19-1563; Rev 0; 1/00

EVALUATION KIT MANUAL FOLLOWS DATA SHEET

Low-Noise Step-Up DC-DC Converter

MAX1790

General Description

The MAX1790 boost converter incorporates high-performance (at 1.2MHz), current-mode, fixed-frequency, pulse-width modulation (PWM) circuitry with a built-in 0.21Ω N-channel MOSFET to provide a highly efficient regulator with fast response.

High switching frequency (640kHz or 1.2MHz selectable) allows easy filtering and faster loop performance. An external compensation pin provides the user flexibility in determining loop dynamics, allowing the use of small, low equivalent series resistance (ESR) ceramic output capacitors. The device can produce an output voltage as high as 12V from an input as low as 2.6V.

Soft-start is programmed with an external capacitor, which sets the input current ramp rate. In shutdown mode, current consumption is reduced to 0.1µA. The MAX1790 is available in a space-saving 8-pin µMAX package. The ultra-small package and high switching frequency allow the total solution to be less than 1.1mm high.

Features

- ♦ 90% Efficiency
- ♦ Adjustable Output from V_{IN} to 12V
- ♦ 1.6A, 0.21Ω, 14V Power MOSFET
- ♦ +2.6V to +5.5V Input Range
- ♦ Pin-Selectable 640kHz or 1.2MHz Switching Frequency
- ♦ 0.1µA Shutdown Current
- ♦ Programmable Soft-Start
- ♦ Small 8-Pin µMAX Package

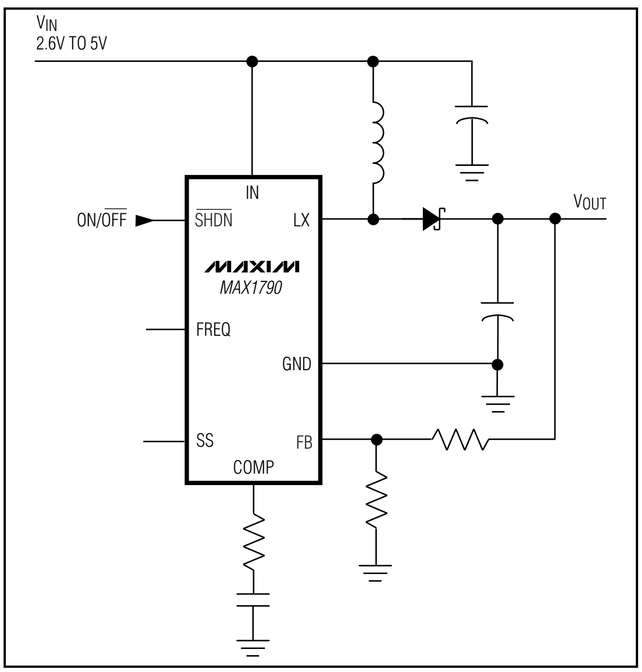
Applications

LCD Displays
PCMCIA Cards
Portable Applications
Hand-Held Devices

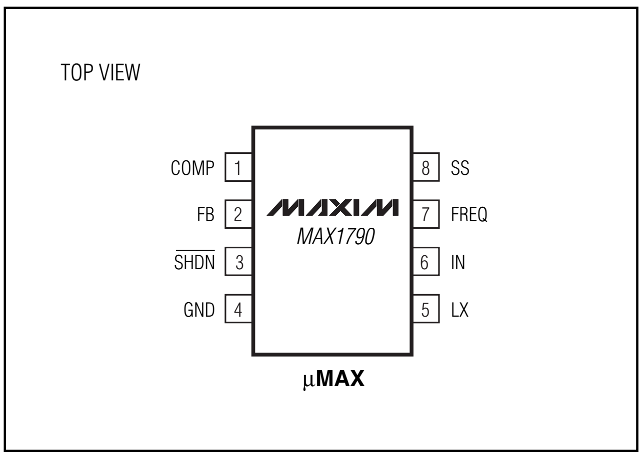
Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE
MAX1790EUA	-40°C to +85°C	8 µMAX

Typical Operating Circuit



Pin Configuration



ABSOLUTE MAXIMUM RATINGS

LX to GND ....-0.3V to +14V
IN, $\overline{SHDN}$, FREQ, FB to GND ....-0.3V to +6V
SS, COMP to GND ....-0.3V to (V_{IN} + 0.3V)
RMS LX Pin Current 1.2A
Continuous Power Dissipation (T_A = +70°C)
8-Pin µMAX (derate 4.1mW/°C above +70°C)...........330mW
Operating Temperature Range
MAX1790EUA ....-40°C to +85°C
Junction Temperature...+150°C
Storage Temperature Range ....-65°C to +150°C
Lead Temperature (soldering, 10s) ....+300°C

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

(V_{IN} = $\overline{SHDN}$ = 3V, FREQ = GND, **T_A = 0°C to +85°C**, unless otherwise noted. Typical values are at T_A = +25°C.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Input Supply Range	V_{IN}		2.6		5.5	V
V_{IN} Undervoltage Lockout	UVLO	V_{IN} rising, typical hysteresis is 40mV, LX remains off below this level	2.25	2.38	2.52	V
Quiescent Current	I_{IN}	V_{FB} = 1.3V, not switching		0.18	0.35	mA
		V_{FB} = 1.0V, switching		2	5	
Shutdown Supply Current	I_{IN}	$\overline{SHDN}$ = GND		0.1	10	µA
ERROR AMPLIFIER						
Feedback Voltage	V_{FB}	Level to produce V_{COMP} = 1.24V	1.222	1.24	1.258	V
FB Input Bias Current	I_{FB}	V_{FB} = 1.24V		0	40	nA
Feedback-Voltage Line Regulation		Level to produce V_{COMP} = 1.24V, 2.6V < V_{IN} < 5.5V		0.05	0.15	%/V
Transconductance	g_m	ΔI = 5µA	70	140	240	µmhos
Voltage Gain	A_V			700		V/V
OSCILLATOR						
Frequency	f_{OSC}	FREQ = GND	540	640	740	kHz
		FREQ = IN	1000	1220	1500	
Maximum Duty Cycle	DC	FREQ = GND	79	85	92	%
		FREQ = IN		84		
N-CHANNEL SWITCH						
Current Limit (Note 1)	I_{LIM}	V_{FB} = 1V, duty cycle = 65%	1.2	1.6	2.3	A
On-Resistance	R_{ON}	I_{LX} = 1.2A		0.21	0.5	Ω
Leakage Current	I_{LXOFF}	V_{LX} = 12V		0.01	20	µA
Current-Sense Transresistance	R_{CS}		0.3	0.45	0.65	V/A
SOFT-START						
Reset Switch Resistance					100	Ω
Charge Current		V_{SS} = 1.2V	1.5	4	7	µA
CONTROL INPUTS						
Input Low Voltage	V_{IL}	$\overline{SHDN}$, FREQ; V_{IN} = 2.6V to 5.5V			0.3 • V_{IN}	V
Input High Voltage	V_{IH}	$\overline{SHDN}$, FREQ; V_{IN} = 2.6V to 5.5V	0.7 • V_{IN}			V
Hysteresis		$\overline{SHDN}$, FREQ		0.1 • V_{IN}		V
FREQ Pull-Down Current	I_{FREQ}		1.8	5	9	µA
$\overline{SHDN}$ Input Current	$I_{\overline{SHDN}}$			0.001	1	µA

ELECTRICAL CHARACTERISTICS

(V_{IN} = $\overline{SHDN}$ = 3V, FREQ = GND, **T_A = -40°C to +85°C**, unless otherwise noted.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Input Supply Range	V_{IN}		2.6		5.5	V
V_{IN} Undervoltage Lockout	UVLO	V_{IN} rising, typical hysteresis is 40mV, LX remains off below this level	2.25		2.52	V
Quiescent Current	I_{IN}	V_{FB} = 1.3V, not switching		0.2	0.35	mA
		V_{FB} = 1.0V, switching		4	5	
Shutdown Supply Current	I_{IN}	$\overline{SHDN}$ = GND			10	µA
ERROR AMPLIFIER						
Feedback Voltage	V_{FB}	Level to produce V_{COMP} = 1.24V	1.215		1.26	V
FB Input Bias Current	I_{FB}	V_{FB} = 1.24V			40	nA
Feedback-Voltage Line Regulation		Level to produce V_{COMP} = 1.24V, 2.6V < V_{IN} < 5.5V			0.15	%/V
Transconductance	g_m	ΔI = 5µA	70		260	µmhos
OSCILLATOR						
Frequency	f_{OSC}	FREQ = GND	490		770	kHz
		FREQ = IN	900		1500	
Maximum Duty Cycle	DC	FREQ = GND	78		92	%
N-CHANNEL SWITCH						
Current Limit	I_{LIM}	V_{FB} = 1V, duty cycle = 65%	1.2		2.3	A
On-Resistance	R_{ON}	I_{LX} = 1.2A			0.5	Ω
Current-Sense Transresistance	R_{CS}		0.3		0.65	V/A
CONTROL INPUTS						
Input Low Voltage	V_{IL}	$\overline{SHDN}$, FREQ, V_{IN} = 2.6V to 5.5V			0.3 • V_{IN}	V
Input High Voltage	V_{IH}	$\overline{SHDN}$, FREQ, V_{IN} = 2.6V to 5.5V	0.7 • V_{IN}			V

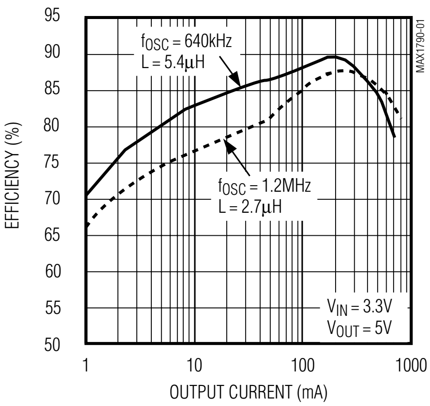
Note 1: Current limit varies with duty cycle due to slope compensation. See the *Output Current Capability* section.
Note 2: Specifications to -40°C are guaranteed by design and not production tested.

Low-Noise Step-Up DC-DC Converter

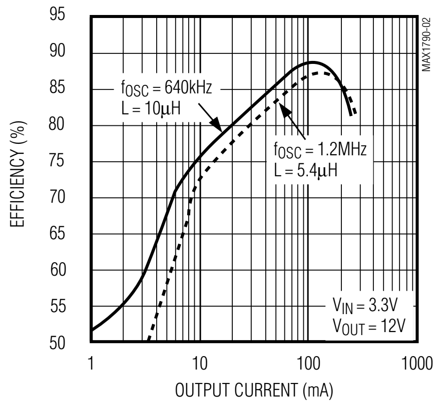
Typical Operating Characteristics

(Circuit of Figure 1, V_{IN} = 3.3V, f_{OSC} = 640kHz, T_A = +25°C, unless otherwise noted.)

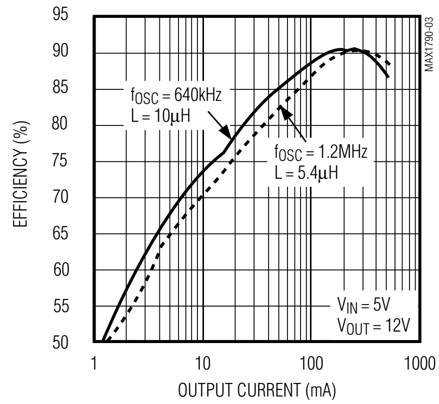
EFFICIENCY vs. OUTPUT CURRENT



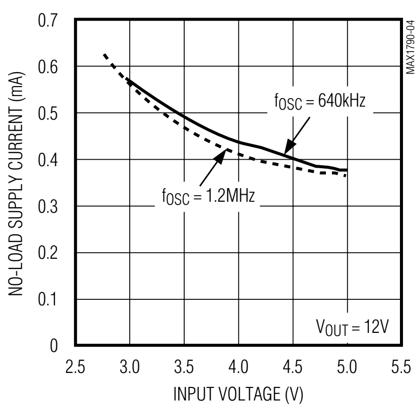
EFFICIENCY vs. OUTPUT CURRENT



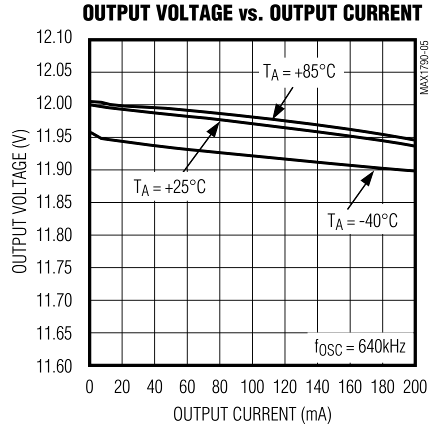
EFFICIENCY vs. OUTPUT CURRENT



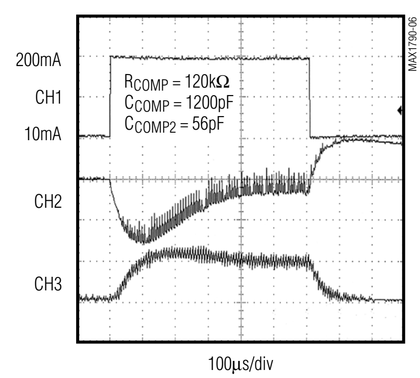
NO-LOAD SUPPLY CURRENT vs. INPUT VOLTAGE



OUTPUT VOLTAGE vs. OUTPUT CURRENT



LOAD-TRANSIENT RESPONSE

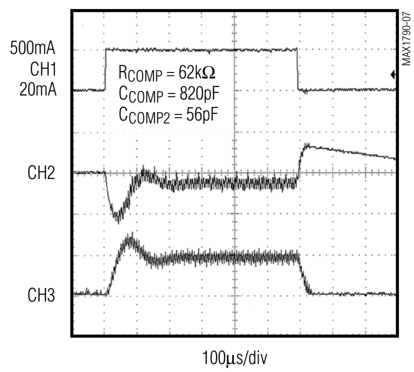


CH1 = LOAD CURRENT, 100mA/div
CH2 = OUTPUT VOLTAGE, AC-COUPLED, 200mV/div
CH3 = INDUCTOR CURRENT, 1A/div
V_{IN} = 3V
V_{OUT} = 12V, f_{OSC} = 640kHz, C_{OUT} = 33µF + 0.1µF

Typical Operating Characteristics (continued)

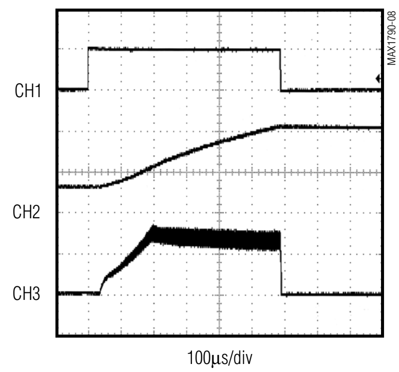
(Circuit of Figure 1, V_{IN} = 3.3V, f_{OSC} = 640kHz, T_A = +25°C, unless otherwise noted.)

LOAD-TRANSIENT RESPONSE



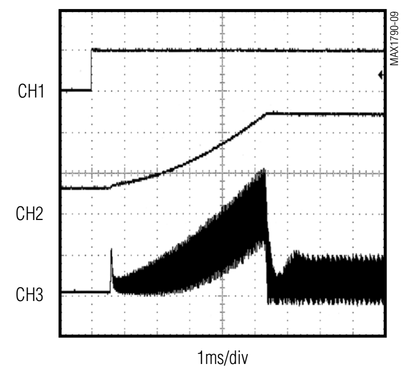
CH1 = LOAD CURRENT, 500mA/div
CH2 = OUTPUT VOLTAGE, AC-COUPLED, 200mV/div
CH3 = INDUCTOR CURRENT, 1A/div
V_{OUT} = 5V, f_{OSC} = 640kHz, C_{OUT} = 47µF + 0.1µF

STARTUP WAVEFORM WITHOUT SOFT-START



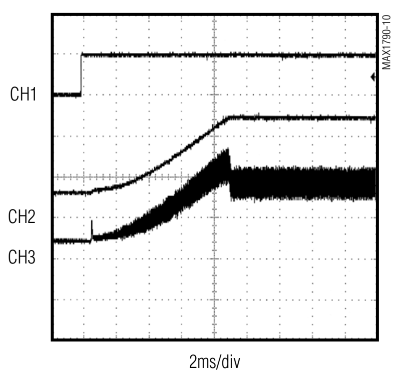
CH1 = $\overline{SHDN}$, 5V/div
CH2 = OUTPUT VOLTAGE, 5V/div
CH3 = INDUCTOR CURRENT, 1A/div
V_{IN} = 3.3V, V_{OUT} = 12V, I_{OUT} = 10mA, f_{OSC} = 640kHz
NO SOFT-START CAPACITOR, C_{OUT} = 33µF

STARTUP WAVEFORM WITH SOFT-START



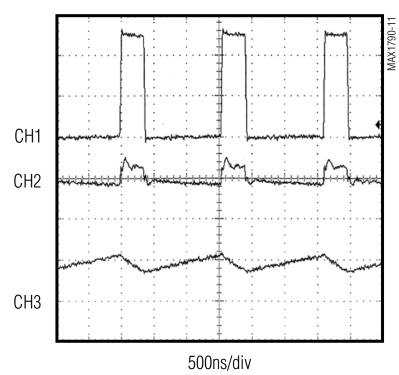
CH1 = $\overline{SHDN}$, 5V/div
CH2 = OUTPUT VOLTAGE, 5V/div
CH3 = INDUCTOR CURRENT, 200mA/div
V_{OUT} = 12V, I_{OUT} = 10mA, f_{OSC} = 640kHz,
C_{SS} = 0.027µF, C_{OUT} = 33µF

STARTUP WAVEFORM WITH SOFT-START



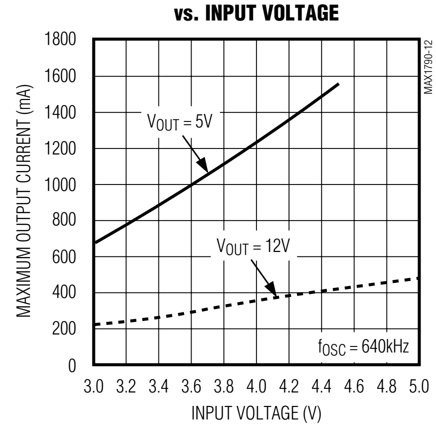
CH1 = $\overline{SHDN}$, 5V/div
CH2 = V_{OUT}, 5V/div
CH3 = INDUCTOR CURRENT, 500mA/div
V_{OUT} = 12V, I_{OUT} = 200mA, f_{OSC} = 640kHz,
C_{SS} = 0.027µF

SWITCHING WAVEFORM



CH1 = LX SWITCHING WAVEFORM, 5V/div
CH2 = OUTPUT VOLTAGE, AC-COUPLED, 200mV/div
CH3 = INDUCTOR CURRENT, 1A/div
V_{OUT} = 12V, I_{OUT} = 200mA, f_{OSC} = 640kHz, L = 10µH;
C_{OUT} = 33µF + 0.1µF

MAXIMUM OUTPUT CURRENT vs. INPUT VOLTAGE



Low-Noise Step-Up DC-DC Converter

Pin Description

PIN	NAME	FUNCTION
1	COMP	Compensation Pin for Error Amplifier. Connect a series RC from COMP to ground. See the *Loop Compensation* section for component selection guidelines.
2	FB	Feedback Pin. Reference voltage is 1.24V nominal. Connect an external resistor-divider tap to FB and minimize the trace area. Set V_{OUT} according to: V_{OUT} = 1.24V (1 + R1 / R2). See Figure 1.
3	$\overline{SHDN}$	Shutdown Control Input. Drive $\overline{SHDN}$ low to turn off the MAX1790.
4	GND	Ground
5	LX	Switch Pin. Connect the inductor/catch diode to LX and minimize the trace area for lowest EMI.
6	IN	Supply Pin. Bypass IN with at least a 1µF ceramic capacitor directly to GND.
7	FREQ	Frequency Select Input. When FREQ is low, the oscillator frequency is set to 640kHz. When FREQ is high, the frequency is 1.2MHz. This input has a 5µA pull-down current.
8	SS	Soft-Start Control Pin. Connect a soft-start capacitor (C_{SS}) to this pin. Leave open for no soft-start. The soft-start capacitor is charged with a constant current of 4µA. Full current limit is reached after t = 2.5 • 10^5 C_{SS}. The soft-start capacitor is discharged to ground when $\overline{SHDN}$ is low. When $\overline{SHDN}$ goes high, the soft-start capacitor is charged to 0.5V, after which soft-start begins.

Detailed Description

The MAX1790 is a highly efficient power supply that employs a current-mode, fixed-frequency pulse-width modulation (PWM) architecture for fast transient response and low-noise operation. The device regulates the output voltage through a combination of an error amplifier, two comparators, and several signal generators (Figure 2). The error amplifier compares the signal at FB to 1.24V and varies the COMP output. The voltage at COMP determines the current trip point each time the internal MOSFET turns on. As the load varies, the error amplifier sources or sinks current to the COMP output accordingly to produce the inductor peak current necessary to service the load. To maintain stability at high duty cycle, a slope compensation signal is summed with the current-sense signal.

At light loads, this architecture allows the MAX1790 to "skip" cycles to prevent overcharging the output voltage. In this region of operation, the inductor ramps up to a peak value of about 50mA, discharges to the output, and waits until another pulse is needed again.

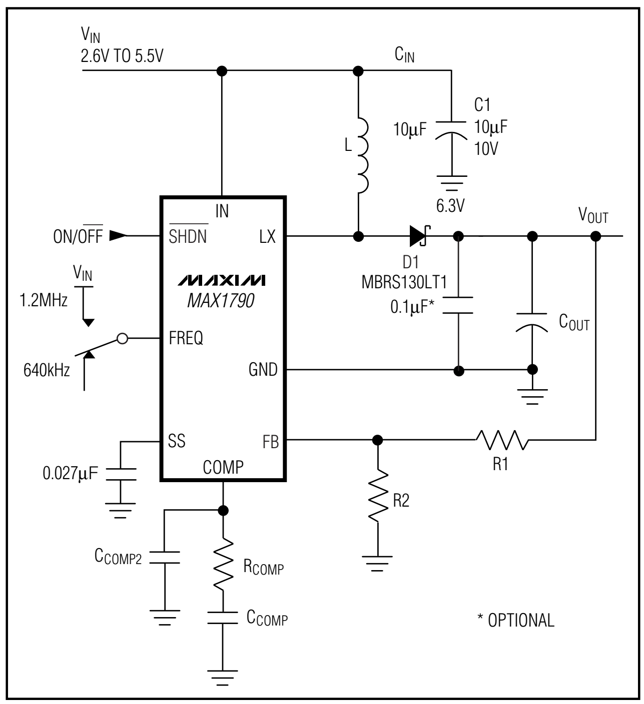


Figure 1. Typical Application Circuit

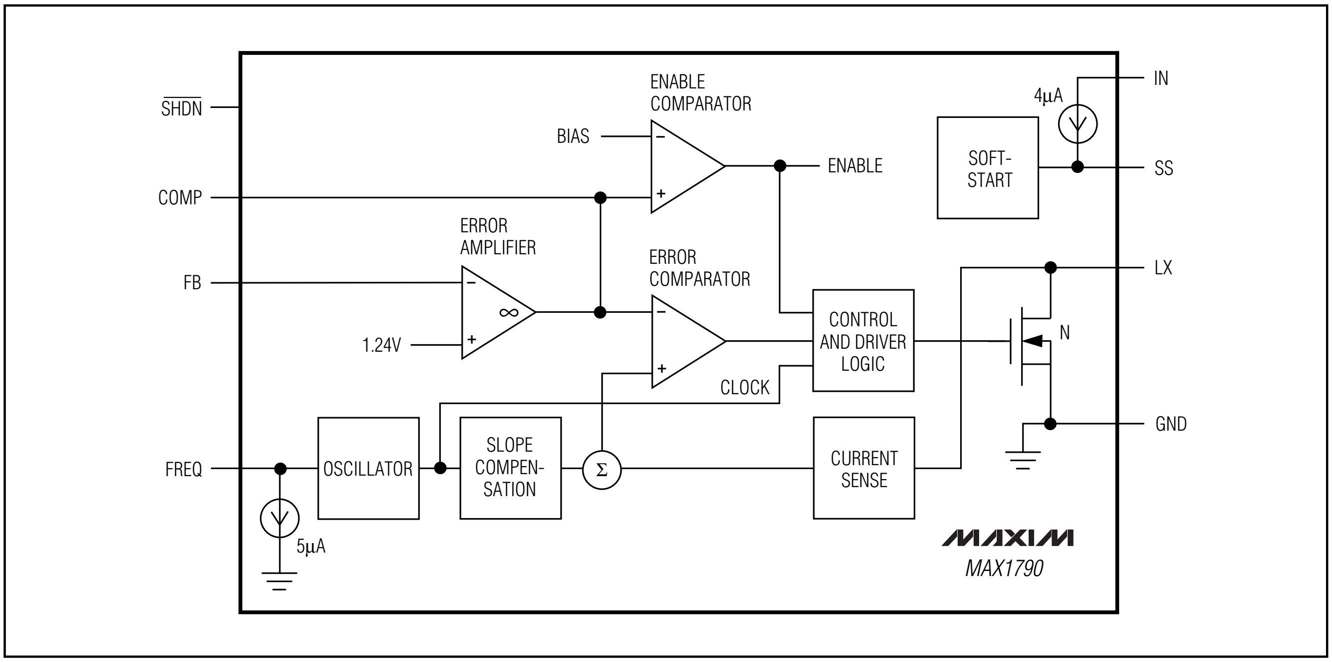


Figure 2. Functional Diagram

Output Current Capability

The output current capability of the MAX1790 is a function of current limit, input voltage, operating frequency, and inductor value. Because of the slope compensation used to stabilize the feedback loop, the duty cycle affects the current limit. The output current capability is governed by the following equation:

$$I_{OUT(MAX)} = [I_{LIM} \cdot (1.26 - 0.4 \cdot Duty) - 0.5 \cdot Duty \cdot V_{IN} / (f_{OSC} \cdot L)] \cdot \eta \cdot V_{IN} / V_{OUT}$$

where:

I_{LIM} = current limit specified at 65% (see *Electrical Characteristics*)

Duty = duty cycle = $(V_{OUT} - V_{IN} + V_{DIODE}) / (V_{OUT} - I_{LIM} \cdot R_{ON} + V_{DIODE})$

V_{DIODE} = catch diode forward voltage at I_{LIM}

η =conversion efficiency, 85% nominal

Soft-Start

The MAX1790 can be programmed for soft-start upon power-up with an external capacitor. When the shutdown pin is taken high, the soft-start capacitor (C_{SS}) is immediately charged to 0.5V. Then the capacitor is charged at a constant current of 4μA (typ). During this time, the SS voltage directly controls the peak inductor current, allowing 0A at V_{SS} = 0.5V to the full current limit at V_{SS} = 1.5V. The maximum load current is available after the soft-start cycle is completed. When the shutdown pin is taken low, the soft-start capacitor is discharged to ground.

Frequency Selection

The MAX1790's frequency can be user selected to operate at either 640kHz or 1.2MHz. Tie FREQ to GND for 640kHz operation. For a 1.2MHz switching frequency, tie FREQ to IN. This allows the use of small, minimum-height external components while maintaining low output noise. FREQ has an internal pull-down, allowing the user the option of leaving FREQ unconnected for 640kHz operation.

Shutdown

The MAX1790 shuts down to reduce the supply current to 0.1μA when $\overline{SHDN}$ is low. In this mode, the internal reference, error amplifier, comparators, and biasing circuitry turn off while the N-channel MOSFET is turned off. The boost converter's output is connected to IN via the external inductor and catch diode.

Applications Information

Boost DC-DC converters using the MAX1790 can be designed by performing simple calculations for a first iteration. All designs should be prototyped and tested prior to production. Table 1 provides a list of components for a range of standard applications. Table 2 lists component suppliers.

Table 1. Component Selection

V_{IN} (V)	V_{OUT} (V)	f_{OSC} (Hz)	L (µH)	C_{OUT} (µF)	R_{COMP} (kΩ)	C_{COMP} (pF)	C_{COMP2} (pF)	TYPICAL $I_{OUT(MAX)}$ (mA)
3.3	12	640k	10 (Sumida CDRH5D18-100NC)	33 tantalum (AVX TPSD336020R0200)	120	1200	33	250
3.3	12	1.2M	5.4 (Sumida CDRH5D18-5R4NC)	33 tantalum (AVX TPSD336020R0200)	180	650	20	250
3.3	5	640k	5.4 (Sumida CDRH5D18-5R4NC)	47 tantalum (6TPA47M)	62	820	56	800
3.3	5	1.2M	2.7 (Sumida CDRH4018-2R7)	47 tantalum (6TPA47M)	91	390	33	800

Table 2. Component Suppliers

SUPPLIER	PHONE	FAX
Inductors		
Coilcraft	847-639-6400	847-639-1469
Coiltronics	561-241-7876	561-241-9339
Sumida USA	847-956-0666	847-956-0702
Toko	847-297-0070	847-699-1194
Capacitors		
AVX	803-946-0690	803-626-3123
Kemet	408-986-0424	408-986-1442
Sanyo	619-661-6835	619-661-1055
Taiyo Yuden	408-573-4150	408-573-4159
Diodes		
Central Semiconductor	516-435-1110	516-435-1824
International Rectifier	310-322-3331	310-322-3332
Motorola	602-303-5454	602-994-6430
Nihon	847-843-7500	847-843-2798
Zetex	516-543-7100	516-864-7630

External component value choice is primarily dictated by the output voltage and the maximum load current, as well as maximum and minimum input voltages. Begin by selecting an inductor value. Once L is known, choose the diode and capacitors.

Inductor Selection

Inductor selection depends on input voltage, output voltage, maximum current, switching frequency, size, and availability of inductor values. Other factors can include efficiency and ripple voltage. Inductors are specified by their inductance (L), peak current (I_{PK}), and resistance (L_r). The following boost-circuit equations are useful in choosing the inductor values based on the application. They allow the trading of peak current and inductor value while allowing for consideration of component availability and cost.

The equation used here includes a constant LIR, which is the ratio of the inductor peak-peak AC current to maximum average DC inductor current. A good compromise between size of the inductor and loss and output ripple is to choose an LIR of 0.3 to 0.5. The peak inductor current is then given by:

$$I_{PK} = \left[\frac{\left(I_{OUT(MAX)} \cdot V_{OUT}\right)}{\eta \cdot V_{IN(MIN)}}\right] \cdot \left(1 + \frac{LIR}{2}\right)$$

The inductance value is then given by:

$$L = \frac{\left(V_{IN(MIN)}\right)^2 \cdot \eta \cdot \left(V_{OUT} - V_{IN(MIN)}\right)}{V_{OUT}^2 \cdot LIR \cdot I_{OUT(MAX)} \cdot f_{OSC}}$$

Considering the typical application circuit, the maximum DC load current ($I_{OUT(MAX)}$) is 500mA with a 5V output. The inductance value is then chosen to be 5.4µH, based on the above equations and using 85% efficiency and a 640kHz operating frequency. The inductor saturation current rating should be greater than I_{PK}. The resistance of the inductor windings should be less than 0.5Ω. To minimize radiated noise in sensitive applications, use a shielded inductor.

Diode Selection

The output diode should be rated to handle the output voltage and the peak switch current. Make sure that the diode's peak current rating is at least I_{PK} and that its breakdown voltage exceeds V_{OUT}. Schottky diodes are recommended.

Input and Output Capacitor Selection

Low-ESR capacitors are recommended for input bypassing and output filtering. Low-ESR tantalum capacitors are a good compromise between cost and performance. Ceramic capacitors are also a good choice. Sanyo OS-CON types are also recommended for their low ESR. Avoid standard aluminum electrolytic capacitors. A simple equation to estimate input and output capacitor values for a given voltage ripple is as follows:

$$C \geq \frac{0.5 \cdot L \cdot \left(I_{PK}{}^2\right)}{V_{RIPPLE} \cdot V_{OUT}}$$

where V_{RIPPLE} is the peak-to-peak ripple voltage on the capacitor.

Output Voltage

The MAX1790 operates with an adjustable output from V_{IN} to 12V. Connect a resistor voltage divider to FB *(Typical Operating Circuit)* from the output to GND. Select the resistor values as follows:

$$R1 = R2\left(\frac{V_{OUT}}{V_{FB}} - 1\right)$$

where V_{FB}, the boost-regulator feedback set point, is 1.24V. Since the input bias current into FB is typically 0, R2 can have a value up to 100kΩ without sacrificing accuracy. Connect the resistor-divider as close to the IC as possible.

Loop Compensation

The voltage feedback loop needs proper compensation to prevent excessive output ripple and poor efficiency caused by instability. This is done by connecting a resistor (R_{COMP}) and capacitor (C_{COMP}) in series from COMP to GND, and another capacitor (C_{COMP2}) from COMP to GND. R_{COMP} is chosen to set the high-frequency integrator gain for fast transient response, while C_{COMP} is chosen to set the integrator zero to maintain loop stability. The second capacitor, C_{COMP2}, is chosen to cancel the zero introduced by output capacitance ESR. For optimal performance, choose the components using the following equations:

$$R_{COMP} \cong (200\Omega / A^2) \cdot V_{OUT}{}^2 \cdot C_{OUT} / L$$

$$C_{COMP} \cong (0.4 \cdot 10^{-3}\ A / \Omega)\ L / V_{IN}$$

$$C_{COMP2} \cong (0.005\ A^2 / \Omega)\ R_{ESR} \cdot L / V_{OUT}{}^2$$

For the ceramic output capacitor, where ESR is small, C_{COMP2} is optional. Table 1 shows experimentally verified external component values for several applications. The best gauge of correct loop compensation is by inspecting the transient response of the MAX1790. Adjust R_{COMP} and C_{COMP} as necessary to obtain optimal transient performance.

Soft-Start Capacitor

The soft-start capacitor should be large enough that it does not reach final value before the output has reached regulation. Calculate C_{SS} to be:

$$C_{SS} > 21 \cdot 10^{-6} \cdot C_{OUT}\left(\frac{V_{OUT}{}^2 - V_{IN} \cdot V_{OUT}}{V_{IN} \cdot I_{INRUSH} - I_{OUT} \cdot V_{OUT}}\right)$$

where:

C_{OUT} = total output capacitance including any bypass capacitor on the output bus

V_{OUT} = maximum output voltage

I_{INRUSH} = peak inrush current allowed

I_{OUT} = maximum output current during power-up stage

V_{IN} = minimum input voltage

The load must wait for the soft-start cycle to finish before drawing a significant amount of load current. The duration after which the load can begin to draw maximum load current is:

$$t_{MAX} = 6.77 \cdot 10^5\ C_{SS}$$

Application Circuits

1-Cell to 3.3V SEPIC Power Supply

Figure 3 shows the MAX1790 in a single-ended primary inductance converter (SEPIC) topology. This topology is useful when the input voltage can be either higher or lower than the output voltage, such as when converting a single lithium-ion (Li+) cell to a 3.3V output. L1A and L1B are two windings on a single inductor. The coupling capacitor between these two windings must be a low-ESR type to achieve maximum efficiency, and must also be able to handle high ripple currents. Ceramic capacitors are best for this application. The circuit in Figure 3 provides 400mA output current at 3.3V output when operating with an input voltage from +2.6V to +5.5V.

AMLCD Application

Figure 4 shows a power supply for active matrix (TFT-LCD) flat-panel displays. Output voltage transient performance is a function of the load characteristic. Add or remove output capacitance (and recalculate compensation network component values) as necessary to meet transient performance. Regulation performance for secondary outputs (V2 and V3) depends on the load characteristics of all three outputs.

Layout Procedure

Good PC board layout and routing are required in high-frequency switching power supplies to achieve good regulation, high efficiency, and stability. It is strongly recommended that the evaluation kit PC board layouts be followed as closely as possible. Place power components as close together as possible, keeping their traces short, direct, and wide. Avoid interconnecting the ground pins of the power components using vias through an internal ground plane. Instead, keep the power components close together and route them in a "star" ground configuration using component-side coper, then connect the star ground to internal ground using multiple vias.

Chip Information

TRANSISTOR COUNT: 1012

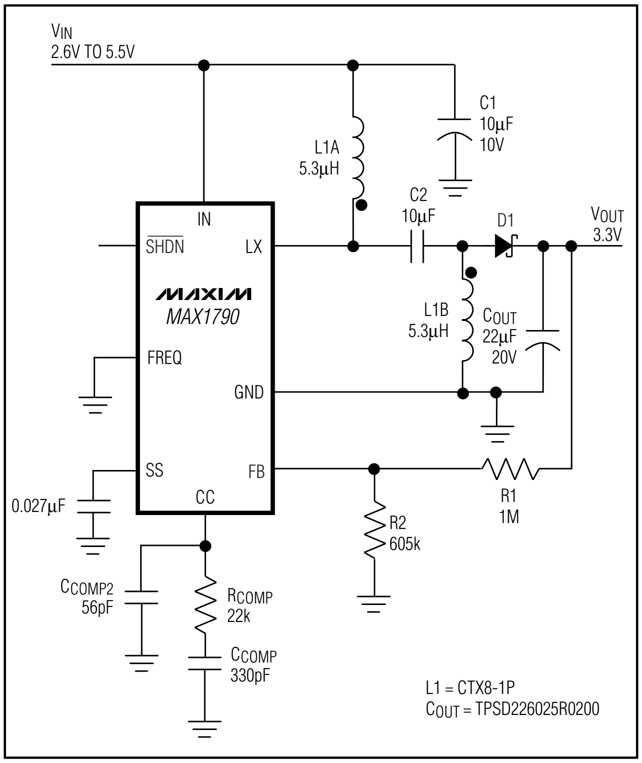


Figure 3. MAX1790 in a SEPIC Configuration

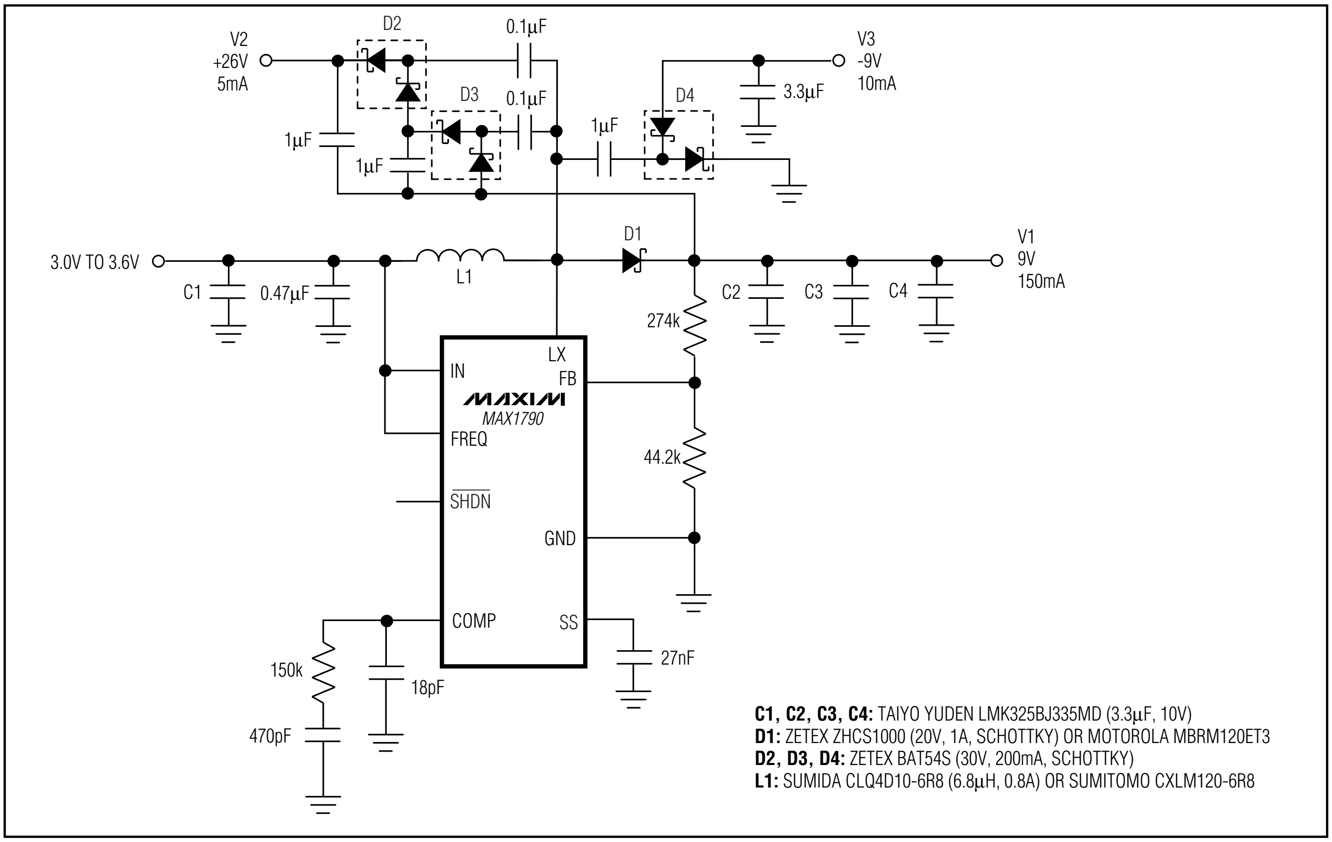
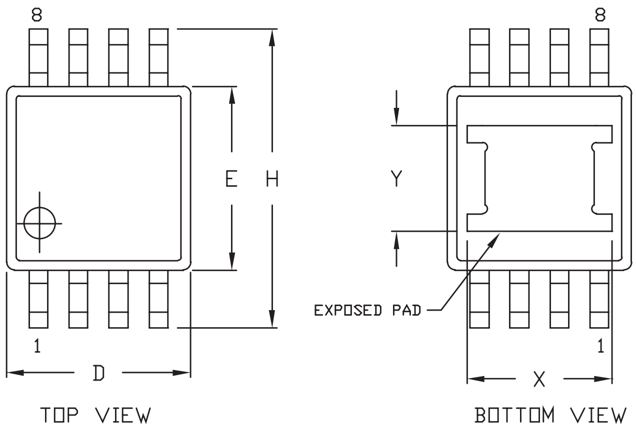


Figure 4. Multiple-Output, Low-Profile (1.2mm max) TFT LCD Power Supply

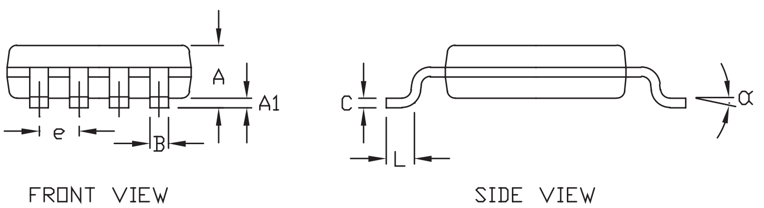
Package Information

8LUMAXD.EPS



	INCHES		MILLIMETERS		JEDEC INCHES		JEDEC MILLIMETERS	
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
A	0.037	0.043	0.94	1.10	---	0.043	---	1.10
A1	0.002	0.006	0.05	0.15	0.002	0.006	0.05	0.15
B	0.010	0.014	0.25	0.36	0.010	0.016	0.25	0.40
C	0.005	0.007	0.13	0.18	0.005	0.009	0.13	0.23
D	0.116	0.120	2.95	3.05	0.114	0.122	2.9	3.1
e	0.0256 BSC		0.65 BSC		0.0256 BSC		0.64 BSC	
E	0.116	0.120	2.95	3.05	0.114	0.122	2.9	3.1
H	0.188	0.198	4.78	5.03	0.193 BSC		4.9 BSC	
L	0.016	0.026	0.41	0.66	0.016	0.027	0.40	0.70
α	0°	6°	0°	6°	0°	6°	0°	6°
*X	0.087	0.099	2.210	2.515				
*Y	0.062	0.074	1.575	1.880				

* EXPOSED PAD



NOTES:
1. D&E DO NOT INCLUDE MOLD FLASH.
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED .15 MM (.006").
3. CONTROLLING DIMENSION: MILLIMETERS.
4. MEETS JEDEC MO-187.
5. DIMENSIONS X & Y APPLY TO EXPOSED PAD VERSIONS ONLY.
6. EXPOSED PAD FLUSH WITH BOTTOM OF PACKAGE WITHIN .002".

PROPRIETARY INFORMATION

TITLE: PACKAGE OUTLINE, 8L uMAX

APPROVAL	DOCUMENT CONTROL NO.	REV	
	21-0036	G	1/1