A5970D

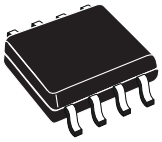
Up to 1 A step down switching regulator for automotive applications

Features

- Qualified following the AEC-Q100 requirements (temperature grade 3), see PPAP for more details.
- Up to 1 A DC output current
- Operating input voltage from 4 V to 36 V
- Output voltage adjustable from 1.235 V to 35 V
- Low dropout operation: 100 % duty cycle
- 250 kHz Internally fixed frequency
- Voltage feedforward
- Zero load current operation
- Internal current limiting
- Inhibit for zero current consumption
- Synchronization
- Protection against feedback disconnection
- Thermal shutdown

Applications

- Dedicated to automotive applications



SO-8

Description

The A5970D is a step down monolithic power switching regulator capable to deliver up to 1 A at output voltages from 1.2 V to 35 V.

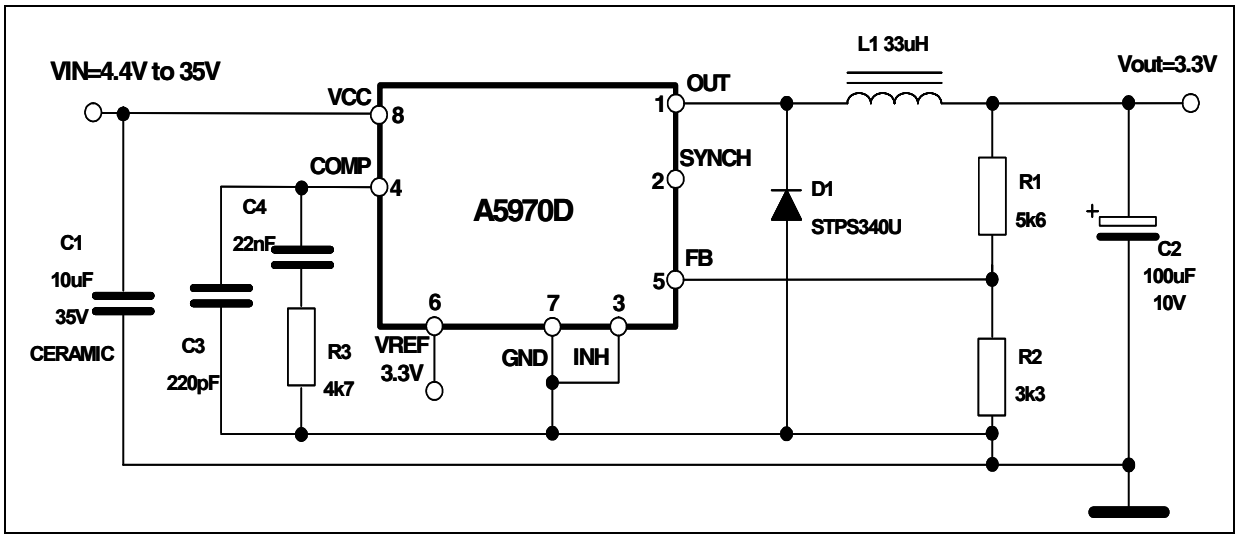
The device uses an internal P-channel D-MOS transistor (with a typical $R_{DS(on)}$ of 250 mΩ) as switching element to minimize the size of the external components.

An internal oscillator fixes the switching frequency at 250 kHz.

Having a minimum input voltage of 4 V only, it is particularly suitable for 5 V bus.

Pulse by pulse current limit with the internal frequency modulation offers an effective constant current short circuit protection.

Figure 1. Application schematic



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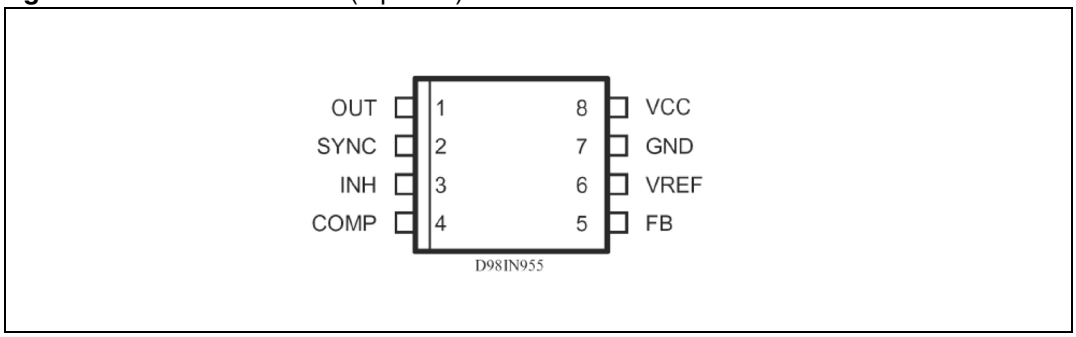
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1 Pin settings

1.1 Pin connection

Figure 1. Pin connection (top view)



1.2 Pin description

Table 1. Pin description

N	Pin	Description
1	OUT	Regulator output.
2	SYNCH	Master/slave synchronization.
3	INH	A logical signal (active high) disables the device. If INH not used the pin must be grounded. When it is open an internal pull-up disable the device.
4	COMP	E/A output for frequency compensation.
5	FB	Feedback input. Connecting directly to this pin results in an output voltage of 1.23 V. An extenal resistive divider is required for higher output voltages.
6	VREF	3.3 V VREF. No cap is requested for stability.
7	GND	Ground.
8	VCC	Unregulated DC input voltage.

2 Electrical data

2.1 Maximum ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_8	Input voltage	40	V
V_1	OUT pin DC voltage OUT pin peak voltage at Δt = 0.1 µs	-1 to 40 -5 to 40	V V
I_1	Maximum output current	int. limit.	
V_4 , V_5	Analog pins	4	V
V_3	INH	-0.3 to V_{CC}	V
V_2	SYNCH	-0.3 to 4	V
P_{TOT}	Power dissipation at $T_A \leq 70$ °C	0.75	W
T_j	Operating junction temperature range	-40 to 150	°C
T_{STG}	Storage temperature range	-55 to 150	°C

2.2 Thermal data

Table 3. Thermal data

Symbol	Parameter	SO8	Unit
R_{thJA}	Maximum thermal resistance junction-ambient	120 (1)	°C/W

1. Package mounted on board

3 Electrical characteristics

Table 4. Electrical characteristics

(T_J = -40 to 125 °C, V_{CC} =12 V, unless otherwise specified)

Symbol	Parameter	Test condition	Min	Typ	Max	Unit
V_{CC}	Operating input voltage range	V_0 = 1.235 V; I_0 = 1 A	4		36	V
$R_{DS(on)}$	MOSFET on resistance			0.250	0.5	Ω
I_L	Maximum limiting current (1)	V_{CC} = 5 V	1.35	1.87	2.25	A
		V_{CC} = 5 V, T_J = 25 °C	1.5	1.87	2.25	
f_{SW}	Switching frequency		212	250	280	kHz
	Duty cycle		0		100	%
Dynamic characteristics (see test circuit).						
V_5	Voltage feedback	4.4 V < V_{CC} < 36 V, 20 mA < I_0 < 2 A	1.198	1.235	1.272	V
η	Efficiency	V_0 = 5 V, V_{CC} = 12 V		90		%
DC characteristics						
I_{qop}	Total operating quiescent current			3	5	mA
I_q	Quiescent current	Duty cycle=0; V_{FB}=1.5 V			2.5	mA
$I_{qst\text{-}by}$	Total stand-by quiescent current	V_{inh} > 2.2 V		50	100	µA
		V_{CC} = 36 V; V_{inh} > 2.2 V		80	150	µA
Inhibit						
	INH threshold voltage	Device ON			0.8	V
		Device OFF	2.2			V
Error amplifier						
V_{OH}	High level output voltage	V_{FB} = 1 V	3.5			V
V_{OL}	Low level output voltage	V_{FB} = 1.5 V			0.4	V
$I_{o\ source}$	Source output current	V_{COMP} = 1.9 V; V_{FB} = 1 V	190	300		µA
$I_{o\ sink}$	Sink output current	V_{COMP} = 1.9 V; V_{FB}=1.5 V	1	1.5		mA
I_b	Source bias current			2.5	4	µA
	DC open loop gain	R_L=∞	50	65		dB

Table 4. Electrical characteristics (continued)

(T_J = -40 to 125 °C, V_{CC} =12 V, unless otherwise specified)

Symbol	Parameter	Test condition	Min	Typ	Max	Unit
gm	Transconductance	I_{COMP} = -0.1 mA to 0.1 mA; V_{COMP} = 1.9 V		2.3		mS
Synch function						
	High input voltage	V_{CC}= 4.4 to 36 V;	2.5		V_{REF}	V
	Low input voltage	V_{CC}= 4.4 to 36 V;			0.74	V
	Slave synch current	V_{synch}= 0.74 V (2) V_{synch}= 2.33 V	0.11 0.21		0.25 0.45	mA
	Master output amplitude	I_{source}= 3 mA	2.75	3		V
	Output pulse width	no load, V_{synch}= 1.65 V	0.20	0.35		µs
Reference section						
	Reference voltage	I_{REF} = 0 to 5 mA V_{CC} = 4.4 V to 36 V	3.2	3.3	3.399	V
	Line regulation	I_{REF} = 0mA V_{CC} = 4.4 V to 36 V		5	10	mV
	Load regulation	I_{REF} = 0 mA		8	15	mV
	Short circuit current		5	18	35	mA

1. With T_J = 85 °C, I_{lim_min} = 1.5 A, assured by design, characterization and statistical correlation.
2. Guaranteed by design

4 Typical characteristics

Figure 2. Junction temperature vs output current

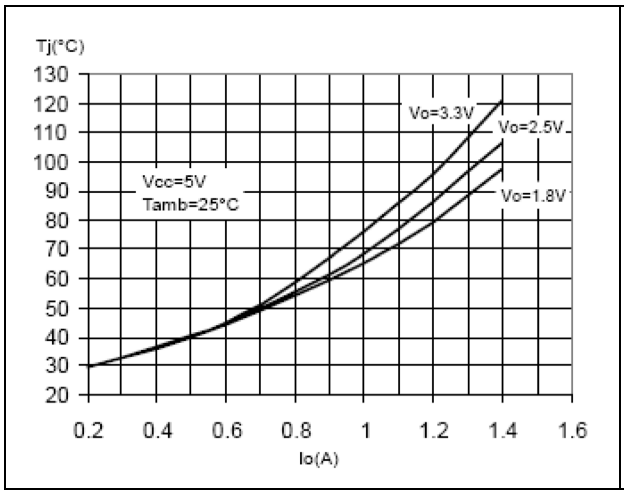


Figure 3. Load regulation

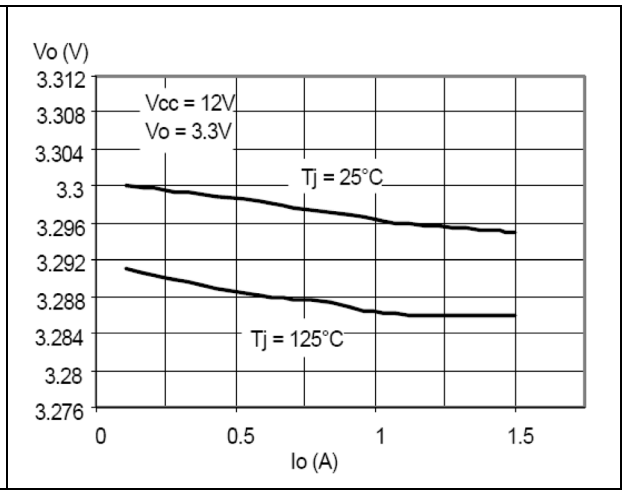


Figure 4. Junction temperature vs output voltage

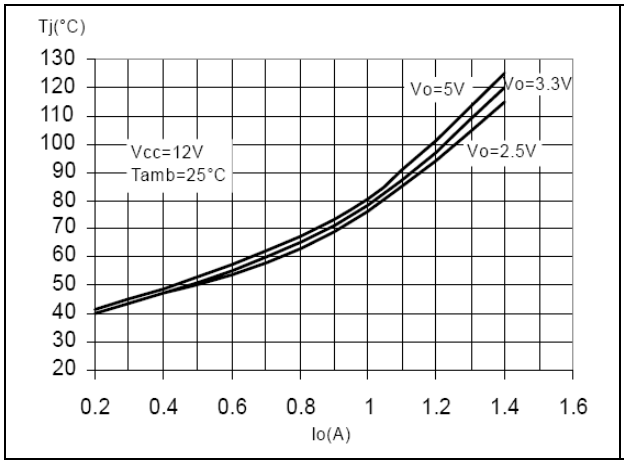


Figure 5. Line regulation

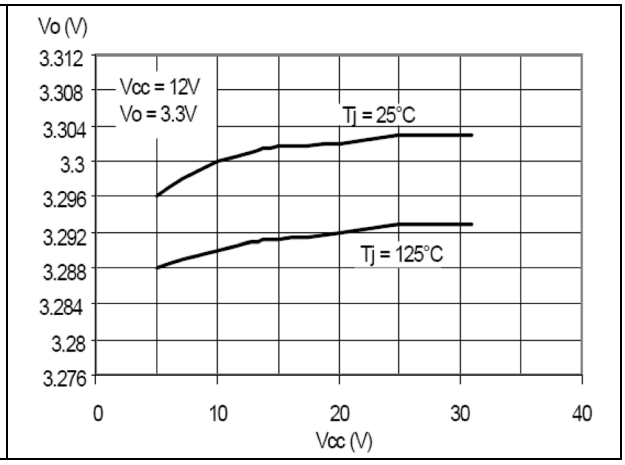


Figure 6. Junction temperature vs output current

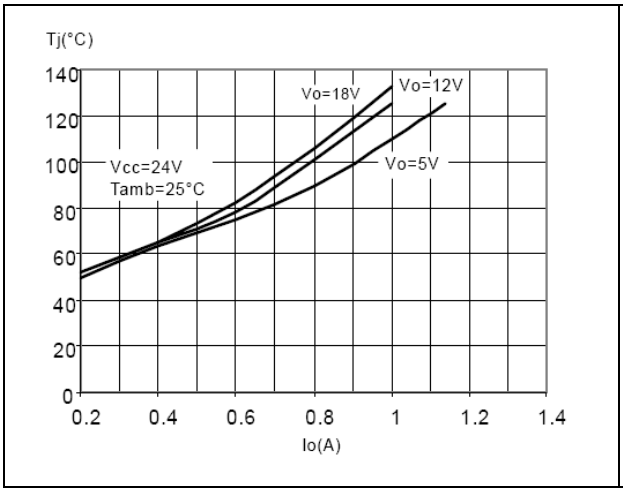


Figure 7. Output voltage vs junction temperature

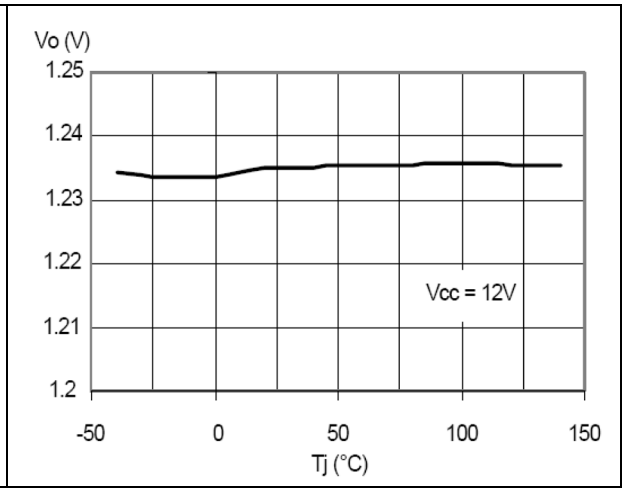


Figure 8. Quiescient current vs junction temperature

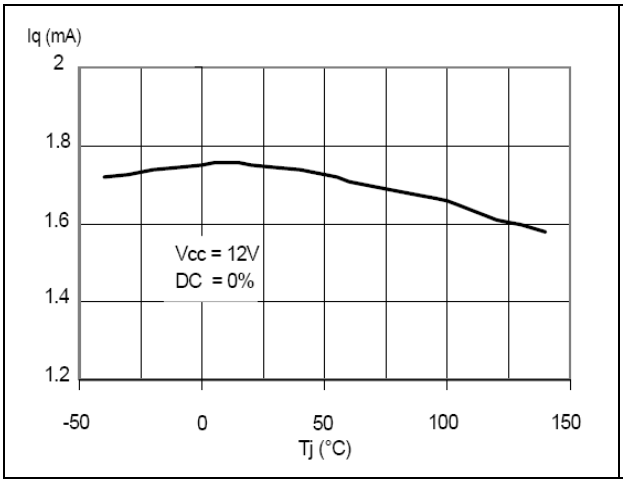


Figure 9. Switching frequency vs junction temperature

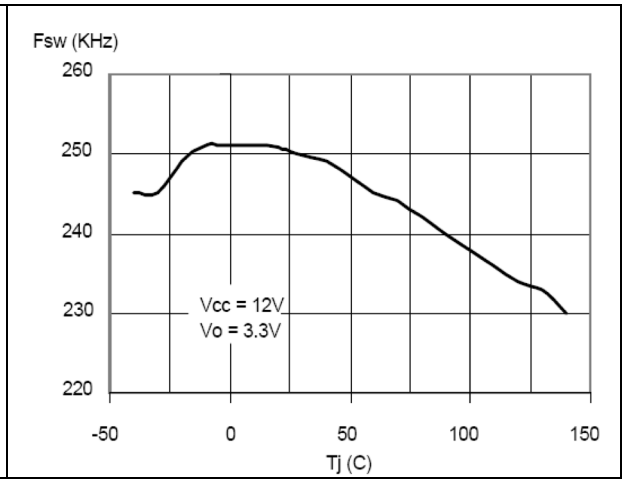


Figure 10. Shutdown current vs junction temperature

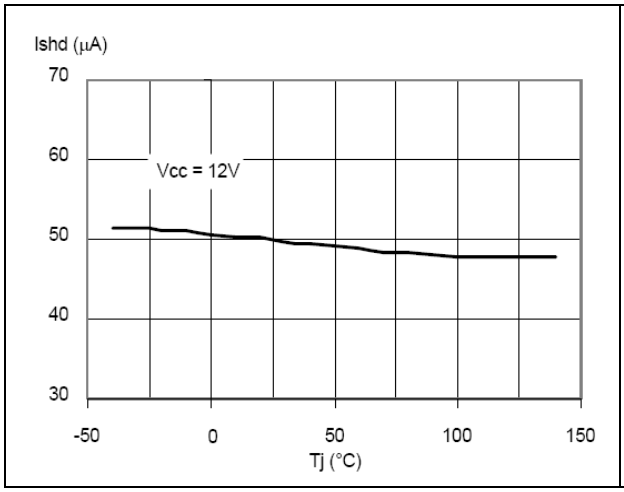


Figure 11. Efficiency vs output current

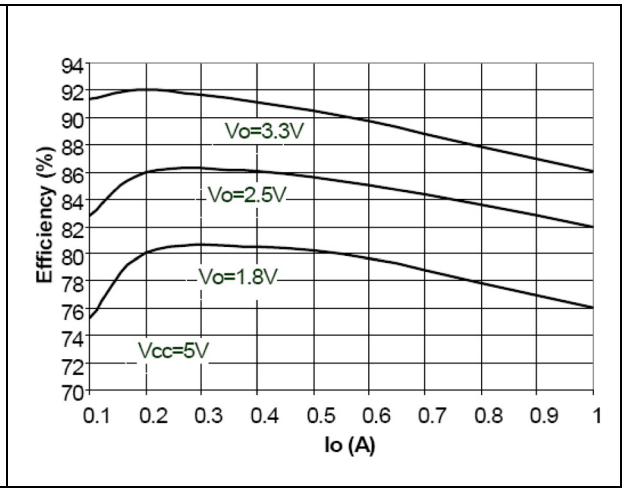
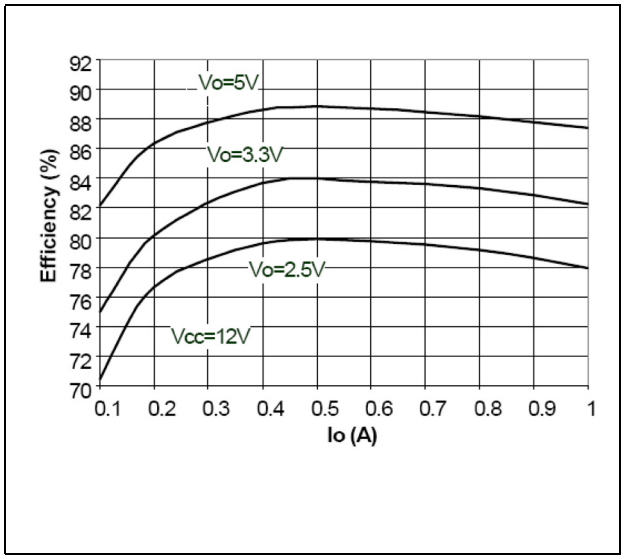


Figure 12. Efficiency vs output current



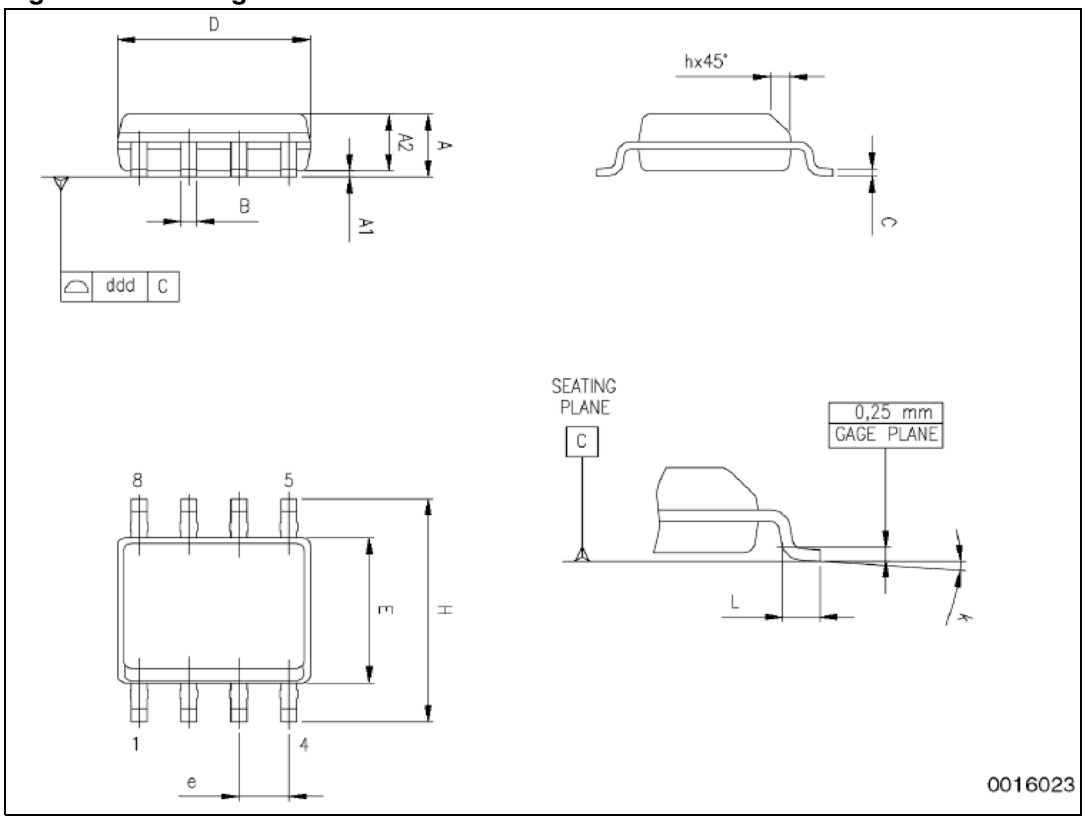
5 Package mechanical data

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 5. SO-8 mechanical data

Dim	mm			inch		
	Min	Typ	Max	Min	Typ	Max
A	1.35		1.75	0.053		0.069
A1	0.10		0.25	0.004		0.010
A2	1.10		1.65	0.043		0.065
B	0.33		0.51	0.013		0.020
C	0.19		0.25	0.007		0.010
D(1)	4.80		5.00	0.1890		0.197
E	3.80		4.00	0.15		0.157
e		1.27			0.050	
H	5.80		6.20	0.228		0.244
h	0.25		0.50	0.010		0.020
L	0.40		1.27	0.016		0.050
k	0° (min), 8° (max)					
ccc			0.10			0.0039

Figure 13. Package dimensions



6 Revision history

Table 6. Document revision history

Date	Revision	Changes
06-Aug-2007	1	Initial release.
24-Oct-2007	2	Updated: *Table 4 on page 5*
2-May-2008	3	Updated: Cover page, *Table 4 on page 5*
27-Aug-2008	4	Updated: Coverpage and *Table 4 on page 5*

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