Signetics

Linear Products

LM139A/239A/339A/ LM139/239/339/ LM2901/MC3302

Quad Voltage Comparator

Product Specification

DESCRIPTION

The LM139 series consists of four independent precision voltage comparators, with an offset voltage specification as low as 2.0mV max for each comparator, which were designed specifically to operate from a single power supply over a wide range of voltages. Operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage. These comparators also have a unique characteristic in that the input common-mode voltage range includes ground, even though they are operated from a single power supply voltage.

The LM139 series was designed to directly interface with TTL and CMOS. When operated from both plus and minus power supplies, the LM139 series will directly interface with MOS logic where their low power drain is a distinct advantage over standard comparators.

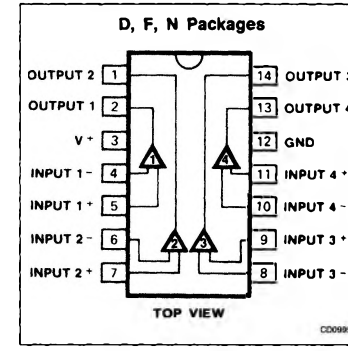
FEATURES

- **Wide single supply voltage range 2.0V_{DC} to 36V_{DC} or dual supplies ± 1.0V_{DC} to ± 18V_{DC}**
- **Very low supply current drain (0.8mA) independent of supply voltage (1.0mW/comparator at 5.0V_{DC})**
- **Low input biasing current 25nA**
- **Low input offset current ± 5nA and offset voltage**
- **Input common-mode voltage range includes ground**
- **Differential input voltage range equal to the power supply voltage**
- **Low output 250mV at 4mA saturation voltage**
- **Output voltage compatible with TTL, DTL, ECL, MOS and CMOS logic systems**

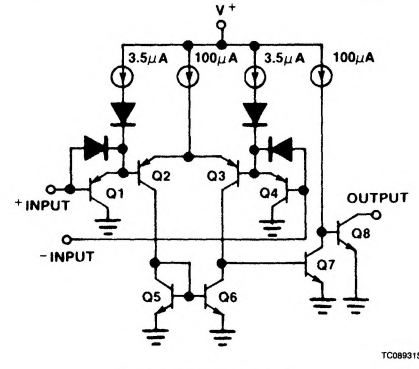
APPLICATIONS

- **A/D converters**
- **Wide range VCO**
- **MOS clock generator**
- **High voltage logic gate**
- **Multivibrators**

PIN CONFIGURATION



EQUIVALENT CIRCUIT



(1 Comparator Only)

ORDERING INFORMATION

DESCRIPTION	TEMPERATURE RANGE	ORDER CODE
14-Pin Cerdip	0 to +125°C	LM139AF
14-Pin Cerdip	0 to +125°C	LM139F
14-Pin Plastic DIP	−25°C to +85°C	LM239AN
14-Pin Plastic DIP	−25°C to +85°C	LM239N
14-Pin Cerdip	−25°C to +85°C	LM239F
14-Pin Plastic SO	−25°C to +85°C	LM239D
14-Pin Cerdip	−40°C to +85°C	LM2901F
14-Pin Plastic DIP	−40°C to +85°C	LM2901N
14-Pin Plastic SO	−40°C to +85°C	LM2901D
14-Pin Plastic DIP	0 to +70°C	LM339AN
14-Pin Plastic SO	0 to +70°C	LM339D
14-Pin Plastic DIP	0 to +70°C	LM339N
14-Pin Cerdip	0 to +70°C	LM339AF
14-Pin Cerdip	0 to +70°C	LM339F
14-Pin Plastic SO	−40°C to +85°C	MC3302D
14-Pin Cerdip	−40°C to +85°C	MC3302F
14-Pin Plastic DIP	−40°C to +85°C	MC3302N

ABSOLUTE MAXIMUM RATINGS

SYMBOL	PARAMETER	RATING	UNIT
V_{CC}	V_{CC} supply voltage	36 or ±18	V_{DC}
V_{DIFF}	Differential input voltage	36	V_{DC}
V_{IN}	Input voltage	−0.3 to +36	V_{DC}
P_D	Maximum power dissipation, T_A = 25°C (still-air)[1]		
	F package	1190	mW
	N package	1420	mW
	D package	1040	mW
	Output short-circuit to ground[2]	Continuous	
I_{IN}	Input current ($V_{IN} < -0.3V_{DC}$)[3]	50	mA
T_A	Operating temperature range		
	LM139A	−55 to +125	°C
	LM239A	−25 to +85	°C
	LM339A	0 to +70	°C
	LM2901/MC3302	−40 to +85	°C
T_{STG}	Storage temperature range	−65 to +150	°C
T_{SOLD}	Lead soldering temperature (10sec max)	300	°C

NOTE:

1. Derate above 25°C, at the following rates:
   F Package at 9.5mW/°C
   N Package at 11.4mW/°C
   D Package at 8.3mW/°C
2. Short circuits from the output to V+ can cause excessive heating and eventual destruction. The maximum output current is aproximately 20mA independent of the magnitude of V+.
3. This input current will only exist when the voltage at any of the input leads is driven negative. It is due to the collector-base junction of the input PNP transistors becoming forward biased and thereby acting as input diode clamps. In addition to this diode action, there is also lateral NPN parasitic transistor action on the IC chip. This transistor action can cause the output voltages of the comparators to go to the V+ voltage level (or to ground for a large overdrive) for the time duration that an input is driven negative. This is not destructive and normal output states will reestablish when the input voltage, which was negative, again returns to a value greater than $-0.3V_{DC}$.

DC AND AC ELECTRICAL CHARACTERISTICS $V+ = 5V_{DC}$, LM139A/LM139: $-55°C \leq T_A \leq 125°C$, unless otherwise specified.
LM239: $-25°C \leq T_A \leq 85°C$, unless otherwise specified.
LM339: $0°C \leq T_A \leq 70°C$, unless otherwise specified.

$V+ = 5V_{DC}$, LM339A: $0°C \leq T_A \leq 70°C$, unless otherwise specified.
LM239A: $-25°C \leq T_A \leq 85°C$, unless otherwise specified.
LM2901/LM3302: $-40°C \leq T_A \leq 85°C$, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	LM139A			LM239A/339A			UNIT
			Min	Typ	Max	Min	Typ	Max	
V_{OS}	Input offset voltage[2]	$T_A = 25°C$ Over temp.		± 1.0	± 2.0 ± 4.0		± 1.0	± 2.0 ± 4.0	mV mV
V_{CM}	Input common-mode voltage range[3]	$T_A = 25°C$ Over temp.	0 0		V+ − 1.5 V+ − 2.0	0 0		V+ − 1.5 V+ − 2.0	V
V_{IDR}	Differential input voltage[1]	Keep all V_{IN}s $\geq 0V_{DC}$ (or V− if need)			V+			V+	V
I_{BIAS}	Input bias current[4]	$I_{IN(+)}$ or $I_{IN(-)}$ with output in linear range $T_A = 25°C$ Over temp.		25	100 300		25	250 400	nA nA
I_{OS}	Input offset current	$I_{IN(+)} - I_{IN(-)}$ $T_A = 25°C$ Over temp.		± 3.0	± 25 ± 100		± 5.0	± 50 ± 150	nA nA
I_{OL}	Output sink current	$V_{IN(-)} \geq 1V_{DC}$, $V_{IN}(+) = 0$, $V_O \leq 1.5V_{DC}$, $T_A = 25°C$ $V_O = 800mV$, over temp.	6.0	16		6.0	16		mA
I_{OH}	Output leakage current	$V_{IN(+)} \geq 1V_{DC}$, $V_{IN}(-) = 0$ $V_O = 5V_{DC}$, $T_A = 25°C$ $V_O = 30V_{DC}$, over temp.		0.1	 1.0		0.1	 1.0	nA μA
I_{CC}	Supply current	$V+ = 28V$, $R_L = \infty$ on comparators, $T_A = 25°C$ $V+ = 30V$		0.8	2.0		0.8	2.0	mA
A_V	Voltage gain	$R_L \geq 15k\Omega$, $V+ = 15V_{DC}$	50	200		50	200		V/mV
V_{OL}	Saturation voltage	$V_{IN(-)} \geq 1V_{DC}$, $V_{IN(+)} = 0$, $I_{SINK} \leq 4mA$ $T_A = 25°C$ Over temp.		250	 400 700		250	 400 700	 mV mV
t_{LSR}	Large-signal response time	V_{IN} = TTL logic swing, $V_{REF} = 1.4V_{DC}$, $V_{RL} = 5V_{DC}$, $R_L = 5.1k\Omega$, $T_A = 25°C$		300			300		ns
t_R	Response time[5]	$V_{RL} = 5V_{DC}$, $R_L = 5.1k\Omega$, $T_A = 25°C$		1.3			1.3		μs

See notes at the end of the Electrical Characteristics.

DC AND AC ELECTRICAL CHARACTERISTICS $V+ = 5V_{DC}$, LM139A/LM139: $-55°C \leq T_A \leq 125°C$, unless otherwise specified.
LM239: $-25°C \leq T_A \leq 85°C$, unless otherwise specified.
LM339: $0°C \leq T_A \leq 70°C$ unless otherwise specified.

$V+ = 5V_{DC}$, LM339A: $0°C \leq T_A \leq 70°C$, unless otherwise specified
LM239A: $-25°C \leq T_A \leq 85°C$, unless otherwise specified.
LM2901/LM3302: $-40°C \leq T_A \leq 85°C$, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	LM139			LM239/339			UNIT
			Min	Typ	Max	Min	Typ	Max	
V_{OS}	Input offset voltage[2]	$T_A = 25°C$ Over temp.		±2.0	±5.0 ±9.0		±2.0	±5.0 ±9.0	mV mV
V_{CM}	Input common-mode voltage range[3]	$T_A = 25°C$ Over temp.	0 0		V+−1.5 V+−2.0	0 0		V+−1.5 V+−2.0	V
V_{IDR}	Differential input voltage[1]	Keep all V_{IN}s $\geq 0V_{DC}$ (or V− if need)			V+			V+	V
I_{BIAS}	Input bias current[4]	$I_{IN(+)}$ or $I_{IN(-)}$ with output in linear range $T_A = 25°C$ Over temp.		25	100 300		25	250 400	nA nA
I_{OS}	Input offset current	$I_{IN(+)} - I_{IN(-)}$ $T_A = 25°C$ Over temp.		±3.0	±25 ±100		±5.0	±50 ±150	nA nA
I_{OL}	Output sink current	$V_{IN(-)} \geq 1V_{DC}$, $V_{IN}(+) = 0$, $V_O \leq 1.5V_{DC}$, $T_A = 25°C$ $V_O = 800mV$, over temp.	6.0	16		6.0	16		mA
I_{OH}	Output leakage current	$V_{IN(+)} \geq 1V_{DC}$, $V_{IN}(-) = 0$ $V_O = 5V_{DC}$, $T_A = 25°C$ $V_O = 30V_{DC}$, over temp.		0.1	 1.0		0.1	 1.0	nA μA
I_{CC}	Supply current	$V+ = 28V$, $R_L = \infty$ on comparators, $T_A = 25°C$ $V+ = 30V$		0.8	2.0		0.8	2.0	mA
A_V	Voltage gain	$R_L \geq 15k\Omega$, $V+ = 15V_{DC}$	50	200		50	200		V/mV
V_{OL}	Saturation voltage	$V_{IN(-)} \geq 1V_{DC}$, $V_{IN(+)} = 0$, $I_{SINK} \leq 4mA$ $T_A = 25°C$ Over temp.		250	400 700		250	400 700	mV mV
t_{LSR}	Large-signal response time	V_{IN} = TTL logic swing, $V_{REF} = 1.4V_{DC}$, $V_{RL} = 5V_{DC}$, $R_L = 5.1k\Omega$, $T_A = 25°C$		300			300		ns
t_R	Response time[5]	$V_{RL} = 5V_{DC}$, $R_L = 5.1k\Omega$, $T_A = 25°C$		1.3			1.3		μs

See notes on following page.

Quad Voltage Comparator

LM139A/239A/339A/LM139/239/339/ LM2901/MC3302

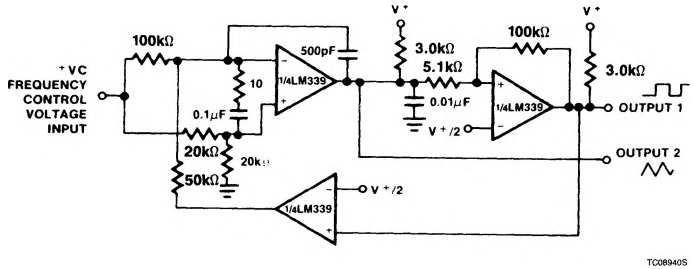
DC AND AC ELECTRICAL CHARACTERISTICS V+ = $5V_{DC}$, LM139A/LM139: $-55°C \leq T_A \leq 125°C$, unless otherwise specified.
LM239: $-25°C \leq T_A \leq 85°C$, unless otherwise specified.
LM339: $0°C \leq T_A \leq 70°C$ unless otherwise specified.

V+ = $5V_{DC}$, LM339A: $0°C \leq T_A \leq 70°C$, unless otherwise specified
LM239A: $-25°C \leq T_A \leq 85°C$, unless otherwise specified.
LM2901/LM3302: $-40°C \leq T_A \leq 85°C$, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	LM2901			MC3302			UNIT
			Min	Typ	Max	Min	Typ	Max	
V_{OS}	Input offset voltage[2]	$T_A = 25°C$ Over temp.		±2.0 ±9	±7.0 ±15		±3.0	±20 ±40	mV mV
V_{CM}	Input common-mode voltage range[3]	$T_A = 25°C$ Over temp.	0 0		V+−1.5 V+−2.0	0 0		V+−1.5 V+−2.0	V
V_{IDR}	Differential input voltage[1]	Keep all V_{IN}s $\geq 0V_{DC}$ (or V− if need)			V+			V+	V
I_{BIAS}	Input bias current[4]	$I_{IN(+)}$ or $I_{IN(-)}$ with output in linear range $T_A = 25°C$ Over temp.		 25 200	 250 500		 25	 500 1000	 nA nA
I_{OS}	Input offset current	$I_{IN(+)} - I_{IN(-)}$ $T_A = 25°C$ Over temp.		 ±5 ±50	 ±50 ±200		 ±5	 ±100 ±300	 nA nA
I_{OL}	Output sink current	$V_{IN(-)} \geq 1V_{DC}$, $V_{IN(+)} = 0$, $V_O \leq 1.5V_{DC}$, $T_A = 25°C$ $V_O = 800mV$, over temp.	6.0	16		 2.0	6		mA mA
I_{OH}	Output leakage current	$V_{IN(+)} \geq 1V_{DC}$, $V_{IN(-)} = 0$ $V_O = 5V_{DC}$, $T_A = 25°C$ $V_O = 30V_{DC}$, over temp.		0.1	 1.0		0.1	 1.0	nA μA
I_{CC}	Supply current	V+ = 28V, $R_L = \infty$ on comparators, $T_A = 25°C$ V+ = 30V		0.8 1.0	2.0 2.5		.8	1.8	mA
A_V	Voltage gain	$R_L \geq 15k\Omega$, V+ = $15V_{DC}$	25	100		2	100		V/mV
V_{OL}	Saturation voltage	$V_{IN(-)} \geq 1V_{DC}$, $V_{IN(+)} = 0$, $I_{SINK} \leq 4mA$ $T_A = 25°C$ Over temp.		 400	 400 700		 150	 400 700	 mV mV
t_{LSR}	Large-signal response time	V_{IN} = TTL logic swing, $V_{REF} = 1.4V_{DC}$, $V_{RL} = 5V_{DC}$, $R_L = 5.1k\Omega$, $T_A = 25°C$		300			300		ns
t_R	Response time[5]	$V_{RL} = 5V_{DC}$, $R_L = 5.1k\Omega$, $T_A = 25°C$		1.3			1.3		μs

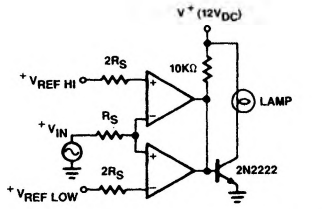
NOTES:
1. Positive excursions of input voltage may exceed the power supply level by 17V. As long as the other voltage remains within the common-mode range, the comparator will provide a proper output state. The low input voltage state must not be less than $-0.3V_{DC}$ (or $0.3V_{DC}$ below the magnitude of the negative power supply, if used).
2. At output switch point, $V_O \cong 1.4V_{DC}$, $R_S = 0\Omega$ with V+ from $5V_{DC}$ to $30V_{DC}$; and over the full input common-mode range ($0V_{DC}$ to V+ − $1.5V_{DC}$). Inputs of unused comparators should be grounded.
3. The input common-mode voltage or either input signal voltage should not be allowed to go negative by more than 0.3V. The upper end of the common-mode voltage range is V+ − 1.5V, but either or both inputs can go to $30V_{DC}$ without damage.
4. The direction of the input current is out of the IC due to the PNP input stage. This current is essentially constant, independent of the state of the output so no loading change exists on the reference or input lines.
5. The response time specified is for a 100mV input step with a 5mV overdrive. For larger overdrive signals, 300ns can be obtained (see typical performance characteristics section).

TYPICAL APPLICATIONS

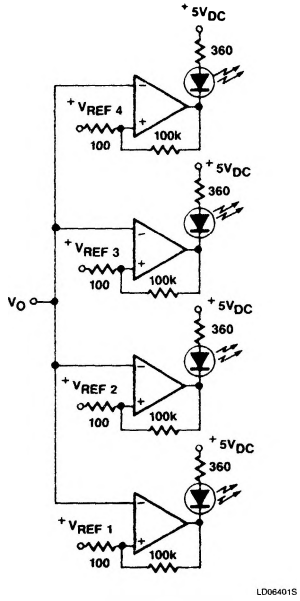


NOTES:
$V+ = +30V_{DC}$
$+250m\ V_{DC} \leq V_C + 50V_{DC}$
$700Hz \leq f_O \leq 100kHz$

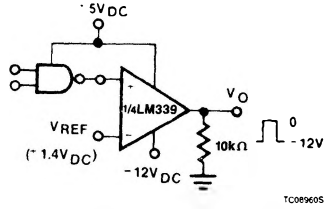
Two-Decade High-Frequency VCO



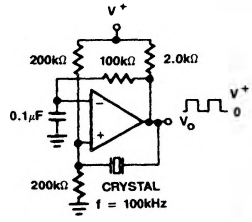
Limit Comparator



Visible Voltage Indicator



TTL-to-MOS Logic Converter

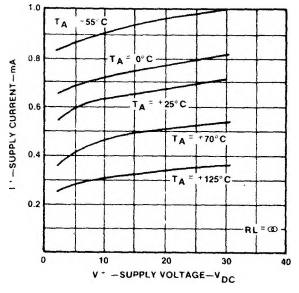


Crystal-Controlled Oscillator

NOTE:
Inputs of unused comparators should be grounded.

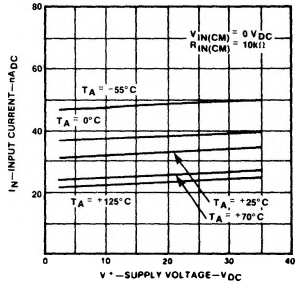
TYPICAL PERFORMANCE CHARACTERISTICS

Supply Current



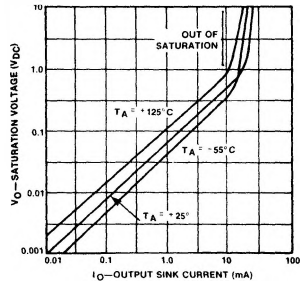
OP05570S

Input Current



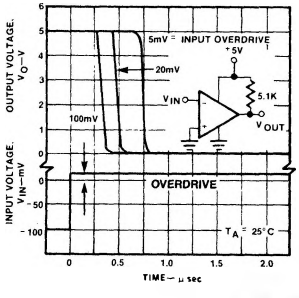
OP05580S

Output Saturation Voltage



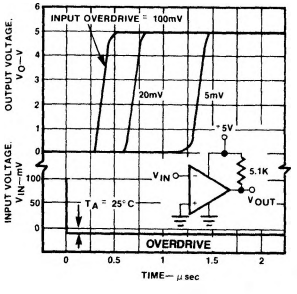
OP05590S

Response Time for Various Input Overdrives — Negative Transition



OP05600S

Response Time for Various Input Overdrives — Positive Transition



OP05610S