TEXAS INSTRUMENTS

LM139, LM239, LM339, LM139A
LM239A, LM339A, LM2901, LM2901AV, LM2901V

SLCS006U – OCTOBER 1979 – REVISED NOVEMBER 2018

LM339, LM239, LM139, LM2901 Quad Differential Comparators

1 Features

- Wide Supply Ranges
  - Single Supply: 2 V to 36 V
    (Tested to 30 V for Non-V Devices and
    32 V for V-Suffix Devices)
  - Dual Supplies: ±1 V to ±18 V
    (Tested to ±15 V for Non-V Devices and
    ±16 V for V-Suffix Devices)
- Low Supply-Current Drain Independent of Supply Voltage: 0.8 mA (Typical)
- Low Input Bias Current: 25 nA (Typical)
- Low Input Offset Current: 3 nA (Typical) (LM139)
- Low Input Offset Voltage: 2 mV (Typical)
- Common-Mode Input Voltage Range Includes Ground
- Differential Input Voltage Range Equal to Maximum-Rated Supply Voltage: ±36 V
- Low Output Saturation Voltage
- Output Compatible With TTL, MOS, and CMOS
- On Products Compliant to MIL-PRF-38535, All Parameters Are Tested Unless Otherwise Noted. On All Other Products, Production Processing Does Not Necessarily Include Testing of All Parameters.

2 Applications

- Industrial
- Automotive
  - Infotainment and Clusters
  - Body Control Modules
- Power Supervision
- Oscillators
- Peak Detectors
- Logic Voltage Translation

3 Description

The LMx39x and the LM2901x devices consist of four independent voltage comparators that are designed to operate from a single power supply over a wide range of voltages. Operation from dual supplies also is possible, as long as the difference between the two supplies is 2 V to 36 V, and V_{CC} is at least 1.5 V more positive than the input common-mode voltage. Current drain is independent of the supply voltage. The outputs can be connected to other open-collector outputs to achieve wired-AND relationships.

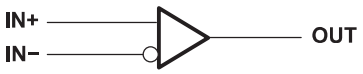
The LM139 and LM139A devices are characterized for operation over the full military temperature range of –55°C to +125°C. The LM239 and LM239A devices are characterized for operation from –25°C to +85°C. The LM339 and LM339A devices are characterized for operation from 0°C to 70°C. The LM2901, LM2901AV, and LM2901V devices are characterized for operation from –40°C to +125°C.

Device Information(1)

PART NUMBER	PACKAGE	BODY SIZE (NOM)
LM139x	CDIP (14)	21.30 mm × 7.60 mm
	LCCC (20)	8.90 mm × 8.90 mm
	CFP (14)	9.20 mm × 6.29 mm
LM139x, LM239x, LM339x, LM2901x	SOIC (14)	8.70 mm × 3.90 mm
LM239, LM339x, LM2901	PDIP (14)	19.30 mm × 6.40 mm
LM239, LM2901	TSSOP (14)	5.00 mm × 4.40 mm
LM339x, LM2901	SO (14)	10.20 mm × 5.30 mm
LM339x	SSOP (14)	6.50 mm × 5.30 mm

(1) For all available packages, see the orderable addendum at the end of the data sheet.

Simplified Schematic



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4 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision T (June 2015) to Revision U — **Page**

- Changed LM239x temperature range from 125°C to 85°C in *Description* section ... 1
- Changed data sheet title ... 1
- Changed LM293AD to LM239AD in *Device Comparison Table* ... 3
- Changed 'I' to dash in GND and VCC in I/O column of the *Pin Functions* table ... 4
- Added Input Current and related footnote in *Absolute Maximum Ratings* ... 5
- Changed layout of *Recommended Operating Conditions* temperatures to separate rows ... 5
- Changed values in the Thermal Information table to align with JEDEC standards. ... 6
- Added LM2901V and LMV2901AV to LM2901 Elect Char Table title to make more clear which devices are covered. ... 8
- Changed "Dual" to "Quad" and removed "Absolute Maximum" wording and mention of Q100 in *Overview* section text. ... 11
- Changed and corrected text in *Feature Description* section ... 11
- Changed Example Values in *Typical Application Design Parameters* table ... 12
- Added *Receiving Notification of Documentation Updates* section ... 15

Changes from Revision S (August 2012) to Revision T — **Page**

- Deleted *Ordering Information* table. ... 1
- Added Military Disclaimer to *Features* list. ... 1
- Added *Applications*, *Device Information* table, *Pin Configuration and Functions* section, *ESD Ratings* table, *Thermal Information* table, *Feature Description* section, *Device Functional Modes*, *Application and Implementation* section, *Power Supply Recommendations* section, *Layout* section, *Device and Documentation Support* section, and *Mechanical, Packaging, and Orderable Information* section. No specification changes. ... 1

5 Device Comparison Table

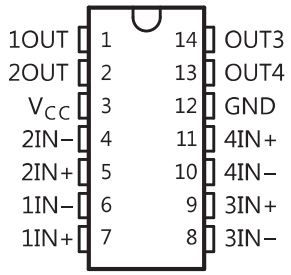
PART NUMBER	PACKAGE	BODY SIZE (NOM)
LM139J, LM139AJ	CDIP (14)	21.30 mm × 7.60 mm
LM139FK, LM139AFK	LCCC (20)	8.90 mm × 8.90 mm
LM139W, LM139AW	CFP (14)	9.20 mm × 6.29 mm
LM139D, LM139AD, LM239D, LM239AD, LM339D, LM339AD, LM2901D	SOIC (14)	8.70 mm × 3.90 mm
LM239N, LM339N, LM339AN, LM2901N	PDIP (14)	19.30 mm × 6.40 mm
LM239PW, LM2901PW	TSSOP (14)	5.00 mm × 4.40 mm
LM339NS, LM339ANS, LM2901NS	SOP (14)	10.20 mm × 5.30 mm
LM339DB, LM339ADB	SSOP (14)	6.50 mm × 5.30 mm

OTHER QUALIFIED VERSIONS OF LM139-SP, LM239A, LM2901, LM2901AV, LM2901V:

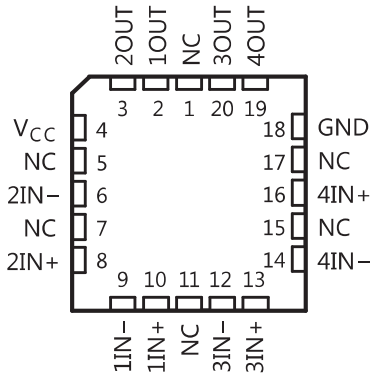
- Automotive Q100: LM239A-Q1, LM2901-Q1, LM2901AV-Q1, LM2901V-Q1
- Enhanced Product: LM239A-EP
- Space: LM139-SP

6 Pin Configuration and Functions

D, DB, N, NS, PW, J, or W Package
SOIC, SSOP, PDIP, SO, TSSOP, CDIP, or CFP
Top View



FK Package
20-Pin LCCC(1)
Top View



(1) NC = no internal connection.

Pin Functions

PIN			I/O(1)	DESCRIPTION
NAME	D, J, W, B, PW, DB, N, NS	FK		
1IN+	7	10	I	Positive input pin of the comparator 1
1IN–	6	9	I	Negative input pin of the comparator 1
1OUT	1	2	O	Output pin of the comparator 1
2IN+	5	8	I	Positive input pin of the comparator 2
2IN–	4	6	I	Negative input pin of the comparator 2
2OUT	2	3	O	Output pin of the comparator 2
3IN+	9	13	I	Positive input pin of the comparator 3
3IN–	8	12	I	Negative input pin of the comparator 3
3OUT	14	20	O	Output pin of the comparator 3
4IN+	11	16	I	Positive input pin of the comparator 4
4IN–	10	14	I	Negative input pin of the comparator 4
4OUT	13	19	O	Output pin of the comparator 4
GND	12	18	—	Ground
V_{CC}	3	4	—	Supply pin
NC	—	1	—	No connect (no internal connection)
		5		
		7		
		11		
		15		
		17		

(1) I = Input, O = Output

7 Specifications

7.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)(1)

			MIN	MAX	UNIT
V_{CC}	Supply voltage(2)			36	V
V_{ID}	Differential input voltage(3)			±36	V
V_I	Input voltage range (either input)		–0.3	36	V
I_K	Input current(4)			–50	mA
V_O	Output voltage			36	V
I_O	Output current			20	mA
	Duration of output short circuit to ground(5)		Unlimited		
T_J	Operating virtual-junction temperature			150	°C
	Case temperature for 60 s	FK package		260	°C
	Lead temperature 1.6 mm (1/16 in) from case for 60 s	J package		300	°C
T_{stg}	Storage temperature		–65	150	°C

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) All voltage values, except differential voltages, are with respect to network ground.
(3) Differential voltages are at xIN+ with respect to xIN–.
(4) Input current flows through parasitic diode to ground and will turn on parasitic transistors that will increase I_{CC} and may cause output to be incorrect. Normal operation resumes when input is removed.
(5) Short circuits from outputs to V_{CC} can cause excessive heating and eventual destruction.

7.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001(1)	±500	V
		Charged-device model (CDM), per JEDEC specification JESD22-C101(2)	±750	

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

7.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

			MIN	MAX	UNIT
V_{CC}	Supply voltage	Non-V devices	2	30	V
		V devices	2	32	V
T_J	Junction temperature	LM139x	–55	125	°C
		LM239x	–25	85	
		LM339x	–0	70	
		LM2901x	–40	125	

7.4 Thermal Information (14-Pin Packages)

THERMAL METRIC[1]		LMx39, LM2901x							UNIT
		D (SOIC)	DB (SSOP)	N (PDIP)	NS (SO)	PW (TSSOP)	J (CDIP)	W (CFP)	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	98.8	111.8	79	96.2	120	89.5	156.2	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	64.3	63.6	73.4	56.1	59	46.1	86.7	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	59.7	60.5	58.7	56.9	68.8	78.7	154.6	°C/W
ψ_{JT}	Junction-to-top characterization parameter	25.7	26.2	48.3	24.8	9.9	3	56.5	°C/W
ψ_{JB}	Junction-to-board characterization parameter	59.3	59.8	58.5	56.4	68.2	71.8	133.5	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	—	—	—	—	—	24.2	14.3	°C/W

(1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC Package Thermal Metrics* application report.

7.5 Thermal Information (20-Pin Packages)

THERMAL METRIC[1]		LM139x	UNIT
		FK (LCCC)	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	82.5	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	60.7	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	59.4	°C/W
ψ_{JT}	Junction-to-top characterization parameter	53	°C/W
ψ_{JB}	Junction-to-board characterization parameter	58.4	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	9.7	°C/W

(1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC Package Thermal Metrics* application report.

7.6 Electrical Characteristics for LM139 and LM139A

at specified free-air temperature, V_{CC} = 5 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS(1)		T_A(2)	LM139			LM139A			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_{CC} = 5 V to 30 V, $V_{IC} = V_{ICR}$ min, V_O = 1.4 V		25°C		2	5		1	2	mV
				Full range			9			4	
I_{IO}	Input offset current	V_O = 1.4 V		25°C		3	25		3	25	nA
				Full range			100			100	
I_{IB}	Input bias current	V_O = 1.4 V		25°C		–25	–100		–25	–100	nA
				Full range			–300			–300	
V_{ICR}	Common-mode input-voltage range(3)			25°C	0 to V_{CC} – 1.5			0 to V_{CC} – 1.5			V
				Full range	0 to V_{CC} – 2			0 to V_{CC} – 2			
A_{VD}	Large-signal differential-voltage amplification	V_{CC+} = ±7.5 V, V_O = –5 V to 5 V		25°C		200		50	200		V/mV
I_{OH}	High-level output current	V_{ID} = 1 V	V_{OH} = 5 V	25°C		0.1			0.1		nA
			V_{OH} = 30 V	Full range			1			1	µA
V_{OL}	Low-level output voltage	V_{ID} = –1 V,	I_{OL} = 4 mA	25°C		150	400		150	400	mV
				Full range			700			700	
I_{OL}	Low-level output current	V_{ID} = –1 V,	V_{OL} = 1.5 V	25°C	6	16		6	16		mA
I_{CC}	Supply current (four comparators)	V_O = 2.5 V,	No load	25°C		0.8	2		0.8	2	mA

(1) All characteristics are measured with zero common-mode input voltage, unless otherwise specified.
(2) Full range (MIN to MAX) for LM139 and LM139A is –55°C to +125°C. All characteristics are measured with zero common-mode input voltage, unless otherwise specified.
(3) The voltage at either input or common-mode must not be allowed to go negative by more than 0.3 V. The upper end of the common-mode voltage range is V_{CC+} – 1.5 V; however, one input can exceed V_{CC}, and the comparator will provide a proper output state as long as the other input remains in the common-mode range. Either or both inputs can go to 30 V without damage.

7.7 Electrical Characteristics for LMx39 and LMx39A

at specified free-air temperature, V_{CC} = 5 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS(1)	T_A(2)	LM239 LM339			LM239A LM339A			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_{CC} = 5 V to 30 V, $V_{IC} = V_{ICR}$ min, V_O = 1.4 V	25°C		2	5		1	3	mV
			Full range			9			4	
I_{IO}	Input offset current	V_O = 1.4 V	25°C		5	50		5	50	nA
			Full range			150			150	
I_{IB}	Input bias current	V_O = 1.4 V	25°C		–25	–250		–25	–250	nA
			Full range			–400			–400	
V_{ICR}	Common-mode input-voltage range(3)		25°C	0 to V_{CC} – 1.5			0 to V_{CC} – 1.5			V
			Full range	0 to V_{CC} – 2			0 to V_{CC} – 2			
A_{VD}	Large-signal differential-voltage amplification	V_{CC} = 15 V, V_O = 1.4 V to 11.4 V, R_L ≥ 15 kΩ to V_{CC}	25°C	50	200		50	200		V/mV

(1) All characteristics are measured with zero common-mode input voltage, unless otherwise specified.
(2) Full range (MIN to MAX) for LM239/LM239A is –25°C to +85°C, and for LM339/LM339A is 0°C to 70°C. All characteristics are measured with zero common-mode input voltage, unless otherwise specified.
(3) The voltage at either input or common-mode must not be allowed to go negative by more than 0.3 V. The upper end of the common-mode voltage range is V_{CC+} – 1.5 V; however, one input can exceed V_{CC}, and the comparator will provide a proper output state as long as the other input remains in the common-mode range. Either or both inputs can go to 30 V without damage.

Electrical Characteristics for LMx39 and LMx39A (continued)

at specified free-air temperature, V_{CC} = 5 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS(1)		T_A(2)	LM239 LM339			LM239A LM339A			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
I_{OH}	High-level output current	V_{ID} = 1 V	V_{OH} = 5 V	25°C		0.1	50		0.1	50	nA
			V_{OH} = 30 V	Full range			1			1	μA
V_{OL}	Low-level output voltage	V_{ID} = –1 V,	I_{OL} = 4 mA	25°C		150	400		150	400	mV
				Full range			700			700	
I_{OL}	Low-level output current	V_{ID} = –1 V,	V_{OL} = 1.5 V	25°C	6	16		6	16		mA
I_{CC}	Supply current (four comparators)	V_O = 2.5 V,	No load	25°C		0.8	2		0.8	2	mA

7.8 Electrical Characteristics for LM2901, LM2901V and LM2901AV

at specified free-air temperature, V_{CC} = 5 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS(1)		T_A(2)	LM2901			UNIT
					MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_{IC} = V_{ICR} min, V_O = 1.4 V, V_{CC} = 5 V to MAX(3)	Non-A devices	25°C		2	7	mV
				Full range			15	
			A-suffix devices	25°C		1	2	
				Full range			4	
I_{IO}	Input offset current	V_O = 1.4 V		25°C		5	50	nA
				Full range			200	
I_{IB}	Input bias current	V_O = 1.4 V		25°C		–25	–250	nA
				Full range			–500	
V_{ICR}	Common-mode input-voltage range(4)			25°C	0 to V_{CC} – 1.5			V
				Full range	0 to V_{CC} – 2			
A_{VD}	Large-signal differential-voltage amplification	V_{CC} = 15 V, V_O = 1.4 V to 11.4 V, R_L ≥ 15 kΩ to V_{CC}		25°C	25	100		V/mV
I_{OH}	High-level output current	V_{ID} = 1 V	V_{OH} = 5 V	25°C		0.1	50	nA
			V_{OH} = V_{CC} MAX(3)	Full range			1	μA
V_{OL}	Low-level output voltage	V_{ID} = –1 V, I_{OL} = 4 mA	Non-V devices	25°C		150	500	mV
			V-suffix devices			150	400	
			All devices	Full range			700	
I_{OL}	Low-level output current	V_{ID} = –1 V,	V_{OL} = 1.5 V	25°C	6	16		mA
I_{CC}	Supply current (four comparators)	V_O = 2.5 V, No load	V_{CC} = 5 V	25°C		0.8	2	mA
			V_{CC} = MAX(3)			1	2.5	

(1) All characteristics are measured with zero common-mode input voltage, unless otherwise specified.
(2) Full range (MIN to MAX) for LM2901 is –40°C to +125°C. All characteristics are measured with zero common-mode input voltage, unless otherwise specified.
(3) V_{CC} MAX = 30 V for non-V devices, and 32 V for V-suffix devices
(4) The voltage at either input or common-mode must not be allowed to go negative by more than 0.3 V. The upper end of the common-mode voltage range is V_{CC+} – 1.5 V; however, one input can exceed V_{CC}, and the comparator will provide a proper output state as long as the other input remains in the common-mode range. Either or both inputs can go to V_{CC} MAX without damage.

7.9 Switching Characteristics for LM2901

V_{CC} = 5 V, T_A = 25°C

PARAMETER	TEST CONDITIONS		LM2901 TYP	UNIT
Response time	R_L connected to 5 V through 5.1 kΩ, C_L = 15 pF(1)(2)	100-mV input step with 5-mV overdrive	1.3	µs
		TTL-level input step	0.3	

(1) C_L includes probe and jig capacitance.
(2) The response time specified is the interval between the input step function and the instant when the output crosses 1.4 V.

7.10 Switching Characteristics for LM139 and LM139A

V_{CC} = 5 V, T_A = 25°C

PARAMETER	TEST CONDITIONS		LM139 LM139A TYP	UNIT
Response time	R_L connected to 5 V through 5.1 kΩ, C_L = 15 pF(1)(2)	100-mV input step with 5-mV overdrive	1.3	µs
		TTL-level input step	0.3	

(1) C_L includes probe and jig capacitance.
(2) The response time specified is the interval between the input step function and the instant when the output crosses 1.4 V.

7.11 Switching Characteristics for LMx39 and LMx39A

V_{CC} = 5 V, T_A = 25°C

PARAMETER	TEST CONDITIONS		LM239 LM239A LM339 LM339A TYP	UNIT
Response time	R_L connected to 5 V through 5.1 kΩ, C_L = 15 pF(1)(2)	100-mV input step with 5-mV overdrive	1.3	µs
		TTL-level input step	0.3	

(1) C_L includes probe and jig capacitance.
(2) The response time specified is the interval between the input step function and the instant when the output crosses 1.4 V.

7.12 Typical Characteristics

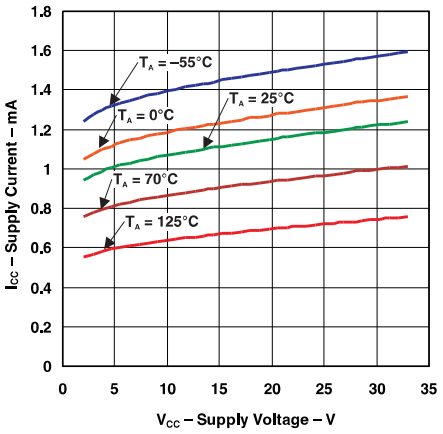


Figure 1. Supply Current vs Supply Voltage

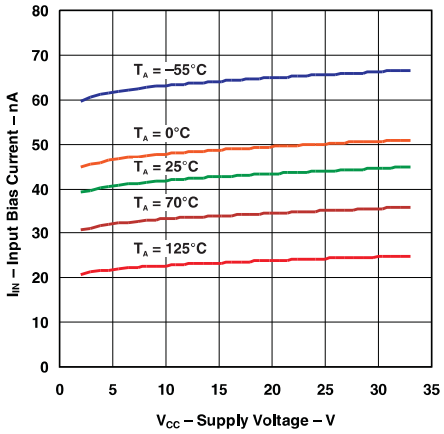


Figure 2. Input Bias Current vs Supply Voltage

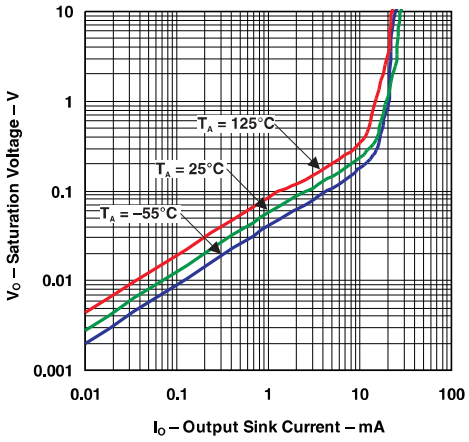


Figure 3. Output Saturation Voltage

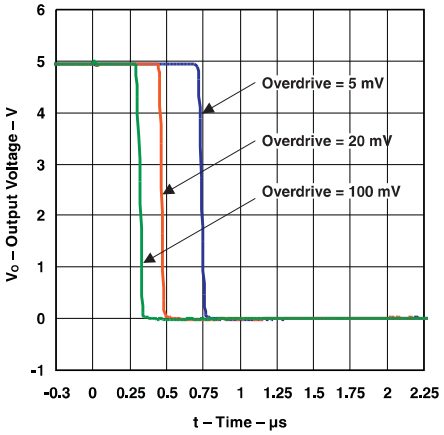


Figure 4. Response Time for Various Overdrives Negative Transition

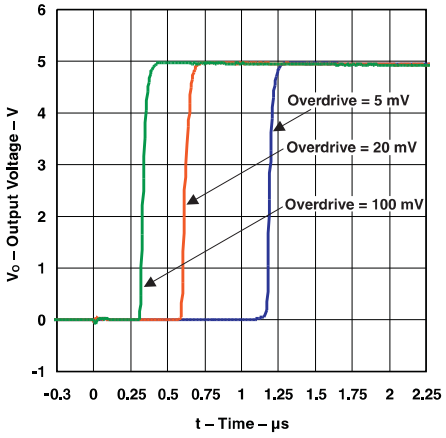


Figure 5. Response Time for Various Overdrives Positive Transition

8 Detailed Description

8.1 Overview

The LMx39 and LM2901x are quad comparators with the ability to operate up to an absolute maximum of 36 V on the supply pin. This standard device has proven ubiquity and versatility across a wide range of applications. This is due to very wide supply voltages range (2 V up to 32 V), low Iq, and fast response of the device.

The open-drain output allows the user to configure the output logic low voltage (V_{OL}) and allows the comparator to be used in AND functionality.

8.2 Functional Block Diagram

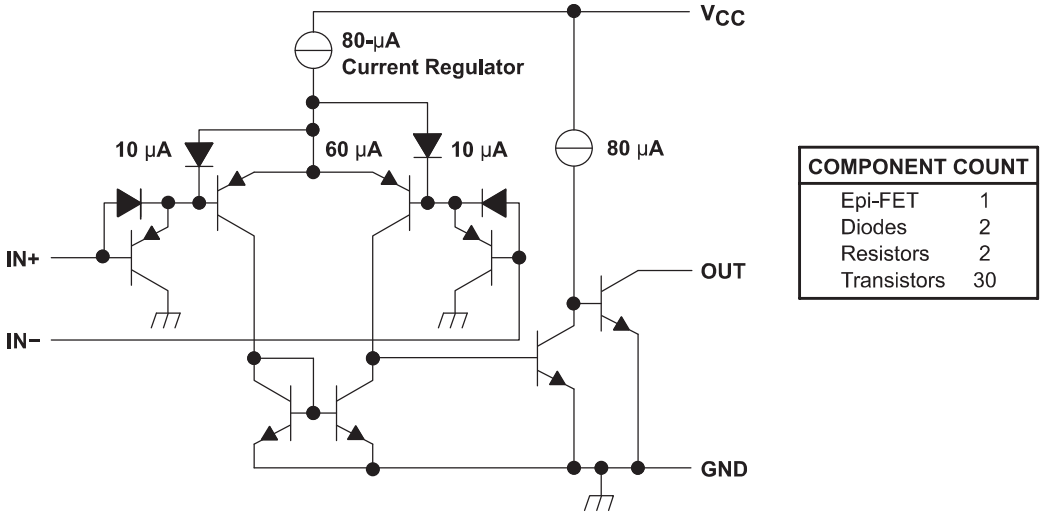


Figure 6. Schematic (Each Comparator)

8.3 Feature Description

The comparator consists of a PNP Darlington pair input, allowing the device to operate with very high gain and fast response with minimal input bias current. The input Darlington pair creates a limit on the input common-mode voltage capability, allowing the comparator to accurately function from ground to (V_{CC} – 1.5 V) differential input. Allow for (V_{CC} – 2 V) at cold temperature.

The output consists of an open-collector NPN (pulldown or low-side) transistor. The output NPN sinks current when the negative input voltage is higher than the positive input voltage and the offset voltage. The VOL is resistive and scales with the output current. See the *Specifications* section for V_{OL} values with respect to the output current.

8.4 Device Functional Modes

8.4.1 Voltage Comparison

The comparator operates solely as a voltage comparator, comparing the differential voltage between the positive and negative pins and outputting a logic low or high impedance (logic high with pullup) based on the input differential polarity.

9 Application and Implementation

NOTE

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Validate and test the design implementation to confirm system functionality.

9.1 Application Information

Typically, a comparator compares either a single signal to a reference, or to two differnt signals. Many users take advantage of the open-drain output to drive the comparison logic output to a logic voltage level to an MCU or logic device. The wide supply range and high voltage capability makes LMx39 or LM2901x optimal for level shifting to a higher or lower voltage.

9.2 Typical Application

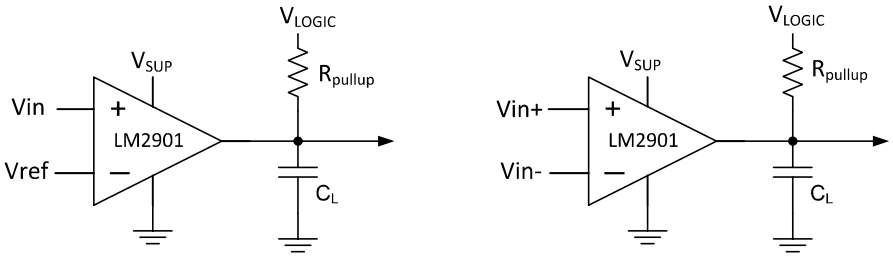


Figure 7. Single-ended and Differential Comparator Configurations

9.2.1 Design Requirements

For this design example, use the parameters listed in Table 1 as the input parameters.

Table 1. Design Parameters

DESIGN PARAMETER	EXAMPLE VALUE
Input Voltage Range	0 V to Vsup-1.5 V
Supply Voltage	4.5 V to V_{CC} maximum
Logic Supply Voltage	0 V to V_{CC} maximum
Output Current (R_{PULLUP})	1 µA to 4 mA
Input Overdrive Voltage	100 mV
Reference Voltage	2.5 V
Load Capacitance (C_L)	15 pF

9.2.2 Detailed Design Procedure

When using the LMx39 in a general comparator application, determine the following:

- Input voltage range
- Minimum overdrive voltage
- Output and drive current
- Response time

9.2.2.1 Input Voltage Range

When choosing the input voltage range, the input common-mode voltage range (V_{ICR}) must be taken in to account. If temperature operation is above or below 25°C the V_{ICR} can range from 0 V to V_{CC}– 2 V. This limits the input voltage range to as high as V_{CC}– 2 V and as low as 0 V. Operation outside of this range can yield incorrect comparisons.

The following list describes the outcomes of some input voltage situations.

- When both IN– and IN+ are both within the common-mode range:
  - If IN– is higher than IN+ and the offset voltage, the output is low and the output transistor is sinking current
  - If IN– is lower than IN+ and the offset voltage, the output is high impedance and the output transistor is not conducting
- When IN– is higher than common mode and IN+ is within common mode, the output is low and the output transistor is sinking current
- When IN+ is higher than common mode and IN– is within common mode, the output is high impedance and the output transistor is not conducting
- When IN– and IN+ are both higher than common mode, the output is low and the output transistor is sinking current

9.2.2.2 Minimum Overdrive Voltage

Overdrive voltage is the differential voltage produced between the positive and negative inputs of the comparator over the offset voltage (V_{IO}). To make an accurate comparison, the overdrive voltage (V_{OD}) must be higher than the input offset voltage (V_{IO}). Overdrive voltage can also determine the response time of the comparator, with the response time decreasing with increasing overdrive. Figure 8 and Figure 9 show positive and negative response times with respect to overdrive voltage.

9.2.2.3 Output and Drive Current

Output current is determined by the load and pullup resistance and logic and pullup voltage. The output current produces a low-level output voltage (V_{OL}) from the comparator, where V_{OL} is proportional to the output current.

The output current can also effect the transient response.

9.2.2.4 Response Time

Response time is a function of input over-drive. See the *Typical Characteristics* graphs for typical response times. The rise and fall times can be determined by the load capacitance (C_L), load/pull-up resistance (R_{PULLUP}) and equivalent collector-emitter resistance (R_{CE}).

- The rise time (τ_R) is approximately $\tau_R \sim R_{PULLUP} \times C_L$
- The fall time (τ_F) is approximately $\tau_F \sim R_{CE} \times C_L$
  - R_{CE} can be determined by taking the slope of Figure 3 in its linear region at the desired temperature, or by dividing the V_{OL} by I_{OUT}

9.2.3 Application Curves

Figure 8 and Figure 9 were generated with scope probe parasitic capacitance of 50 pF.

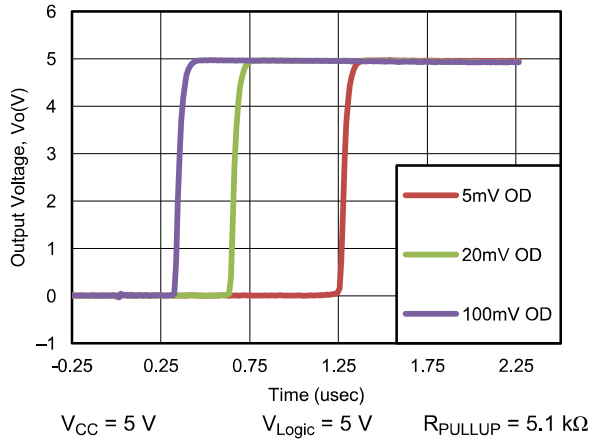


Figure 8. Response Time vs Output Voltage (Positive Transition)

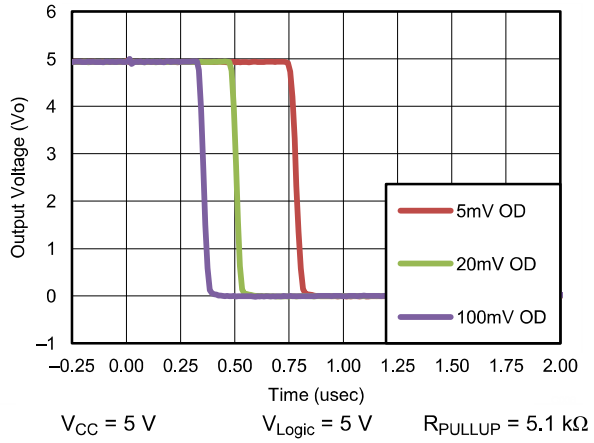


Figure 9. Response Time vs Output Voltage (Negative Transition)

10 Power Supply Recommendations

For fast response and comparison applications with noisy or AC inputs, use a bypass capacitor on the supply pin to reject any variation on the supply voltage. This variation can affect the common-mode range of the comparator input and create an inaccurate comparison.

11 Layout

11.1 Layout Guidelines

To create an accurate comparator application without hysteresis, maintain a stable power supply with minimized noise and glitches, which can affect the high level input common-mode voltage range. To achieve this accuracy, add a bypass capacitor between the supply voltage and ground. Place a bypass capacitor on the positive power supply and negative supply (if available).

NOTE

If a negative supply is not being used, do not place a capacitor between the GND pin of the device and system ground.

11.2 Layout Example

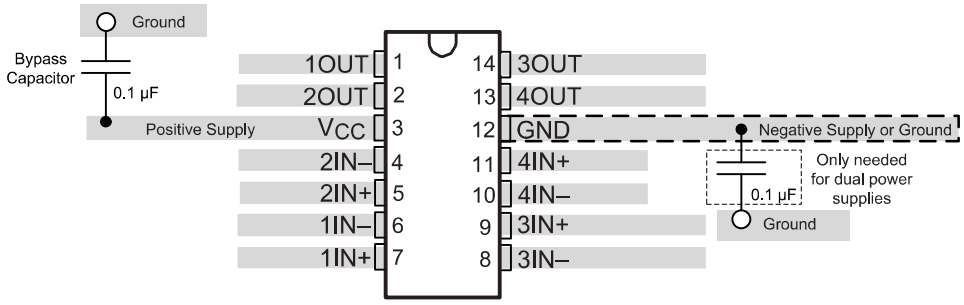


Figure 10. LMx39 Layout Example

12 Device and Documentation Support

12.1 Related Links

The table below lists quick access links. Categories include technical documents, support and community resources, tools and software, and quick access to sample or buy.

Table 2. Related Links

PARTS	PRODUCT FOLDER	SAMPLE & BUY	TECHNICAL DOCUMENTS	TOOLS & SOFTWARE	SUPPORT & COMMUNITY
LM139	Click here	Click here	Click here	Click here	Click here
LM239	Click here	Click here	Click here	Click here	Click here
LM339	Click here	Click here	Click here	Click here	Click here
LM139A	Click here	Click here	Click here	Click here	Click here
LM239A	Click here	Click here	Click here	Click here	Click here
LM339A	Click here	Click here	Click here	Click here	Click here
LM2901	Click here	Click here	Click here	Click here	Click here
LM2901AV	Click here	Click here	Click here	Click here	Click here
LM2901V	Click here	Click here	Click here	Click here	Click here

12.2 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. In the upper right corner, click on *Alert me* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

12.3 Community Resources

The following links connect to TI community resources. Linked contents are provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's Terms of Use.

TI E2E™ Online Community ***TI's Engineer-to-Engineer (E2E) Community.*** Created to foster collaboration among engineers. At e2e.ti.com, you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

Design Support ***TI's Design Support*** Quickly find helpful E2E forums along with design support tools and contact information for technical support.

12.4 Trademarks

E2E is a trademark of Texas Instruments.
All other trademarks are the property of their respective owners.

12.5 Electrostatic Discharge Caution

These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

12.6 Glossary

SLYZ022 — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

13 Mechanical, Packaging, and Orderable Information

The following pages include mechanical packaging and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser based versions of this data sheet, refer to the left hand navigation.