



Not Intended For New Designs

T-46-07-07

# 100135 Triple J-K Flip-Flop

## General Description

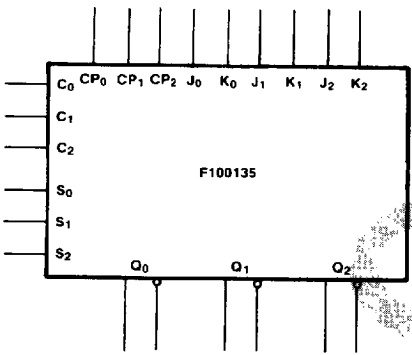
The 100135 contains three J-K, edge-triggered master-slave flip-flops with true and complement outputs. All have individual Clock (CP<sub>n</sub>), Clear (C<sub>n</sub>), and Set (S<sub>n</sub>) inputs. Clocking occurs on the rising edge of CP<sub>n</sub>. All inputs have 50 kΩ pull-down resistors.

## Features

- Toggle frequency 750 MHz Typical
- Propagation delay 2.2 ns max
- Outputs specified to drive a 50Ω load

**Ordering Code:** See Section 6

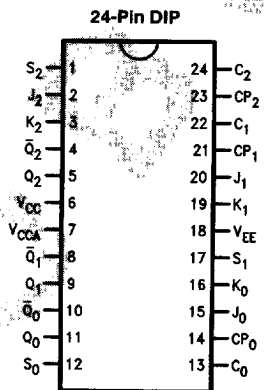
## Logic Symbol



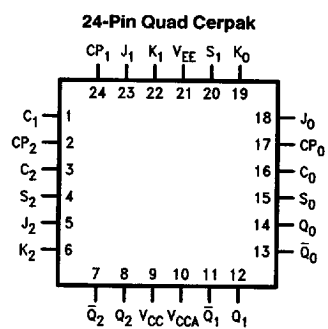
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| Pin Names                        | Description                |
|----------------------------------|----------------------------|
| J <sub>0</sub> -J <sub>2</sub>   | J Inputs                   |
| K <sub>0</sub> -K <sub>2</sub>   | K Inputs                   |
| S <sub>0</sub> -S <sub>2</sub>   | Direct Set Inputs          |
| C <sub>0</sub> -C <sub>2</sub>   | Direct Clear Inputs        |
| CP <sub>0</sub> -CP <sub>2</sub> | Clock Inputs               |
| Q <sub>0</sub> -Q <sub>2</sub>   | Data Outputs               |
| $\bar{Q}_0$ - $\bar{Q}_2$        | Complementary Data Outputs |

## Connection Diagrams



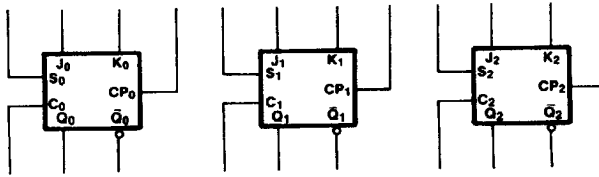
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### Logic Diagram



TL/F78854-5

### Truth Tables (Each Flip-Flop)

#### Synchronous Operation

| Inputs |       |        |       |       | Outputs             |
|--------|-------|--------|-------|-------|---------------------|
| $J_n$  | $K_n$ | $CP_n$ | $S_n$ | $C_n$ | $Q_n(t + 1)$        |
| L      | L     | ↗      | L     | L     | $Q_n(t)$            |
| L      | H     | ↗      | L     | L     | L                   |
| H      | L     | ↗      | L     | L     | H                   |
| H      | H     | ↗      | L     | L     | $\overline{Q_n(t)}$ |
| X      | X     | H      | L     | L     | $Q_n(t)$            |
| X      | X     | L      | L     | L     | $Q_n(t)$            |

#### Asynchronous Operation

| Inputs |       |        |       |       | Outputs |
|--------|-------|--------|-------|-------|---------|
| $J_n$  | $K_n$ | $CP_n$ | $S_n$ | $C_n$ | $Q_n$   |
| X      | X     | X      | H     | L     | H       |
| X      | X     | X      | L     | H     | L       |
| X      | X     | X      | H     | H     | U       |

- H = HIGH Voltage Level
- L = LOW Voltage Level
- X = Don't Care
- U = Undefined
- t = Time before CP Positive Transition
- t + 1 = Time after CP Positive Transition
- ↗ = LOW-to-HIGH Transition

### Absolute Maximum Ratings

Above which the useful life may be impaired. (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Storage Temperature -65°C to +150°C  
 Maximum Junction Temperature (T<sub>J</sub>) +150°C

Case Temperature under Bias (T<sub>C</sub>) 0°C to +85°C  
 V<sub>EE</sub> Pin Potential to Ground Pin -7.0V to +0.5V  
 Input Voltage (DC) V<sub>EE</sub> to +0.5V  
 Output Current (DC Output HIGH) -50 mA  
 Operating Range (Note 2) -5.7V to -4.2V

### DC Electrical Characteristics

V<sub>EE</sub> = -4.5V, V<sub>CC</sub> = V<sub>CCA</sub> = GND, T<sub>C</sub> = 0°C to +85°C (Note 3)

| Symbol           | Parameter           | Min   | Typ   | Max   | Units | Conditions (Note 4)   |                              |
|------------------|---------------------|-------|-------|-------|-------|---|------------------------------|
| V <sub>OH</sub>  | Output HIGH Voltage | -1025 | -955  | -880  | mV    | V <sub>IN</sub> = V <sub>IH</sub> (Max)<br>or V <sub>IL</sub> (Min) | Loading with<br>50Ω to -2.0V |
| V <sub>OL</sub>  | Output LOW Voltage  | -1810 | -1705 | -1620 |       |   |                              |
| V <sub>OHC</sub> | Output HIGH Voltage | -1035 |       |       | mV    | V <sub>IN</sub> = V <sub>IH</sub> (Min)<br>or V <sub>IL</sub> (Max) | Loading with<br>50Ω to -2.0V |
| V <sub>OLC</sub> | Output LOW Voltage  |       |       | -1610 |       |   |                              |
| V <sub>IH</sub>  | Input HIGH Voltage  | -1165 |       | -880  | mV    | Guaranteed HIGH Signal<br>for All Inputs                            |                              |
| V <sub>IL</sub>  | Input LOW Voltage   | -1810 |       | -1475 | mV    | Guaranteed LOW Signal<br>for All Inputs                             |                              |
| I <sub>IL</sub>  | Input LOW Current   | 0.50  |       |       | μA    | V <sub>IN</sub> = V <sub>IL</sub> (Min)                             |                              |

### DC Electrical Characteristics

V<sub>EE</sub> = -4.2V, V<sub>CC</sub> = V<sub>CCA</sub> = GND, T<sub>C</sub> = 0°C to +85°C (Note 3)

| Symbol           | Parameter           | Min   | Typ | Max   | Units | Conditions (Note 4)   |                              |
|------------------|---------------------|-------|-----|-------|-------|---|------------------------------|
| V <sub>OH</sub>  | Output HIGH Voltage | -1020 |     | -870  | mV    | V <sub>IN</sub> = V <sub>IH</sub> (Max)<br>or V <sub>IL</sub> (Min) | Loading with<br>50Ω to -2.0V |
| V <sub>OL</sub>  | Output LOW Voltage  | -1810 |     | -1605 |       |   |                              |
| V <sub>OHC</sub> | Output HIGH Voltage | -1030 |     |       | mV    | V <sub>IN</sub> = V <sub>IH</sub> (Min)<br>or V <sub>IL</sub> (Max) | Loading with<br>50Ω to -2.0V |
| V <sub>OLC</sub> | Output LOW Voltage  |       |     | -1595 |       |   |                              |
| V <sub>IH</sub>  | Input HIGH Voltage  | -1150 |     | -870  | mV    | Guaranteed HIGH Signal<br>for All Inputs                            |                              |
| V <sub>IL</sub>  | Input LOW Voltage   | -1810 |     | -1475 | mV    | Guaranteed LOW Signal<br>for All Inputs                             |                              |
| I <sub>IL</sub>  | Input LOW Current   | 0.50  |     |       | μA    | V <sub>IN</sub> = V <sub>IL</sub> (Min)                             |                              |

### DC Electrical Characteristics

V<sub>EE</sub> = -4.8V, V<sub>CC</sub> = V<sub>CCA</sub> = GND, T<sub>C</sub> = 0°C to +85°C (Note 3)

| Symbol           | Parameter           | Min   | Typ | Max   | Units | Conditions (Note 4)   |                              |
|------------------|---------------------|-------|-----|-------|-------|---|------------------------------|
| V <sub>OH</sub>  | Output HIGH Voltage | -1035 |     | -880  | mV    | V <sub>IN</sub> = V <sub>IH</sub> (Max)<br>or V <sub>IL</sub> (Min) | Loading with<br>50Ω to -2.0V |
| V <sub>OL</sub>  | Output LOW Voltage  | -1830 |     | -1620 |       |   |                              |
| V <sub>OHC</sub> | Output HIGH Voltage | -1045 |     |       | mV    | V <sub>IN</sub> = V <sub>IH</sub> (Min)<br>or V <sub>IL</sub> (Max) | Loading with<br>50Ω to -2.0V |
| V <sub>OLC</sub> | Output LOW Voltage  |       |     | -1610 |       |   |                              |
| V <sub>IH</sub>  | Input HIGH Voltage  | -1165 |     | -880  | mV    | Guaranteed HIGH Signal<br>for All Inputs                            |                              |
| V <sub>IL</sub>  | Input LOW Voltage   | -1830 |     | -1490 | mV    | Guaranteed LOW Signal<br>for All Inputs                             |                              |
| I <sub>IL</sub>  | Input LOW Current   | 0.50  |     |       | μA    | V <sub>IN</sub> = V <sub>IL</sub> (Min)                             |                              |

**Note 1:** Absolute maximum ratings are those values beyond which the device may be damaged or have its useful life impaired. Functional operation under these conditions is not implied.

**Note 2:** Parametric values specified at -4.2V to -4.8V

**Note 3:** The specified limits represent the "worst case" value for the parameter. Since these "worst case" values normally occur at the temperature extremes, additional noise immunity and guard banding can be achieved by decreasing the allowable system operating ranges.

**Note 4:** Conditions for testing shown in the tables are chosen to guarantee operation under "worst case" conditions.

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**DC Electrical Characteristics**
 $V_{EE} = -4.2V$  to  $-4.8V$  unless otherwise specified,  $V_{CC} = V_{CCA} = GND$ ,  $T_C = 0^\circ C$  to  $+85^\circ C$ 

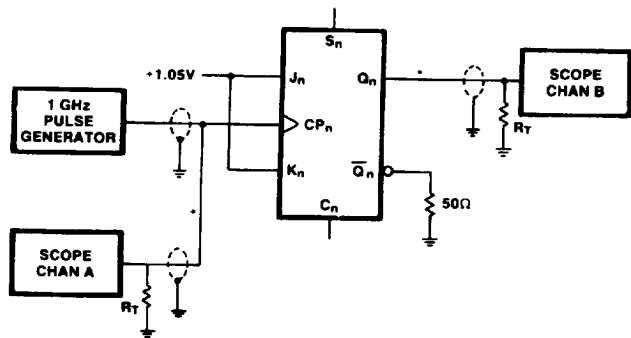
| Symbol   | Parameter                        | Min  | Typ  | Max | Units   | Conditions              |
|----------|----------------------------------|------|------|-----|---------|-------------------------|
| $I_{IH}$ | Input HIGH Current<br>All Inputs |      |      | 350 | $\mu A$ | $V_{IN} = V_{IH} (Max)$ |
| $I_{EE}$ | Power Supply Current             | -195 | -150 | -90 | mA      | Inputs Open             |

**Ceramic Dual-In-Line Package AC Characteristics**
 $V_{EE} = -4.2V$  to  $-4.8V$ ,  $V_{CC} = V_{CCA} = GND$ 

| Symbol                 | Parameter   | $T_C = 0^\circ C$ |      | $T_C = +25^\circ C$ |      | $T_C = +85^\circ C$ |      | Units | Conditions           |
|------------------------|---|-------------------|------|---------------------|------|---------------------|------|-------|----------------------|
|                        |   | Min               | Max  | Min                 | Max  | Min                 | Max  |       |                      |
| $f_{max}$              | Toggle Frequency  | 600               |      | 600                 |      | 600                 |      | MHz   | Figure 1             |
| $t_{PLH}$<br>$t_{PHL}$ | Propagation Delay<br>$C_n$ to Output                                  | 0.70              | 2.20 | 0.70                | 2.00 | 0.70                | 2.20 | ns    | Figures 2 and 3      |
| $t_{PLH}$<br>$t_{PHL}$ | Propagation Delay<br>$C_n$ , $S_n$ to Output                          | 0.90              | 1.80 | 0.90                | 2.00 | 0.90                | 2.40 | ns    | $CP_n = L, CP_n = H$ |
| $t_{TLH}$<br>$t_{THL}$ | Transition Time<br>20% to 80%, 80% to 20%                             | 0.30              | 1.40 | 0.30                | 1.40 | 0.30                | 1.40 | ns    | Figures 2 and 3      |
| $t_S$                  | Setup Time<br>$J_n$ , $K_n$ to $CP_n$<br>$C_n$ , $S_n$ (Release Time) | 0.90<br>1.50      |      | 0.70<br>1.30        |      | 0.90<br>1.50        |      | ns    |                      |
| $t_H$                  | Hold Time<br>$J_n$ , $K_n$ to $CP_n$                                  | 0.80              |      | 0.80                |      | 0.80                |      | ns    |                      |
| $t_{pw(H)}$            | Pulse Width HIGH<br>$CP_n$ , $C_n$ , $S_n$                            | 2.00              |      | 2.00                |      | 2.00                |      | ns    |                      |

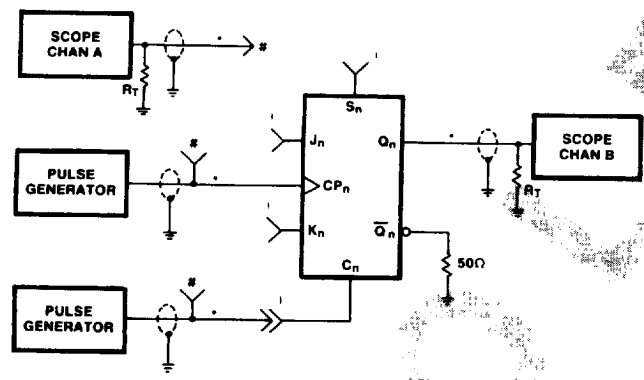
**Cerpak AC Characteristics**
 $V_{EE} = -4.2V$  to  $-4.8V$ ,  $V_{CC} = V_{CCA} = GND$ 

| Symbol                 | Parameter   | $T_C = 0^\circ C$ |      | $T_C = +25^\circ C$ |      | $T_C = +85^\circ C$ |      | Units | Conditions           |
|------------------------|---|-------------------|------|---------------------|------|---------------------|------|-------|----------------------|
|                        |   | Min               | Max  | Min                 | Max  | Min                 | Max  |       |                      |
| $f_{max}$              | Toggle Frequency  | 650               |      | 650                 |      | 650                 |      | MHz   | Figure 1             |
| $t_{PLH}$<br>$t_{PHL}$ | Propagation Delay<br>$CP_n$ to Output                                 | 0.70              | 2.00 | 0.70                | 1.80 | 0.70                | 2.00 | ns    | Figures 2 and 3      |
| $t_{PLH}$<br>$t_{PHL}$ | Propagation Delay<br>$C_n$ , $S_n$ to Output                          | 0.90              | 1.60 | 0.90                | 1.80 | 0.90                | 2.20 | ns    | $CP_n = L, CP_n = H$ |
| $t_{TLH}$<br>$t_{THL}$ | Transition Time<br>20% to 80%, 80% to 20%                             | 0.30              | 1.30 | 0.30                | 1.30 | 0.30                | 1.30 | ns    | Figures 2 and 3      |
| $t_S$                  | Setup Time<br>$J_n$ , $K_n$ to $CP_n$<br>$C_n$ , $S_n$ (Release Time) | 0.80<br>1.40      |      | 0.60<br>1.20        |      | 0.80<br>1.40        |      | ns    |                      |
| $t_H$                  | Hold Time<br>$J_n$ , $K_n$ to $CP_n$                                  | 0.70              |      | 0.70                |      | 0.70                |      | ns    |                      |
| $t_{pw(H)}$            | Pulse Width HIGH<br>$CP_n$ , $C_n$ , $S_n$                            | 2.00              |      | 2.00                |      | 2.00                |      | ns    |                      |



TL/F/9854-6  
**FIGURE 1. Toggle Frequency Test Circuit**

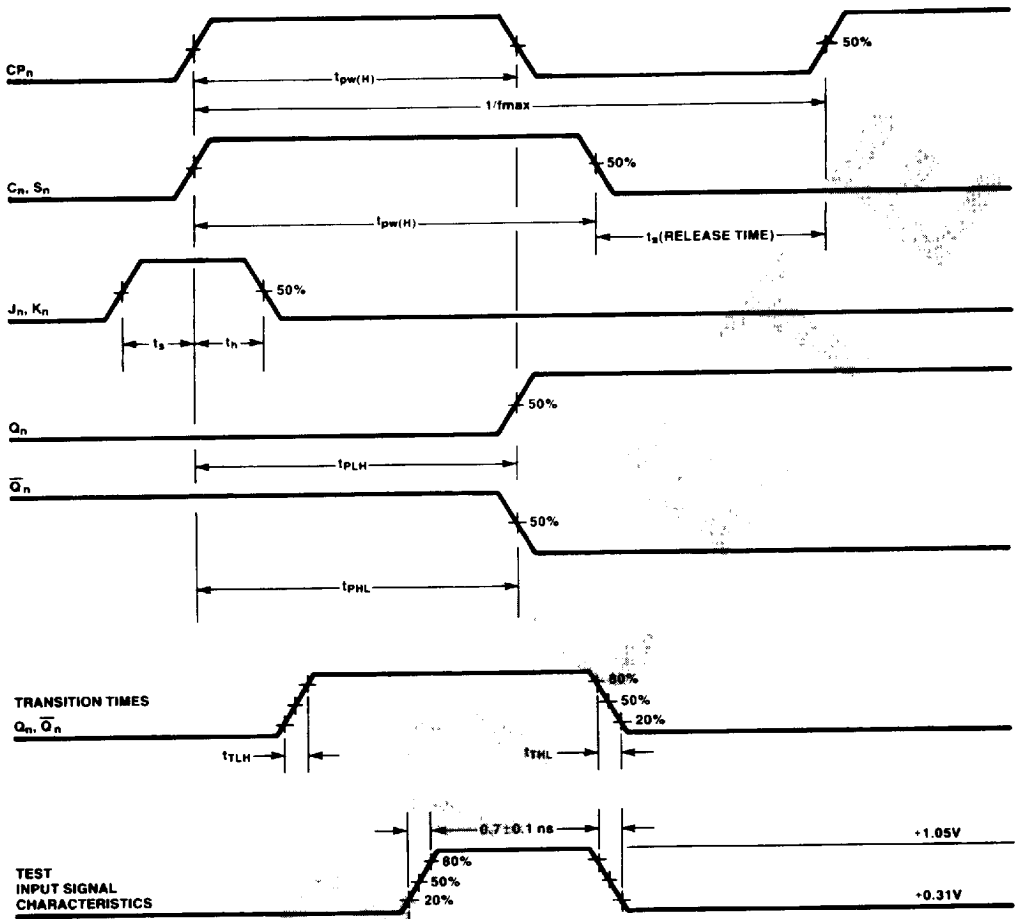
**Notes:**  
 $V_{CC} = V_{CCA} = +2V$   
 $V_{EE} = -2.5V$   
 \* = equal electrical length 50Ω lines  
 $R_T = 50\Omega$  termination  
 Decouple power supplies with 0.1 μF from  $V_{CC}$  and  $V_{EE}$  to GND  
 $C_L$  = Fixture and stray capacitance ≤ 3 pF  
 Load all unused outputs with 50Ω to GND  
 Set pulse generator output level for 740 mV p-p at a frequency of 10 MHz as measured at the clock input pin of the device under test. Do not readjust this voltage for frequencies up to  $f_{max}$ . The pad isolates the generator output for D.U.T input impedance variations. Signal voltage measured at the D.U.T. input will vary as input impedance varies with frequency



TL/F/9854-7  
**FIGURE 2. AC Test Circuit**

**Notes:**  
 $V_{CC} = V_{CCA} = +2V$   
 $V_{EE} = -2.5V$   
 Decouple power supplies with 0.1 μF from  $V_{CC}$  and  $V_{EE}$  to GND  
 $R_T = 50\Omega$  termination  
 Load all unused outputs with 50Ω to GND  
 $C_L$  = Fixture and stray capacitance ≤ 3 pF  
 \* = equal electrical length 50Ω lines  
 # = Connect Scope CHAN A to pulse generator as required  
 † = Connect pulse generator to input under test; else connect input to voltage source set to +1.05 volts for logic HIGH or +0.31 volts for logic LOW  
 Consult truth table for appropriate logical condition

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FIGURE 3. Propagation Delays and Setup and Hold Time