

Fast, High Voltage Comparator with Master Slave Flip-Flop

élantec

The EL2019 offers a new feature previously unavailable in a comparator before—a master/slave edge triggered

flip-flop. The comparator output will only change output state after a positive going clock edge is applied. Thus the output can't feed back to the input and cause oscillation.

Manufactured with Elantec's proprietary Complementary Bipolar process, this device uses fast PNP and NPN transistors in the signal path. A unique circuit design gives the inputs the ability to handle large common mode and differential mode signals, yet retain high speed and excellent accuracy. Careful design of the front end insures speed and accuracy when operating with a mix of small and large signals. The three-state output stage is designed to be TTL compatible for any power supply combination, yet it draws a constant current and does not generate current glitches.

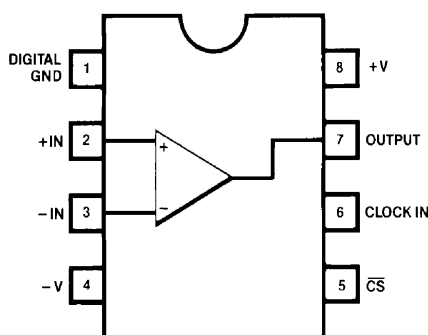
When the output is disabled, the supply current consumption drops by 50%, but the input stage and master slave flip-flop remain active.

Ordering Information

| PART NUMBER | TEMP. RANGE | PACKAGE | PKG. NO. |
|-------------|----------------|------------|----------|
| EL2019CN | -40°C to +85°C | 8-Pin PDIP | MDP0006 |

Pinout

**EL2019
(8-PIN PDIP)
TOP VIEW**



Features

- Comparator cannot oscillate
- Fast response—5ns data to clock setup, 20ns clock to output
- Wide input differential voltage range—24V on $\pm 15V$ supplies
- Wide input common mode voltage range— $\pm 12V$
- Precision input stage— $V_{OS} = 1.5mV$
- Low input bias current—100nA
- Low input offset current—30nA
- $\pm 4.5V$ to $\pm 18V$ supplies
- Three-State TTL compatible output
- No supply current glitch during switching
- 103dB voltage gain (Low input uncertainty $\approx 30\mu V$)
- 50% power reduction in shut-down mode
- Input and flip-flop remain active in shutdown mode

Applications

- Analog to digital converters
- ATE pin receiver
- Zero crossing detector
- Window detector
- "Go/no-go" detector

Absolute Maximum Ratings ($T_A = 25^\circ\text{C}$)

| | | |
|-----------|--------------------------------|--------------------------------|
| V_S | Supply Voltage | $\pm 18\text{V}$ |
| V_{IN} | Input Voltage $+V_S$ to $-V_S$ | |
| V_{IN} | Differential Input Voltage | Limited only by Power Supplies |
| I_{IN} | Input Current (Pins 1, 2 or 3) | $\pm 10\text{mA}$ |
| I_{INS} | Input Current (Pins 5 or 6) | $\pm 5\text{mA}$ |
| P_D | Maximum Power Dissipation | 1.25W |

| | | |
|----------|--------------------------------|---|
| I_{OP} | Peak Output Current | 50mA |
| I_O | Continuous Output Current | 25mA |
| T_A | Operating Temperature Range | -40°C to $+85^\circ\text{C}$ |
| T_J | Operating Junction Temperature | 150°C |
| T_{ST} | Storage Temperature | -65°C to $+150^\circ\text{C}$ |

The maximum power dissipation depends on package type, ambient temperature and heat sinking. See the Typical Performance curves for more details.

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

IMPORTANT NOTE: All parameters having Min/Max specifications are guaranteed. Typical values are for information purposes only. Unless otherwise noted, all tests are at the specified temperature and are pulsed tests, therefore: $T_J = T_C = T_A$

DC Electrical Specifications $V_S = \pm 15\text{V}$, unless otherwise specified

| PARAMETER | DESCRIPTION | TEMP | LIMITS | | | UNITS |
|-------------|--|-----------------------|----------|-----------|-----------|--------------------------|
| | | | MIN | TYP | MAX | |
| V_{OS} | Input Offset Voltage $V_{CM} = 0\text{V}$, V_O Transition Point | 25°C | | 1.5 | 6 | mV |
| | | T_{MIN} , T_{MAX} | | | 8 | mV |
| I_B | Input Bias Current $V_{CM} = 0\text{V}$, Pin 2 or 3 | 25°C | | ± 100 | ± 400 | nA |
| | | T_{MIN} , T_{MAX} | | | ± 600 | nA |
| I_{OS} | Input Offset Current $V_{CM} = 0\text{V}$ | 25°C | | 30 | 150 | nA |
| | | T_{MIN} , T_{MAX} | | | 250 | nA |
| CMRR | Common Mode Rejection Ratio (Note 1) | 25°C | 75 | 90 | | dB |
| PSRR | Power Supply Rejection Ratio (Note 2) | 25°C | 75 | 95 | | dB |
| V_{CM} | Common Mode Input Range | 25°C | ± 12 | ± 13 | | V |
| | | T_{MIN} , T_{MAX} | ± 12 | | | V |
| V_{UNCER} | Input Uncertainty Range | | | 30 | | $\mu\text{V}/\text{RMS}$ |
| V_{OL} | Output Voltage Logic Low $I_{OL} = 8\text{mA}$ and $I_{OL} = 0\text{mA}$ | 25°C | -0.05 | 0.15 | 0.4 | V |
| | | T_{MIN} , T_{MAX} | -0.1 | | 0.4 | V |
| V_{OH} | Output Voltage Logic High $V_S = \pm 15\text{V}$ $V_S = \pm 15\text{V}$ $V_S = \pm 5\text{V}$ $V_S = \pm 5\text{V}$ $V_S = \pm 5\text{V}$ | | | | | |
| | | 25°C | 3.5 | 4.0 | 4.65 | V |
| | | T_{MIN} , T_{MAX} | 3.5 | | 4.65 | V |
| | | 25°C | 2.4 | | | V |
| | | T_{MIN} | 2.4 | | | V |
| | | T_{MAX} | 2.4 | | | V |
| V_{ODIS1} | V_{OUT} Range, Disabled, $I_{OL} = -1\text{mA}$ $V_S = \pm 15\text{V}$ $V_S = \pm 15\text{V}$ $V_S = \pm 5\text{V}$ | | | | | |
| | | 25°C | 4.65 | | | V |
| | | T_{MIN} , T_{MAX} | 4.65 | | | V |
| V_{ODIS2} | V_{OUT} Range, Disabled, $I_{OL} = +1\text{mA}$ $V_S = \pm 5\text{V}$ to $+15\text{V}$ | 25°C | | 3.65 | | V |
| | | All | -0.3 | -1 | | V |

DC Electrical Specifications $V_S = \pm 15V$, unless otherwise specified (Continued)

| PARAMETER | DESCRIPTION | TEMP | LIMITS | | | UNITS |
|-------------|---|--------------------|--------|------|------|-------|
| | | | MIN | TYP | MAX | |
| V_{INH} | Clock or \overline{CS} Inputs Logic High Input Voltage | 25°C | 2 | | | V |
| | | T_{MIN}, T_{MAX} | 2 | | | V |
| I_{IN} | Clock or \overline{CS} Inputs Logic Input Current $V_{IN} = 0V$ and $V_{IN} = 5V$ | 25°C | | | ±200 | µA |
| | | T_{MIN}, T_{MAX} | ±300 | | ±300 | µA |
| V_{INL} | Clock or \overline{CS} Inputs Logic Low Input Voltage | 25°C | | | 0.8 | V |
| | | T_{MIN}, T_{MAX} | | | 0.8 | V |
| I_{S+EN} | Positive Supply Current Enabled | 25°C | | 8.8 | 13 | mA |
| | | T_{MIN}, T_{MAX} | | | 14 | mA |
| I_{S+DIS} | Positive Supply Current Disabled | 25°C | | 4.9 | 6 | mA |
| | | T_{MIN}, T_{MAX} | | | 7 | mA |
| I_{S-EN} | Negative Supply Current Enabled | 25°C | | 14.5 | 17 | mA |
| | | T_{MIN}, T_{MAX} | | | 18 | mA |
| I_{S-DIS} | Negative Supply Current Disabled | 25°C | | 6.4 | 8.0 | mA |
| | | T_{MIN}, T_{MAX} | | | 8.0 | mA |

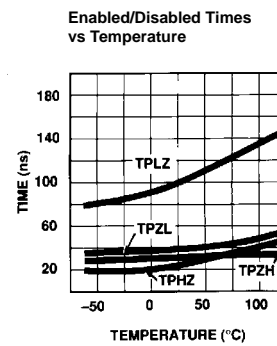
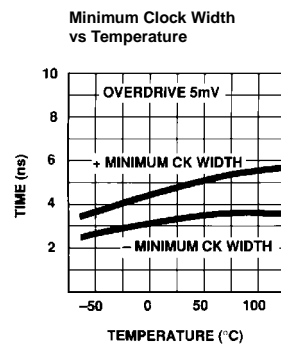
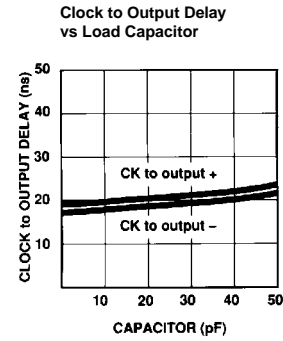
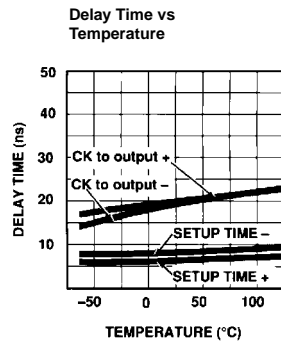
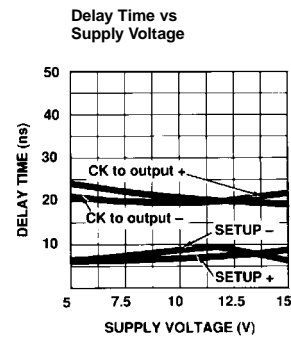
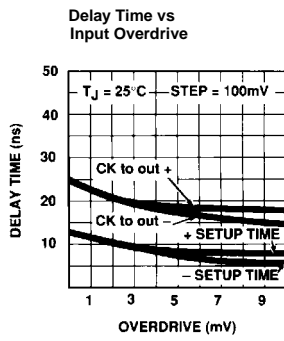
NOTES:

1. $V_{CM} = +12V$ to $-12V$
2. $V_S = \pm 5V$ to $\pm 15V$

AC Electrical Specifications $V_S = \pm 15V$, $T_A = 25^\circ C$

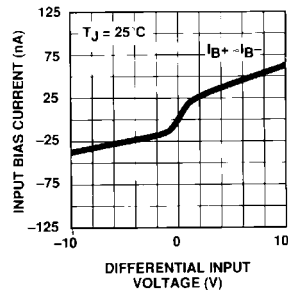
| PARAMETER | DESCRIPTION | LIMITS | | | UNITS |
|-------------|----------------------------------|--------|-----|-----|-------|
| | | MIN | TYP | MAX | |
| T_S | Setup Time 5mV Overdrive | | 12 | 20 | ns |
| T_H | Hold Time | | -3 | 0 | ns |
| T_{OPOUT} | Clock to Output Delay | | 20 | 25 | ns |
| T_{OPMIN} | Minimum Clock Width | | 7 | | ns |
| T_{EN} | Output Three-State Enable Delay | | 40 | 70 | ns |
| T_{DIS} | Output Three-State Disable Delay | | 150 | 300 | ns |

Typical AC Performance Curves

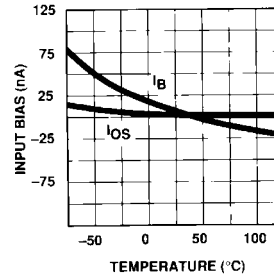


Typical AC Performance Curves (Continued)

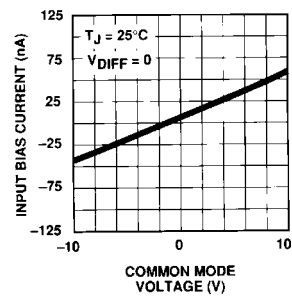
Input Bias Current vs
Differential Input Voltage



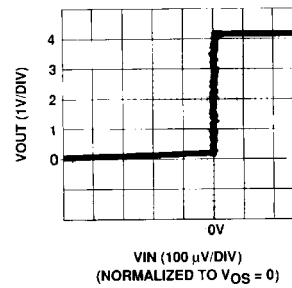
Input Bias Current
vs Temperature



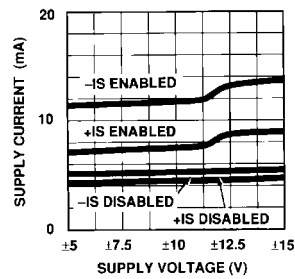
Input Bias Current vs
Common Mode Voltage



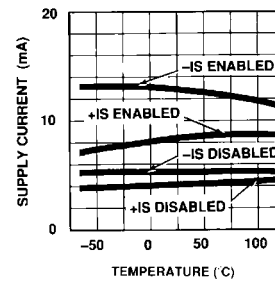
V_O/V_I Transfer Characteristics



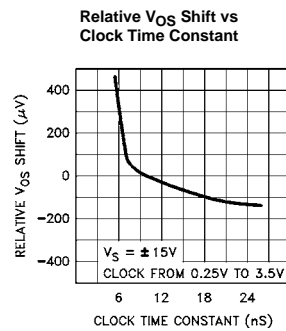
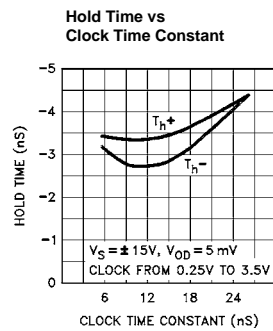
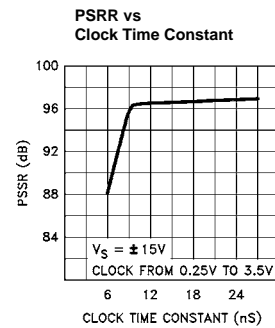
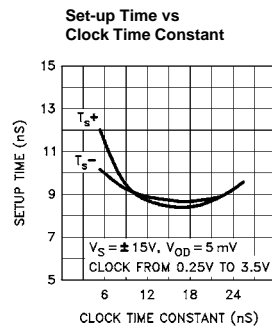
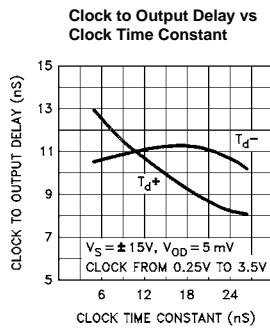
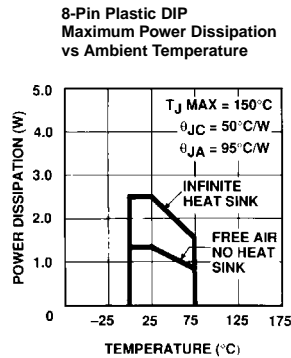
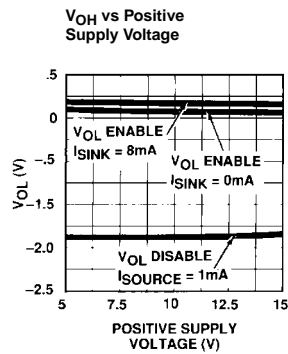
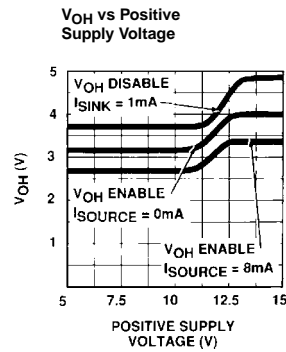
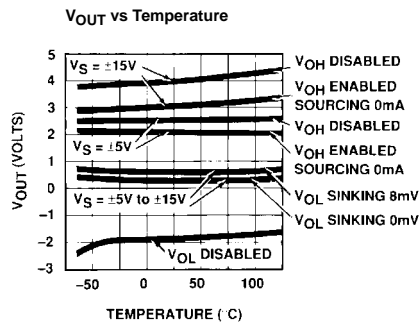
Supply Current
vs Supply Voltage



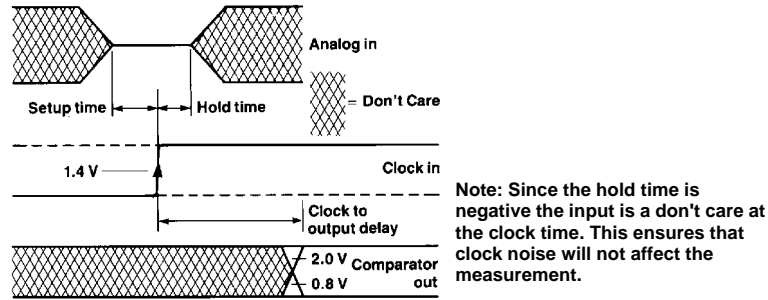
Supply Current
vs Temperature



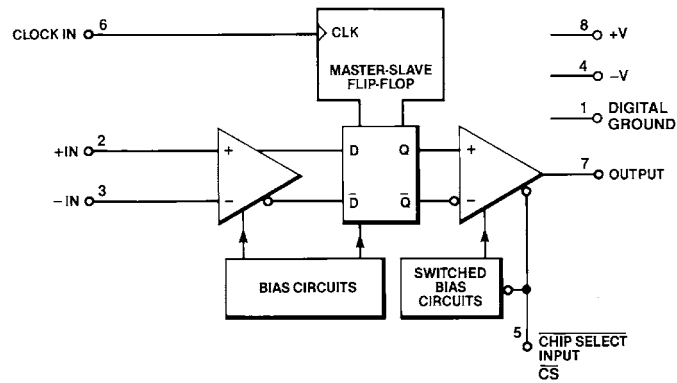
Typical AC Performance Curves (Continued)



Timing Diagram



Block Diagram



Function Table

| INPUTS (TIME N-1) | | | | INTERNAL Q (TIME N) | NOTES | OUTPUT (TIME N) |
|-------------------|-----|-----------------|-----|---------------------|--|-----------------|
| +IN | -IN | \overline{CS} | CLK | | | |
| + | - | L | | H | Normal Comparator Operation With "D" Flip-Flop | H |
| - | + | L | | L | | L |
| + | - | H | | H | Normal Comparator Operation With "D" Flip-Flop; Power Down Mode | High Z |
| - | + | H | | L | | High Z |
| X | X | L | H | Qn-1 | Data Retained in Flip-Flop | Qn-1 |
| X | X | L | L | Qn-1 | | Qn-1 |
| X | X | L | | Qn-1 | | Qn-1 |
| X | X | H | H | Qn-1 | Data Retained in Flip-Flop, Output Power Down Mode | High Z |
| X | X | H | L | Qn-1 | | High Z |
| X | X | H | | Qn-1 | | High Z |

Application Hints

Device Overview

The EL2019 is the first comparator of its kind. It is capable of 24V differential signals, yet has excellent accuracy, linearity and voltage gain. The EL2019 has an internal master/slave flip-flop between the input and output. It even has a three-state output feature that reduces the power supply currents 50% when the output is disabled, yet the input stage and

latch remain active. This extremely fast and accurate device is built with the proprietary Elantec Complementary Bipolar Process, which is immune to power sequencing and latch up problems.

Power Supplies

The EL2019 will work with $\pm 5V$ to $\pm 18V$ supplies or any combination between (Example +12V and -5V). The supplies should be well bypassed with good high frequency

capacitors (0.01 μ F monolithic ceramic recommended) within 1/4 inch of the power supply pins. Good ground plane construction techniques improve stability, and the pin from pin 1 to ground should be short.

Front End

The EL2019 uses schottky diodes to make a “bullet proof” front end with very low input bias currents, even if the two inputs are tied to very large differential voltages (± 24 V).

The large common mode range (± 12 V minimum) and differential voltage handling ability (± 24 V min.) of the device make it useful in ATE applications without the need for an input attenuator with its associated delay.

Recovery from Large Overdrives

Timing accuracy is excellent for all signals within the common mode range of the device (± 12 V with ± 15 V supply). When the common mode range is exceeded the input stage will saturate, input bias currents increase and it may take as much as 200ns for the device to recover to normal operation after the inputs are returned to the common mode range. If signals greater than the common mode range of the device are anticipated, the inputs should be diode clamped to remain within the common mode range of the device, or the supply voltage be raised to encompass the input signal in the common mode range.

Input Slew Rate

All comparators have input slew rate limitations. The EL2019 operates normally with any input slew rate up to 300V/ μ s. Input signal slew rates over 300V/ μ s induce offset voltages of 5mV to 20mV. This induced offset voltage settles out in about 20ns, 20 times faster than previous high voltage comparators. This shows up as an increased set-up time.

Master Slave Flip-Flop

The built-in Master/Slave Flip-Flop only allows the output to change when a positive edge is received on the clock input. This feature has some major benefits to the user. First, the device cannot oscillate due to feedback from the output to the inputs. Second, the device must make a decision when it receives a clock input, and the difference between deciding on a “0” or a “1” is limited only by the input circuit noise, both internal and external to the EL2019. With low impedance sources and a good layout this uncertainty can be less than 30 μ V/RMS. Since a 30 μ V change on the input can cause a 4V change on the output this works out to an effective gain of 103dB, more than adequate for a 16-bit analog to digital converter.

The hold time of the EL2019 is worst case 0ns, and typically -3ns. This means that the analog signal is sampled typically 3ns before the clock time and, worst case, concurrent with the clock.

The EL2019 is sensitive to a large clock edge rates. More than a 500V/ μ s edge rate at the clock input will induce V_{OS}

shifts, reduce PSRR, and cause the device to operate incorrectly at low temperatures and low supply voltages. A good method to control the clock edge rate is to place a resistor in series and a capacitor to ground in parallel with the clock input. Generally, any time constant 10ns or greater will suffice.

Elantec tests the EL2019 with a nominal 20ns time constant, using a series 330 Ω resistor and 61pF of capacitance to ground (including strays). All clocks are generated by Schottky TTL and have a 0.25V to 3.5V swing.

Output Stage

The output stage of the EL2019 is a pair of complementary emitter followers operating as a linear amplifier. This makes the output stage of the EL2019 glitch free, and improves accuracy and stability when operating with small signals.

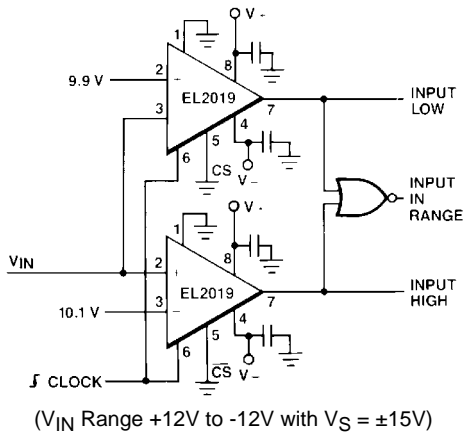
Three-State Output, Power Saving Feature

The EL2019 has an output stage which can be put into a high impedance “three-state” mode. When it is in this mode, the input stage and latch remain active, yet the device dissipates only 50% of the power used when the output is active. This has advantages in large ATE systems where there may be 1000 comparators, but only 10% are in use at any one time.

The EL2019 will work properly with the chip select input (pin 5) floating, however, good R.F. technique would be to ground this input if it is not used.

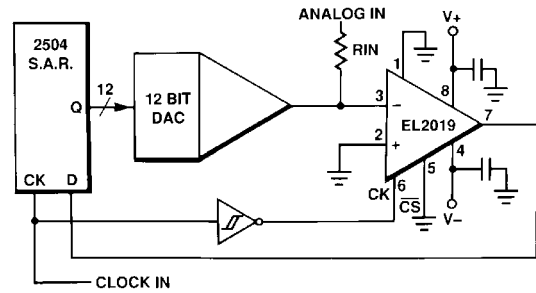
Due to the power saving feature and linear output stage, the EL2019 does not have a standard TTL three-state output stage. As such one must be careful when using the three-state feature with devices other than other EL2018's or EL2019's. When operating from ± 15 V supplies the three-state feature is compatible with all TTL families, however CMOS families may conflict on high outputs. Since the output stage of the EL2019 turns on faster than it turns off, a 50 Ω to 100 Ω resistor in series with the output will limit fault currents between devices with minimum impact on logic drive capability.

Typical Applications

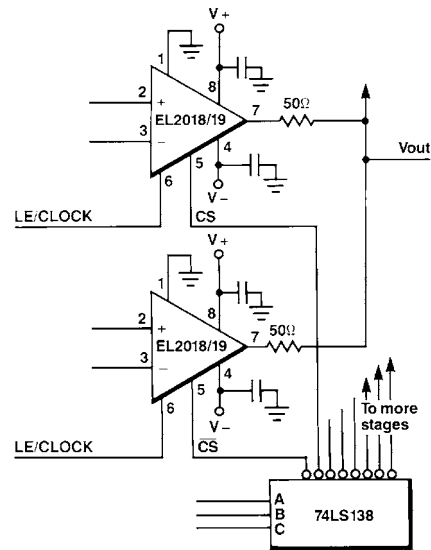


A WIDE INPUT RANGE WINDOW COMPARATOR

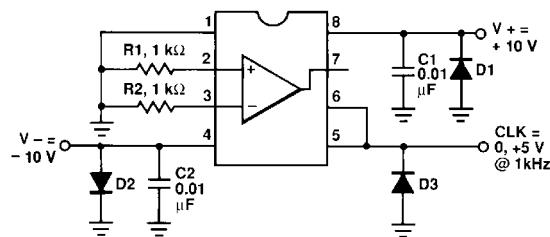
The EL2019 makes an excellent comparator in most analog to digital converters, due to its high gain and fast response. Most 2504 based A to D designs can be modified to use the EL2019 simply by using an inverted clock to the EL2019 as shown below. This results in improved performance due to less jitter of the transition voltages.



USING THE POWER DOWN/THREE-STATE FEATURE

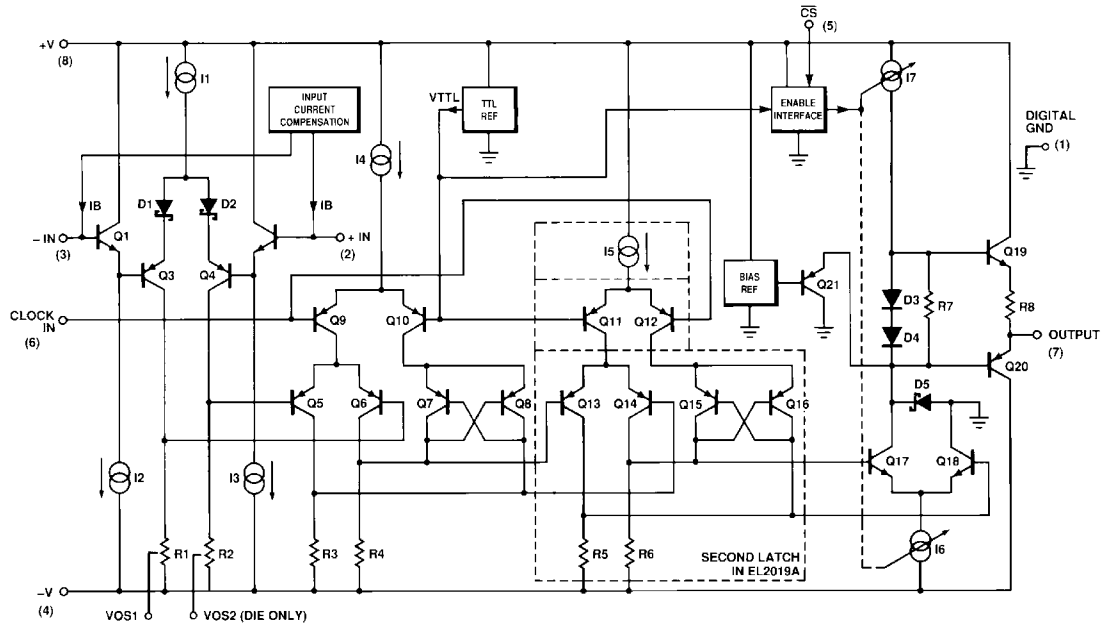


Burn-In Circuit



PIN NUMBERS ARE FOR DIP PACKAGES. ALL PACKAGES USE THE SAME SCHEMATIC.

Equivalent Schematic



EL2019 Macromodel

```
* Connections:
```

| | | | | | | |
|----------------|---|--------|----|----|------------------------|--------|
| * | | -input | | | | |
| * | | | +V | | | |
| * | | | | -V | | |
| * | | | | | Cpin | |
| * | | | | | $\overline{\text{CS}}$ | |
| * | | | | | | output |
| *.subckt M2019 | | | | | | |
| * | 2 | 3 | 8 | 4 | 6 | 5 |
| | | | | | | 7 |

- * Input Stage
- *

```
i1 8 10 700μA
r1 13 4 1K
r2 14 4 1K
q1 8 3 11 qn
q2 8 2 12 qn
q3 13 11 10 qp
q4 14 12 10 qp
i2 11 4 200μA
i3 12 4 200μA
```

* 2nd Stage & Flip Flop

*i4 8 24 700μA
i4 8 24 1mA
q9 22 6 24 qp
q10 18 17 24 qp
v1 17 0 2.5V
q5 15 14 22 qp
q6 16 13 22 qp
r3 15 4 1K
r4 16 4 1K
q7 16 15 18 qp
q8 15 16 18 qp
i5 8 40 500μA
q11 41 17 40 qp
q12 42 6 40 qp
q13 43 16 41 qp
q14 44 15 41 qp
q15 44 43 42 qp
q16 43 44 42 qp
r5 43 4 1K
r6 44 4 1K

* Output Stage

i7 8 35 2mA
s1 35 20 5 0 sw
d2 35 8 ds
i6 26 34 5mA
s2 34 4 5 0 sw
d3 34 26 ds
q19 8 20 21 qn 2
q20 4 19 7 qp 2
r8 21 7 60
r7 20 19 4K
q17 19 44 26 qn 5
q18 0 43 26 qn 5

```
q22 20 20 30 qn 5
q23 19 19 30 qn 8
d1 0 19 ds
q21 0 17 19 qp
*
* Power Supply Current
*
ips 8 4 4mA
*
* Models
*
.model qn npn (is=2e-15 bf=400 tf=0.05nS cje=0.3pF cjc=0.2pF ccs=0.2pF)
.model qp pnp (is=0.6e-15 bf=60 tf=0.3nS cje=0.5pF cjc=0.5pF ccs=0.4pF)
.model ds d(is=2e-12 tt=0.05nS eg=0.62V vj=0.58)
.model sw vswitch (von=0.4V voff=2.5V)
.ends
```

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