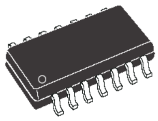
L6377

0.5 A high-side driver quad intelligent power switch

Features

- Multipower BCD technology
- 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 hysteresys
- 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 61000-4-5)
- Immunity against burst transient (IEC 61000-4-4)



SO-14

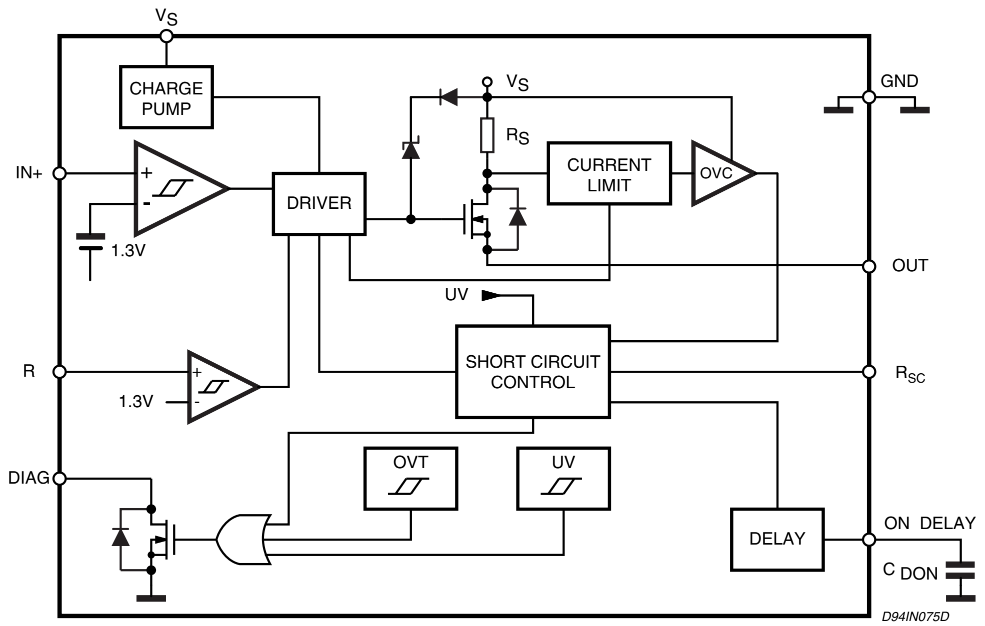
Description

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 indestructible and suitable for general purpose industrial applications.

Table 1. Device summary

Order codes	Package	Packaging
L6377D	SO-14	Tube
L6377D013TR	SO-14	Tape and reel

Figure 1. Block diagram



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Contents

1 Maximum rating

1.1 Absolute maximum ratings

Table 2. Absolute maximum ratings

Symbol	Pin	Parameter	Value	Unit
V_s	4	Supply voltage (tw ≤ 10 ms)	50	V
		Supply voltage (DC)	40	V
V_s - V_{out}	4 vs 3	Supply to output differential voltage	internally limited	
V_{od}	10	Externally forced voltage	-0.3 to 7	V
I_{od}		Externally forced current	±1	mA
I_{RESET}	5	Reset input current (forced)	±2	mA
V_{RESET}		Reset input voltage	-0.3 to 40	V
I_{out}	3	Output current (see also Isc)	internally limited	
V_{out}		Output voltage	internally limited	
Eil		Total energy inductive load (T_J = 125 °C)	50	mJ
P_{tot}		Power dissipation	internally limited	
V_{diag}	11	External voltage	-0.3 to 40	V
I_{diag}		Externally forced current	-10 to 10	mA
I_i	12	Input current	20	mA
V_i		Input voltage	-10 to V_s +0.3	V
T_{op}		Ambient temperature, operating range	-25 to 85	°C
T_J		Junction temperature, operating range (see overtemperature protection)	-25 to 125	°C
T_{stg}		Storage temperature	-55 to 150	°C

1.2 Thermal data

Table 3. Thermal data

Symbol	Parameter	Value	Unit
R_{thJA}	Thermal resistance, junction to ambient (max)	150	°C/W

2 Pin connections

Figure 2. Pin connections (top view)

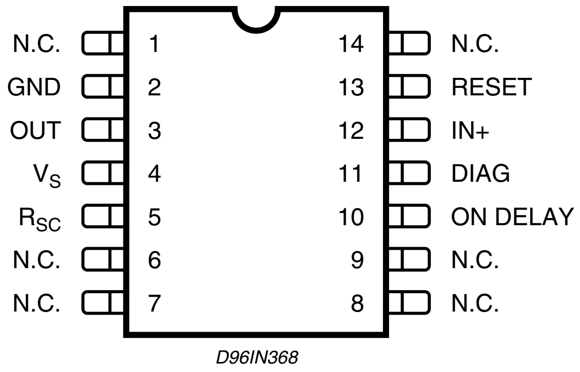


Table 4. Pin description

N#	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	Vs	Supply voltage. Range with under voltage monitoring
5	Rsc	Current limiting setting
10	ON DELAY	Delay setting for overcurrent diagnostic
11	DIAG	Diagnostic open drain output for over temperature, under voltage and overcurrent
12	IN+	Comparator non inverting input
13	RESET	Asynchronous reset input

3 Electrical characteristics

Table 5. Electrical characteristcs
(V_S = 24 V; T_J = -25 to 125 °C; unless otherwise specified.)

Symbol	Pin	Parameter	Test condition	Min	Typ	Max	Unit
DC operation							
V_{smin}	4	Supply voltage for valid diagnostic	$I_{diag} \geq 0.5$ mA; V_{diag} = 1.5 V;	4		35	V
V_s	4	Operative supply voltage		8	24	35	V
V_{sth}	4	Under voltage lower threshold		7		8	V
V_{shys}	4	Under voltage hysteresis		300	500	700	mV
I_q	4	Quiescent current	Output open		800		µA
I_{qo}	4	Quiescent current	Output on		1.6		mA
V_{ith}	12	Input threshold voltage		0.8	1.3	2	V
V_{iths}	12	Input threshold hysteresis		50		400	mV
V_{il}	12	Input low level voltage		-7		0.8	V
V_{ih}	12	Input high level voltage	V_s < 18 V	2		V_s-3	V
	12		V_s > 18 V	2		15	V
I_{ib}	12	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}	13	Reset low level voltage		0		0.8	V
V_{rh}	13	Reset high level voltage		2		40	V
I_{rb}	13	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}	5	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

Table 5. **Electrical characteristcs** (continued)
(V_S = 24 V; T_J = -25 to 125 °C; unless otherwise specified.)

Symbol	Pin	Parameter	Test condition	Min	Typ	Max	Unit
V_{don}		Output voltage drop	I_{out} = 625 mA; T_J = 25 °C		250	350	mV
			I_{out} = 625 mA; T_J = 125 °C		400	550	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}	3	Internal voltage clamp (V_S-V_{out})	I_o = 200 mA single pulsed =300ms	48	53	58	V
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
			V_S = 8 to 35 V; R_l = 2 Ω; R_{sc} < 5 KΩ	0.75	1.1	1.5	A
T_{max}		Over temperature upper threshold			150		°C
T_{hys}		Over temperature 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		µs
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

Figure 3. Undervoltage comparator hysteresis

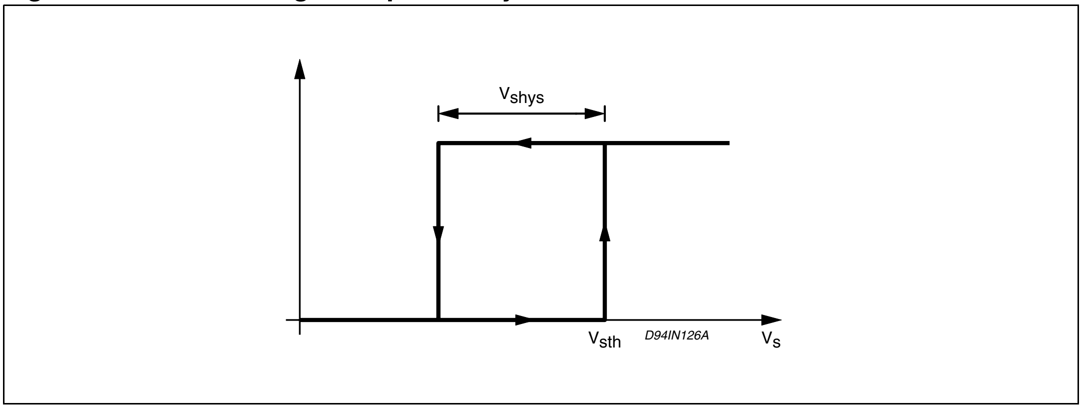
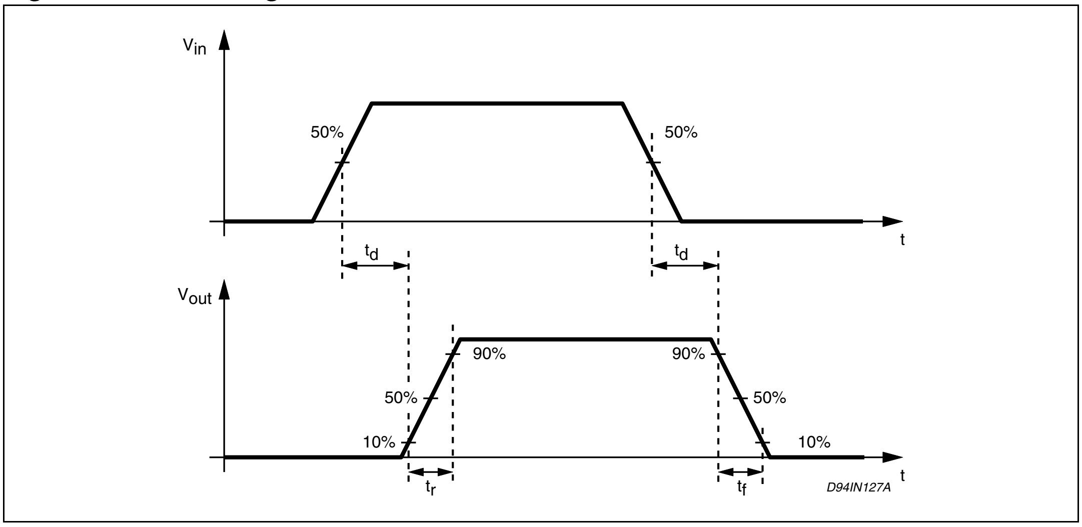


Figure 4. Switching waveforms



4 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.

5 Over temperature protection (OVT)

An on-chip Over Temperature 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 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}-T_{hys} = 130 °C (typical value). The hysteresis avoid thats an intermittent behaviour take place.

6 Under voltage protection (UV)

The supply voltage is expected to range from 8 to 35 V. In this range the device operates correctly. Below 8V 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. 4) 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.

7 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 Isc 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} (kΩ)

with

$5 < R_{sc} < 30$ (kΩ)

For

$R_{sc} < 5$ (kΩ)

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

This condition (current limited to the Isc value) lasts for a Ton 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 µs/pF

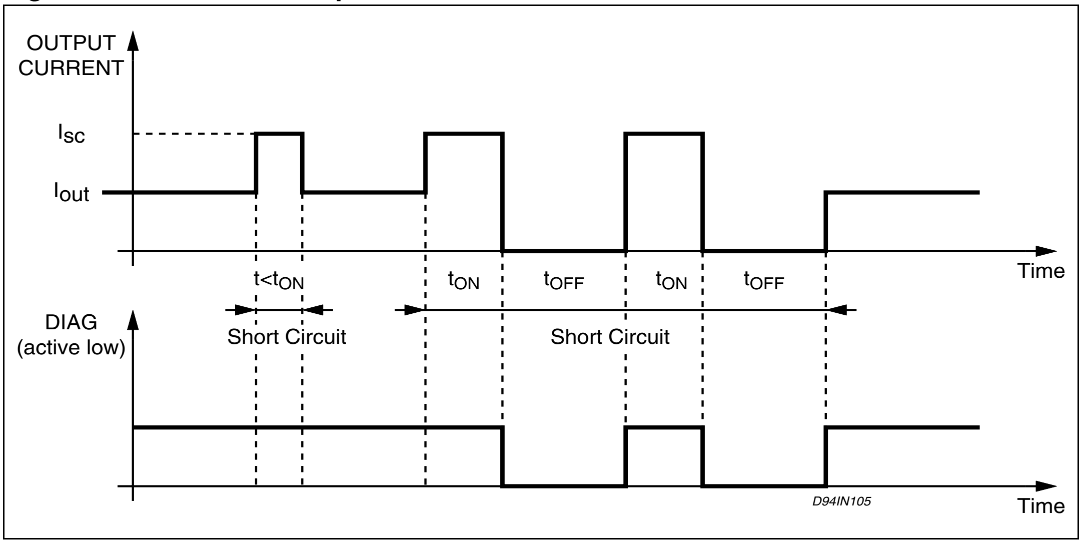
for

50 pF < C_{DON} < 2 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 5. Short circuit operation waveforms



When also the t_{OFF} 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 5). 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 Isc, and Diagnostic disabled) simply shorting to ground the the ON DELAY pin.

8 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 6. Input comparator hysteresis

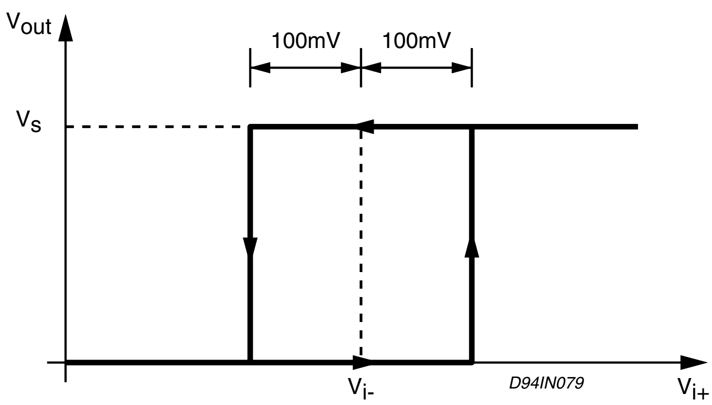


Figure 7. External demagnetisation circuit (versus ground)

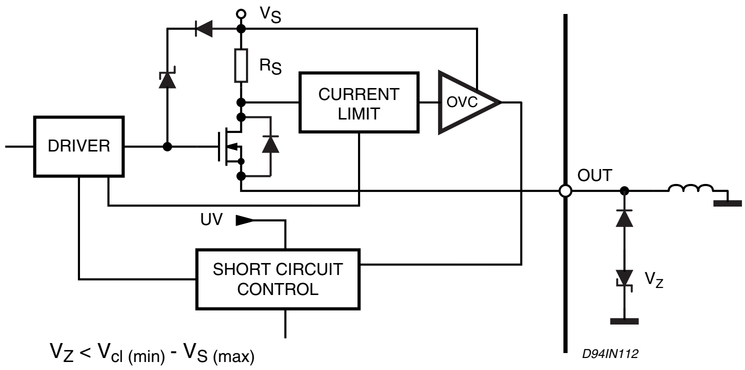
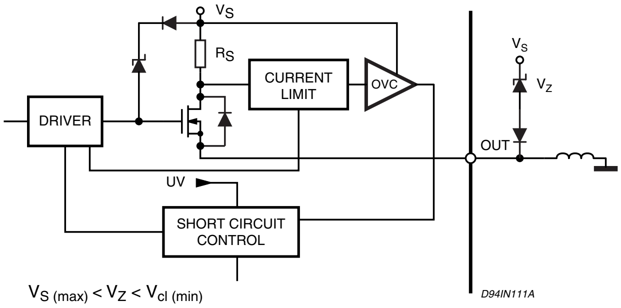


Figure 8. External demagnetisation circuit (versus)



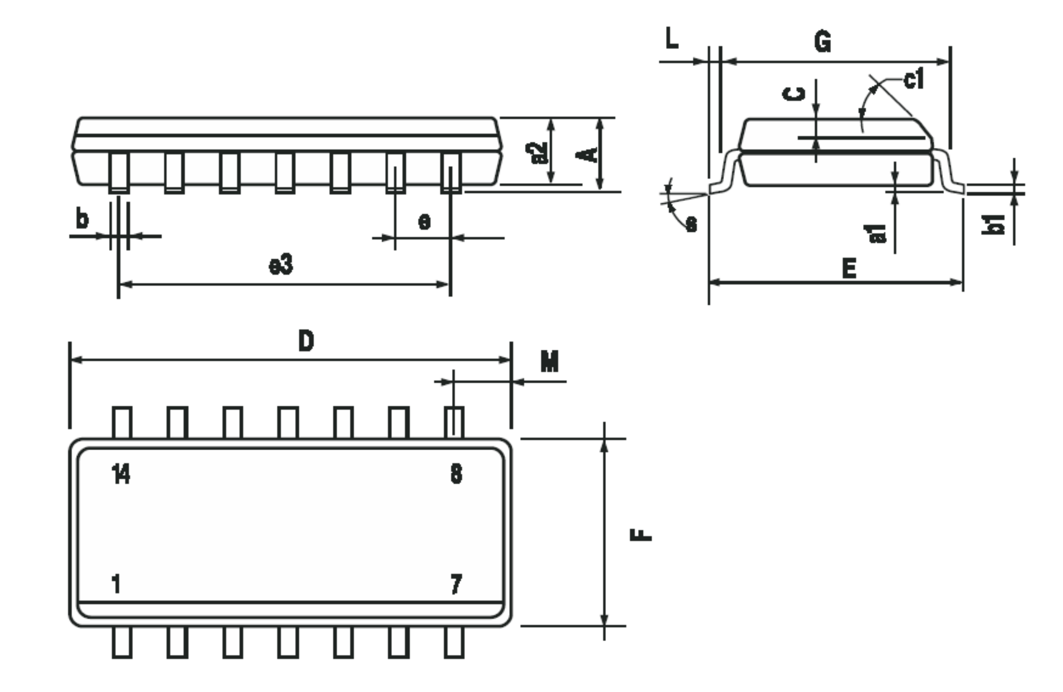
9 Package mechanical data

In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a lead-free second level interconnect . The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark. ECOPACK specifications are available at: www.st.com

Table 6. SO-14 mechanical data

Dim.	mm			inch		
	Min	Typ	Max	Min	Typ	Max
A			1.75			0.069
a1	0.1		0.25	0.004		0.009
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° (typ.)					
D (1)	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 (1)	3.8		4	0.150		0.157
G	4.6		5.3	0.181		0.209
L	0.4		1.27	0.016		0.050
M			0.68			0.027
S	8° (max.)					

Figure 9. Package dimensions



10 Revision history

Table 7. Document revision history

Date	Revision	Changes
August 2001	3	First Issue in EDOCS dms
25-Feb-2008	4	Modified: Removed obsolete package DIP-14