LX2172/73

1.25A High-Efficiency 100kHz Switching Regulator

THE INFINITE POWER OF INNOVATION

PRELIMINARY DATA SHEET

DESCRIPTION

The LX2172/73 are fixed-frequency, current-mode switching regulator integrated circuits. These ICs contain all necessary control circuitry plus a 1.25A on-board transistor to design a complete DC:DC switching regulator with minimum external components.

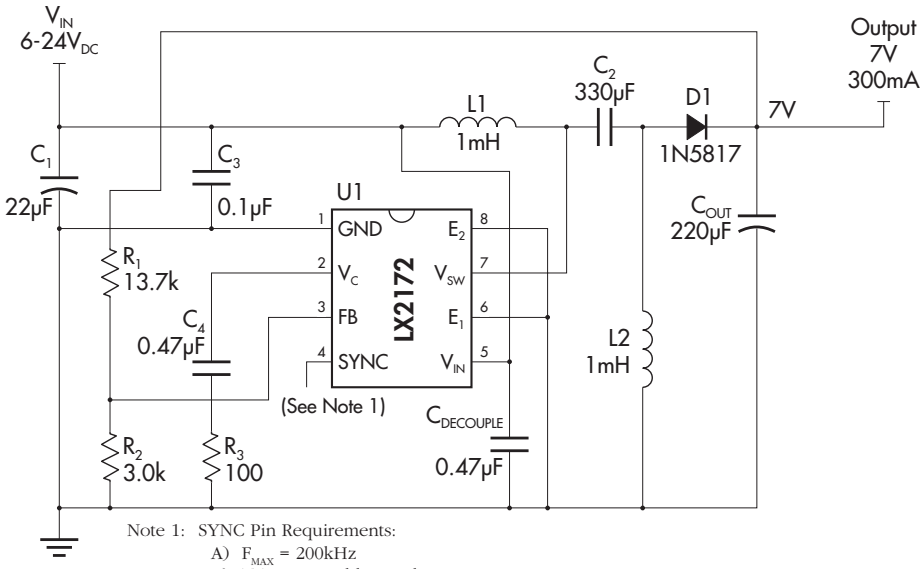
All functions are integrated into a single IC, available in 8-pin DIP and SOIC or a 5-pin TO-220 power package, making them extremely easy to design with and use. The LX2172/73 are optimized for boost and flyback applications, but can also be used in forward and inverting converter configuations.

The LX2172 can be connected to an external clock for synchronization, and can enter micropower operation when the V_C pin is pulled low. The LX2173 has an enable function, which permits extremely low micropower operation, consuming under 10µA current when the ENABLE pin is brought low.

NOTE: For current data & package dimensions, visit our web site: **http://www.linfinity.com.**

PRODUCT HIGHLIGHT

SEPIC Converter Using The LX2172
Input 6-24V, Output 7V, 300mA



Note 1: SYNC Pin Requirements:
A) F_{MAX} = 200kHz
B) TTL Compatible Level
C) Pulse Width T_P Range - 0.1µs < T_P < 2.0µs

KEY FEATURES

- 1.25A, 65V Internal Power Switch
- 3V - 25V Input Voltage Range
- Current-Mode Operation
- Improved Internal Cycle-By-Cycle Current Limiting
- Thermal Shutdown
- Less Than 10µA Quiescent Current In Microprocessor Shutdown Mode
- External Frequency Synchronization Possible
- 100kHz Operating Frequency

APPLICATIONS

- Boost Converter
- Laptop / Notebook Computers
- Portable Equipment
- Small Motor Applications
- Flyback Converters

AVAILABLE OPTIONS PER PART #

Part #	Pin 4 Connections
LX2172	SYNC Input
LX2173	Low µPower Mode (HI ENABLE)

= Samples Not Yet Available.

PACKAGE ORDER INFORMATION

T_A (°C)	M Plastic DIP 8-pin	DM Plastic SOIC 8-pin	P Plastic TO-220 5-pin
0 to 70	LX217xCM	LX217xCDM	LX217xCP

Note: All surface-mount packages are available in Tape & Reel.
Append the letter "T" to part number. (i.e. LX217xCDMT)

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LINFINITY MICROELECTRONICS INC.
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1.25A High-Efficiency 100kHz Switching Regulator

Preliminary Data Sheet

ABSOLUTE MAXIMUM RATINGS (Note 1)

Supply Voltage (V_{IN}) 25V
Collector Supply Voltage (V_C) 65V
Digital Inputs (SYNC) ..... -0.3 to 7V
Operating Junction Temperature ..... 0°C to 125°C
Storage Temperature Range ..... -65°C to +150°C
Solder Temperature (Soldering, 10 seconds) ..... 300°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

THERMAL DATA

M PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	95°C/W

DM PACKAGE:

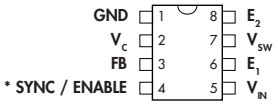
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	165°C/W

P PACKAGE:

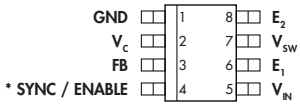
THERMAL RESISTANCE-JUNCTION TO TAB, θ_{JT}	4.5°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	60°C/W

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

PACKAGE PIN OUTS

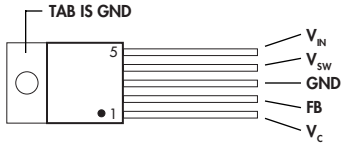


M PACKAGE
(Top View)



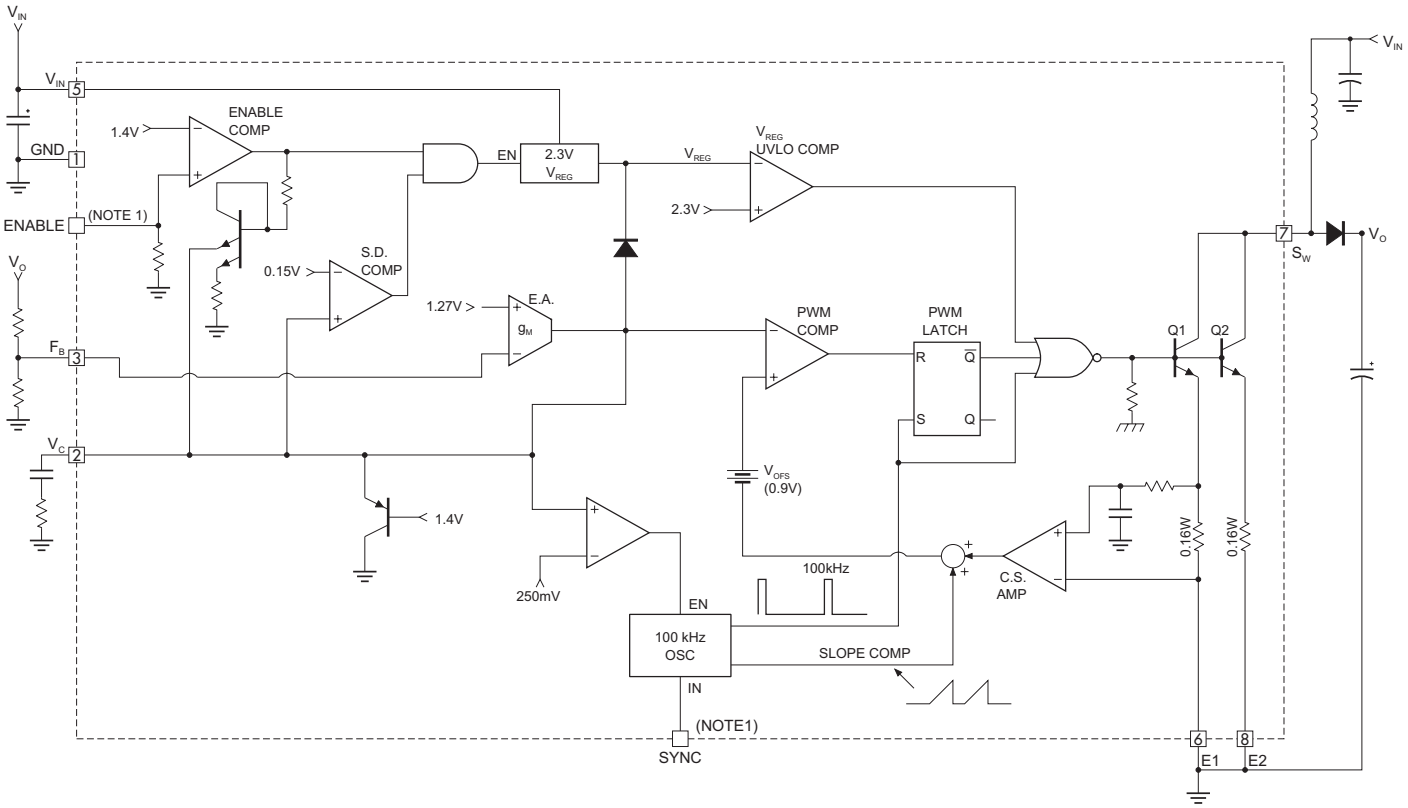
DM PACKAGE
(Top View)

* Pin 4 = SYNC for LX2172, ENABLE for LX2173/2174



P PACKAGE
(Top View)

BLOCK DIAGRAM



Note 1: **LX2172 Only:** SYNC brought out to pin 4. ENABLE is tied to V_{IN}. **LX2173 Only:** ENABLE brought out to pin 4. SYNC is open.

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ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the ranges T_A = 0 to 70°C for the LX217xC. V_{IN} = V_C = 5V. All devices must be functional over junction temperature of -65°C to 150°C. Typ. number represents T_A = 25°C value.)

Parameter	Symbol	Test Conditions	LX2172 / 2173			Units
			Min.	Typ.	Max.	
Reference Section						
Initial Accuracy	V_{REF}	T_J = 25°C, Measured at FB pin	1.224	1.244	1.264	V
		Over Temperature, Measured at FB pin	1.214	1.244	1.274	V
Line Regulation		3V < V_{CC} < 25V		0.03		% / V
Oscillator Section						
Switching Frequency	f	T_A = 25°C	90	100	110	kHz
		Over Temperature	85	100	115	kHz
Line Voltage Stability		V_{IN} = 3V to 25V			±5	%
Error Amplifier Section						
Input Bias Current	I_B	T_J = 25°C; V_{FB} = V_{REF}		350	750	nA
		Over Temperature			1100	nA
Open Loop Gain	A_{VOL}			500	1000	V / V
Transconductance	g_m	T_J = 25°C; V_{FB} = V_{REF}; ΔI = ±25µA	3000	4400	6000	µMHO
		Over Temperature	2400		7000	µMHO
Output Sink Current	$I_{EA\ (SINK)}$		120	200		µA
Output Source Current	$I_{EA\ (SOURCE)}$		120			µA
Output HI Voltage	$V_{COMP-HI}$	V_{FB} = 1V	1.8	2.1	2.3	V
Output LO Voltage	$V_{COMP-LO}$	V_{FB} = 1.5V	0.2	0.3	0.52	V
Slew Rate	S			2		V/µsec
C.S. Comparator Section						
C.S. Delay to Driver Output		10% Over drive GBNT		100		ns
V_C to Output Transconductance				2		A / V
PWM Section						
E.A. Output to PWM Drive Offset (VPWM)	V_{OFS}	Duty Cycle = 0	0.6	1.2	1.25	V
Minimum Duty Cycle				36	40	%
Maximum Duty Cycle			80	90	98	%
Output Drive Section						
Output Switch Breakdown Voltage		I_{SW} = 1.5mA	65			V
Output Switch On Resistance	R_{ON}	I_O = 2A		0.4	0.6	Ω
Switch Current Limit	I_{LIM}	D.C = 50%	1.25	1.7	2.8	A
		50% < D.C < 80%	1.0	1.5	2.0	A
Total Switching Loss (On Time + Off Time)		V_{IN} = 25V, D.C = 50%, I_O = 1A, V_{SW} = 60V		100		mW
Input Supply Section						
Start-Up Threshold			2.2	2.7	2.9	V
Normal Mode Quiescent Current	I_Q	ENABLE = HI, V_C = 0.6V, I_O = 0A		5	8	mA
V_C Shutdown Threshold		3V < V_{IN} < V_{MAX}, T_J = 25°C	100	150	260	mV
		3V < V_{IN} < V_{MAX}, Over Temperature	50		300	mV
Sleep Mode Current		ENABLE = HI, V_C = 50mV		100		µA
		ENABLE = LO (LX2173 only)		5		µA

ELECTRICAL CHARACTERISTICS

Parameter	Symbol	Test Conditions	LX2172 / 2173			Units
			Min.	Typ.	Max.	
SYNC Input Section (LX2172 only)						
SYNC Pulse Width			0.2		2	µsec
SYNC Input HI			2		6	V
SYNC Input LO					0.7	V
SYNC Input Current HI		Input = 2V		100	400	µA
SYNC Input Current LO		Input = 0.4V		1	5	µA
ENABLE Section (LX2173 only)						
Enable Input Threshold			0.4	1.2	2.4	V
HI Input Current		Input = 2.4V			200	µA
LO Input Current		Input = 0.4V			100	µA

FUNCTIONAL PIN DESCRIPTION

Pin Name	Pin # (8-pin Pkgs.)	Pin # (5-pin TO-220)	Description
GND	1	3	Signal ground. Keep separate from power grounds (E_1 and E_2).
V_C	2	1	Output of transconductance error amplifier. An R-C compensation network is connected from this pin to the ground to stabilize the feedback loop. If this pin is pulled lower than 0.15V, the IC goes into micropower mode.
FB	3	2	Error amplifier inverting input. A resistor divider from the output of the converter to this pin sets its nominal voltage.
SYNC	4		**LX2172 only.** This pin is used to synchronize the device directly with a logic level input pulse. External synchronization frequency must always be at a higher frequency than the minimum internal clock. When not used, should be left open.
ENABLE	4		**LX2173 only.** This pin is the input to the enable comparator. A voltage under 1.4V will put the device in micropower mode. Pin must be connected to V_{IN} when not in use.
V_{IN}	5	5	Input supply voltage (3.0V to 25V).
E_1	6		Power return of first transistor (Q_1). This pin must be connected to ground.
V_{SW}	7	4	Collector of output transistors. Connect to external inductor or input voltage, depending on circuit topology.
E_2	8		Grounding this pin sets the current limit point to the maximum value. If pin is left open, the current limit is set to half its maximum value.

THEORY OF OPERATION

IC OPERATION

Referring to the block diagram, when V_{IN} is above the UVLO start threshold the 2.3V UVLO comparator output switches to low state, allowing Q1 to turn on upon receiving a clock pulse from the internal 100kHz oscillator. Once Q1 is on, current in the inductor ramps up. Inductor current is then sensed, and amplified by a current sense amplifier and compared to a threshold set by the output of the error amplifier minus the offset voltage (V_{OFS} typically 0.9V). This allows the PWM comparator to reset the flip flop, causing Q1 to turn off. The oscillator then sets the flip flop, and the operation repeats itself.

CURRENT LIMIT

Current limiting is performed by sensing the peak switch current and turning Q1 off until the next clock cycle. When the converter goes into current limit the error amplifier output goes to the rail and sets a maximum limit on the current.

ERROR AMPLIFIER

The function of the error amplifier is to set a threshold voltage for inductor peak current and control the switch duty cycle so that the power supply output voltage is closely regulated. Regulation is accomplished by sensing the output voltage and comparing it to the internal 1.27V bandgap reference. A compensation network is placed from the output of the amplifier to ground for closed loop stability purposes, as well as a high d.c. gain for tight regulation. The function of V_{OFS} is to keep Q1 off without requiring an error amplifier output to swing to ground level. It is required the V_{OL} of the error amplifier is always less than the offset at all times. The transfer function between the error amplifier output (V_C) and peak inductor current is therefore given by:

$$V_C - V_{OFS} = I_P * G * R_S$$

Where: I_P = Inductor peak current
G = Current sense gain (typically 6)
R_S = Internal sense resistor

OSCILLATOR

The oscillator is designed to operate at 100kHz frequency. Its function is to turn the switch Q1 on at a fixed 10µs interval and to provide a slope compensation for the feedback loop. Slope compensation is required for fixed frequency continuous Current Mode regulators operating above 50% duty cycle in order to prevent loop instability. The SYNC input is a logic input that allows easy synchronization to an external clock. Synchronization is done such that the external clock terminates the cycle before the internal oscillator sets the PWM latch again.

UNDER-VOLTAGE LOCKOUT

The 2.3V internal regulator is monitored as the input supply ramps up, ensuring glitch-free operation.

EXTRA PINS ON 8-PIN DEVICE

The 8-pin versions of the LX217x have the emitters of the power transistors brought out separately. Connecting these pins to ground reduces errors due to ground pin voltage drops. The E_2 pin also allows the user to half the switch current limit if the pin is left open. Note that the switch resistance will increase when E_2 is open, so efficiency will decrease and heat dissipation will increase, especially for currents over 300mA.

MICROPOWER SHUTDOWN

The LX2172/73 enter micropower shutdown mode when the V_C pin is pulled below 0.15V. Supply current required for biassing shutdown circuitry is less than 250µA. The LX2173 has an ENABLE pin which allows ultra-low micropower shutdown operation, consuming less than 10µA.

THEORY OF OPERATION

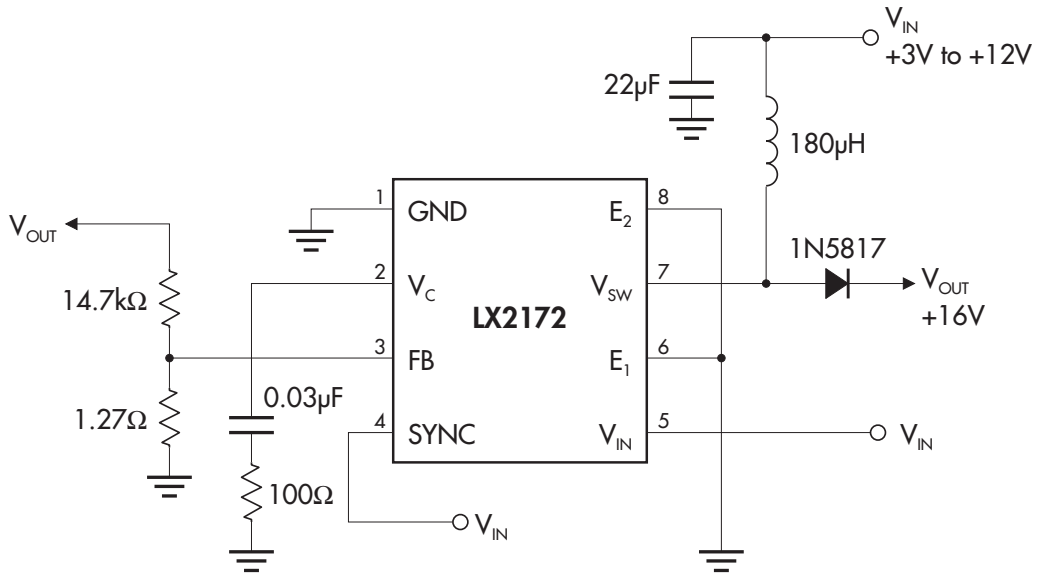

FIGURE 1 — Boost Coverter Circuit Using The LX2172 / 2173