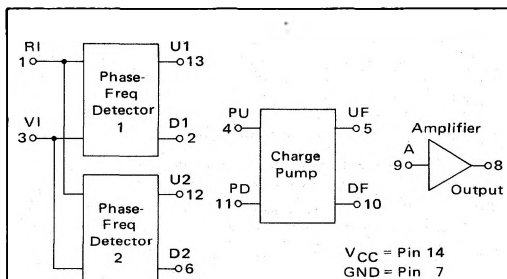


PHASE-FREQUENCY DETECTOR

MC4300/MC4000 series

MC4344F, L*
MC4044F, L, P*



Input Loading Factor: RI, VI = 3
Output Loading Factor (Pin 8) = 10
Total Power Dissipation = 85 mW typ/pkg
Propagation Delay Time = 9.0 ns typ
(thru phase detector)

This device contains two digital phase detectors and a charge pump circuit which converts MTTL inputs to a dc voltage level for use in frequency discrimination and phase-locked-loop applications.

The two phase detectors have common inputs. Phase-frequency detector 1 is locked in (indicated by both outputs high) when the negative transitions of the variable input (VI) and reference input (RI) are equal in frequency and phase. If the variable input is lower in frequency or lags in phase, the U1 (up) output goes low; conversely the D1 (down) output goes low when the variable input is higher in frequency or leads the reference input in phase. It is important to note that the duty cycles of the variable input and the reference input are not important since negative transitions control system operation.

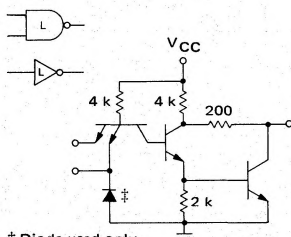
Phase detector 2, on the other hand, is locked in when the variable input phase lags the reference phase by 90° (indicated by the U2 and D2 outputs alternately going low with equal pulse widths). If the variable input phase lags by more than 90°, U2 will remain low longer than D2, and, conversely, if the variable input phase lags the reference phase by less than 90°, D2 remains low longer. In this phase detector the variable input and the reference must have 50% duty cycles.

The charge pump accepts the phase detector outputs (U1 or U2 applied to PU, and D1 or D2 applied to PD) and converts them to fixed amplitude positive and negative pulses at the UF and DF outputs respectively. These pulses are applied to a lag-lead active filter, which incorporates external components, as well as the amplifier provided in the MC4344/4044 circuit. The filter provides a dc voltage proportional to the phase error.

PHASE DETECTOR

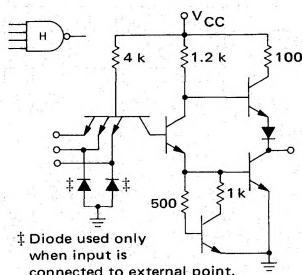
The phase detector portion of this device is constructed using low and high-level gates interconnected as shown by the logic diagram.

LOW-LEVEL "NAND" GATE



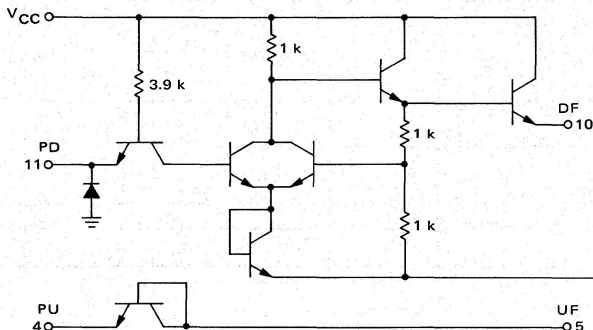
‡ Diode used only when input is connected to external point.

HIGH-LEVEL "NAND" GATE

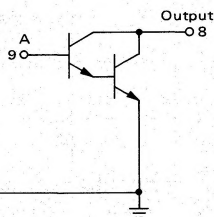


‡ Diode used only when input is connected to external point.

CHARGE PUMP



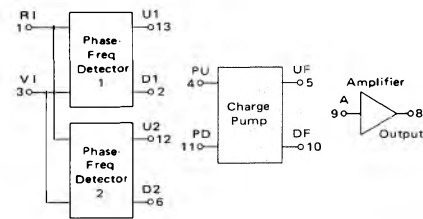
AMPLIFIER



*F suffix = TO-86 ceramic flat package (Case 607).
L suffix = TO-116 ceramic dual in-line package (Case 632).
P suffix = TO-116 plastic dual in-line package (Case 605).

MC4344F,L , MC4044F,L,P (continued)

ELECTRICAL CHARACTERISTICS



INPUT STATE	INPUT		OUTPUT			
	RI	VI	U1	D1	U2	D2
1	0	0	X	X	1	1
2	1	0	X	X	0	1
3	1	1	X	X	1	0
4	1	0	X	X	0	1
5	0	0	X	X	1	1
6	1	0	X	X	0	1
7	0	0	X	X	1	1
8	1	0	X	X	0	1
9	0	0	0	1	1	1
10	0	1	0	1	1	1
11	0	0	1	1	1	1
12	0	1	1	1	1	1
13	0	0	1	0	1	1
14	0	1	1	0	1	1
15	0	1	0	1	1	1
16	1	0	1	0	0	1
17	0	0	1	1	1	1

TRUTH TABLE

This is not strictly a functional truth table; i.e., it does not show all possible modes of operation. It is useful for dc testing.

1. X indicates output state unknown.
2. U1 and D1 outputs are sequential; i.e., they must be sequenced in order shown.
3. U2 and D2 outputs are combinational; i.e., they need only inputs shown to obtain outputs.

Characteristic		Symbol	Pin Under Test	TEST CURRENT/VOLTAGE VALUES												TEST CURRENT/VOLTAGE APPLIED TO PINS LISTED BELOW:												Pulse 1	Gnd				
				MC4344 Test Limits						MC4044 Test Limits						mA																	
				-55°C		+25°C		+125°C		0°C		+25°C		+75°C		Volts																	
				Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	I _{OL}	I _{OH1}	I _{OH2}	I _{in}	I _A	V _{IL}	V _{IF}	V _R	V _{RH}	V _{out}	V _{CC}	V _{CLL}	V _{CCH}					
Input																																	
Forward Current		I _F	1	-4.8	-4.8	-4.8	-4.8	-4.8	-4.8	-4.8	-4.8	-4.8	-4.8	-4.8	-4.8	mAdc	-	-	-	-	-	-	-	-	-	-	-	-	-				
			3	-	-4.8	-4.8	-4.8	-4.8	-4.8	-4.8	-4.8	-4.8	-4.8	-4.8	-4.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
			11	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
Leakage Current		I _R	1	-	-120	-120	-120	-120	-120	-120	-120	-120	-120	-120	-120	μAdc	-	-	-	-	-	-	-	-	-	-	-	-	-				
			3	-	-120	-120	-120	-120	-120	-120	-120	-120	-120	-120	-120	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
			4	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
			11	-	-40	-40	-40	-40	-40	-40	-40	-40	-40	-40	-40	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
Breakdown Voltage		BV _{DS}	1	-	-5.5	-	-	-	-	-	-	-	-	-	-	Vdc	-	-	-	-	-	-	-	-	-	-	-	-	-				
			3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
			11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
Clamp Voltage		V _D	1	-	-1.5	-	-	-	-	-	-	-	-	-	-	V _{DS}	-	-	-	-	-	-	-	-	-	-	-	-	-				
			3	-	-1.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
Output (Note 1)		V _{OH}	6	2.4	2.4	2.4	2.4	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	Vdc	6	12	12	12	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3				
Output Voltage			12	2.4	2.4	2.4	2.4	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
		V _{OL}	6	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	Vdc	6	12	12	12	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3				
			12	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
		V _{OH}	2	2.4	2.4	2.4	2.4	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	Vdc	2	13	13	13	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3				
			13	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
		V _{OL}	2	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	Vdc	2	13	13	13	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3				
			13	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
		V _{OH}	2	2.4	2.4	2.4	2.4	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	Vdc	2	13	13	13	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3				
			13	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
		V _{OL}	2	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	Vdc	2	13	13	13	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3				
			13	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
		V _{OH}	2	2.4	2.4	2.4	2.4	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	Vdc	2	13	13	13	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3				
			13	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
		V _{OL}	2	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	Vdc	2	13	13	13	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3				
			13	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
		V _{OH}	2	2.4	2.4	2.4	2.4	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	Vdc	2	13	13	13	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3				
			13	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
		V _{OL}	2	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	Vdc	2	13	13	13	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3				
			13	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
		V _{OH}	2	2.4	2.4	2.4	2.4	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	Vdc	2	13	13	13	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3				
			13	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
		V _{OL}	2	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	Vdc	2	13	13	13	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3				
			13	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
		V _{OH}	2	2.4	2.4	2.4	2.4	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	Vdc	2	13	13	13	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3				
			13	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
		V _{OL}	2	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	Vdc	2	13	13	13	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3				
			13	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
		V _{OH}	2	2.4	2.4	2.4	2.4	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	Vdc	2	13	13	13	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3				
			13	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
		V _{OL}	2	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	Vdc	2	13	13	13	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3				
			13	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
		V _{OH}	2	2.4	2.4	2.4	2.4	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	Vdc	2	13	13	13	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3				
			13	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
		V _{OL}	2	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	Vdc	2	13	13	13	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3				
			13	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
		V _{OH}	2	2.4	2.4	2.4	2.4	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	Vdc	2	13	13	13	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3				
			13	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
		V _{OL}	2	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	Vdc	2	13	13	13	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3				
			13	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
		V _{OH}	2	2.4	2.4	2.4	2.4	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	Vdc	2	13	13	13	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3				
			13	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
		V _{OL}	2	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	Vdc	2	13	13	13	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3				
			13	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
		V _{OH}	2	2.4	2.4	2.4	2.4	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	Vdc	2	13	13	13	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3				
			13	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
		V _{OL}	2	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	Vdc	2	13	13	13	1												

APPLICATIONS INFORMATION

FIGURE 1 – PHASE-LOCKED, FREQUENCY SYNTHESIZER LOOP

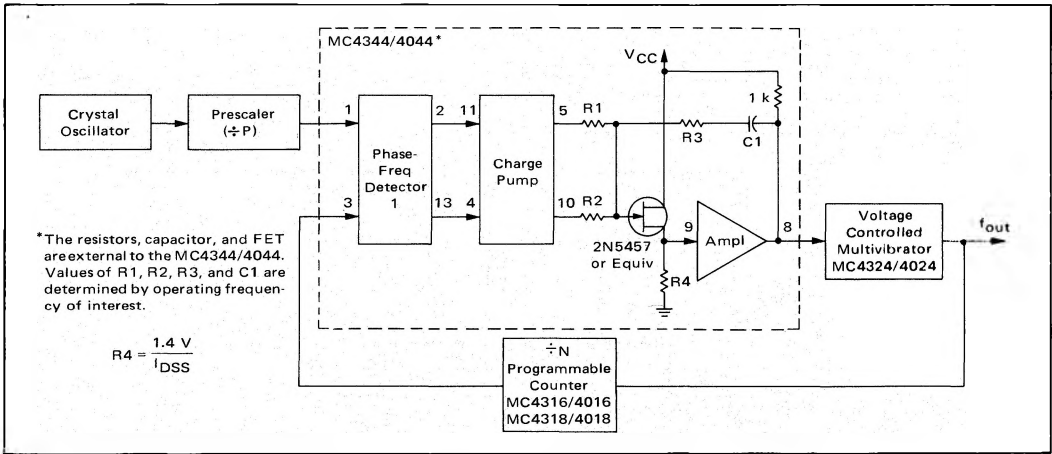
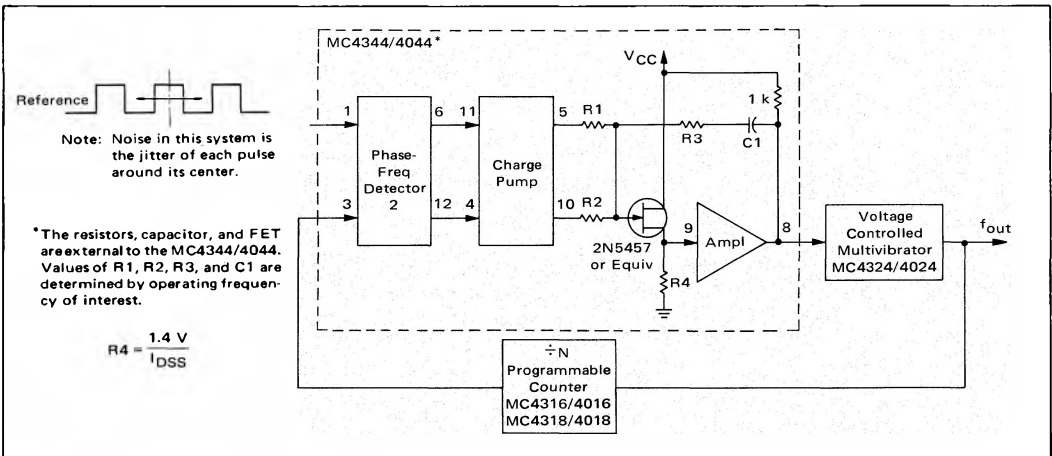


Figure 2 shows phase detector 2 of the MC4344/4044, which operates as a correlation detector, used in a phase-locked loop. There are two differences between this system and that shown in Figure 1. First, the VCM output, when locked in, lags the reference by 90°. Second, since the correlation detector integrates the product of its two inputs over each cycle, it can handle signals in a high-noise environment. This loop is sensitive to harmonics, therefore care must be taken to limit the frequency range of the VCM.

FIGURE 2 – PHASE-LOCKED, CORRELATION DETECTOR LOOP



APPLICATIONS INFORMATION (continued)

FIGURE 3 – SLAVE CLOCK
PULSE GENERATOR

Figure 3 depicts the MC4344/4044 in a system used to generate a slave clock pulse with its negative edge locked to the negative edge of the master clock, but with adjustable pulse width. The pulse width of the slave clock pulse is controlled only by the monostable multivibrator, which is triggered from the negative edge of an input pulse.

The slave clock application is useful when the clock from a master computer must be slaved to that of a satellite.

