



**MC12009
MC12011
MC12013**

Dual Modulus Prescaler

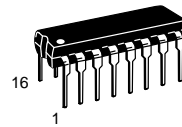
These devices are two-modulus prescalers which will divide by 5 and 6, 8 and 9, and 10 and 11, respectively. A MECL-to-MTTL translator is provided to interface directly with the MC12014 Counter Control Logic. In addition, there is a buffered clock input and MECL bias voltage source.

- MC12009 480 MHz (÷ 5/6), MC12011 550 MHz (÷ 8/9), MC12013 550 MHz (÷ 10/11)
- MECL to MTTL Translator on Chip
- MECL and MTTL Enable Inputs
- 5.0 or -5.2 V Operation*
- Buffered Clock Input — Series Input RC Typ, 20 Ohms and 4 pF
- V_{BB} Reference Voltage
- 310 Milliwatts (Typ)

* When using a 5.0 V supply, apply 5.0 V to Pin 1 (V_{CCO}), Pin 6 (MTTL V_{CC}), Pin 16 (V_{CC}), and ground Pin 8 (V_{EE}). When using -5.2 V supply, ground Pin 1 (V_{CCO}), Pin 6 (MTTL V_{CC}), and Pin 16 (V_{CC}) and apply -5.2 V to Pin 8 (V_{EE}). If the translator is not required, Pin 6 may be left open to conserve dc power drain.

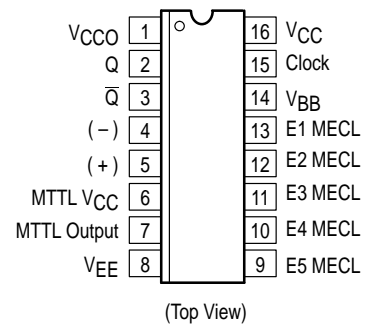
**MECL PLL COMPONENTS
DUAL MODULUS PRESCALER**

**SEMICONDUCTOR
TECHNICAL DATA**



**P SUFFIX
PLASTIC PACKAGE
CASE 648**

PIN CONNECTIONS



MAXIMUM RATINGS

Characteristic	Symbol	Rating	Unit
(Ratings above which device life may be impaired)			
Power Supply Voltage (V _{CC} = 0)	V _{EE}	-8.0	Vdc
Input Voltage (V _{CC} = 0)	V _{in}	0 to V _{EE}	Vdc
Output Source Current Continuous Surge	I _O	< 50 < 100	mAdc
Storage Temperature Range	T _{stg}	-65 to +175	°C

(Recommended Maximum Ratings above which performance may be degraded)

Operating Temperature Range MC12009, MC12011, MC12013	T _A	-30 to +85	°C
DC Fan-Out (Note 1) (Gates and Flip-Flops)	n	70	—

- NOTES:** 1. AC fan-out is limited by desired system performance.
2. ESD data available upon request.

ORDERING INFORMATION

Device	Operating Temperature Range	Package
MC12009P	T _A = -35° to +85°C	Plastic
MC12011P		
MC12013P		

MC12009 MC12011 MC12013

Figure 1. Logic Diagrams

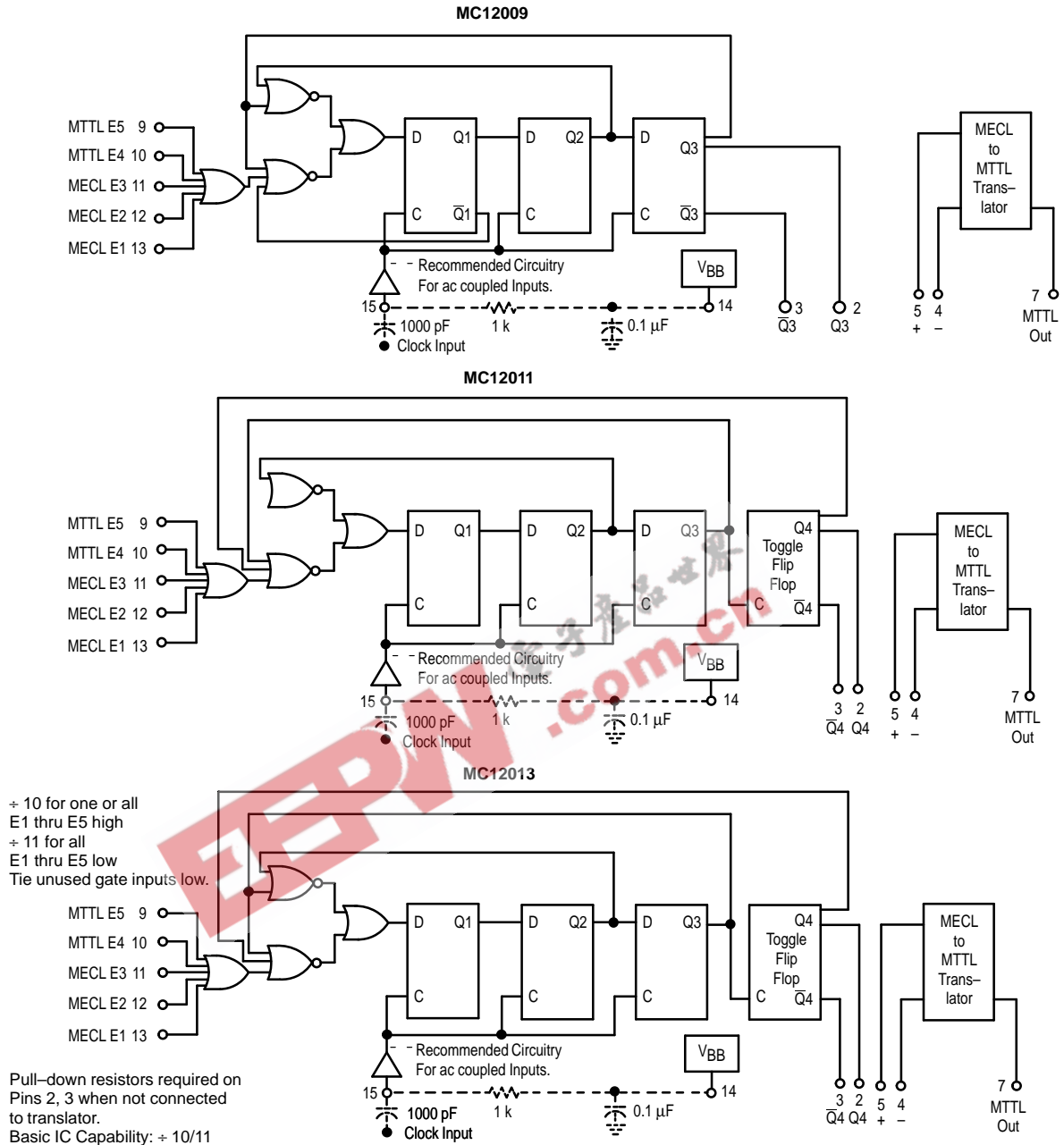
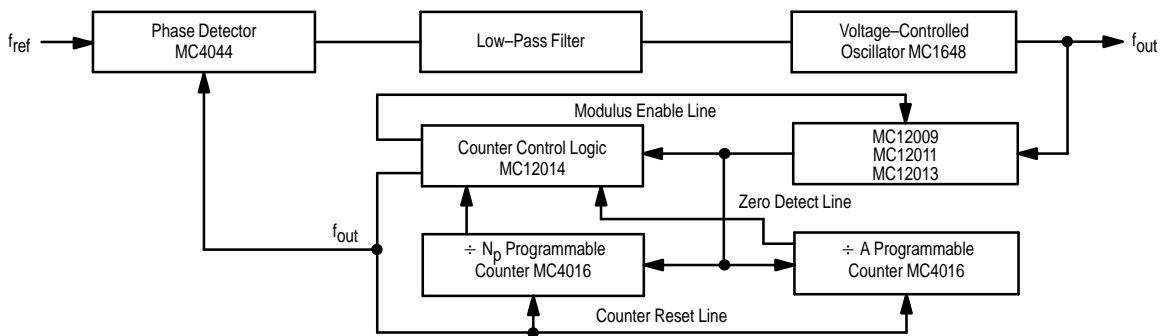


Figure 2. Typical Frequency Synthesizer Application

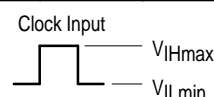


MC12009 MC12011 MC12013

ELECTRICAL CHARACTERISTICS (Supply Voltage = -5.2 V, unless otherwise noted.)

Characteristic	Symbol	Pin Under Test	Test Limits						Unit
			-30°C		+25°C		+85°C		
			Min	Max	Min	Max	Min	Max	
Power Supply Drain Current	I _{CC1}	8	-88		-80		-80		mAdc
	I _{CC2}	6		5.2		5.2		5.2	mAdc
Input Current	I _{inH1}	15		375		250		250	μAdc
		11		375		250		250	
		12		375		250		250	
		13		375		250		250	
	I _{inH2}	4	1.7	6.0	2.0	6.0	2.0	6.4	mAdc
		5	1.7	6.0	2.0	6.0	2.0	6.4	
I _{inH3}	5	0.7	3.0	1.0	3.0	1.0	3.6		
I _{inH4}	9		100		100		100	μAdc	
	10		100		100		100		
Leakage Current	I _{inL1}	15	-10		-10		-10		μAdc
		11	-10		-10		-10		
		12	-10		-10		-10		
		13	-10		-10		-10		
I _{inL2}	9	-1.6		-1.6		-1.6		mAdc	
	10	-1.6		-1.6		-1.6			
Reference Voltage	V _{BB}	14			-1.360	-1.160		Vdc	
Logic '1' Output Voltage	V _{OH1} (Note 1)	2	-1.100	-0.890	-1.000	-0.810	-0.930	-0.700	Vdc
		3	-1.100	-0.890	-1.000	-0.810	-0.930	-0.700	
	V _{OH2}	7	-2.8		-2.6		-2.4		
Logic '0' Output Voltage	V _{OL1} (Note 1)	2	-1.990	-1.675	-1.950	-1.650	-1.925	-1.615	Vdc
		3	-1.990	-1.675	-1.950	-1.650	-1.925	-1.615	
	V _{OL2}	7		-4.26		-4.40		-4.48	
Logic '1' Threshold Voltage	V _{OHA} (Note 2)	2	-1.120		-1.020		-0.950		Vdc
		3	-1.120		-1.020		-0.950		
Logic '0' Threshold Voltage	V _{OLA} (Note 3)	2		-1.655		-1.630		-1.595	Vdc
		3		-1.655		-1.630		-1.595	
Short Circuit Current	I _{OS}	7	-65	-20	-65	-20	-65	-20	mAdc

1. Test outputs of the device must be tested by sequencing through the truth table. All input, power supply and ground voltages must be maintained between tests. The clock input is the waveform shown.
2. In addition to meeting the output levels specified, the device must divide by 5, 8 or 10 during this test. The clock input is the waveform shown.
3. In addition to meeting the output levels specified, the device must divide by 6, 9 or 11 during this test. The clock input is the waveform shown.



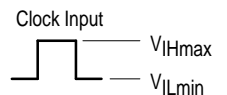
Each MECL 10,000 series circuit has been designed to meet the dc specifications shown in the test table, after thermal equilibrium has been established. The circuit is in a test socket or mounted on a printed circuit board and transverse air flow greater than 500 linear fpm is maintained. Outputs are terminated through a 50 Ω resistor to -2.0 V. Test procedures are shown for only one gate. The other gates are tested in the same manner.

MC12009 MC12011 MC12013

ELECTRICAL CHARACTERISTICS (Supply Voltage = -5.2 V, unless otherwise noted.) (continued)

			TEST VOLTAGE/CURRENT VALUES						Gnd
			Volts						
			V_{IHmax}	V_{ILmin}	V_{IHmin}	V_{ILmax}	V_{IH}	V_{ILH}	
@ Test Temperature									
			-30°C	-0.890	-1.990	-1.205	-1.500	-2.8	-4.7
			+25°C	-0.810	-1.950	-1.105	-1.475	-2.8	-4.7
			+85°C	-0.700	-1.925	-1.035	-1.440	-2.8	-4.7
Characteristic	Symbol	Pin Under Test	TEST VOLTAGE APPLIED TO PINS LISTED BELOW						
			V_{IHmax}	V_{ILmin}	V_{IHmin}	V_{ILmax}	V_{IH}	V_{IL}	
Power Supply Drain Current	I_{CC1}	8							1,16
	I_{CC2}	6	4	5					6
Input Current	I_{inH1}	15	15						1,16
		11	11						1,16
		12	12						1,16
		13	13						1,16
	I_{inH2}	4	5	4					6
		5	5	4				6	
	I_{inH3}	5	4	5					6
	I_{inH4}	9				9			1,16
		10				10			1,16
Leakage Current	I_{inL1}	15							1,16
		11							1,16
12								1,16	
13								1,16	
	I_{inL2}	9					9		1,16
		10					10		1,16
Reference Voltage	V_{BB}	14							1,16
Logic '1' Output Voltage	V_{OH1} (Note 1.)	2		11,12,13				9,10	1,16
		3		11,12,13				9,10	1,16
	V_{OH2}	7	5	4					6
Logic '0' Output Voltage	V_{OL1} (Note 1.)	2		11,12,13				9,10	1,16
		3		11,12,13				9,10	1,16
	V_{OL2}	7	4	5					6
Logic '1' Threshold Voltage	V_{OHA} (Note 2.)	2			11,12,13				1,16
		3			11,12,13				1,16
Logic '0' Threshold Voltage	V_{OLA} (Note 3.)	2				11,12,13			1,16
		3				11,12,13			1,16
Short Circuit Current	I_{OS}	7	5	4				7	6

1. Test outputs of the device must be tested by sequencing through the truth table. All input, power supply and ground voltages must be maintained between tests. The clock input is the waveform shown.
2. In addition to meeting the output levels specified, the device must divide by 5, 8 or 10 during this test. The clock input is the waveform shown.
3. In addition to meeting the output levels specified, the device must divide by 6, 9 or 11 during this test. The clock input is the waveform shown.

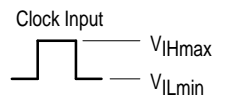


MC12009 MC12011 MC12013

ELECTRICAL CHARACTERISTICS (Supply Voltage = -5.2 V, unless otherwise noted.) (continued)

			TEST VOLTAGE/CURRENT VALUES						Gnd	
			Volts			mA				
			V _{IHT}	V _{I LT}	V _{EE}	I _L	I _{OL}	I _{OH}		
			@ Test Temperature							
			-30°C	-3.2	-4.4	-5.2	-0.25	16	-0.40	
			+25°C	-3.2	-4.4	-5.2	-0.25	16	-0.40	
			+85°C	-3.2	-4.4	-5.2	-0.25	16	-0.40	
Characteristic	Symbol	Pin Under Test	TEST VOLTAGE APPLIED TO PINS LISTED BELOW						Gnd	
			V _{IHT}	V _{I LT}	V _{EE}	I _L	I _{OL}	I _{OH}		
Power Supply Drain Current	I _{CC1}	8			8					1,16
	I _{CC2}	6			8					6
Input Current	I _{inH1}	15			8					1,16
		11	9,10		8					1,16
		12	9,10		8					1,16
		13	9,10		8					1,16
	I _{inH2}	4			8					6
		5			8					6
	I _{inH3}	5			8					6
	I _{inH4}	9			8					1,16
10				8					1,16	
Leakage Current	I _{inL1}	15			8,15					1,16
		11			8,11					1,16
		12			8,12					1,16
		13			8,13					1,16
	I _{inL2}	9			8					1,16
		10			8					1,16
Reference Voltage	V _{BB}	14			8	14				1,16
Logic '1' Output Voltage	V _{OH1} (Note 1.)	2			8					1,16
		3			8					1,16
	V _{OH2}	7			8			7		6
Logic '0' Output Voltage	V _{OL1} (Note 1.)	2			8					1,16
		3			8					1,16
	V _{OL2}	7			8		7			6
Logic '1' Threshold Voltage	V _{OHA} (Note 2.)	2	9,10		8					1,16
		3	9,10		8					1,16
Logic '0' Threshold Voltage	V _{OLA} (Note 3.)	2		9,10	8					1,16
		3		9,10	8					1,16
Short Circuit Current	I _{OS}	7			8					6

1. Test outputs of the device must be tested by sequencing through the truth table. All input, power supply and ground voltages must be maintained between tests. The clock input is the waveform shown.
2. In addition to meeting the output levels specified, the device must divide by 5, 8 or 10 during this test. The clock input is the waveform shown.
3. In addition to meeting the output levels specified, the device must divide by 6, 9 or 11 during this test. The clock input is the waveform shown.

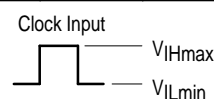


MC12009 MC12011 MC12013

ELECTRICAL CHARACTERISTICS (Supply Voltage = 5.0 V, unless otherwise noted.)

Characteristic	Symbol	Pin Under Test	Test Limits						Unit
			-30°C		+25°C		+85°C		
			Min	Max	Min	Max	Min	Max	
Power Supply Drain Current	I _{CC1}	8	-88		-80		-80		mAdc
	I _{CC2}	6		5.2		5.2		5.2	mAdc
Input Current	I _{inH1}	15		375		250		250	μAdc
		11		375		250		250	
		12		375		250		250	
		13		375		250		250	
	I _{inH2}	4	1.7	6.0	2.0	6.0	2.0	6.4	mAdc
		5	1.7	6.0	2.0	6.0	2.0	6.4	
I _{inH3}	5	0.7	3.0	1.0	3.0	1.0	3.6		
I _{inH4}	9			100	100		100	μAdc	
	10			100	100		100		
Leakage Current	I _{inL1}	15	-10		-10		-10		μAdc
		11	-10		-10		-10		
		12	-10		-10		-10		
		13	-10		-10		-10		
I _{inL2}	9	-1.6		-1.6		-1.6		mAdc	
	10	-1.6		-1.6		-1.6			
Reference Voltage	V _{BB}	14			3.67	3.87		Vdc	
Logic '1' Output Voltage	V _{OH1} (Note 4.)	2	3.900	4.110	4.000	4.190	4.070	4.300	Vdc
		3	3.900	4.110	4.000	4.190	4.070	4.300	
	V _{OH2}	7	2.4		2.6		2.8		
Logic '0' Output Voltage	V _{OL1} (Note 4.)	2	3.070	3.385	3.110	3.410	3.135	3.445	Vdc
		3	3.070	3.385	3.110	3.410	3.135	3.445	
	V _{OL2}	7		0.94		0.80		0.72	
Logic '1' Threshold Voltage	V _{OHA} (Note 5.)	2	3.880		3.980		4.050		Vdc
		3	3.880		3.980		4.050		
Logic '0' Threshold Voltage	V _{OLA} (Note 6.)	2		3.405		3.430		3.465	Vdc
		3		3.405		3.430		3.465	
Short Circuit Current	I _{OS}	7	-65	-20	-65	-20	-65	-20	mAdc

4. Test outputs of the device must be tested by sequencing through the truth table. All input, power supply and ground voltages must be maintained between tests. The clock input is the waveform shown.
5. In addition to meeting the output levels specified, the device must divide by 5, 8 or 10 during this test. The clock input is the waveform shown.
6. In addition to meeting the output levels specified, the device must divide by 6, 9 or 11 during this test. The clock input is the waveform shown.



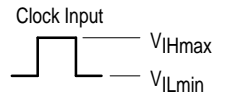
Each MECL 10,000 series circuit has been designed to meet the dc specifications shown in the test table, after thermal equilibrium has been established. The circuit is in a test socket or mounted on a printed circuit board and transverse air flow greater than 500 linear fpm is maintained. Outputs are terminated through a 50 Ω resistor to -2.0 V. Test procedures are shown for only one gate. The other gates are tested in the same manner.

MC12009 MC12011 MC12013

ELECTRICAL CHARACTERISTICS (Supply Voltage = 5.0 V, unless otherwise noted.) (continued)

			TEST VOLTAGE/CURRENT VALUES						(V _{EE}) Gnd
			Volts						
			V _{IHmax}	V _{ILmin}	V _{IHAmin}	V _{ILAmx}	V _{IH}	V _{ILH}	
			@ Test Temperature						
			-30°C	+4.110	+3.070	+3.795	+3.500	+2.4	+0.5
			+25°C	+4.190	+3.110	+3.895	+3.525	+2.4	+0.5
			+85°C	+4.300	+3.135	+3.965	+3.560	+2.4	+0.5
Characteristic	Symbol	Pin Under Test	TEST VOLTAGE APPLIED TO PINS LISTED BELOW						
			V _{IHmax}	V _{ILmin}	V _{IHAmin}	V _{ILAmx}	V _{IH}	V _{IL}	
Power Supply Drain Current	I _{CC1}	8							8
	I _{CC2}	6	4	5					8
Input Current	I _{inH1}	15	15						8
		11	11						8
		12	12						8
		13	13						8
	I _{inH2}	4	5	4					8
		5	5	4					8
	I _{inH3}	5	4	5					8
	I _{inH4}	9					9		8
10						10		8	
Leakage Current	I _{inL1}	15							8,15
		11							8,11
		12							8,12
		13							8,13
I _{inL2}	9						9	8	
	10						10	8	
Reference Voltage	V _{BB}	14							8
Logic '1' Output Voltage	V _{OH1} (Note 4.)	2			11,12,13				8
		3			11,12,13			9,10	8
	V _{OH2}	7	5	4					8
Logic '0' Output Voltage	V _{OL1} (Note 4.)	2			11,12,13				8
		3			11,12,13			9,10	8
	V _{OL2}	7	4	5					8
Logic '1' Threshold Voltage	V _{OHA} (Note 5.)	2			11,12,13				8
		3			11,12,13				8
Logic '0' Threshold Voltage	V _{OLA} (Note 6.)	2					11,12,13		8
		3					11,12,13		8
Short Circuit Current	I _{OS}	7	5	4				7	8

4. Test outputs of the device must be tested by sequencing through the truth table. All input, power supply and ground voltages must be maintained between tests. The clock input is the waveform shown.
5. In addition to meeting the output levels specified, the device must divide by 5, 8 or 10 during this test. The clock input is the waveform shown.
6. In addition to meeting the output levels specified, the device must divide by 6, 9 or 11 during this test. The clock input is the waveform shown.

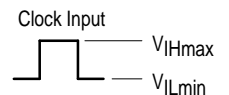


MC12009 MC12011 MC12013

ELECTRICAL CHARACTERISTICS (Supply Voltage = 5.0 V, unless otherwise noted.) (continued)

			TEST VOLTAGE/CURRENT VALUES						(V _{EE}) Gnd
			Volts			mA			
			V _{IHT}	V _{I LT}	V _{CC}	I _L	I _{OL}	I _{OH}	
			@ Test Temperature						
			-30°C						
			+25°C						
			+85°C						
Characteristic	Symbol	Pin Under Test	TEST VOLTAGE APPLIED TO PINS LISTED BELOW						
			V _{IHT}	V _{I LT}	V _{CC}	I _L	I _{OL}	I _{OH}	
Power Supply Drain Current	I _{CC1}	8			1,16				8
	I _{CC2}	6			6				8
Input Current	I _{inH1}	15			1,16				8
		11	9,10		1,16				8
		12	9,10		1,16				8
		13	9,10		1,16				8
	I _{inH2}	4			6				8
		5			6				8
	I _{inH3}	5			6				8
	I _{inH4}	9			1,16				8
10				1,16				8	
Leakage Current	I _{inL1}	15			1,16				8,15
		11			1,16				8,11
		12			1,16				8,12
		13			1,16				8,13
	I _{inL2}	9			1,16				8
		10			1,16				8
Reference Voltage	V _{BB}	14			1,16	14			8
Logic '1' Output Voltage	V _{OH1} (Note 4.)	2			1,16				8
		3			1,16				8
	V _{OH2}	7			6		7		8
Logic '0' Output Voltage	V _{OL1} (Note 4.)	2			1,16				8
		3			1,16				8
	V _{OL2}	7			6		7		8
Logic '1' Threshold Voltage	V _{OHA} (Note 5.)	2	9,10		1,16				8
		3	9,10		1,16				8
Logic '0' Threshold Voltage	V _{OLA} (Note 6.)	2		9,10	1,16				8
		3		9,10	1,16				8
Short Circuit Current	I _{OS}	7			6				8

4. Test outputs of the device must be tested by sequencing through the truth table. All input, power supply and ground voltages must be maintained between tests. The clock input is the waveform shown.
5. In addition to meeting the output levels specified, the device must divide by 5, 8 or 10 during this test. The clock input is the waveform shown.
6. In addition to meeting the output levels specified, the device must divide by 6, 9 or 11 during this test. The clock input is the waveform shown.



MC12009 MC12011 MC12013

SWITCHING CHARACTERISTICS

Characteristic	Symbol	Pin Under Test	MC12009, MC12011, MC12013									TEST VOLTAGES/WAVEFORMS APPLIED TO PINS LISTED BELOW:									
			-30°C			+25°C			+85°C			Unit	Pulse Gen.1	Pulse Gen.2	Pulse Gen.3	V _{IHmin} †	V _{ILmin} †	V _F -3.0 V	V _{EE} -3.0 V	V _{CC} +2.0	
			Min	Typ	Max	Min	Typ	Max	Min	Typ	Max										
Propagation Delay (See Figures 3 and 5)	t ₁₅₊₂₊	2	—	—	8.1	—	—	8.1	—	—	8.9	ns	15	—	—	—	11,12,13	9,10	8	1,6,16	
	t ₁₅₊₂₋	2	—	—	7.5	—	—	7.5	—	—	8.2	ns	15	—	—	—	11,12,13	9,10	8	1,6,16	
	t ₅₊₇₊	7	—	—	8.4	—	—	8.1	—	—	8.9	ns	A	—	—	—	—	—	8	1,6,16	
	t ₅₋₇₋	7	—	—	6.5	—	—	6.5	—	—	7.1	ns	A	—	—	—	—	—	8	1,6,16	
Setup Time (See Figures 4 and 5)	t _{setup1}	11	5.0	—	—	5.0	—	—	5.0	—	—	ns	15	*	—	—	*	9,10	8	1,6,16	
	t _{setup2}	9	5.0	—	—	5.0	—	—	5.0	—	—	ns	15	—	*	—	11,12,13	*	8	1,6,16	
Release Time (See Figures 4 and 5)	t _{rel1}	11	5.0	—	—	5.0	—	—	5.0	—	—	ns	15	*	—	—	*	9,10	8	1,6,16	
	t _{rel2}	9	5.0	—	—	5.0	—	—	5.0	—	—	ns	15	—	*	—	11,12,13	*	8	1,6,16	
Toggle Frequency (See Figure 6)	f _{max}	2										MHz									
		MC12009 : 5/6	440	—	—	480	—	—	440	—	—	—					11	—	—	8	16
		MC12011 : 8/9	500	—	—	550	—	—	500	—	—	—					11	—	—	8	16
		MC12013 : 10/11	500	—	—	550	—	—	500	—	—	—					11	—	—	8	16

*Test inputs sequentially, with Pulse Generator 2 or 3 as indicated connected to input under test, and the voltage indicated applied to the other input(s) of the same type (i.e., MECL or MTTL).

	-30°C	+25°C	+85°C	
t _{IHmin}	+1.03	+1.115	+1.20	V _{dcc}
t _{VLmin}	+0.175	+0.200	+0.235	V _{dcc}

Figure 3. AC Voltage Waveforms

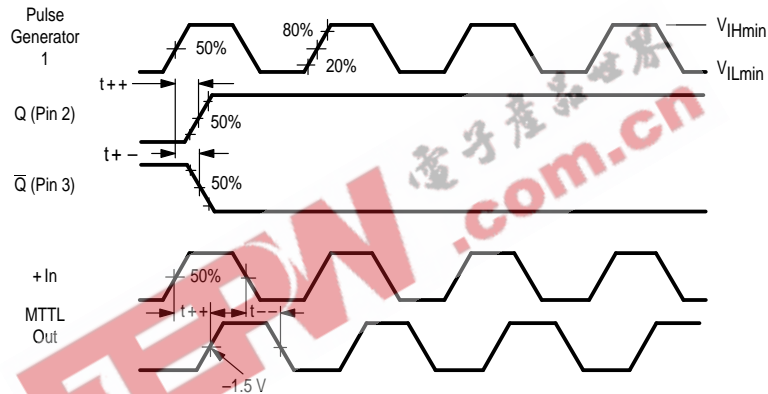
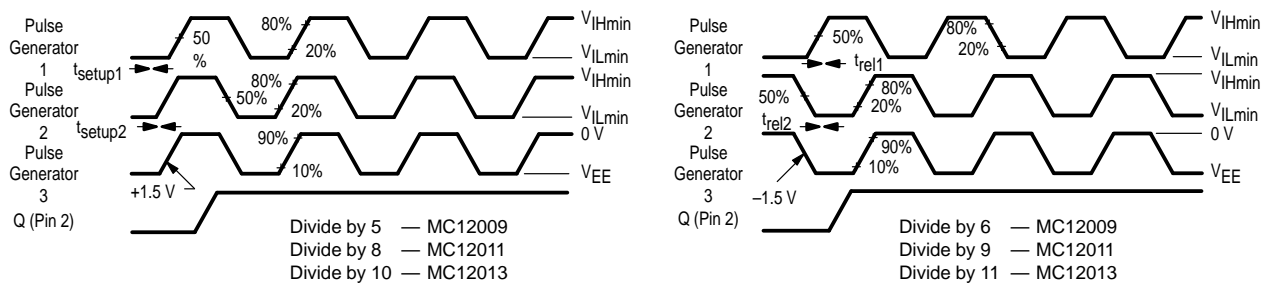
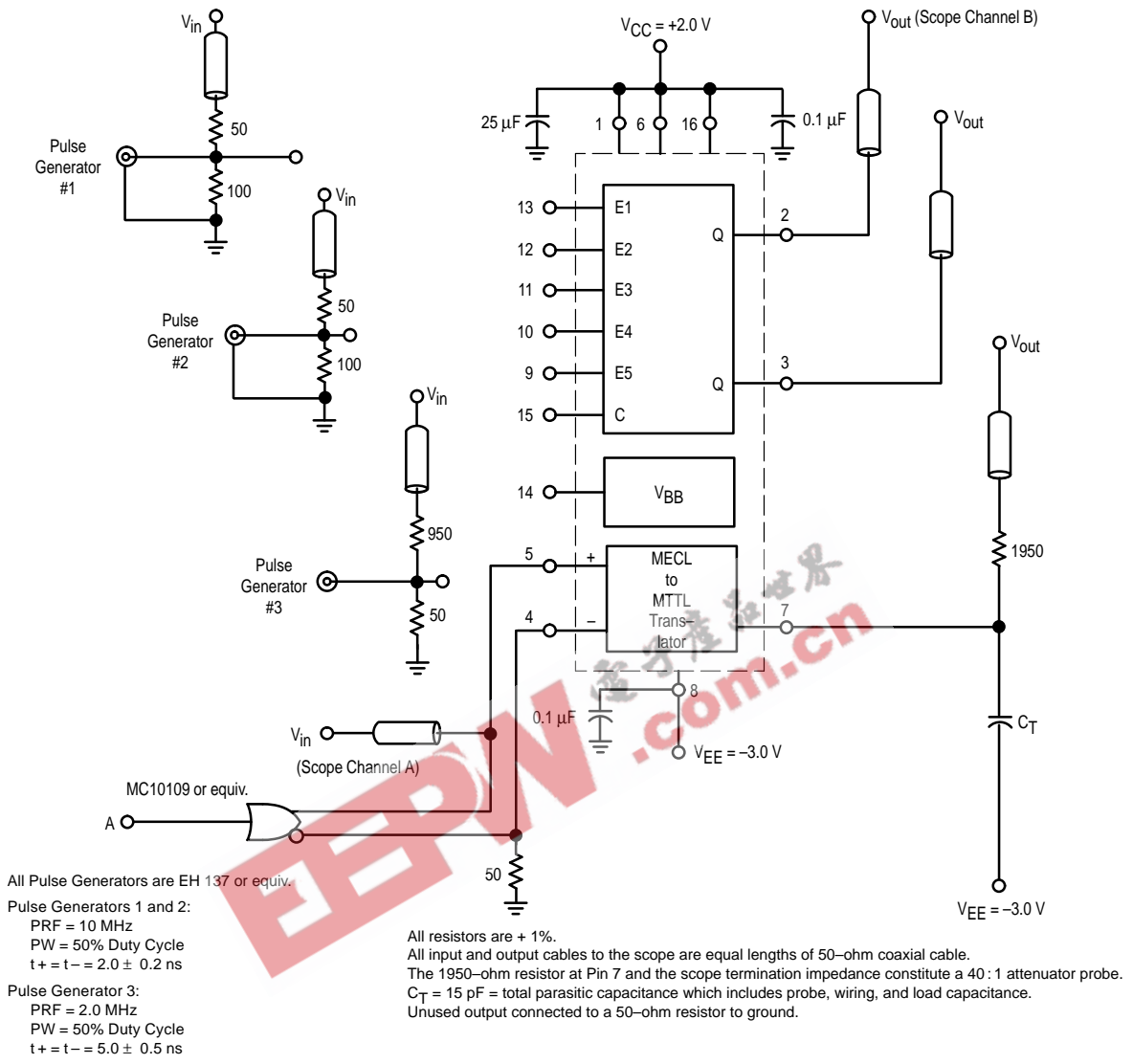


Figure 4. Setup and Release Time Waveforms



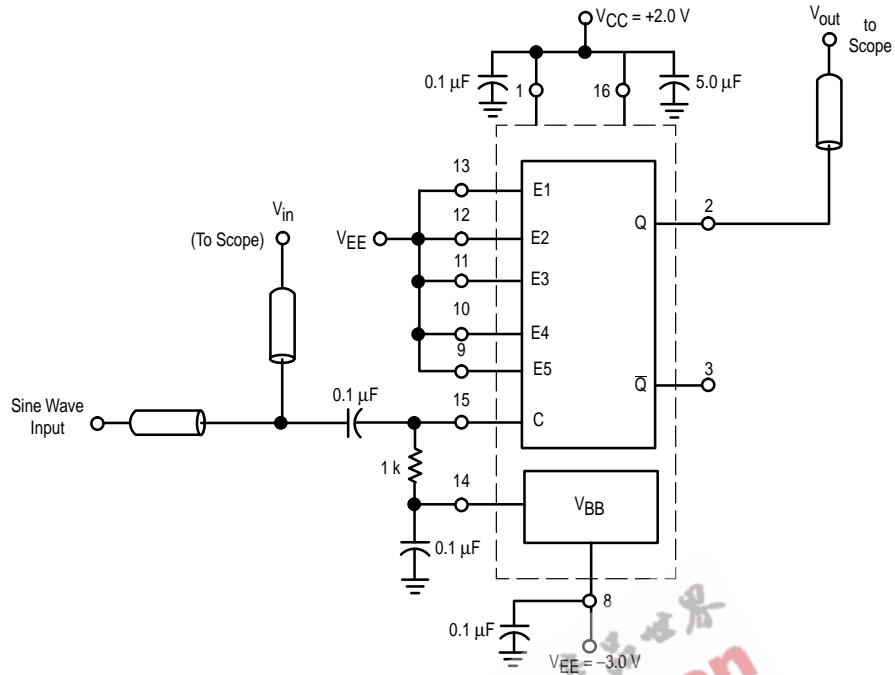
MC12009 MC12011 MC12013

Figure 5. AC Test Circuit

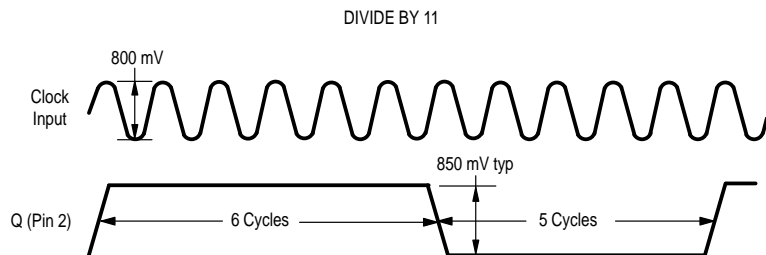
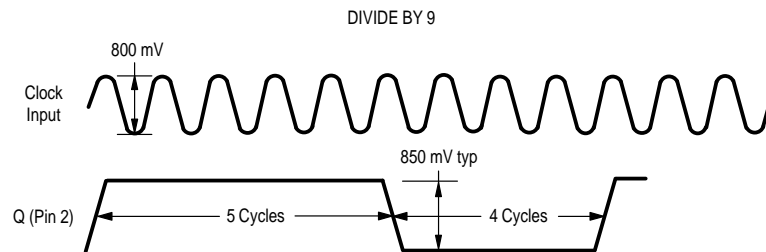
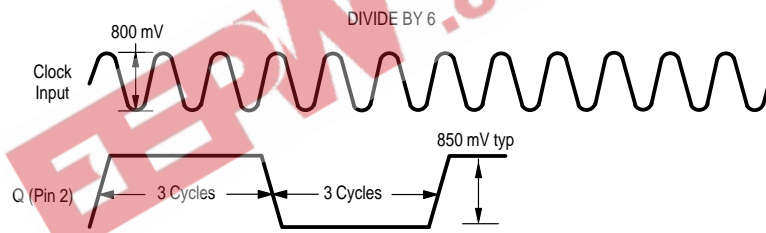


MC12009 MC12011 MC12013

Figure 6. Maximum Frequency Test Circuit

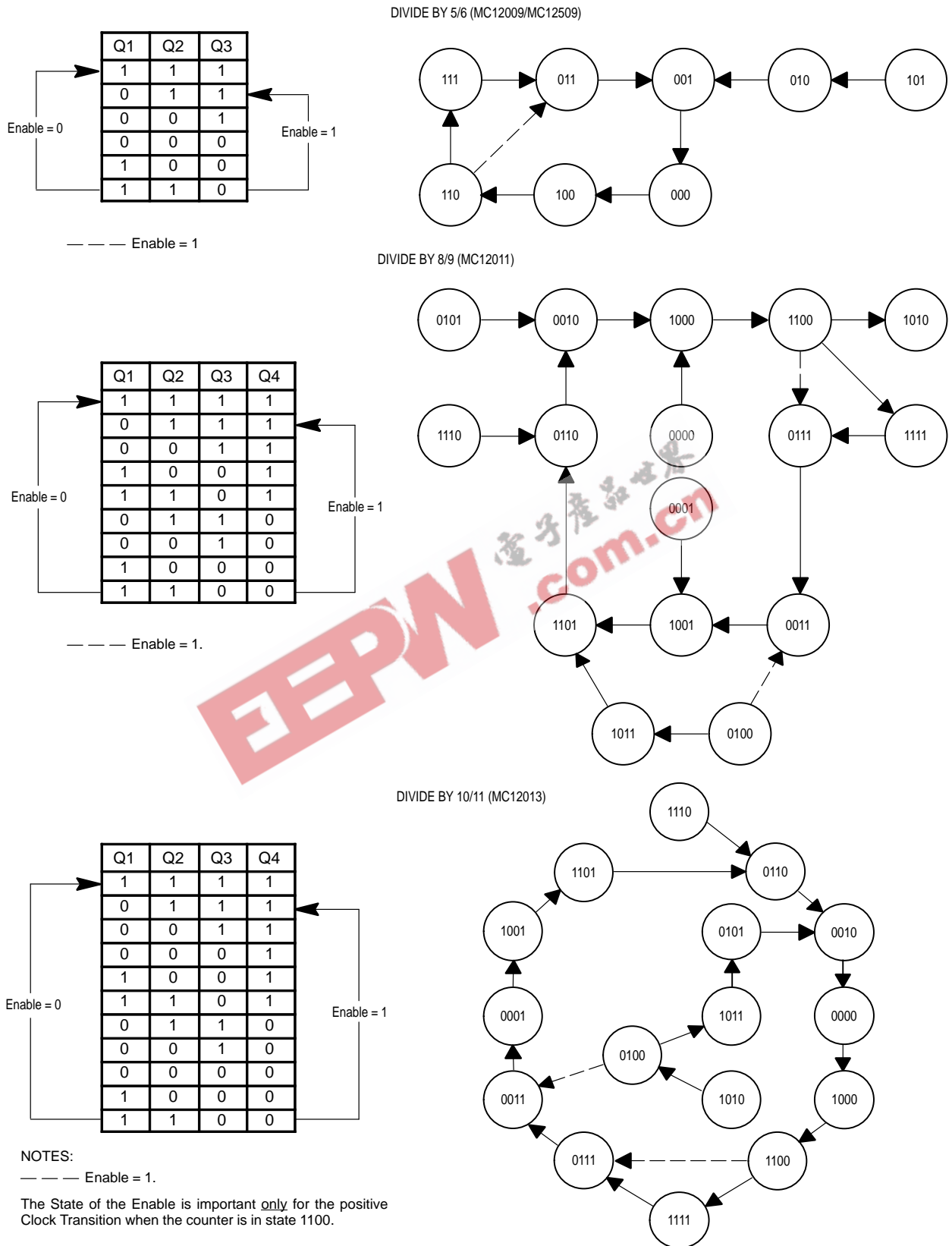


Unused output connected to a 50 Ω resistor to ground



MC12009 MC12011 MC12013

Figure 7. State Diagram



MC12009 MC12011 MC12013

APPLICATIONS INFORMATION

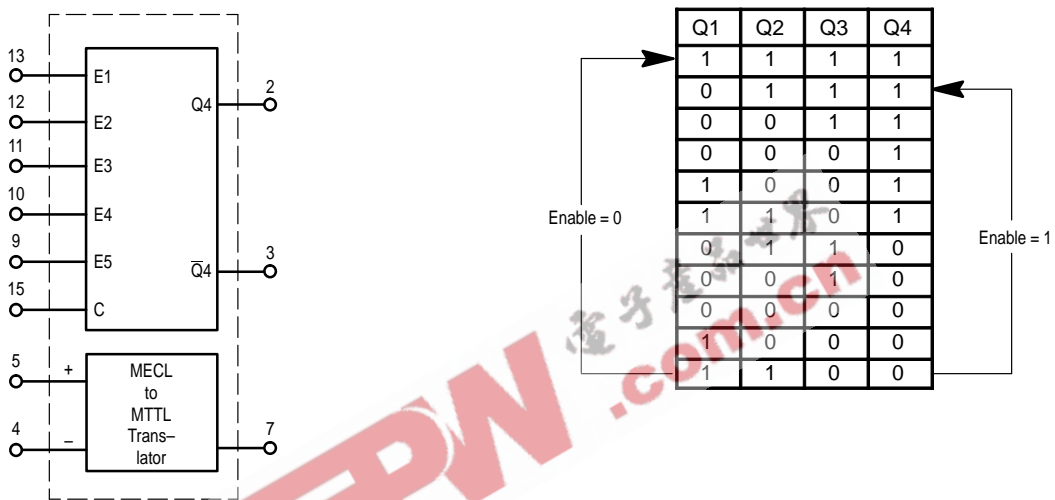
The primary application of these devices is as a high-speed variable modulus prescaler in the divide by N section of a phase-locked loop synthesizer used as the local oscillator of two-way radios.

Proper VHF termination techniques should be followed when the clock is separated from the prescaler by any appreciable distance.

In their basic form, these devices will divide by 5/6, 8/9, or 10/11. Division by 5, 8, or 10 occurs when any one or all

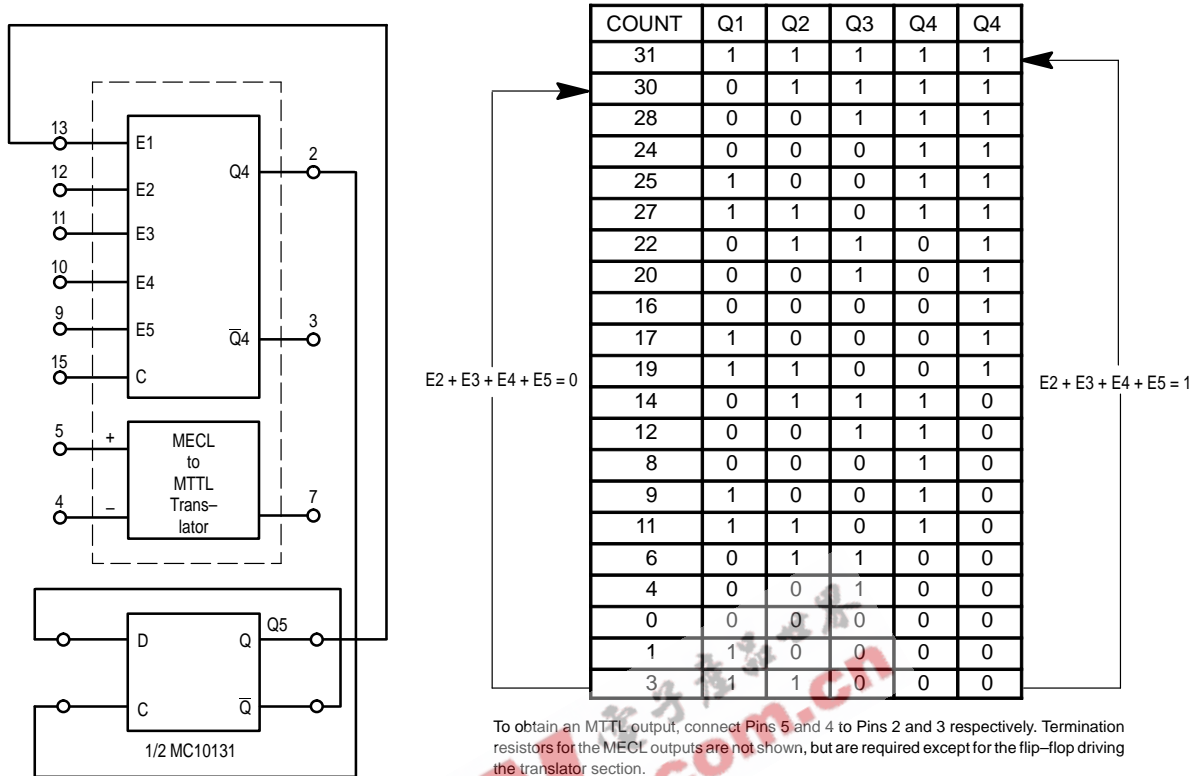
of the five gate inputs E1 through E5 are high. Division by 6, 9, or 11 occurs when all inputs E1 through E5 are low. (Unconnected MTTL inputs are normally high, unconnected MECL inputs are normally low). With the addition of extra parts, many different division configurations may be obtained (20/21, 40/41, 50/51, 100/101, etc.) A few of the many configurations are shown below, only for the MC12013.

Figure 8. Divide By 10/11 (MC12013)



MC12009 MC12011 MC12013

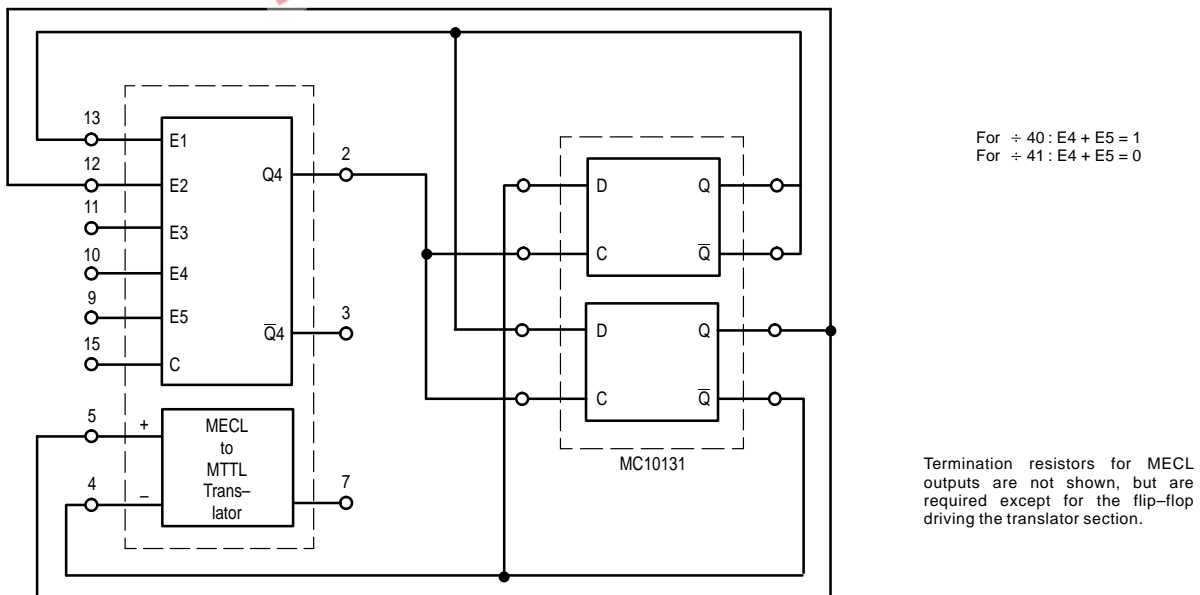
Figure 9. Divide By 20/21 (MC12013)



To obtain an M TTL output, connect Pins 5 and 4 to Pins 2 and 3 respectively. Termination resistors for the MECL outputs are not shown, but are required except for the flip-flop driving the translator section.

The ÷ 20/21 counter may also be built using an M TTL flip-flop by connecting Pins 5 and 4 to Pins 2 and 3 respectively, and driving the M TTL flip-flop with Pin 7. MC12013 inputs E4 and E5 are used rather than E1. With E1 + E2 + E3 = 0, operation remains as shown.

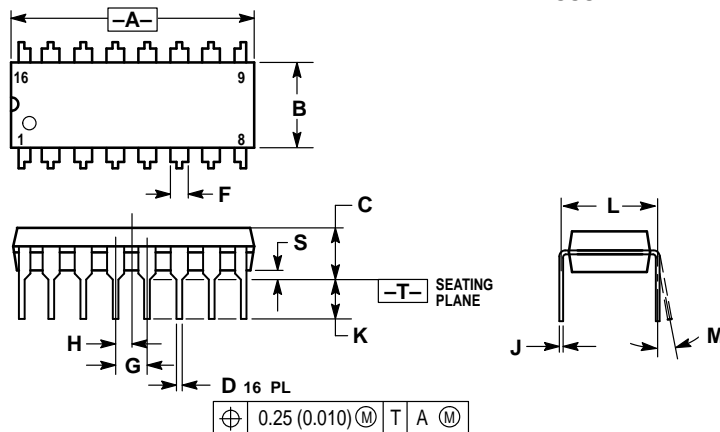
Figure 10. Divide By 40/41 (MC12013)



MC12009 MC12011 MC12013

OUTLINE DIMENSIONS

P 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	0.70	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

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