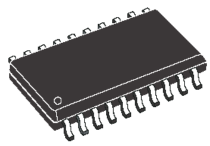
L6375D

0.5 A high side driver intelligent power switch

Features

- 0.5 A output current
- 8 V to 35 V supply voltage range
- Internal current limiting
- Thermal shutdown
- Open ground protection
- Internal negative voltage clamping for fast demagnetization
- Differential inputs with large common mode range and threshold hysteresis
- Undervoltage lockout with hysteresis
- Open load detection
- Two diagnostic outputs
- Output status LED driver
- Non-dissipative short-circuit protection
- Immunity against burst transient (IEC 61000-4-4)
- ESD protection (human body model ±2 kV)



SO20

Description

The L6375D is a monolithic intelligent power switch in BCDmultipower technology, for driving inductive or resistive loads with controlled output voltage slew rate and short-circuit protection.

An internal clamping diode enables the fast demagnetization of inductive loads. Diagnostics for CPU feedback and extensive use of electrical protection make this device extremely rugged and specially suitable for industrial automation applications.

Table 1. Device summary

Order codes	Op. temp. range	Package	Packaging
L6375D	-25 to +125 °C	SO20	Tube
L6375DTR			Tape and reel

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1 Block diagram and pin description

Figure 1. Block diagram

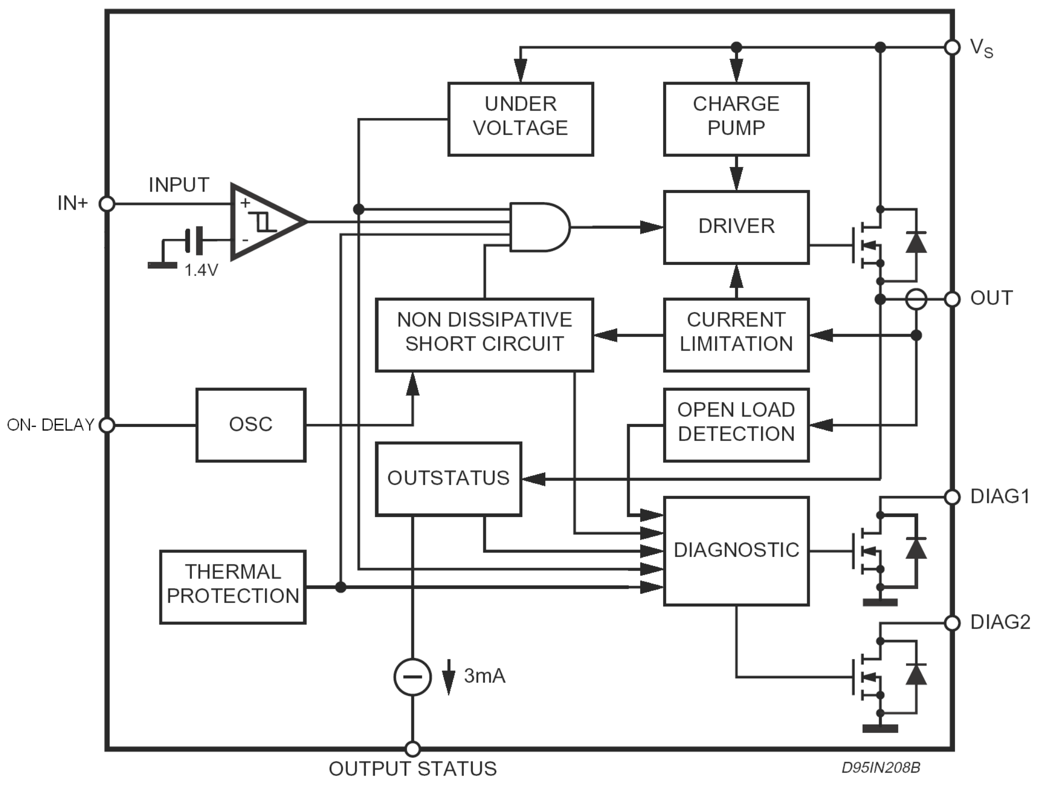
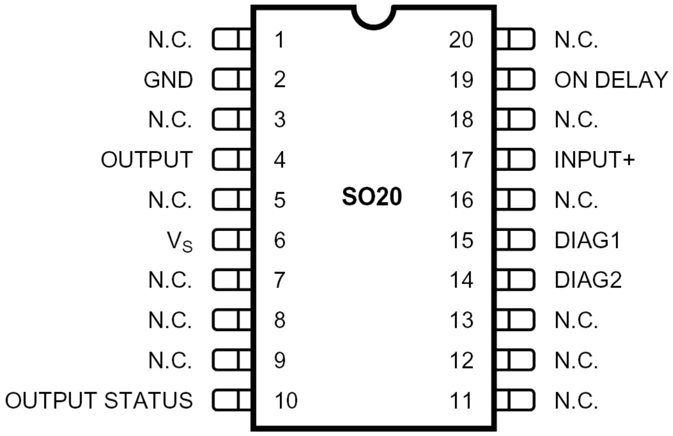


Figure 2. Pin connection (top view)



1.1 Pin description

Table 2. Pin description

Pin n°	Pin name	Function
2	GND	Ground
4	OUT	High side output with built-in current limitation
6	V_S	Supply voltage input; the value of the supply voltage is monitored to detect undervoltage condition
10	Output status	This current source output is capable of driving an LED to signal the status of the output pin. The pin is active (source current) when the output pin is considered high (see *Figure 4*)
15	DIAG1	DIAGNOSTIC 1 output. This open drain reports the IC working conditions (see *Table 6: Diagnostic truth table*)
14	DIAG2	DIAGNOSTIC 2 output. This open drain reports the IC working conditions (see *Table 6: Diagnostic truth table*)
17	IN+	Comparator inverting input
19	ON-DELAY	Programmable ON time interval duration during short-circuit operation
1, 3, 5, 7, 8, 9, 11, 12, 13, 16, 18, 20	N.C.	Not connected

2 Electrical specifications

2.1 Absolute maximum ratings

Table 3. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_S	Supply voltage (tw < 10 ms)	50	V
V_S	Supply voltage (DC)	40	V
V_S -V_{out}	Supply to output differential voltage	Internally limited	V
Vod	Externally forced voltage	-0.3 to 7	V
Iod	Externally forced current	±1	mA
Iout	Output current (see also I_{sc})	Internally limited	A
V_{out}	Output voltage	Internally limited	V
P_{TOT}	Power dissipation	Internally limited	W
V_{diag}	External voltage	-0.3 to 40	V
I_{diag}	Externally forced current	-10 to 10	mA
Ii	Input current	20	mA
Vi	Input voltage	-10 to V_S +0.3	V
Top	Ambient temperature, operating range	-25 to 85	°C
T_J	Junction temperature, operating range (see *Section 2.6*)	-25 to 125	°C
TSTG	Storage temperature	-55 to 150	°C
E_I	Energy inductive load T_J = 85 °C	200	mJ

2.2 Thermal data

Table 4. Thermal data

Symbol	Parameter	Value	Unit
R_{thJA}	Thermal resistance junction-ambient max. (1)	65	°C/W
R_{thJP}	Thermal resistance junction-pins max.	15	°C/W

1. When mounted on an FR4 printed circuit board with 0.5 cm2 of Cu (at least 35 mm thick).

2.3 Electrical characteristics

V_S = 24 V; T_J = –25 to +125 °C, unless otherwise specified.

Table 5. Electrical characteristics

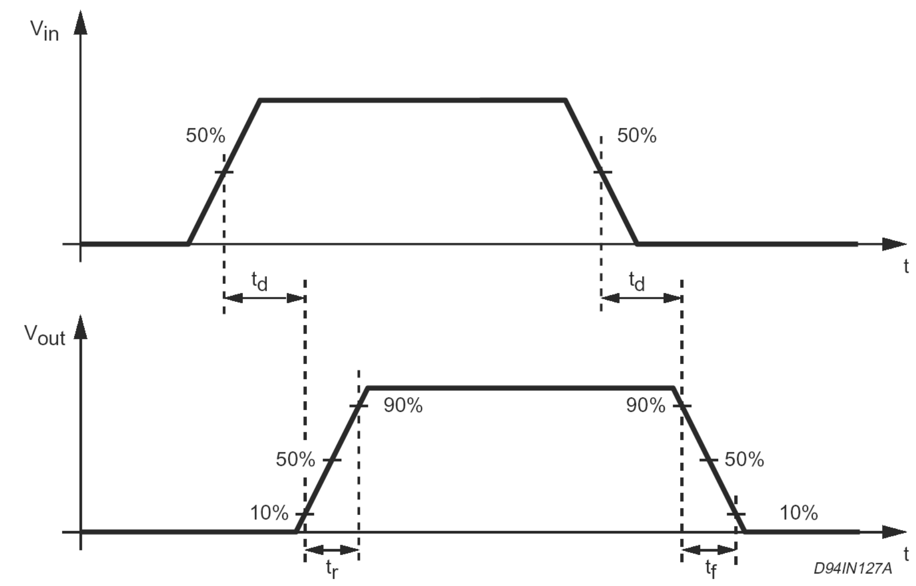
Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
V_{smin}	Supply voltage for valid diagnostic	I_{diag} = > 0.5 mA; V_{diag} = 1.5 V;	4		35	V
V_S	Operative supply voltage		8	24	35	V
V_{sth1}	Undervoltage threshold 1		7	7.5	8	V
V_{sth2}	Undervoltage threshold 2		6.5	7	7.5	V
V_{shys}	Undervoltage hysteresis		300	500	700	mV
I_q	Quiescent current	Output open		800		µA
I_{qo}	Quiescent current	Output ON		1.6		mA
V_{ith}	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_{ih}	Input high level voltage	V_S > 18 V	2		15	V
I_{ib}	Input bias current	V_i = -7 to 15 V	-250		250	µA
I_{dch}	Delay capacitor charging current	ON DELAY pin shorted to ground		2.5		µA
V_{don}	Output voltage drop	Iout = 500 mA T_J = 25 °C T_J = 125 °C Iout =625 mA T_J = 25 °C T_J= 125 °C		200 320 250 400	280 440 350 550	mV mV mV mV
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
I_{sc}	Short-circuit output current	V_S = 8 to 35 V; R_l = 2 Ω;	0.75	1.1	1.5	A
I_{old}	Open load detection current	V_i = V_{ih}; T_A= 0 to +85 °C	1	3	6	mA
V_{oth1}	Output status threshold 1 voltage		4.5	5	5.5	V
V_{oth2}	Output status threshold 2 voltage		4	4.5	5	V
V_{ohys}	Output status threshold hysteresis		300	500	700	mV
I_{osd}	Output status source current	V_{out} > Voth1; Vos = 2.5 V	2		4	mA

Table 5. Electrical characteristics (continued)

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
V_{osd}	Active output status driver drop voltage	$V_S - V_{OS}$; I_{OS} = 2 mA T_A = 0 to +85 °C		1.5	3	V
I_{oslk}	Output status driver leakage current	$V_{out} < V_{oth2}$; V_{os} = 0 V V_S = 18 to 35 V			25	mA
V_{dgl}	Diagnostic drop voltage	D1 / D2 = L; I_{diag} = 0.5 mA D1 / D2 = L; I_{diag} = 3 mA		40 250		mV mV
I_{dglk}	Diagnostic leakage current	D1 / D2 = H; $0 < V_{dg} < V_S$ V_S = 15.6 to 35 V			5	µA
T_{max}	Overtemperature upper threshold			150		°C
T_{hys}	Overtemperature hysteresis			20		°C
AC operation (pin numbering referred to Minidip package)						
t_r -t_r	Rise or fall time	V_S = 24 V; R_l =70 Ω R_l to ground		20		µs
t_d	Delay time	V_S = 24 V; R_l =70 Ω R_l to ground		5		µs
dV/dt	Slew-rate (rise and fall edge)		0.7	1	1.5	V/µs
t_{ON}	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_f	Forward ON voltage	@ Ifsd = 625 mA		1	1.5	V
I_{fD}	Forward peak voltage	t = 10 ms; d = 20%			2	A
t_{rr}	Reverse recovery time	If= 625 mA di/dt = 25 A/ms		200		ns
t_{fr}	Forward recovery time			50		ns

2.4 Switching waveform

Figure 3. Switching waveform



2.5 Input section

A single ended input TTL/CMOS compatible with a wide voltage range and high noise immunity (thanks to a built-in hysteresis) is available.

2.6 Overtemperature protection (OVT)

An on-chip overtemperature protection provides 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 is shut off, and the DIAG2 output goes LOW. Normal operation is resumed as the chip temperature (normally after a few seconds) falls below T_{max} - T_{hys} = 130 °C (typical value). The hysteresis avoids that an intermittent behavior takes place.

2.7 Undervoltage protection (UV)

The supply voltage is expected to range from 8 to 35 V. In this range the device operates correctly. To avoid any malfunctioning 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 1*) the output Power MOSFET is switched off and DIAG1 and DIAG2 (see *Section 2.11*). Normal operation is resumed as soon as V_S exceeds V_{sth}. The hysteretic behavior prevents intermittent operation at low supply voltage.

2.8 Overcurrent operation

In order to implement a short-circuit protection the output Power MOSFET is driven in linear mode to limit the output current to the 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 means of a capacitor (C_{don}) connected to the ON DELAY pin according to the following formula:

T_{on} = 1.28 μsec/ pF

for

50 pF< C_{don} < 2 nF

After the T_{on} interval has expired the output Power MOSFET is switched off for the T_{off} time interval with:

$T_{off} = 64 \cdot T_{on}$.

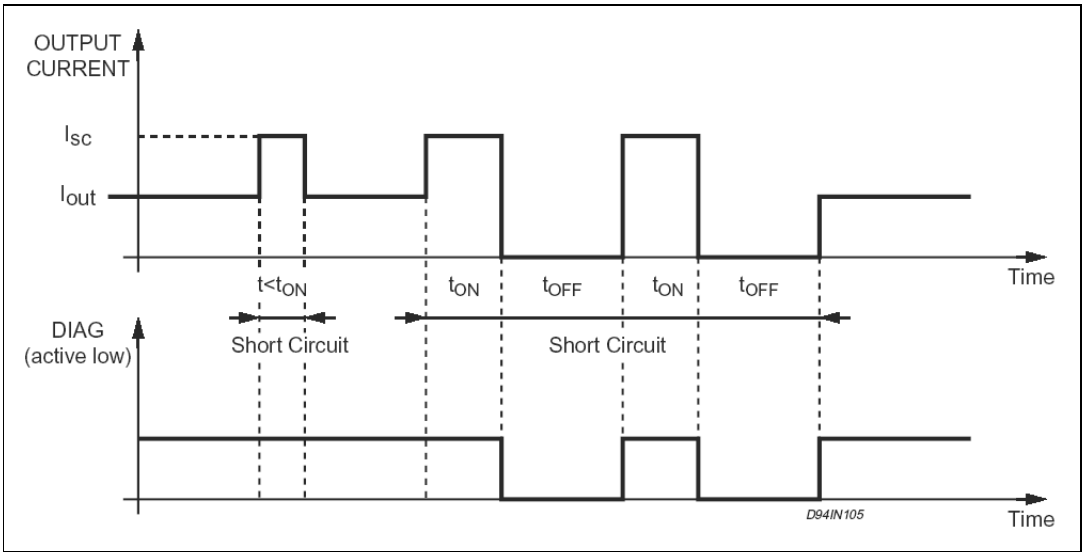
When also the T_{off} interval has expired, the output Power MOSFET is switched ON. At this point in time two conditions may occur

a) The overload is still present, and then the output Power MOSFET is again driven in linear mode (limiting the output current to I_{sc}) for another T_{on}, starting a new cycle, or

b) the overload condition is removed, and the output Power MOSFET is no longer driven in linear mode. All these occurrences are presented on the DIAG2 pin (see *Figure 2*).

This unique feature is called non-dissipative short-circuit protection and it ensures a very safe operation even in permanent overload conditions. Note that 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) prevents that misleading short-circuit information is presented on the DIAG2 output, when driving capacitive loads (that acts as a 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 ON DELAY pin.

Figure 4. Non-dissipative short-circuit protection operation



2.9 Diagnostic logic

The operating conditions of the device are permanently monitored and the following occurrences are signalled via the DIAG1/DIAG2 open drain output pins, see *Table 6: Diagnostic truth table*.

- Short-circuit vs. ground
- Short-circuit vs. VS
- Undervoltage (UV)
- Overtemperature (OVT)
- Open load, if the output current is less than 3 mA (typical value).

2.10 Demagnetization of inductive loads

An internal Zener diode, limiting the voltage across the Power MOSFET to between 50 and 60 V (V_{cl}), provides safe and fast demagnetization of inductive loads without external clamping devices. The maximum energy that can be absorbed from an inductive load is specified as 200 mJ (at T_J = 85 °C).

2.11 Diagnostic truth table

Table 6. Diagnostic truth table

Diagnostic conditions	Input	Output	Diag1	Diag2
Normal operation	L H	L H	H H	H H
Open load condition (I_o< I_{old})	L H	L H	H L	H H
Short to V_S	L H	H H	L L	H H
Short-circuit to ground (I_O = I_{sc}) (1) (pin ON-DELAY grounded)	H L	X L	H H	H H
Output DMOS open	L H	L L	H L	H H
Overtemperature	L H	L L	H H	L L
Supply undervoltage (V_S< V_{sth2})	L H	L L	L L	L L

1. A cold lamp filament, or a capacitive load may activate the current limiting circuit of the IPS, when the IPS is initially turned on.

3 Application circuits

Figure 5. Inductive load equivalent circuit

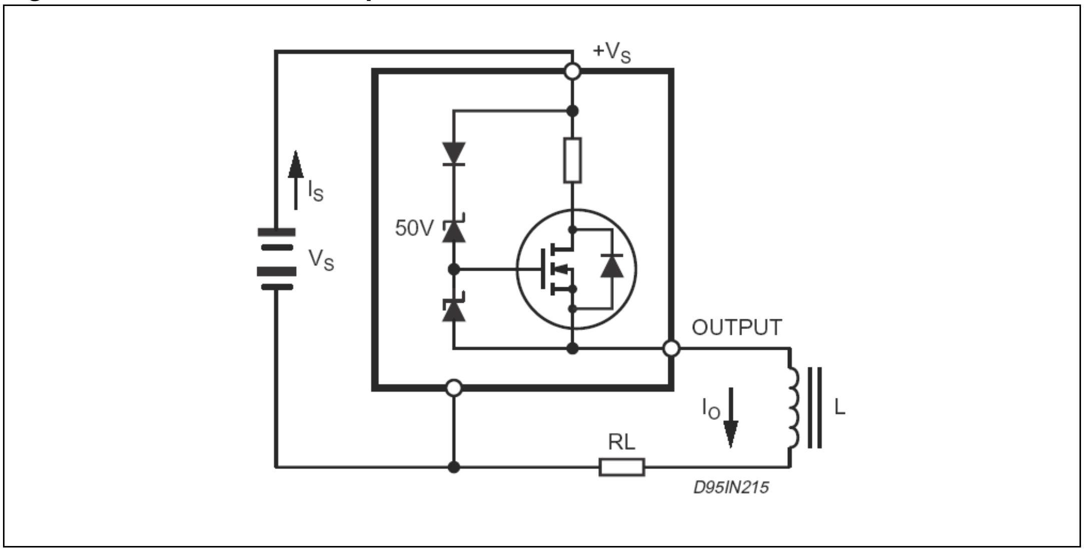


Figure 6. External demagnetization circuit (vs. ground)

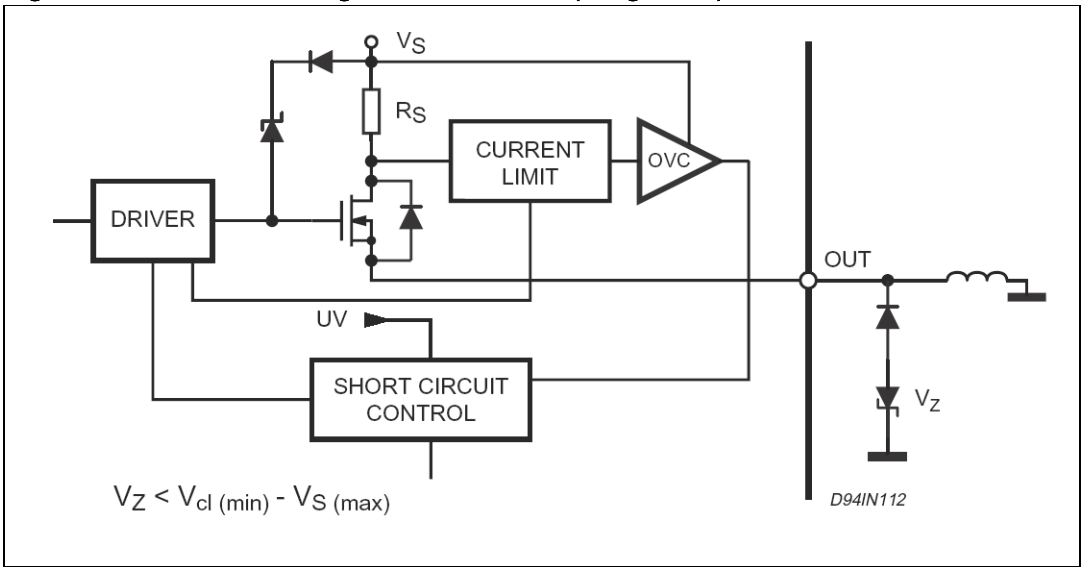


Figure 7. External demagnetization circuit (vs. VS)

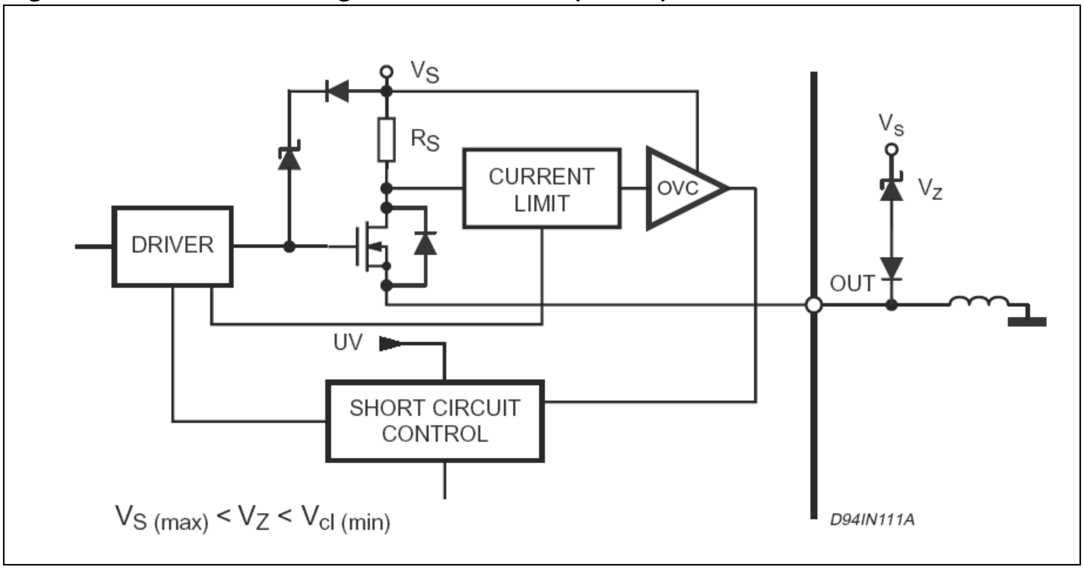
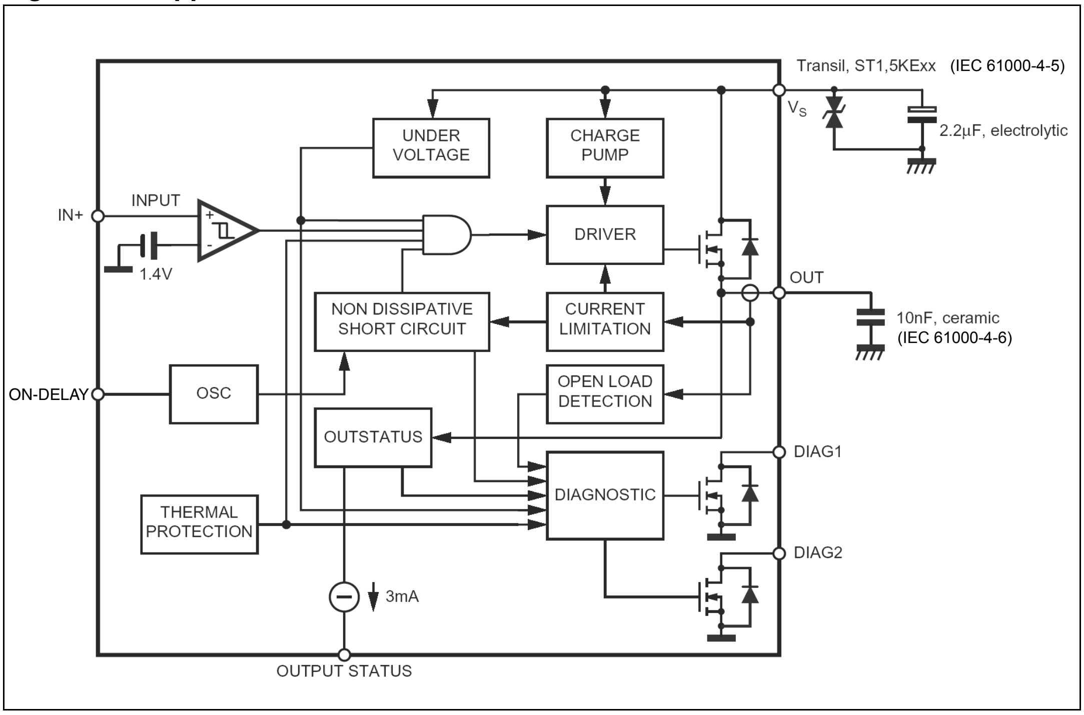


Figure 8. Application schematic



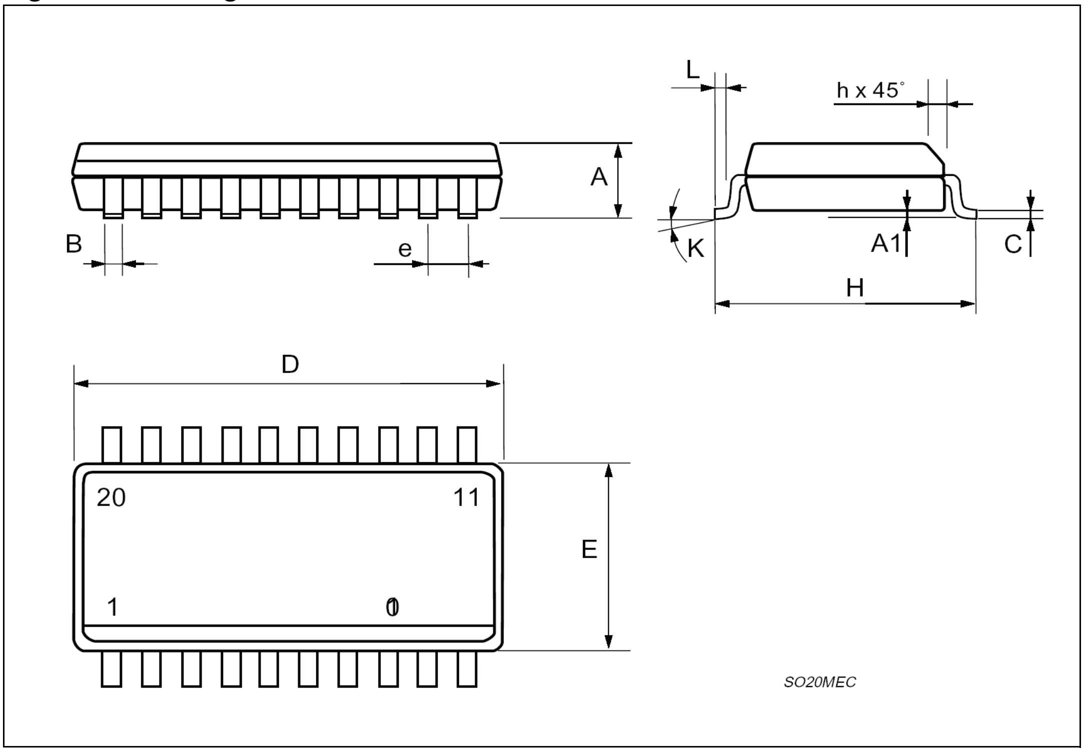
4 Package mechanical data

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.

Table 7. SO20 mechanical data

Dim.	mm			inch		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	2.35		2.65	0.093		0.104
A1	0.1		0.3	0.004		0.012
B	0.33		0.51	0.013		0.020
C	0.23		0.32	0.009		0.013
D	12.6		13	0.496		0.512
E	7.4		7.6	0.291		0.299
e		1.27			0.050	
H	10		10.65	0.394		0.419
h	0.25		0.75	0.010		0.030
L	0.4		1.27	0.016		0.050
K	0° (min.)8° (max.)					

Figure 9. Package dimensions



5 Revision history

Table 8. Document revision history

Date	Revision	Changes
24-Jul-2007	1	Initial release
29-Jun-2009	2	Updated *Table 5 on page 7*
21-Dec-2011	3	Updated *Table 5 on page 7*

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