

3.3V ECL Phase-Frequency Detector

MC100EP140

Description

The MC100EP140 is a three state phase frequency–detector intended for phase–locked loop applications which require a minimum amount of phase and frequency difference at lock. Since the part is designed with fully differential internal gates, the noise is reduced throughout the circuit, especially at high speeds. The basic operation of a Phase/Frequency Detector (PFD) is to “compare” an incoming signal (feedback) to a set reference signal. When the Reference (R) and Feedback (FB) 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. Detector states of operation are shown in the Figure 2 and the State Table.

The typical output amplitude of the EP140 is 400 mV, allowing faster switching time and greater bandwidth. For proper operation, the input edge rate of the R and FB inputs should be less than 5 ns.

More information on Phase Lock Loop operation and application can be found in AND8040.

The pinout is shown in Figure 1, the logic diagram in Figure 3, and the typical termination in Figure 5.

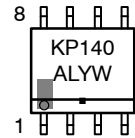
Features

- 500 ps Typical Propagation Delay
- Maximum Frequency > 2.1 GHz Typical
- Fully Differential Internally
- Advanced High Band Output Swing of 400 mV
- Transfer Gain: 1.0 mV/Degree at 1.4 GHz
1.2 mV/Degree at 1.0 GHz
- Rise and Fall Time: 100 ps Typical
- The 100 Series Contains Temperature Compensation
- PECL Mode Operating Range: $V_{CC} = 3.0\text{ V to }3.6\text{ V}$
with $V_{EE} = 0\text{ V}$
- NECL Mode Operating Range: $V_{CC} = 0\text{ V}$
with $V_{EE} = -3.0\text{ V to }-3.6\text{ V}$
- Open Input Default State
- These are Pb–Free Devices



SOIC–8
D SUFFIX
CASE 751

MARKING DIAGRAM



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

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 5 of this data sheet.

MC100EP140

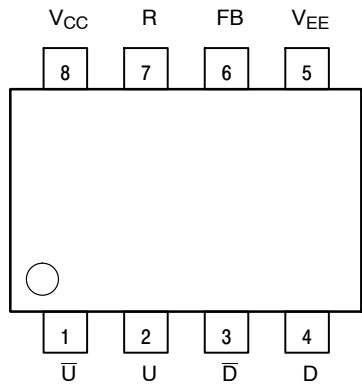


Figure 1. 8-Lead Pinout (Top View)

Table 1. PIN DESCRIPTION

| PIN | FUNCTION |
|-----------------|---------------------------|
| D, \bar{D} | Differential Down Outputs |
| U, \bar{U} | Differential Up Outputs |
| R* | ECL Reference Input |
| FB* | ECL Feedback Input |
| V _{CC} | Positive Supply |
| V _{EE} | Negative Supply |

* Pins will default LOW when left open.

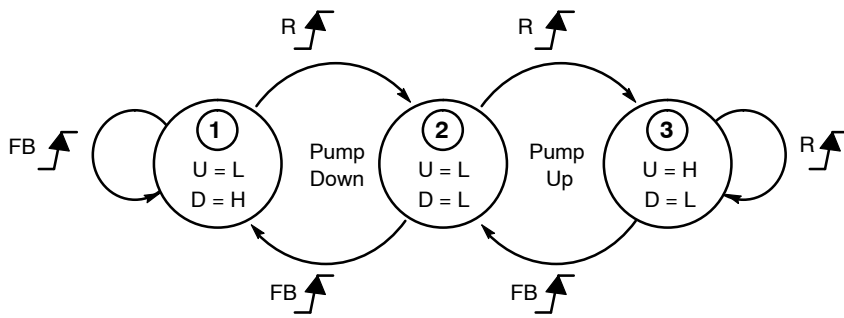


Figure 2. Phase Detector Logic Model

Table 2. STATE TABLE

| PHASE DETECTOR STATE | INPUT | | OUTPUT | |
|----------------------|-------|-----|--------|-----|
| | R | FB | U | D |
| PUMP DOWN 2-1-2 | 2 | L L | L L | L L |
| | 2-1 | L H | L H | L H |
| | 1-2 | H L | L L | L L |
| | 2 | L L | L L | L L |
| PUMP UP 2-3-2 | 2 | L L | L L | L L |
| | 2-3 | H L | H L | L L |
| | 3-2 | H H | L L | L L |
| | 2 | L L | L L | L L |

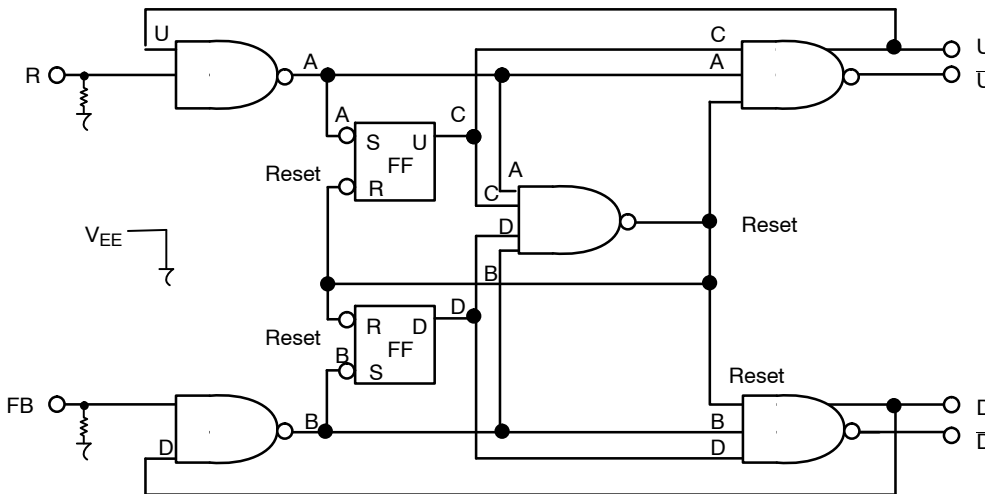


Figure 3. Logic Diagram

MC100EP140

Table 3. ATTRIBUTES

| Characteristics | | Value | |
|---|---|-----------------------------|-------------|
| Internal Input Pulldown Resistor | | 75 kΩ | |
| Internal Input Pullup Resistor | | 37.5 kΩ | |
| ESD Protection | Human Body Model Machine Model Charged Device Model | > 2 kV > 200 V > 2 kV | |
| Moisture Sensitivity, Indefinite Time Out of Drypack (Note 1) | | Pb Pkg | Pb-Free Pkg |
| SOIC-8 | | Level 1 | Level 1 |
| Flammability Rating | Oxygen Index: 28 to 34 | UL 94 V-0 @ 0.125 in | |
| Transistor Count | | 457 Devices | |
| Meets or exceeds JEDEC Spec EIA/JESD78 IC Latchup Test | | | |

1. For additional information, see Application Note AND8003/D.

Table 4. MAXIMUM RATINGS

| Symbol | Parameter | Condition 1 | Condition 2 | Rating | Unit |
|------------------|--|--|--|-------------|--------------|
| V _{CC} | PECL Mode Power Supply | V _{EE} = 0 V | | 6 | V |
| V _{EE} | NECL Mode Power Supply | V _{CC} = 0 V | | -6 | V |
| V _I | PECL Mode Input Voltage NECL Mode Input Voltage | V _{EE} = 0 V V _{CC} = 0 V | V _I ≤ V _{CC} V _I ≥ V _{EE} | 6 -6 | V V |
| I _{out} | Output Current | Continuous Surge | | 50 100 | mA mA |
| T _A | Operating Temperature Range | | | -40 to +85 | °C |
| T _{stg} | Storage Temperature Range | | | -65 to +150 | °C |
| θ _{JA} | Thermal Resistance (Junction-to-Ambient) | 0 lfpm 500 lfpm | SOIC-8 SOIC-8 | 190 130 | °C/W °C/W |
| θ _{JC} | Thermal Resistance (Junction-to-Case) | Standard Board | SOIC-8 | 41 to 44 | °C/W |
| T _{sol} | Wave Solder | Pb Pb-Free | | 265 265 | °C |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

Table 5. 100EP DC CHARACTERISTICS, PECL V_{CC} = 3.3 V, V_{EE} = 0 V (Note 2)

| Symbol | Characteristic | -40°C | | | 25°C | | | 85°C | | | Unit |
|-----------------|-----------------------------------|-------|------|------|------|------|------|------|------|------|------|
| | | Min | Typ | Max | Min | Typ | Max | Min | Typ | Max | |
| I _{EE} | Power Supply Current | 45 | 65 | 85 | 50 | 70 | 90 | 53 | 73 | 93 | mA |
| V _{OH} | Output HIGH Voltage (Note 3) | 2255 | 2350 | 2475 | 2275 | 2400 | 2525 | 2300 | 2425 | 2550 | mV |
| V _{OL} | Output LOW Voltage (Note 3) | 1755 | 1900 | 2025 | 1800 | 1925 | 2050 | 1825 | 1950 | 2075 | mV |
| V _{IH} | Input HIGH Voltage (Single-Ended) | 2075 | | 2420 | 2075 | | 2420 | 2075 | | 2420 | mV |
| V _{IL} | Input LOW Voltage (Single-Ended) | 1355 | | 1675 | 1355 | | 1675 | 1355 | | 1675 | mV |
| I _{IH} | Input HIGH Current | | | 150 | | | 150 | | | 150 | μA |
| I _{IL} | Input LOW Current | 0.5 | | | 0.5 | | | 0.5 | | | 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.

- Input and output parameters vary 1:1 with V_{CC}. V_{EE} can vary +0.3 V to -0.3 V.
- All loading with 50 Ω to V_{CC} - 2.0 V.

MC100EP140

Table 6. 100EP DC CHARACTERISTICS, NECL $V_{CC} = 0\text{ V}$, $V_{EE} = -3.6\text{ V to }-3.0\text{ V}$ (Note 4)

| Symbol | Characteristic | -40°C | | | 25°C | | | 85°C | | | Unit |
|----------|-----------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|---------------|
| | | Min | Typ | Max | Min | Typ | Max | Min | Typ | Max | |
| I_{EE} | Power Supply Current | 45 | 65 | 85 | 50 | 70 | 90 | 53 | 73 | 93 | mA |
| V_{OH} | Output HIGH Voltage (Note 5) | -1075 | -950 | -825 | -1025 | -900 | -775 | -1000 | -875 | -750 | mV |
| V_{OL} | Output LOW Voltage (Note 5) | -1525 | -1400 | -1275 | -1500 | -1375 | -1250 | -1475 | -1350 | -1225 | mV |
| V_{IH} | Input HIGH Voltage (Single-Ended) | -1225 | | -880 | -1225 | | -880 | -1225 | | -880 | mV |
| V_{IL} | Input LOW Voltage (Single-Ended) | -1945 | | -1625 | -1945 | | -1625 | -1945 | | -1625 | mV |
| I_{IH} | Input HIGH Current | | | 150 | | | 150 | | | 150 | μA |
| I_{IL} | Input LOW Current | 0.5 | | | 0.5 | | | 0.5 | | | 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 lpm.

4. Input and output parameters vary 1:1 with V_{CC} .
 5. All loading with $50\ \Omega$ to $V_{CC} - 2.0\text{ V}$.

Table 7. AC CHARACTERISTICS $V_{CC} = 0\text{ V}$; $V_{EE} = -3.0\text{ V to }-3.6\text{ V}$ or $V_{CC} = 3.0\text{ V to }3.6\text{ V}$; $V_{EE} = 0\text{ V}$ (Note 6)

| Symbol | Characteristic | -40°C | | | 25°C | | | 85°C | | | Unit | |
|--------------------------|--|--------------|------------|------------|------------|------------|------------|------------|------------|------------|------|----|
| | | Min | Typ | Max | Min | Typ | Max | Min | Typ | Max | | |
| f_{max} | Maximum Frequency (Figure 4) | | > 2 | | | > 2 | | | > 2 | | GHz | |
| t_{PLH} , t_{PHL} | Propagation Delay to Output Differential R to U, FB to D FB to U, R to D | 300 400 | 450 600 | 600 800 | 325 450 | 475 650 | 625 850 | 350 500 | 500 700 | 650 900 | ps | |
| t_{JITTER} | Cycle-to-Cycle Jitter (Figure 4) | | .2 | < 1 | | .2 | < 1 | | .2 | < 1 | ps | |
| V_{PP} | Input Voltage Swing | 400 | 800 | 1200 | 400 | 800 | 1200 | 400 | 800 | 1200 | mV | |
| t_r , t_f | Output Rise/Fall Times (20% - 80%) | Q, \bar{Q} | 50 | 90 | 180 | 60 | 100 | 200 | 70 | 120 | 220 | 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 lpm.

6. Measured using a 750 mV V_{PP} pk-pk, 50% duty cycle, clock source. All loading with $50\ \Omega$ to $V_{CC} - 2.0\text{ V}$.

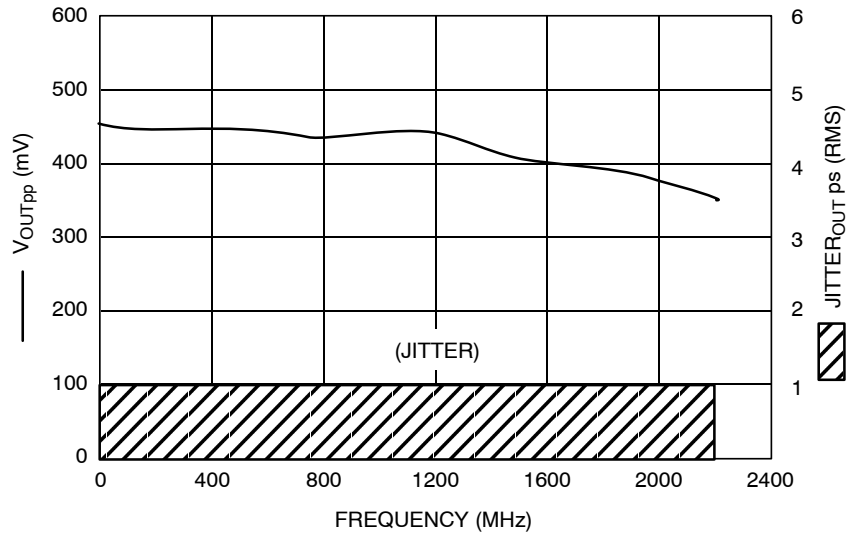
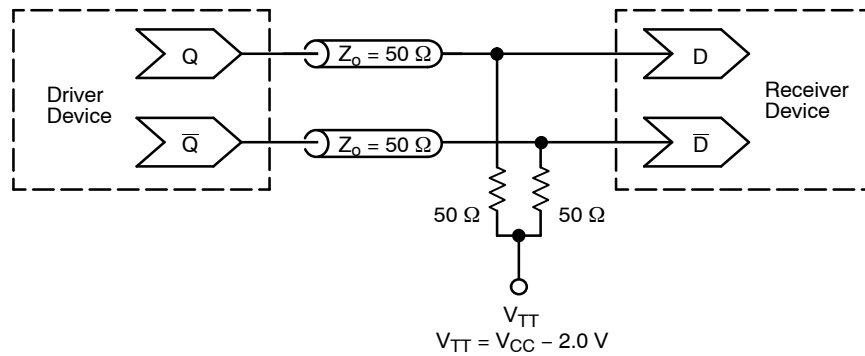


Figure 4. F_{max} /Jitter

MC100EP140



**Figure 5. Typical Termination for Output Driver and Device Evaluation
(See Application Note AND8020/D – Termination of ECL Logic Devices.)**

ORDERING INFORMATION

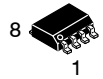
| Device | Package | Shipping [†] |
|----------------|---------------------|-----------------------|
| MC100EP140DG | SOIC-8 (Pb-Free) | 98 Units / Rail |
| MC100EP140DR2G | SOIC-8 (Pb-Free) | 2500 / Tape & Reel |

[†]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.

Resource Reference of Application Notes

- AN1405/D** – ECL Clock Distribution Techniques
- AN1406/D** – Designing with PECL (ECL at +5.0 V)
- AN1503/D** – ECLinPS™ I/O SPICE Modeling Kit
- AN1504/D** – Metastability and the ECLinPS Family
- AN1568/D** – Interfacing Between LVDS and ECL
- AN1672/D** – The ECL Translator Guide
- AND8001/D** – Odd Number Counters Design
- AND8002/D** – Marking and Date Codes
- AND8020/D** – Termination of ECL Logic Devices
- AND8066/D** – Interfacing with ECLinPS
- AND8090/D** – AC Characteristics of ECL Devices

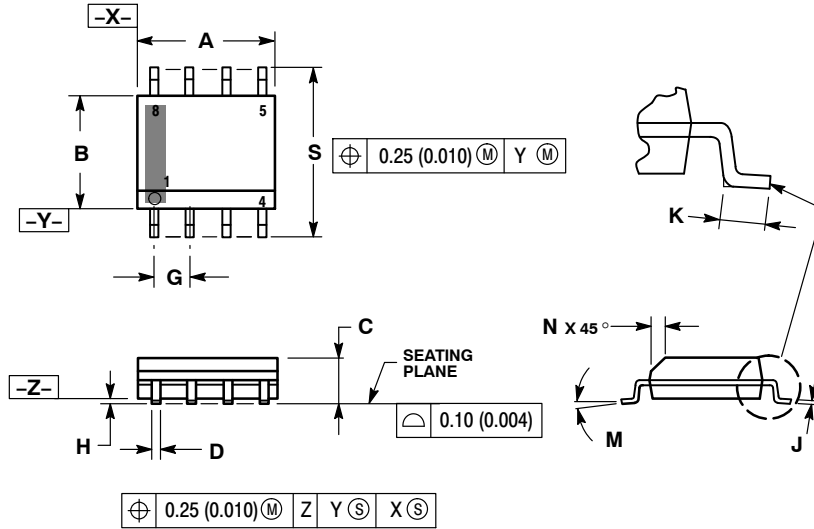
MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS



SCALE 1:1

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CASE 751-07
ISSUE AK

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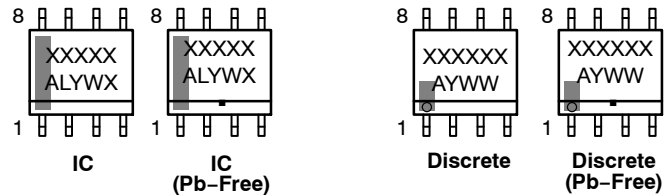
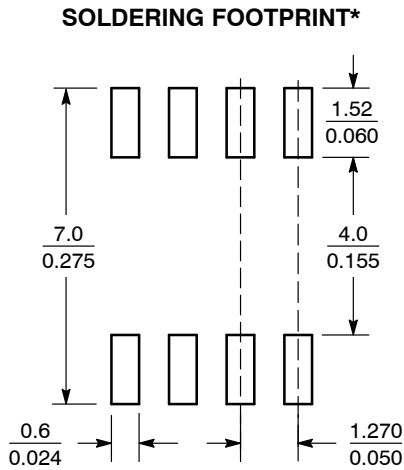


NOTES:

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 |

GENERIC MARKING DIAGRAM*



XXXXXX = Specific Device Code
A = Assembly Location
L = Wafer Lot
Y = Year
W = Work Week
▪ = Pb-Free Package

XXXXXX = Specific Device Code
A = Assembly Location
Y = Year
WW = Work Week
▪ = Pb-Free Package

*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present. Some products may not follow the Generic Marking.

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

STYLES ON PAGE 2

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- | | | | |
|--|---|---|---|
| <p>STYLE 1: PIN 1. EMITTER 2. COLLECTOR 3. COLLECTOR 4. EMITTER 5. EMITTER 6. BASE 7. BASE 8. EMITTER</p> | <p>STYLE 2: PIN 1. COLLECTOR, DIE, #1 2. COLLECTOR, #1 3. COLLECTOR, #2 4. COLLECTOR, #2 5. BASE, #2 6. EMITTER, #2 7. BASE, #1 8. EMITTER, #1</p> | <p>STYLE 3: PIN 1. DRAIN, DIE #1 2. DRAIN, #1 3. DRAIN, #2 4. DRAIN, #2 5. GATE, #2 6. SOURCE, #2 7. GATE, #1 8. SOURCE, #1</p> | <p>STYLE 4: PIN 1. ANODE 2. ANODE 3. ANODE 4. ANODE 5. ANODE 6. ANODE 7. ANODE 8. COMMON CATHODE</p> |
| <p>STYLE 5: PIN 1. DRAIN 2. DRAIN 3. DRAIN 4. DRAIN 5. GATE 6. GATE 7. SOURCE 8. SOURCE</p> | <p>STYLE 6: PIN 1. SOURCE 2. DRAIN 3. DRAIN 4. SOURCE 5. SOURCE 6. GATE 7. GATE 8. SOURCE</p> | <p>STYLE 7: PIN 1. INPUT 2. EXTERNAL BYPASS 3. THIRD STAGE SOURCE 4. GROUND 5. DRAIN 6. GATE 3 7. SECOND STAGE Vd 8. FIRST STAGE Vd</p> | <p>STYLE 8: PIN 1. COLLECTOR, DIE #1 2. BASE, #1 3. BASE, #2 4. COLLECTOR, #2 5. COLLECTOR, #2 6. EMITTER, #2 7. EMITTER, #1 8. COLLECTOR, #1</p> |
| <p>STYLE 9: PIN 1. EMITTER, COMMON 2. COLLECTOR, DIE #1 3. COLLECTOR, DIE #2 4. EMITTER, COMMON 5. EMITTER, COMMON 6. BASE, DIE #2 7. BASE, DIE #1 8. EMITTER, COMMON</p> | <p>STYLE 10: PIN 1. GROUND 2. BIAS 1 3. OUTPUT 4. GROUND 5. GROUND 6. BIAS 2 7. INPUT 8. GROUND</p> | <p>STYLE 11: PIN 1. SOURCE 1 2. GATE 1 3. SOURCE 2 4. GATE 2 5. DRAIN 2 6. DRAIN 2 7. DRAIN 1 8. DRAIN 1</p> | <p>STYLE 12: PIN 1. SOURCE 2. SOURCE 3. SOURCE 4. GATE 5. DRAIN 6. DRAIN 7. DRAIN 8. DRAIN</p> |
| <p>STYLE 13: PIN 1. N.C. 2. SOURCE 3. SOURCE 4. GATE 5. DRAIN 6. DRAIN 7. DRAIN 8. DRAIN</p> | <p>STYLE 14: PIN 1. N-SOURCE 2. N-GATE 3. P-SOURCE 4. P-GATE 5. P-DRAIN 6. P-DRAIN 7. N-DRAIN 8. N-DRAIN</p> | <p>STYLE 15: PIN 1. ANODE 1 2. ANODE 1 3. ANODE 1 4. ANODE 1 5. CATHODE, COMMON 6. CATHODE, COMMON 7. CATHODE, COMMON 8. CATHODE, COMMON</p> | <p>STYLE 16: PIN 1. EMITTER, DIE #1 2. BASE, DIE #1 3. EMITTER, DIE #2 4. BASE, DIE #2 5. COLLECTOR, DIE #2 6. COLLECTOR, DIE #2 7. COLLECTOR, DIE #1 8. COLLECTOR, DIE #1</p> |
| <p>STYLE 17: PIN 1. VCC 2. V2OUT 3. V1OUT 4. TXE 5. RXE 6. VEE 7. GND 8. ACC</p> | <p>STYLE 18: PIN 1. ANODE 2. ANODE 3. SOURCE 4. GATE 5. DRAIN 6. DRAIN 7. CATHODE 8. CATHODE</p> | <p>STYLE 19: PIN 1. SOURCE 1 2. GATE 1 3. SOURCE 2 4. GATE 2 5. DRAIN 2 6. MIRROR 2 7. DRAIN 1 8. MIRROR 1</p> | <p>STYLE 20: PIN 1. SOURCE (N) 2. GATE (N) 3. SOURCE (P) 4. GATE (P) 5. DRAIN 6. DRAIN 7. DRAIN 8. DRAIN</p> |
| <p>STYLE 21: PIN 1. CATHODE 1 2. CATHODE 2 3. CATHODE 3 4. CATHODE 4 5. CATHODE 5 6. COMMON ANODE 7. COMMON ANODE 8. CATHODE 6</p> | <p>STYLE 22: PIN 1. I/O LINE 1 2. COMMON CATHODE/VCC 3. COMMON CATHODE/VCC 4. I/O LINE 3 5. COMMON ANODE/GND 6. I/O LINE 4 7. I/O LINE 5 8. COMMON ANODE/GND</p> | <p>STYLE 23: PIN 1. LINE 1 IN 2. COMMON ANODE/GND 3. COMMON ANODE/GND 4. LINE 2 IN 5. LINE 2 OUT 6. COMMON ANODE/GND 7. COMMON ANODE/GND 8. LINE 1 OUT</p> | <p>STYLE 24: PIN 1. BASE 2. EMITTER 3. COLLECTOR/ANODE 4. COLLECTOR/ANODE 5. CATHODE 6. CATHODE 7. COLLECTOR/ANODE 8. COLLECTOR/ANODE</p> |
| <p>STYLE 25: PIN 1. VIN 2. N/C 3. REXT 4. GND 5. IOUT 6. IOUT 7. IOUT 8. IOUT</p> | <p>STYLE 26: PIN 1. GND 2. dv/dt 3. ENABLE 4. ILIMIT 5. SOURCE 6. SOURCE 7. SOURCE 8. VCC</p> | <p>STYLE 27: PIN 1. ILIMIT 2. OVLO 3. UVLO 4. INPUT+ 5. SOURCE 6. SOURCE 7. SOURCE 8. DRAIN</p> | <p>STYLE 28: PIN 1. SW_TO_GND 2. DASIC_OFF 3. DASIC_SW_DET 4. GND 5. V_MON 6. VBULK 7. VBULK 8. VIN</p> |
| <p>STYLE 29: PIN 1. BASE, DIE #1 2. EMITTER, #1 3. BASE, #2 4. EMITTER, #2 5. COLLECTOR, #2 6. COLLECTOR, #2 7. COLLECTOR, #1 8. COLLECTOR, #1</p> | <p>STYLE 30: PIN 1. DRAIN 1 2. DRAIN 1 3. GATE 2 4. SOURCE 2 5. SOURCE 1/DRAIN 2 6. SOURCE 1/DRAIN 2 7. SOURCE 1/DRAIN 2 8. GATE 1</p> | | |

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