

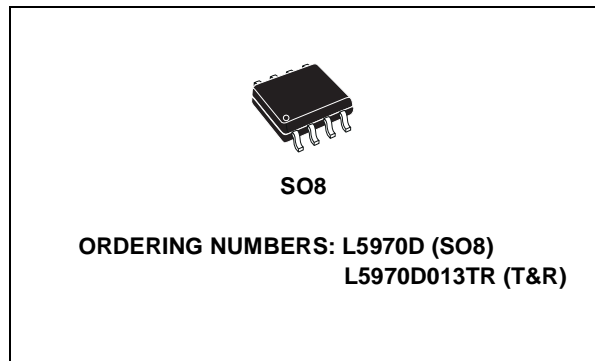


## UP TO 1A STEP DOWN SWITCHING REGULATOR

- UP TO 1A OUTPUT CURRENT
- OPERATING INPUT VOLTAGE FROM 4.4V TO 36V
- 3.3V / ( $\pm 2\%$ ) / REFERENCE VOLTAGE
- OUTPUT VOLTAGE ADJUSTABLE FROM 1.2V TO 35V
- LOW DROPOUT OPERATION: 100% DUTY CYCLE
- 250KHz INTERNALLY FIXED FREQUENCY
- VOLTAGE FEEDFORWARD
- ZERO LOAD CURRENT OPERATION
- INTERNAL CURRENT LIMITING
- INHIBIT FOR ZERO CURRENT CONSUMPTION
- SINCHRONIZATION
- PROTECTION AGAINST FEEDBACK DISCONNECTION
- THERMAL SHUTDOWN

### APPLICATIONS:

- CONSUMER: STB, DVD, TV, VCR, CAR RADIO, LCD MONITORS
- NETWORKING: XDSL, MODEMS, DC-DC MODULES
- COMPUTER: PRINTERS, AUDIO/GRAPHIC CARDS, OPTICAL STORAGE, HARD DISK DRIVE
- INDUSTRIAL: CHARGERS, CAR BATTERY DC-DC CONVERTERS



### DESCRIPTION

The L5970D is a step down monolithic power switching regulator capable to deliver up to 1A at output voltages from 1.2V to 35V.

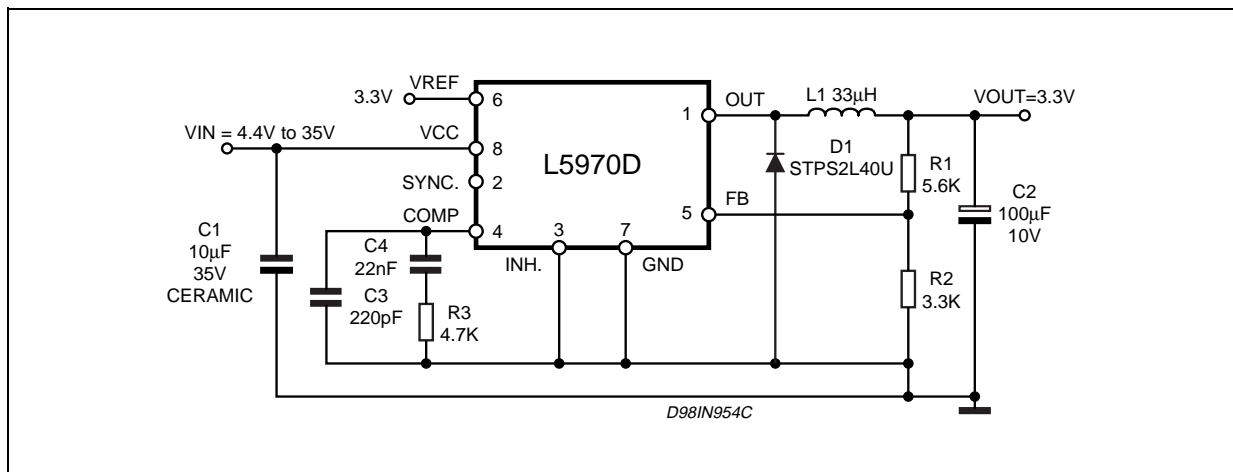
The device uses an internal P-Channel D-MOS transistor (with a typical  $R_{ds(on)}$  of 250m $\Omega$ ) as switching element to minimize the size of the external components.

An internal oscillator fixes the switching frequency at 250KHz.

Having a minimum input voltage of 4.4V only, it is particularly suitable for 5V bus, available in all computer related applications.

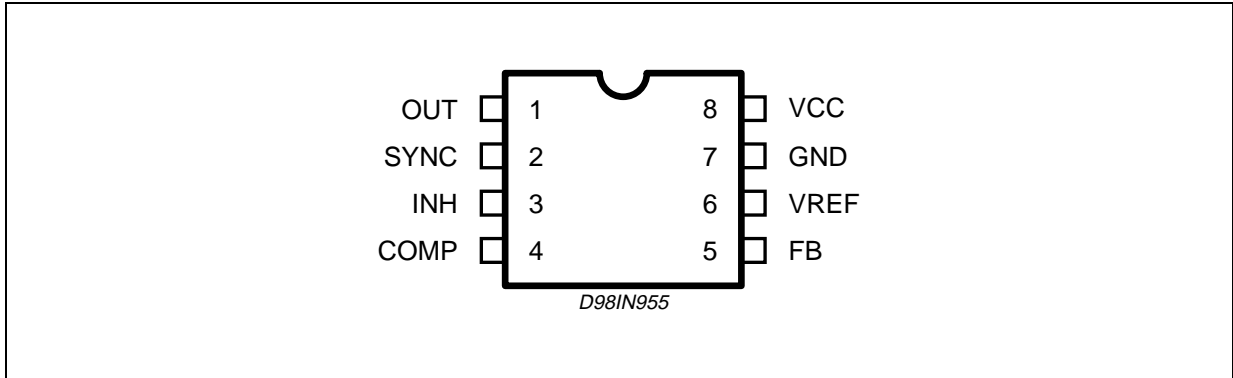
Pulse by pulse current limit with the internal frequency modulation offers an effective constant current short circuit protection.

### TEST APPLICATION CIRCUIT



## L5970D

### PINS CONNECTION (Top View)



### PINS FUNCTION

N.	Name	Description
1	OUT	Regulator Output.
2	SYNC	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 1.23V. An external resistive divider is required for higher output voltages.
6	V <sub>REF</sub>	3.3V V <sub>REF</sub> . No cap is requested for stability.
7	GND	Ground.
8	V <sub>CC</sub>	Unregulated DC input voltage.

### THERMAL DATA

Symbol	Parameter	Value	Unit
R <sub>th(j-amb)</sub>	Thermal Resistance Junction to ambient Max.	120 (*)	°C/W

(\*) Package mounted on board

### ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V <sub>8</sub>	Input Voltage	40	V
V <sub>1</sub>	Output DC voltage Output peak voltage at t = 0.1μs	-1 to 40 -5 to 40	V V
I <sub>1</sub>	Maximum output current	int. limit.	
V <sub>4, V5</sub>	Analog pins	4	V
V <sub>3</sub>	INH	-0.3V to V <sub>CC</sub>	
V <sub>2</sub>	SYNC	-0.3 to 4	V
P <sub>tot</sub>	Power dissipation at T <sub>amb</sub> ≤ 60°C	0.75	W
T <sub>j</sub>	Operating junction temperature range	-40 to 150	°C
T <sub>stg</sub>	Storage temperature range	-55 to 150	°C

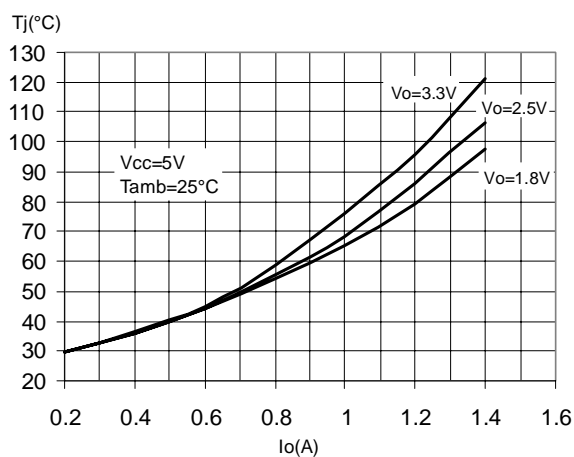
**ELECTRICAL CHARACTERISTICS** ( $T_j = 25^\circ\text{C}$ ,  $V_{CC} = 12\text{V}$ , unless otherwise specified.)(\*) Specification Referred to  $T_j$  from  $-40$  to  $+125^\circ\text{C}$  (1).

Symbol	Parameter	Test Condition		Min.	Typ.	Max.	Unit
$V_{CC}$	Operating input voltage range	$V_o = 1.235\text{V}$ ; $I_o = 1\text{A}$	*	4.4		36	V
$V_d$	Dropout voltage	$V_{CC} = 4.4\text{V}$ ; $I_o = 1\text{A}$	*		0.25	0.5	V
$I_l$	Maximum limiting current	$V_{CC} = 4.4\text{V}$ to $36\text{V}$	*	1.5	1.87	2.25	A
fs	Switching frequency		*	212	250	280	KHz
				225	250	275	KHz
	Duty cycle			0		100	%
<b>DYNAMIC CHARACTERISTICS</b> (see test circuit fig. xx note 1).							
$V_5$	Voltage feedback	$4.4\text{V} < V_{CC} < 36\text{V}$ , $20\text{mA} < I_o < 1\text{A}$		1.220	1.235	1.25	V
			*	1.198	1.235	1.272	V
$\eta$	Efficiency	$V_o = 5\text{V}$ , $V_{CC} = 12\text{V}$			90		%
<b>DC CHARACTERISTICS</b>							
$I_{qop}$	Total operating quiescent current		*		3	5	mA
$I_q$	Quiescent current	Duty Cycle = 0; $V_{FB} = 1.5\text{V}$				2.5	mA
$I_{qst-by}$	Total stand-by quiescent current	$V_{inh} > 2.2\text{V}$ $V_{CC} = 36\text{V}$ ; $V_{inh} > 2.2\text{V}$	*		50	100	$\mu\text{A}$
			*		80	150	$\mu\text{A}$
<b>INHIBIT</b>							
	INH Threshold voltage	Device ON				0.8	V
		Device OFF		2.2			V
<b>ERROR AMPLIFIER</b>							
$V_{OH}$	High level output voltage	$V_{FB} = 1\text{V}$		3.5			V
$V_{OL}$	Low level output voltage	$V_{FB} = 1.5\text{V}$				0.4	V
$I_{o\ source}$	Source output current	$V_{COMP} = 1.9\text{V}$ ; $V_{FB} = 1\text{V}$		200	300		$\mu\text{A}$
$I_{o\ sink}$	Sink output current	$V_{comp} = 1.9\text{V}$ ; $V_{FB} = 1.5\text{V}$		1	1.5		mA
$I_b$	Source bias current				2.5	4	$\mu\text{A}$
	DC open loop gain	$R_L = \infty$		50	65		dB
gm	Transconductance	$I_{comp} = -0.1\text{mA}$ to $0.1\text{mA}$ $V_{comp} = 1.9\text{V}$			2.3		mS
<b>SYNC FUNCTION</b>							
	High Input Voltage	$V_{CC} = 4.4\text{V}$ to $36\text{V}$		2.5		$V_{REF}$	V
	Low Input Voltage	$V_{CC} = 4.4\text{V}$ to $36\text{V}$				0.74	V
	Slave Sink Current	$V_{sync} = 0.74\text{V}$ (2) $V_{sync} = 2.33\text{V}$		0.11 0.21		0.25 0.45	mA mA
	Master Output Amplitude	$I_{source} = 3\text{mA}$		2.75	3		V
	Output Pulse Width	no load, $V_{sync} = 1.65\text{V}$		0.20	0.35		$\mu\text{s}$
<b>REFERENCE SECTION</b>							
	Reference Voltage			3.234	3.3	3.366	V
			$I_{REF} = 0$ to $5\text{mA}$ $V_{CC} = 4.4\text{V}$ to $36\text{V}$	*	3.2	3.3	3.399
	Line Regulation	$I_{REF} = 0\text{mA}$ $V_{CC} = 4.4\text{V}$ to $36\text{V}$			5	10	mV
	Load Regulation	$I_{REF} = 0$ to $5\text{mA}$			8	15	mV
	Short Circuit Current			10	8	30	mA

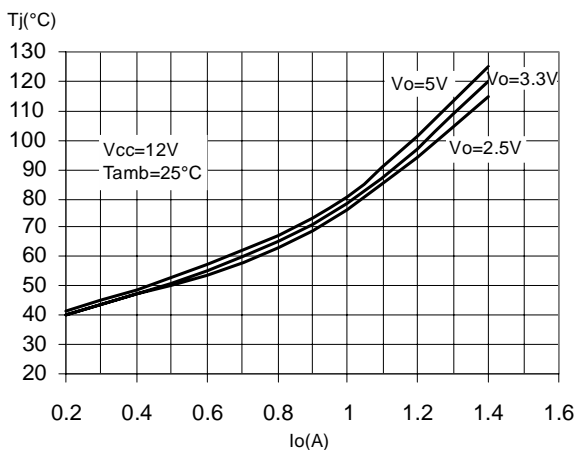
Note (1): Specification over the  $-40$  to  $+125$   $T_j$  Temperature range are assured by design, characterization and statistical correlation.

Note (2): Guaranteed by design.

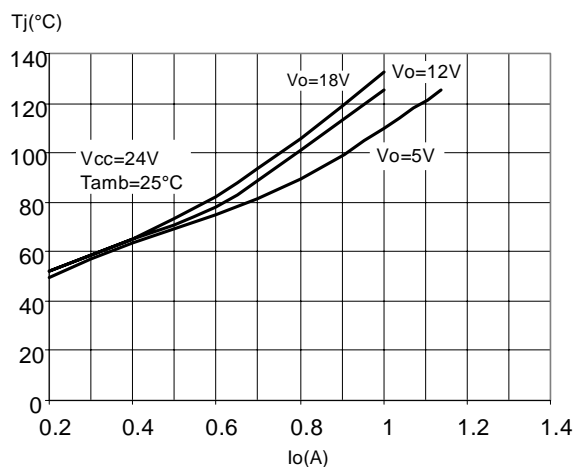
**Figure 1. Junction Temperature vs. Output Current (SO8 \*)**



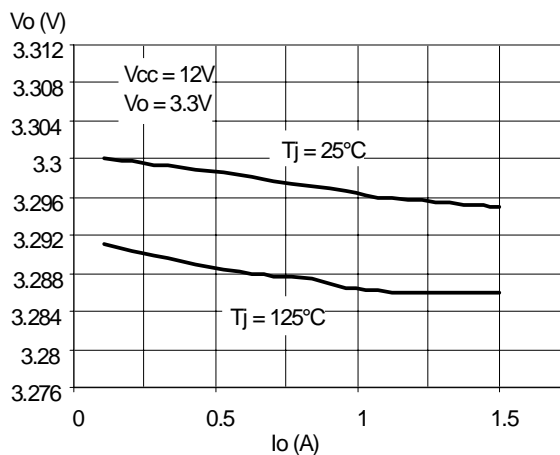
**Figure 2. Junction Temperature vs. Output Current (SO8 \*)**



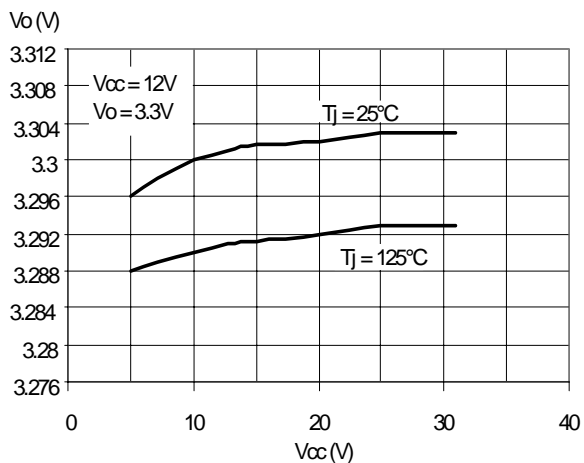
**Figure 3. Junction Temperature vs. Output Current (SO8 \*)**



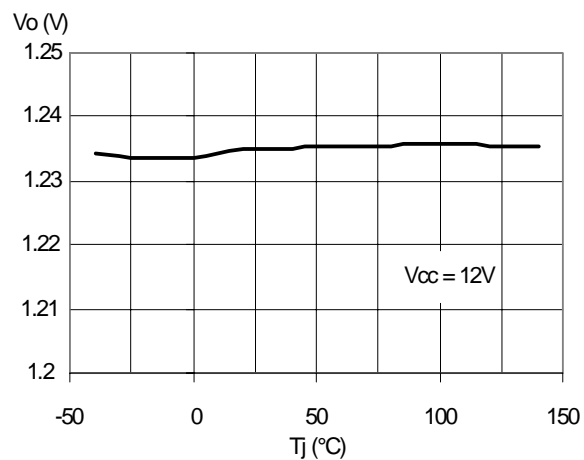
**Figure 4. Load Regulation**



**Figure 5. Line Regulation**

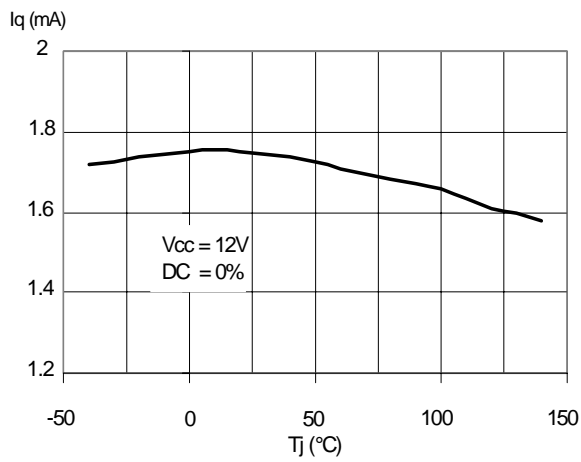


**Figure 6. Output Voltage vs. Junction Temperature**

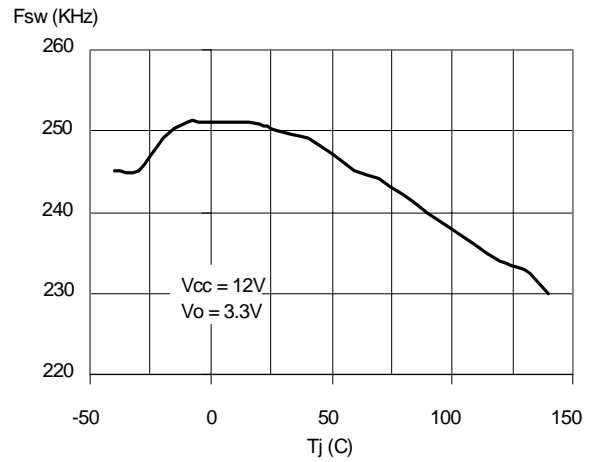


\*) Package mounted on demoboard

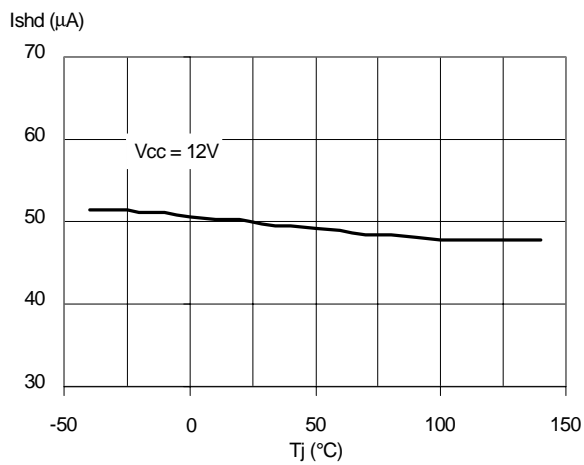
**Figure 7. Quiescent Current vs. Junction Temperature**



**Figure 9. Switching Frequency vs. Junction Temperature**

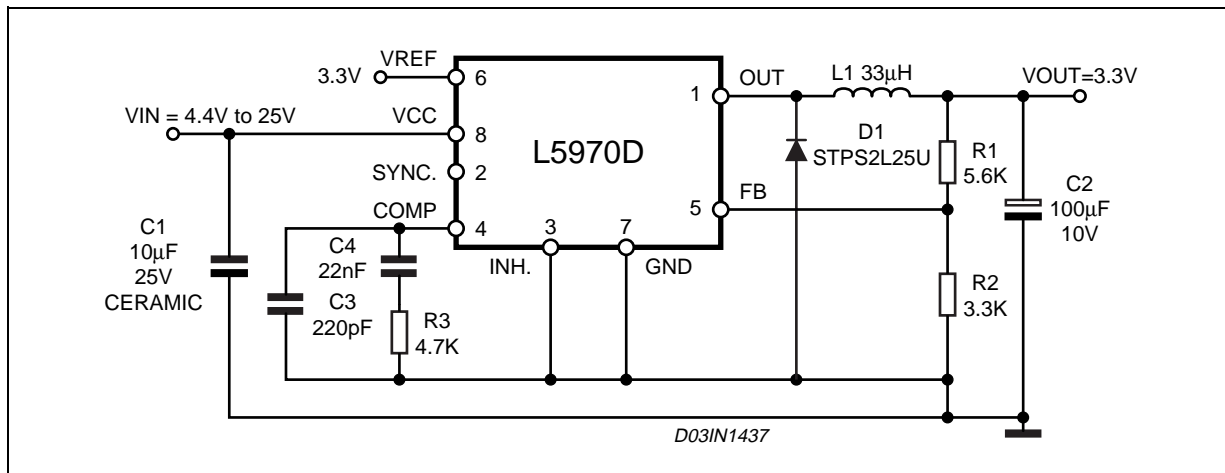


**Figure 8. Shutdown Current vs. Junction Temperature**



# L5970D

Figure 10. Demoboard schematic



## Part list demoboard

Reference	Part Number	Description	Manufacturer
C1		10µF, 25V	TOKIN
C2	POSCAP 10TPB100M	100µF, 10V	Sanyo
C3	C1206C221J5GAC	220pF, 5%, 50V	KEMET
C4	C1206C223K5RAC	22nF, 10%, 50V	KEMET
R1		5.6K, 1%, 0.1W 0603	Neohm
R2		3.3K, 1%, 0.1W 0603	Neohm
R3		4.7K, 1%, 0.1W 0603	Neohm
D1	STPS2L25U	2A, 25V	STMicroelectronics
L1	DO3316P-333	33µH, 2A	COILCRAFT

Figure 11. Efficiency vs. Output Current

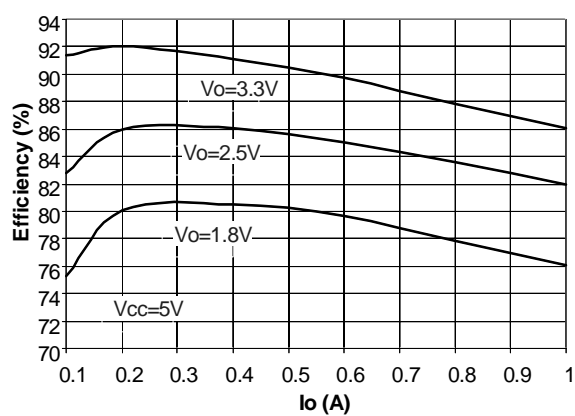


Figure 12. Efficiency vs. Output Current

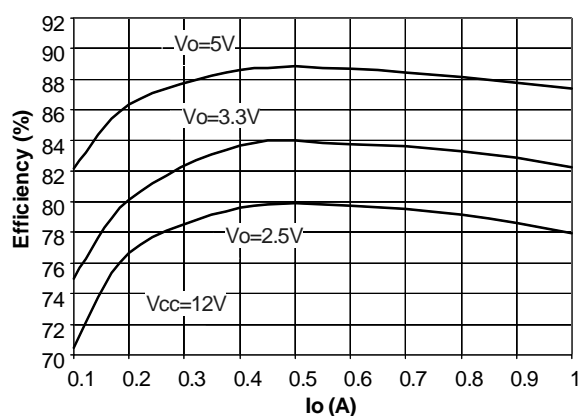


Figure 13. PCB layout (component side)

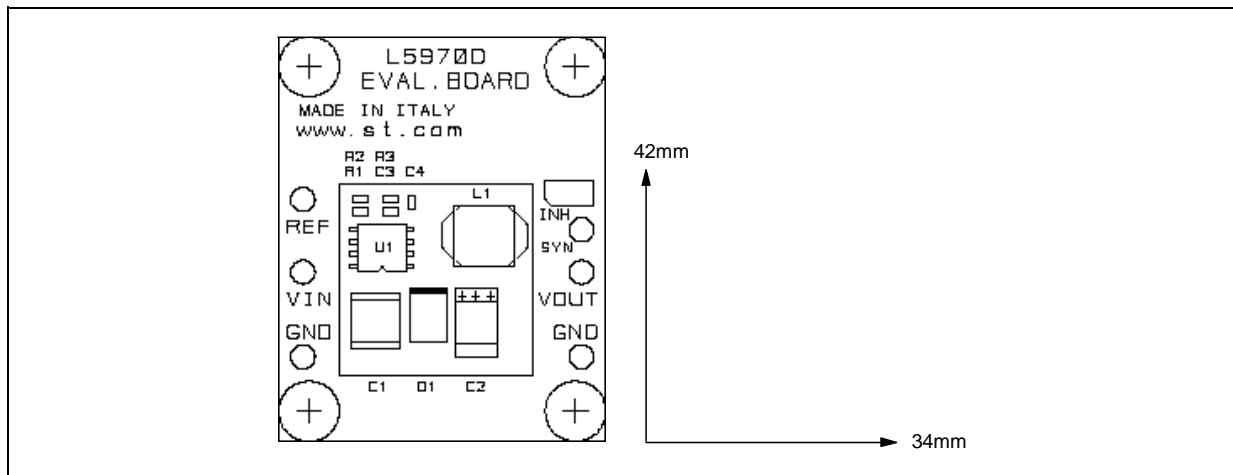


Figure 14. PCB layout (bottom side)

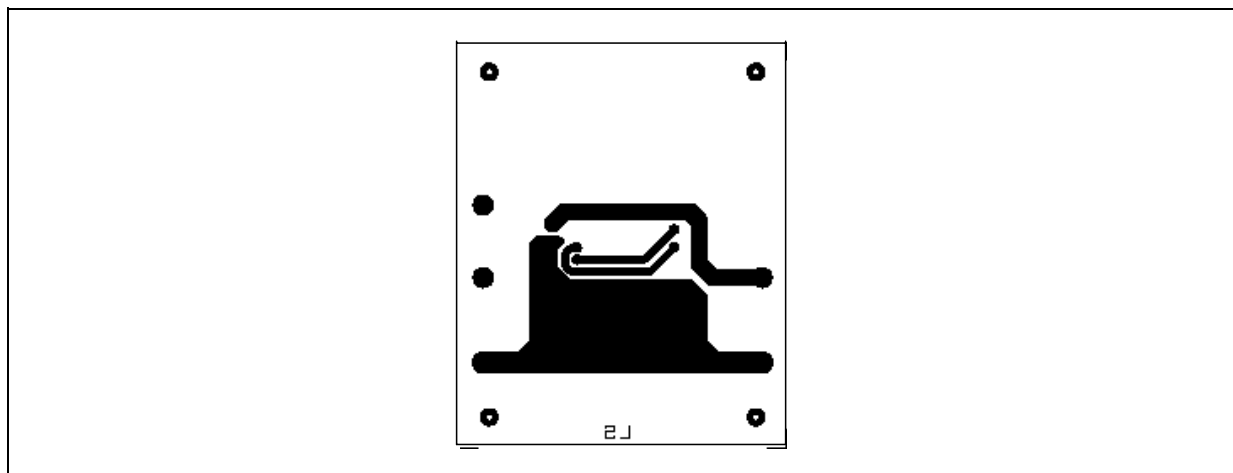
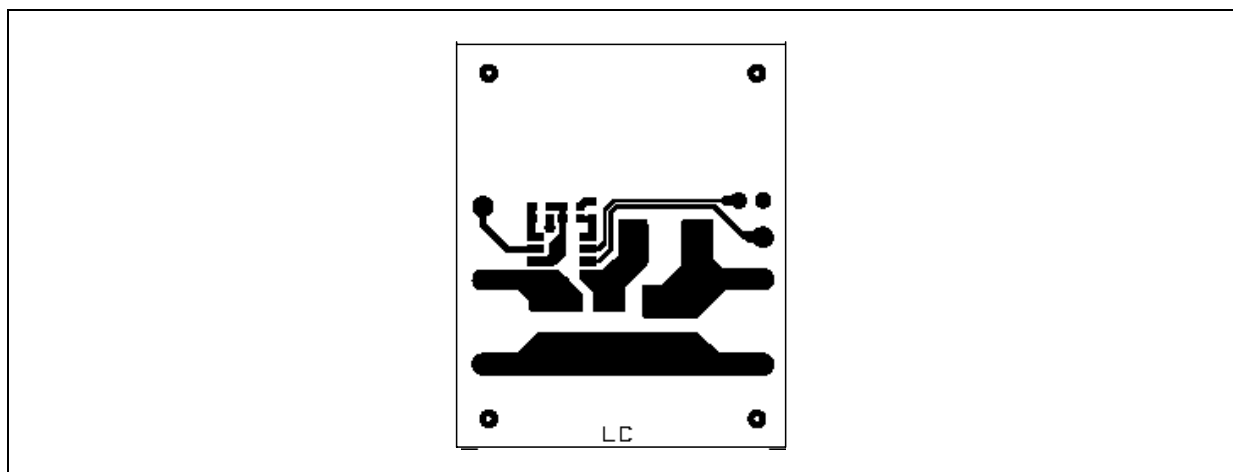


Figure 15. PCB layout (front side)



# L5970D

## APPLICATION IDEAS

Figure 16. Dual output voltage with auxiliary winding

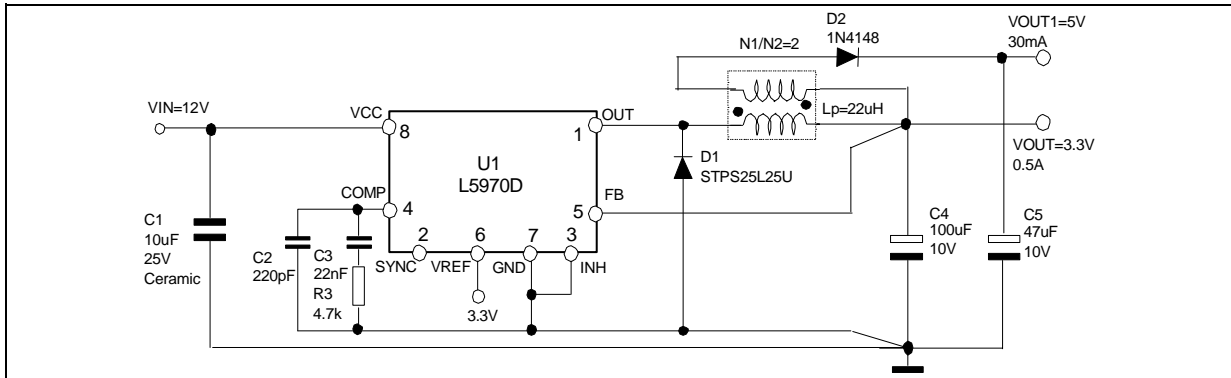


Figure 17. Buck-Boost regulator

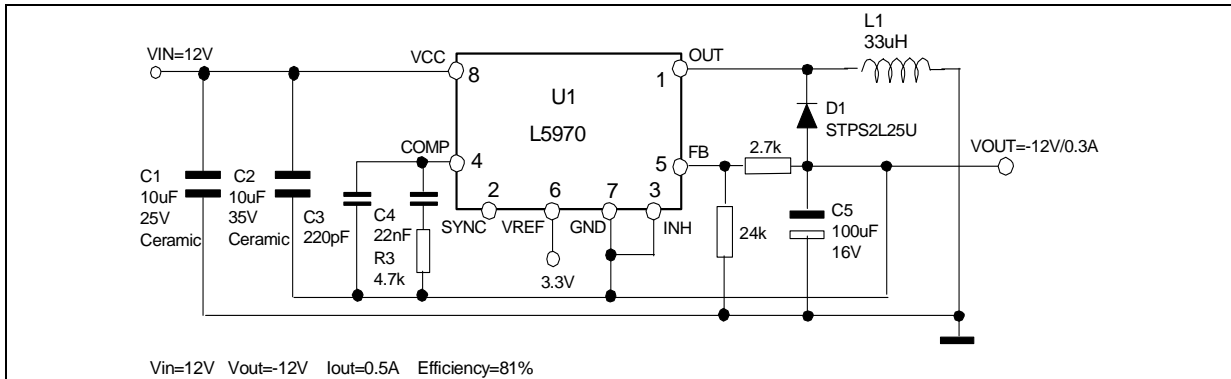


Figure 18. Positive Buck-Boost regul

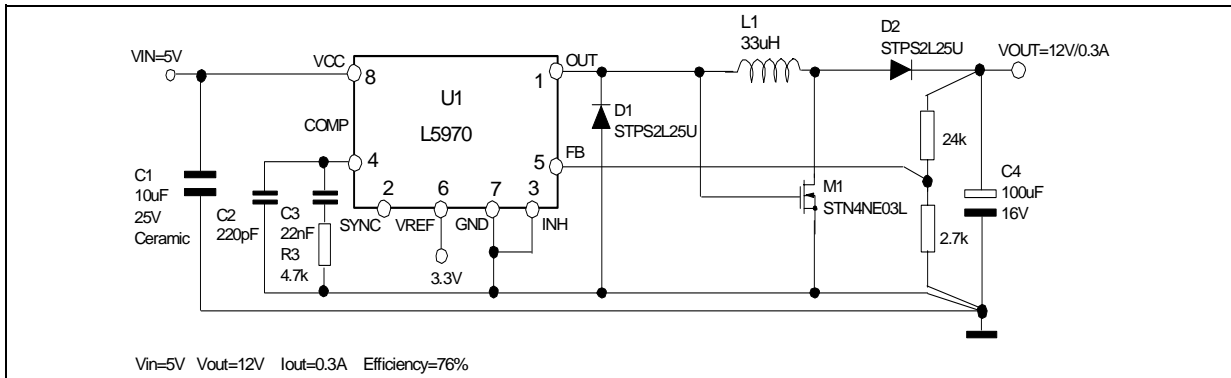
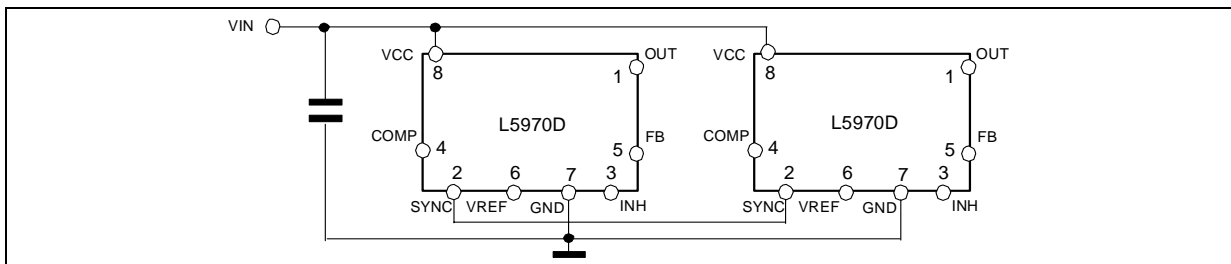


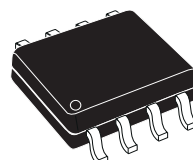
Figure 19. Synchronization example





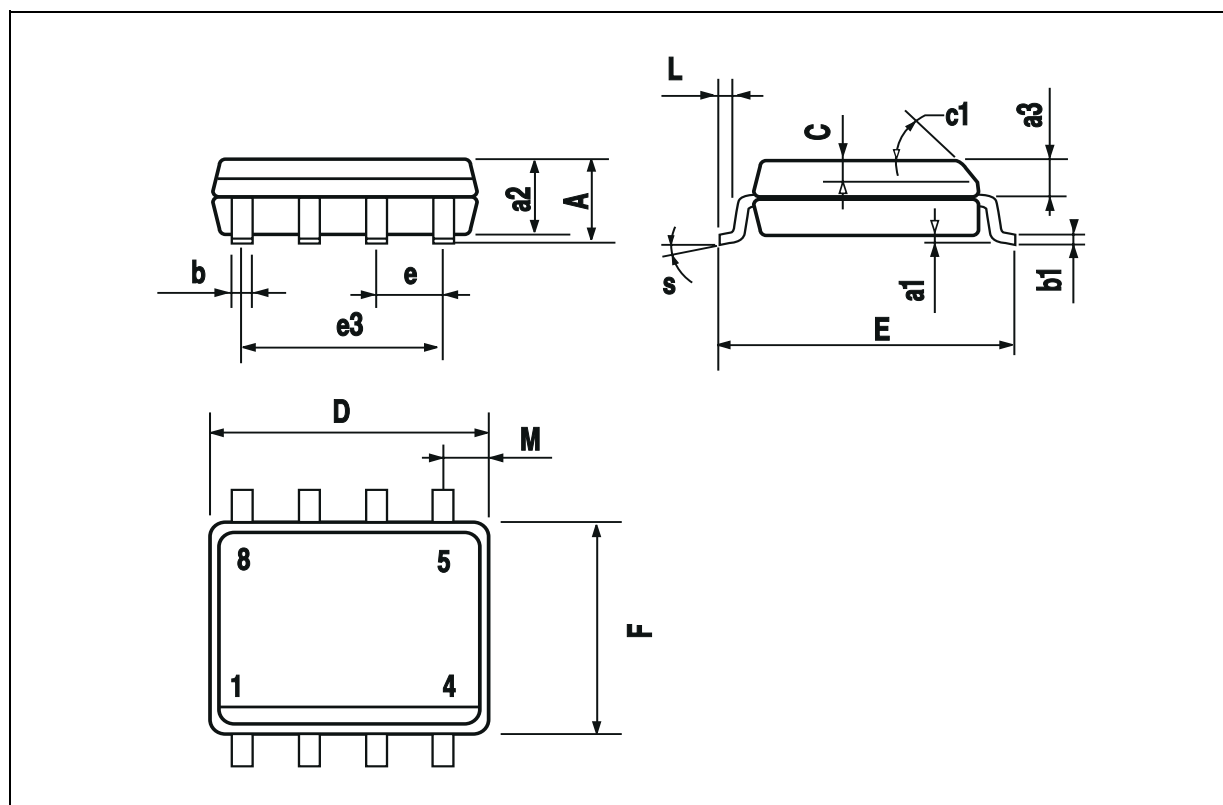
DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			1.75			0.069
a1	0.1		0.25	0.004		0.010
a2			1.65			0.065
a3	0.65		0.85	0.026		0.033
b	0.35		0.48	0.014		0.019
b1	0.19		0.25	0.007		0.010
C	0.25		0.5	0.010		0.020
c1	45° (typ.)					
D (1)	4.8		5.0	0.189		0.197
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		3.81			0.150	
F (1)	3.8		4.0	0.15		0.157
L	0.4		1.27	0.016		0.050
M			0.6			0.024
S	8° (max.)					

## OUTLINE AND MECHANICAL DATA



### SO8

(1) D and F do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.15mm (.006inch).



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