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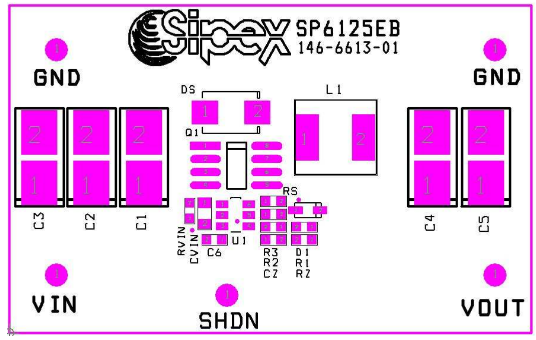
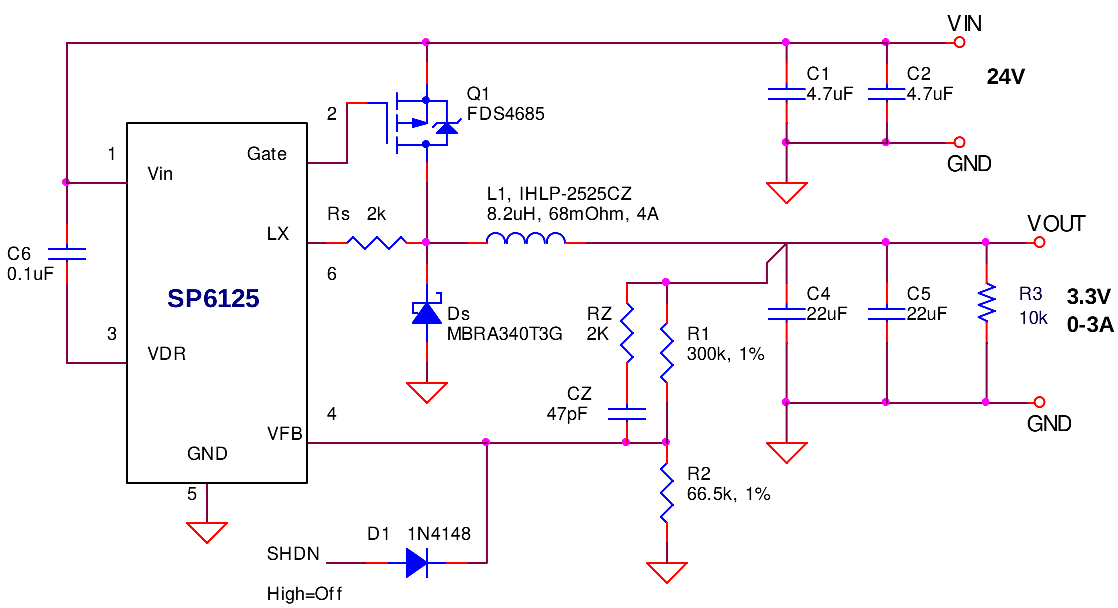
SP6125, 3A
Evaluation Board Manual

- Easy Evaluation for the SP6125EK1 24V Input, 0 to 3A Output Non-Synchronous Buck Converter
- Precision 0.60V ±1% High -Accuracy Reference.
- Small form factor
- Feature Rich: Single supply operation, Over-current protection with auto-restart, on/off function, Preset internal soft start, Type-II internal compensation



SP6125EB SCHEMATIC



* R(10k) is optional. It helps keep the output capacitor discharged under no-load condition.

USING THE EVALUATION BOARD

1) Powering Up the SP6125EB Circuit

Connect the SP6125 Evaluation Board to an external +24V power supply. Connect with short leads directly to the "VIN" and "GND" posts. Connect a Load between the "VOUT" and "GND" posts, again using short leads to minimize inductance and voltage drop.

2) Measuring Output Load Characteristics

It's best to GND reference scope and digital meters using the Star GND post near the output of the board. VOUT ripple can best be seen touching probe tip to the pad for COUT and scope GND collar touching Star GND post – avoid a GND lead on the scope which will increase noise pickup.

3) Using the Evaluation Board with Different Output Voltages

While the SP6125 Evaluation Board has been tested and delivered with the output set to 3.30V, by simply changing one resistor, R2, the SP6125 can be set to other output voltages. The relationship in the following formula is based on a voltage divider from the output to the feedback pin FB, which is set to an internal reference voltage of 0.60V. Standard 1% metal film resistors of surface mount size 0603 are recommended.

$$R2 = \frac{R1}{\left(\frac{Vout}{Vref} - 1\right)}$$

Where R1 = 300kΩ. For Vout = 0.60V setting, simply remove R2 from the board.

Note that since the SP6125 Evaluation Board design was optimized for 24V down conversion to 3.30V, changes of output voltage and/or input voltage will alter performance from the data given in the Power Supply Data section.

Using the SHDN (ON/OFF function)

Feedback pin serves a dual role of ON/OFF control. The MOSFET driver is disabled when a voltage greater than 1V is applied at FB pin. Maximum voltage rating of this pin is 5.5V. The controlling signal should be applied through a small signal diode as shown on page 1. Under no-load condition an optional 10kOhm bleeding resistor across the output helps keep the output capacitor discharged.

POWER SUPPLY DATA

The SP6125EB is designed with an accurate 2% reference over line, load and temperature. Figure 1 data shows a typical SP6125 Evaluation Board efficiency plot, with efficiencies to 82% and output currents to 3A. SP6125 Load Regulation in Figure 2 shows little change in output voltage from no load to 3A load. Figures 3 and 4 show the transient response and Overcurrent. Figures 5 and 6 show a controlled start-up with no load and 3A load when power is applied where the input current rises smoothly as the soft-start ramp increases. Figures 7 and 8 show the output ripple under no load and 3A load.

Typical Performance Characteristics

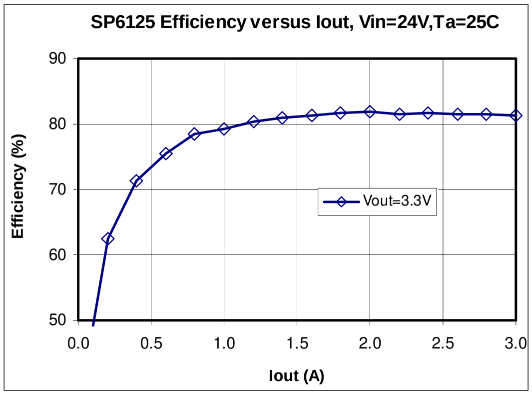


Figure 1- Efficiency, natural convection

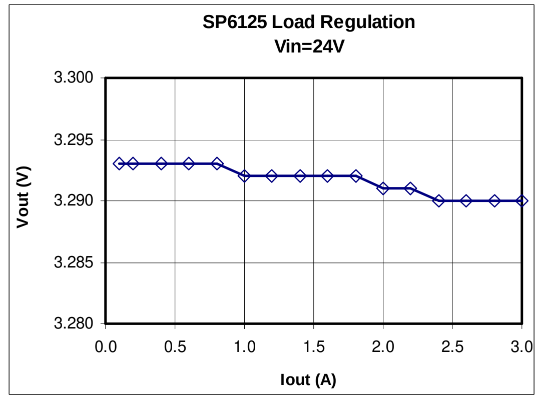


Figure 2- Load regulation

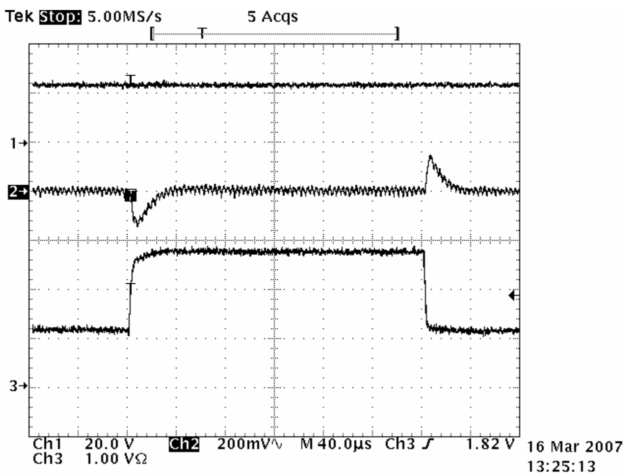


Figure 3- Step load 1.2-2.8A, ch1: Vin
ch2: Vout, ch3: Iout

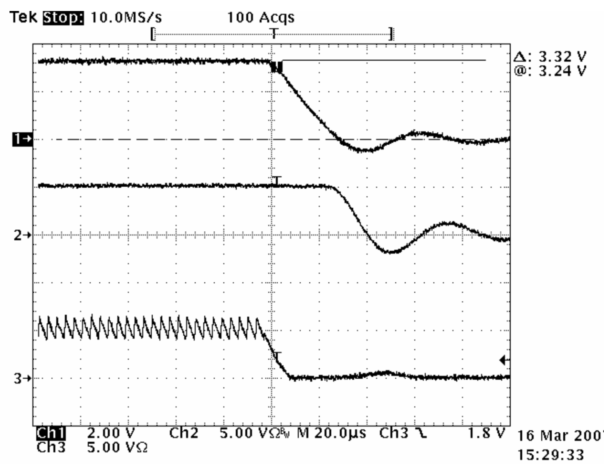


Figure 4- Overcurrent test, ch1: Vout
ch2: Iout, ch3: inductor current

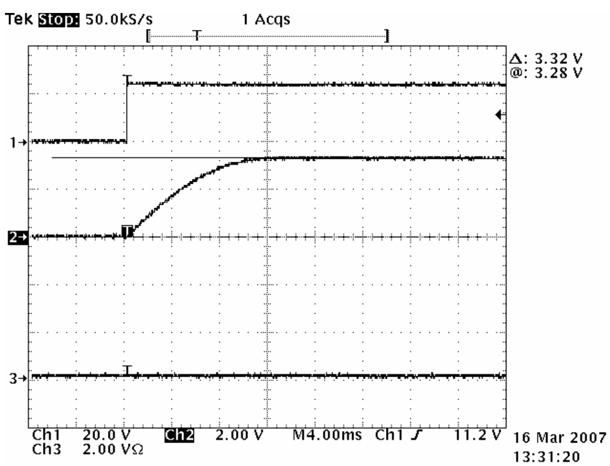


Figure 5- Startup no load, ch1: Vin
ch2: Vout, ch3: Iout

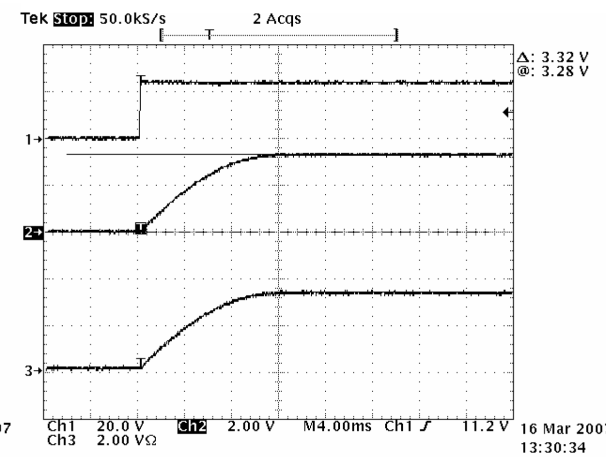


Figure 6- Start up 3A, ch1: Vin
ch2: Vout, ch3: Iout

Typical Performance Characteristics

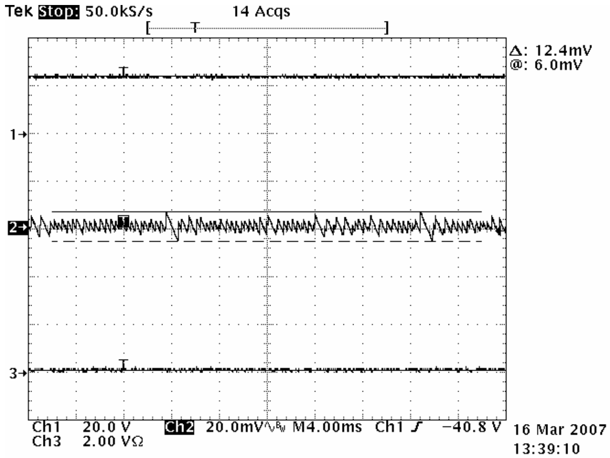


Figure 7- Output ripple at 0A is 12mV,
ch1: Vin, ch2: Vout, ch3: Iout

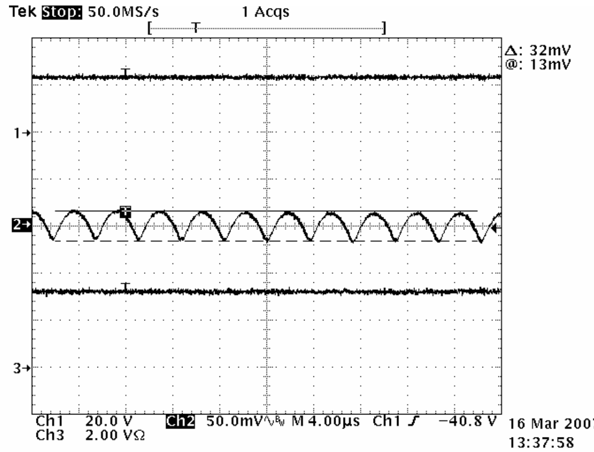


Figure 8- Output ripple at 3A is 32mV,
ch1: Vin, ch2: Vout, ch3: Iout

LOOP COMPENSATION

The SP6125 includes Type-II internal compensation components for loop compensation. External compensation components are not required for systems with tantalum or aluminum electrolytic output capacitors with sufficiently high ESR. Use the condition below as a guideline to determine whether or not the internal compensation is sufficient for your design.

Type-II internal compensation is sufficient if the following condition is met:

$$f_{ESRZERO} < f_{DBPOLE} \quad \ldots\ldots\ldots\ldots\ldots\ldots \text{(1)}$$

where:

$$f_{ESRZERO} = \frac{1}{2.\pi.R_{ESR}.C_{OUT}} \quad \ldots\ldots\ldots\ldots \text{(2)}$$

$$f_{DBPOLE} = \frac{1}{2.\pi.\sqrt{L \cdot C_{OUT}}} \quad \ldots\ldots\ldots\ldots \text{(3)}$$

Creating a Type-III compensation Network

The above condition requires the ESR zero to be at a lower frequency than the double-pole from the LC filter. If this condition is not met, Type-III compensation should be used and can be accomplished by placing a series RC combination in parallel with R1 as shown below. The value of CZ can be calculated as follows and RZ selected from table 1.

$$CZ = \frac{\sqrt{L \cdot C}}{1.3 \times R1} \quad \ldots\ldots\ldots\ldots\ldots \text{(4)}$$

$f_{ESRZERO}/f_{DBPOLE}$	RZ
1X	50K
2X	40K
3X	30K
5X	10K
>= 10X	2K

Table1- Selection of RZ

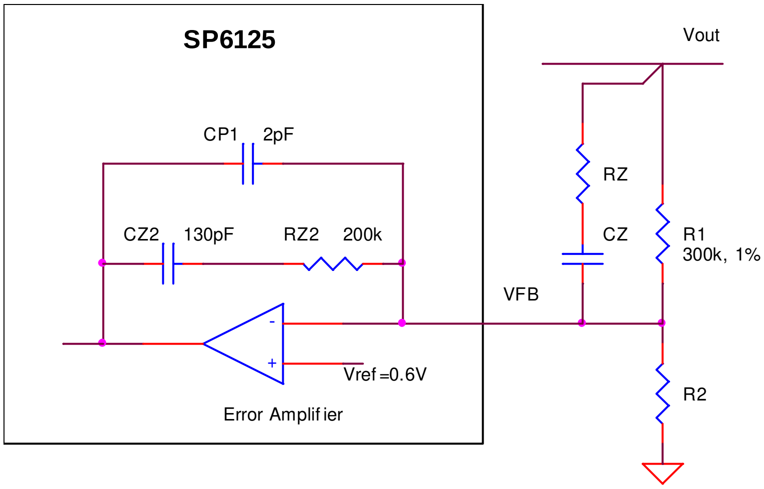


Figure 9- RZ and CZ in conjunction with internal compensation components form a Type-III compensation

Loop Compensation for the SP6125EB

L = 8.2uH, C = 2x22uF/5mOhm ceramic capacitor

From equation (2) $f_{ESRZERO}$ = 1.45MHz. From equation (3) f_{DBPOLE} = 8.4 kHz. Since the condition specified in (1) is not met, Type-III compensation has to be used by adding external components RZ and CZ. Using equation (4) CZ is calculated 48.7pF (use 47pF). Following the guideline given in table 1, a 2kΩ RZ was used.

PCB LAYOUT DRAWINGS

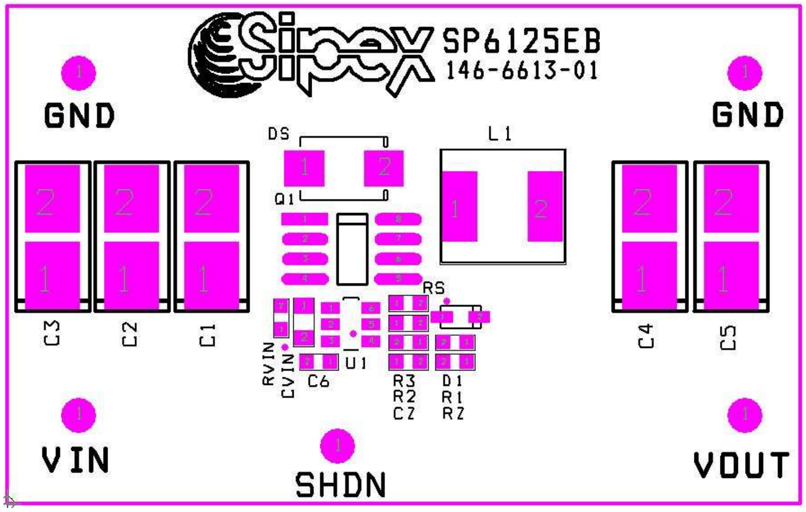


Figure 10. SP6125EB Component Placement

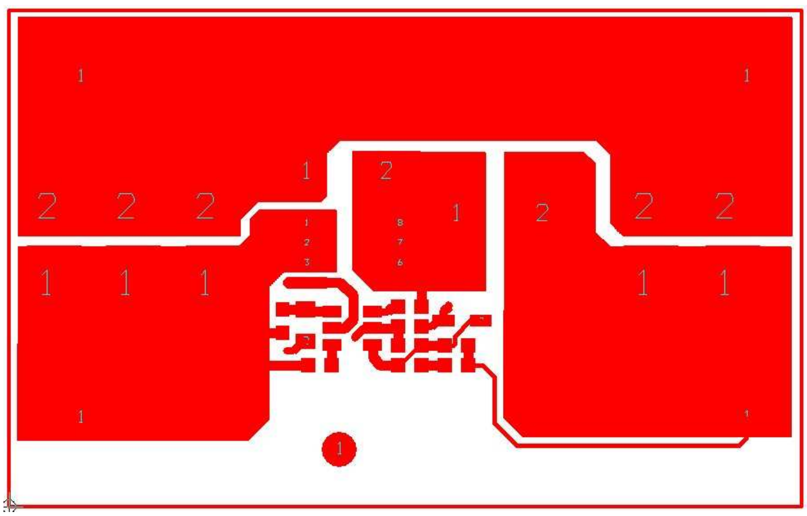


Figure 11. SP6125EB PCB Layout Top Side

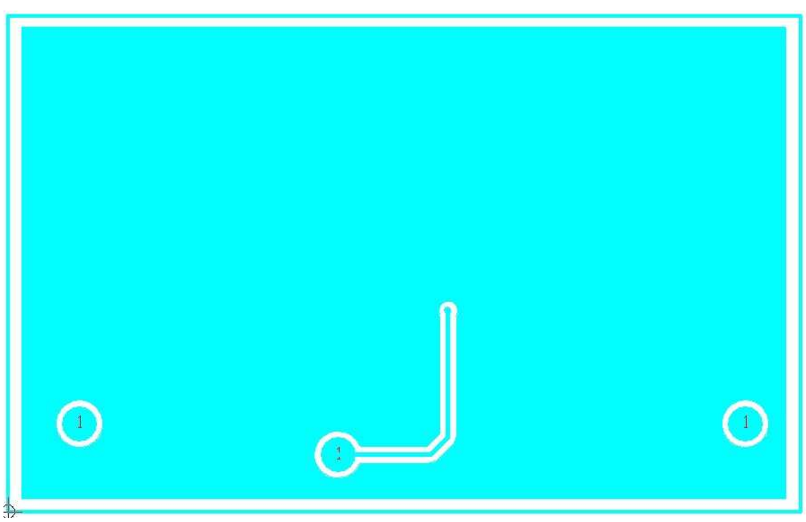


Figure 12. SP6125EB PCB Layout Bottom Side

Line No.	Ref. Des.	Qty.	Manuf.	Manuf. Part Number	Layout Size	Component	Vendor Phone Number
1	PCB	1	Sipex	146-6613-01	1.175"x1.934"	SP6125EB	408-934-7500
2	U1	1	Sipex	SP6125EK1	TSOT-6	Non-synchronous Buck Controller	408-934-7500
3	Q1	1	FAIRCHILD	FDS4685	SO8	PFET, 40V, 35mOhm	402-563-6866
4	DS	1	On Semi	MBRA340T3	SMA	Schotkky, 40V, 3A	602-244-6600
5	L1	1	Vishay	IHLP2525CZ	6.86x6.47mm	8.2uH Coil 7.5A 68mOhm	914-347-2474
6	D1	1	MCC	1N4148WX	SOD323	Fast Switching Diode 500mW	818-701-4933
7	C1, C2	2	MURATA	GRM32ER71H475K	1210	4.7 uF Ceramic X5R 50V	770-436-1300
8	C4, C5	2	MURATA	GRM31CR61C226M	1206	22uF Ceramic X5R 16V	770-436-1300
9	C6	1	MURATA	GRM18ER61E104K	0603	0.1uF Ceramic X5R 25V	770-436-1300
10	CZ	1	MURATA	GRM18ER61H470K	0603	47pF Ceramic C0G 50V	770-436-1300
11	CVIN		Not Populated				
12	R1	1	VISHAY/DALE	CRCW0603300K	0603	300K	402-563-6866
13	R2	1	VISHAY/DALE	CRCW060366K5	0603	66.5K	402-563-6866
14	RZ, Rs	2	VISHAY/DALE	CRCW06032K0	0603	2.0K	402-563-6866
15	R3		Not Populated				
16	RVIN	1	VISHAY/DALE	CRCW06030000Z0	0603	0 Ohm	402-563-6866
17	R	1	VISHAY/DALE	CRCW060310K0	0603	10.0K	402-563-6866
18	VIN, VOUT, GND, GND, SHDN	5	Vector Electronic	K24C/M	.042 Dia	Test Point Post	800-344-4539

Table 2- SP6125EB List of Materials

INDUCTORS - SURFACE MOUNT							
Inductance (uH)	Manufacturer/Part No.	Inductor Specification					Manufacturer Website
		DCR mOhms	Isat (A)	Size LxW(mm)	Ht.(mm)	Inductor Type	
8.2	VISHAY	68.0	7.50	6.47x6.86	3.00	Shielded	www.vishay.com

CAPACITORS - SURFACE MOUNT								
Capacitance(uF)	Manufacturer/Part No.	Capacitor Specification						Manufacturer Website
		ESR ohms (max)	Ripple Current (A) 45C Delta	Size LxW(mm)	Ht.(mm)	Voltage (V)	Capacitor Type	
4.7	MURATA GRM32ER71H475K	0.005	3.20	3.20x2.50	2.50	50.0	X5R Ceramic	www.murata.com
22	MURATA GRM31CR61C226M	0.005	2.80	3.20x1.60	1.60	16.0	X5R Ceramic	www.murata.com

MOSFETS - SURFACE MOUNT								
MOSFET	Manufacturer/Part No.	MOSFET Specification						Manufacturer Website
		RDS(on) mohms (max)	ID Current (A)	Qg nC (Typ)	nC (Max)	Voltage (V)	Foot Print	
P-Ch	FAIRCHILD FDS4685	35	8.2	19.0	27.0	40.0	SO8	www.fairchildsemi.com

Table 3- SP6125EB Suggested Components and Vendor Lists

ORDERING INFORMATION

Model	Temperature Range	Package Type
SP6125EB …..........................	– 40°C to +125°C..................	SP6125 Evaluation Board
SP6125EK1............................	– 40°C to +125°C......................................	6-pin TSOT-6