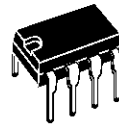


**0.5A HIGH-SIDE DRIVER  
INTELLIGENT POWER SWITCH**

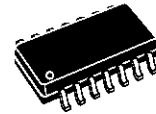
PRODUCT PREVIEW

- 0.5 A OUTPUT CURRENT
- 8 TO 35 V SUPPLY VOLTAGE RANGE
- EXTERNALLY PROGRAMMABLE CURRENT LIMIT
- NON-DISSIPATIVE OVER-CURRENT PROTECTION
- THERMAL SHUTDOWN
- UNDER VOLTAGE LOCKOUT WITH HYSTERESIS
- DIAGNOSTIC OUTPUT FOR UNDER VOLTAGE, OVER TEMPERATURE AND OVER CURRENT
- EXTERNAL ASYNCHRONOUS RESET INPUT
- PRESETTABLE DELAY FOR OVERCURRENT DIAGNOSTIC
- OPEN GROUND PROTECTION
- PROTECTION AGAINST SURGE TRANSIENT (IEC 801-5)
- IMMUNITY AGAINST BURST TRANSIENT (IEC 801-4)
- ESD PROTECTION (HUMAN BODY MODEL ±2KV)

**MULTIPOWER BCD TECHNOLOGY**



**MINIDIP**



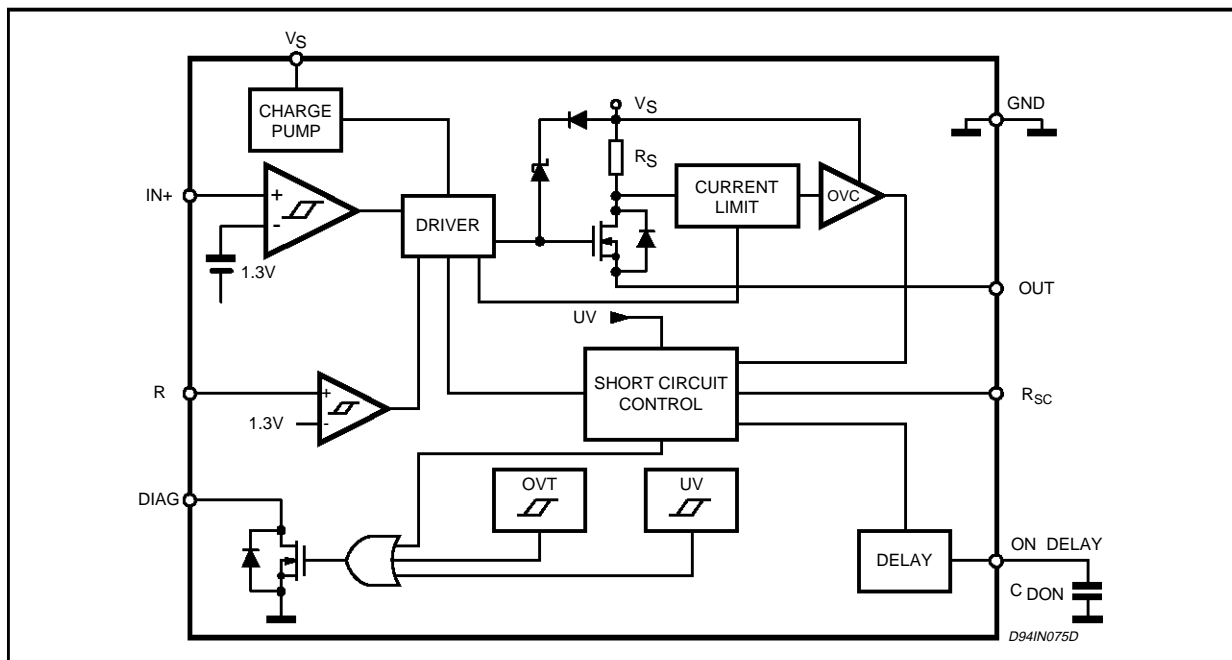
**SO14**

**ORDERING NUMBERS:** L6377 (MINIDIP)  
L6377D (SO)

**DESCRIPTION**

This device is a monolithic Intelligent Power Switch in Multipower BCD Technology for driving inductive, capacitive or resistive loads. Diagnostic for CPU feedback and extensive use of electrical protections make this device inherently indstructible and suitable for general purpose industrial applications.

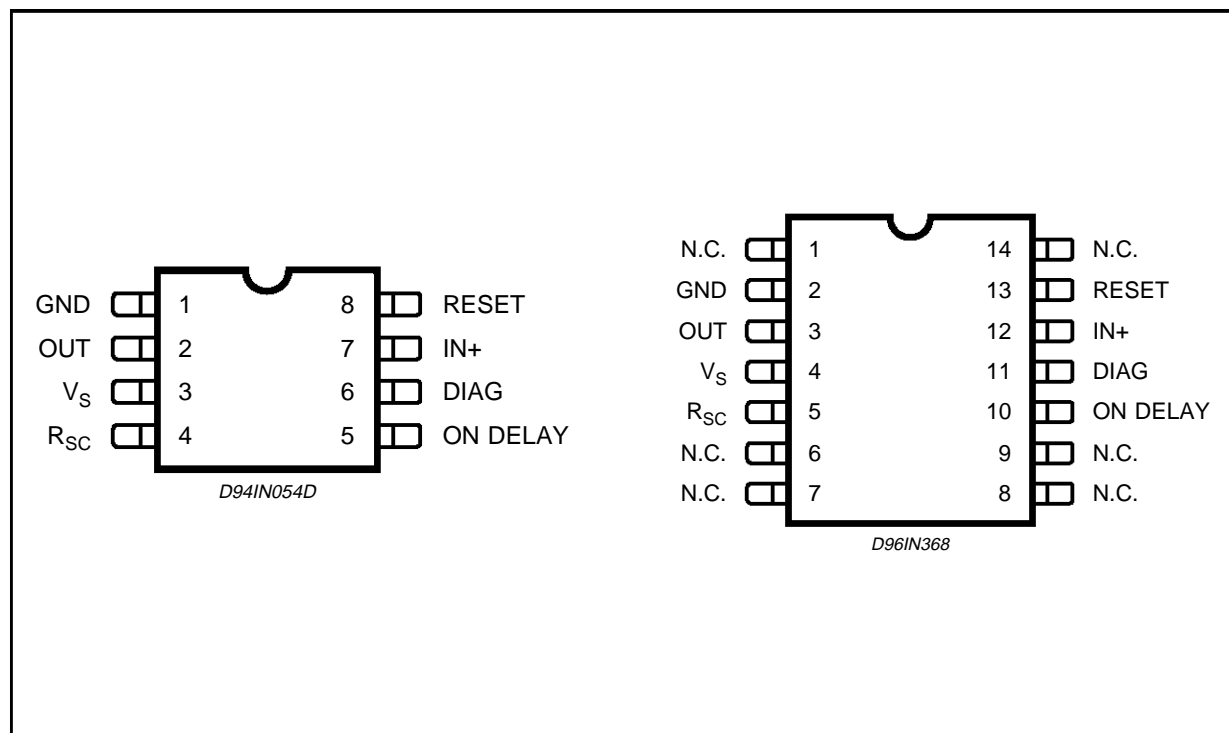
**BLOCK DIAGRAM**



**ABSOLUTE MAXIMUM RATINGS**

Symbol	Pin	Parameter	Value	Unit
V <sub>s</sub>	3	Supply Voltage ( $t_w \leq 10\text{ms}$ )	50	V
		Supply Voltage (DC)	40	V
V <sub>s</sub> - V <sub>out</sub>	3 vs 2	Supply to Output Differential voltage	internally limited	
V <sub>od</sub>	5	Externally Forced Voltage	-0.3 to 7	V
I <sub>od</sub>		Externally Forced Current	±1	mA
I <sub>RESET</sub>	4	Reset Input Current (forced)	±2	mA
V <sub>RESET</sub>		Reset Input Voltage	-0.3 to 40	V
I <sub>out</sub>	2	Output Current (see also I <sub>sc</sub> )	internally limited	
V <sub>out</sub>		Output Voltage	internally limited	
E <sub>il</sub>		Total Energy Inductive Load (T <sub>j</sub> = 125°C)	50	mJ
P <sub>tot</sub>		Power Dissipation	internally limited	
V <sub>diag</sub>	6	External voltage	-0.3 to 40	V
I <sub>diag</sub>		Externally forced current	-10 to 10	mA
I <sub>i</sub>	7	Input Current	20	mA
V <sub>i</sub>		Input Voltage	-10 to V <sub>s</sub> +0.3	V
T <sub>op</sub>		Ambient temperature, operating range	-25 to 85	°C
T <sub>j</sub>		Junction temperature, operating range (see Overtemperature Protection)	-25 to 125	°C
T <sub>stg</sub>		Storage temperature	-55 to 150	°C

**PIN CONNECTION (Top view)**



**PIN DESCRIPTION**

No	Pins	Description
1	GND	Ground pin.
2	OUT	High side output. Controlled output with current limitation.
3	V <sub>S</sub>	Supply voltage. Range with under voltage monitoring
4	Rsc	Current limiting setting.
5	ON DELAY	Delay setting for overcurrent diagnostic
6	DIAG	Diagnostic open drain output for over temperature, under voltage and overcurrent
7	IN+	Comparator non inverting input
8	RESET	Asynchronous reset input

**THERMAL DATA**

Symbol	Parameter	MINIDIP	SO14	Unit
R <sub>th j-amb</sub>	Thermal Resistance, Junction Ambient Max.	100	150	°C/W

**ELECTRICAL CHARACTERISTICS** ( $V_s = 24V$ ;  $T_j = -25$  to  $125^\circ C$ ; unless otherwise specified.)**DC OPERATION**

Symbol	Pin	Parameter	Test Condition	Min.	Typ.	Max.	Unit
$V_{smin}$	3	Supply Voltage for Valid Diagnostic	$I_{diag} = >0.5mA$ ; $V_{diag} = 1.5V$ ;	4		35	V
$V_s$		Operative Supply Voltage		8	24	35	V
$V_{sth}$		Under Voltage Lower Threshold		7		8	V
$V_{shys}$		Under Voltage Hysteresis		300	500	700	mV
$I_q$		Quiescent Current	Output Open		800		$\mu A$
$I_{qo}$		Quiescent Current	Output On		1.6		mA
$V_{ith}$	7	Input Threshold Voltage		0.8	1.3	2	V
$V_{iths}$		Input Threshold Hysteresis		50		400	mV
$V_{il}$		Input Low Level Voltage		-7		0.8	V
$V_{ih}$		Input High Level Voltage	$V_s < 18V$	2		$V_s - 3$	V
			$V_s > 18V$	2		15	V
$I_{ib}$		Input Bias Current	$V_i = -7$ to $15V$	-250		250	$\mu A$
$V_{rth}$	8	Reset Threshold Voltage		0.8	1.3	2	V
$V_{rl}$		Reset Low Level Voltage		0		0.8	V
$V_{rh}$		Reset High Level Voltage		2		40	V
$I_{rb}$		Reset Pull Down Current			5		$\mu A$
$I_{dch}$	5	Delay Capacitor Charging Current	ON DELAY pin shorted to Ground		2.5		$\mu A$
$V_{rsc}$	4	Output Voltage on $R_{sc}$ pin	$R_{sc}$ pin floating		1.25		V
$I_{rsc}$		Output Current on $R_{sc}$ pin	$R_{sc}$ pin shorted to GND			300	$\mu A$
$I_{dlkg}$	6	Diagnostic Output Leakage Curr.	Diagnostic Off			25	$\mu A$
$V_{diag}$		Diagnostic Output Voltage Drop	$I_{diag} = 5mA$ ;			1.5	V
$V_{don}$	2	Output Voltage Drop	$I_{out} = 625mA$ ; $T_j = 25^\circ C$		250	350	mV
			$I_{out} = 625mA$ ; $T_j = 125^\circ C$		400	550	mV
$I_{olk}$		Output Leakage Current	$V_i = LOW$ ; $V_{out} = 0$			100	$\mu A$
$V_{ol}$		Output Low State Voltage	$V_i = HIGH$ ; pin floating		0.8	1.5	V
$V_{cl}$		Internal Voltage Clamp ( $V_s - V_{out}$ )	$I_o = 200mA$ single pulsed $= 300\mu s$	48	53	58	V
$I_{sc}$		Short Circuit Output Current	$V_s = 8$ to $35V$ ; $R_i = 2\Omega$ ; $R_{sc} = 5$ to $30K\Omega$	$5/R_{sc} = K\Omega$			A
			$V_s = 8$ to $35V$ ; $R_i = 2\Omega$ ; $R_{sc} < 5K\Omega$	0.75	1.1	1.5	A
$T_{max}$		Over Temperature Upper Threshold		150		$^\circ C$	
$T_{hys}$		Over Temperature Hysteresis		20		$^\circ C$	

## AC OPERATION

Symbol	Pin	Parameter	Test Condition	Min.	Typ.	Max.	Unit
$t_r$ - $t_f$	2	Rise or Fall Time	$V_s = 24V$ ; $R_i = 70\Omega$ $R_i$ to ground		20		$\mu s$
$t_d$		Delay Time			5		$\mu s$
$dV/dt$		Slew Rate (Rise and Fall Edge)	$V_s = 24V$ ; $R_i = 70\Omega$ $R_i$ to ground	0.7	1	1.5	$V/\mu s$
$t_{ON}$	5	On time during Short Circuit Condition	$50pF < C_{DON} < 2nF$		1.28		$\mu s/pF$
$t_{OFF}$		Off time during Short Circuit Condition			64		$t_{ON}$
$f_{max}$		Maximum Operating Frequency			25		kHz

## SOURCE DRAIN NDMOS DIODE

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
$V_{fSD}$	Forward On Voltage	$I_{fSD} = 625mA$		1	1.5	V
$I_{fp}$	Forward Peak Current	$t_p = 10ms$ ; duty cycle = 20%			1.5	A
$t_{rr}$	Reverse Recovery Time	$I_{fSD} = 500mA$ ; $dI_{fSD}/dt = 25A/\mu s$		200		ns
$t_{fr}$	Forward Recovery Time			50		ns

Figure 1: Undervoltage Comparator Hysteresis

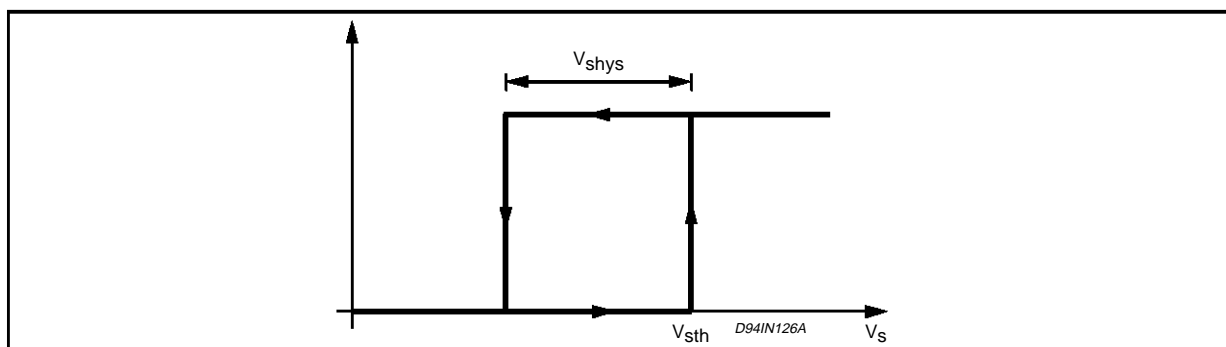
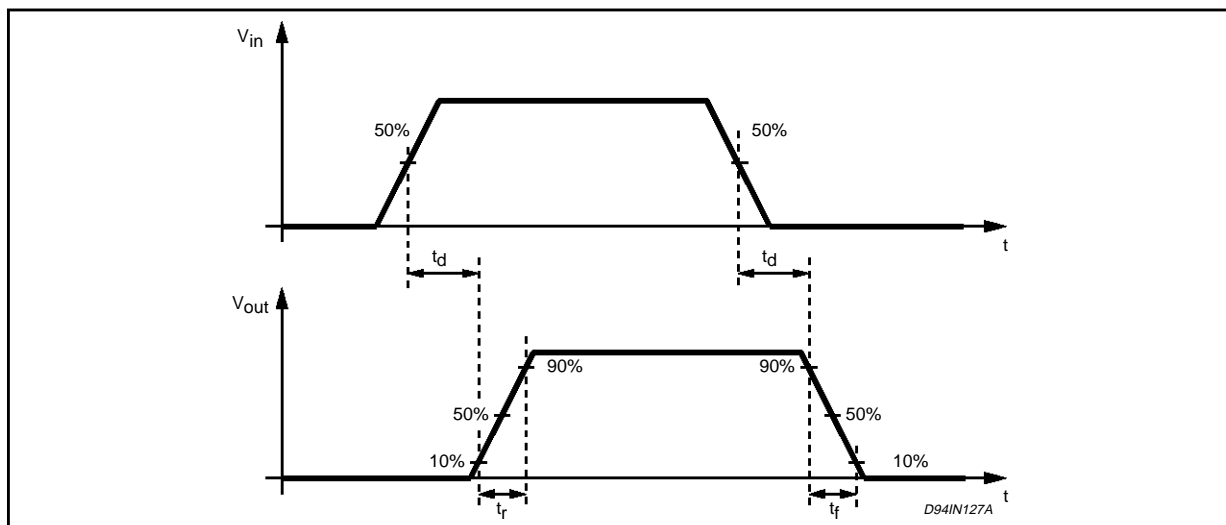


Figure 2: Switching Waveforms



**INPUT SECTION**

An Input and Asynchronous RESET, both TTL/CMOS compatible with wide voltage range and high noise immunity (thanks to a built in hysteresis) are available.

**OVER TEMPERATURE PROTECTION (OVT)**

An on-chip Over Temperature Protection provide an excellent protection of the device in extreme conditions. Whenever the temperature - measured on a central portion of the chip- exceeds  $T_{max}=150\text{ C}$  (typical value) the device is shut off, and the DIAG output goes LOW.

Normal operation is resumed as the chip temperature (normally after few seconds) falls below  $T_{max-Thys}= 130\text{ C}$  (typical value). The hysteresis avoid thats an intermittent behaviour take place.

**UNDER VOLTAGE PROTECTION (UV)**

The supply voltage is expected to range from 8 to 35 V. In this range the device operates correctly. Below 8 V the overall system has to be considered not reliable. To avoid any misfunctioning the supply voltage is continuously monitored to provide an under voltage protection. As  $V_s$  falls below  $V_{sth}-V_{shys}$  (typically 7.5 V, see fig.1) the output power MOS is switched off and DIAG output goes LOW. Normal operation is resumed as soon as  $V_s$  exceeds  $V_{sth}$ . The hysteretic behaviour prevents intermittent operation at low supply voltage.

**OVER CURRENT OPERATION**

In order to implement a short circuit protection the output power MOS is driven in linear mode to limit the output current to the  $I_{sc}$  value. This  $I_{sc}$  limit is externally settable by means of an external 1/4 W resistor connected from  $R_{sc}$  pin and GND. The value of the resistor must be chosen according to the following formula:

$$I_{sc} (A) = 5/R_{sc} (\text{kohm})$$

with

$$5 < R_{sc} < 30 (\text{kohm})$$

For

$$R_{sc} < 5 (\text{kohm})$$

$I_{sc}$  is limited to  $I_{sc}=1.1\text{ A}$  (typical value).

This condition (current limited to the  $I_{sc}$  value) lasts for a  $T_{on}$  time interval, that can be set by means of a capacitor ( $C_{don}$ ) connected to the ON DELAY pin according to the following formula:

$$T_{on} = 1.28 \text{ msec}/\mu\text{F}$$

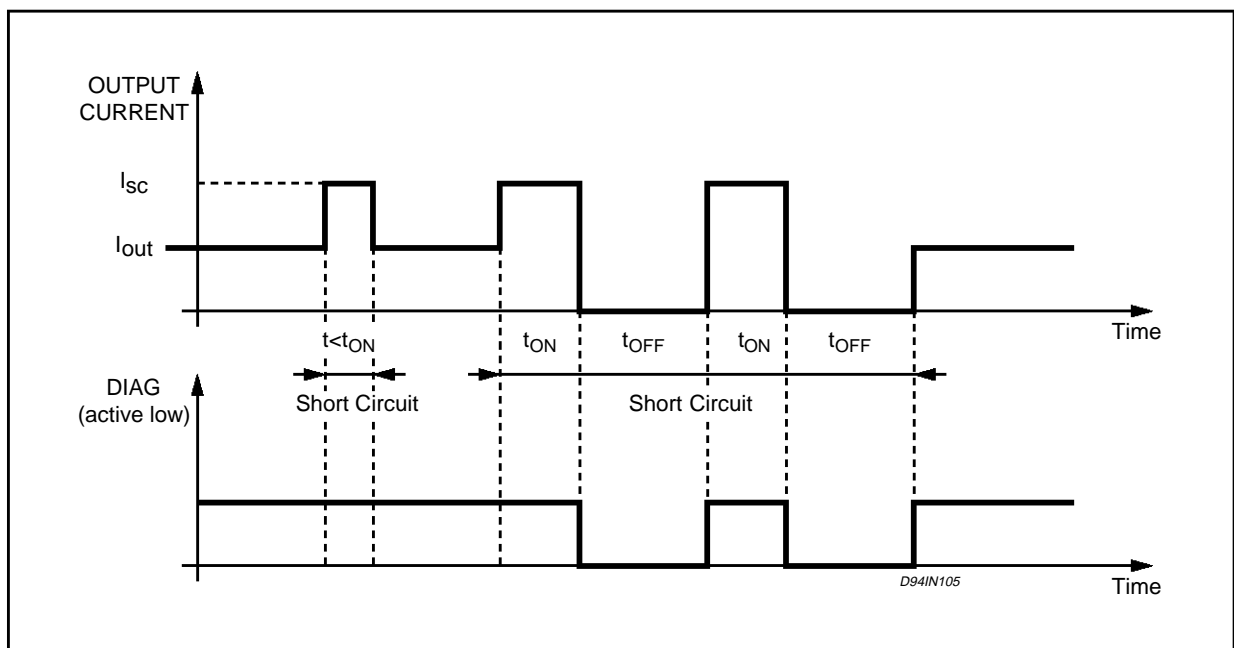
for

$$50\mu\text{F} < C_{don} < 2\text{nF}$$

After the  $T_{on}$  interval has expired the output power MOS is switched off for the  $T_{off}$  time interval with:

$$T_{off} = 64 * T_{on}$$

**Figure 3:** Short Circuit Operation Waveforms



When also the Toff interval has expired, the output power MOS is switched ON.

Now two conditions may occur

- the overload is still present. In this case the output power MOS is again driven in linear mode (limiting the output current to  $I_{sc}$ ) for another  $T_{on}$ , starting a new cycle, or
- the overload condition is removed, and the output power MOS is no longer driven in linear mode.

All these occurrences are presented on the DIAG pin (see fig 2). We call this unique feature **Non Dissipative Short Circuit Protection** and it ensures a very safe operation even in permanent overload conditions. Note that, of course, choosing the most appropriate value for the  $T_{on}$  interval (i.e. the value of the  $C_{don}$  capacitor) a delay (the  $T_{on}$  itself) will prevent that a misleading Short Circuit information is presented on the DIAG output, when driving capacitive loads (that acts like short circuit in the very beginning) or Incandescent Lamp (a cold filament has a very low resistive value).

The Non Dissipative Short Circuit Protection can be disabled (keeping  $T_{on} = 0$  but with the output current still limited to  $I_{sc}$ , and Diagnostic disabled) simply shorting to ground the the ON DELAY pin.

#### DEMAGNETISATION OF INDUCTIVE LOADS

The L6377 has an internal clamping zener diode able to demagnetise inductive loads. Note that the limitation comes from the peak power that the package can handle. Attention must be paid to a

proper thermal design of the board. If, for whatever reason (load current or inductive value too big) the peak power dissipation is too high, an external Zener plus Diode arrangement, can perform a demagnetisation versus Ground or versus  $V_s$  (see fig 5 and 6). The breakdown voltage of the external Zener Diode must be chosen considering the internal clamping voltage ( $V_{cl}$ ) and the supply voltage ( $V_s$ ) according to:

$$V_z < V_{cl}(\min) - V_s(\max)$$

for demagnetisation versus Ground or

$$V_s(\max) < V_z < V_{cl}(\min)$$

for demagnetisation versus  $V_s$ .

**Figure 4:** Input Comparator Hysteresis

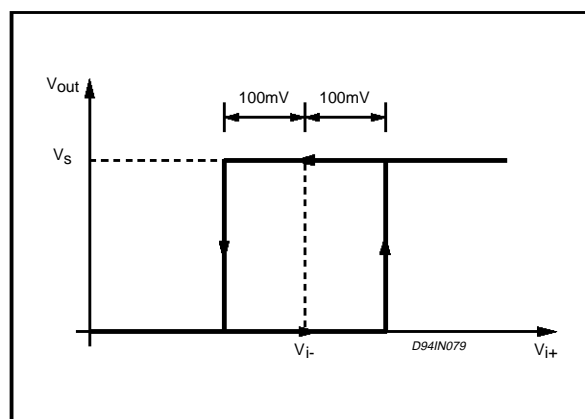


Figure 5: External Demagnetisation Circuit (versus ground)

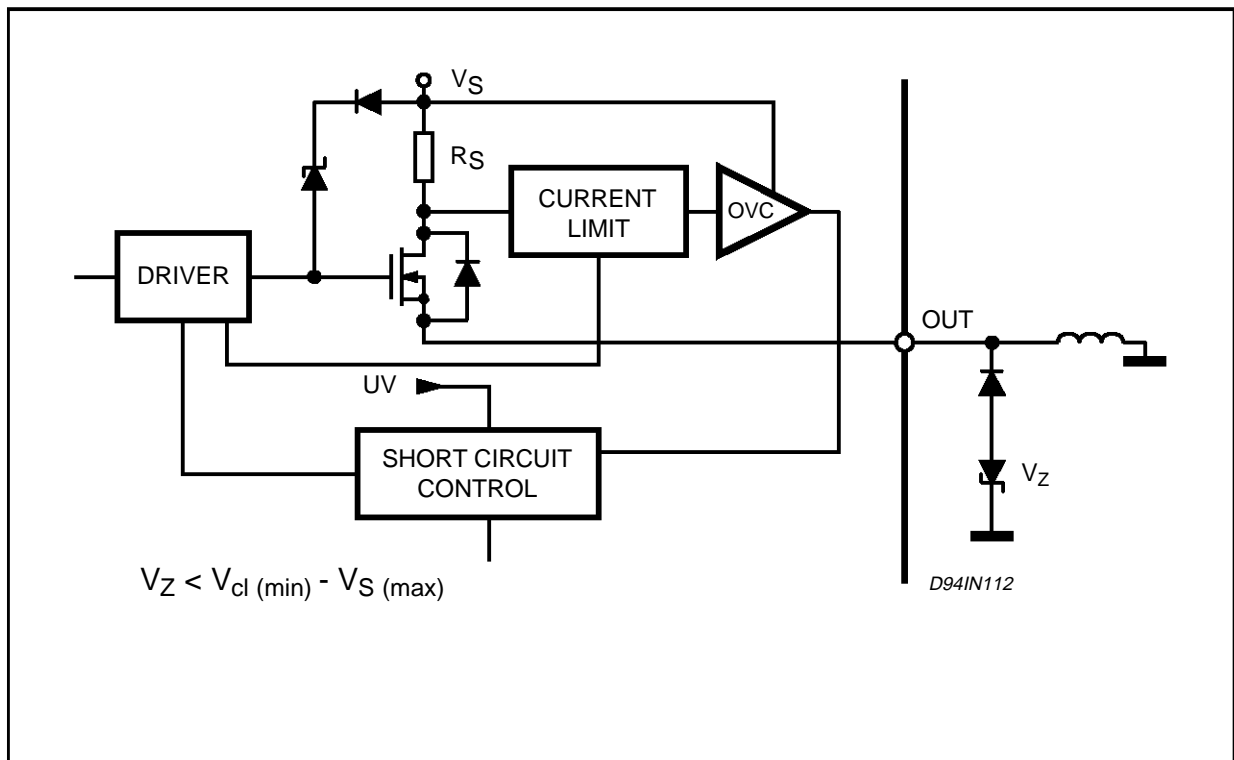
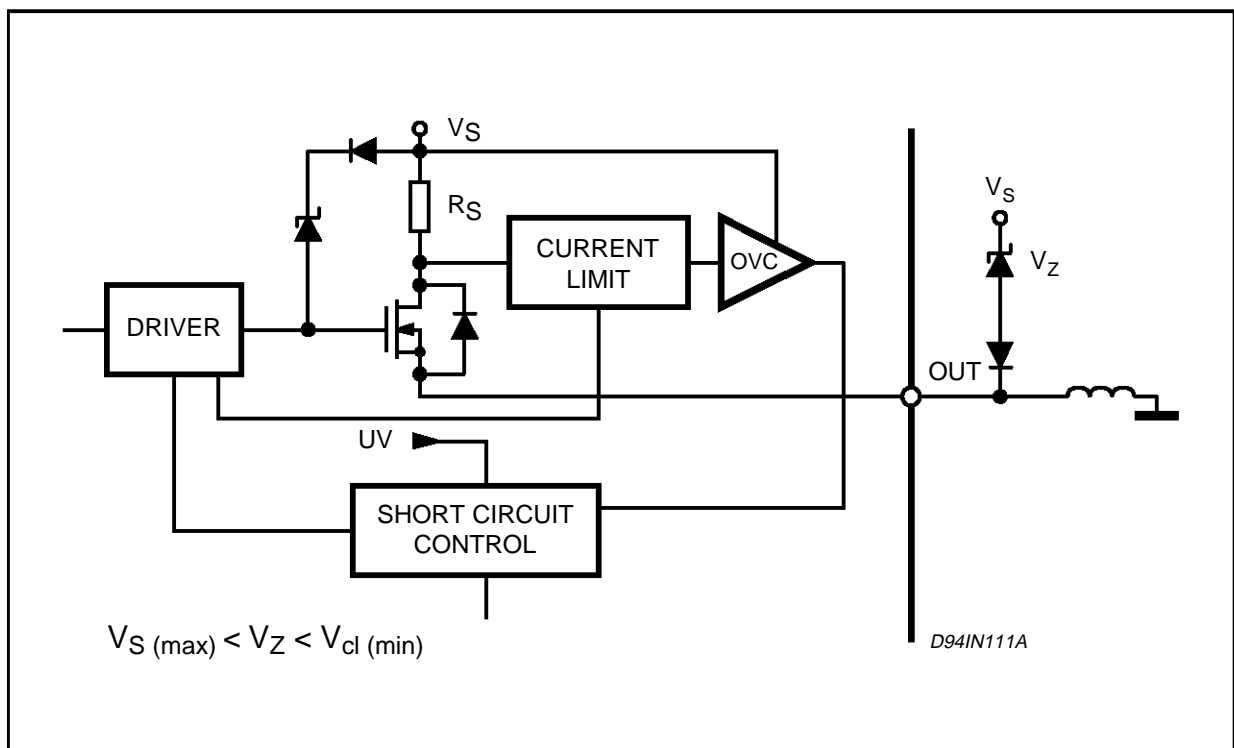


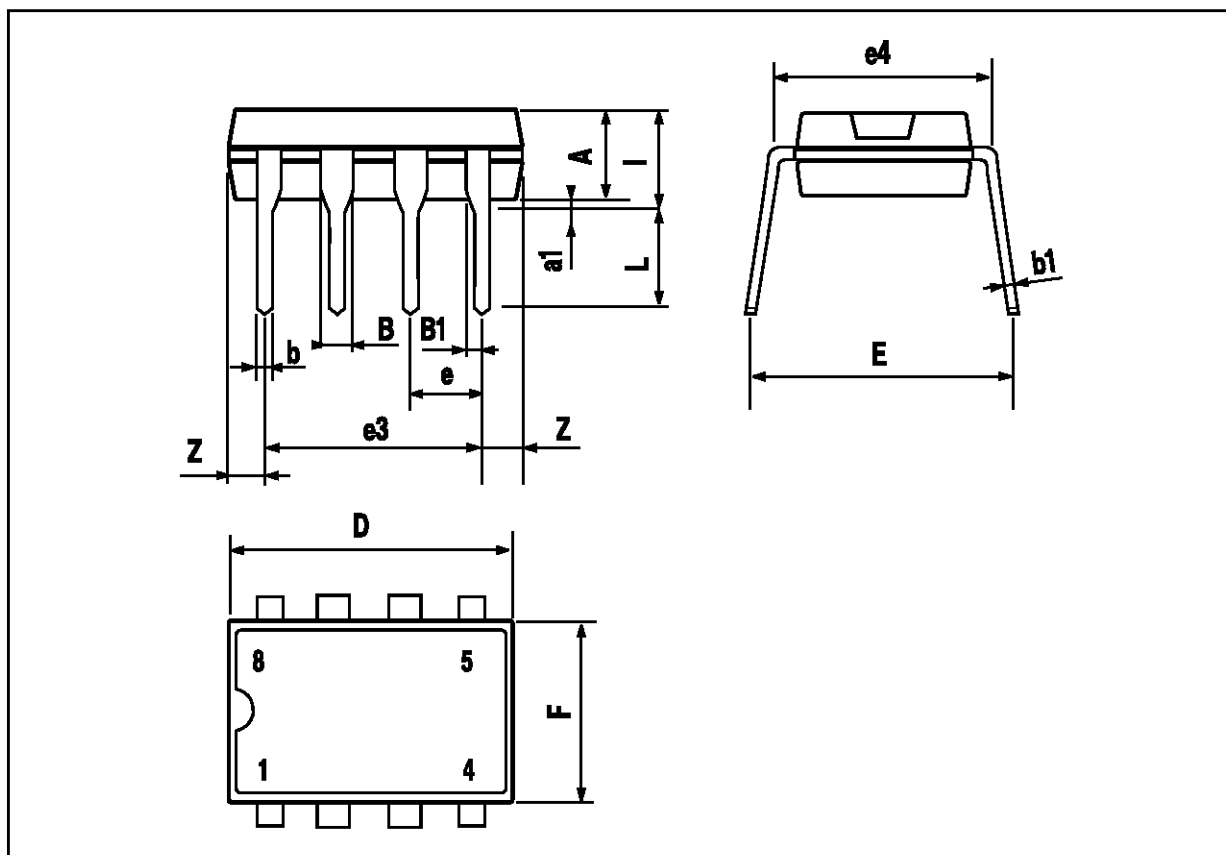
Figure 6: External Demagnetisation Circuit (versus Vs)





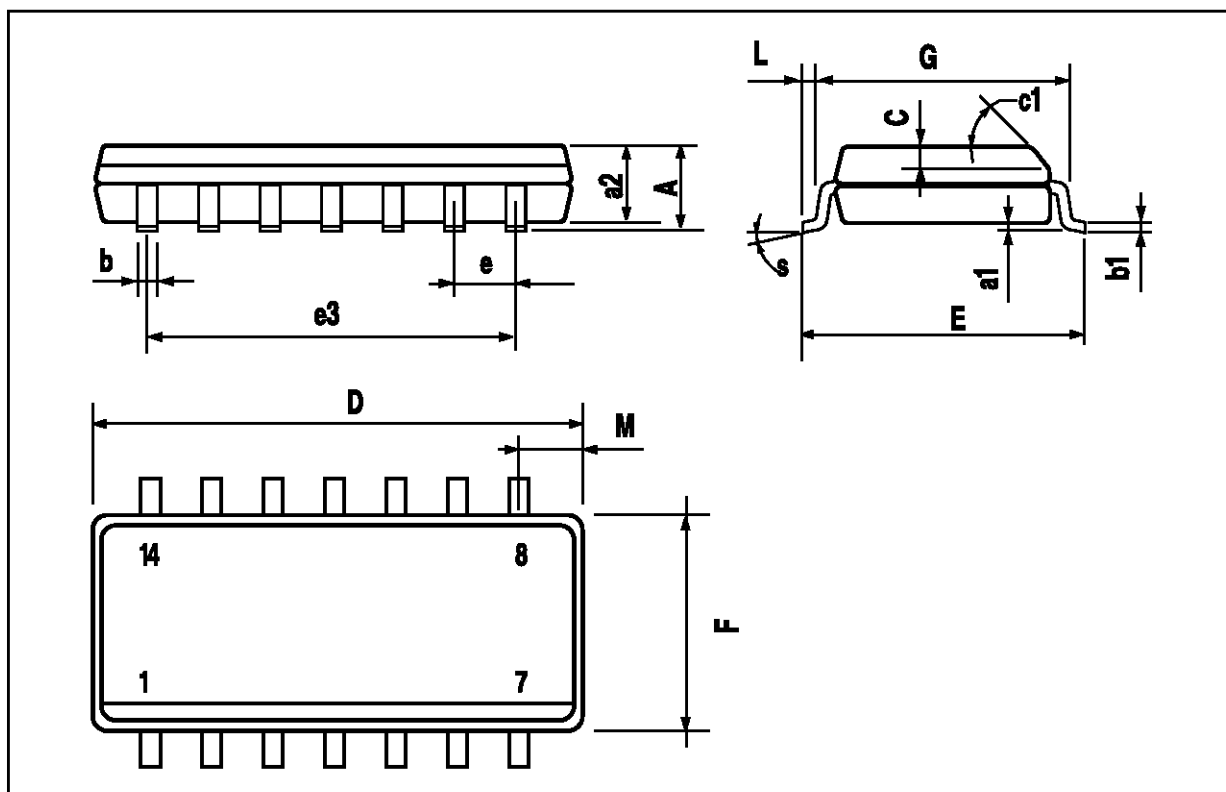
## MINIDIP PACKAGE MECHANICAL DATA

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
l			5.08			0.200
L	3.18		3.81	0.125		0.150
Z			1.52			0.060



**L6377**

016019	MIN	TYP	MAX	MIN	TYP	MAX
A			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
C		0.5			0.020	
c1		45			1.772	
D		1	8.55		0.039	0.337
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		7.62			0.300	
F		1	3.8		0.039	0.150
G	4.6		5.3	0.181		0.209
L	0.5		1.27	0.020		0.050
M			0.68			0.027
S			8			0.315



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