

MCH12140, MCK12140

Phase-Frequency Detector

Description

The MCH/K12140 is a phase frequency–detector intended for phase–locked loop applications which require a minimum amount of phase and frequency difference at lock. When used in conjunction with high performance VCO such as the MC100EL1648, a high bandwidth PLL can be realized. The device is functionally compatible with the MC12040 phase–frequency detector with the maximum frequency extending to 800 MHz.

When the Reference (R) and VCO (V) inputs are unequal in frequency and/or phase, the differential UP (U) and DOWN (D) outputs will provide pulse streams which when subtracted and integrated provide an error voltage for control of a VCO. See AND8040 for further information. The device is packaged in a small outline, surface mount 8–lead SOIC package. There are two versions of the device to provide I/O compatibility to the two existing ECL standards. The MCH12140 is compatible with MECL 10H™ logic levels while the MCK12140 is compatible to 100 K ECL logic levels. This device can also be used in +5.0 V systems. See AND8020 for termination information

Features

- 800 MHz Typical Bandwidth
- Small Outline 8-Lead SOIC Package
- 75 kΩ Internal Input Pulldown Resistors
- >1000 V ESD Protection
- Pb–Free Packages are Available

For proper operation, the input edge rate of the R and V inputs should be less than 5.0 ns.

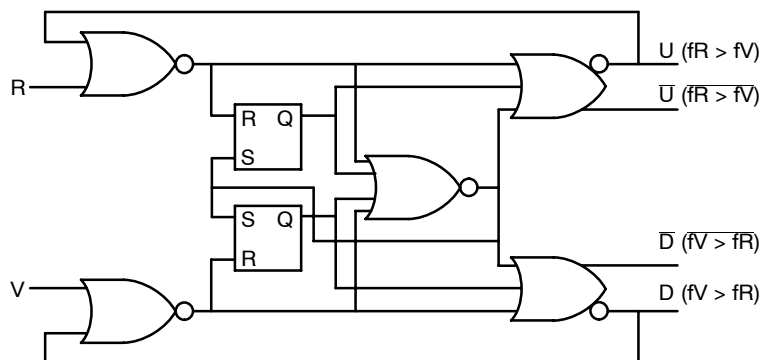


Figure 1. Logic Diagram



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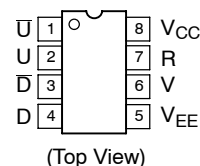
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MARKING DIAGRAM



- x = H or K
- A = Assembly Location
- L = Wafer Lot
- Y = Year
- W = Work Week
- = Pb–Free Package

PIN CONNECTIONS



ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 4 of this data sheet.

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Table 1. TRUTH TABLE*

| Input | | Output | | | | Input | | Output | | | |
|-------|---|--------|---|---|---|-------|---|--------|---|---|---|
| R | V | U | D | U | D | R | V | U | D | U | D |
| 0 | 0 | X | X | X | X | 1 | 1 | 0 | 0 | 1 | 1 |
| 0 | 1 | X | X | X | X | 1 | 0 | 0 | 0 | 1 | 1 |
| 1 | 1 | X | X | X | X | 1 | 1 | 0 | 1 | 1 | 0 |
| 0 | 1 | X | X | X | X | 1 | 0 | 0 | 1 | 1 | 0 |
| 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 0 |
| 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 |
| 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 |
| 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 |

*This is not strictly a functional table; i.e., it does not cover all possible modes of operation. However, it gives a sufficient number of tests to ensure that the device will function properly.

Table 2. H-SERIES DC CHARACTERISTICS ($V_{EE} = V_{EE(min)} - V_{EE(max)}$; $V_{CC} = GND$ (Note 1), unless otherwise noted.)

| Symbol | Characteristic | -40°C | | 0°C | | 25°C | | 70°C | | Unit |
|----------|---------------------|-------|-------|-------|-------|-------|-------|-------|-------|------|
| | | Min | Max | Min | Max | Min | Max | Min | Max | |
| V_{OH} | Output HIGH Voltage | -1080 | -890 | -1020 | -840 | -980 | -810 | -910 | -720 | mV |
| V_{OL} | Output LOW Voltage | -1950 | -1650 | -1950 | -1630 | -1950 | -1630 | -1950 | -1595 | mV |
| V_{IH} | Input HIGH Voltage | -1230 | -890 | -1170 | -840 | -1130 | -810 | -1060 | -720 | mV |
| V_{IL} | Input LOW Voltage | -1950 | -1500 | -1950 | -1480 | -1950 | -1480 | -1950 | -1445 | mV |
| I_{IL} | Input LOW Current | 0.5 | - | 0.5 | - | 0.5 | - | 0.3 | - | μA |

Table 3. K-SERIES DC CHARACTERISTICS ($V_{EE} = V_{EE(min)} - V_{EE(max)}$; $V_{CC} = GND$ (Note 2), unless otherwise noted.)

| Symbol | Characteristic | -40°C | | | 0°C to 70°C | | | Condition | Unit |
|-----------|---------------------|-------|-------|-------|-------------|-------|-------|--|------|
| | | Min | Typ | Max | Min | Typ | Max | | |
| V_{OH} | Output HIGH Voltage | -1085 | -1005 | -880 | -1025 | -955 | -880 | $V_{IN} = V_{IH(max)}$ or $V_{IL(min)}$ | mV |
| V_{OL} | Output LOW Voltage | -1830 | -1695 | -1555 | -1810 | -1705 | -1620 | | mV |
| V_{OHA} | Output HIGH Voltage | -1095 | - | - | -1035 | - | - | $V_{IN} = V_{IH(min)}$ or $V_{IL(max)}$ | mV |
| V_{OLA} | Output LOW Voltage | - | - | -1555 | - | - | -1610 | | mV |
| V_{IH} | Input HIGH Voltage | -1165 | - | -880 | -1165 | - | -880 | - | mV |
| V_{IL} | Input LOW Voltage | -1810 | - | -1475 | -1810 | - | -1475 | - | mV |
| I_{IL} | Input LOW Current | 0.5 | - | - | 0.5 | - | - | $V_{IN} = V_{IL(max)}$ | μA |

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Table 4. MAXIMUM RATINGS

| Symbol | Rating | Value | Unit |
|-----------|---|--------------|------|
| V_{EE} | Power Supply ($V_{CC} = 0\text{ V}$) | -8.0 to 0 | VDC |
| V_I | Input Voltage ($V_{CC} = 0\text{ V}$) | 0 to -6.0 | VDC |
| I_{out} | Output Current Continuous Surge | 50 100 | mA |
| T_A | Operating Temperature Range | -40 to +70 | °C |
| V_{EE} | Operating Range (Note 3) | -5.7 to -4.2 | V |

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

NOTE: ESD data available upon request.

- 10H circuits are designed to meet the DC specifications shown in the table after thermal equilibrium has been established. The circuit is in a test socket or mounted on a printed circuit board and transverse airflow greater than 500 lfpm is maintained. Outputs are terminated through a 50 Ω resistor to -2.0 V except where otherwise specified on the individual data sheets.
- This table replaces the three tables traditionally seen in ECL 100 K data books. The same DC parameter values at $V_{EE} = -4.5\text{ V}$ now apply across the full V_{EE} range of -4.2 V to -5.5 V. Outputs are terminated through a 50 Ω resistor to -2.0 V except where otherwise specified on the individual data sheets.
- Parametric values specified at: H-Series: -4.20 V to -5.50 V
K-Series: -4.94 V to -5.50 V

Table 5. DC CHARACTERISTICS ($V_{EE} = V_{EE}(\text{min}) - V_{EE}(\text{max})$; $V_{CC} = \text{GND}$, unless otherwise noted.)

| Symbol | Characteristic | -40°C | | | 0°C | | | 25°C | | | 70°C | | | Unit |
|----------|--------------------------------|-------|------|------|-------|------|------|-------|------|------|-------|------|------|---------------|
| | | Min | Typ | Max | Min | Typ | Max | Min | Typ | Max | Min | Typ | Max | |
| I_{EE} | Power Supply Current H K | - | 45 | - | 38 | 45 | 52 | 38 | 45 | 52 | 38 | 45 | 52 | mA |
| | | - | 45 | - | 38 | 45 | 52 | 38 | 45 | 52 | 42 | 50 | 58 | |
| V_{EE} | Power Supply Voltage H K | -4.75 | -5.2 | -5.5 | -4.75 | -5.2 | -5.5 | -4.75 | -5.2 | -5.5 | -4.75 | -5.2 | -5.5 | V |
| | | -4.20 | -4.5 | -5.5 | -4.20 | -4.5 | -5.5 | -4.20 | -4.5 | -5.5 | -4.20 | -4.5 | -5.5 | |
| I_{IH} | Input HIGH Current | - | - | 150 | - | - | 150 | - | - | 150 | - | - | 150 | μA |

NOTE: Device will meet the specifications after thermal equilibrium has been established when mounted in a test socket or printed circuit board with maintained transverse airflow greater than 500 lfpm. Electrical parameters are guaranteed only over the declared operating temperature range. Functional operation of the device exceeding these conditions is not implied. Device specification limit values are applied individually under normal operating conditions and not valid simultaneously.

Table 6. AC CHARACTERISTICS ($V_{EE} = V_{EE}(\text{min}) - V_{EE}(\text{max})$; $V_{CC} = \text{GND}$, unless otherwise noted.)

| Symbol | Characteristic | -40°C | | | 0°C | | | 25°C | | | 70°C | | | Unit |
|------------------------|---|-------|-----|-----|-----|-----|-----|------|-----|-----|------|-----|-----|------|
| | | Min | Typ | Max | Min | Typ | Max | Min | Typ | Max | Min | Typ | Max | |
| F_{MAX} | Maximum Toggle Frequency | - | 800 | - | 650 | 800 | - | 650 | 800 | - | 650 | 800 | - | - |
| t_{PLH} t_{PHL} | Propagation Delay-to-Output R, V to D, U | 250 | 375 | 500 | 250 | 375 | 500 | 250 | 375 | 500 | 250 | 375 | 500 | ps |
| t_r t_f | Output Rise/Fall Times Q (20 to 80%) | - | 225 | - | 100 | 225 | 350 | 100 | 225 | 350 | 100 | 225 | 350 | ps |

NOTE: Device will meet the specifications after thermal equilibrium has been established when mounted in a test socket or printed circuit board with maintained transverse airflow greater than 500 lfpm. Electrical parameters are guaranteed only over the declared operating temperature range. Functional operation of the device exceeding these conditions is not implied. Device specification limit values are applied individually under normal operating conditions and not valid simultaneously.

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APPLICATIONS INFORMATION

The 12140 is a high speed digital circuit used as a phase comparator in an analog phase-locked loop. The device determines the “lead” or “lag” phase relationship and time difference between the leading edges of a VCO (V) signal and a Reference (R) input. Since these edges occur only once per cycle, the detector has a range of $\pm 2\pi$ radians.

The operation of the 12140 can best be described using the plots of Figure 2. Figure 2 plots the average value of \bar{U} , \bar{D} and the difference between \bar{U} and \bar{D} versus the phase difference between the V and R inputs.

There are four potential relationships between V and R: R lags or leads V and the frequency of R is less than or greater than the frequency of V. Under these four conditions the 12140 will function as follows:

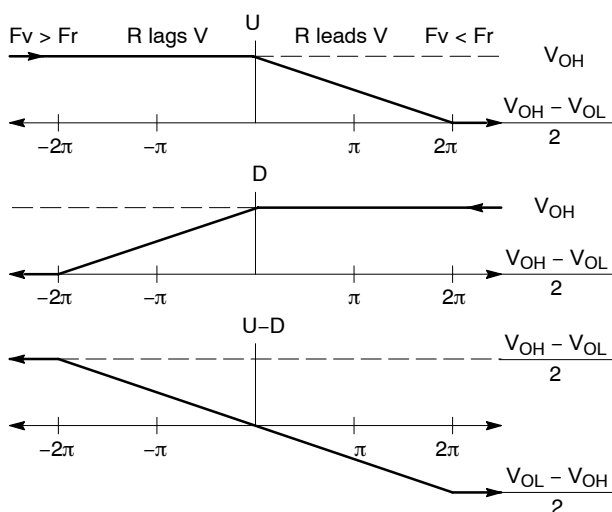


Figure 2. Average Output Voltage vs. Phase Difference

R lags V in phase

When the R and V inputs are equal in frequency and the phase of R lags that of V the \bar{U} output will stay HIGH while the \bar{D} output will pulse from HIGH to LOW. The magnitude of the pulse will be proportional to the phase difference between the V and R inputs reaching a minimum 50% duty cycle under a 180° out of phase condition. The signal on \bar{D} indicates to the VCO to decrease in frequency to bring the loop into lock.

V frequency > R frequency

When the frequency of V is greater than that of R the 12140 behaves in a similar fashion as above. Again the signal on \bar{D} indicates that the VCO frequency must be decreased to bring the loop into lock.

R leads V in phase

When the R and V inputs are equal in frequency and the phase of R leads that of V the \bar{D} output will stay HIGH while the \bar{U} output pulses from HIGH to LOW. The magnitude of the pulse will be proportional to the phase difference between the V and R inputs reaching a minimum 50% duty cycle under a 180° out of phase condition. The signal on \bar{U} indicates to the VCO to increase in frequency to bring the loop into lock.

V frequency < R frequency

When the frequency of V is less than that of R the 12140 behaves in a similar fashion as above. Again the signal on \bar{U} indicates that the VCO frequency must be decreased to bring the loop into lock.

From Figure 2 when V and R are at the same frequency and in phase the value of $\bar{U} - \bar{D}$ is zero thus providing a zero error voltage to the VCO. This situation indicates the loop is in lock and the 12140 action will maintain the loop in its locked state.

ORDERING INFORMATION

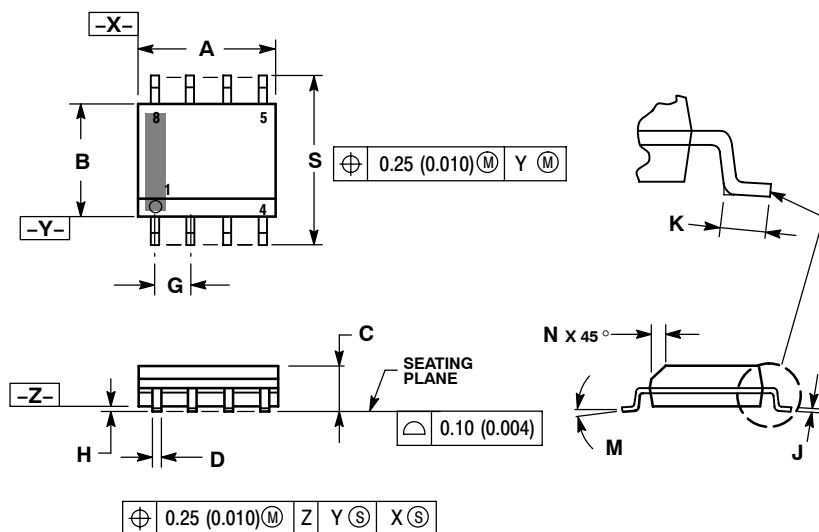
| Device | Package | Shipping† |
|--------------|---------------------|--------------------|
| MCH12140D | SOIC-8 | 98 Units / Rail |
| MCH12140DG | SOIC-8 (Pb-Free) | 98 Units / Rail |
| MCH12140DR2 | SOIC-8 | 2500 / Tape & Reel |
| MCH12140DR2G | SOIC-8 (Pb-Free) | 2500 / Tape & Reel |
| MCK12140D | SOIC-8 | 98 Units / Rail |
| MCK12140DG | SOIC-8 (Pb-Free) | 98 Units / Rail |
| MCK12140DR2 | SOIC-8 | 2500 / Tape & Reel |
| MCK12140DR2G | SOIC-8 (Pb-Free) | 2500 / Tape & Reel |

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

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PACKAGE DIMENSIONS

SOIC-8 NB CASE 751-07 ISSUE AH

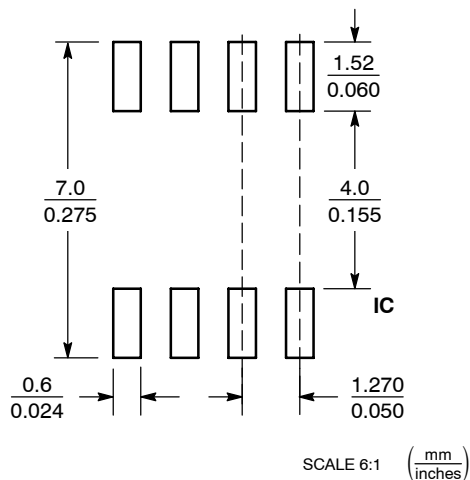


NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION 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.
6. 751-01 THRU 751-06 ARE OBSOLETE. NEW STANDARD IS 751-07.

| DIM | MILLIMETERS | | INCHES | |
|-----|-------------|------|-----------|-------|
| | MIN | MAX | MIN | MAX |
| A | 4.80 | 5.00 | 0.189 | 0.197 |
| B | 3.80 | 4.00 | 0.150 | 0.157 |
| C | 1.35 | 1.75 | 0.053 | 0.069 |
| D | 0.33 | 0.51 | 0.013 | 0.020 |
| G | 1.27 BSC | | 0.050 BSC | |
| H | 0.10 | 0.25 | 0.004 | 0.010 |
| J | 0.19 | 0.25 | 0.007 | 0.010 |
| K | 0.40 | 1.27 | 0.016 | 0.050 |
| M | 0° | 8° | 0° | 8° |
| N | 0.25 | 0.50 | 0.010 | 0.020 |
| S | 5.80 | 6.20 | 0.228 | 0.244 |

SOLDERING FOOTPRINT*



*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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