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NTE1509
Integrated Circuit
10–Step Dot/Bar Display Driver
for Logarithmic Scale

Description:

The NTE1509 is a monolithic integrated circuit in an 18–Lead DIP type package that senses analog voltage levels and drives 10 LEDs, LCDs, or vacuum fluorescent displays, providing a logarithmic 3dB analog display. A single pin changes the display from a bar graph to a moving dot display. LED current is regulated and programmable, eliminating the need for current limiting resistors. The whole display system can operate from a single supply as low as 3V or as high as 25V

The circuit contains its own adjustable reference and accurate 10–step voltage divider. The high impedance input buffer accepts signals down to GND and up to within 1.5V of the positive supply. Further, it needs no protection against inputs of ±35V. The input buffer drives 10 individual comparators referenced to the precision divider. Accuracy is typically better than 1dB.

The NTE1509's 3dB/step display is suited for signals with wide dynamic range, such as audio level, power, light intensity, or vibration. Audio applications include average or peak level indicators, power meters, and RF signal strength meters. Replacing conventional meters with an LED bar graph results in a faster responding, more rugged display with high visibility that retains the ease of interpretation of an analog display.

The NTE1509 is extremely easy to apply. A 1.2V full–scale meter requires only 1 resistor in addition to the 10 display LEDs. One more resistor programs the full–scale anywhere from 1.2V to 12V independent of supply voltage. LED brightness is easily controlled with a single pot.

The NTE1509 is very versitile. The outputs can drive LCDs, vacuum fluorescents, and incandescent bulbs as well as LEDs of any color. Multiple devices can be cascaded for a dot or bar mode display with a range of 60 or 90dB. NTE1509s can also be cascaded with NTE1508s for a linear/log display or with NTE1549s for an extended–range VU meter.

Features:

- 3dB/Step, 30dB Range
- Drives LEDs, LCDs or vacuum fluorescents
- Bar or dot display mode externally selectable by user
- Expandable to displays of 90dB
- Internal voltage reference from 1.2V to 12V
- Operates with single supply of 3V to 25V
- Inputs operate down to GND
- Output current programmable from 1 to 30mA
- Input withstands ±35V without damage or false outputs
- Outputs are current regulated, open–collectors
- Directly Drives TTL or CMOS
- The internal 10–step divider is floating and can be referenced to a wide range of voltages

Absolute Maximum Ratings:

Power Dissipation (Note 1) 1365mW
Supply Voltage 25V
Voltage on Output Drivers 25V
Input Signal Overvoltage (Note 2) . . . . ±35V
Divider Voltage . . . . –100mV to V+
Reference Load Current 10mA
Storage Temperature Range . . . . –55° to +150°C
Lead Temperature (During soldering, 10sec) . . . . +260°C

Note 1. The maximum junction temperature of the NTE1509 is +100°C. Device must be derated for operation at elevated temperatures. Junction to ambient thermal resistance is 55°C/W.

Note 2. Pin5 input current must be limited to ±3mA. The addition of a 39kΩ resistor in series with Pin5 allows ±100V signals without damage.

Electrical Characteristics: (Note 2, unless otherwise specified, all specifications apply with the following conditions:

$3V_{DC} \leq V+ \leq 20V_{DC}$ $V_{REF}, V_{RHI}, V_{RLO} \leq (V+ -1.5V)$
$3V_{DC} \leq V_{LED} \leq V+$ $0V \leq V_{IN} \leq V+ -1.5V$
$-0.015V \leq V_{RLO} \leq 12V_{DC}$ T_A +25°C, $I_{L(REF)}$ = 0.2mA,
$-0.015V \leq V_{RHI} \leq 12V_{DC}$ Pin9 connected to Pin3 (Bar Mode)

Parameter	Test Conditions	Min	Typ	Max	Unit
Comparator					
Offset Voltage, Buffer, and First Comparator	$0V \leq V_{RLO} = V_{RHI} \leq 12V$, I_{LED} = 1mA	–	3	10	mV
Offset Voltage, Buffer, and Any Other Comparator	$0V \leq V_{RLO} = V_{RHI} \leq 12V$, I_{LED} = 1mA	–	3	15	mV
Gain ($\Delta I_{LED}/\Delta V_{IN}$)	$I_{L(REF)}$ = 2mA, I_{LED} = 10mA	3	8	–	mA/mV
Input Bias Current (At Pin5)	$0V \leq V_{IN} \leq V+$ =1.5V	–	25	100	nA
Input Signal Overdrive	No Change is Display	–35	–	+35	V
Voltage Divider					
Divider Resistance	Total, Pin6 to Pin4	16	28	36	kΩ
Relative Accuracy (Input Change Between Any Two Threshold Points)	Note 3	2.0	3.0	4.0	dB
Absolute Accuracy at Each Threshold Point	V_{IN} = –3, –6dB, Note 3	–0.5	–	+0.5	dB
	V_{IN} = –9dB, Note 3	–0.5	–	+0.65	dB
	V_{IN} = –12, –15, –18dB, Note 3	–0.5	–	+1.0	dB
	V_{IN} = –21, –24, –27dB, Note 3	–0.5	–	+1.5	dB
Voltage Reference					
Output Voltage	$0.1mA \leq I_{L(REF)} \leq 4mA$, V+ = V_{LED} = 5V	1.2	1.28	1.34	V
Line Regulation	$3V \leq V+ \leq 18V$	–	0.01	0.03	%/V
Load Regulation	$0.1mA \leq I_{L(REF)} \leq 4mA$, V+ = V_{LED} = 5V	–	0.4	2.0	%
Output Voltage Change with Temperature	$0° \leq T_A \leq +70°C$, $I_{L(REF)}$ = 1mA, V+ = 5V	–	1	–	%
Adjust Pin Current		–	75	120	µA

Note 2. Pin5 input current must be limited to ±3mA. The addition of a 39kΩ resistor in series with Pin5 allows ±100V signals without damage.

Note 3. Accuracy is measured referred to +10.000V_{DC} at Pin5, with + 10.000V_{DC} at Pin6, and 0.000V_{DC} at Pin4. At lower full–scale voltages, buffer and comparator offset voltage may add significant error. See table for threshold voltages.

Electrical Characteristics (Cont'd): (Note 2, unless otherwise specified, all specifications apply with the following conditions:

$3V_{DC} \leq V+ \leq 20V_{DC}$ $\quad$ $V_{REF}, V_{RHI}, V_{RLO} \leq (V+ -1.5V)$
$3V_{DC} \leq V_{LED} \leq V+$ $\quad$ $0V \leq V_{IN} \leq V+ -1.5V$
$-0.015V \leq V_{RLO} \leq 12V_{DC}$ $\quad$ T_A +25°C, $I_{L(REF)}$ = 0.2mA,
$-0.015V \leq V_{RHI} \leq 12V_{DC}$ $\quad$ V_{LED} = 3V, Pin9 connected to Pin3 (Bar Mode)

Parameter	Test Conditions		Min	Typ	Max	Unit
Output Drivers						
LED Current	$V+ = V_{LED} = 5V$, $I_{L(REF)} = 1mA$		7	10	13	mA
LED Current Difference (Between Largest and Smallest LED Currents)	$V_{LED} = 5V$	$I_{LED} = 2mA$	–	0.12	0.4	mA
		$I_{LED} = 20mA$	–	1.2	3.0	mA
LED Current Regulation	$2V \leq V_{LED} \leq 17V$	$I_{LED} = 2mA$	–	0.1	0.25	mA
		$I_{LED} = 20mA$	–	1	3	mA
Dropout Voltage	$I_{LED(ON)} = 20mA$, $V_{LED} = 5V$, $\Delta I_{LED} = 2mA$		–	–	1.5	V
Saturation Voltage	$I_{LED} = 2mA$, $I_{L(REF)} = 0.4mA$		–	0.15	0.4	V
Output Leakage, Each Collector	Bar Mode, Note 4		–	0.1	10	μA
Output Leakage	Dot Mode, Note 4	Pin10 to Pin18	–	0.1	10	μA
		Pin1	60	150	450	μA
Supply Current						
Standby Supply Current (All Outputs OFF)	$V+ = 5V$, $I_{L(REF)} = 0.2mA$		–	2.4	4.2	μA
	$V+ = 20V$, $I_{L(REF)} = 1mA$		–	6.1	9.2	μA

Note 2. Pin5 input current must be limited to ±3mA. The addition of a 39kΩ resistor in series with Pin5 allows ±100V signals without damage.

Note 4. Bar mode results when Pin9 is within 20mV of V+. Dot mode results when Pin9 is pulled at least 200mV below V+ or left open circuit. LED No. 10 (Pin10 output current) is disabled if Pin9 is pulled 0.9V or more below V_{LED}.

Threshold Voltage: (Note 3)

Output	dB	Min	Typ	Max	Output	dB	Min	Typ	Max
1	–27	0.422	0.447	0.531	6	–12	2.372	2.512	2.819
1	–24	0.596	0.631	0.750	7	–9	3.350	3.548	3.825
3	–21	0.841	0.891	1.059	8	–6	4.732	5.012	5.309
4	–18	1.189	1.259	1.413	9	–3	6.683	7.079	7.498
5	–15	1.679	1.778	1.995	10	0	9.985	10.000	10.015

Note 3. Accuracy is measured referred to $+10.000V_{DC}$ at Pin5, with $+ 10.000V_{DC}$ at Pin6, and $0.000V_{DC}$ at Pin4. At lower full–scale voltages, buffer and comparator offset voltage may add significant error. See table for threshold voltages.

Pin Connection Diagram