INTEGRATED CIRCUITS
UNITRODE

UC161A
UC161B
UC161C

Micropower Quad Comparator

FEATURES

- Programmable Output Drive Capability
- Direct CMOS Logic Compatibility
- Low Power
- Direct Wire-OR of Outputs
- Wide Input Common Mode Range

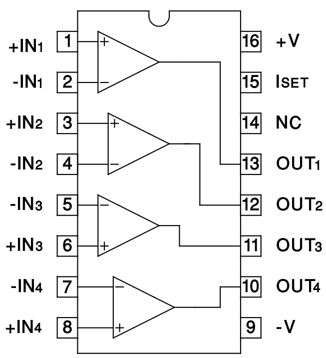
DESCRIPTION

The UC161 family of quad comparators feature programmable DC and AC parameters. A single external resistor can set the comparators to operate in the microwatt region for battery applications, or higher current levels can be set to obtain improved speed or drive capabilities. The outputs on these devices can be wire OR'd together, simplifying external logic requirements in some applications.

These devices are available in three temperature ranges, the UC161A is specified for the full military range, -55° C to +125°C, the UC161B for the industrial range, -25°C to +85°C, and the UC161C for the commercial range of 0°C to +70°C.

CONNECTION DIAGRAM

DIL-16 (TOP VIEW)
N or J Package

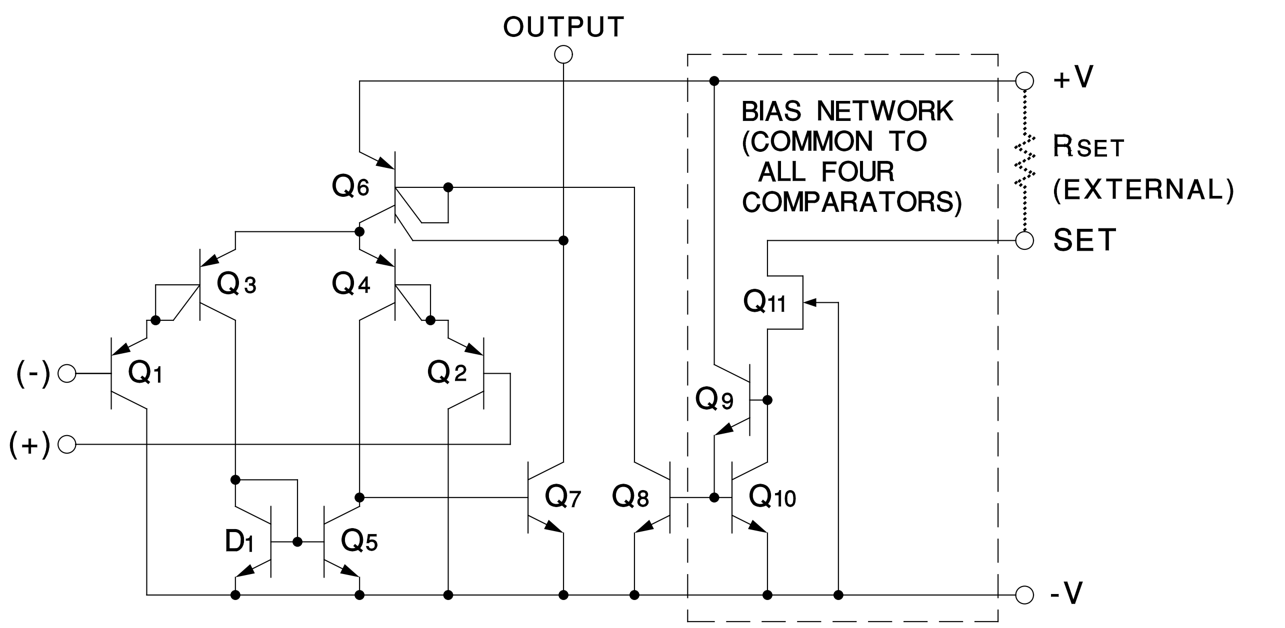


ABSOLUTE MAXIMUM RATINGS

Supply Voltage (+V to -V)	36V
Differential Input Voltage	±30V
Input Voltage	–V–0.3V to +V
Power Dissipation at T_A = 25°C	1000 mW
Power Dissipation at T_C = 25°C	2000 mW
Operating Junction Temperature	-55°C to +150°C
Storage Temperature	-65°C to +150°C
Lead Temperature (Soldering, 10 Sec.)	+300°C

Note: Consult Packaging Section of Databook for thermal limitations and considerations of package.

SIMPLIFIED SCHEMATIC (ONE COMPARATOR)



ELECTRICAL CHARACTERISTICS: Temperature range is -55° to +125°C for the UC161A, -25°C to +85°C for the UC161B, and 0°C to +70°C for the UC161C.

LOW POWER ELECTRICAL CHARACTERISTICS: Unless Otherwise Stated: $V_S = \pm 3V$, $I_{SET}{}^2 = 10\mu A$, $R_2 = 10M\Omega$, $C_L = 10pF$, $T_A = 25°C$, $T_A = T_J$.

	PARAMETER	SYMBOL	TEST CONDITIONS	UC161A			UC161B/C			UNITS
				MIN	TYP	MAX	MIN	TYP	MAX	
INPUT	Input Offset Voltage	V_{OS}			1	3		1	6	mV
	Input Offset Current	I_{OS}			1	20		1	25	nA
	Input Bias Current	I_{BT}			20	100		20	200	nA
OUTPUT	DC Open Loop Voltage Gain	A_{VOL}		20	30		10	30		V/mV
	Low Output Voltage[1]	V_{OL}	$R_L = 20k\Omega$		-2.95	-2.6		-2.95	-2.6	V
	High Output Voltage[1]	V_{OH}	$R_L = 200k\Omega$	2.5	2.9		2.5	2.9		V
DYNAMIC	Common Mode Range	CMR			+1.3/-3			+1.3/-3		V
	Response Time	t	100mV Overdrive, $C_L = 10pF$		5			5		µs
	Common Mode Rejection Ratio	CMRR	V_{IN} = CMR	75	90		75	90		dB
SUPPLY	Power Supply Rejection Ratio	PSRR		65	80		65	80		dB
	Supply Current	I_S	All Inputs Grounded, $R_L = \infty$		210	300		210	300	µA
										T_A = Over Temperature Range
	Input Offset Voltage	V_{OS}				5				mV
	DC Open Loop Voltage Gain	A_{VOL}		10			5			V/mV
	Supply Current	I_S	All Inputs Grounded, $R_L = \infty$			350			350	µA

HIGH POWER ELECTRICAL CHARACTERISTICS: Unless Otherwise Stated: $V_S = \pm 15V$, $I_{SET}{}^2 = 100\mu A$, $R_L = 2M\Omega$, $C_L = 10pF$, $T_A = 25°C$, $T_A = T_J$.

	PARAMETER	SYMBOL	TEST CONDITIONS	UC161A			UC161B/C			UNITS
				MIN	TYP	MAX	MIN	TYP	MAX	
INPUT	Input Offset Voltage	V_{OS}			1.5	3		1.5	6	mV
	Input Offset Current	I_{OS}			5	60		5	90	nA
	Input Bias Current	I_{BT}			100	400		100	800	nA
OUTPUT	DC Open Loop Voltage Gain	A_{VOL}		50	100		30	100		V/mV
	Low Output Voltage1	V_{OL}	$R_L = 20k\Omega$		-14.9	-14.6		-14.9	-14.6	V
	High Output Voltage1	V_{OH}	$R_L = 200k\Omega$	14.5	14.9		14.5	14.9		V
DYNAMIC	Common Mode Range	CMR			+13/-15			+13/-15		V
	Response Time	t	100mV Overdrive, $C_L = 10pF$		1			1		µs
	Common Mode Rejection Ratio	CMRR	V_{IN} = CMR	75	90		75	90		dB
SUPPLY	Power Supply Rejection Ratio	PSRR		65	80		65	80		dB
	Supply Current	I_S	All Inputs Grounded, $R_L = \infty$		2100	3500		2100	3500	µA

Note 1: The output current drive of the UC161 is non-symmetrical. This facilitates the wire-ORing of two comparator outputs. The output pull-down current capability is typically 75–150 times the pull-up current.

Note 2: Set current (I_{SET}) and supply current (I_{SUPPLY}) can be determined by the following formulas:

$$I_{SET} = \frac{[(+V) - (2V_{BE}) - (-V)]}{R_{SET}} \;:\; I_{SUPPLY} = 21 \times I_{SET}.$$

HIGH POWER ELECTRICAL CHARACTERISTICS (Continued): $T_A = T_J$.

T_A = Over Temperature Range

	PARAMETER	SYMBOL	TEST CONDITIONS	UC161A			UC161B/C			UNITS
				MIN	TYP	MAX	MIN	TYP	MAX	
	Input Offset Voltage	V_{OS}				6				mV
	Input Bias Current	I_{BT}				500				nA
	DC Open Loop Voltage Gain	A_{VOL}		25			15			V/mV
	Supply Current	I_S	All Inputs Grounded $R_L = \infty$			4000			4000	µA

Note 1: The output current drive of the UC161 is non-symmetrical. This facilitates the wire-ORing of two comparator outputs. The output pull-down current capability is typically 75–150 times the pull-up current.

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$$I_{SET} = \frac{[(+V) - (2V_{BE}) - (-V)]}{R_{SET}} : I_{SUPPLY} = 21 \times I_{SET}.$$

APPLICATION AND OPERATION INFORMATION DESCRIPTION

The UC161 is a monolithic quad micropower comparator with an external control for varying its AC and DC characteristics. The variation of a single programming resistor will simultaneously alter parameters such as supply current, input bias, current slew rate, output drive capability, and gain. By making this resistor large, operation at very small supply current levels and power dissipations is possible. The UC161 is therefore ideal for systems requiring minimum power drain, such as battery-powered instrumentation, aerospace systems, CMOS designs, and remote security systems.

The circuit (see Simplified Schematic) is composed of five major blocks–four comparators and a common bias network. Q_1-Q_6, and D_1 from a darlington differential amplifier with double-to-single ended conversion. Q_6 is a dual current source whose outputs are exactly twice the current flowing through Q_8. The collector current of Q_8 is a function of the current supplied externally to Q_9-Q_{10}, which in turn is known as the set current of I_{SET}. This set current is established by a resistor connected between the I_{SET} terminal and a voltage source, most commonly the positive supply. Q_{11} prevents excessive current from flowing through Q_9 and Q_{10} in the event the I_{SET} terminal is shorted to the positive supply; it has no effect on circuit operation under normal conditions.

SETTING THE SET CURRENT

The set current can be expressed as:

$$I_{SET} = \frac{[(+V) - (2V_{BE}) - (-V)]}{R_{SET}}$$

where +V is the voltage to which the control resistor is connected, -V is the negative supply voltage, V_{BE} is the base emitter drop of Q_9 or Q_{10} (about 0.7V), and R_{SET} is the value of the external control resistor or set resistor. Equation 1 is simply a derivative of ohms law. There is also an analytical relationship between I_{SET} and the total supply current:

I_{SUPPLY} = [I_{SET} (current sourced by Q_6 to Q_8)

+2 I_{SET} (current sourced to the differential amplifier by Q_6)

+2 I_{SET} (current sourced to the comparator output by Q_6)

× 4 (the total number of comparators)

+ I_{SET} (current sourced through Q_{11}, Q_{10}, and Q_9 to –V)

$= [I_{SET} + 2\ I_{SET} + 2\ I_{SET}] \times 4 + I_{SET}$

$= 21\ I_{SET}$

The output current pulldown capability (I_{OL}) of the UC161 is about 2 orders of magnitude greater than the high output drive current, (I_{OH}), which allows wire-ORing the outputs. I_{OH} is simply the current sourced by Q_6:

$$I_{OH} = 2 \times I_{SET}$$

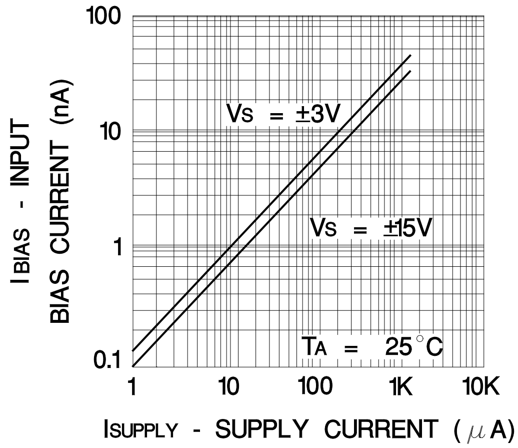
I_{OL} is found by multiplying the current sourced by the collector of Q_6 by the gain Q_7:

$$I_{OL} = \beta\,(Q_7) \times 2\ I_{SET}$$

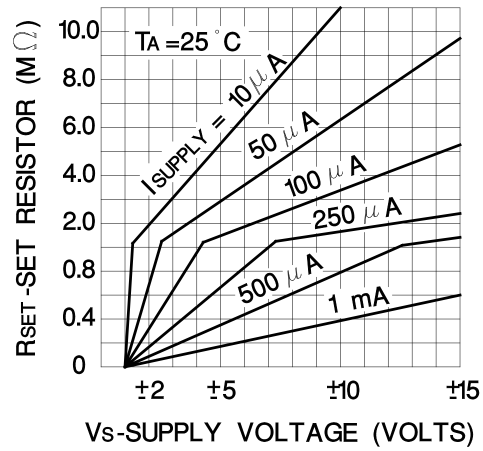
The beta of Q_7 is about 75–150.

APPLICATION AND OPERATION INFORMATION (Continued)

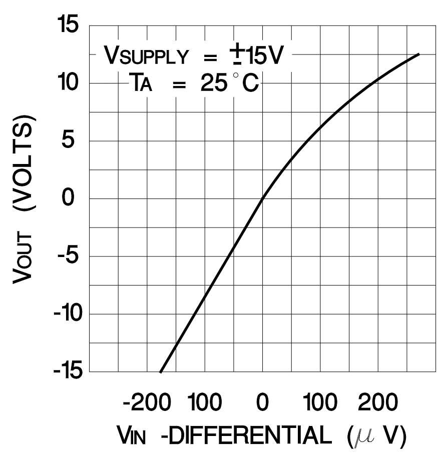
Input Bias Current vs Supply Current



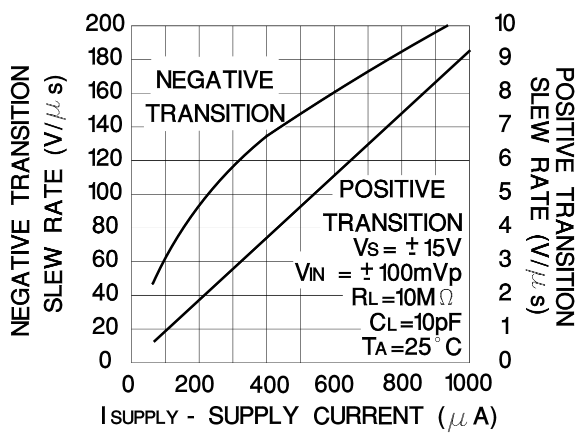
RSET vs VSUPPLY for Various Supplies



Transfer Characteristics



Slew Rate vs Supply Current



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