

Single General Purpose Voltage Comparator

Check for Samples: [SM73403](#)

FEATURES

- ($T_A = 25^\circ\text{C}$. Typical Values Unless Otherwise Specified).
- 5-Pin SOT23 Package
- Industrial Operating Range -40°C to $+85^\circ\text{C}$
- Single or Dual Power Supplies
- Wide Supply Voltage Range 5V to 30V
- Low Supply Current 300 μA
- Low Input Bias Current 7nA
- Low Input Offset Current $\pm 1\text{nA}$
- Low Input Offset Voltage $\pm 2\text{mV}$
- Response Time 440ns (50mV Overdrive)
- Input Common Mode Voltage 0 to $V_S - 1.5\text{V}$

APPLICATIONS

- Photovoltaic Electronics
- A/D Converters
- Pulse, Square Wave Generators
- Peak Detector
- Industrial Applications

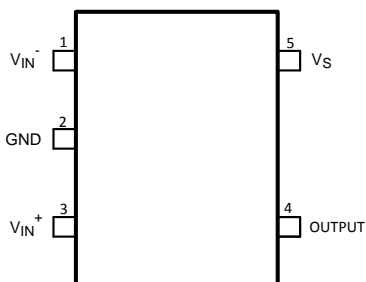
DESCRIPTION

The SM73403 is a single voltage comparator with an input common mode that includes ground. The SM73403 is designed to operate from a single 5V to 30V power supply or a split power supply. Its low supply current is virtually independent of the magnitude of the supply voltage.

The SM73403 features an open collector output stage. This allows the connection of an external resistor at the output. The output can directly interface with TTL, CMOS and other logic levels, by tying the resistor to different voltage levels (level translator).

The SM73403 is available in a space saving 5-Pin SOT23 package.

Connection Diagram



**Figure 1. 5-Pin SOT23
Package Number DBV0005A
Top View**



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Typical Circuit

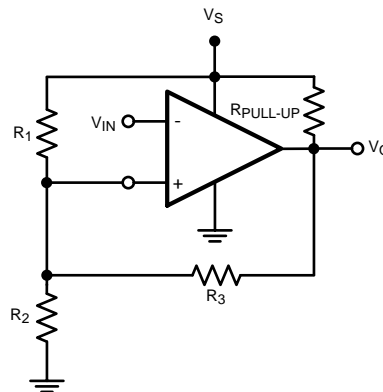


Figure 2. Inverting Comparator with Hysteresis



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.

Absolute Maximum Ratings ⁽¹⁾⁽²⁾

ESD Tolerance ⁽³⁾	
Human Body Model	2KV
Machine Model	200V
V_{IN} Differential	30V
Supply Voltages	30V or $\pm 15V$
Voltage at Input Pins	-0.3V to 30V
Storage Temperature Range	-65°C to +150°C
Junction Temperature ⁽⁴⁾	+150°C
Soldering Information	
Infrared or Convection (20 sec.)	235°C
Wave Soldering (10 sec.)	260°C

- (1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but specific performance is not guaranteed. For guaranteed specifications and the test conditions, see the Electrical Characteristics.
- (2) If Military/Aerospace specified devices are required, please contact the Texas Instruments Sales Office/ Distributors for availability and specifications.
- (3) Human Body Model, applicable std. MIL-STD-883, Method 3015.7. Machine Model, applicable std. JESD22-A115-A (ESD MM std. of JEDEC) Field-Induced Charge-Device Model, applicable std. JESD22-C101-C (ESD FICDM std. of JEDEC).
- (4) The maximum power dissipation is a function of $T_{J(MAX)}$, θ_{JA} . The maximum allowable power dissipation at any ambient temperature is $P_D = (T_{J(MAX)} - T_A) / \theta_{JA}$. All numbers apply for packages soldered directly onto a PC board.

Operating Ratings ⁽¹⁾

Supply Voltage, V_S	5V to 30V
Temperature Range ⁽²⁾	-40°C to +85°C
Package Thermal Resistance ⁽²⁾	
5-Pin SOT23	168°C/W

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Electrical Characteristics

Unless otherwise specified, all limits are guaranteed for $T_A = 25^\circ\text{C}$, $V_S = 5\text{V}$, $V^- = 0\text{V}$, $V_{CM} = V^+/2 = V_O$. **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Min (1)	Typ (2)	Max (1)	Units
V_{OS}	Input Offset Voltage	$V_S = 5\text{V to } 30\text{V}$, $V_O = 1.4\text{V}$, $V_{CM} = 0\text{V}$		2	7 10	mV
I_{OS}	Input Offset Current	$V_O = 1.4\text{V}$, $V_{CM} = 0\text{V}$		1.6	50 250	nA
I_B	Input Bias Current	$V_O = 1.4\text{V}$, $V_{CM} = 0\text{V}$		10	250 400	nA
I_S	Supply Current	$R_L = \text{Open}$, $V_S = 5\text{V}$		0.25	0.7	mA
		$R_L = \text{Open}$, $V_S = 30\text{V}$		0.30	2	
I_O	Output Sink Current	$V_{IN}^+ = 1\text{V}$, $V_{IN}^- = 0\text{V}$, $V_O = 1.5\text{V}$	6	13		mA
$I_{LEAKAGE}$	Output Leakage Current	$V_{IN}^+ = 1\text{V}$, $V_{IN}^- = 0\text{V}$, $V_O = 5\text{V}$		0.1		nA
		$V_{IN}^+ = 1\text{V}$, $V_{IN}^- = 0\text{V}$, $V_O = 30\text{V}$		1		μA
V_{OL}	Output Voltage Low	$I_O = -4\text{mA}$, $V_{IN}^+ = 0\text{V}$, $V_{IN}^- = 1\text{V}$		180	400 700	mV
V_{CM}	Common-Mode Input Voltage Range	$V_S = 5\text{V to } 30\text{V}$ (3)	0 0		$V_S - 1.5\text{V}$ $V_S - 2\text{V}$	V
A_V	Voltage Gain	$V_S = 15\text{V}$, $V_O = 1.4\text{V to } 11.4\text{V}$, $R_L > = 15\text{k}\Omega$ connected to V_S		120		V/mV
t_{PHL}	Propagation Delay (High to Low)	Input Overdrive = 5mV $R_L = 5.1\text{k}\Omega$ connected to 5V, $C_L = 15\text{pF}$		900		ns
		Input Overdrive = 50mV $R_L = 5.1\text{k}\Omega$ connected to 5V, $C_L = 15\text{pF}$		250		
t_{PLH}	Propagation Delay (Low to High)	Input Overdrive = 5mV $R_L = 5.1\text{k}\Omega$ connected to 5V, $C_L = 15\text{pF}$		940		μs
		Input Overdrive = 50mV $R_L = 5.1\text{k}\Omega$ connected to 5V, $C_L = 15\text{pF}$		440		ns

- (1) All limits are guaranteed by testing or statistical analysis.
- (2) Typical values represent the most likely parametric norm as determined at the time of characterization. Actual typical values may vary over time and will also depend on the application and configuration. The typical values are not tested and are not guaranteed on shipped production material.
- (3) The input common-mode voltage of either input should not be permitted to go below the negative rail by more than 0.3V. The upper end of the common-mode voltage range is $V_S - 1.5\text{V}$ at 25°C .

Typical Performance Characteristics

T_A = 25°C. Unless otherwise specified.

Supply Current vs. Supply Voltage

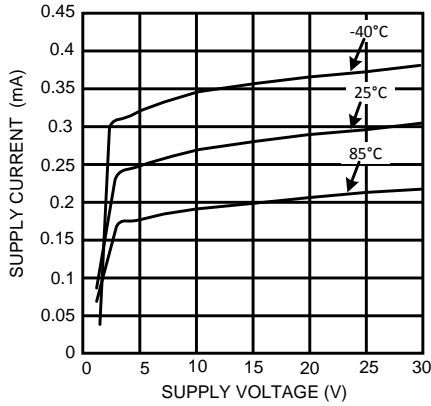


Figure 3.

Input Bias Current vs. Supply Current

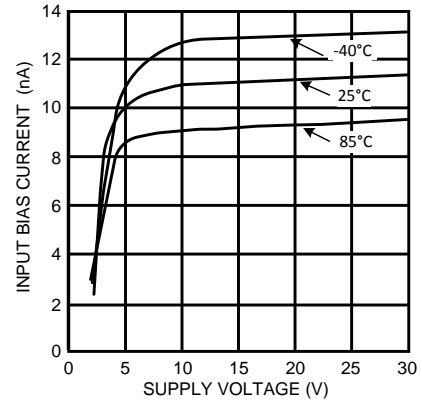


Figure 4.

Output Saturation Voltage vs. Output Sink Current

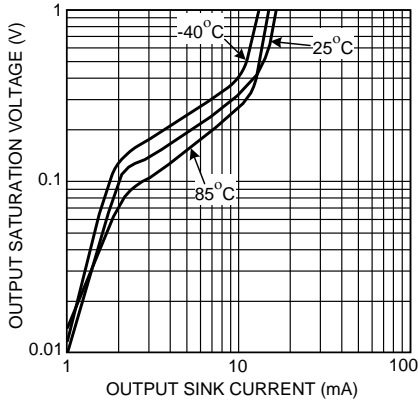


Figure 5.

Input Offset Voltage vs. Supply Voltage

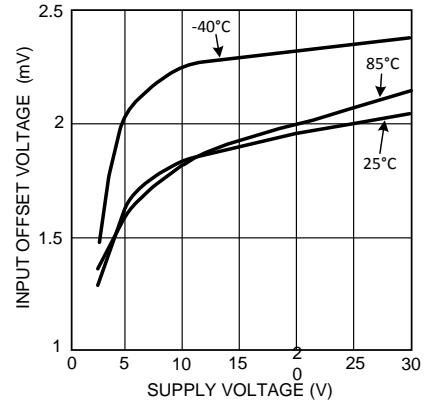


Figure 6.

Response Time for Various Input Overdrives – t_{PHL}

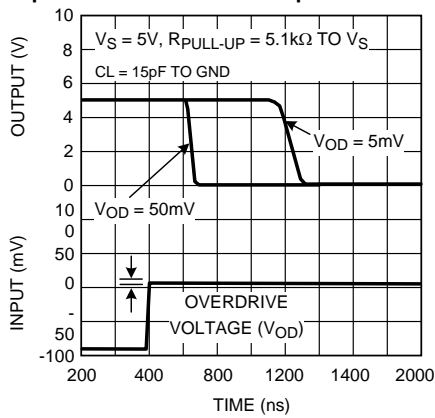


Figure 7.

Response Time for Various Input Overdrives – t_{PLH}

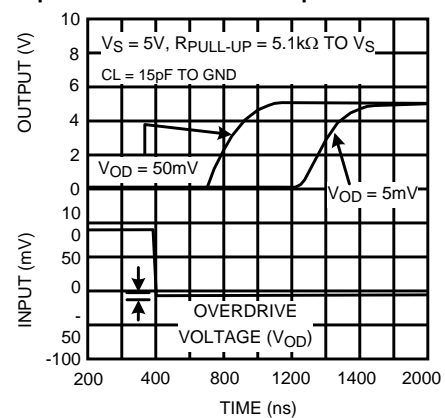


Figure 8.

APPLICATION NOTES

Basic Comparators

A comparator is quite often used to convert an analog signal to a digital signal. The comparator compares an input voltage (V_{IN}) at the non-inverting pin to the reference signal voltage (V_{REF}) at the inverting pin. If V_{IN} is less than V_{REF} the output (V_O) is low (V_{OL}). However, if V_{IN} is greater than V_{REF} , the output voltage (V_O) is high (V_{OH}). Refer to [Figure 9](#).

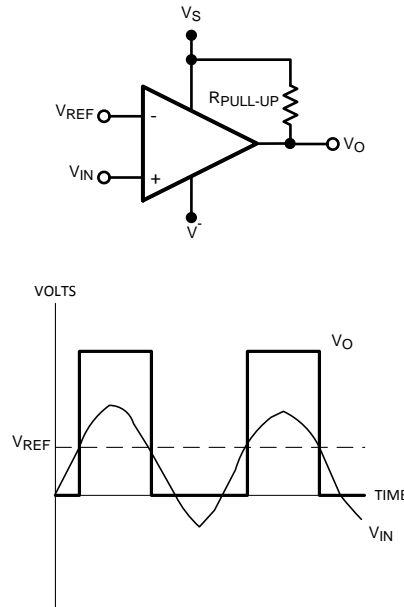


Figure 9. Basic Comparator

Hysteresis

The basic comparator configuration may oscillate or produce a noisy output if the applied differential input is near the comparator's input offset voltage. This tends to occur when the voltage on the input is equal or very close to the other input voltage. Adding hysteresis can prevent this problem. Hysteresis creates two switching thresholds (one for the rising input voltage and the other for the falling input voltage). Hysteresis is the voltage difference between the two switching thresholds. When both inputs are nearly equal, hysteresis causes one input to effectively move quickly pass the other. Thus, effectively moving the input out of the region that oscillation may occur.

For an inverting configured comparator, hysteresis can be added with a three resistor network and positive feedback. When input voltage (V_{IN}) at the inverting node is less than non-inverting node (V_T), the output is high. The equivalent circuit for the three resistor network is R_1 in parallel with R_3 and in series with R_2 . The lower threshold voltage V_{T1} is calculated by:

$$V_{T1} = ((V_S R_2) / (((R_1 R_3) / (R_1 + R_3)) + R_2)) \quad (1)$$

When V_{IN} is greater than V_T , the output voltage is low. The equivalent circuit for the three resistor network is R_2 in parallel with R_3 and in series with R_1 . The upper threshold voltage V_{T2} is calculated by:

$$V_{T2} = V_S ((R_2 R_3) / (R_2 + R_3)) / (R_1 + ((R_2 R_3) / (R_2 + R_3))) \quad (2)$$

The hysteresis is defined as

$$\Delta V_{IN} = V_{T1} - V_{T2} \quad (3)$$

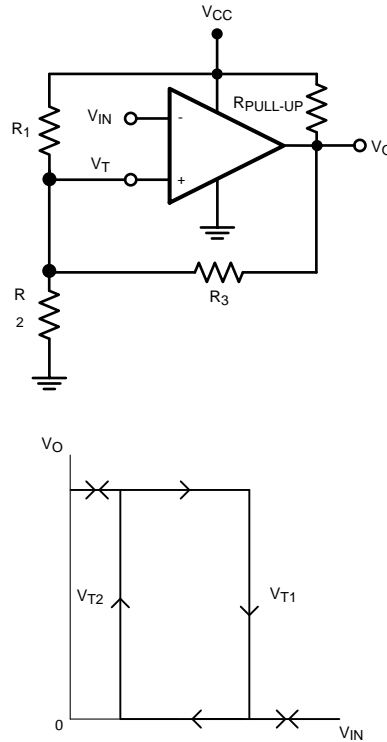


Figure 10. Inverting Configured Comparator – SM73403

Input Stage

The SM73403 has a bipolar input stage. The input common mode voltage range is from 0 to $(V_S - 1.5V)$.

Output Stage

The SM73403 has an open collector grounded-emitter NPN output transistor for the output stage. This requires an external pull-up resistor connected between the positive supply voltage and the output. The external pull-up resistor should be high enough resistance so to avoid excessive power dissipation. In addition, the pull-up resistor should be low enough resistance to enable the comparator to switch with the load circuitry connected. Because it is an open collector output stage, several comparator outputs can be connected together to create an OR'ing function output. With an open collector, the output can be used as a simple SPST switch to ground. The amount of current which the output can sink is approximately 10mA. When the maximum current limit is reached, the output transistor will saturate and the output will rise rapidly (Figure 11).

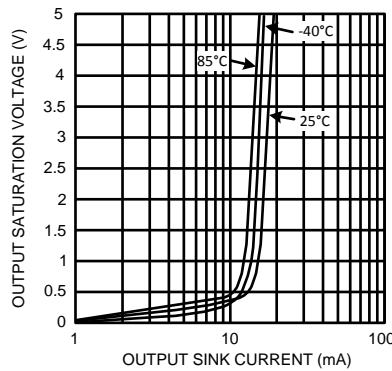


Figure 11. Output Saturation Voltage vs. Output Sink Current

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