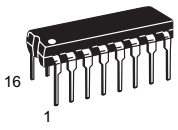
ML12509
ML12511
ML12513
MECL PLL Components
Dual Modulus Prescaler

Legacy Device: *Motorola 12509, 12511, 12513*

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

- ML12509 480 MHz (÷5/6), ML12511 550 MHz (÷8/9), ML12513 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 Ω and 4.0 pF
- VBB Reference Voltage
- 310 mW (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.

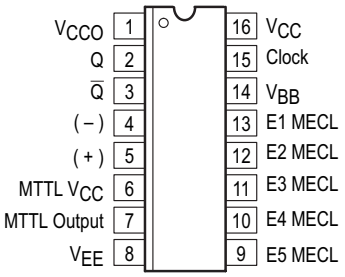


CERDIP 16 = E
CERAMIC PACKAGE
CASE 620

CROSS REFERENCE/ORDERING INFORMATION

PACKAGE	MOTOROLA	LANSDALE
CERDIP 16	12509/BEA	ML12509/BEA
CERDIP 16	12511/BEA	ML12511/BEA
CERDIP 16	12513/BEA	ML12513/BEA

PIN CONNECTIONS



(Top View)

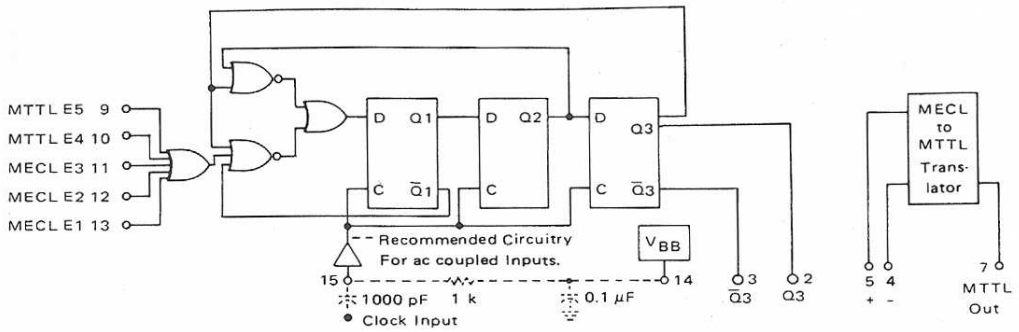
MAXIMUM RATINGS

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	T_A	–55 to 125	°C
DC Fan–Out (Note 1) (Gates and Flip–Flops)	n	70	—

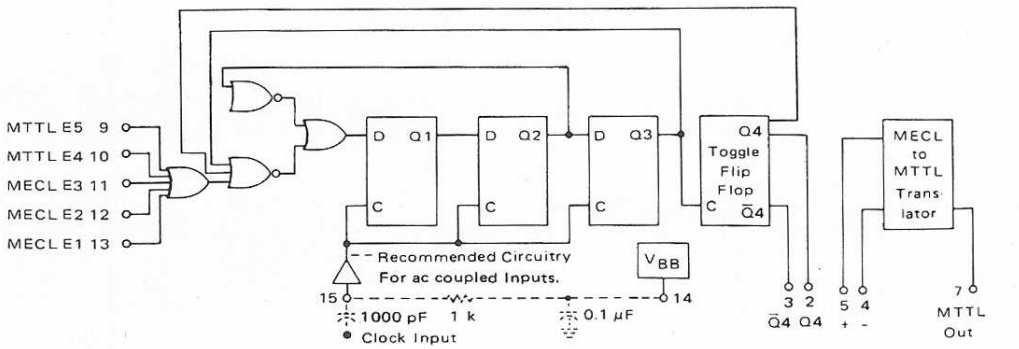
NOTES: 1. AC fan–out is limited by desired system performance.

FIGURE 1 – LOGIC DIAGRAMS

ML12509



ML12511



ML12513

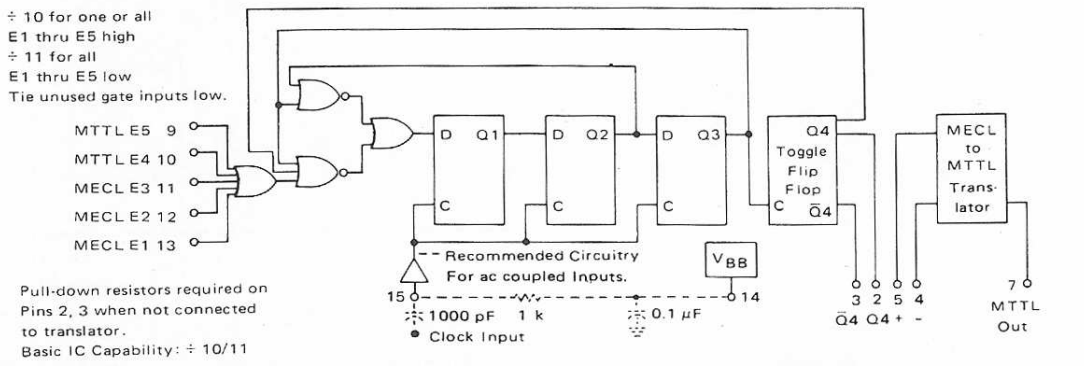
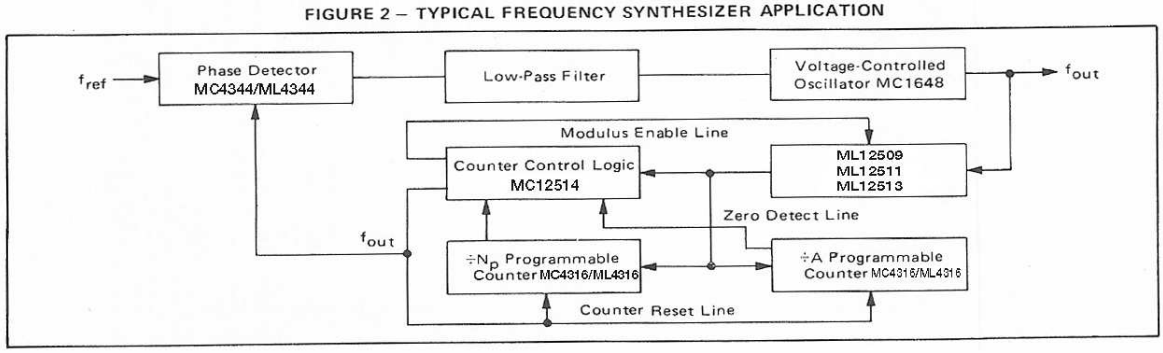


FIGURE 2 – TYPICAL FREQUENCY SYNTHESIZER APPLICATION



ELECTRICAL CHARACTERISTICS

Test Temperature	Test Voltage Values (Volts)														Test Current Values (mA)		
	V_{IH}	V_{IL}	V_{IHA}	V_{ILA}	V_{IHB}	V_{ILB}	V_{IHT}	V_{ILT}	V_{EE}	V_{CC}	V_{IHmin}	V_{ILmin}	V_{ILL}	V_{EEL}	V_{CCA}	I_L	I_{OL}	I_{OH}
T_A = 25 °C	+ 2.4	+ 0.5	+ 3.895	+ 3.525	+ 4.22	+ 3.11	+ 2.0	+ 0.8	0.0	+ 5.0	+ 1.15	+ 0.215	- 3.0	- 3.0	+ 2.0	- 0.25	+ 16	- 0.4
T_A = 125 °C	+ 2.4	+ 0.5	+ 4.0	+ 3.6	+ 4.37	+ 3.14	+ 2.0	+ 0.8	0.0	+ 5.0	+ 1.27	+ 0.26	- 3.0	- 3.0	+ 2.0	- 0.25	+ 16	- 0.4
T_A = -55 °C	+ 2.4	+ 0.5	+ 3.745	+ 3.5	+ 4.12	+ 3.04	+ 2.0	+ 0.8	0.0	+ 5.0	+ 1.02	+ 0.165	- 3.0	- 3.0	+ 2.0	- 0.25	+ 16	- 0.4

Symbol	Parameter	Limits						Units	TEST VOLTAGE APPLIED TO PINS BELOW									
	Functional Parameters:	+ 25 °C		+ 125 °C		- 55 °C			Pinouts referenced are for DIL package, check Pin Assignments Output Load = 100 Ω to + 3.0 V									
		Subgroup 1		Subgroup 2		Subgroup 3												
		Min	Max	Min	Max	Min	Max		V_{IH}	V_{IL}	$V_{IHA/B}$	$V_{ILA/B}$	V_{CC}	V_{EE}	C_{P1}	$I_{OH/OL}$	I_L	P.U.T.
V_{OH1}	Output Voltage High	4.03	4.22	4.135	4.37	3.88	4.12	V	9, 10	9, 10	11 - 13	11 - 13	1, 16	8	15			2, 3 (Note 2)
V_{OH2}	Output Voltage High	2.70	4.5	3.00	4.5	2.40	4.5	V			5	4	6	8		7 I_{OH}		7
V_{OL1}	Output Voltage Low	3.11	3.44	3.14	3.515	3.04	3.405	V	9, 10	9, 10	11 - 13	11 - 13	1, 16	8	15			2, 3 (Note 2)
V_{OL2}	Output Voltage Low	0.10	0.80	0.10	0.66	0.10	1.00	V			4	5	6	8		7 I_{OL}		7
V_{OHA}	Output Voltage High	4.01	4.5	4.115	4.5	3.86	4.5	V		9, 10	11 - 13	11 - 13	1, 16	8	15			2, 3 (Note 3)
V_{OLA}	Output Voltage Low	3.11	3.46	3.14	3.535	3.04	3.425	V		9, 10	11 - 13	11 - 13	1, 16	8	15			2, 3 (Note 3)
V_{BB1}	Reference Bias Supply Voltage	3.67	3.87					V					1, 16	8			14	14
I_{OS}	Output Short Circuit Current	- 65	- 20	- 65	- 20	- 65	- 20	mA		7	5	4	6	8				7
I_{CC1}	Power Supply Current	- 80		- 80		- 88		mA					1, 16	8				8
I_{CC2}	Power Supply Current		5.2		5.2		5.2	mA			4	5	6	8				6

1. Power Supply Voltage = 5.0 V, Power Supply Voltage = - 5.2 V is guaranteed but not tested.
2. See Sequence Table 1.
3. See Sequence Table 2.

ELECTRICAL CHARACTERISTICS

Test Temperature	Test Voltage Values (Volts)															Test Current Values (mA)		
	V_{IH}	V_{IL}	V_{IHA}	V_{ILA}	V_{IHB}	V_{ILB}	V_{IHT}	V_{ILT}	V_{EE}	V_{CC}	V_{IHmin}	V_{ILmin}	V_{ILL}	V_{EEL}	V_{CCA}	I_L	I_{OL}	I_{OH}
T_A = 25 °C	+ 2.4	+ 0.5	+ 3.895	+ 3.525	+ 4.22	+ 3.11	+ 2.0	+ 0.8	0.0	+ 5.0	+ 1.15	+ 0.215	- 3.0	- 3.0	+ 2.0	- 0.25	+ 16	- 0.4
T_A = 125 °C	+ 2.4	+ 0.5	+ 4.0	+ 3.6	+ 4.37	+ 3.14	+ 2.0	+ 0.8	0.0	+ 5.0	+ 1.27	+ 0.26	- 3.0	- 3.0	+ 2.0	- 0.25	+ 16	- 0.4
T_A = -55 °C	+ 2.4	+ 0.5	+ 3.745	+ 3.5	+ 4.12	+ 3.04	+ 2.0	+ 0.8	0.0	+ 5.0	+ 1.02	+ 0.165	- 3.0	- 3.0	+ 2.0	- 0.25	+ 16	- 0.4

Symbol	Parameter	Limits						Units	TEST VOLTAGE APPLIED TO PINS BELOW						
	Functional Parameters:	+ 25 °C		+ 125 °C		- 55 °C			Pinouts referenced are for DIL package, check Pin Assignments Output Load = 100 Ω to + 3.0 V						
		Subgroup 1		Subgroup 2		Subgroup 3									
		Min	Max	Min	Max	Min	Max		V_{IH}	V_{IL}	$V_{IHA/B}$	$V_{ILA/B}$	V_{CC}	V_{EE}	P.U.T.
I_{INH1}	Input Current High		250		400		400	µA		9, 10	11 - 13, 15		1, 16	8	11, 12, 13, 15
I_{INH2}	Input Current High	2.0	6.0	2.0	6.4	1.7	6.0	mA			4, 5	4, 5	6	8	4, 5
I_{INH3}	Input Current High	1.0	3.0	1.0	3.6	0.7	3.0	mA			4	5	6	8	5
I_{INH4}	Input Current High		100		100		100	µA	9, 10				1, 16	8	9, 10
I_{INI1}	Input Current Low	- 10		- 10		- 10		µA					1, 16	8, 15, 11 - 13	11, 12, 13, 15
I_{INI1}	Input Current Low	- 1.6		- 1.6		- 1.6		mA		9, 10			1, 16	8	9, 10

1. Power Supply Voltage = 5.0 V, Power Supply Voltage = - 5.2 V is guaranteed but not tested.

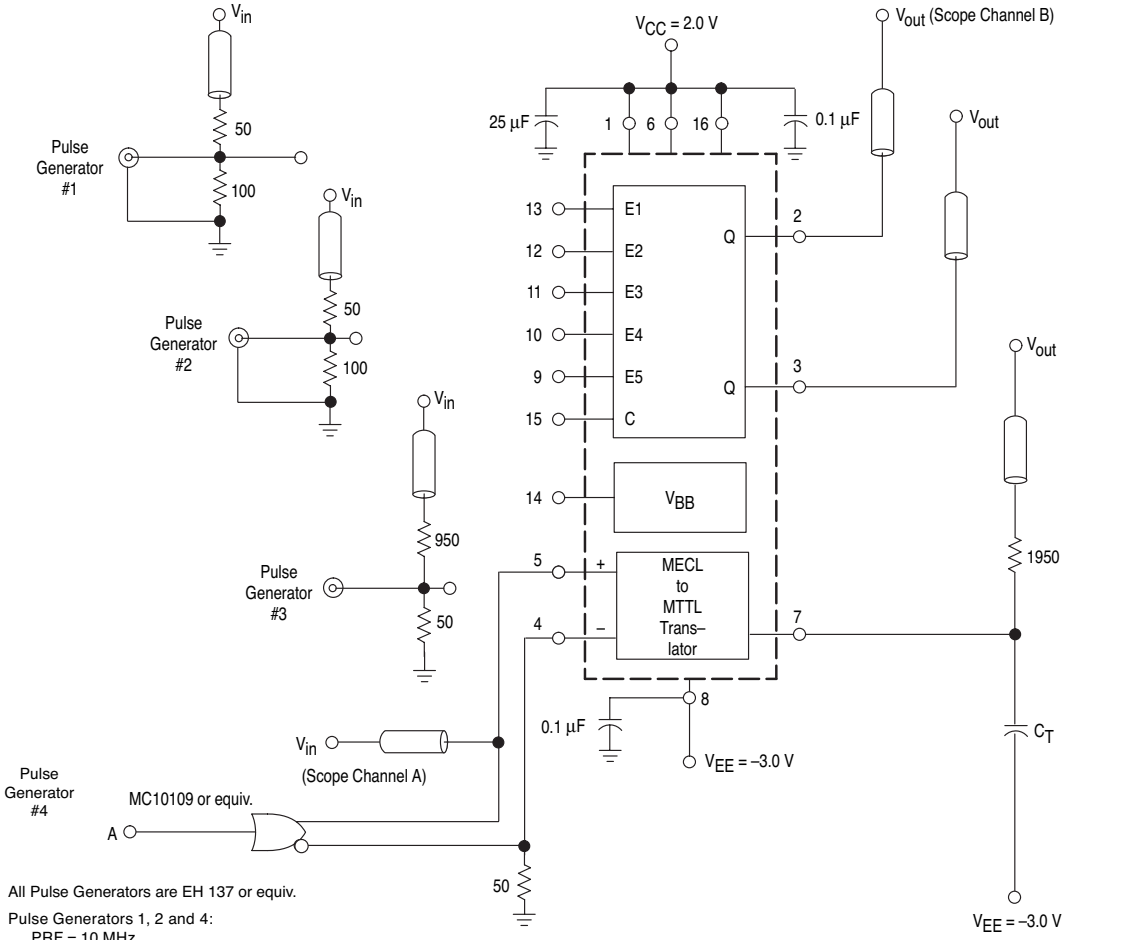
* **ELECTRICAL CHARACTERISTICS:** This device is designed to meet the dc specifications shown in the test table after thermal equilibrium has been established. Outputs are terminated through a 100 Ω resistor to + 3.0 V.

Test Temperature	Test Voltage Values (Volts)															Test Current Values (mA)		
	V_{IH}	V_{IL}	V_{IHA}	V_{ILA}	V_{IHB}	V_{ILB}	V_{IHT}	V_{ILT}	V_{EE}	V_{CC}	V_{IHmin}	V_{ILmin}	V_{ILL}	V_{EEL}	V_{CCA}	I_L	I_{OL}	I_{OH}
T_A = 25 °C	+ 2.4	+ 0.5	+ 3.895	+ 3.525	+ 4.22	+ 3.11	+ 2.0	+ 0.8	0.0	+ 5.0	+ 1.15	+ 0.215	- 3.0	- 3.0	+ 2.0	- 0.25	+ 16	- 0.4
T_A = 125 °C	+ 2.4	+ 0.5	+ 4.0	+ 3.6	+ 4.37	+ 3.14	+ 2.0	+ 0.8	0.0	+ 5.0	+ 1.27	+ 0.26	- 3.0	- 3.0	+ 2.0	- 0.25	+ 16	- 0.4
T_A = -55 °C	+ 2.4	+ 0.5	+ 3.745	+ 3.5	+ 4.12	+ 3.04	+ 2.0	+ 0.8	0.0	+ 5.0	+ 1.02	+ 0.165	- 3.0	- 3.0	+ 2.0	- 0.25	+ 16	- 0.4

SWITCHING CHARACTERISTICS

Symbol	Parameter	Limits						Units	TEST VOLTAGE APPLIED TO PINS BELOW						
	Functional Parameters: (Fig. 5)	+ 25 °C Subgroup 9		+ 125 °C Subgroup 10		- 55 °C Subgroup 11			Pinouts referenced are for DIL package, check Pin Assignments Output Load = 100 Ω to + 3.0 V						
		Min	Max	Min	Max	Min	Max		V_{ILL}	V_{ILmin}	V_{IN}	V_{OUT}	V_{CCA}	V_{EEL}	P.U.T.
t_{PHH}	Propagation Delay (15+ 2+)		8.1		9.4		8.1	ns	9, 10	11 - 13	15	2, 3	1, 6, 16	8	2, 3
t_{PHH}	Propagation Delay (5+ 7+)		8.1		9.4		8.1	ns	9, 10	11 - 13	15	2, 3	1, 6, 16	8	2, 3
t_{PLL}	Propagation Delay (15+ 2-)		7.5		8.7		7.5	ns	9, 10	11 - 13	15	2, 3	1, 6, 16	8	7
t_{PLL}	Propagation Delay (5- 7-)		6.5		7.6		6.5	ns	9, 10	11 - 13	15	2, 3	1, 6, 16	8	7
		Min	Typ	Min	Max	Min	Max		V_{ILL}	V_{ILmin}	V_{IN}	V_{OUT}	V_{CCA}	V_{EEL}	P.U.T.
$t_{Setup\ 1}$	Setup Time MECL	5.0		5.0		5.0		ns	9, 10	11 - 13	9 - 13		1, 6, 16	8	9 - 13
$t_{Setup\ 2}$	Setup Time MTTL	5.0		5.0		5.0		ns	9, 10	11 - 13	9 - 13		1, 6, 16	8	9 - 13
$t_{Rel\ 1}$	Release Time MECL	5.0		5.0		5.0		ns	9, 10	11 - 13	9 - 13		1, 6, 16	8	9 - 13
$t_{Rel\ 2}$	Release Time MTTL	5.0		5.0		5.0		ns	9, 10	11 - 13	9 - 13		1, 6, 16	8	9 - 13
		Min	Typ	Min	Typ	Min	Typ		V_{ILL}	V_{ILmin}	V_{IN}	V_{OUT}	V_{CCA}	V_{EEL}	P.U.T.
f_{max} ÷5/6	(Fig. 6) Toggle Frequency ML12509	480	520	420	440	420	500	MHz			15	2	1, 6, 16	8 - 13	2
÷8/9	ML12511	500	550	500	550	500	550	MHz			15	2	1, 6, 16	8 - 13	2
÷10/11	ML12513	550	600	500	540	500	600	MHz			15	2	1, 6, 16	8 - 13	2

Figure 5. AC Test Circuit



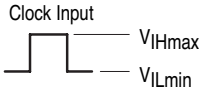
All Pulse Generators are EH 137 or equiv.

Pulse Generators 1, 2 and 4:
PRF = 10 MHz
PW = 50% Duty Cycle
$t_+ = t_- = 2.0 \pm 0.2$ ns

Pulse Generator 3:
PRF = 2.0 MHz
PW = 50% Duty Cycle
$t_+ = t_- = 5.0 \pm 0.5$ ns

All resistors are +1%.
All input and output cables to the scope are equal lengths of 50 Ω coaxial cable.
The 1950 Ω resistor at Pin 7 and the scope termination impedance constitute a 40 :1 attenuator probe.
C_T = 15 pF = total parasitic capacitance which includes probe, wiring, and load capacitance.
Unused output connected to a 50 Ω resistor to ground.

NOTES: 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 or 8 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 or 9 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.

Figure 3. AC Voltage Waveforms

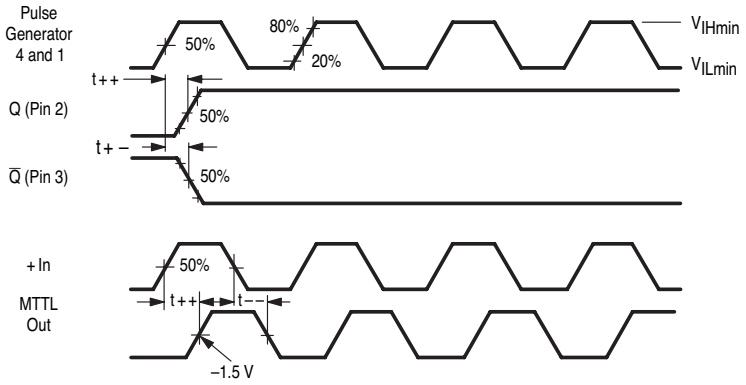


Figure 4. Setup and Release Time Waveforms

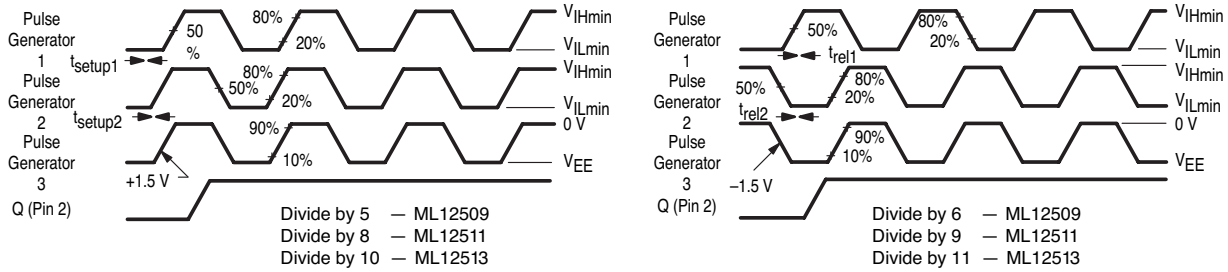
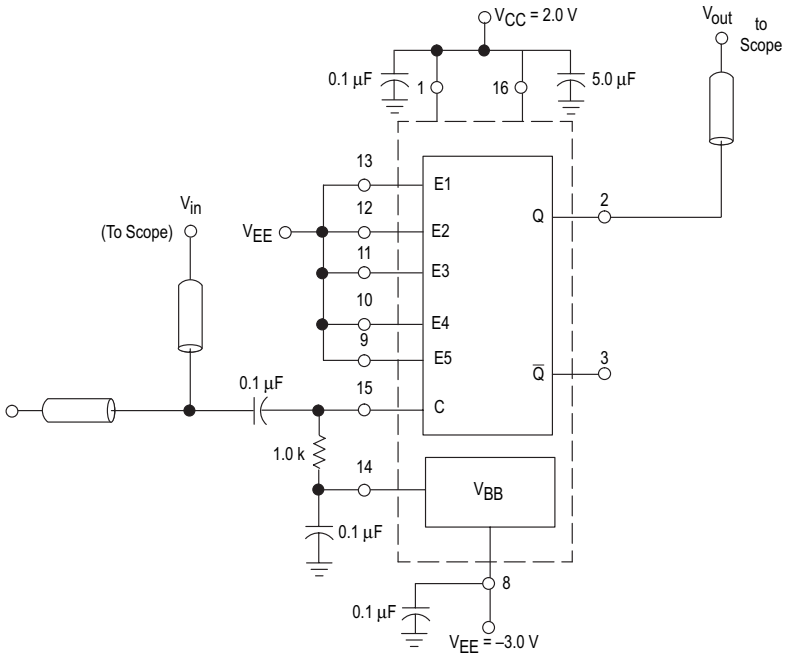
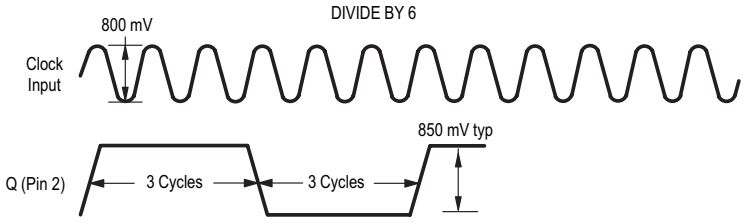


Figure 6. Maximum Frequency Test Circuit



Unused output connected to a 50 Ω resistor to ground



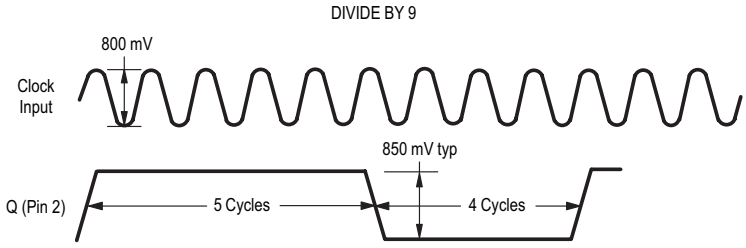


FIGURE 7 – STATE DIAGRAM

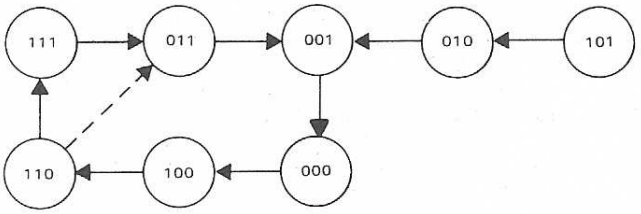
DIVIDE BY 5/6 (ML12509)

Q1	Q2	Q3
1	1	1
0	1	1
0	0	1
0	0	0
1	0	0
1	1	0

Enable = 0

Enable = 1

— — — Enable = 1



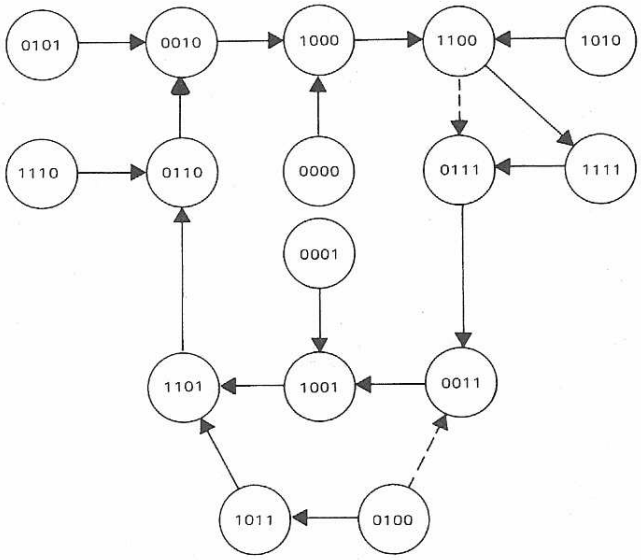
DIVIDE BY 8/9 (ML12511)

Q1	Q2	Q3	Q4
1	1	1	1
0	1	1	1
0	0	1	1
1	0	0	1
1	1	0	1
0	1	1	0
0	0	1	0
1	0	0	0
1	1	0	0

Enable = 0

Enable = 1

— — — Enable = 1



DIVIDE BY 10/11 (ML12513)

Q1	Q2	Q3	Q4
1	1	1	1
0	1	1	1
0	0	1	1
0	0	0	1
1	0	0	1
1	1	0	1
0	1	1	0
0	0	1	0
0	0	0	0
1	0	0	0
1	1	0	0

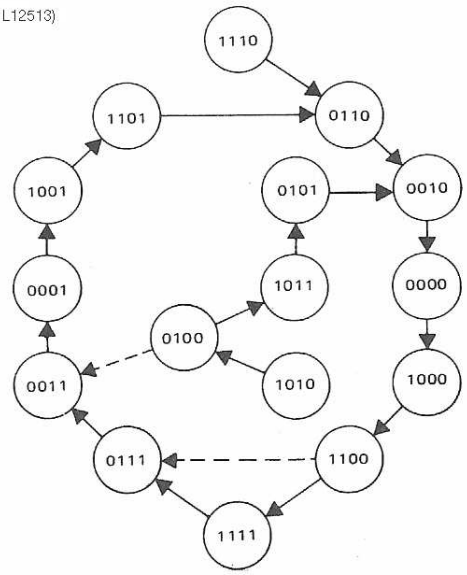
Enable = 0

Enable = 1

NOTES:

— — — Enable = 1.

The State of the Enable is important only for the positive Clock Transition when the counter is in state 1100.



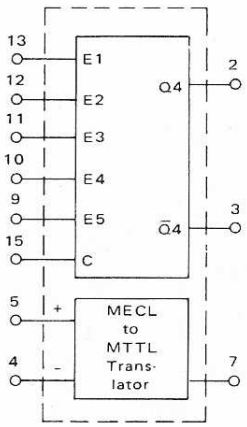
APPLICATIONS INFORMATION

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. The theory and advantages of variable modulus prescaling, along with typical applications, are covered in Motorola's "Electronic Tuning Address Systems" (SG72).

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 ML12513

FIGURE 8 — DIVIDE BY 10/11 (ML12513)

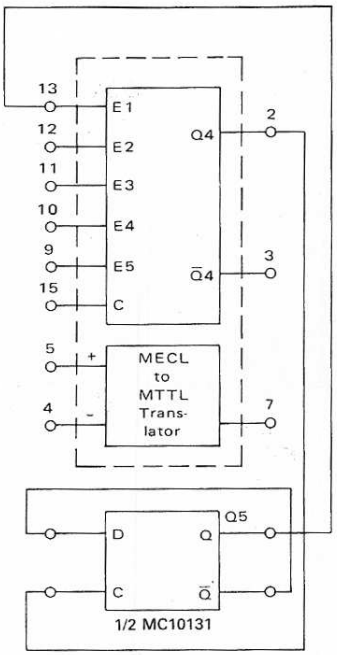


Q1	Q2	Q3	Q4
1	1	1	1
0	1	1	1
0	0	1	1
0	0	0	1
1	0	0	1
1	1	0	1
0	1	1	0
0	0	1	0
0	0	0	0
1	0	0	0
1	1	0	0

Enable = 0

Enable = 1

FIGURE 9 — DIVIDE BY 20/21 (ML12513)



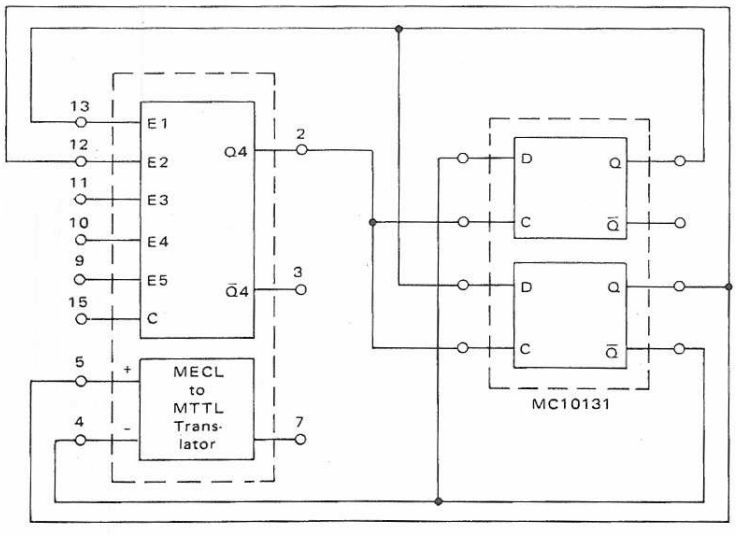
COUNT	Q1	Q2	Q3	Q4	Q4
31	1	1	1	1	1
30	0	1	1	1	1
28	0	0	1	1	1
24	0	0	0	1	1
25	1	0	0	1	1
27	1	1	0	1	1
22	0	1	1	0	1
20	0	0	1	0	1
16	0	0	0	0	1
17	1	0	0	0	1
19	1	1	0	0	1
14	0	1	1	1	0
12	0	0	1	1	0
8	0	0	0	1	0
9	1	0	0	1	0
11	1	1	0	1	0
6	0	1	1	0	0
4	0	0	1	0	0
0	0	0	0	0	0
1	1	0	0	0	0
3	1	1	0	0	0

E2 + E3 + E4 + E5 = 0

E2 + E3 + E4 + E5 = 1

To obtain an MTTL 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 MTTL flip-flop by connecting Pins 5 and 4 to Pins 2 and 3 respectively, and driving the MTTL flip-flop with Pin 7. ML12513 inputs E4 and E5 are used rather than E1. With E1 + E2 + E3 = 0, operation remains as shown.

FIGURE 10 — DIVIDE BY 40/41 (ML12513)

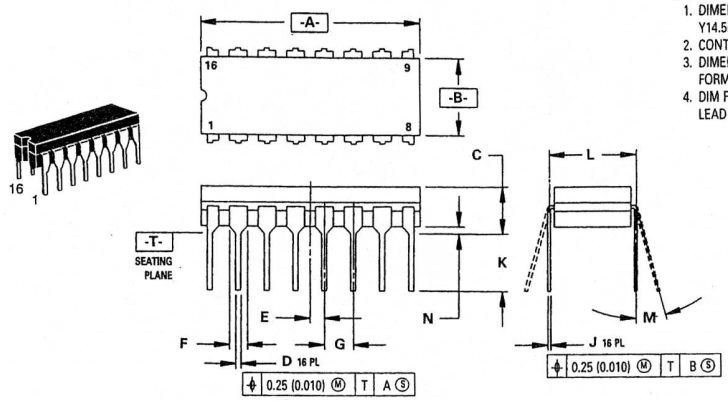


For ÷40: E4 + E5 = 1
For ÷41: E4 +E5 = 0

Termination resistors for MECL outputs are not shown, but are required except for the flip-flop driving the translator section.

OUTLINE DIMENSIONS

CERDIP 16 = E
CERAMIC PACKAGE
(ML12509/BEA, ML12511/BEA, ML12513/BEA)
CASE 620



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.

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