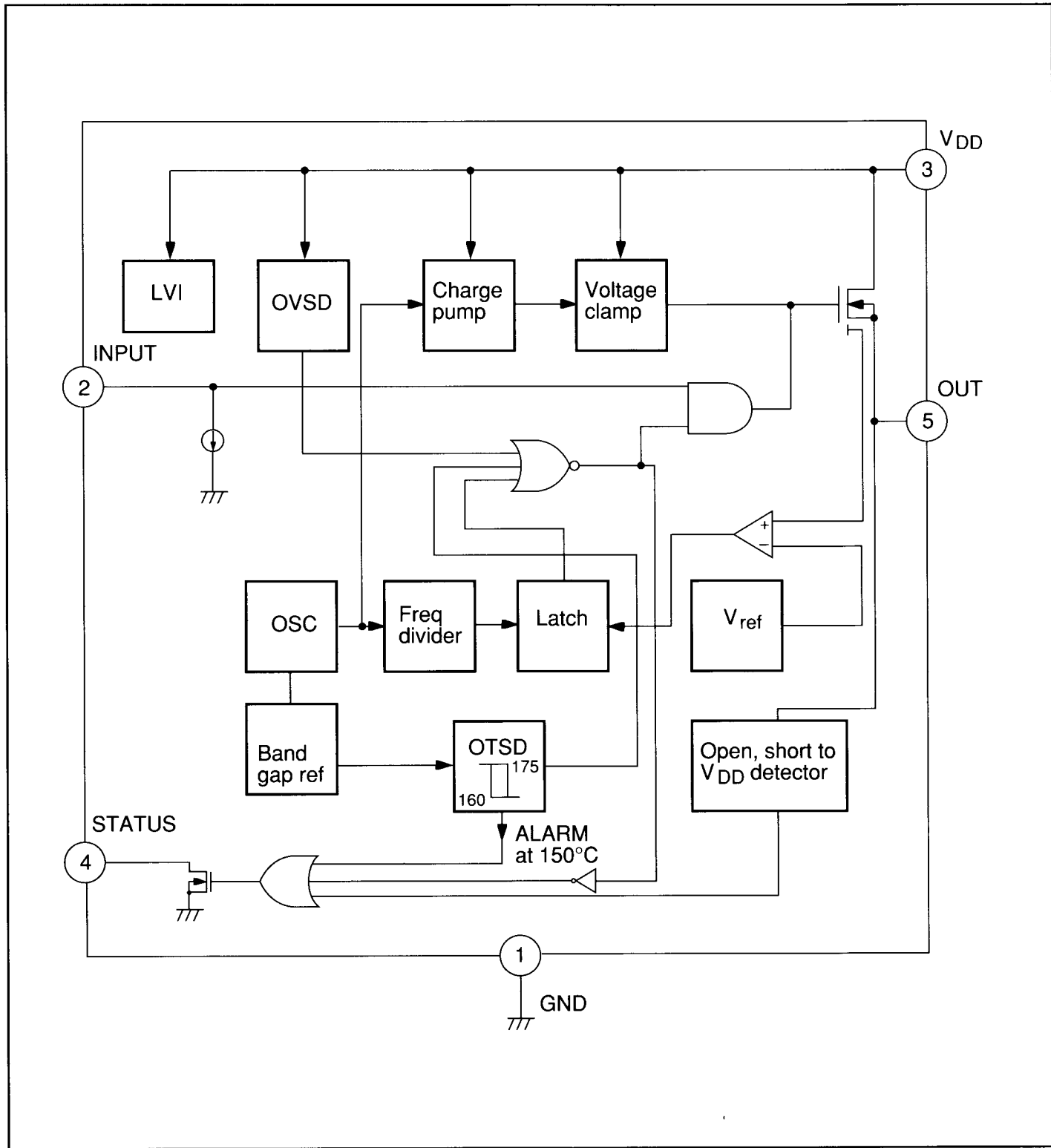


Figure 2 Block Diagram

**Function Description**

**Peak Current and Turn-off Time**

Figure 3 shows waveforms of load current (I<sub>out</sub>) and output voltage (V<sub>out</sub>) at driving inductive load.

The peak output current (I<sub>p</sub>) and sustaining time (t<sub>sus</sub>) can be described as

$$I_p = \frac{V_{DD}}{R} (1 - e^{-\frac{R}{L} t_{ON}}) \quad (1)$$

$$t_{sus} = \frac{L}{R} \ln \left( 1 + \frac{I_p \cdot R}{V_B} \right) \quad (2)$$

Where

R : Equivalent resistance of the load

L : Equivalent inductance of the load

HA13703A has the internal protector to prevent turn on during t<sub>sus</sub> period.

**Table 1 Truth Table**

Mode	In	Out	Status
Normal	L	L	H
	H	H	H
Load short	L	L	H
	H	L	L
Load open	L	L	H
	H	H	L
Short to V <sub>DD</sub>	L	H	L
	H	H	L
OTSD *1	L	L	L
	H	L	L
OVSD *2	L	L	L
	H	L	L
LVI *3	L	L	H
	H	L	H

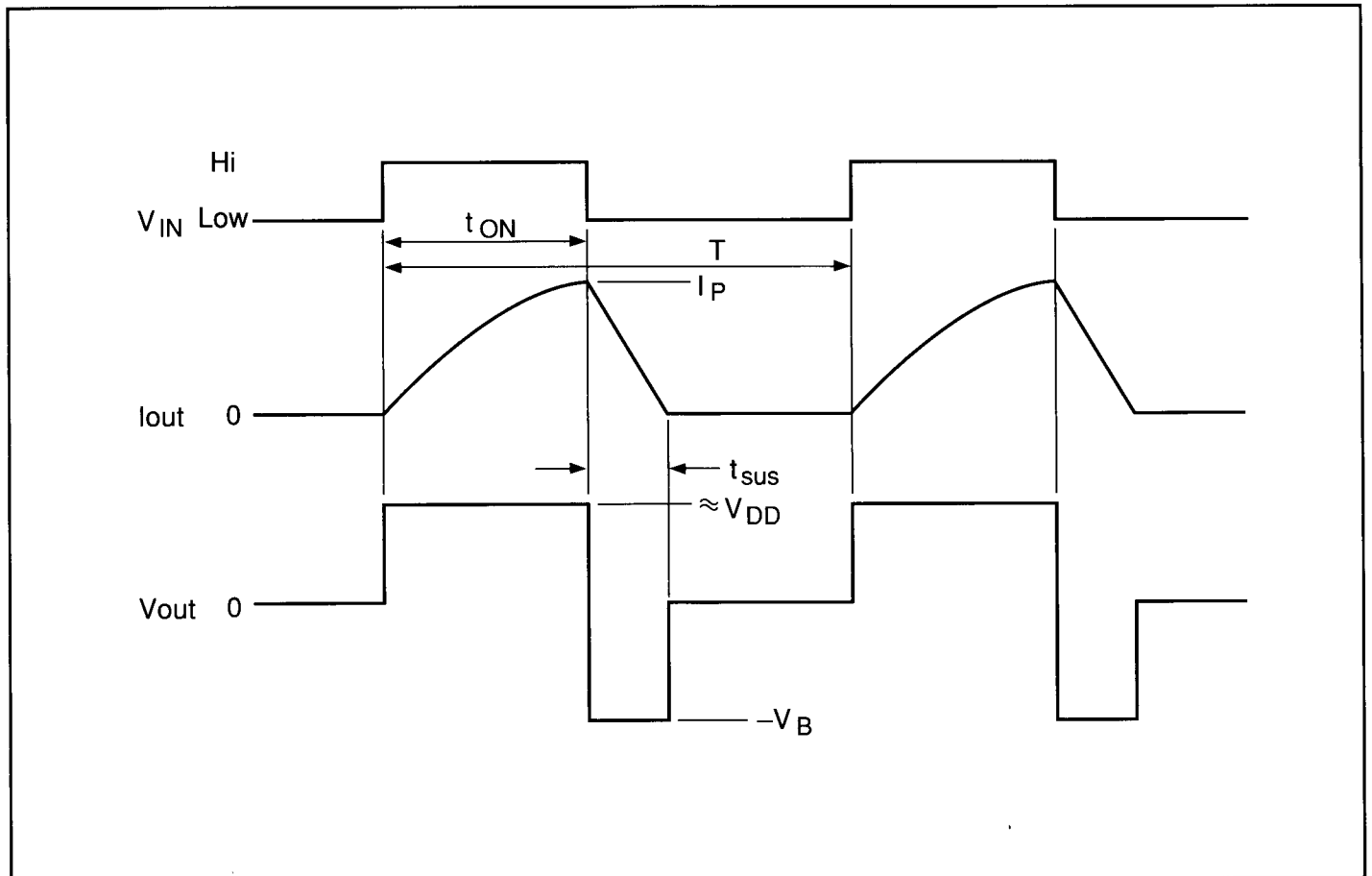
Note: L: Low level (0.8 V)

H: High level (2.0 V)

\*1) OTSD: Over temperature shut down

\*2) OVSD: Over voltage shut down

\*3) LVI: Low voltage inhibit



**Figure 3 Peak Current and Turn-off Time**

Application

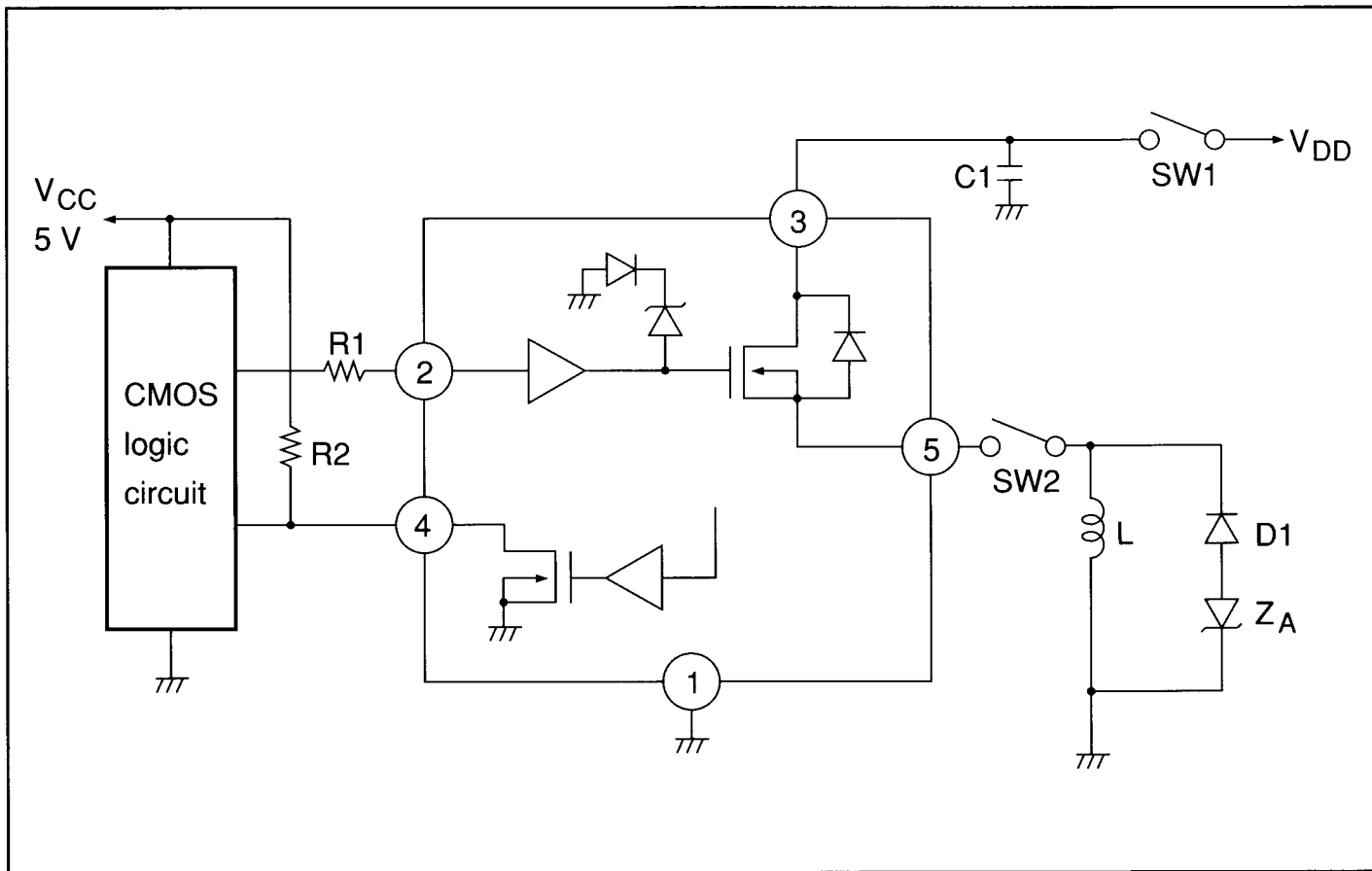


Figure 4 Solenoid Drive with Switched Power Supply

**D1 & ZA:** The external voltage clamp circuit using D1 & ZA are necessary to protect the HA13703A when SW2 switches under normal operating conditions. D1 & ZA must be in parallel with the load.

The zener voltage ( $V_{ZB}$ ) and forward diode voltage ( $V_{D1}$ ) must satisfy the following:

$$V_{D1} + V_{ZB} < 15 \text{ V} (= V_{(sus) \text{ MIN}}) \quad (3)$$

**R1:** When SW1 opens with output ON, the Input (Pin 2) may be shorted to GND. In this case, R1 will limit the current from logic circuits at pin 2.

**R2:** Pull up resistor at Status output.

**C1:** When SW1 opens with Output ON, the energy stored in the load L can not be dissipated through  $V_{DD}$ . Therefore, C1 must be able to absorb this energy, and can be selected from

$$C1 > L \cdot \left(\frac{I_P}{V_{DD}}\right)^2 \quad (4)$$

Note that when using D1 & ZA clamp, it may not be necessary to use as large a capacitor as described above. In this case, C1 must have the value to compensate the inductance at  $V_{DD}$  line (refer equation 4) and should be located near the device.

**Reverse Battery**

Under reverse battery condition, the HA13703A will dissipate power ( $P_D^*$ ) because of current through the intrinsic diode on power MOS.  $P_D^*$  can be calculated as follows and must not exceed the absolute maximum rating on power dissipation.

$$P_D^* = \frac{-V_{DD}^* - V_{F(B)}}{R} \cdot V_{F(B)} \quad (5)$$

Where

$V_{DD}^*$  = reverse battery voltage

$V_{F(B)}$  = forward intrinsic diode voltage

R = equivalent resistance of the load

The input and status voltage must not exceed the absolute maximum rating (-0.3 V) in reverse battery condition.

Table 2 Absolute Maximum Ratings (Ta = 25°C)

Item	Symbol	HA13703A	Unit	Note
Continuous supply voltage	V <sub>DD</sub>	-13 to 35	V	1
Transient supply voltage	V <sub>DD</sub>	60	V	2
Input voltage	V <sub>IN</sub>	-0.3 to 15	V	
Output voltage	V <sub>out</sub>	-15 to V <sub>DD</sub>	V	
Status voltage	V <sub>S</sub>	-0.3 to 15	V	
Output current	I <sub>out</sub>	—	A	3
Status current	I <sub>S</sub>	5	mA	
Power dissipation	P <sub>T</sub>	—	W	4
Package thermal resistance	Junction to case	θ <sub>jc</sub>	5	°C/W
	Junction to air	θ <sub>ja</sub>	70	°C/W
Junction temperature range	T <sub>j</sub>	-40 to OTSD	°C	5
Storage temperature range	T <sub>stg</sub>	-55 to 150	°C	

Notes: 1. Recommended operating voltage:

V<sub>DD</sub> = 7 to 16 V (Normal)  
16 to 25 V (Jump start)

2. Load dump condition (Refer to figure 5)

3. Refer to ASO data (figure 6)

Internally limited at

Short circuit condition ; I<sub>D</sub> ≥ 10A

Over voltage condition ; V<sub>DD</sub> ≥ 26V

4. Maximum power dissipation (P<sub>T</sub>(Max)) can be defined as:

$$P_T(\text{MAX}) = (T_{jopr}(\text{MAX}) - T_{\text{ambient}}) / (\theta_{jc} + \theta_{ca})$$

θ<sub>ca</sub>: Thermal resistance between case and air (Depend on heat sink size)

5. Junction temperature operating range T<sub>jopr</sub> = -40 to +125 °C

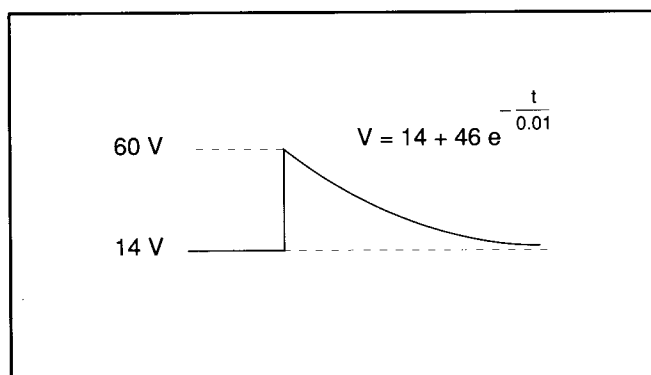


Figure 5 Load Dump Condition

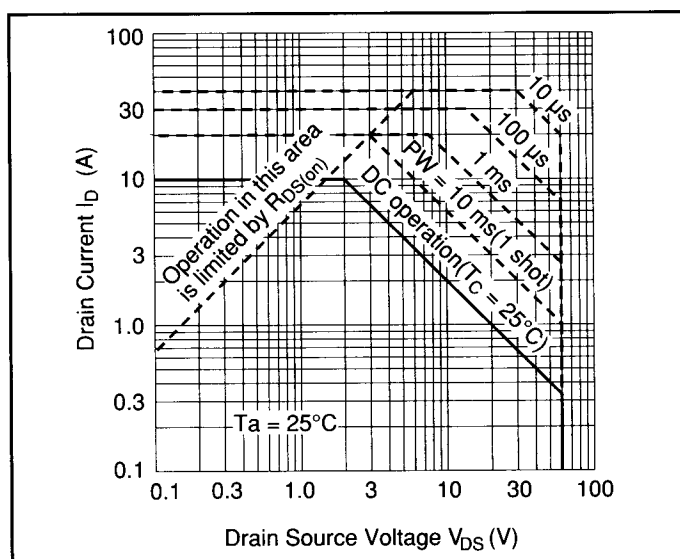


Figure 6 Output Transistor Area of Safe Operation (Reference Data)

**Table 3 Electrical Characteristics (Ta = 25°C)**

Item	Symbol	Min	Typ	Max	Unit	Test condition	Pin	Note	
Operating supply voltage	V <sub>DD</sub>	7	—	25	V		3		
Quiescent current	I <sub>DD1</sub>	—	3.0	8.0	mA	V <sub>IN</sub> = 0 V, out = open	3		
	I <sub>DD2</sub>	—	6.0	10.0	mA	V <sub>IN</sub> = 5.5 V, out = open	3		
Output ON Resistance	R <sub>DS(ON)</sub>	—	0.10	0.15	Ω	I <sub>o</sub> = 4 A (@T <sub>j</sub> = -40 to 25°C)	5		
		—	0.15	0.22	Ω	I <sub>o</sub> = 4 A (@T <sub>j</sub> = 125°C)	5		
Output leak current	I <sub>LEAK</sub>	—	—	5	mA	V <sub>DD</sub> = 35 V, V <sub>IN</sub> = 0 V T <sub>j</sub> = 125°C	5		
Input threshold voltage	V <sub>IL</sub>	—	—	0.8	V		2		
	V <sub>IH</sub>	2.0	—	—	V		2		
Input current	I <sub>IL</sub>	-10	—	60	μA	V <sub>IN</sub> = 0 to 0.8 V	2		
	I <sub>IH</sub>	5	35	60	μA	V <sub>IN</sub> = 2.0 to 5.5 V	2		
Propagation delay time	T <sub>d(ON)</sub>	—	5	—	μs	I <sub>o</sub> = 3 A	2, 5		
	T <sub>r</sub>	—	20	—	μs		5		
	T <sub>d(OFF)</sub>	—	10	—	μs		2, 5		
	T <sub>f</sub>	—	5	—	μs		5		
Open detect threshold current	I <sub>OD</sub>	0.3	0.7	1.2	A		4, 5		
Current limiter operating level	I <sub>CS</sub>	10	20	30	A	R <sub>L</sub> = short	5	6	
Low voltage inhibit operating level	L.V.I	—	5	6	V				
Over voltage shut down	Operating level	OVSD	26	30	33	V		3	
	Hysteresis	V <sub>HYS</sub>	0.25	0.5	1.0	V		3	
Output sustain voltage	V <sub>(SUS)</sub>	-21	-18	-15	V	I <sub>o</sub> = 25 mA	5		
Over temperature shut down	Operating level	OTSD	—	175	—	°C		5	7
		OTSD (Alarm)	—	150	—			4	7
	Hysteresis	T <sub>HYS</sub>	—	15	—	°C		5	7
Status on voltage	V <sub>SL</sub>	—	0.1	0.4	V	I <sub>S</sub> = 1 mA	4		
Status leak current	I <sub>S(Leak)</sub>	—	—	100	μA	V <sub>S</sub> = 5.5 V	4		

Notes: 6. Output current will be constant pulse width controlled under current limit condition  
 7. Design parameter only (not production tested)

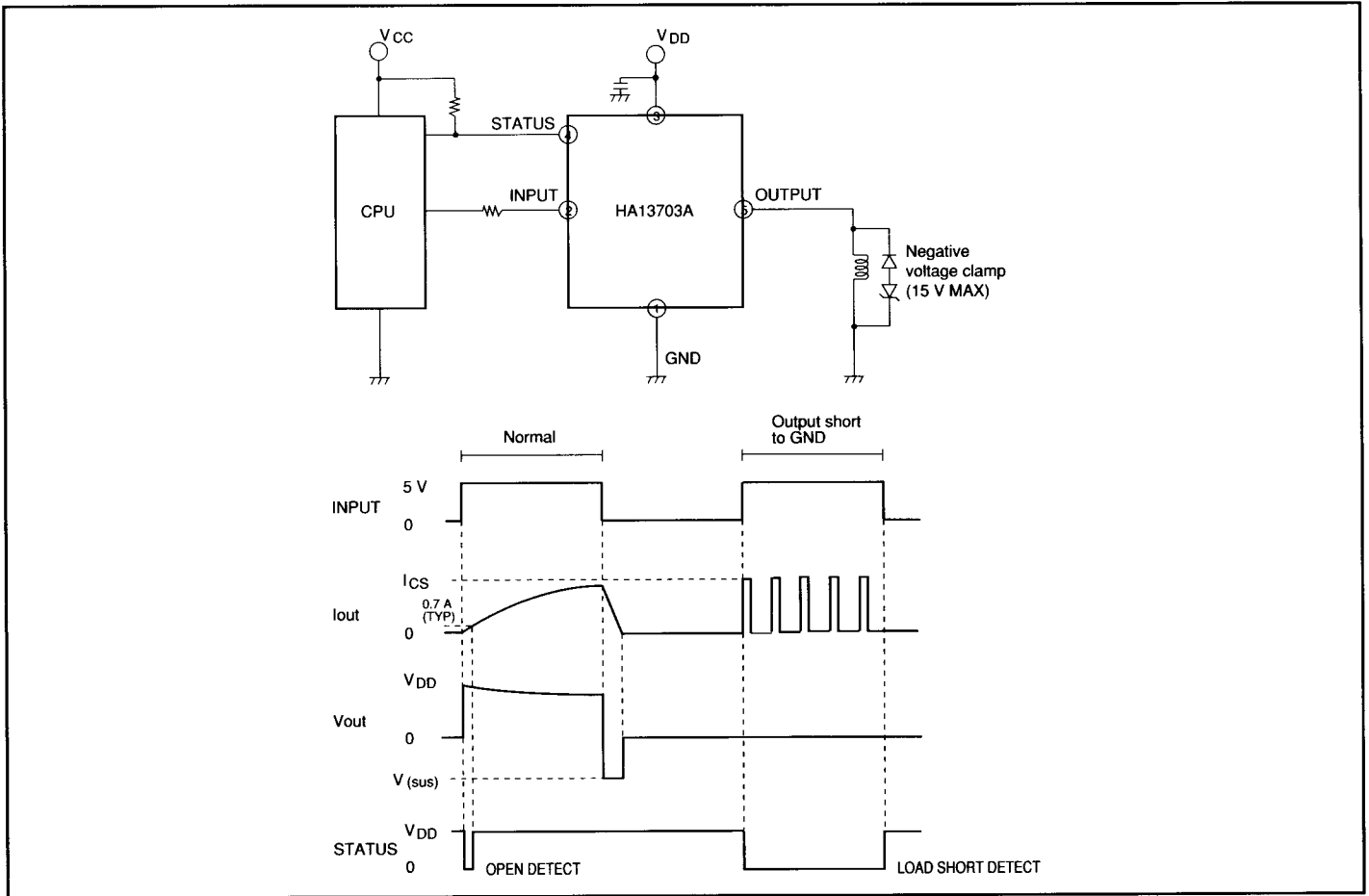


Figure 7 Solenoid Drive Application and Output Waveform

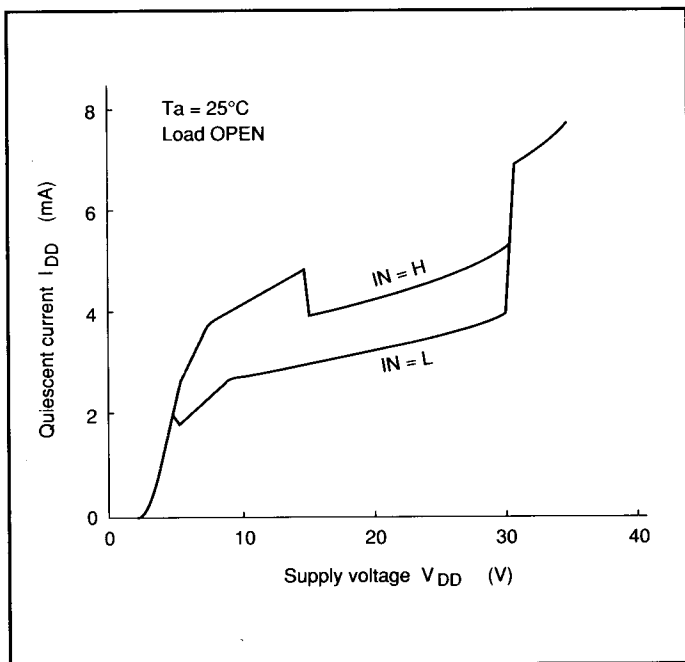


Figure 8  $I_{DD}$  vs.  $V_{DD}$

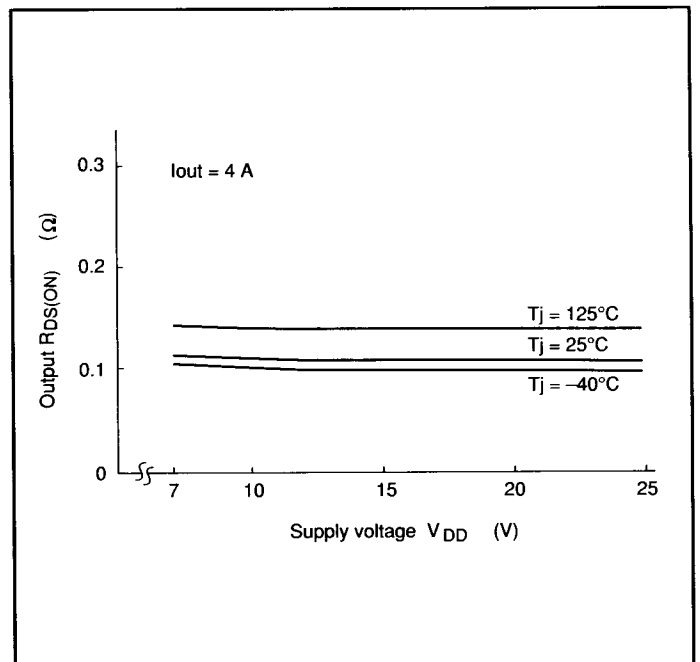


Figure 9  $R_{DS(ON)}$  vs.  $V_{DD}$

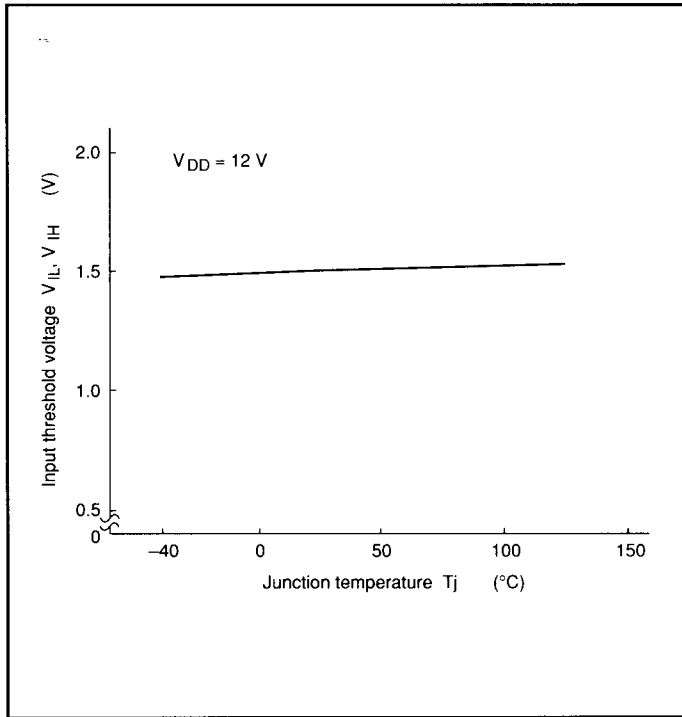


Figure 10  $V_{IL}, V_{IH}$  vs.  $T_j$

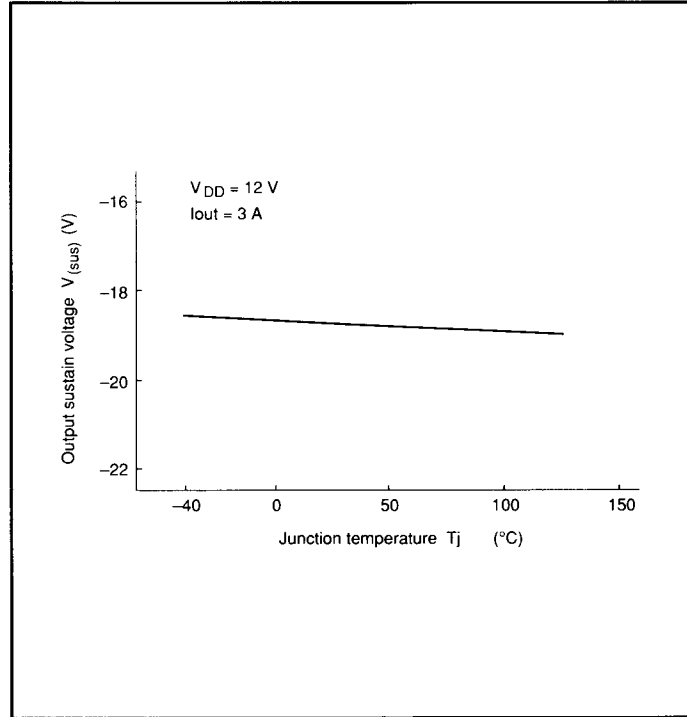


Figure 11  $V_{(sus)}$  vs.  $T_j$

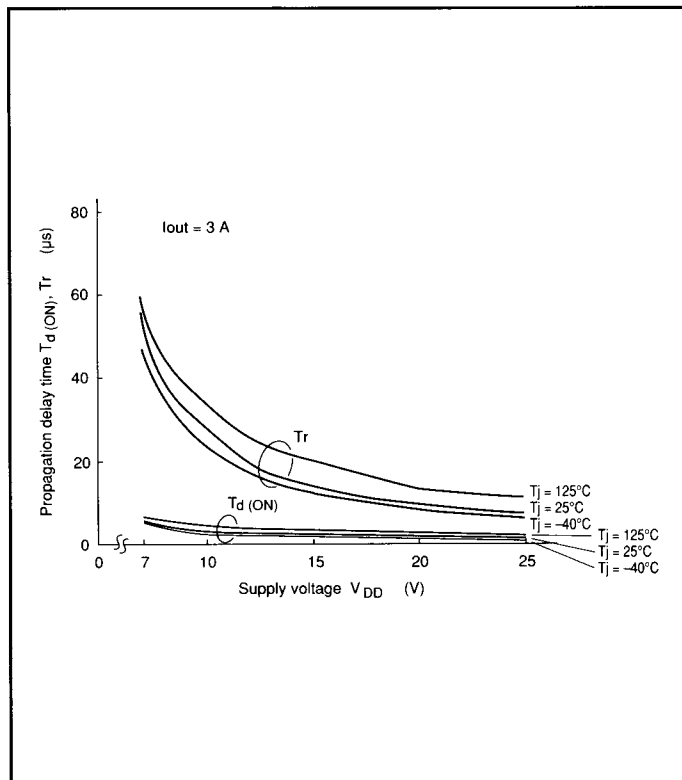


Figure 12  $T_{d(ON)}, T_r$  vs.  $V_{DD}$

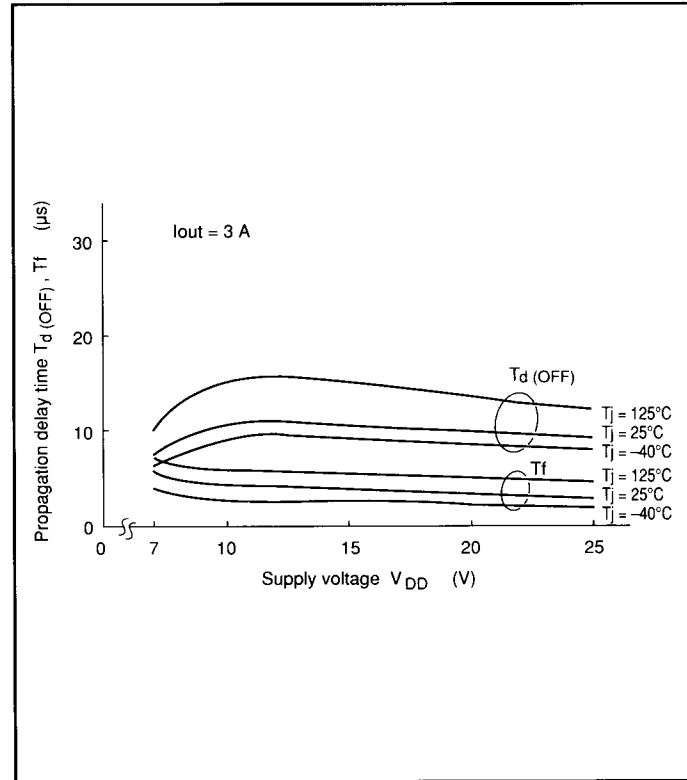


Figure 13  $T_{d(OFF)}, T_f$  vs.  $V_{DD}$

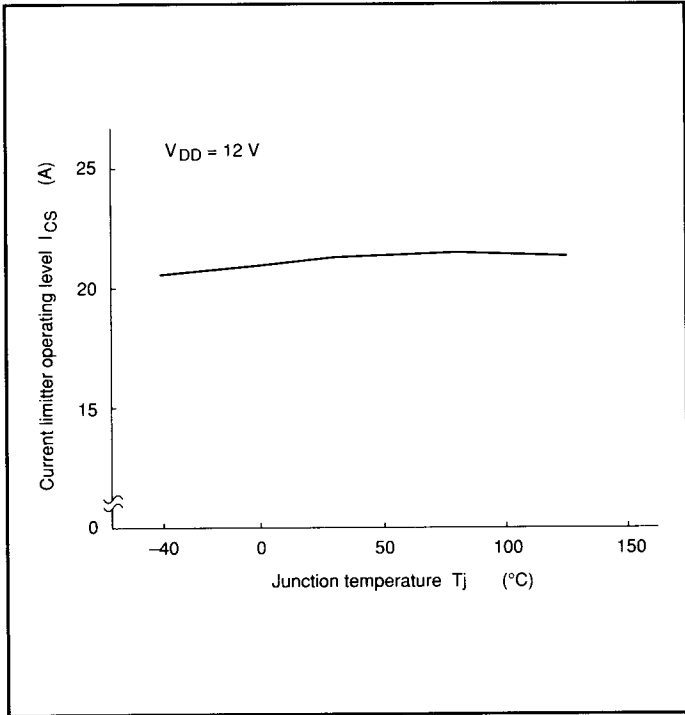


Figure 14  $I_{CS}$  vs.  $T_j$

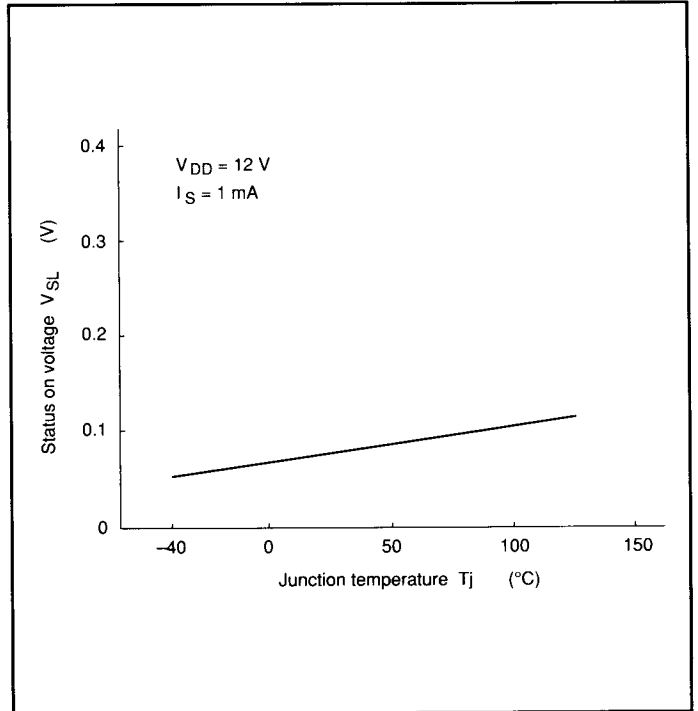


Figure 15  $V_{SL}$  vs.  $T_j$

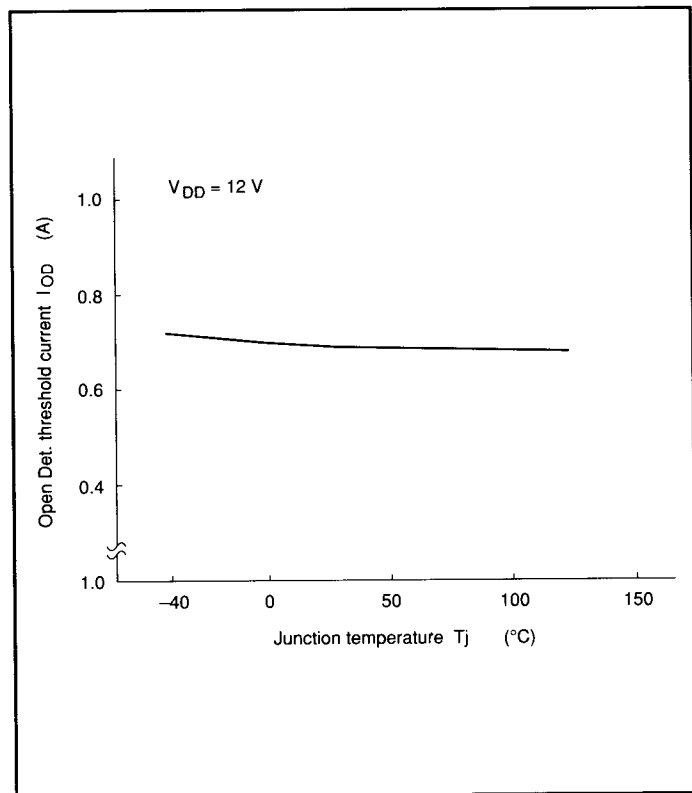


Figure 16  $I_{OD}$  vs.  $T_j$

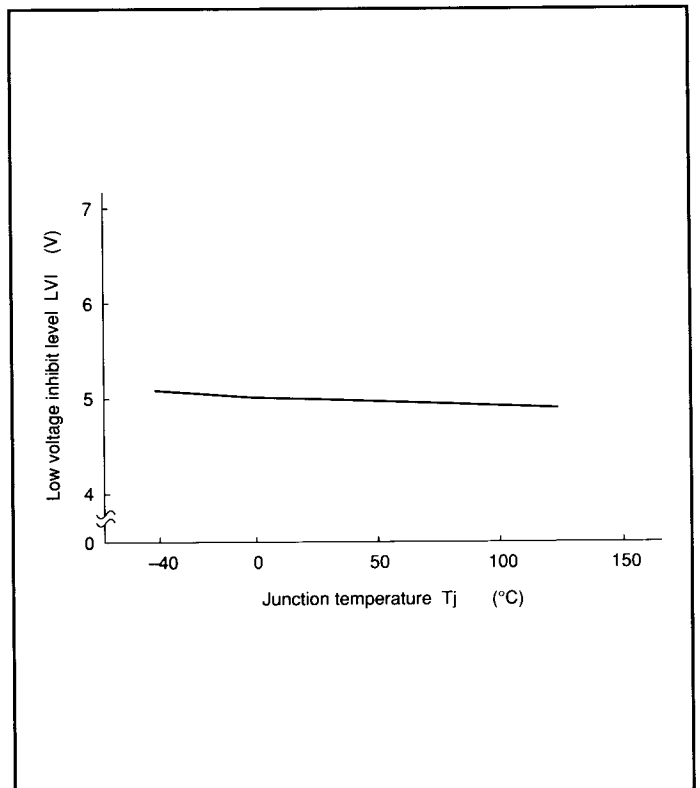


Figure 17  $LVI$  vs.  $T_j$

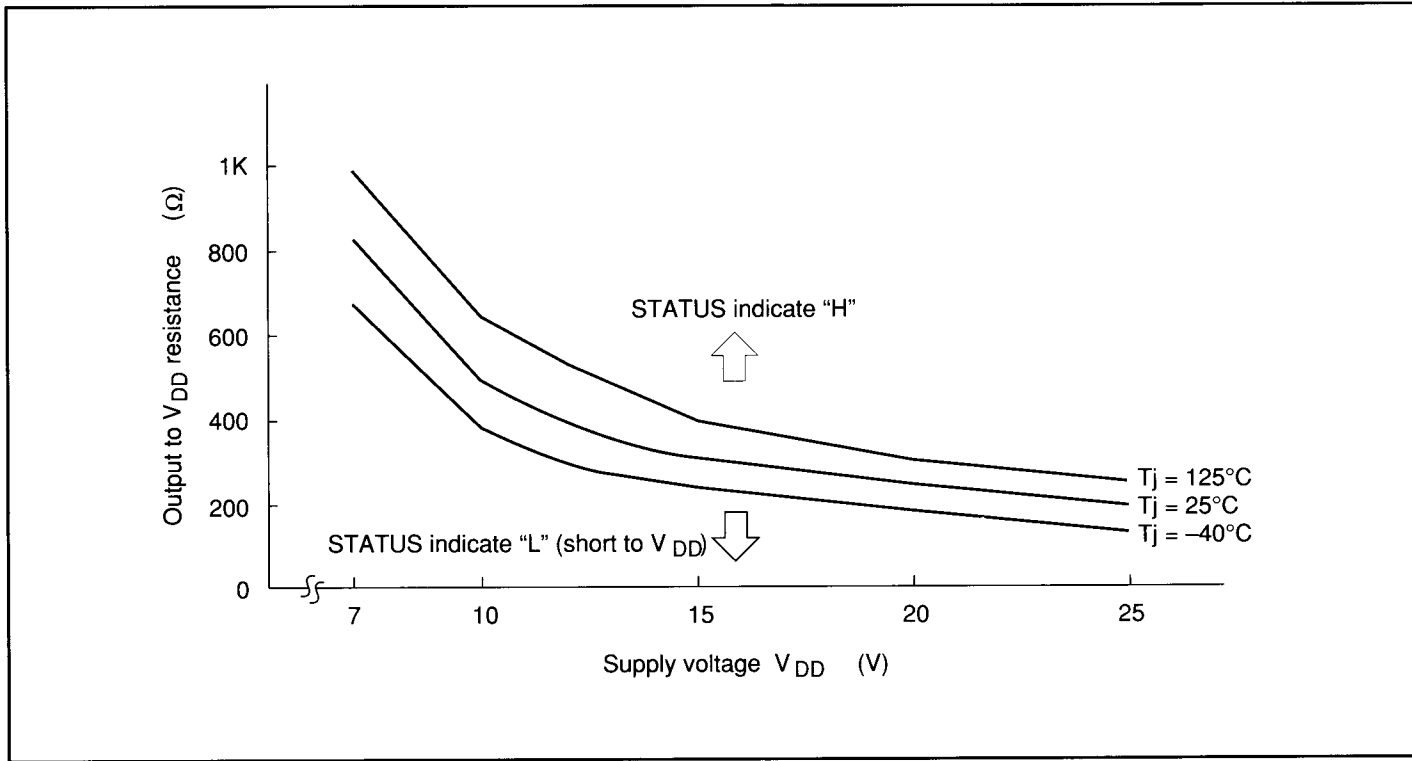


Figure 18 Output to V<sub>DD</sub> Resistance vs. Supply Voltage

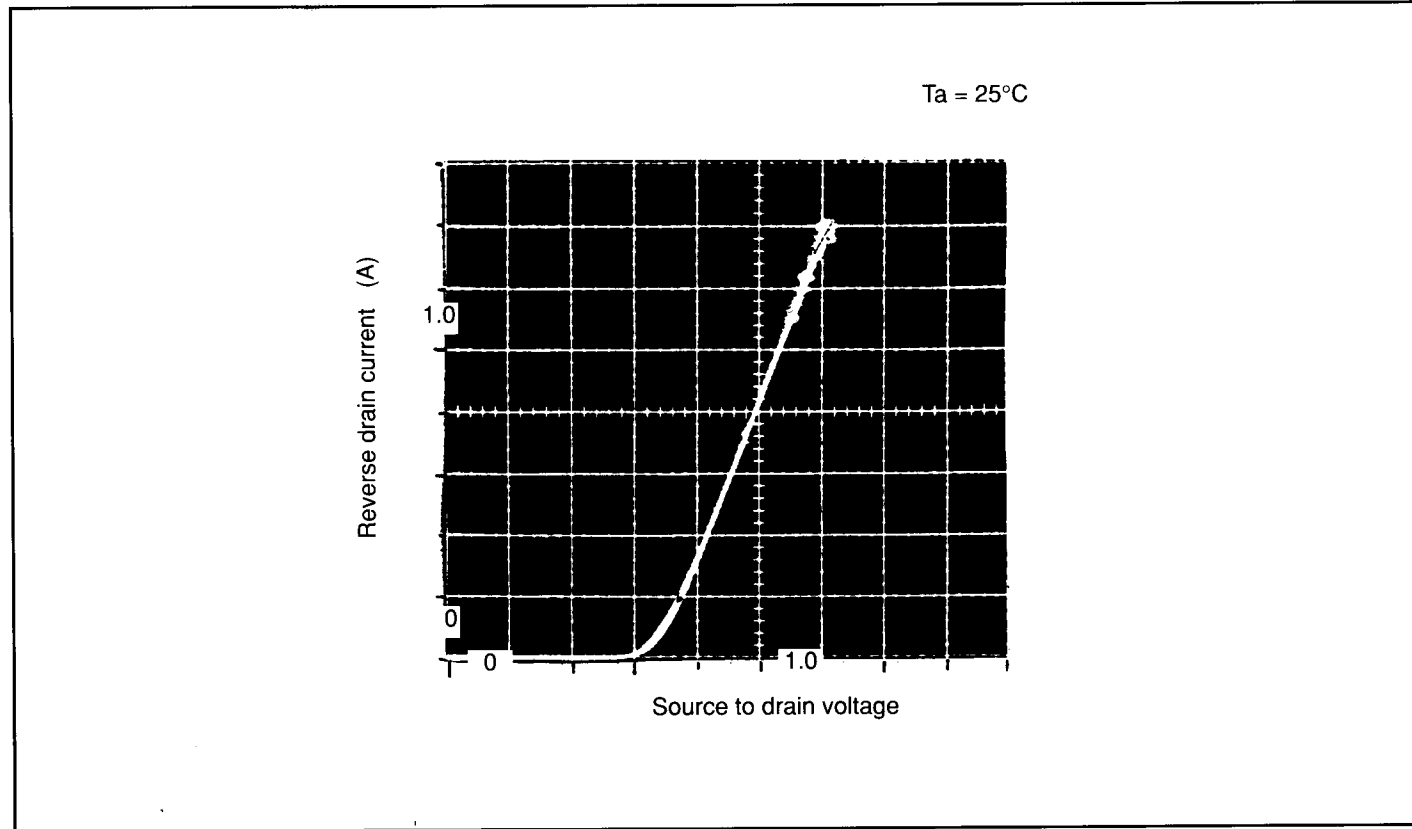
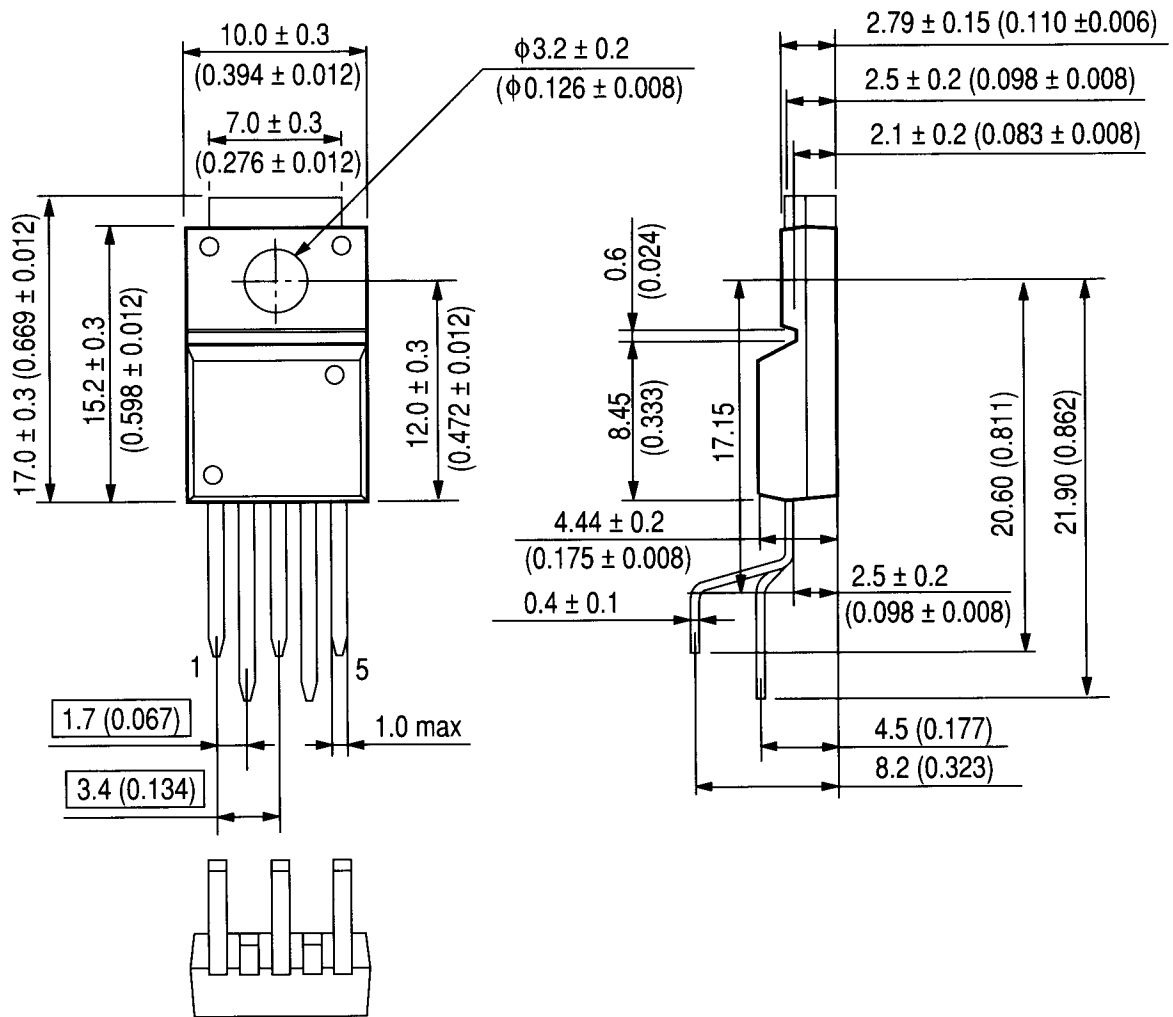


Figure 19 Reverse Drain Current vs. Source to Drain Voltage on Power MOS

Package Dimensions

Unit: mm (inch)

5Pin



Hitachi Code	SP-5TA
EIAJ	—
JEDEC	—

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