LT1578
Monolithic 1.5A Switcher
4.3V to 15V Input
3.3V or 5V Output

DESCRIPTION

Demonstration circuit DC303 is a complete DC/DC step-down regulator using the LT®1578, constant frequency, high efficiency converter in an SO-8 package. This circuit is primarily used in personal computers, disk drives, portable handheld devices and, in larger systems, as a local onboard regulator. High frequency switching allows the use of small inductors, making these all surface mount solutions ideal for space-conscious systems.

PERFORMANCE SUMMARY

T_A = 25°C, V_{IN} = 10V, I_{LOAD} = 0.5A, V_{OUT} = 3.3V (Jumper J1 inserted), $\overline{SHDN}$ pin open unless otherwise noted.

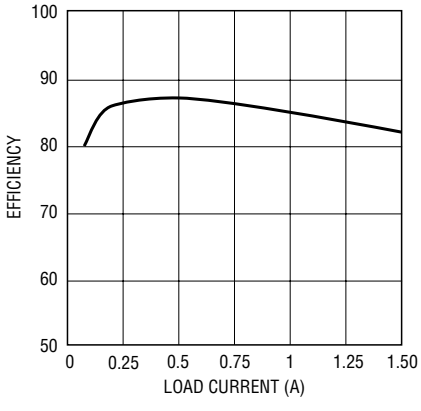
PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Output Voltage	Jumper J1 Removed (Note 1) Jumper J1 Inserted	4.91 3.23	5.02 3.30	5.20 3.42	V V
Maximum I_{LOAD}		1.25			A
Input Voltage Range	(Note 2)	4.3		15	V
Switching Frequency		180	200	220	kHz
Output Ripple Voltage			60		mV_{P-P}
Line Regulation	4.3V to 15V		6		mV
Load Regulation	I_{LOAD} = 10mA to 1.25A		5		mV
$\overline{SHDN}$ Lockout Threshold		2.36	2.44	2.52	V
$\overline{SHDN}$ Shutdown Threshold		0.13	0.37	0.6	V
Synchronization Range		250		400	kHz
Supply Current	$\overline{SHDN}$ = 0V		20		µA

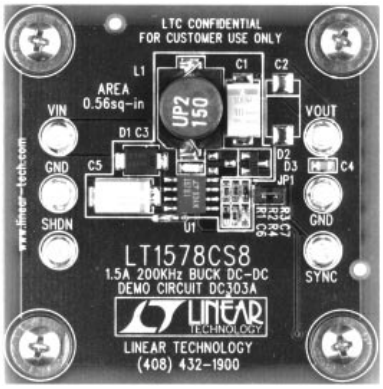
Note 1: Output voltage variations include the ±1% tolerance of the feedback-divider network. For tighter voltage range, use higher tolerance resistors or a fixed 2.5V output device, the LT1578-2.5.

Note 2: For operating voltages up to 25V consult LTC Marketing for details on the LT1576.

TYPICAL PERFORMANCE CHARACTERISTICS AND BOARD PHOTO

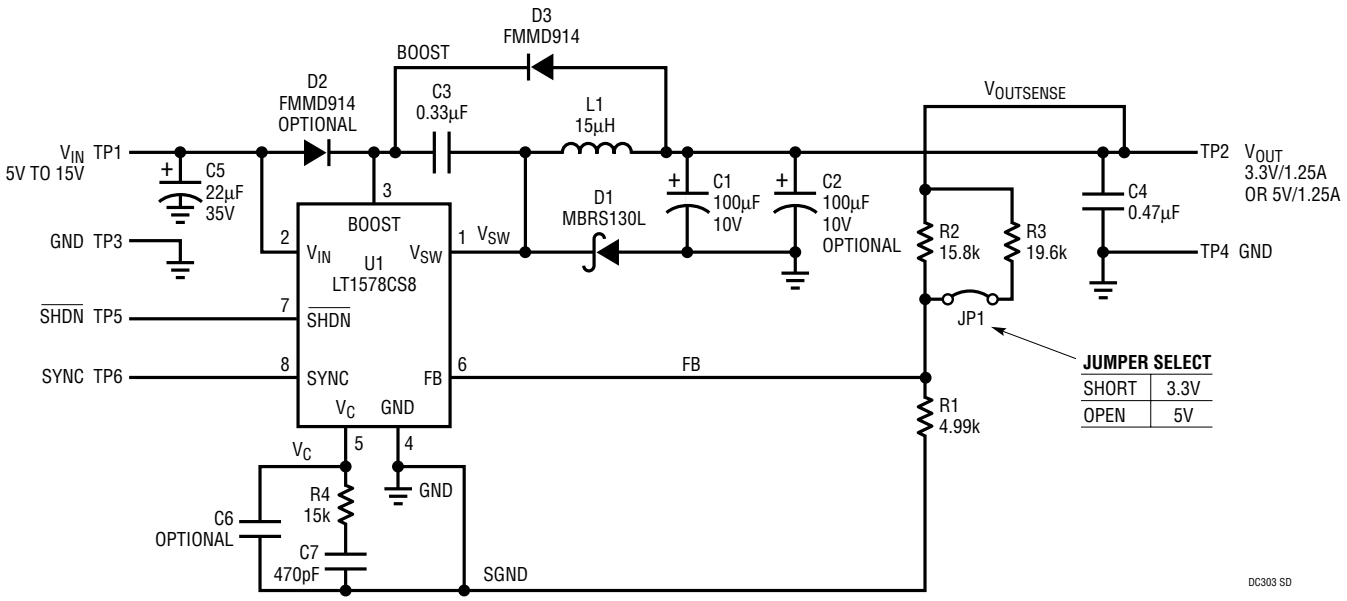
$5V_{IN}$, $3.3V_{OUT}$ Efficiency

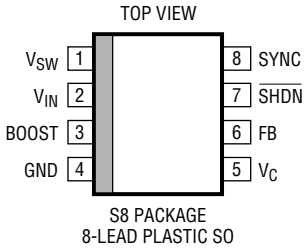




SCHEMATIC AND PACKAGE DIAGRAMS

200kHz Buck Converter with Shutdown





S8 PACKAGE
8-LEAD PLASTIC SO

LT1578CS8

PARTS LIST

REFERENCE DESIGNATOR	QUANTITY	PART NUMBER	DESCRIPTION	VENDOR	TELEPHONE
C1	1	TPSD107K010R0065	100µF 10V 10% Tantalum Capacitor	AVX	(207) 282-5111
C2	1	TPSD107K010R0065	100µF 10V 10% Tantalum Capacitor (Optional)	AVX	(207) 282-5111
C3	1	0805YC334KAT1A	0.33µF 16V 10% X7R Chip Capacitor	AVX	(843) 946-0362
C4	1	0805YC474MAT1A	0.47µF 16V 20% X7R Chip Capacitor	AVX	(843) 946-0362
C5	1	T495X226M035AS	22µF 35V 20% Tantalum Capacitor	Kemet	(864) 963-6300
C6	1		Optional		
C7	1	06035A471JAT1A	470pF 50V 5% NPO Capacitor	AVX	(843) 946-0362
D1	1	MBRS130LT3	1A 30V Schottky Diode	On Semiconductor	(602) 244-6600
D2	1	FMMD914TA	100V General Purpose Diode (Optional)	Zetex	(631) 543-7100
D3	1	FMMD914TA	100V General Purpose Diode	Zetex	(631) 543-7100
JP1	1	2802S-02G2	2mm 2-Pin Jumper	Comm Con	(626) 301-4200
L1	1	UP2-150	15µH 3.8A SMT Inductor	Cooper Electronic Tech.	(561) 752-5000
R1	1	CR16-4991FM	4.99k 1/16W 1% Chip Resistor	ACC	(714) 255-9123
R2	1	CR16-1582FM	15.8k 1/16W 1% Chip Resistor	ACC	(714) 255-9123
R3	1	CR16-1962FM	19.6k 1/16W 1% Chip Resistor	ACC	(800) 508-1521
R4	1	CR16-1502FM	15k 1/16W 1% Chip Resistor	ACC	(800) 508-1521
TP1 to TP6	6	2501-2	0.090 Turret Testpoint	Mill-Max	(516) 922-6000
	4		1/4" #4-40 Screw	Any	
	4	14HTSP101	1/4" #4-40 Nylon Hex Spacer	Micro Plastics	(870) 453-8861
	1	CC1J2mm-138-G	2mm 2-Pin Shunt	Comm Con	(626) 301-4200
U1	1	LT1578CS8	200kHz 1.5A Buck DC/DC SO-8 IC	LTC	(408) 432-1900

OPERATION

LT1578 Operation

The LT1578 data sheet gives a complete description of the part, operation and applications information. The data sheet must be read in conjunction with this demo manual.

Hook-Up

Solid turret terminals are provided for easy connection to supplies and test equipment. The jumper should be inserted if a 3.3V output is required. It should be removed for 5V operation. Connect a 0V to 15V, 2A power supply across the V_{IN} and GND terminals and the load across the V_{OUT} and GND terminals. When measuring load/line regulation, remember to Kelvin connect to the turrets. Also, when measuring output ripple voltage with an oscilloscope probe, the wire from the probe to the ground clip will act as an antenna, picking up noise. For improved results, the ground clip should be removed from the probe. The tip should be touched against the output turret, with the bare ground shield pressed against the ground turret. This reduces the noise seen on the waveform.

Shutdown Operation

For normal operation, the $\overline{SHDN}$ pin can be left floating. $\overline{SHDN}$ has two output-disable modes, lockout and shutdown. When the pin is taken below the lockout threshold, switching is disabled. This is typically used for input undervoltage lockout. Grounding the $\overline{SHDN}$ pin places the LT1578 in shutdown mode. This reduces total board supply current to 20µA.

Synchronization Operation

To synchronize switching to an external clock, apply a logic-level signal to the SYNC pin. Amplitude must be from a logical low to greater than 2.2V with a duty cycle from 10% to 90%. The synchronization frequency must be greater than that of the free-running oscillator. It ranges from 250kHz to 400kHz. Additional circuitry may be required to prevent subharmonic oscillation—refer to the data sheet for more details.

COMPONENTS

Inductor L1

The inductor is a Cooper Electronic Technology UP2-150, a 15µH unshielded ferrite unit. It is selected for its low cost and small size. Various surface mount inductor selections can be found in the LT1578 data sheet.

Input/Output Capacitors C1, C2, C4 and C5

The input capacitor, C5, is a Kemet tantalum capacitor. It was selected for its small size and high voltage rating. The input ripple current for a buck converter is high, typically $I_{OUT}/2$. The output capacitor, C1, is an AVX tantalum capacitor. A ceramic is not recommended as the main output capacitor since loop stability relies on a resistive characteristic at higher frequencies to form a zero. The AVX TPS series, specifically designed for use in switch mode power supplies, has very low ESR. At switching frequencies, ripple voltage is more a function of ESR than of the absolute capacitance value. If lower output ripple voltage is required, use the optional capacitor, C2, to reduce ESR, rather than increasing the capacitance of C1. For very low ripple, an additional LC filter on the output may be a cheaper solution. The output contains very narrow voltage spikes because of the parasitic inductance of C1. A small ceramic capacitor, C4, removes these spikes on the demo board. In application circuits, trace inductance and local bypass capacitors may perform this function, negating the need for C4.

Catch Diode D1

Use diodes designed for switching applications, such as Schottky or ultrafast diodes, with adequate current rating and fast turn-on times. In selecting a diode, the basic parameters of interest are forward voltage, maximum reverse voltage, average operating current and peak current. Lower forward voltage yields higher circuit efficiency and lowers power dissipation in the diode. The MBRS130LT3 has a maximum forward drop of 0.395V at 1A. The reverse voltage rating must be greater than the input voltage. Average diode current is always less than output current, but under a shorted output condition,

OPERATION

diode current can equal the switch current limit. If the application must withstand this condition, the diode must be rated for maximum switch current.

Compensation: C6, C7 and R4

A detailed discussion of frequency compensation can be found in the LT1578 data sheet. R4, a 15k resistor and C7, a 470pF capacitor from V_C to ground, give a stable loop response over a wide range of input and output conditions. Option C6 is included to optimize the dynamic response for specific applications.

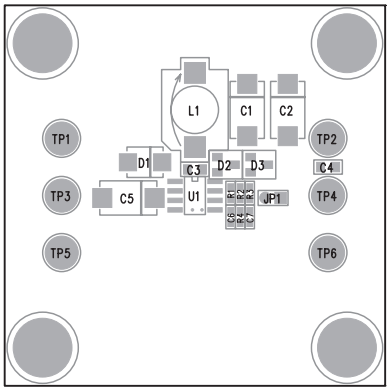
Boost: D2, D3 and C3

A boost voltage of at least 2.8V is required throughout the on time of the switch to guarantee that it remains saturated. For output voltages of 3.3V or more, diode D3 provides sufficient boost voltage to C3. Below 3.3V, D3 can be moved to position D2, powering boost from V_{IN}.

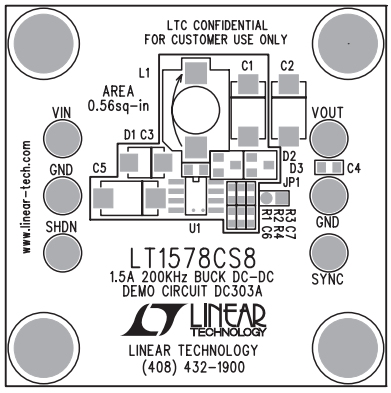
PCB LAYOUT

In many cases, the layout of the demonstration board may be dropped directly into the application with minimal changes. If this is not practical, there are several precautions that must be taken when laying out high frequency converter circuits. The high frequency switching path runs from ground, through C5 to the V_{IN} pin of the LT1578, out of the V_{SW} pin, through D1 and back to ground. This loop acts as an antenna and will radiate noise if not kept as short as possible. Also, at higher switching currents the associated trace inductance can cause excessive voltage spikes across the switch. The use of a ground plane will reduce many noise problems. The ground pin of the LT1578 contains some high frequency signal currents, but more importantly, it is the 0V reference for the output voltage. Connect the ground pin directly to the ground plane. The FB and V_C components should be kept away from the power components as much as possible. The ground for these components should be separated from power grounds. Run a Kelvin sense to V_{OUT} as required, but keep the divider network close to the LT1578 to prevent noise pick-up on the FB node. Noise pickup on the V_C pin appears as various problems, including poor load regulation, subharmonic oscillation and instability. Thermal management must also be considered. The SO-8 package has a fused ground pin. Soldering this pin to a large copper area will significantly reduce its thermal resistance. Solder filled feedthroughs close to the ground pin provide a good thermal path to the ground plane. For more information or advice, contact the LTC Applications department.

PCB LAYOUT AND FILM

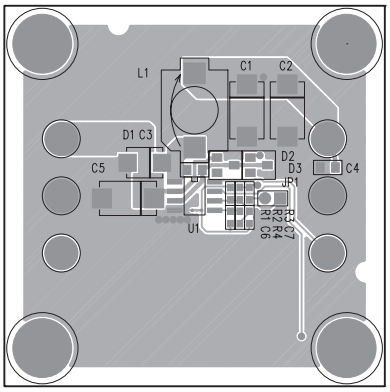


Assembly Top

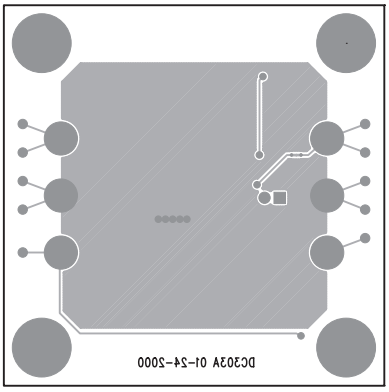


Silkscreen Top

PCB LAYOUT AND FILM

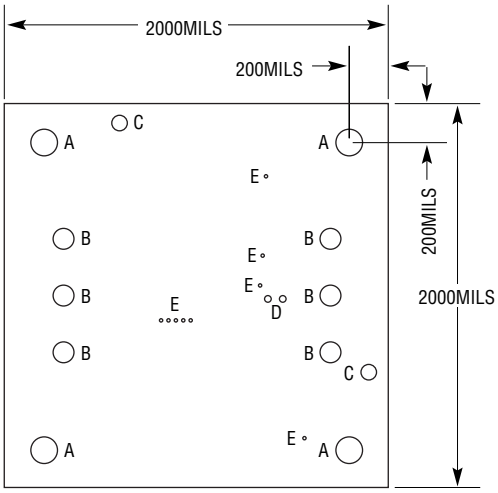


Copper Layer 1 (Top)



Copper Layer 2 (Bottom)

PC FAB DRAWING



SYMBOL	DIAMETER	# OF HOLES	PLATED
A	0.120	4	YES
B	0.094	6	YES
C	0.070	2	NO
D	0.030	2	YES
E	0.015	9	YES
	TOTAL HOLES	23	

NOTES: UNLESS OTHERWISE SPECIFIED

1. MATERIAL: FR4 OR EQUIVALENT EPOXY, 2 OZ. COPPER CLAD THICKNESS 0.062 ± 0.006 TOTAL OF 2 LAYERS.
2. FINISH: ALL PLATED HOLES 0.001 MIN / 0.0015 MAX. COPPER PLATE ELECTRODEPOSITED TIN-LEAD COMPOSITION BEFORE REFLOW. SOLDER MASK OVER BARE COPPER (SMOBC).
3. SOLDER MASK: BOTH SIDES USING LPI OR EQUIVALENT.
4. SILKSCREEN: USING WHITE NONCONDUCTIVE EPOXY INK.

303 FabDwg

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dc303f LT/TP 0700 500 • PRINTED IN USA