# 14-Bit Binary Counter and Oscillator

The MC14060B is a 14–stage binary ripple counter with an on–chip oscillator buffer. The oscillator configuration allows design of either RC or crystal oscillator circuits. Also included on the chip is a reset function which places all outputs into the zero state and disables the oscillator. A negative transition on Clock will advance the counter to the next state. Schmitt trigger action on the input line permits very slow input rise and fall times. Applications include time delay circuits, counter controls, and frequency dividing circuits.

- Fully static operation
- Diode Protection on All Inputs
- Supply Voltage Range = 3.0 V to 18 V
- Capable of Driving Two Low–power TTL Loads or One Low–power Schottky TTL Load Over the Rated Temperature Range
- Buffered Outputs Available from Stages 4 Through 10 and 12 Through 14
- Common Reset Line
- Pin–for–Pin Replacement for CD4060B

MC14060B
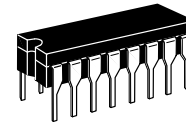
L SUFFIX
CERAMIC
CASE 620
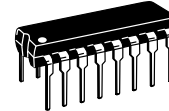
P SUFFIX
PLASTIC
CASE 648
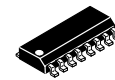
D SUFFIX
SOIC
CASE 751B

ORDERING INFORMATION

MC14XXXBCP   Plastic
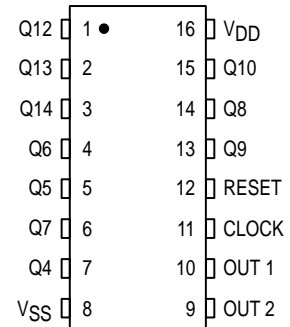MC14XXXBCL   Ceramic
MC14XXXBD   SOIC

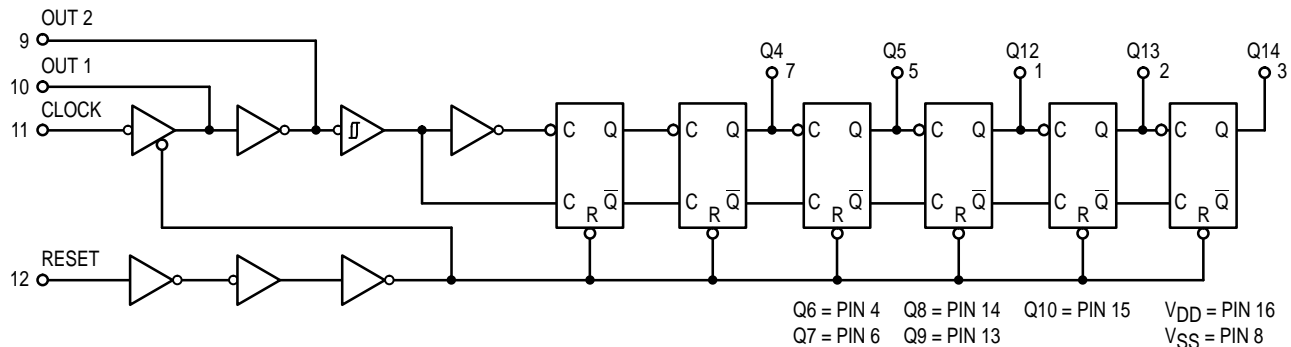$T_A = -55°$ to $125°C$ for all packages.

TRUTH TABLE

Clock	Reset	Output State
⌐‾	L	No Change
‾⌐	L	Advance to next state
X	H	All Outputs are low

X = Don't Care

PIN ASSIGNMENT

Q12	1 ●	16	V$_{DD}$
Q13	2	15	Q10
Q14	3	14	Q8
Q6	4	13	Q9
Q5	5	12	RESET
Q7	6	11	CLOCK
Q4	7	10	OUT 1
V$_{SS}$	8	9	OUT 2

LOGIC DIAGRAM

Q6 = PIN 4   Q8 = PIN 14   Q10 = PIN 15   V$_{DD}$ = PIN 16
Q7 = PIN 6   Q9 = PIN 13   V$_{SS}$ = PIN 8

MOTOROLA

MAXIMUM RATINGS* (Voltages Referenced to V_{SS})

Symbol	Parameter	Value	Unit
V_{DD}	DC Supply Voltage	− 0.5 to + 18.0	V
V_{in}, V_{out}	Input or Output Voltage (DC or Transient)	− 0.5 to V_{DD} + 0.5	V
I_{in}, I_{out}	Input or Output Current (DC or Transient), per Pin	± 10	mA
P_D	Power Dissipation, per Package†	500	mW
T_{stg}	Storage Temperature	− 65 to + 150	°C
T_L	Lead Temperature (8–Second Soldering)	260	°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_{in} and V_{out} should be constrained to the range $V_{SS} \leq (V_{in}$ or $V_{out}) \leq V_{DD}$.

Unused inputs must always be tied to an appropriate logic voltage level (e.g., either V_{SS} or V_{DD}). Unused outputs must be left open.

* Maximum Ratings are those values beyond which damage to the device may occur.

†Temperature Derating:
   Plastic "P and D/DW" Packages: − 7.0 mW/°C From 65°C To 125°C
   Ceramic "L" Packages – 12 mW/°C From 100°C To 125°C

ELECTRICAL CHARACTERISTICS (Voltages Referenced to V_{SS})

| Characteristic	Symbol	V_{DD} Vdc	− 55°C Min	− 55°C Max	25°C Min	25°C Typ #	25°C Max	125°C Min	125°C Max	Unit
Output Voltage "0" Level $V_{in} = V_{DD}$ or 0	V_{OL}	5.0	—	0.05	—	0	0.05	—	0.05	V
		10	—	0.05	—	0	0.05	—	0.05	
		15	—	0.05	—	0	0.05	—	0.05	
$V_{in} = 0$ or V_{DD} "1" Level	V_{OH}	5.0	4.95	—	4.95	5.0	—	4.95	—	V
		10	9.95	—	9.95	10	—	9.95	—	
		15	14.95	—	14.95	15	—	14.95	—	
Input Voltage "0" Level (V_O = 4.5 or 0.5 V) (V_O = 9.0 or 1.0 V) (V_O = 13.5 or 1.5 V)	V_{IL}	5.0	—	1.5	—	2.25	1.5	—	1.5	V
		10	—	3.0	—	4.50	3.0	—	3.0	
		15	—	4.0	—	6.75	4.0	—	4.0	
(V_O = 0.5 or 4.5 V) "1" Level (V_O = 1.0 or 9.0 V) (V_O = 1.5 or 13.5 V)	V_{IH}	5.0	3.5	—	3.5	2.75	—	3.5	—	V
		10	7.0	—	7.0	5.50	—	7.0	—	
		15	11.0	—	11.0	8.25	—	11.0	—	
Input Voltage "0" Level (V_O = 4.5 Vdc) (For Input 11 (V_O = 9.0 Vdc) and Output 10) (V_O = 13.5 Vdc)	V_{IL}	5.0	—	1.0	—	2.25	1.0	—	1.0	Vdc
		10	—	2.0	—	4.50	2.0	—	2.0	
		15	—	2.5	—	6.75	2.5	—	2.5	
(V_O = 0.5 Vdc) "1" Level (V_O = 1.0 Vdc) (V_O = 1.5 Vdc)	V_{IH}	5.0	4.0	—	4.0	2.75	—	4.0	—	Vdc
		10	8.0	—	8.0	5.50	—	8.0	—	
		15	12.5	—	12.5	8.25	—	12.5	—	
Output Drive Current (V_{OH} = 2.5 V) (Except Source (V_{OH} = 4.6 V) Pins 9 and 10) (V_{OH} = 9.5 V) (V_{OH} = 13.5 V)	I_{OH}	5.0	− 3.0	—	− 2.4	− 4.2	—	− 1.7	—	mA
		5.0	− 0.64	—	− 0.51	− 0.88	—	− 0.36	—	
		10	− 1.6	—	− 1.3	− 2.25	—	− 0.9	—	
		15	− 4.2	—	− 3.4	− 8.8	—	− 2.4	—	
(V_{OL} = 0.4 V) Sink (V_{OL} = 0.5 V) (V_{OL} = 1.5 V)	I_{OL}	5.0	0.64	—	0.51	0.88	—	0.36	—	mA
		10	1.6	—	1.3	2.25	—	0.9	—	
		15	4.2	—	3.4	8.8	—	2.4	—	
Input Current	I_{in}	15	—	± 0.1	—	±0.00001	± 0.1	—	± 1.0	µA
Input Capacitance (V_{in} = 0)	C_{in}	—	—	—	—	5.0	7.5	—	—	pF
Quiescent Current (Per Package)	I_{DD}	5.0	—	5.0	—	0.005	5.0	—	150	µA
		10	—	10	—	0.010	10	—	300	
		15	—	20	—	0.015	20	—	600	
Total Supply Current**† (Dynamic plus Quiescent, Per Package) (C_L = 50 pF on all outputs, all buffers switching)	I_T	5.0	$I_T = (0.25$ µA/kHz) f + I_{DD}							µA
		10	$I_T = (0.54$ µA/kHz) f + I_{DD}							
		15	$I_T = (0.85$ µA/kHz) f + I_{DD}							

Data labelled "Typ" is not to be used for design purposes but is intended as an indication of the IC's potential performance.

** The formulas given are for the typical characteristics only at 25°C.

SWITCHING CHARACTERISTICS (C_L = 50 pF, T_A = 25°C)

Characteristic	Symbol	V_{DD} Vdc	Min	Typ #	Max	Unit
Output Rise Time (Counter Outputs)	t_{TLH}	5.0 10 15	— — —	40 25 20	200 100 80	ns
Output Fall Time (Counter Outputs)	t_{THL}	5.0 10 15	— — —	50 30 20	200 100 80	ns
Propagation Delay Time Clock to Q4	t_{PLH} t_{PHL}	5.0 10 15	— — —	415 175 125	740 300 200	ns
Clock to Q14		5.0 10 15	— — —	1.5 0.7 0.4	2.7 1.3 1.0	µs
Clock Pulse Width	t_{wH}	5.0 10 15	100 40 30	65 30 20	— — —	ns
Clock Pulse Frequency	f_ϕ	5.0 10 15	— — —	5 14 17	3.5 8 12	MHz
Clock Rise and Fall Time	t_{TLH} t_{THL}	5.0 10 15	No Limit			ns
Reset Pulse Width	t_w	5.0 10 15	120 60 40	40 15 10	— — —	ns
Propagation Delay Time Reset to On	t_{PHL}	5.0 10 15	— — —	170 80 60	350 160 100	ns

#Data labelled "Typ" is not to be used for design purposes but is intended as an indication of the IC's potential performance.
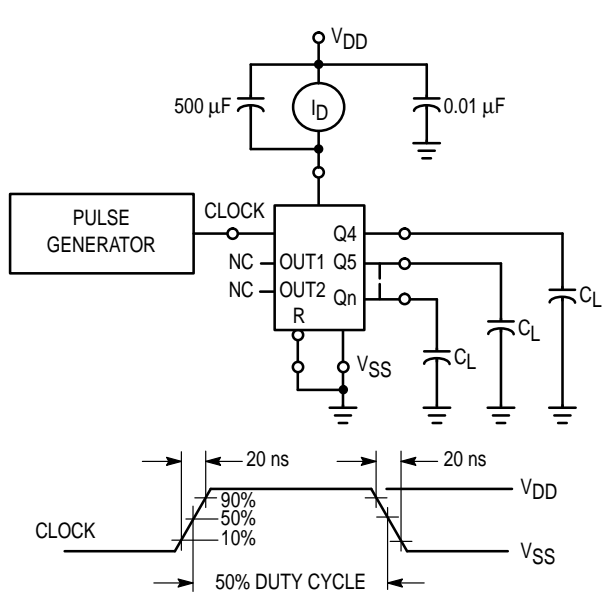
Figure 1. Power Dissipation Test Circuit and Waveform
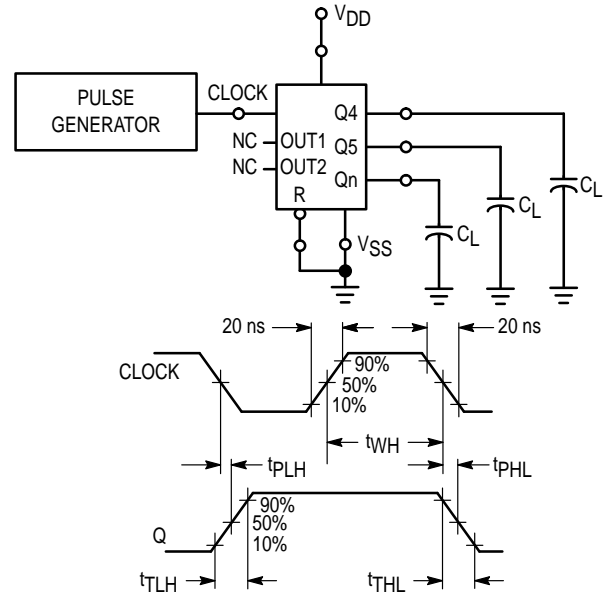
Figure 2. Switching Time Test Circuit and Waveforms
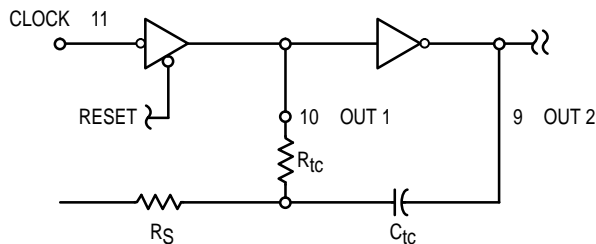
$$f \approx \frac{1}{2.3 R_{tc} C_{tc}}$$

if $1 \text{ kHz} \leq f \leq 100 \text{ kHz}$
and $2R_{tc} < R_S < 10R_{tc}$
(f in Hz, R in ohms, C in farads)

The formula may vary for other frequencies. Recommended maximum value for the resistors in 1 MΩ.

Figure 3. Oscillator Circuit Using RC Configuration
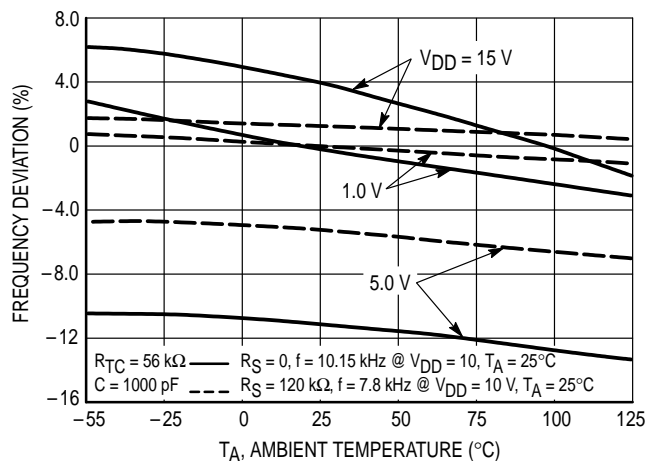
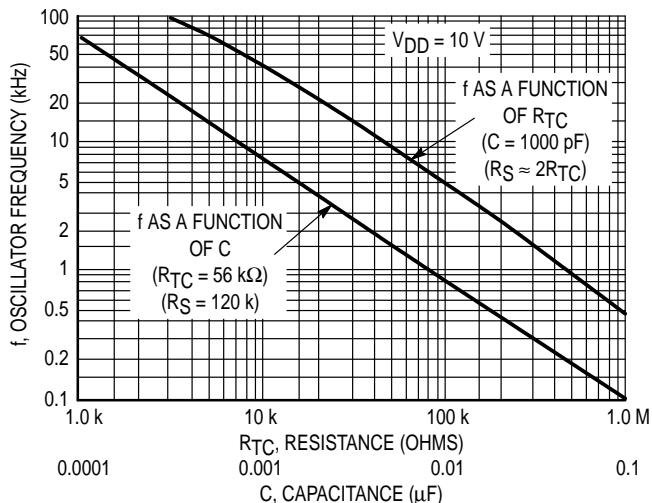## TYPICAL RC OSCILLATOR CHARACTERISTICS

Figure 4. RC Oscillator Stability

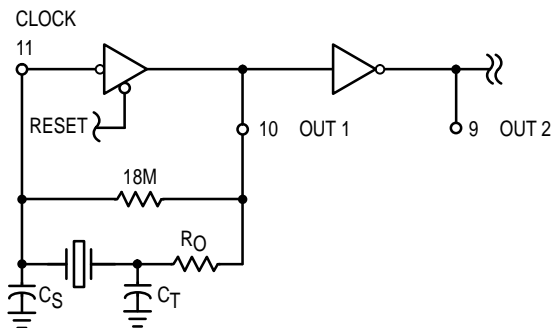**Figure 5. RC Oscillator Frequency as a Function of R$_{TC}$ and C**

Figure 6. Typical Crystal Oscillator Circuit

Characteristic	500 kHz Circuit	32 kHz Circuit	Unit
Crystal Characteristics			
Resonant Frequency	500	32	kHz
Equivalent Resistance, R$_S$	1.0	6.2	kΩ
External Resistor/Capacitor Values			
R$_O$	47	750	kΩ
C$_T$	82	82	pF
C$_S$	20	20	pF
Frequency Stability			
Frequency Changes as a Function of V$_{DD}$ (T$_A$ = 25°C)			
V$_{DD}$ Change from 5.0 V to 10V	+ 6.0	+ 2.0	ppm
V$_{DD}$ Change from 10 V to 15 V	+ 2.0	+ 2.0	ppm
Frequency Change as a Function of Temperature (V$_{DD}$ = 10 V)			
T$_A$ Change from − 55°C to +25°C Complete Oscillator*	+ 100	+ 120	ppm
T$_A$ Change from + 25°C to +125°C Complete Oscillator*	− 160	− 560	ppm

* Complete oscillator includes crystal, capacitors, and resistors.

Figure 7. Typical Data for Crystal Oscillatgor Circuit

OUTLINE DIMENSIONS

L SUFFIX
CERAMIC DIP PACKAGE
CASE 620–10
ISSUE V
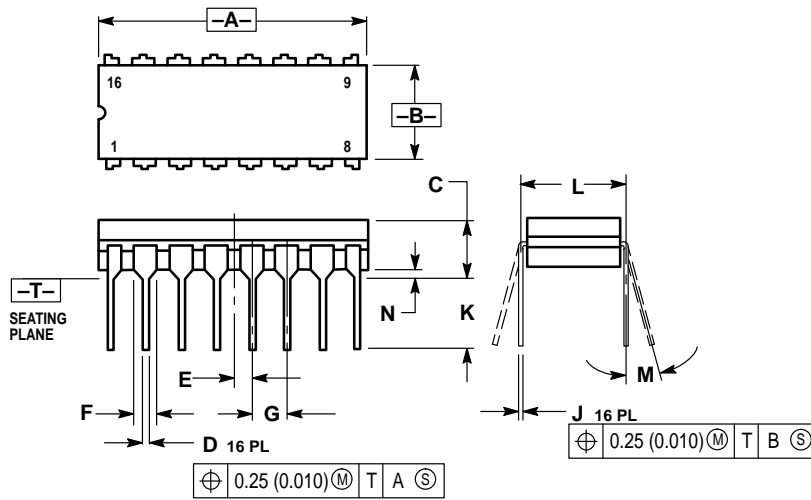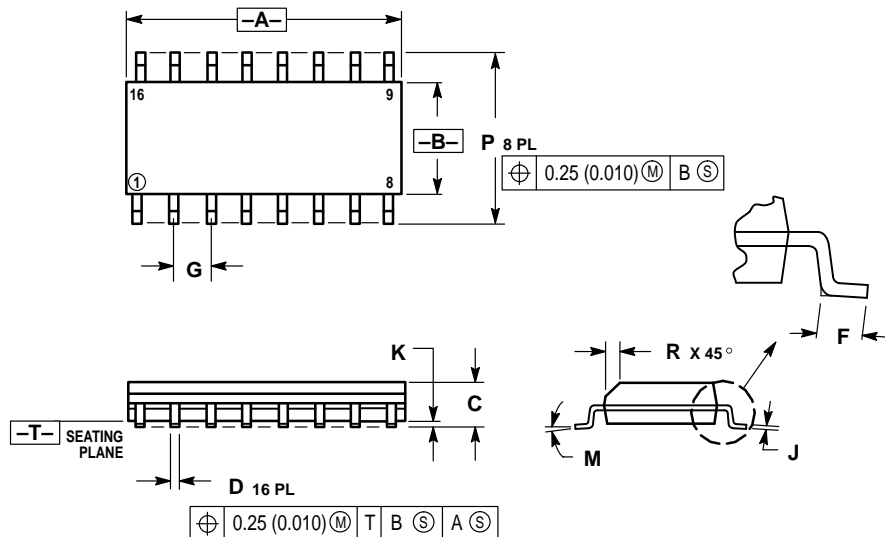
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION L TO CENTER OF LEAD WHEN FORMED PARALLEL.
4. DIMENSION F MAY NARROW TO 0.76 (0.030) WHERE THE LEAD ENTERS THE CERAMIC BODY.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS 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	
H	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

⊕ 0.25 (0.010) Ⓜ T A Ⓢ

⊕ 0.25 (0.010) Ⓜ T B Ⓢ

P SUFFIX
PLASTIC DIP 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 MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS 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	0.70	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

⊕ 0.25 (0.010) Ⓜ T A Ⓜ

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

Ⓜ **MOTOROLA**

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