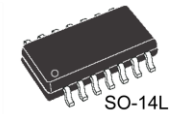
L6377

0.5 A high-side driver quad intelligent power switch

Datasheet - production data



Features

- Multipower BCD technology
- 0.5 A output current
- 8 to 35 V supply voltage range
- External programmable current limit
- Non-dissipative overcurrent protection
- Thermal shutdown
- Undervoltage lockout with hysteresys
- Diagnostic output for undervoltage, overtemperature and overcurrent
- External asynchronous reset input
- Presettable delay for overcurrent diagnostic
- Open ground protection
- Protection against surge transient (IEC 61000-4-5)
- Immunity against burst transient (IEC 61000-4-4)

Description

This device is a monolithic intelligent power switch in multipower BCD technology to drive inductive, capacitive or resistive loads. Diagnostic for CPU feedback and extensive use of electrical protections make this device robust and suitable for general purpose industrial applications.

Table 1: Device summary

Order code	Package	Packing
L6377D	SO-14L	Tube
L6377D013TR		Tape and reel

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1 Pin connections

Figure 1: Pin connections (top view)

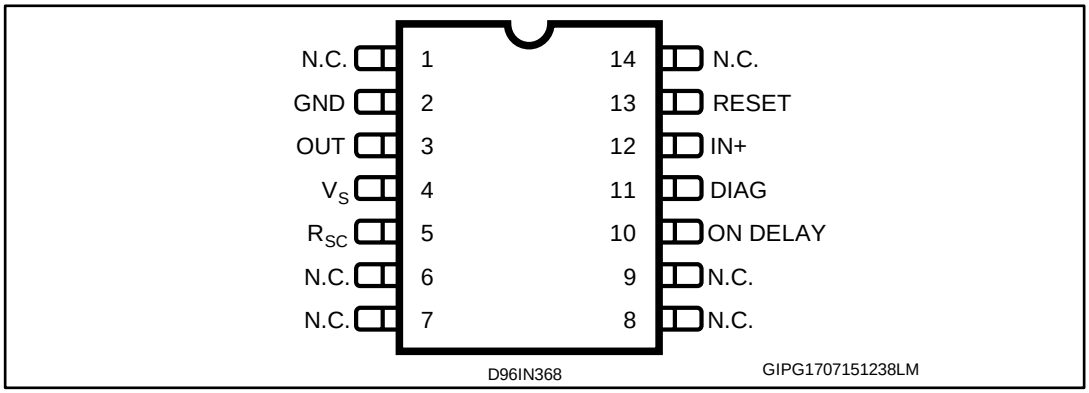


Table 2: Pin description

Pin	Pin name	Function
1, 6, 7, 8, 9, 14	N.C.	Not connected
2	GND	Ground pin
3	OUT	High-side output. Controlled output with current limitation
4	V_S	Supply voltage. Range with undervoltage monitoring
5	R_{SC}	Current limiting setting
10	ON DELAY	Delay setting for overcurrent diagnostic
11	DIAG	Diagnostic open drain output for overtemperature, undervoltage and overcurrent
12	IN+	Comparator non-inverting input
13	RESET	Asynchronous reset input

2 Maximum ratings

Table 3: Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_S	Pin 4: supply voltage (tw ≤ 10 ms)	50	V
	Pin 4: supply voltage (DC)	40	V
V_S- V_{OUT}	Pin 4 vs 3: supply to output differential voltage	Internally limited	V
V_{od}	Pin 10: externally forced voltage	-0.3 to 7	V
I_{od}	Pin 10: externally forced current	± 1	mA
I_{RESET}	Pin 13: reset input current (forced)	± 2	mA
V_{RESET}	Pin 13: reset input voltage	-0.3 to 40	V
I_{out}	Pin 3: output current	Internally limited	
V_{out}	Pin 3: output voltage	Internally limited	W
E_{il}	Total energy inductive load: (T_J = 125 °C	50	mJ
P_{tot}	Power dissipation	Internally limited	
V_{diag}	Pin 11: external voltage	-0.3 to 40	V
I_{diag}	Pin 11: externally forced current	-10 to 10	mA
I_i	Pin 12: input current	20	mA
V_i	Pin 12: input voltage	-10 to V_S+0.3	V
T_{op}	Ambient temperature, operating range	-25 to 85	°C
T_J	Junction tmperature, operating range	-25 to 125	°C
T_{stg}	Storage temperature	-55 to 150	°C

Table 4: Thermal data

Symbol	Parameter	Value	Unit
$R_{th(JA)}$	Thermal resistance junction-ambient	150 max.	°C/W

3 Electrical characteristics

V_S = 24 V; T_J = -25 to 125 °C, unless otherwise specified

Table 5: Electrical characteristics

Symbol	Pin	Parameter	Test conditions	Min.	Typ.	Max.	Unit
DC operation							
V_{smin}	4	Supply voltage for valid diagnostic	I_{diag} ≥ 0.5 mA; V_{diag} = 1.5 V;	4		35	V
V_S		Operative supply voltage		8	24	35	V
V_{sth}		Undervoltage lower treshold		7		8	V
V_{shys}		Undervolatge hysteresis		300	500	700	mV
I_q		Quiescent current	Output pen		800		µA
I_{qo}			Output on		1.6		mA
V_{ith}	12	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 < 18 V	2		V_S-3	V
			V_S >18 V	2		15	
I_{ib}		Input bias current	V_i = -7 to 15 V	-250		250	µA
V_{rth}	13	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		µA
I_{dch}	10	Delay capacitor charging current	ON delay pin shorted-to-ground		2.5		µA
V_{rsc}	5	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	µA
I_{dlkg}	11	Diagnostic output leakage current	Diagnostic off			25	µA
V_{diag}		Diagnostic output voltage drop	I_{diag} = 5 mA			1.5	V
V_{don}	3	Output voltage drop	I_{out} = 625 mA T_J = 25 °C		250	350	mV
			I_{out} = 625 mA T_J = 125 °C		400	500	
I_{olk}		Output leakage current	V_i= low; V_{out} = 0			100	µA
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 = 200 mA single pulsed = 300 ms	48	53	58	V

Symbol	Pin	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SC}		Short-circuit output current	V_s = 8 to 35 V; R_l = 2 Ω; R_{sc} = 5 to 30 kΩ	$5/R_{SC}$ = kΩ			A
$T_{max.}$		Overtemperature upper threshold			150		°C
T_{hys}		Overtemperature hysteresis			20		°C
AC operation							
t_r- t_f	3	Rise or fall time	V_s = 24 V; R_l = 70 Ω R_l to ground		20		µs
t_d		Delay time			5		
dV/dt		Slew rate (rise and fall edge)	V_s = 24 V; R_l = 70 Ω R_l to ground	0.7	1	1.5	V/µs
t_{ON}	10	On-time during short-circuit condition	50 pF < C_{DON} < 2 nF		1.28		µs/pF
t_{OFF}		Off-time during short-circuit condition			64		t_{ON}
$f_{max.}$		Maximum operating frequency			25		kHz
Source drain NDMOS diode							
V_{fsd}		Forward on voltage	I_{fsd} = 625 mA		1	1.5	V
I_{fp}		Forward peak current	t_p = 10 ms; duty cycle = 20%			1.5	A
t_{rr}		Reverse recovery time	I_{fsd} = 500 mA; dI_{fsd}/dt = 25 A/µs		200		ns
t_{fr}		Forward recovery time			50		ns

3.1 Schematic diagram

Figure 2: Block diagram

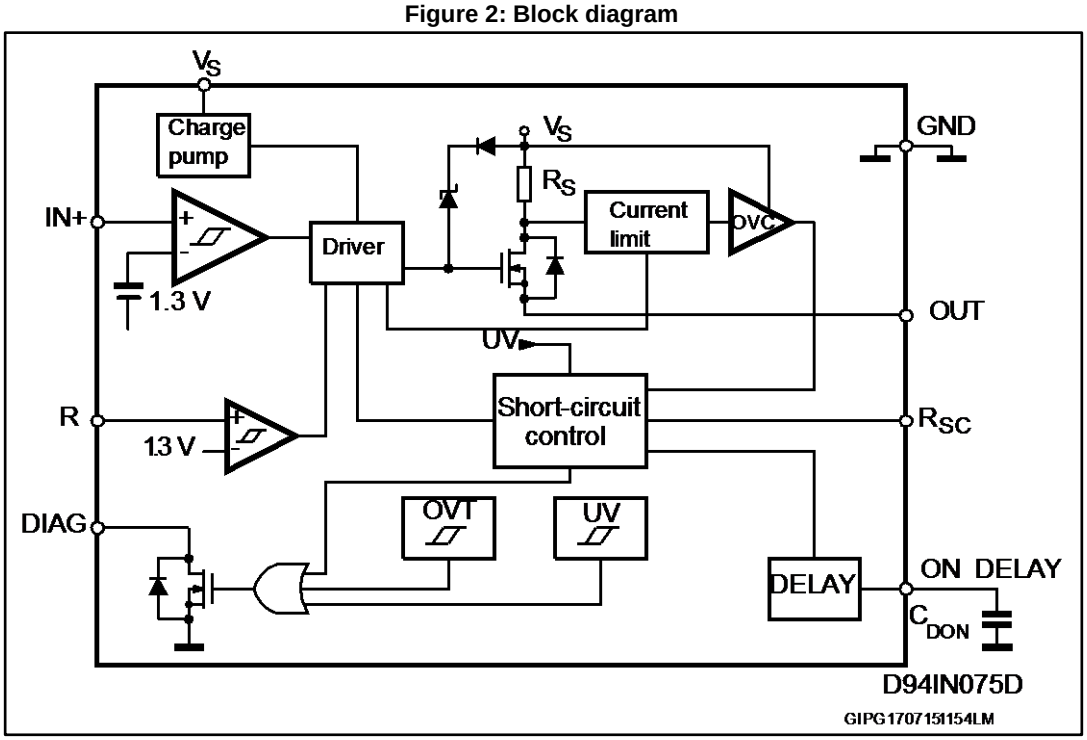


Figure 3: Undervoltage comparator hysteresis

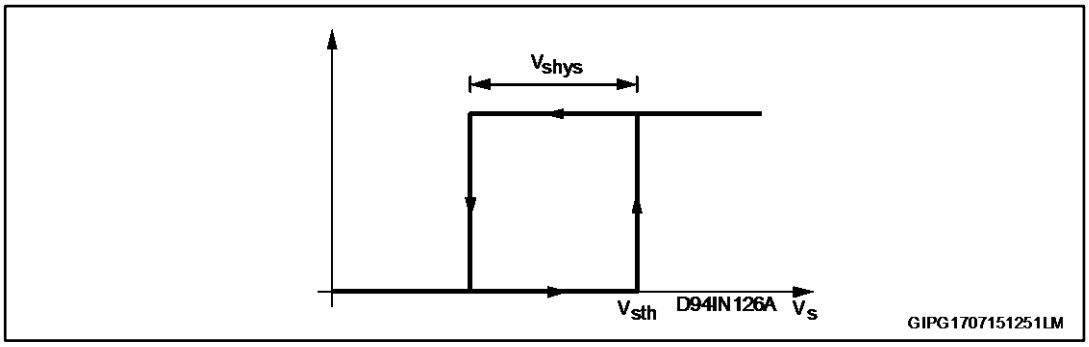
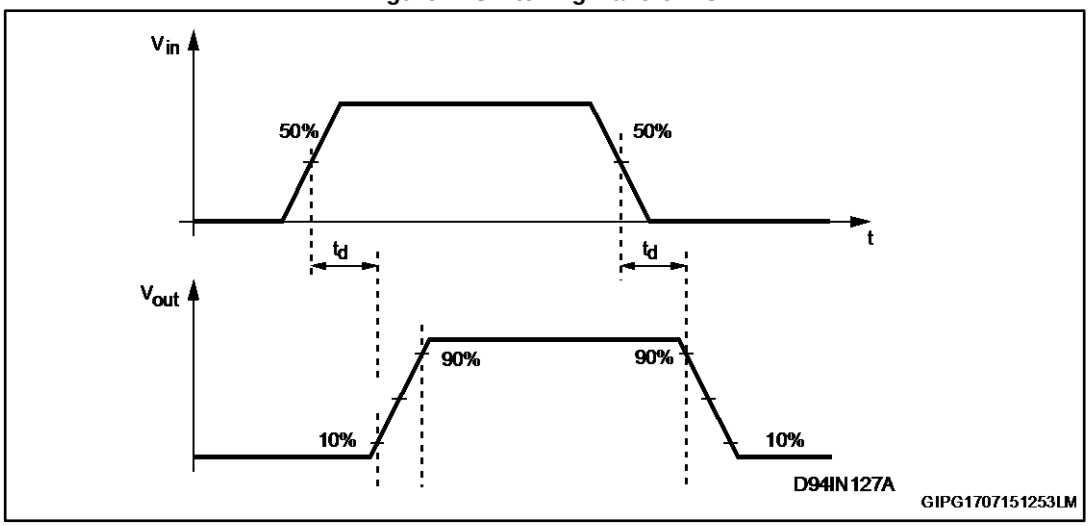


Figure 4: Switching waveforms



3.2 Input section

An input and asynchronous reset, TTL/CMOS compatible with wide voltage range and high noise immunity (thanks to a built-in hysteresis) is available.

3.3 Overtemperature protection

An on-chip overtemperature protection provides an excellent protection of the device in extreme conditions. Whenever the temperature, measured on a central portion of the chip, exceeds $T_{max.}$ = 150 °C (typical value) the device shuts down, and the DIAG output goes low. Normal operation is resumed as the chip temperature (normally after few seconds) falls below $T_{max.}$-T_{hys} = 130 °C (typical value). The hysteresis avoids that an intermittent behavior occurs.

3.4 Undervoltage protection

The supply voltage operates correctly in a range from 8 to 35 V. 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 undervoltage protection. As V_s falls below V_{sth}-V_{shys} (typically 7.5 V, see *Figure 4: "Switching waveforms"*) the output power MOSFET switches 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.

4 Overcurrent operation

In order to implement a short-circuit protection, the output power MOSFET is driven to linear mode to limit the output current to the I_{SC} value. This I_{SC} limit is externally set by 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:

Equation 1:

I_{sc} (A) = 5/R_{SC} (kohm) with 5 < R_{SC} < 30 (kohm).

Concerning R_{SC} < 5 (kohm) I_{SC} is limited to I_{SC} = 1.1 A (typical value).

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

Equation 2:

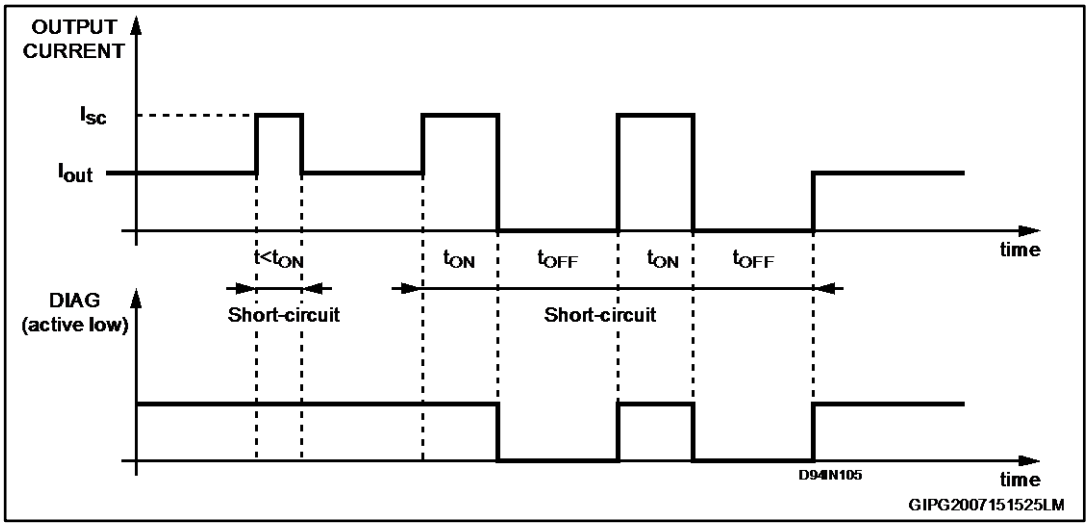
t_{ON} = 1.28 µsec/pF for 50 pF < C_{DON} < 2 nF

After the t_{ON} interval has expired the output power MOSFET switches off for the t_{OFF} time interval:

Equation 3:

t_{OFF} = 64· t_{ON}.

Figure 5: Short-circuit operation waveforms



When the t_{OFF} interval has expired, the output power MOSFET switches on. In this manner two conditions may occur:

- the overload is still present. In this case, the output power MOSFET is again driven to linear mode (limiting the output current to I_{SC}) for another t_{ON}, starting a new cycle
- the overload condition is removed, and the output power MOSFET is no longer driven to linear mode

Please, see the DIAG pin (see *Figure 5: "Short-circuit operation waveforms"*). This unique feature is called short-circuit protection and it ensures a very safe operation even in permanent overload conditions. Note that, the choice of the most appropriate value for the t_{ON} interval (the value of the C_{DON} capacitor), a delay (the t_{ON} itself) prevents a misleading short-circuit information is presented on the DIAG output, when capacitive loads are driven

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 ON DELAY pin.

5 Demagnetization of inductive loads

The L6377 has an internal clamping Zener diode, which demagnetises 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 load current or inductive value are too big, the peak power dissipation is too high, an external Zener plus diode can perform a demagnetisation versus ground or versus V_s (see *Figure 5: "Short-circuit operation waveforms"* and *Figure 6: "Input comparator hysteresis"*). 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:

Equation 4:

$V_z < V_{cl(min.)}-V_{s(max.)}$

for demagnetisation versus ground or

Equation 5:

$V_{s(max.)} < V_z < V_{cl(min.)}$

for demagnetisation versus V_s.

Figure 6: Input comparator hysteresis

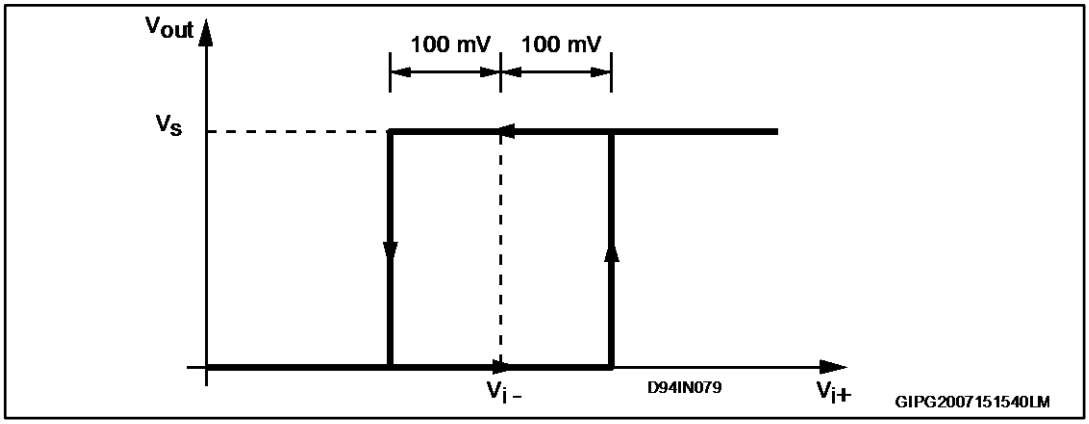


Figure 7: External demagnetisation circuit (versus ground)

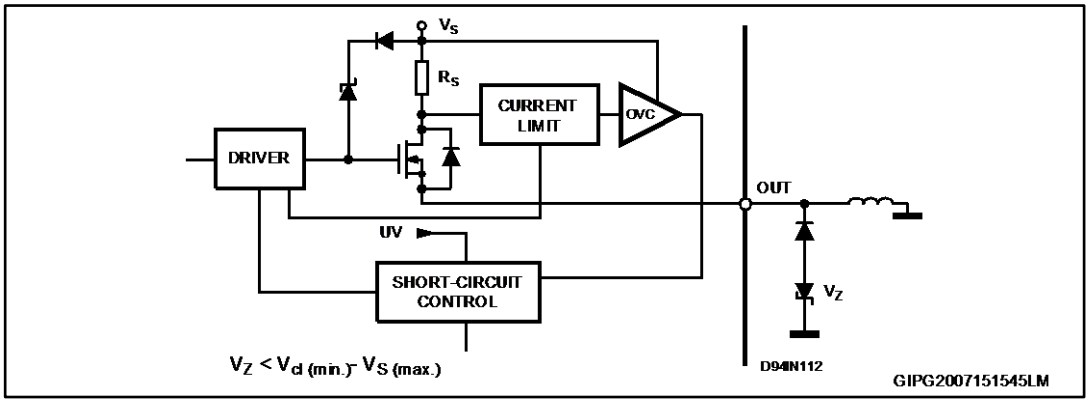
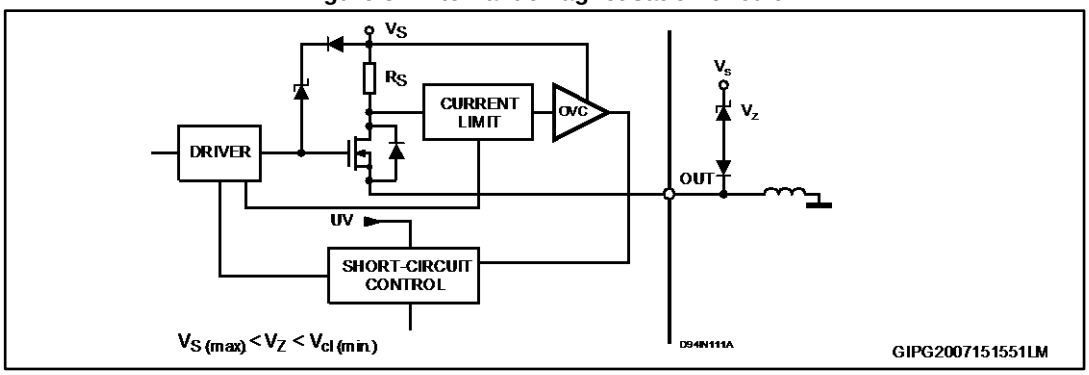


Figure 8: External demagnetisation circuit



6 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: ***www.st.com***. ECOPACK® is an ST trademark.

6.1 SO-14L package information

Figure 9: SO-14L package outline

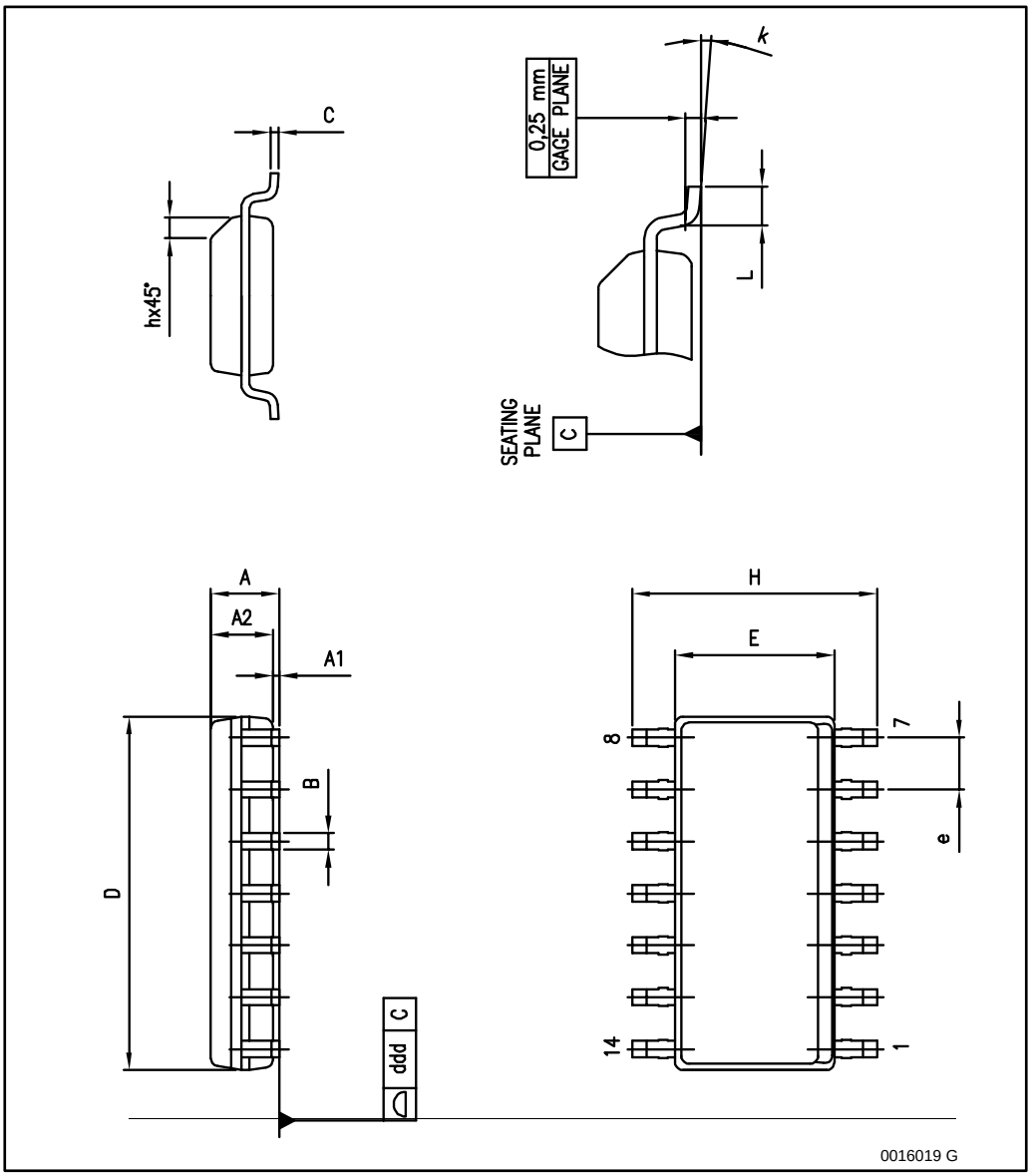


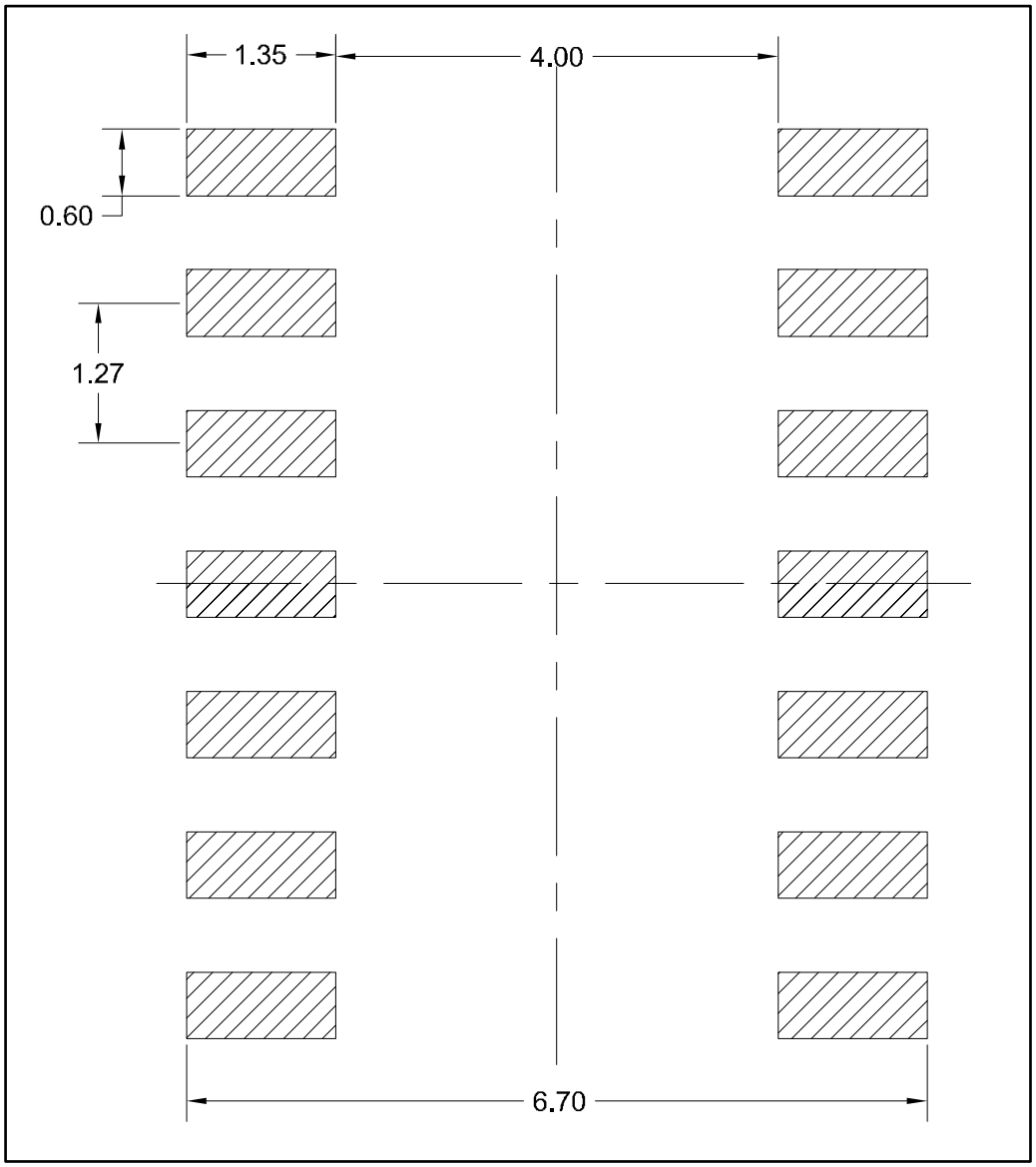
Table 6: SO-14L package mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	1.35		1.75
A1	0.10		0.25
A2	1.10	3.30	1.65
B	0.19		0.25
C	1.14	1.52	1.78
D	8.55		8.75
E	3.80		4.00
e		1.27	
H	5.80		6.20
h	0.25		0.50
L	0.40		1.27
k	0		8
ddd			0.10

Dimension D doesn't include mold flash, protrusions or gate burrs, which do not exceed 0.15 mm per side.

Drawing dimensions include single and matrix versions.

Figure 10: SO-14L recommended footprint outline



7 Revision history

Table 7: Document revision history

Date	Revision	Changes
17-Aug-2001	1	Initial release.
19-Apr-2005	2	Changed style sheet
22-Jun-2007	3	Changed style sheet
25-Feb-2008	4	Removed obsolete package DIP-14
24-Jul-2015	5	Updated I_{RESET} and V_{RESET} parameter in the table of maximum ratings.

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