



UNIVERSAL SEMICONDUCTOR, INC.

## CMOS FLASH CONVERTERS

### USC1070; 1071; 1072; 1073

### USC1170; 1173

#### FEATURES

- Low power CMOS
- One pulse conversion
- 7 bit resolution
- 10 MHz sampling rate
- TTL & CMOS interface
- Three state outputs
- 20 & 24 pin, 300 mil DIP
- Military & industrial temp ranges
- Half LSB versions available
- Several package options

#### VERSIONS

USC1070 - 7 bit, high speed

USC1071 - 7 bit, for 12 bit 1/2 flash

USC1072 - 7 bit, ultra low power

USC1073 - 7 bit, 20 pin package

USC1170 - 7 bit, 3-state output

#### DESCRIPTION

The USC1070 is a CMOS flash (parallel) A/D converter designed for sampling at rates up to 10 MHz at very low power operation. The USC1073 utilizes the 1070 die for low cost 7 bit converters in 20 pin plastic packages. The USC1071 uses a modified die for 12 bit half flash applications. The USC1072 die is an ultra low power converter. The USC1170 and 1173 are tri-state output versions of the standard converters.

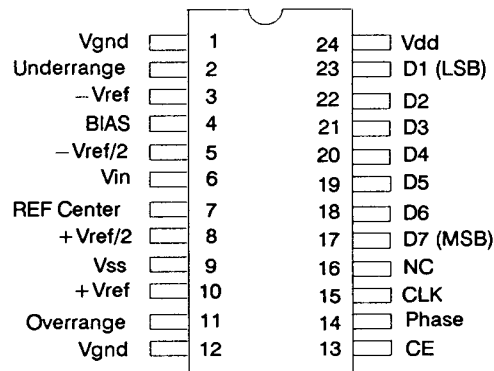
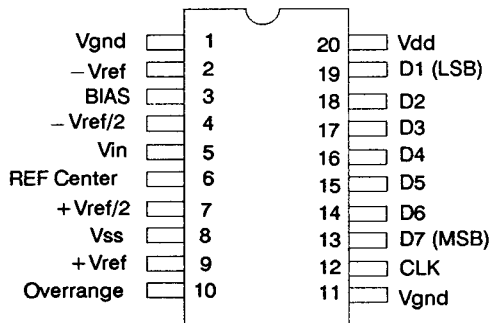
Conversion is accomplished with only one pulse. Data appears at the outputs following the conversion clock transition. The converter is ready after a minimum reset time. No extra clock steps are required to bring data out.

Underrange and overrange status lines indicate whether the input signal is below or above the input range. The nominal input voltage range is  $-3.2V$  to  $+3.2V$  and  $\pm 2.5V$  has been used in many applications.

The family of devices may easily be interfaced to TTL & CMOS logic. The standard converters have open-drain N-channel devices to the digital ground,  $V_{gnd}$ . The 11xx devices have tri-state output drivers to connect directly to a data bus.

Both military and industrial temperature range devices are available. Special test requirements and mil screening (883C) may be ordered. A wide variety of packages are also available. The standard packages are 300 mil 24 pin ceramic, 300 mil 20 pin plastic, 600 mil 24 pin ceramic, and 24 pin Leadless Chip Carriers (LCC) packages. Die are also available for hybrids and other special packaging.

#### PIN CONFIGURATION





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CMOS FLASH CONVERTERS  
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USC1170; 1173

ABSOLUTE MAXIMUM RATINGS

DC Supply Voltage (Vdd-Vss)	12V max
Logic Supply (Vdd-Vgnd)	7V max
Logic Output Voltage (Vo-Vgnd)	8V max
Logic Input Voltage	Vgnd -0.3V, Vdd +0.3V
Vin Reference Voltages	Vss min, Vdd max
Idd Supply	20mA max
Temperature Range	
Storage	-65°C to +150°C
Operating	-55°C to +125°C (military) -25°C to +85°C (industrial)

ELECTRICAL CHARACTERISTICS

Test Conditions Temp. = +25°C	
Vdd = 5V	Vss = -5V
Vgnd = 0V	Idd = 15mA
+Vref = +3.2V	-Vref = -3.2V
Clock = 8 million samples per second (MSPS)	
Source Impedance = 100 ohms	

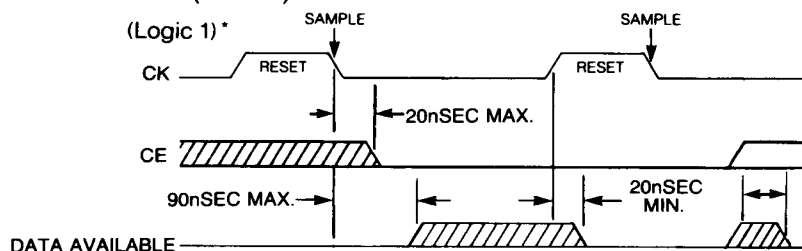
COMMON CHARACTERISTICS

Parameter	Min	Max	Units
Quantizing Error	-1/2	+1/2	LSB
Logic Supply (Vdd-Vgnd)	4	6	V
<b>Analog Inputs:</b>			
Full Scale Range (Ref)	Vss + 1.5	Vdd -1.5	V
Input Capacitance		50	pF
Input Current (DC)		1	uA
Input Impedance	1000		MOhm
<b>Digital Inputs:</b>			
Low Voltage (Vil=0)		1.5	V
High Voltage (Vih=1)	3.5		V
Input Current		+/-1	uA
<b>Logic Outputs:</b>			
High Voltage (open drain)		7	V
High Voltage (3-state)		4	V
Low Voltage (Io = 6mA)		.7	V
Sink Current (Vo = 0.7V)	6		mA
Minimum Reset Pulse Width	25		nS
Max Input Signal Slew Rate		10	V/uS
Resolution	7		Bits
Linearity Error		+/-1	LSB

TIMING DIAGRAM

\*NOTE:

PHASE(PIN 14) = HIGH



Timing for PHASE = Low (logic 0) is same as above except the CK and CE lines are inverted. Output data is NOT inverted and is independent of the PHASE line. All data output lines are high when CK is in RESET, the chip is disabled (CE + PHASE = 0), or the chip is in Overrange. (Underrange condition has no effect on data output pins.)

**DEVICE OPERATION**

The internal features of the flash converter family consist of a set of reference resistors, 130 voltage comparators, NAND gates, 128 encoders, output buffers, and clock generation circuitry. A reference voltage is applied between +Vref and -Vref driving a resistor with 128 taps. The taps provide the set of voltages to the inverting inputs of the comparators. In the RESET mode the comparator outputs are disabled. When the CLOCK changes, the comparator outputs are latched into their new state. The digital state is determined by the location where the comparators make the transition from all high to all low outputs. This location is encoded into a 7 bit code that is gated to the output terminals.

Three control lines are used: CLOCK, CE (Chip Enable), and PHASE. The PHASE line determines the active state of the CLOCK and CE lines. With a high PHASE line, Vin is sampled on the falling edge of the CLOCK line and CE is active low. The state of CLOCK for a sample and CE is active high for a low PHASE line. The Chip Enable line activates the digital outputs. With the standard devices external resistors will pull the outputs high when disabled. The outputs of the 3-state devices (USC117x) will go to a high impedance state with CE disabled. During the RESET mode of the CLOCK the outputs will be in a high state.

Two status lines are available: OR (OVERRANGE) indicating that Vin is greater than +Vref at the sample and UR (UNDERRANGE) signalling that Vin is less than -Vref. The active state of these two signals is high. The OR and UR signals will be low during RESET mode.

Care should be taken to prevent driving any pin beyond the supply rails. The three control input pins (CLOCK, CE, PHASE), the digital output pins (D1-D7), and the status pins (OR UR) should not be driven below Vgnd (digital ground). Any of these conditions could cause latch up. During initial debug of a circuit using the devices, one should use a 10 ohm resistor in series with the Vdd (+5volt) supply to prevent damage to the device due to transients causing latch up.

Vdd should be bypassed to digital ground with a high frequency 0.1uF (or larger) capacitor. Analog ground should be bypassed to Vss and all 5 reference resistor taps should be bypassed to analog ground.

The converter is biased by a resistor from Vdd to the BIAS pin. The current in this resistor is approximately 1/100 of the current used by the converter. The bias current is calculated by the formula:  $(V_{dd} - V_{ss} - 2.0v)/R$ . For  $V_{dd} = 5v$ ,  $V_{ss} = -5v$ , and a resistor of 82Kohms, the converter's DC operating current will be approximately 10 mA. Decreasing the resistor towards 47K ohms will increase the operating speed of the converter at the cost of some power. Increased speed may also be provided by using an asymmetric clock. By keeping the RESET time to a minimum of 25 nS one can increase the effective speed of the conversion. Data can be strobed from the device up to 20 nS after the sample time (into the RESET mode). The Vin line should be driven from a low impedance source of 100 ohms or less.

**Device Characteristics**

<u>Parameter</u>	<u>USC1070</u>		<u>USC1071</u>		<u>USC1072</u>		<u>USC1073</u>		<u>USC1170</u>		<u>USC1173</u>		<u>Units</u>
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	
Sample Rate	0	8	0	8	0	5	0	8	0	8	0	8	MSPS
DLE **	(1)		(1)		+/- 40		+/- 40		(1)		+/-40		mV
Ladder Resistance	2	6	2	6	10	30	2	6	2	6	2	6	Kohm
Supply Current (2)	1	20	1	20	0.5	10	1	20	1	20	1	20	mA
Digital Output Delay	90		90		300		90		90		90		nSec
Number of Pins	24		24		24		24		24		20		

\*\* DLE-Differential Linearity Error; (1) +/- 40 mV for 1 LSB version; +/- 20 mV for 1/2 LSB version; (2) programmable, excludes ladder current



**USC1070; 1071; 1072; 1073**

**USC1170; 1173**

**12 BIT CONVERSION**  
High speed precision conversions can be attained as shown in Figure 1. A sample/hold (S/H) module is required to sample the incoming signal. The reading is taken in a two step process. With  $\overline{Q}$  low, the flash converter is connected to the S/H output ( $V_{in}$ ). CK1 then goes low and this provides a 7 bit digital output that is stored in a latch when  $\overline{Q}$  goes high. The output of the latch drives a 7 bit binary adder. Its output, which presently is the same as the latch, is then stored in a DAC when CK1 returns high. Note that the converter, reference voltages are 0.1V high. This means that the digital output is typically two counts low.

The output of the DAC (+/- 3.2V full scale swing) is added to a 96.9mV offset (100mV-(100/32)mV) which adjusts for the two count error in the first reading and the 0.1V shift in the converter's reference voltage. The composite signal is then subtracted from a differential amplifier with a gain of 32. Its output drives the converter which then digitizes this remaining signal when CK1 goes low again. The lower 5 bits of data appear at the output.

The upper two bits are gated into the adder and summed with the previous 7 most significant bits when CK2 goes high. The 12 bit result is now available at the outputs. This scheme will correct errors in the first approximation that are (up to) two counts off.

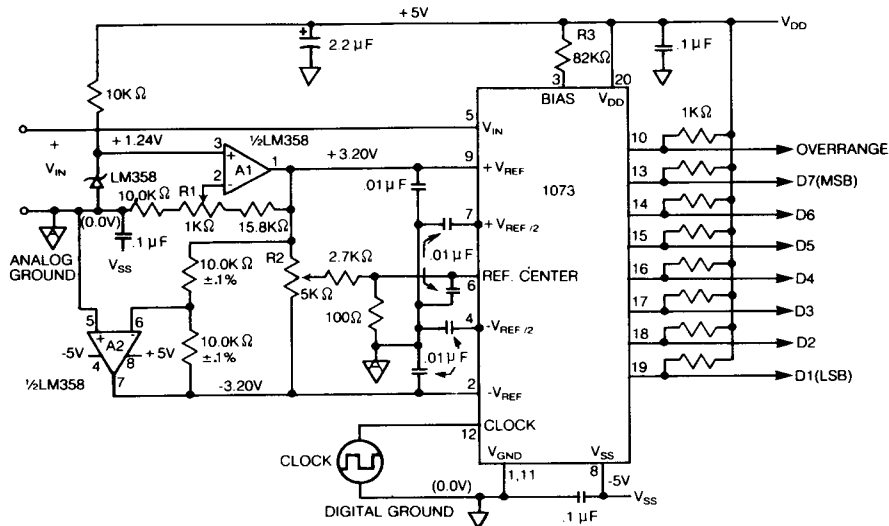
As an example, suppose  $V_{in} = +0.03V$  which looks like  $-0.07V$  to the converter's input due to the  $0.1V$  offset. This would normally give a reading of  $0111111$ . Assume there is an error and the output is  $0111110$  (62). The DAC would put out a signal of  $(62/128) \times 6.4 = 3.2 = -0.100V$  which is offset by  $0.0969$  to give  $-0.0031$ . The x32 amplifier puts out  $32 \times (0.03 -) (-0.0031) = +1.059V$  which looks like  $+0.959$  to the flash converter and becomes digitized as  $1001011$  (83). The final output is then  $((62 + 2) \times 32) + 19 = 2067$  which represents a signal  $(2067/4096) \times 6.4 = 3.2 = 29.7mV$  which is very close to the input value of  $30mV$ .



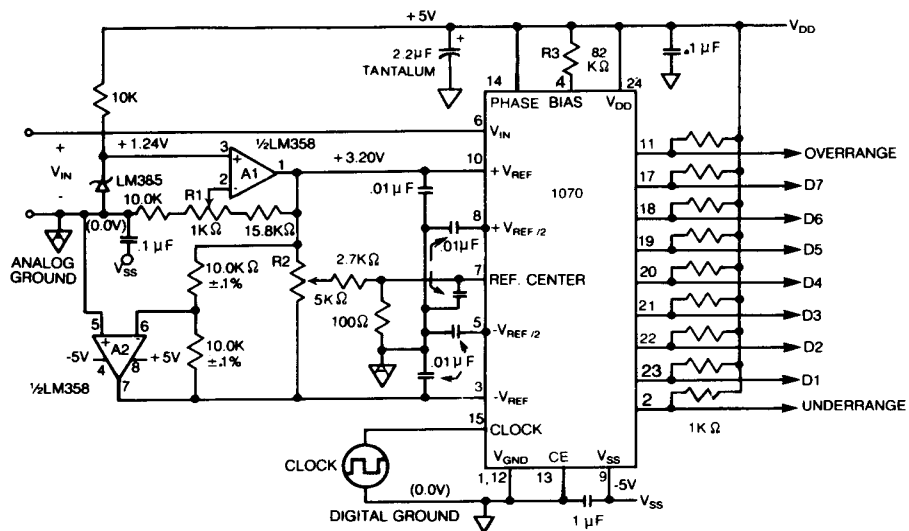


## TYPICAL PIN CONFIGURATIONS

### 20 PIN



### 24 PIN

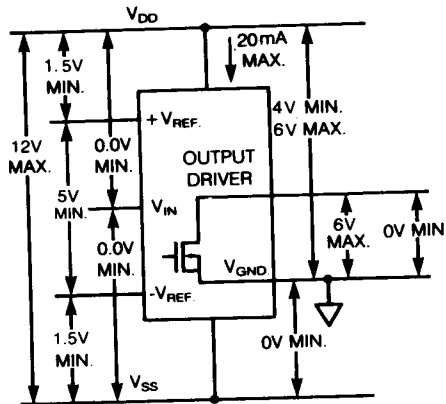




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MIN / MAX OPERATING VOLTAGES

## Ordering Information

The basic structure is USC prefix; 10 for open drain output or 11 for 3-state output; 70 for standard flash, 71 for 12 bit half flash applications, 72 for ultra low power, & 73 for 20 pin plastic; -A for 1/2 LSB accuracy, -B for 1 LSB; I for industrial temperature, M for military temp; -C for cerdip, -P for plastic, & -L for leadless chip carriers: -24 or -20 for the package pin count. Examples:

USC1070-AM-C24	1/2 LSB Military Temperature
USC1073-BI-P20	1 LSB 20 Pin Industrial
USC1071-AI-DIE	1/2 LSB DIE for 12 BIT

$$+V_{REF} = 3.20V$$

$$-V_{REF} = -3.20V$$

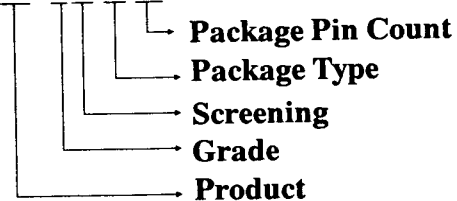
OR

+3.175V	1111111
+3.125V	1111110
+3.075V	1111101
+3.025V	1111100
+2.975V	
+0.075V	1000001
+0.025V	1000000
-0.025V	0111111
-0.075V	0111110
-0.125V	
-3.025V	0000011
-3.075V	0000010
-3.125V	0000001
-3.175V	0000000
-3.225V	

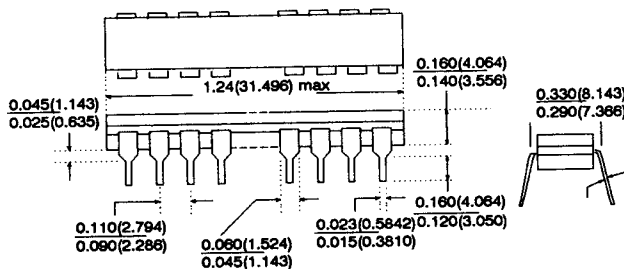
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## OUTPUT CODING

USC1070 -AI -C 24

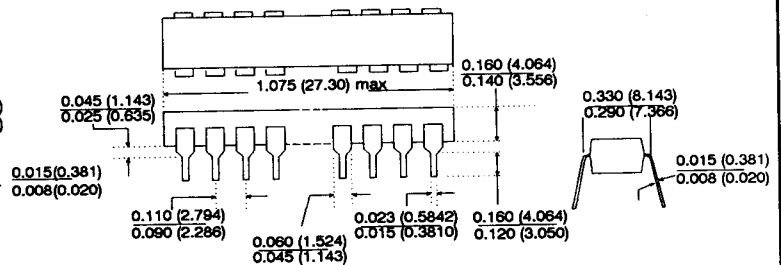


## 24 LEAD CERDIP



All dimensions in inches and (millimeters)

## 20 LEAD PLASTIC



All dimensions in inches and (millimeters)

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