

19-4667; Rev 0; 9/92



# Switched-Capacitor Voltage Converters

## General Description

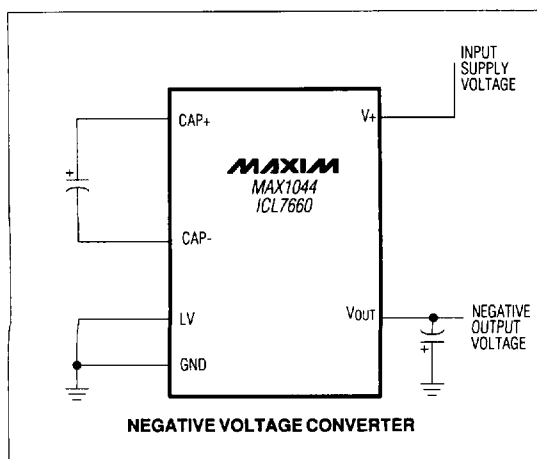
The MAX1044 and ICL7660 are monolithic, CMOS switched-capacitor voltage converters that invert, double, divide, or multiply input voltage. They are pin compatible with the industry-standard ICL7660. Operation is guaranteed to 10V with no external diode over the full temperature range. The MAX1044 has a BOOST pin that raises the oscillator frequency above the audio band and also reduces external capacitor size.

The MAX1044/ICL7660 combine low quiescent current with high efficiency. Oscillator control circuitry and four power MOS switches are included on-chip. Applications include generating a -5V supply from a +5V logic supply to power analog circuitry. When used as doublers, these devices generate 6V from a single 3V lithium cell, or 3V from a single 1.5V alkaline cell. For applications requiring more power, the MAX660 can deliver up to 100mA with a voltage drop of less than 0.65V.

## Applications

- 5V Supply from +5V Logic Supply
- Personal Communication Equipment
- Op-Amp Power Supplies
- EIA/TIA-232E and EIA/TIA-562 Power Supplies
- Data-Acquisition Systems
- Hand-Held Instruments
- Panel Meters

## Typical Operating Circuit



## Features

- ◆ 1.5V to 10.0V Operating Supply Voltage Range
- ◆ 95% Min Power-Conversion Efficiency
- ◆ Invert, Double, Divide, or Multiply Input Voltage
- ◆ BOOST Pin Increases Switching Frequencies (MAX1044)
- ◆ No-Load Supply Current: 200µA Max at 5V
- ◆ No External Diode Required for Higher Voltage Operation

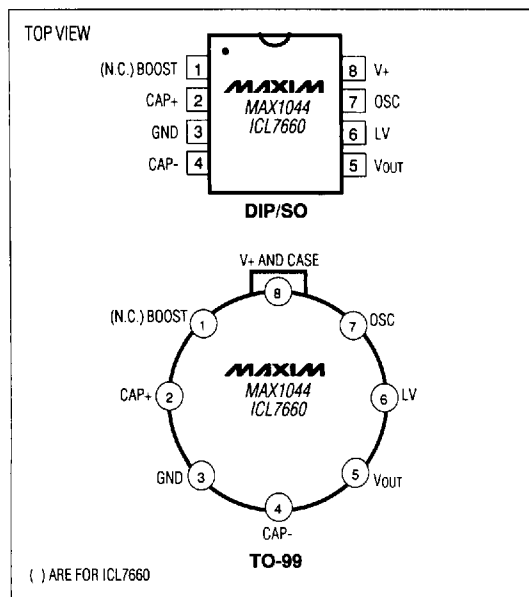
## Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE
MAX1044CPA	0°C to +70°C	8 Plastic DIP
MAX1044CSA	0°C to +70°C	8 SO
MAX1044CTV	0°C to +70°C	8 TO-99
MAX1044C/D	0°C to +70°C	Dice*
MAX1044EPA	-40°C to +85°C	8 Plastic DIP
MAX1044ESA	-40°C to +85°C	8 SO
MAX1044ETV	-40°C to +85°C	8 TO-99

Ordering Information continued on last page.

\* Contact factory for dice specifications.

## Pin Configurations



MAX1044/ICL7660

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MAX1044/ICL7660

## ABSOLUTE MAXIMUM RATINGS

Supply Voltage (V+ to GND, or GND to Vout) .....	10.5V
Input Voltage on Pins 1, 6, and 7 (Note 1) .....	-0.3V ≤ VIN ≤ (V+ + 0.3V)
LV Input Current (Note 1) .....	20μA
Output Short-Circuit Duration (V+ ≤ 5.5V) .....	Continuous
Continuous Power Dissipation (TA = +70°C) Plastic DIP (derate 9.09mW/°C above +70°C) .....	727mW
SO (derate 5.88mW/°C above +70°C) .....	471mW

CERDIP (derate 8.00mW/°C above +70°C) .....	640mW
TO-99 (derate 6.67mW/°C above +70°C) .....	533mW
Operating Temperature Ranges:	
MAX1044C_/ICL7660C .....	0°C to +70°C
MAX1044I_/ICL7660I .....	-25°C to +85°C
MAX1044E_/ICL7660E .....	-40°C to +85°C
MAX1044M_/ICL7660M .....	-55°C to +125°C
Storage Temperature Range .....	-65°C to +150°C
Lead Temperature (soldering, 10 sec) .....	+300°C

**Note 1:** Connecting any input terminal to voltages greater than V+ or less than ground may cause latchup. Do not apply any inputs from sources operating from external supplies before device power-up.

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

(Circuit of Figure 1, V+ = 5.0V, LV pin = 0V, BOOST pin = open, ILOAD = 0mA, TA = TMIN to TMAX, unless otherwise noted.)

PARAMETER	CONDITIONS	MAX1044			ICL7660			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
Supply Current	RL = ∞, pins 1 and 7 no connection, LV open	TA = +25°C	30	200	110	175	μA	
		TA = 0°C to +70°C		200		225		
		TA = -40°C to +85°C		200		250		
		TA = -55°C to +125°C		200		250		
	RL = ∞, pins 1 and 7 = V+ = 3V		10					
Supply Voltage Range (Note 1)	RL = 10kΩ, LV open				3.0	10.0	V	
	RL = 10kΩ, LV to GND	1.5	10	1.5	3.5			
Output Resistance	IL = 20mA, fOSC = 5kHz, LV open	TA = +25°C	65	100	55	100	Ω	
		TA = 0°C to +70°C		130		120		
		TA = -40°C to +85°C		130		140		
		TA = -55°C to +125°C (Note 2)		150		150		
	fOSC = 2.7kHz (ICL7660), fOSC = 1kHz (MAX1044), V+ = 2V, IL = 3mA, LV to GND	TA = +25°C		325		250		
		TA = 0°C to +70°C		325		300		
		TA = -40°C to +85°C		325		300		
TA = -55°C to +125°C		400		400				
Oscillator Frequency	COSC = 1pF, LV to GND (Note 3)	V+ = 5V	5		10	kHz		
		V+ = 2V	1					
Power Efficiency	RL = 5kΩ, TA = +25°C, fOSC = 5kHz, LV open	95	98	95	98	%		
Voltage Conversion Efficiency	RL = ∞, TA = +25°C, LV open	97.0	99.9	99.0	99.9	%		
Oscillator Sink or Source Current	VOSC = 0V or V+, LV open	Pin 1 = 0V		3		μA		
		Pin 1 = V+		20				
Oscillator Impedance	TA = +25°C	V+ = 2V	1.0		1.0	MΩ		
		V+ = 5V	100		100	kΩ		

**Note 1:** The Maxim ICL7660 and MAX1044 can operate without an external output diode over the full temperature and voltage ranges. The Maxim ICL7660 can also be used with the external output diode DX when replacing the Intersil ICL7660. Tests performed with DX out of circuit.

**Note 2:** Maxim ICL7660A and MAX1044 only.

**Note 3:** fOSC is tested with COSC = 100pF to minimize the effects of test fixture capacitance loading. The 1pF frequency is correlated to this 100pF test point, and is intended to simulate pin 7's capacitance when the device is plugged into a test socket with no external capacitor. For this test, the LV pin is connected to GND for comparison to the original manufacturer's device, which automatically connects this pin to GND for (V+ > 3V).

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MAX1044/ICL7660

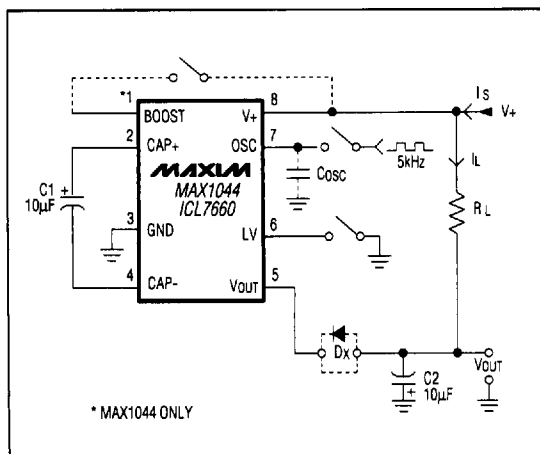


Figure 1. Maxim ICL7660 and MAX1044 Test Circuit (C1 and C2 should be increased to 100µF if C<sub>osc</sub> exceeds 10pF).  
Note: Dx not required with Maxim ICL7660 or MAX1044.

## Ordering Information (continued)

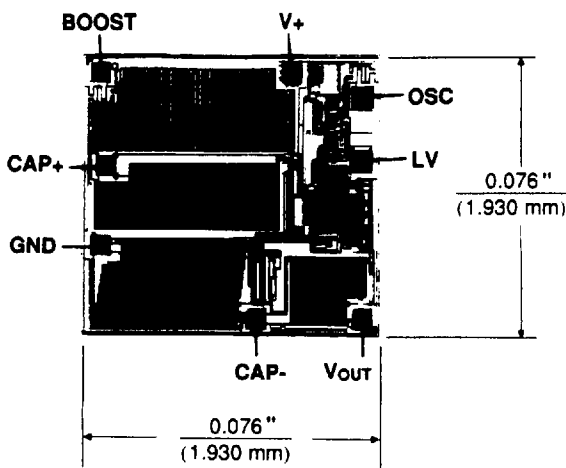
PART	TEMP. RANGE	PIN-PACKAGE
MAX1044MJA	-55°C to +125°C	8 CERDIP**
MAX1044MTV	-55°C to +125°C	8 TO-99**
ICL7660CPA	0°C to +70°C	8 Plastic DIP
ICL7660CSA	0°C to +70°C	8 SO
ICL7660CTV	0°C to +70°C	8 TO-99
ICL7660C/D	0°C to +70°C	Dice*
ICL7660IPA	-20°C to +85°C	8 Plastic DIP
ICL7660ISA	-20°C to +85°C	8 SO
ICL7660IJA	-20°C to +85°C	8 CERDIP
ICL7660ITV	-20°C to +85°C	8 TO-99
ICL7660EPA	-40°C to +85°C	8 Plastic DIP
ICL7660ESA	-40°C to +85°C	8 SO
ICL7660EJA	-40°C to +85°C	8 CERDIP
ICL7660ETV	-40°C to +85°C	8 TO-99
ICL7660MTV	Order ICL7660AMTV	
ICL7660AMJA	-55°C to +125°C	8 CERDIP**
ICL7660AMTV	-55°C to +125°C	8 TO-99**

\* Contact factory for dice specifications.

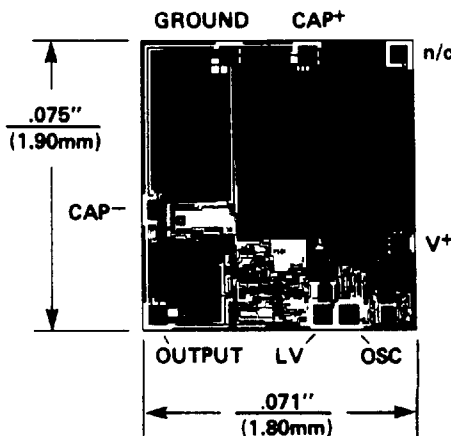
\*\*Contact factory for availability and processing to MIL-STD-883.

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## Chip Topographies



MAX1044



ICL7660