

# 14-Stage Binary Ripple Counter With Oscillator

## High-Performance Silicon-Gate CMOS

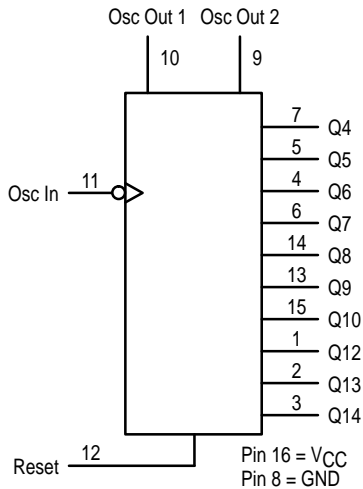
The MC54/74C4060A is identical in pinout to the standard CMOS MC14060B. The device inputs are compatible with standard CMOS outputs; with pullup resistors, they are compatible with LSTTL outputs.

This device consists of 14 master-slave flip-flops and an oscillator with a frequency that is controlled either by a crystal or by an RC circuit connected externally. The output of each flip-flop feeds the next and the frequency at each output is half of that of the preceding one. The state of the counter advances on the negative-going edge of the Osc In. The active-high Reset is asynchronous and disables the oscillator to allow very low power consumption during stand-by operation.

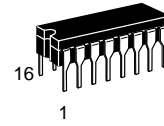
State changes of the Q outputs do not occur simultaneously because of internal ripple delays. Therefore, decoded output signals are subject to decoding spikes and may have to be gated with Osc Out 2 of the HC4060A.

- Output Drive Capability: 10 LSTTL Loads
- Outputs Directly Interface to CMOS, NMOS, and TTL
- Operating Voltage Range: 2 to 6 V
- Low Input Current: 1  $\mu$ A
- High Noise Immunity Characteristic of CMOS Devices
- In Compliance With JEDEC Standard No. 7A Requirements
- Chip Complexity: 390 FETs or 97.5 Equivalent Gates

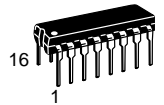
### LOGIC DIAGRAM



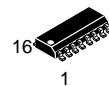
# MC54/74HC4060A



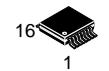
**J SUFFIX**  
CERAMIC PACKAGE  
CASE 620-10



**N SUFFIX**  
PLASTIC PACKAGE  
CASE 648-08



**D SUFFIX**  
SOIC PACKAGE  
CASE 751B-05



**DT SUFFIX**  
TSSOP PACKAGE  
CASE 748C-03

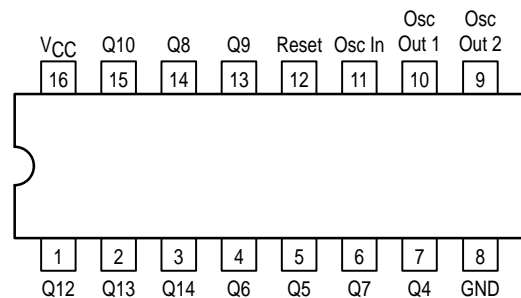
### ORDERING INFORMATION

MC54HCXXXXAJ	Ceramic
MC74HCXXXXAN	Plastic
MC74HCXXXXAD	SOIC
MC74HCXXXXADT	TSSOP

### FUNCTION TABLE

Clock	Reset	Output State
	L	No Change
	L	Advance to Next State
X	H	All Outputs Are Low

### Pinout: 16-Lead Plastic Package (Top View)



**MAXIMUM RATINGS\***

Symbol	Parameter	Value	Unit
V <sub>CC</sub>	DC Supply Voltage (Referenced to GND)	- 0.5 to + 7.0	V
V <sub>in</sub>	DC Input Voltage (Referenced to GND)	- 0.5 to V <sub>CC</sub> + 0.5	V
V <sub>out</sub>	DC Output Voltage (Referenced to GND)	- 0.5 to V <sub>CC</sub> + 0.5	V
I <sub>in</sub>	DC Input Current, per Pin	± 20	mA
I <sub>out</sub>	DC Output Current, per Pin	± 25	mA
I <sub>CC</sub>	DC Supply Current, V <sub>CC</sub> and GND Pins	± 50	mA
P <sub>D</sub>	Power Dissipation in Still Air, Plastic or Ceramic DIP† SOIC Package† TSSOP Package†	750 500 450	mW
T <sub>stg</sub>	Storage Temperature Range	- 65 to + 150	°C
T <sub>L</sub>	Lead Temperature, 1 mm from Case for 10 Seconds Plastic DIP, SOIC or TSSOP Package Ceramic DIP	260 300	°C

This device contains protection circuitry to guard against damage due to high static voltages or electric fields. However, precautions must be taken to avoid applications of any voltage higher than maximum rated voltages to this high-impedance circuit. For proper operation, V<sub>in</sub> and V<sub>out</sub> should be constrained to the range GND ≤ (V<sub>in</sub> or V<sub>out</sub>) ≤ V<sub>CC</sub>. Unused inputs must always be tied to an appropriate logic voltage level (e.g., either GND or V<sub>CC</sub>). Unused outputs must be left open.

\* Maximum Ratings are those values beyond which damage to the device may occur. Functional operation should be restricted to the Recommended Operating Conditions.

† Derating — Plastic DIP: - 10 mW/°C from 65° to 125°C  
Ceramic DIP: - 10 mW/°C from 100° to 125°C  
SOIC Package: - 7 mW/°C from 65° to 125°C  
TSSOP Package: - 6.1 mW/°C from 65° to 125°C

For high frequency or heavy load considerations, see Chapter 2 of the Motorola High-Speed CMOS Data Book (DL129/D).

**RECOMMENDED OPERATING CONDITIONS**

Symbol	Parameter	Min	Max	Unit	
V <sub>CC</sub>	DC Supply Voltage (Referenced to GND)	2.5*	6.0	V	
V <sub>in</sub> , V <sub>out</sub>	DC Input Voltage, Output Voltage (Referenced to GND)	0	V <sub>CC</sub>	V	
T <sub>A</sub>	Operating Temperature Range, All Package Types	- 55	+ 125	°C	
t <sub>r</sub> , t <sub>f</sub>	Input Rise/Fall Time (Figure 1)	V <sub>CC</sub> = 2.0 V V <sub>CC</sub> = 4.5 V V <sub>CC</sub> = 6.0 V	0 0 0	1000 500 400	ns

\* The oscillator is guaranteed to function at 2.5 V minimum. However, parametrics are tested at 2.0 V by driving Pin 11 with an external clock source.

**DC CHARACTERISTICS** (Voltages Referenced to GND)

Symbol	Parameter	Condition	V <sub>CC</sub> V	Guaranteed Limit			Unit
				-55 to 25°C	≤85°C	≤125°C	
V <sub>IH</sub>	Minimum High-Level Input Voltage	V <sub>out</sub> = 0.1V or V <sub>CC</sub> - 0.1V  I <sub>out</sub>   ≤ 20µA	2.0	1.50	1.50	1.50	V
			3.0	2.10	2.10	2.10	
			4.5	3.15	3.15	3.15	
			6.0	4.20	4.20	4.20	
V <sub>IL</sub>	Maximum Low-Level Input Voltage	V <sub>out</sub> = 0.1V or V <sub>CC</sub> - 0.1V  I <sub>out</sub>   ≤ 20µA	2.0	0.50	0.50	0.50	V
			3.0	0.90	0.90	0.90	
			4.5	1.35	1.35	1.35	
			6.0	1.80	1.80	1.80	
V <sub>OH</sub>	Minimum High-Level Output Voltage (Q4-Q10, Q12-Q14)	V <sub>in</sub> = V <sub>IH</sub> or V <sub>IL</sub>  I <sub>out</sub>   ≤ 20µA	2.0	1.9	1.9	1.9	V
			4.5	4.4	4.4	4.4	
			6.0	5.9	5.9	5.9	
		V <sub>in</sub> = V <sub>IH</sub> or V <sub>IL</sub>  I <sub>out</sub>   ≤ 2.4mA  I <sub>out</sub>   ≤ 4.0mA  I <sub>out</sub>   ≤ 5.2mA	3.0	2.48	2.34	2.20	
			4.5	3.98	3.84	3.70	
			6.0	5.48	5.34	5.20	

**DC CHARACTERISTICS** (Voltages Referenced to GND)

Symbol	Parameter	Condition	V <sub>CC</sub> V	Guaranteed Limit			Unit
				-55 to 25°C	≤85°C	≤125°C	
V <sub>OL</sub>	Maximum Low-Level Output Voltage (Q4–Q10, Q12–Q14)	V <sub>in</sub> = V <sub>IH</sub> or V <sub>IL</sub>  I <sub>out</sub>   ≤ 20μA	2.0	0.1	0.1	0.1	V
			4.5	0.1	0.1	0.1	
			6.0	0.1	0.1	0.1	
		V <sub>in</sub> = V <sub>IH</sub> or V <sub>IL</sub>  I <sub>out</sub>   ≤ 2.4mA  I <sub>out</sub>   ≤ 4.0mA  I <sub>out</sub>   ≤ 5.2mA	3.0	0.26	0.33	0.40	
			4.5	0.26	0.33	0.40	
			6.0	0.26	0.33	0.40	
V <sub>OH</sub>	Minimum High-Level Output Voltage (Osc Out 1, Osc Out 2)	V <sub>in</sub> = V <sub>CC</sub> or GND  I <sub>out</sub>   ≤ 20μA	2.0	1.9	1.9	1.9	V
			4.5	4.4	4.4	4.4	
			6.0	5.9	5.9	5.9	
		V <sub>in</sub> = V <sub>CC</sub> or GND  I <sub>out</sub>   ≤ 0.7mA  I <sub>out</sub>   ≤ 1.0mA  I <sub>out</sub>   ≤ 1.3mA	3.0	2.48	2.34	2.20	
			4.5	3.98	3.84	3.70	
			6.0	5.48	5.34	5.20	
V <sub>OL</sub>	Maximum Low-Level Output Voltage (Osc Out 1, Osc Out 2)	V <sub>in</sub> = V <sub>CC</sub> or GND  I <sub>out</sub>   ≤ 20μA	2.0	0.1	0.1	0.1	V
			4.5	0.1	0.1	0.1	
			6.0	0.1	0.1	0.1	
		V <sub>in</sub> = V <sub>CC</sub> or GND  I <sub>out</sub>   ≤ 0.7mA  I <sub>out</sub>   ≤ 1.0mA  I <sub>out</sub>   ≤ 1.3mA	3.0	0.26	0.33	0.40	
			4.5	0.26	0.33	0.40	
			6.0	0.26	0.33	0.40	
I <sub>in</sub>	Maximum Input Leakage Current	V <sub>in</sub> = V <sub>CC</sub> or GND	6.0	±0.1	±1.0	±1.0	μA
I <sub>CC</sub>	Maximum Quiescent Supply Current (per Package)	V <sub>in</sub> = V <sub>CC</sub> or GND I <sub>out</sub> = 0μA	6.0	4	40	160	μA

NOTE: Information on typical parametric values can be found in Chapter 2 of the Motorola High-Speed CMOS Data Book (DL129/D).

**AC CHARACTERISTICS** (C<sub>L</sub> = 50 pF, Input t<sub>r</sub> = t<sub>f</sub> = 6 ns)

Symbol	Parameter	V <sub>CC</sub> V	Guaranteed Limit			Unit
			-55 to 25°C	≤85°C	≤125°C	
f <sub>max</sub>	Maximum Clock Frequency (50% Duty Cycle) (Figures 1 and 4)	2.0	6.0	9.0	8.0	MHz
		3.0	10	14	12	
		4.5	30	28	25	
		6.0	50	45	40	
t <sub>PLH</sub> , t <sub>PHL</sub>	Maximum Propagation Delay, Osc In to Q4* (Figures 1 and 4)	2.0	300	375	450	ns
		3.0	180	200	250	
		4.5	60	75	90	
		6.0	51	64	75	
t <sub>PLH</sub> , t <sub>PHL</sub>	Maximum Propagation Delay, Osc In to Q14* (Figures 1 and 4)	2.0	500	750	1000	ns
		3.0	350	450	600	
		4.5	250	275	300	
		6.0	200	220	250	
t <sub>PHL</sub>	Maximum Propagation Delay, Reset to Any Q (Figures 2 and 4)	2.0	195	245	300	ns
		3.0	75	100	125	
		4.5	39	49	61	
		6.0	33	42	53	
t <sub>PLH</sub> , t <sub>PHL</sub>	Maximum Propagation Delay, Q <sub>n</sub> to Q <sub>n+1</sub> (Figures 3 and 4)	2.0	75	95	125	ns
		3.0	60	75	95	
		4.5	15	19	24	
		6.0	13	16	20	

**AC CHARACTERISTICS** ( $C_L = 50$  pF, Input  $t_r = t_f = 6$  ns) – **continued**

Symbol	Parameter	V <sub>CC</sub> V	Guaranteed Limit			Unit
			–55 to 25°C	≤85°C	≤125°C	
t <sub>TLH</sub> , t <sub>THL</sub>	Maximum Output Transition Time, Any Output (Figures 1 and 4)	2.0	75	95	110	ns
		3.0	27	32	36	
		4.5	15	19	22	
		6.0	13	16	19	
C <sub>in</sub>	Maximum Input Capacitance		10	10	10	pF

NOTE: For propagation delays with loads other than 50 pF, and information on typical parametric values, see Chapter 2 of the Motorola High-Speed CMOS Data Book (DL129/D).

\* For T<sub>A</sub> = 25°C and C<sub>L</sub> = 50 pF, typical propagation delay from Clock to other Q outputs may be calculated with the following equations:

$$V_{CC} = 2.0 \text{ V: } t_p = [93.7 + 59.3(n-1)] \text{ ns}$$

$$V_{CC} = 4.5 \text{ V: } t_p = [30.25 + 14.6(n-1)] \text{ ns}$$

$$V_{CC} = 3.0 \text{ V: } t_p = [61.5 + 34.4(n-1)] \text{ ns}$$

$$V_{CC} = 6.0 \text{ V: } t_p = [24.4 + 12(n-1)] \text{ ns}$$

C <sub>PD</sub>	Power Dissipation Capacitance (Per Package)*	Typical @ 25°C, V <sub>CC</sub> = 5.0 V		pF
		35		

\* Used to determine the no-load dynamic power consumption:  $P_D = C_{PD} V_{CC}^2 f + I_{CC} V_{CC}$ . For load considerations, see Chapter 2 of the Motorola High-Speed CMOS Data Book (DL129/D).

**TIMING REQUIREMENTS** (Input  $t_r = t_f = 6$  ns)

Symbol	Parameter	V <sub>CC</sub> V	Guaranteed Limit			Unit
			–55 to 25°C	≤85°C	≤125°C	
t <sub>rec</sub>	Minimum Recovery Time, Reset Inactive to Clock (Figure 2)	2.0	100	125	150	ns
		3.0	75	100	120	
		4.5	20	25	30	
		6.0	17	21	25	
t <sub>w</sub>	Minimum Pulse Width, Clock (Figure 1)	2.0	75	95	110	ns
		3.0	27	32	36	
		4.5	15	19	23	
		6.0	13	16	19	
t <sub>w</sub>	Minimum Pulse Width, Reset (Figure 2)	2.0	75	95	110	ns
		3.0	27	32	36	
		4.5	15	19	23	
		6.0	13	16	19	
t <sub>r</sub> , t <sub>f</sub>	Maximum Input Rise and Fall Times (Figure 1)	2.0	1000	1000	1000	ns
		3.0	800	800	800	
		4.5	500	500	500	
		6.0	400	400	400	

NOTE: Information on typical parametric values can be found in Chapter 2 of the Motorola High-Speed CMOS Data Book (DL129/D).

**PIN DESCRIPTIONS**

**INPUTS**

**Osc In (Pin 11)**

Negative-edge triggering clock input. A high-to-low transition on this input advances the state of the counter. Osc In may be driven by an external clock source.

**Reset (Pin 12)**

Active-high reset. A high level applied to this input asynchronously resets the counter to its zero state (forcing all Q outputs low) and disables the oscillator.

**OUTPUTS**

**Q4—Q10, Q12—Q14 (Pins 7, 5, 4, 6, 13, 15, 1, 2, 3)**

Active-high outputs. Each Q<sub>n</sub> output divides the Clock input frequency by 2<sup>N</sup>. The user should note the Q1, Q2, Q3 and Q11 are not available as outputs.

**Osc Out 1, Osc Out 2 (Pins 9, 10)**

Oscillator outputs. These pins are used in conjunction with Osc In and the external components to form an oscillator (See NO TAG and NO TAG). When Osc In is being driven with an external clock source, Osc Out 1 and Osc Out 2 must be left open circuited. With the crystal oscillator configuration in Figure 6, Osc Out 2 must be left open circuited.

**SWITCHING WAVEFORMS**

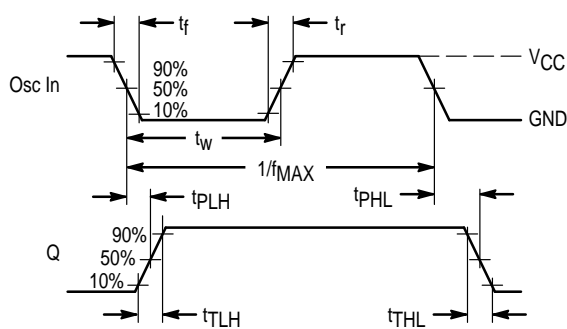


Figure 1.

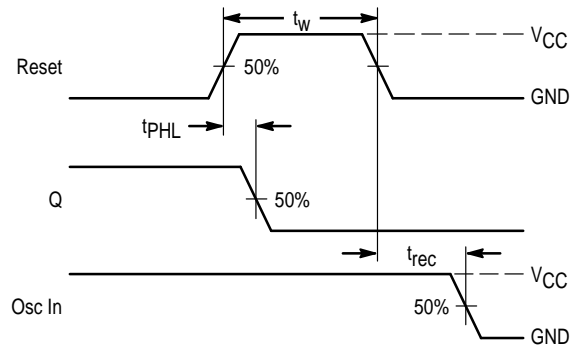


Figure 2.

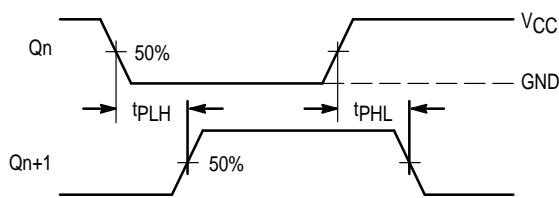
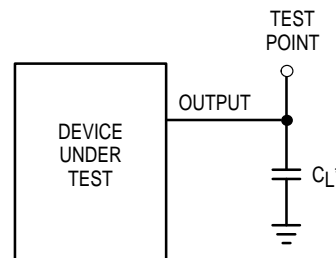


Figure 3.



\*Includes all probe and jig capacitance

Figure 4. Test Circuit

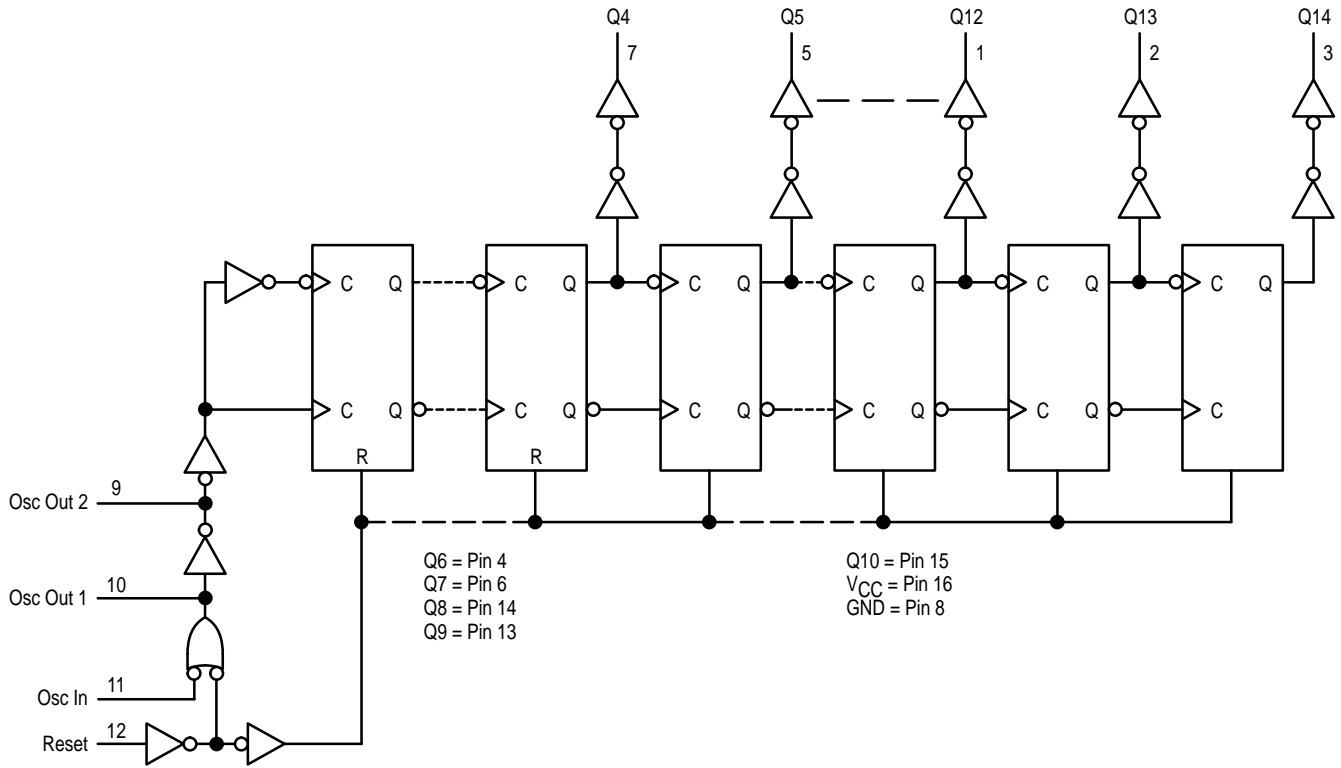
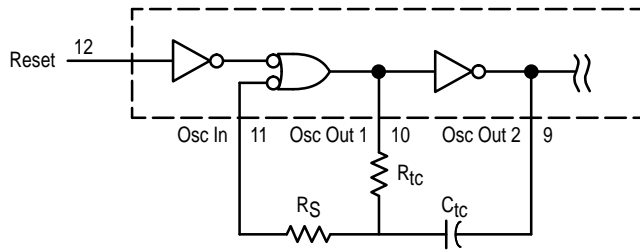


Figure 5. Expanded Logic Diagram



For  $2.0V \leq V_{CC} \leq 6.0V$   
 $10R_{tc} > R_S > 2R_{tc}$   
 $400Hz \leq f \leq 400KHz$ :

$$f \approx \frac{1}{3 R_{tc} C_{tc}} \quad (f \text{ in Hz, } R_{tc} \text{ in ohms, } C_{tc} \text{ in farads})$$

The formula may vary for other frequencies.

Figure 6. Oscillator Circuit Using RC Configuration

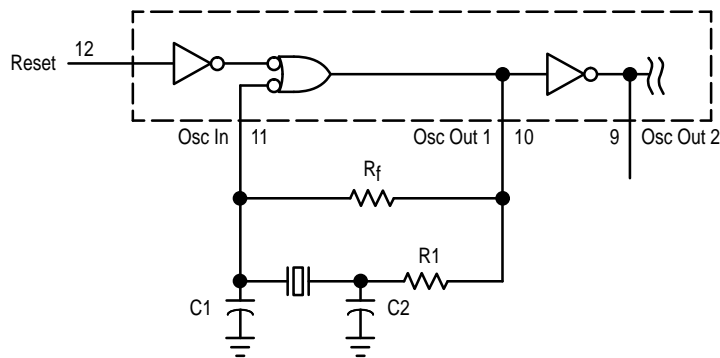
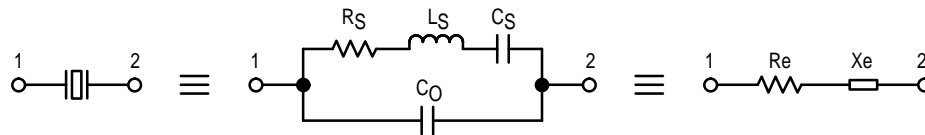


Figure 7. Pierce Crystal Oscillator Circuit

**TABLE 1. CRYSTAL OSCILLATOR AMPLIFIER SPECIFICATIONS** ( $T_A = 25^\circ\text{C}$ ; Input = Pin 11, Output = Pin 10)

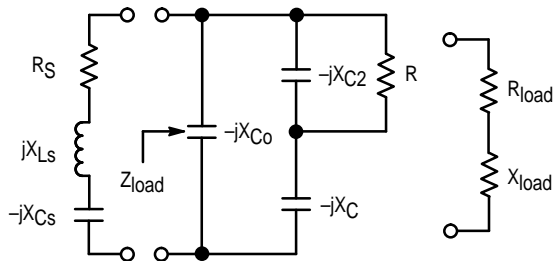
Type		Positive Reactance (Pierce)
Input Resistance, $R_{in}$		60M $\Omega$ Minimum
Output Impedance, $Z_{out}$ (4.5V Supply)		200 $\Omega$ (See Text)
Input Capacitance, $C_{in}$		5pF Typical
Output Capacitance, $C_{out}$		7pF Typical
Series Capacitance, $C_a$		5pF Typical
Open Loop Voltage Gain with Output at Full Swing, $\alpha$	3Vdc Supply	5.0 Expected Minimum
	4Vdc Supply	4.0 Expected Minimum
	5Vdc Supply	3.3 Expected Minimum
	6Vdc Supply	3.1 Expected Minimum

**PIERCE CRYSTAL OSCILLATOR DESIGN**



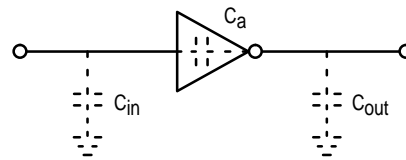
Value are supplied by crystal manufacturer (parallel resonant crystal).

**Figure 8. Equivalent Crystal Networks**



NOTE:  $C = C_1 + C_{in}$  and  $R = R_1 + R_{out}$ .  $C_0$  is considered as part of the load.  $C_a$  and  $R_f$  typically have minimal effect below 2MHz.

**Figure 9. Series Equivalent Crystal Load**



Values are listed in Table 1.

**Figure 10. Parasitic Capacitances of the Amplifier**

## DESIGN PROCEDURES

The following procedure applies for oscillators operating below 2MHz where Z is a resistor R1. Above 2MHz, additional impedance elements should be considered:  $C_{out}$  and  $C_a$  of the amp, feedback resistor  $R_f$ , and amplifier phase shift error from 180°C.

Step 1: Calculate the equivalent series circuit of the crystal at the frequency of oscillation.

$$Z_e = \frac{-jX_{C_0}(R_s + jX_{L_s} - jX_{C_s})}{-jX_{C_0} + R_s + jX_{L_s} - jX_{C_s}} = R_e + jX_e$$

Reactance  $jX_e$  should be positive, indicating that the crystal is operating as an inductive reactance at the oscillation frequency. The maximum  $R_s$  for the crystal should be used in the equation.

Step 2: Determine  $\beta$ , the attenuation, of the feedback network. For a closed-loop gain of 2,  $A_V\beta = 2$ ,  $\beta = 2/A_V$  where  $A_V$  is the gain of the HC4060A amplifier.

Step 3: Determine the manufacturer's loading capacitance. For example: A manufacturer may specify an external load capacitance of 32pF at the required frequency.

Step 4: Determine the required Q of the system, and calculate  $R_{load}$ . For example, a manufacturer specifies a crystal Q of 100,000. In-circuit Q is arbitrarily set at 20% below crystal Q or 80,000. Then  $R_{load} = (2\pi f_0 L_s / Q) - R_s$  where  $L_s$  and  $R_s$  are crystal parameters.

Step 5: Simultaneously solve, using a computer,

$$\beta = \frac{X_C \cdot X_{C2}}{R \cdot R_e + X_{C2} (X_e - X_C)} \quad (\text{with feedback phase shift} = 180^\circ) \quad (\text{Eq 1})$$

$$X_e = X_{C2} + X_C + \frac{R_e X_{C2}}{R} = X_{load} \quad (\text{where the loading capacitor is an external load, not including } C_0) \quad (\text{Eq 2})$$

$$R_{load} = \frac{R X_{C_0} X_{C2} [(X_C + X_{C2})(X_C + X_{C_0}) - X_C(X_C + X_{C_0} + X_{C2})]}{X_{C2}^2 (X_C + X_{C_0})^2 + R^2 (X_C + X_{C_0} + X_{C2})^2} \quad (\text{Eq 3})$$

Here  $R = R_{out} + R1$ .  $R_{out}$  is amp output resistance, R1 is Z. The C corresponding to  $X_C$  is given by  $C = C1 + C_{in}$ .

Alternately, pick a value for R1 (i.e, let  $R1 = R_s$ ). Solve Equations 1 and 2 for C1 and C2. Use Equation 3 and the fact that  $Q = 2\pi f_0 L_s / (R_s + R_{load})$  to find in-circuit Q. If Q is not satisfactory pick another value for R1 and repeat the procedure.

### CHOOSING R1

Power is dissipated in the effective series resistance of the crystal. The drive level specified by the crystal manufacturer is the maximum stress that a crystal can withstand without damage or excessive shift in frequency. R1 limits the drive level.

To verify that the maximum dc supply voltage does not overdrive the crystal, monitor the output frequency as a function of voltage at Osc Out 2 (Pin 9). The frequency should increase very slightly as the dc supply voltage is increased. An overdriven crystal will decrease in frequency or become unstable with an increase in supply voltage. The operating supply voltage must be reduced or R1 must be increased in value if the overdriven condition exists. The user should note that the oscillator start-up time is proportional to the value of R1.

### SELECTING $R_f$

The feedback resistor,  $R_f$ , typically ranges up to 20M $\Omega$ .  $R_f$  determines the gain and bandwidth of the amplifier. Proper bandwidth insures oscillation at the correct frequency plus roll-off to minimize gain at undesirable frequencies, such as

the first overtone.  $R_f$  must be large enough so as to not affect the phase of the feedback network in an appreciable manner.

### ACKNOWLEDGEMENTS AND RECOMMENDED REFERENCES

The following publications were used in preparing this data sheet and are hereby acknowledged and recommended for reading:

Technical Note TN-24, Statek Corp.

Technical Note TN-7, Statek Corp.

D. Babin, "Designing Crystal Oscillators", Machine Design, March 7, 1985.

D. Babin, "Guidelines for Crystal Oscillator Design", Machine Design, April 25, 1985.

### ALSO RECOMMENDED FOR READING:

E. Hafner, "The Piezoelectric Crystal Unit-Definitions and Method of Measurement", Proc. IEEE, Vol. 57, No. 2, Feb., 1969.

D. Kemper, L. Rosine, "Quartz Crystals for Frequency Control", Electro-Technology, June, 1969.

P. J. Ottowitz, "A Guide to Crystal Selection", Electronic Design, May, 1966.



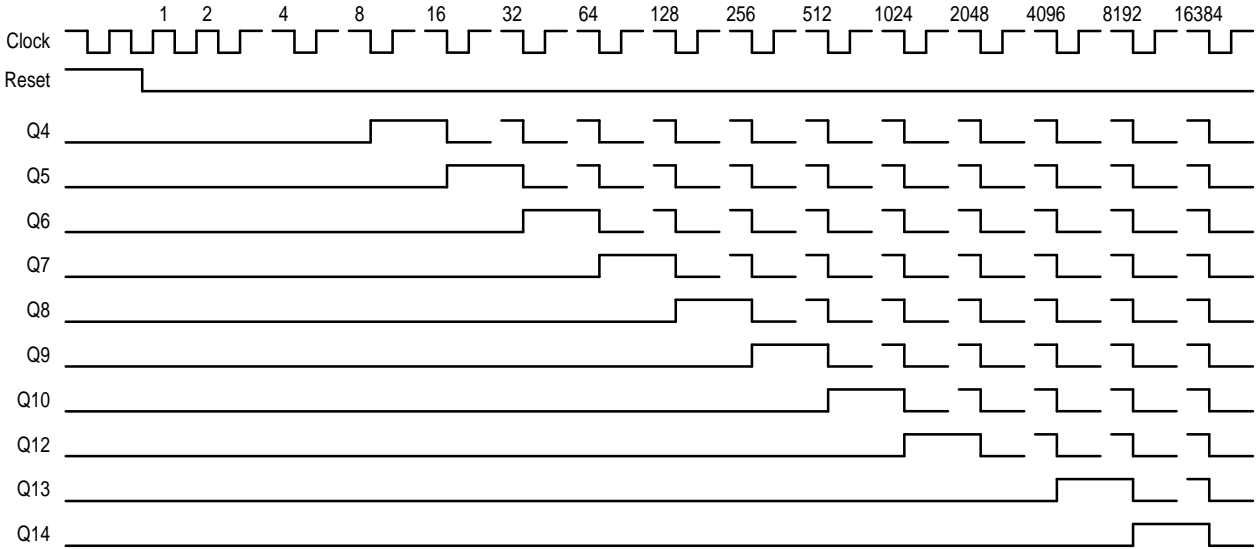
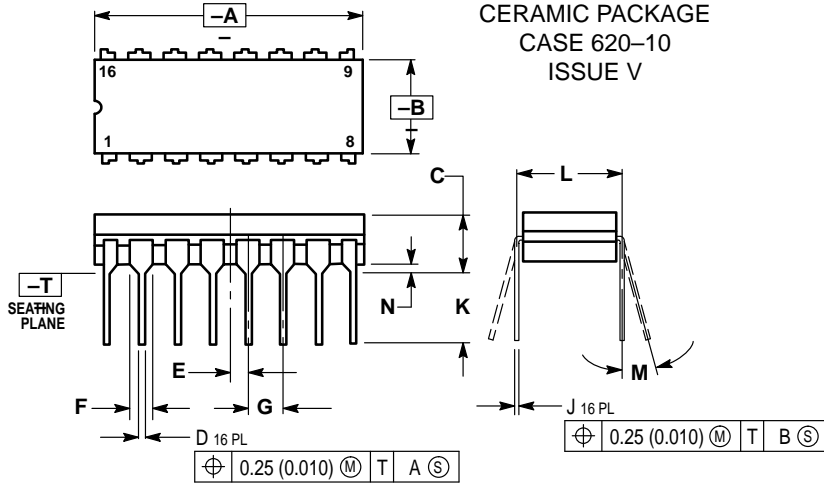


Figure 11. Timing Diagram

OUTLINE DIMENSIONS

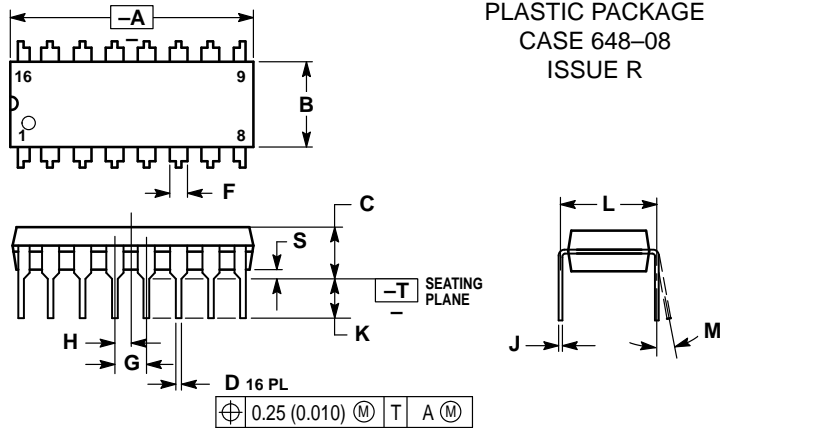
**J SUFFIX**  
**CERAMIC PACKAGE**  
**CASE 620-10**  
**ISSUE V**



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH.
  3. DIMENSION L TO CENTER OF LEAD WHEN FORMED PARALLEL.
  4. DIM F MAY NARROW TO 0.76 (0.030) WHERE THE LEAD ENTERS THE CERAMIC BODY.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.750	0.785	19.05	19.93
B	0.240	0.295	6.10	7.49
C	—	0.200	—	5.08
D	0.015	0.020	0.39	0.50
E	0.050 BSC		1.27 BSC	
F	0.055	0.065	1.40	1.65
G	0.100 BSC		2.54 BSC	
J	0.008	0.015	0.21	0.38
K	0.125	0.170	3.18	4.31
L	0.300 BSC		7.62 BSC	
M	0°	15°	0°	15°
N	0.020	0.040	0.51	1.01

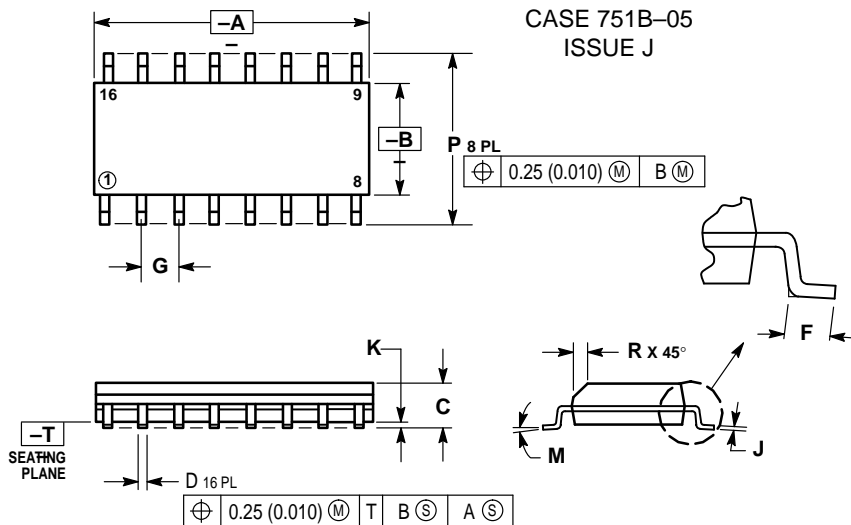
**N SUFFIX**  
**PLASTIC PACKAGE**  
**CASE 648-08**  
**ISSUE R**



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH.
  3. DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
  4. DIMENSION B DOES NOT INCLUDE MOLD FLASH.
  5. ROUNDED CORNERS OPTIONAL.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.740	0.770	18.80	19.55
B	0.250	0.270	6.35	6.85
C	0.145	0.175	3.69	4.44
D	0.015	0.021	0.39	0.53
F	0.040	0.070	1.02	1.77
G	0.100 BSC		2.54 BSC	
H	0.050 BSC		1.27 BSC	
J	0.008	0.015	0.21	0.38
K	0.110	0.130	2.80	3.30
L	0.295	0.305	7.50	7.74
M	0°	10°	0°	10°
S	0.020	0.040	0.51	1.01

**D SUFFIX**  
**PLASTIC SOIC PACKAGE**  
**CASE 751B-05**  
**ISSUE J**

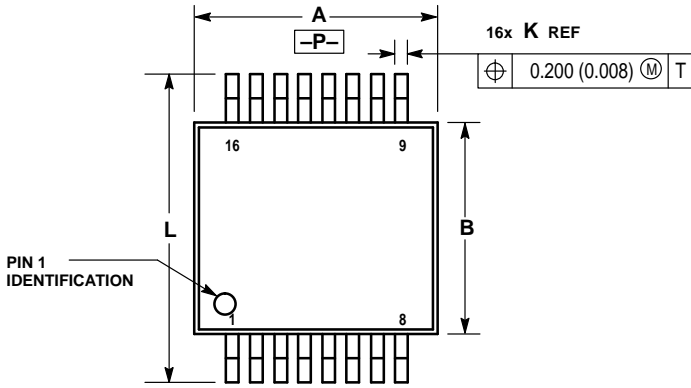


- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: MILLIMETER.
  3. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
  4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
  5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.

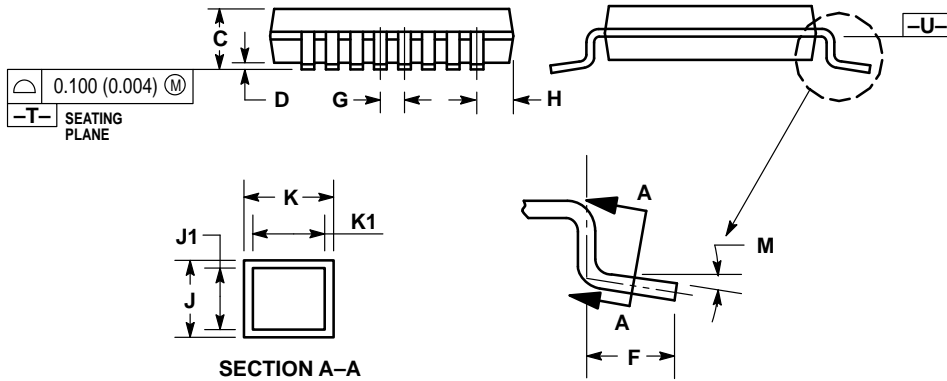
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.80	10.00	0.386	0.393
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.054	0.068
D	0.35	0.49	0.014	0.019
F	0.40	1.25	0.016	0.049
G	1.27 BSC		0.050 BSC	
J	0.19	0.25	0.008	0.009
K	0.10	0.25	0.004	0.009
M	0°	7°	0°	7°
P	5.80	6.20	0.229	0.244
R	0.25	0.50	0.010	0.019

OUTLINE DIMENSIONS

DT SUFFIX  
TSSOP PACKAGE  
CASE 948C-03  
ISSUE B



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: MILLIMETER.
  3. DIMENSION A DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH OR GATE BURRS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
  4. DIMENSION B DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 (0.010) PER SIDE.
  5. DIMENSION K DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 (0.003) TOTAL EXCESS OF THE K DIMENSION AT MAXIMUM MATERIAL CONDITION.
  6. TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
  7. DIMENSIONS A AND B ARE TO BE DETERMINED AT DATUM PLANE -U-.



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	—	5.10	—	0.200
B	4.30	4.50	0.169	0.177
C	—	1.20	—	0.047
D	0.05	0.25	0.002	0.010
F	0.45	0.55	0.018	0.022
G	0.65 BSC		0.026 BSC	
H	0.22	0.23	0.009	0.010
J	0.09	0.24	0.004	0.009
J1	0.09	0.18	0.004	0.007
K	0.16	0.32	0.006	0.013
K1	0.16	0.26	0.006	0.010
L	6.30	6.50	0.248	0.256
M	0°	10°	0°	10°

Motorola reserves the right to make changes without further notice to any products herein. Motorola makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does Motorola assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation consequential or incidental damages. "Typical" parameters can and do vary in different applications. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. Motorola does not convey any license under its patent rights nor the rights of others. Motorola products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the Motorola product could create a situation where personal injury or death may occur. Should Buyer purchase or use Motorola products for any such unintended or unauthorized application, Buyer shall indemnify and hold Motorola and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that Motorola was negligent regarding the design or manufacture of the part. Motorola and are registered trademarks of Motorola, Inc. Motorola, Inc. is an Equal Opportunity/Affirmative Action Employer.

How to reach us:

USA/EUROPE: Motorola Literature Distribution;  
P.O. Box 20912; Phoenix, Arizona 85036. 1-800-441-2447

JAPAN: Nippon Motorola Ltd.; Tatsumi-SPD-JLDC, Toshikatsu Otsuki,  
6F Seibu-Butsuryu-Center, 3-14-2 Tatsumi Koto-Ku, Tokyo 135, Japan. 03-3521-8315

MFAX: RMFAX0@email.sps.mot.com -TOUCHTONE (602) 244-6609  
INTERNET: http://Design-NET.com

HONG KONG: Motorola Semiconductors H.K. Ltd.; 8B Tai Ping Industrial Park,  
51 Ting Kok Road, Tai Po, N.T., Hong Kong. 852-26629298

