

2 A step down switching regulator for automotive applications

Features

- Qualified following the AEC-Q100 requirements (temperature Grade 1), see PPAP for more details.
- 2 A DC output current
- Operating input voltage from 4 V to 36 V
- 3.3 V / (±2 %) reference voltage
- 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

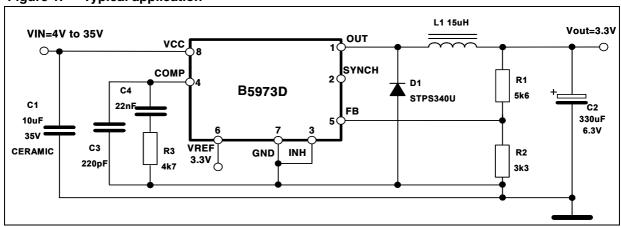
Dedicated to automotive applications



Description

The B5973D is a step down monolithic power switching regulator with a minimum switch current limit of 2.25 A so it is able to deliver up to 2 A DC current to the load depending on the application conditions. The output voltage can be set from 1.235 V to 35 V. The high current level is also achieved thanks to an SO8 package with exposed frame, that allows to reduce the $R_{th(JA)}$ down to approximately 40 °C/W. The device uses an internal P-channel DMOS transistor (with a typical R_{DSon} of 250 $m\Omega)$ 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 4V 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. Pulse by pulse current limit with the internal frequency modulation offers an effective constant current short circuit protection.





B5973D Contents

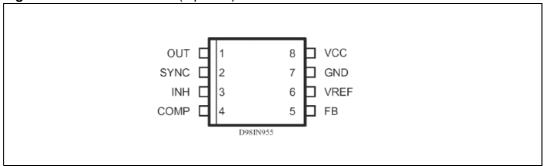
Contents

1	Pin s	settings	. 2
	1.1	Pin connection	. 2
	1.2	Pin description	. 2
2	Elect	trical data	. 3
	2.1	Maximum ratings	. 3
	2.2	Thermal data	. 3
3	Elect	trical characteristics	. 4
4	Туріс	cal characteristics	. 6
5	Pack	age mechanical data	. 8
6	Revis	sion history	10

1 Pin settings

1.1 Pin connection

Figure 2. 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 pi must be grounded. When it is open an internal pull-up disable the device.		
4	COMP	E/A output for frequency compensation.		
5	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.			

2/11

Electrical data B5973D

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 $\Delta t = 0.1 \mu s$	-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 Ta ≤ 70 °C	2.25	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
RthJA	Maximum thermal resistance junction-ambient	40 ⁽¹⁾	°C/W

^{1.} Package mounted on board

3 Electrical characteristics

Table 4. Electrical characteristics $(T_J = -40 \, ^{\circ}\text{C} \text{ to } 125 \, ^{\circ}\text{C}, \, V_{CC} = 12 \, \text{V}, \, \text{unless otherwise specified})$

Symbol	Parameter	Test condition	Min	Тур	Max	Unit
V _{CC}	Operating input voltage range	V ₀ = 1.235 V; I ₀ = 2 A	4		36	V
R _{DS(on)}	MOSFET on resistance			0.250	0.5	Ω
ı	Maximum limiting	V _{CC} = 5 V	2.25	3	3.5	Α
IL	current (1)	V_{CC} = 5 V, T_{J} = 25 °C	2.5	3	3.5	
f _{SW}	Switching frequency		212	250	280	kHz
	Duty cycle		0		100	%
Dynamic c	haracteristics (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 charact	teristics		•			
I _{qop}	Total operating quiescent current			3	5	mA
Iq	Quiescent current	Duty cycle = 0; V _{FB} = 1.5 V			2.5	mA
	Total stand-by quiescent current	V _{inh} > 2.2 V		50	100	μΑ
I _{qst-by}		V _{CC} = 36 V; V _{inh} > 2.2 V		80	150	μΑ
Inhibit						
	INH threshold voltage	Device ON			0.8	V
	INH threshold voltage	Device OFF	2.2			V
Error ampl	ifier					
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
lo source	Source output current	V _{COMP} = 1.9 V; V _{FB} = 1 V	190	300		μΑ
lo sink	Sink output current	V _{COMP} = 1.9 V; V _{FB} = 1.5 V	1	1.5		mA
lb	Source bias current			2.5	4	μΑ
	DC open loop gain	RL = ∞	50	65		dB

577

Electrical characteristics B5973D

Table 4. Electrical characteristics

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

Symbol	Parameter	Test condition	Min	Тур	Max	Unit
gm	Transconductance	$I_{COMP} = -0.1 \text{ mA to } 0.1 \text{ mA};$ $V_{COMP} = 1.9 \text{ V}$		2.3		mS
Synch fund	ction					
	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	$I_{REF} = 0 \text{ to 5 mA}$ $V_{CC} = 4.4 \text{ V to 36 V}$	3.2	3.3	3.399	٧
	Line regulation	$I_{REF} = 0 \text{ mA}$ $V_{CC} = 4.4 \text{ V to } 36 \text{ V}$		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, $I_{lim_min} = 2.5$ A, assured by design, characterization and statistical correlation.

^{2.} Guarantee by design

4 Typical characteristics

Figure 3. Line regulation

Vo (V) 3.312 -Vcc = 12V _Vo = 3.3V 3.308 Tj = 25°C 3.304 3.3 3.296 3.292 Tj = 125°C 3.288 3.284 3.28 3.276 40 0 10 20 30 Vcc (V)

Figure 4. Shutdown current vs junction temperature

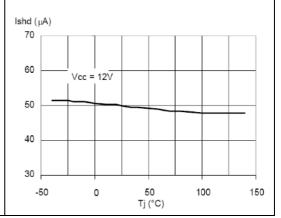


Figure 5. Output voltage vs junction temperature

Vo (V)
1.25
1.24
1.23
1.22
1.21
1.2
-50
0
50
100
150
Tj (°C)

Figure 6. Switching frequency vs junction temperature

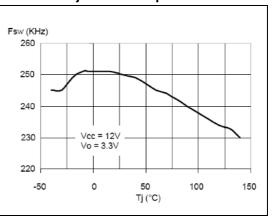
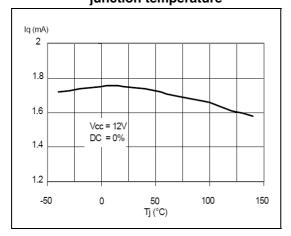


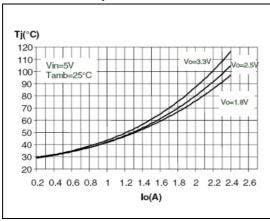
Figure 7. Quiescent current vs junction temperature



6/11

Figure 8. Junction temperature vs output current

Figure 9. Junction temperature vs output current



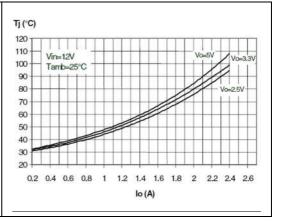
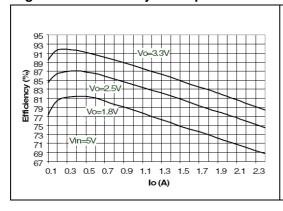
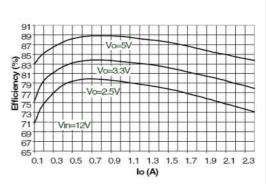


Figure 10. Efficiency vs output current

Figure 11. Efficiency vs output current





5 Package mechanical data

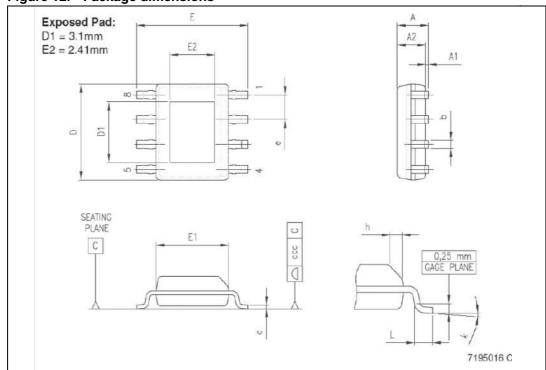
In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a lead-free second level interconnect. The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings 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

57

Table 5. HSOP8 mechanical data

Dim	mm			inch			
DIM	Min	Тур	Max	Min	Тур	Max	
Α			1.70			0.0669	
A1	0.00		0.10		0.00	0.0039	
A2	1.25			0.0492			
b	0.31		0.51	0.0122		0.0201	
С	0.17		0.25	0.0067		0.0098	
D	4.80	4.90	5.00	0.1890	0.1929	0.1969	
D1	3	3.1	3.2	0.118	0.122	0.126	
E	5.80	6.00	6.20	0.2283		0.2441	
E1	3.80	3.90	4.00	0.1496		0.1575	
E2	2.31	2.41	2.51	0.091	0.095	0.099	
е		1.27					
h	0.25		0.50	0.0098		0.0197	
L	0.40		1.27	0.0157		0.0500	
k	0° (min), 8° (max)						
ccc			0.10			0.0039	

Figure 12. Package dimensions



6 Revision history

Table 6. Document revision history

Date	Revision	Changes		
07-Nov-2007	1	Initial release		
14-Jan-2008	Updated <i>Table 5 on page 9</i>			
27-Aug-2008	3	Updated: Coverpage and Table 4 on page 4		

577

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