National Semiconductor

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LM231A/LM231/LM331A/LM331
Precision Voltage-to-Frequency Converters

General Description

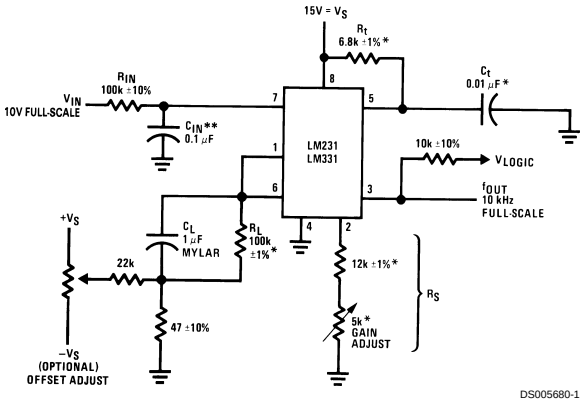
The LM231/LM331 family of voltage-to-frequency converters are ideally suited for use in simple low-cost circuits for analog-to-digital conversion, precision frequency-to-voltage conversion, long-term integration, linear frequency modulation or demodulation, and many other functions. The output when used as a voltage-to-frequency converter is a pulse train at a frequency precisely proportional to the applied input voltage. Thus, it provides all the inherent advantages of the voltage-to-frequency conversion techniques, and is easy to apply in all standard voltage-to-frequency converter applications. Further, the LM231A/LM331A attain a new high level of accuracy versus temperature which could only be attained with expensive voltage-to-frequency modules. Additionally the LM231/331 are ideally suited for use in digital systems at low power supply voltages and can provide low-cost analog-to-digital conversion in microprocessor-controlled systems. And, the frequency from a battery powered voltage-to-frequency converter can be easily channeled through a simple photoisolator to provide isolation against high common mode levels.

The LM231/LM331 utilize a new temperature-compensated band-gap reference circuit, to provide excellent accuracy over the full operating temperature range, at power supplies as low as 4.0V. The precision timer circuit has low bias currents without degrading the quick response necessary for 100 kHz voltage-to-frequency conversion. And the output are capable of driving 3 TTL loads, or a high voltage output up to 40V, yet is short-circuit-proof against V_{CC}.

Features

- Guaranteed linearity 0.01% max
- Improved performance in existing voltage-to-frequency conversion applications
- Split or single supply operation
- Operates on single 5V supply
- Pulse output compatible with all logic forms
- Excellent temperature stability, ±50 ppm/°C max
- Low power dissipation, 15 mW typical at 5V
- Wide dynamic range, 100 dB min at 10 kHz full scale frequency
- Wide range of full scale frequency, 1 Hz to 100 kHz
- Low cost

Typical Applications



$$f_{OUT} = \frac{V_{IN}}{2.09\ V} \bullet \frac{R_S}{R_L} \bullet \frac{1}{R_t C_t}$$

*Use stable components with low temperature coefficients. See Typical Applications section.
**0.1μF or 1μF, See "Principles of Operation."

FIGURE 1. Simple Stand-Alone Voltage-to-Frequency Converter with ±0.03% Typical Linearity (f = 10 Hz to 11 kHz)

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Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

	LM231A/LM231	LM331A/LM331
Supply Voltage	40V	40V
Output Short Circuit to Ground	Continuous	Continuous
Output Short Circuit to V_{CC}	Continuous	Continuous
Input Voltage	−0.2V to $+V_S$	−0.2V to $+V_S$
	T_{MIN} T_{MAX}	T_{MIN} T_{MAX}
Operating Ambient Temperature Range	−25˚C to +85˚C	0˚C to +70˚C
Power Dissipation (P_D at 25˚C) and Thermal Resistance (θ_{jA})		
(N Package) P_D	1.25W	1.25W
θ_{jA}	100˚C/W	100˚C/W
Lead Temperature (Soldering, 10 sec.)		
Dual-In-Line Package (Plastic)	260˚C	260˚C
ESD Susceptibility (Note 4)		
N Package	500V	500V

Electrical Characteristics

T_A=25˚C unless otherwise specified (Note 2)

Parameter	Conditions	Min	Typ	Max	Units
VFC Non-Linearity (Note 3)	$4.5V \le V_S \le 20V$		±0.003	±0.01	% Full-Scale
	$T_{MIN} \le T_A \le T_{MAX}$		±0.006	±0.02	% Full-Scale
VFC Non-Linearity	V_S = 15V, f = 10 Hz to 11 kHz		±0.024	±0.14	%Full-Scale
In Circuit of *Figure 1*					
Conversion Accuracy Scale Factor (Gain)	V_{IN} = −10V, R_S = 14 kΩ				
LM231, LM231A		0.95	1.00	1.05	kHz/V
LM331, LM331A		0.90	1.00	1.10	kHz/V
Temperature Stability of Gain	$T_{MIN} \le T_A \le T_{MAX}$, $4.5V \le V_S \le 20V$				
LM231/LM331			±30	±150	ppm/˚C
LM231A/LM331A			±20	±50	ppm/˚C
Change of Gain with V_S	$4.5V \le V_S \le 10V$		0.01	0.1	%/V
	$10V \le V_S \le 40V$		0.006	0.06	%/V
Rated Full-Scale Frequency	V_{IN} = −10V	10.0			kHz
Gain Stability vs Time (1000 Hrs)	$T_{MIN} \le T_A \le T_{MAX}$		±0.02		% Full-Scale
Overrange (Beyond Full-Scale) Frequency	V_{IN} = −11V	10			%
INPUT COMPARATOR					
Offset Voltage			±3	±10	mV
LM231/LM331	$T_{MIN} \le T_A \le T_{MAX}$		±4	±14	mV
LM231A/LM331A	$T_{MIN} \le T_A \le T_{MAX}$		±3	±10	mV
Bias Current			−80	−300	nA
Offset Current			±8	±100	nA
Common-Mode Range	$T_{MIN} \le T_A \le T_{MAX}$	−0.2		V_{CC}−2.0	V
TIMER					
Timer Threshold Voltage, Pin 5		0.63	0.667	0.70	x V_S
Input Bias Current, Pin 5	V_S = 15V				
All Devices	$0V \le V_{PIN\ 5} \le 9.9V$		±10	±100	nA
LM231/LM331	$V_{PIN\ 5}$ = 10V		200	1000	nA
LM231A/LM331A	$V_{PIN\ 5}$ = 10V		200	500	nA