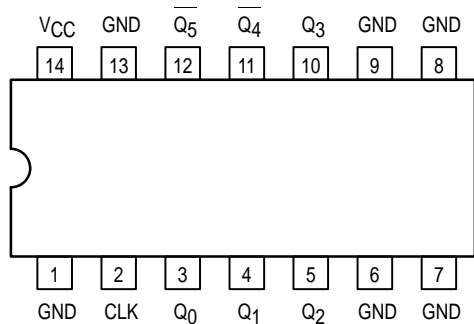


# Low Skew CMOS Clock Driver

The MC88913 is a high-speed, low power, hex divide-by-two D-type flip-flop with two inverting and four non-inverting outputs that have closely matched propagation delays. With a TTL compatible buffered clock input that is common to all flip-flops, the MC88913 is ideal for use in high-frequency systems as a clock driver, providing multiple outputs that are synchronous.

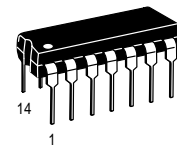
- Minimum Clock Input  $f_{MAX}$  of 110MHz
- TTL Compatible Positive Edge-Triggered Clock
- Matched Outputs for Synchronous Applications
- Outputs Source/Sink 24mA
- Part-to-Part Skew of Less Than 4.0ns
- Guaranteed Rise and Fall Times for a Given Capacitive Load

**Pinout: 14-Lead Plastic (Top View)**

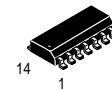


**MC88913**

**LOW SKEW CMOS  
CLOCK DRIVER**



**N SUFFIX**  
PLASTIC PACKAGE  
CASE 646-06



**D SUFFIX**  
PLASTIC PACKAGE  
CASE 751A-03

**MAXIMUM RATINGS\***

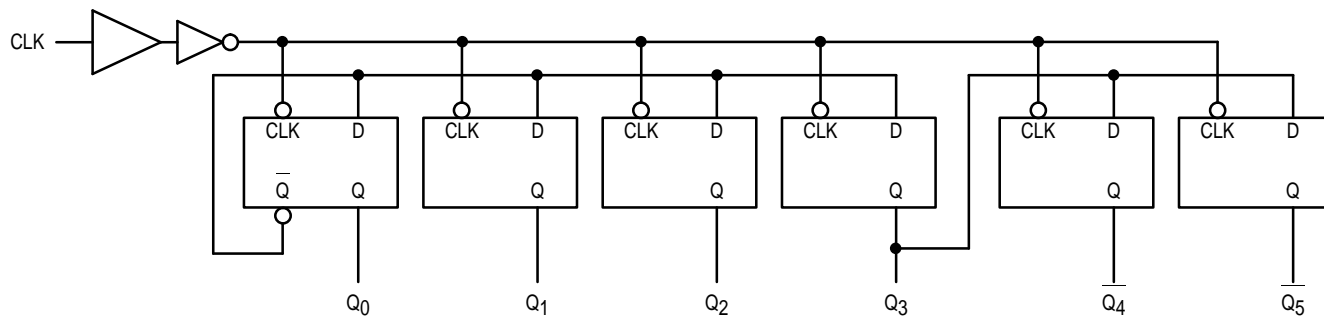
| Symbol    | Parameter   | Value                  | Units       |
|-----------|---|------------------------|-------------|
| $V_{CC}$  | DC Supply Voltage (Referenced to GND)                                 | -0.5 to +7.0           | V           |
| $V_{in}$  | DC Input Voltage (Referenced to GND)                                  | -0.5 to $V_{CC} + 0.5$ | V           |
| $V_{out}$ | DC Output Voltage (Referenced to GND)                                 | -0.5 to $V_{CC} + 0.5$ | V           |
| $I_{in}$  | DC Input Current, per Pin   | $\pm 20$               | mA          |
| $I_{out}$ | DC Output Sink/Source Current, per Pin                                | $\pm 50$               | mA          |
| $I_{CC}$  | DC $V_{CC}$ or GND Current per Output Pin                             | $\pm 50$               | mA          |
| $P_D$     | Power Dissipation in Still Air<br>Plastic Package**<br>SOIC Package** | 750<br>500             | mW          |
| $T_{stg}$ | Storage Temperature   | -65 to +150            | $^{\circ}C$ |
| $T_L$     | Lead Temperature, 1mm from Case for 10s (Plastic or SOIC Package)     | 260                    | $^{\circ}C$ |

\* Maximum Ratings are those values beyond which damage to the device may occur. Functional operation should be restricted to the Recommended Operating Conditions.

\*\* Derating: Plastic Package: -10mW/ $^{\circ}C$  from 65 $^{\circ}C$  to 125 $^{\circ}C$   
SOIC Package: -7.0mW/ $^{\circ}C$  from 65 $^{\circ}C$  to 125 $^{\circ}C$



LOGIC DIAGRAM



NOTE: This diagram is provided only for understanding of logic operation and should **not** be used to estimate propagation delays

RECOMMENDED OPERATING CONDITIONS

| Symbol            | Parameter  | Min | Max      | Unit |
|-------------------|--|-----|----------|------|
| $V_{CC}$          | DC Supply Voltage (Referenced to GND)  | 2.0 | 6.0      | V    |
| $V_{in}, V_{out}$ | DC Input Voltage, Output Voltage (Referenced to GND)                                 | 0   | $V_{CC}$ | V    |
| $T_A$             | Operating Temperature  | -40 | +85      | °C   |
| $t_r, t_f$        | Input Rise and Fall Time<br>$V_{in}$ from 0.8 to 2.0V<br>$V_{meas}$ from 0.8 to 2.0V | 0   | 10       | ns/V |

DC CHARACTERISTICS (unless otherwise specified)

| Symbol    | Parameter                          |     | Unit    | Condition  |
|-----------|------------------------------------|-----|---------|--|
| $I_{CC}$  | Maximum Quiescent Supply Current   | 80  | $\mu A$ | $V_{IN} = V_{CC}$ or GND<br>$V_{CC} = 5.5V$ ,<br>$T_A = \text{Worst Case}$ |
| $I_{CC}$  | Maximum Quiescent Supply Current   | 8.0 | $\mu A$ | $V_{IN} = V_{CC}$ or GND<br>$V_{CC} = 5.5V$ ,<br>$T_A = 25^\circ C$        |
| $I_{CCT}$ | Maximum Additional $I_{CC}$ /Input | 1.5 | mA      | $V_{IN} = V_{CC} - 2.1V$<br>$V_{CC} = 5.5V$ ,<br>$T_A = \text{Worst Case}$ |

AC OPERATING REQUIREMENTS

| Symbol | Parameter                     | $V_{CC}$ (V) | $T_A = 25^\circ C$<br>$C_L = 50 \text{ pF}$ |     | $T_A = -40 \text{ to } +85^\circ C$<br>$C_L = 50 \text{ pF}$ |     | Unit |
|--------|-------------------------------|--------------|---|-----|--|-----|------|
|        |                               |              | Min   | Max | Min  | Max |      |
| $t_W$  | CLK Pulse Width (HIGH to LOW) | 5.0          | 3.0   |     | 3.0  |     | ns   |

CAPACITANCE

| Symbol   | Parameter                     | Typ | Unit | Condition       |
|----------|-------------------------------|-----|------|-----------------|
| $C_{IN}$ | Input Capacitance             | 4.5 | pF   | $V_{CC} = 5.0V$ |
| $C_{PD}$ | Power Dissipation Capacitance | 30  | pF   | $V_{CC} = 5.0V$ |

## DC CHARACTERISTICS

| Symbol           | Parameter                        | V <sub>CC</sub> | T <sub>A</sub> = +25°C |                | T <sub>A</sub> = -40 to +85°C |    | Unit  | Conditions |
|------------------|----------------------------------|-----------------|------------------------|----------------|-------------------------------|----|---|------------|
|                  |                                  |                 | Typ                    | Guaranteed Max |                               |    |   |            |
|                  |                                  |                 |                        |                |                               |    |   |            |
| V <sub>IH</sub>  | Minimum High Level Input Voltage | 4.5             | 1.5                    | 2.0            | 2.0                           | V  | V <sub>OUT</sub> = 0.1V or V <sub>CC</sub> - 0.1V   |            |
|                  |                                  | 5.5             | 1.5                    | 2.0            | 2.0                           |    |   |            |
| V <sub>IL</sub>  | Maximum Low Level Input Voltage  | 4.5             | 1.5                    | 0.8            | 0.8                           | V  | V <sub>OUT</sub> = 0.1V or V <sub>CC</sub> - 0.1V   |            |
|                  |                                  | 5.5             | 1.5                    | 0.8            | 0.8                           |    |   |            |
| V <sub>OH</sub>  | Minimum High Level               | 4.5             | 4.49                   | 4.4            | 4.4                           | V  | I <sub>OUT</sub> = -50μA  |            |
|                  |                                  | 5.5             | 5.49                   | 5.4            | 5.4                           |    |   |            |
|                  |                                  | 4.5             |                        | 3.86           | 3.76                          | V  | *V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub><br>I <sub>OH</sub> = -24mA<br>-24mA |            |
|                  |                                  | 5.5             |                        | 4.86           | 4.76                          |    |   |            |
| V <sub>OL</sub>  | Maximum Low Level Output Voltage | 4.5             | 0.001                  | 0.1            | 0.1                           | V  | I <sub>OUT</sub> = 50μA   |            |
|                  |                                  | 5.5             | 0.001                  | 0.1            | 0.1                           |    |   |            |
|                  |                                  | 4.5             |                        | 0.36           | 0.44                          | V  | *V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub><br>I <sub>OH</sub> = 24mA<br>24mA   |            |
|                  |                                  | 5.5             |                        | 0.36           | 0.44                          |    |   |            |
| I <sub>IN</sub>  | Maximum Input                    | 5.5             |                        | ±0.1           | ±0.1                          | μA | V <sub>I</sub> = V <sub>CC</sub> , GND  |            |
| I <sub>CCT</sub> | Maximum I <sub>CC</sub> /Input   | 5.5             | 0.6                    |                | 1.5                           | mA | V <sub>I</sub> = V <sub>CC</sub> - 2.1V   |            |
| I <sub>OLD</sub> | Minimum Dynamic Output Current** | 5.5             |                        |                | 75                            | mA | V <sub>OLD</sub> = 1.65V  |            |
| I <sub>OHD</sub> |                                  | 5.5             |                        |                | -75                           | mA | V <sub>OHD</sub> = 3.85V  |            |

\* All outputs loaded; thresholds on inputs associated with output under test.

\*\* Maximum test duration 20ms, one output at a time.

AC CHARACTERISTICS (V<sub>CC</sub> = 5.0V ±10%)

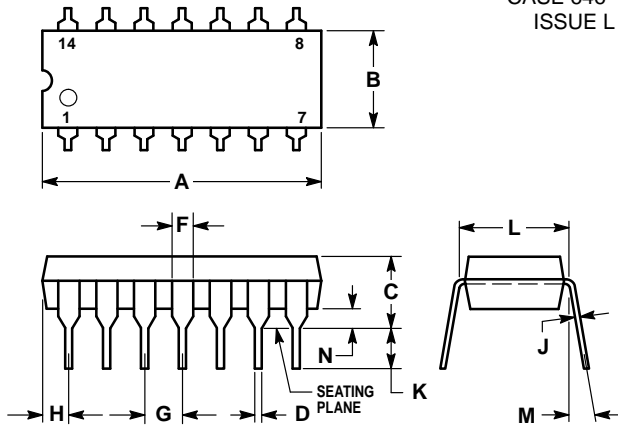
| Symbol                                 | Parameter  | V <sub>CC</sub> (V) | T <sub>A</sub> = 25°C<br>C <sub>L</sub> = 50 pF |      | T <sub>A</sub> = -40 to +85°C<br>C <sub>L</sub> = 50 pF |      | Unit |
|--|--|---------------------|---|------|---|------|------|
|  |  |                     | Min   | Max  | Min   | Max  |      |
|  |  |                     |   |      |   |      |      |
| f <sub>MAX</sub>                       | Maximum Clock Frequency (50% Duty Cycle)   | 5.0                 | 110   |      | 110   |      | MHz  |
| t <sub>PLH</sub> ,<br>t <sub>PHL</sub> | Propagation Delay<br>CLK to Q <sub>n</sub> , Q <sub>n</sub>  | 5.0                 | 4.0   | 10.5 | 4.0   | 11.5 | ns   |
| t <sub>PV</sub>                        | Propagation Delay Variation<br>CLK to Q <sub>0</sub> , Q <sub>1</sub> , Q <sub>2</sub> (see Note 1)  | 5.0                 |   | 4.0  |   | 5.0  | ns   |
|  | Propagation Delay Variation<br>CLK to All Outputs (see Note 1)   | 5.0                 |   | 4.5  |   | 5.5  | ns   |
| t <sub>PS</sub>                        | Propagation Delay Skew (Q <sub>0</sub> , Q <sub>1</sub> , Q <sub>2</sub> )<br> t <sub>PHL</sub> Actual - t <sub>PLH</sub> Actual                           | 5.0                 |   | 1.0  |   | 1.0  | ns   |
|  | Propagation Delay Skew (All Outputs)<br> t <sub>PHL</sub> Actual - t <sub>PLH</sub> Actual   | 5.0                 |   | 1.5  |   | 1.5  | ns   |
| t <sub>OS</sub>                        | Output-to-Output Skew (Q <sub>0</sub> , Q <sub>1</sub> , Q <sub>2</sub> )<br> t <sub>p</sub> Q <sub>n</sub> - t <sub>p</sub> Q <sub>m</sub>   (see Note 2) | 5.0                 |   | 1.0  |   | 1.0  | ns   |
|  | Output-to-Output Skew (All Outputs)<br> t <sub>p</sub> Q <sub>n</sub> - t <sub>p</sub> Q <sub>m</sub>   (see Note 2)                                       | 5.0                 |   | 1.5  |   | 1.5  | ns   |
| t <sub>rise</sub><br>t <sub>fall</sub> | Rise/Fall Time for Q <sub>0</sub> , Q <sub>1</sub> , Q <sub>2</sub><br>(0.2 x V <sub>CC</sub> to 0.8 x V <sub>CC</sub> )                                   | 5.0                 |   | 3.0  |   | 4.0  | ns   |
|  | Rise/Fall Time for All Outputs<br>(0.2 x V <sub>CC</sub> to 0.8 x V <sub>CC</sub> )  | 5.0                 |   | 3.5  |   | 4.5  | ns   |

1. For a given set of conditions (i.e., capacitive load, temperature and V<sub>CC</sub>) the variation from device to device is guaranteed to be less than or equal to the maximum.

2. Where t<sub>p</sub> Q<sub>n</sub> and t<sub>p</sub> Q<sub>m</sub> are the actual propagation delays (any combination of HIGH or LOW) for any two separate outputs from a given high transition of CLK.

OUTLINE DIMENSIONS

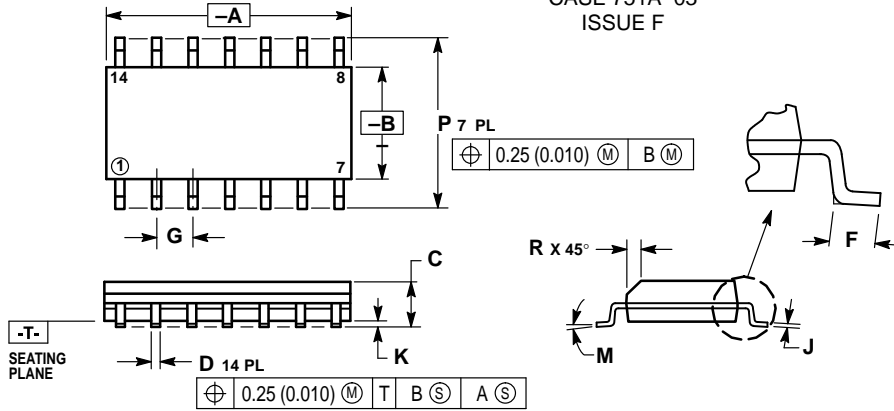
**N SUFFIX**  
**PLASTIC PACKAGE**  
**CASE 646-06**  
**ISSUE L**



- NOTES:
- LEADS WITHIN 0.13 (0.005) RADIUS OF TRUE POSITION AT SEATING PLANE AT MAXIMUM MATERIAL CONDITION.
  - DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
  - DIMENSION B DOES NOT INCLUDE MOLD FLASH.
  - ROUNDED CORNERS OPTIONAL.

| DIM | INCHES    |       | MILLIMETERS |       |
|-----|-----------|-------|-------------|-------|
|     | MIN       | MAX   | MIN         | MAX   |
| A   | 0.715     | 0.770 | 18.16       | 19.56 |
| B   | 0.240     | 0.260 | 6.10        | 6.60  |
| C   | 0.145     | 0.185 | 3.69        | 4.69  |
| D   | 0.015     | 0.021 | 0.38        | 0.53  |
| F   | 0.040     | 0.070 | 1.02        | 1.78  |
| G   | 0.100 BSC |       | 2.54 BSC    |       |
| H   | 0.052     | 0.095 | 1.32        | 2.41  |
| J   | 0.008     | 0.015 | 0.20        | 0.38  |
| K   | 0.115     | 0.135 | 2.92        | 3.43  |
| L   | 0.300 BSC |       | 7.62 BSC    |       |
| M   | 0°        | 10°   | 0°          | 10°   |
| N   | 0.015     | 0.039 | 0.39        | 1.01  |

**D SUFFIX**  
**PLASTIC SOIC PACKAGE**  
**CASE 751A-03**  
**ISSUE F**



- NOTES:
- DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  - CONTROLLING DIMENSION: MILLIMETER.
  - DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
  - MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
  - 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   | 8.55        | 8.75 | 0.337     | 0.344 |
| 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 | 0.228     | 0.244 |
| R   | 0.25        | 0.50 | 0.010     | 0.019 |

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**MFAX:** RMFA00@email.sps.mot.com -TOUCHTONE (602) 244-6609  
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