### Daftar Komponen

<table>
<thead>
<tr>
<th>Kode</th>
<th>Nama Komponen</th>
<th>Bahan</th>
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</thead>
<tbody>
<tr>
<td>R1</td>
<td>Resistor</td>
<td>Karbon</td>
<td>RA KΩ/0,5 W</td>
</tr>
<tr>
<td>R2</td>
<td>Resistor</td>
<td>Karbon</td>
<td>1 KΩ/0,5 W</td>
</tr>
<tr>
<td>R3</td>
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<td>Karbon</td>
<td>100 KΩ/0,5 W</td>
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<td>Karbon</td>
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<tr>
<td>R5</td>
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<td>1 MΩ/0,5 W</td>
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<tr>
<td>R6</td>
<td>Resistor</td>
<td>Karbon</td>
<td>10 KΩ/0,5 W</td>
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<td>Karbon</td>
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<tr>
<td>R8</td>
<td>Resistor</td>
<td>Karbon</td>
<td>6,8 KΩ/0,5 W</td>
</tr>
<tr>
<td>R9</td>
<td>Resistor</td>
<td>Karbon</td>
<td>10 KΩ/0,5 W</td>
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<td>R10</td>
<td>Resistor</td>
<td>Karbon</td>
<td>10 KΩ/0,5 W</td>
</tr>
<tr>
<td>R11</td>
<td>Resistor</td>
<td>Karbon</td>
<td>56 KΩ/0,5 W</td>
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<tr>
<td>C1</td>
<td>Kapasitor</td>
<td>Elektrolit</td>
<td>0,22 μF/16 V</td>
</tr>
<tr>
<td>C2</td>
<td>Kapasitor</td>
<td>Elektrolit</td>
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<td>C3</td>
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<td>C4</td>
<td>Kapasitor</td>
<td>Elektrolit</td>
<td>0,1 μF/16 V</td>
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<tr>
<td>C5</td>
<td>Kapasitor</td>
<td>Elektrolit</td>
<td>0,1 μF/16 V</td>
</tr>
<tr>
<td>C6</td>
<td>Kapasitor</td>
<td>Elektrolit</td>
<td>1 μF/16 V</td>
</tr>
<tr>
<td>C7</td>
<td>Kapasitor</td>
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<td>0,22 μF/16 V</td>
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<tr>
<td>VR</td>
<td>Trimpot</td>
<td>Karbon</td>
<td>100 KΩ/0,5 W</td>
</tr>
<tr>
<td>D</td>
<td>Infra merah</td>
<td>G As</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>Phototransistor</td>
<td></td>
<td></td>
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<tr>
<td>A1</td>
<td>IC</td>
<td></td>
<td>LM 5 5 5</td>
</tr>
<tr>
<td>A2</td>
<td>IC</td>
<td></td>
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</tr>
<tr>
<td>A3</td>
<td>IC</td>
<td></td>
<td>LM 3 3 1</td>
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</table>
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National Semiconductor

LM555/LM555C Timer

General Description

The LM555 is a highly stable device for generating accurate time delays and oscillations. Additional terminals are provided for integrating or starting if desired. In the time delay mode of operation, the time is precisely controlled by one external resistor and capacitor. For oscillation operation as an astable, the free running frequency and duty cycle are accurately controlled with two external resistors and one capacitor. The output may be triggered and reset on falling waveform, and the external circuit can source or sink up to 20mA in either TTL circuits.

Features

- Direct replacement for 555/NE555
- Timing from microseconds through hours
- Operates in both astable and monostable modes
- Adjustable time delay
- Output TTL compatible
- Temperature stability better than ±0.01% per °C
- Normally on and normally off output

Applications

- Precision timing
- Pulse generation
- Sequential timing
- Timer divider generation
- Pulse width modulation
- Pulse position modulation
- Linear ramp generator

Schematic Diagram

Connection Diagrams

Order Numbers: LM555C, LM555CH, LM555CN
Order Number: LM555CH
Order Number: LM555CN
Order Number: LM555CN
Order Number: LM555CN
Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
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<td>15V</td>
<td>6V</td>
<td></td>
<td>12V</td>
<td>V</td>
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<tr>
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<td>5V</td>
<td></td>
<td>10V</td>
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<td>Output Power (Pout)</td>
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<td>mW</td>
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<td>LM308N-3</td>
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<tr>
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<td></td>
<td>300</td>
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<td>Output Current (Io)</td>
<td></td>
<td></td>
<td>52</td>
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<td>µA</td>
</tr>
<tr>
<td>LM308N-1</td>
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<td>45</td>
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<td>µA</td>
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<td>LM308N-3</td>
<td></td>
<td></td>
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<td></td>
<td>µA</td>
</tr>
<tr>
<td>LM308N</td>
<td></td>
<td></td>
<td>45</td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td>Input Current (Ii)</td>
<td></td>
<td></td>
<td>300</td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td>LM308N-1</td>
<td></td>
<td></td>
<td>45</td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td>LM308N-3</td>
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<td></td>
<td>45</td>
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<td>µA</td>
</tr>
<tr>
<td>LM308N</td>
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<td></td>
<td>45</td>
<td></td>
<td>µA</td>
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<tr>
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<td>%</td>
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<td></td>
<td>0.2</td>
<td></td>
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<td>LM308N-3</td>
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<td>%</td>
</tr>
<tr>
<td>LM308N</td>
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<td></td>
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<td></td>
<td>%</td>
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<tr>
<td>Power Supply Rejection Rate (PSRR)</td>
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<td>60</td>
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<td>µA</td>
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<td>LM308N-1</td>
<td></td>
<td></td>
<td>60</td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td>LM308N-3</td>
<td></td>
<td></td>
<td>60</td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td>LM308N</td>
<td></td>
<td></td>
<td>60</td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td>Input Capacitance (Capac)</td>
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<td></td>
<td>95</td>
<td></td>
<td>kΩ</td>
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<td>kΩ</td>
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<tr>
<td>LM308N</td>
<td></td>
<td></td>
<td>95</td>
<td></td>
<td>kΩ</td>
</tr>
</tbody>
</table>

Note 1: For operation in ambient temperatures above 25°C, the device must be derated based on a 15°C maximum junction temperature and a thermal resistance of 100°C/W to ambient.

Note 2: For operation in ambient temperatures above 25°C, the device must be derated based on a 15°C maximum junction temperature and a thermal resistance of 100°C/W to ambient.

Application Hints

GAIN CONTROL

To make the LM308 a more versatile amplifier, two pins (1 and 8) are provided for gain control. Pins 1 and 8 can be used to vary the feedback resistance to control the gain. The gain can be set by choosing a feedback resistor value between 300 and 2000 kΩ. A 200 kΩ feedback resistor provides a gain of about 6.8, which is useful for many applications.

Additional external components can be placed in parallel with the internal feedback network to tailor the gain or harmonic frequency response for individual applications. For example, we can compensate low-pass filters with resistor values that are greater than 1 kΩ to achieve a gain of 6.8. This is achieved by inserting a capacitor in series with the resistor, which helps to reduce the gain.

INPUT BEASING

The schematic shows that the input signals are biased to a common mode signal of 1 V. The input current through the input transistors is about 200 nA, so the input biasing is not affected by the 1.2K resistor. The input current will be less than 50 µA, and the output power will be less than 25 µW. If the output current is less than 50 µA, then it is not necessary to add an external resistor to the output. For the desired output, the voltage across the source must be less than 10 V, which is achieved by using a 0.1 µF capacitor in the output. If the output voltage is not sufficient, the output can be increased by increasing the output current or increasing the supply voltage.

When using the LM308 with higher gain, be careful to stay within the specifications of the LM308. If the output current is too high, the input current may become excessive, leading to a decrease in the overall gain. It is recommended to monitor the input current and adjust the output current accordingly.
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Precision Voltage-to-Frequency Converters

General Description
The LM313A/LM321A/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, ramp-kHz 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 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. Furthermore, the LM313A/LM321A/LM331A attains a new level of accuracy versus temperature which could only be attained with more complex voltage-to-frequency circuits. Additionally, the LM313A/LM321A/LM331A is 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 phototransistor to provide isolation against high common mode levels.

The LM313A/LM321A/LM331 utilizes 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 is capable of driving 3 TTL loads, or a high voltage output up to 40V yet is short-circuit-proof against VCC.

Features
- Guaranteed linearity 0.01% max
- Improved performance in existing voltage-to-frequency conversion applications
- Suits single supply operation
- Optional 5V output
- 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 in 10 kHz full scale frequency
- Wide range of full scale frequency, 1 Hz to 100 kHz
- Low cost

Typical Applications

FIGURE 1. Simple Stand-Alone Voltage-to-Frequency Converter with ±0.003% Typical Linearity (10 Hz to 11 kHz)


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FIGURE 1. Simple Stand-Alone Voltage-to-Frequency Converter with ±0.003% Typical Linearity (10 Hz to 11 kHz)
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Minimum</th>
<th>Typical</th>
<th>Maximum</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage</td>
<td>40V</td>
<td>-</td>
<td>40V</td>
<td>-</td>
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<tr>
<td>Operating Ambient Temperature Range</td>
<td>-55°C to +125°C</td>
<td>-</td>
<td>25°C to +85°C</td>
<td>-</td>
</tr>
<tr>
<td>Power Dissipation (Pd)</td>
<td>1.25W</td>
<td>-</td>
<td>1.25W</td>
<td>-</td>
</tr>
<tr>
<td>Lead Temperature (Soldering, 10 sec.)</td>
<td>260°C</td>
<td>-</td>
<td>260°C</td>
<td>-</td>
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<tr>
<td>ESD Susceptibility (Note 4)</td>
<td>±2000V</td>
<td>-</td>
<td>±500V</td>
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### Electrical Characteristics

#### Operating Conditions

<table>
<thead>
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<th>Parameter</th>
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<th>Typical</th>
<th>Maximum</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>VFC Non-Linearity (Note 3)</td>
<td>±0.02%</td>
<td>-</td>
<td>±0.02%</td>
<td>% Full-scale</td>
</tr>
<tr>
<td>VFC Non-Linearity (In Circuit of Figure 1)</td>
<td>±0.02%</td>
<td>-</td>
<td>±0.14%</td>
<td>% Full-scale</td>
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<td>Conversion Accuracy Scale Factor (Gain)</td>
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<td>1.00</td>
<td>1.05</td>
<td>ppm/K</td>
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<td>Temperature Stability of Gain</td>
<td>±30 ppm/K</td>
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<td>±150 ppm/K</td>
<td>ppm/K</td>
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<td>Change of Gain with Vs</td>
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<td>%/V</td>
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<td>Rated Full-Scale Frequency</td>
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<td>kHz</td>
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<td>Gain Stability vs Time (1000 Hrs)</td>
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<td>-</td>
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<td>% Full-scale</td>
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<td>Overload Frequency (20% Duty Cycle)</td>
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<td>&gt;1 MHz</td>
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#### Input Comparator

<table>
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<th>Parameter</th>
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<th>Maximum</th>
<th>Units</th>
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<td>Offset Voltage</td>
<td>±3 mV</td>
<td>&lt;14 mV</td>
<td>±10 mV</td>
<td>mV</td>
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<tr>
<td>Bias Current</td>
<td>±90 nA</td>
<td>±900 nA</td>
<td>±100 nA</td>
<td>nA</td>
</tr>
<tr>
<td>Common-Mode Range</td>
<td>±0.2 V</td>
<td>Vcc - 2.0 V</td>
<td></td>
<td>V</td>
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</tbody>
</table>

(Note 1): If military/aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.
### Electrical Characteristics

**Parameter** | **Conditions** | **Min** | **Typ** | **Max** | **Units**
---|---|---|---|---|---
**TIMER**
Timer Threshold Voltage, Pin 5 | $V_T = 15V$ | 0.63 | 0.667 | 0.70 | $V_T$
Input Bias Current, Pin 5
All Devices | $0V < V_{IN} < 9.9V$ | $\pm 10$ | $\pm 100$ | nA | 
LM131/LM231/LM331 | $V_{IN} < 10V$ | 200 | 1000 | nA | 
LM131A/LM231A/LM331A | $V_{IN} > 10V$ | 200 | 500 | nA | 
$V_{SAT}$ Pin 5 (Reset) | $I_S = 5$ mA | 0.22 | 0.5 | V | 
**CURRENT SOURCE (Pin 1)**
Output Current
LM131, LM131A, LM231, LM231A | $R_S = 14$ kΩ, $V_{OUT} = 0$ | 126 | 126 | 144 | μA | 
LM331, LM331A | 116 | 126 | 156 | μA | 
Change with Voltage
LM131, LM131A, LM231, LM231A | $0V < V_{IN} < 9.9V$ | 0.2 | 1.0 | μA | 
LM331, LM331A | 0.01 | 1.0 | nA | 
All Devices | $V_{TMIN} = V_{TMAX}$ | 0.02 | 1.0 | nA | 
Operating Range of Current (Typical) | (10 to 500) | μA | 
**REFERENCE VOLTAGE (Pin 2)**
LM131, LM131A, LM231, LM231A | $V_{TMIN} = V_{TMAX}$ | 1.76 | 1.89 | 2.02 | $V_{PP}$ | 
LM331, LM331A | 1.70 | 1.89 | 2.00 | $V_{PP}$ | 
Stability vs Temperature | $\pm 60$ | ppm/°C | 
Stability vs Time, 1000 Hours | $\pm 0.1$ | % | 
**LOGIC OUTPUT (Pin 3)**
$V_{SAT}$ | $I_S = 5$ mA | 0.15 | 0.50 | V | 
$V_{OFF}$ | $I_S = 3.2$ mA (2 TTL Loads), $V_{IN} = \frac{1}{2} V_{PP}$ | 0.10 | 0.40 | V | 
OFF Leakage | $\leq 0.05$ | 1.0 | μA | 
**SUPPLY CURRENT**
LM131, LM131A, LM231, LM231A | $V_S = 5$V | 2.0 | 3.0 | 4.0 | mA | 
LM331, LM331A | $V_S = 4$V | 2.5 | 4.0 | 6.0 | mA | 
LM131A, LM231A | $V_S = 5$V | 1.5 | 3.0 | 6.0 | mA | 
LM331A, LM331A | $V_S = 4$V | 2.0 | 4.0 | 8.0 | mA | 

**Note 1:** Absolute Maximum Ratings: values limits beyond which damage to the device may occur. DC and AC electrical specifications do not apply when operating the device beyond its specified operating conditions.

**Note 2:** All specifications apply in the circuit of Figure 3, with $4.7V < V_S < 40V$, unless otherwise noted.

**Note 3:** Nominal $V_{OFF}$ is defined as the deviation of $V_{OFF}$ from $V_{OFF} = \frac{1}{2} V_{PP}$ when the circuit has been trimmed for zero output at 10 Hz and at 10 kHz, over the frequency range 1 Hz to 11 MHz. For the timing capacitor, $C_T$, use NPO ceramic, tantalum, or glass polyester.

**Note 4:** Human body model, 100 pF discharged through a 1.5 kΩ resistor.
Typical Applications (Continued)

PRINCIPLES OF OPERATION OF A SIMPLIFIED VOLTAGE-TO-FREQUENCY CONVERTER

The LM131 is a monolithic circuit designed for accuracy and versatility operation when applied as a voltage-to-frequency (V-to-F) converter or as a frequency-to-voltage (F-to-V) converter. A simplified block diagram of the LM131 is shown in Figure 2 and consists of a switched current source, input comparator, and 1-shot timer.

The operation of these blocks is best understood by going through the operating cycle of the basic V-to-F converter. Figure 2, which consists of the simplified block diagram of the LM131 and the various resistors and capacitors connected to it.

The voltage comparator compares a positive input voltage, V1, at pin 7 to the voltage, Vref, at pin 6. If V1 is greater, the comparator will trigger the 1-shot timer. The output of the timer will remain ON both the frequency output transistor and the switched current source for a period of \( t \approx \frac{1.1 R_C}{C} \). During this period, the current will flow out of the switched current source and provide a fixed amount of charge, \( Q = \frac{1}{2} CV \), into the capacitor, C1. This will make V1 charge V2 up to a higher level than V1. At the end of the timing period, the current will turn OFF, and the timer will reset itself.

Now there is no current flowing from pin 1, and the capacitor C2 will be gradually discharged by R3 until V2 falls to the level of V1. Then the comparator will trigger the timer and start another cycle.

The current flowing into C1 is exactly \( I_{FREF} = \frac{1}{2} (1.1 R_C) \), and the current flowing out of C2 is exactly \( I_{FREF} R3 = \frac{V_{FREF}}{R3} \). If \( V_{FREF} \) is doubled, the frequency will double to maintain this balance. Even a simple V-to-F converter can provide a frequency precisely proportional to its input voltage over a wide range of frequencies.

**FIGURE 2. Simplified Block Diagram of Stand-Alone Voltage-to-Frequency Converter Showing LM131 and External Components**

**DETAILED DIAGRAM (FIGURE 1(a))**

This block diagram shows a band gap reference which provides a stable 1.2 VCC output. This 1.2 VCC is well regulated over a VCC range of 3.6V to 40V. It also has a flat, low temperature coefficient, and typically changes less than \( \pm 0.2\% \) over a 100°C temperature change.

The current pump circuit forces the voltage at pin 2 to be at 1.2V, and causes a current \( I = \frac{1}{1000} \frac{VCC}{R2} \) to flow. For \( R2 = 14k \), \( I = 135 \mu A \). The precision current refiner provides a current equal to \( I \) to the current switch. The current switch switches the current to pin 1 or to ground depending on the state of the R3 flip-flop.

The timing function consists of an R5 flip-flop, and a timer comparator connected to the external R4C network. When the input comparator detects a voltage at pin 7 higher than pin 6, it sets the R5 flip-flop which turns ON the current switch and the output driver transistor. When the voltage at pin 5 rises to \( \frac{1}{2} VCC \), the timer comparator causes the R5 flip-flop to reset. The reset transistor is then turned ON and the current switch is turned OFF.

However, if the input comparator still detects pin 7 higher than pin 6 when pin 5 crosses \( \frac{1}{2} VCC \), the flip-flop will not be reset, and the current at pin 1 will continue to flow, in its attempt to make the voltage at pin 6 higher than pin 7. This condition will usually apply under start-up conditions or in the case of an overload voltage at signal input. It should be noted that during this sort of overload, the output frequency will be zero as soon as the overload is restored to the working range, the output frequency will be resumed.

The output driver transistor acts to saturate pin 3 with an ON state of over 50% in case of overvoltage, the output current is actively limited to less than 50 mA.

The voltage at pin 2 is regulated at 1.2V VCC for all values of \( R \) between 10 \( \mu A \) to 500 \( \mu A \). It can be used as a voltage reference for other components, but care must be taken to ensure that the current is not taken from it which could reduce the accuracy of the converter.

**PRINCIPLES OF OPERATION OF BASIC VOLTAGE-TO-FREQUENCY CONVERTER (FIGURE 1)**

The simple stand-alone V-to-F converter shown in Figure 1 includes all the basic circuitry of Figure 2 plus a few components for improved performance.

A resistor, \( R_H = 100 \, k \Omega \pm 10\% \), has been added in the path to pin 7, so that the bias current at pin 7 (\( \approx 80 \, nA \) typical) will cancel the effect of the bias current at pin 6 and help provide minimum frequency offset.

The resistance \( R_3 \) at pin 2 is made up of a 12 k\( \Omega \) fixed resistor plus a 5 k\( \Omega \) (nominal, preferably) gain adjust rheostat. The function of this adjustment is to trim out the gain tolerance of the LM131, and the tolerance of \( R_4 \) and \( C_2 \).
Typical Performance Characteristics
(All electrical characteristics apply for the circuit of Figure 3, unless otherwise noted.)

Nonlinearity Error, LM131 Family, as Precision V-top-F Converter (Figure 3)

Frequency vs Temperature, LM131A

100 kHz Nonlinearity Error, LM131 Family (Figure 4)

Power Drain vs V\textsubscript{SUPPLY}

Nonlinearity Error, LM131 Family

Nonlinearity Error vs Power Supply Voltage

Output Saturation Voltage vs I\textsubscript{OUT} (Pin 3)

Nonlinearity Error, Precision F-top-V Converter (Figure 8)

Input Current (Pins 6, 7) vs Temperature
Typical Applications (Continued)

For best results, all the components should be stable low-temperature-coefficient components, such as metal-film resistors. Trimmable capacitor should have low dielectric absorption; depending on the characteristics desired, NPO ceramic, polystyrene, Teflon or polypropylene are best suited.

A capacitor, Cw, is added from pin 7 to ground to act as a filter for Vw. A value of 0.01 μF to 0.1 μF will be adequate in most cases; however, in cases where better filtering is required, a 1 μF capacitor can be used. When the RC time constants are matched at pin 6 and pin 7, a voltage step at Vw will cause a step change in ip.

If Cw is much less than C1, a step at Vw may cause ip to stop momentarily. A 470 Ω resistor, in series with the 1 μF Cw, is added to give hysteresis effect which helps the input comparator provide the excellent linearity (0.03% typical).

DETAIL OF OPERATION OF PRECISION V-TO-F CONVERTER (FIGURE 3)

In this circuit, integration is performed by using a conventional operational amplifier and feedback capacitor, C1. When the integrator's output crosses the nominal threshold level at pin 6 of the LM131, the timing cycle is initiated.

The average current fed into the op amp's summing point (pin 2) iS \( \frac{V_2}{(11.1 \times R_C)} \) which is perfectly balanced with \( V_2 = V_6 \). In this circuit, the voltage offset of the LM131 input comparator does not affect the offset or accuracy of the V-to-F converter as it does in the stand-alone V-to-F converter, nor does the LM131 bias current or offset current. Instead, the offset voltage and offset current of the operational amplifier are the only limits on how small the signal can be accurately converted. Since op amps with voltage offsets well below 1 mV and offset currents well below 2 nA are available at low cost, this circuit is recommended for best accuracy for small signals. This circuit also responds immediately to any change of input signal (which is a stand-alone circuit does not so that the output frequency will be an accurate representation of Vw, as quickly as 2 output pulses' spacing can be measured.

In the precision mode, excellent linearity is obtained because the current source (pin 1) is always at ground potential and that voltage does not vary with \( V_2 \) or \( V_6 \). In the stand-alone circuit does not so that the output frequency is the output impedance at pin 1 which causes I to change as a function of Vw.

The circuit of Figure 4 operates in the same way as Figure 2, but with the necessary changes for high speed operation.

* Use stable components with low temperature coefficients. See Typical Applications section.
* This resistor can be 5 kΩ or 10 kΩ for \( V_2 = 8 V \) to 25V, but must be 10 kΩ for \( V_2 = 4.5 V \) to 8V.
* Use low offset voltage and low offset current op amps for A1: recommended types LM108, LM309A, LF411A

**FIGURE 3. Standard Test Circuit and Applications Circuit, Precision Voltage-to-Frequency Converter**
Typical Applications (Continued)

DETAILS OF OPERATION, FREQUENCY-TO-
VOLTAGE CONVERTERS (FIGURES 5 AND 8)

In these applications, a pulse input at IN is differentiated by a C-R network, and the negative-going edge at pin 6 causes
the input comparator to trigger the timer circuit. Just as with
a V-to-F converter, the average current flowing out of pin 1
eqvivalent to (1.1 R C) .

In the simple circuit of FIGURE 5, this current is filtered in
the network $R_1 = 100 \text{k} \Omega$ and $1 \mu \text{F}$. The ripple will be
less than 10 mV peak, but the response will be slow, with a
0.1 second time constant, and settling of 0.7 second to
0.1% accuracy.

In the present circuit, an operational amplifier provides a
buffered output and also acts as a 2-pole filter. This ripple
will be less than 5 mV peak for all frequencies above 1 Hz,
and the response time will be much quicker than in Figure 5.
However, for input frequencies below 200 Hz, this circuit will
have worse ripple than Figure 5. The engineering of the filter
will time-constants to get adequate response and small enough
ripple simply requires a study of the compromises to be
made; inherently, V-to-F converter response can be fast,
but F-to-V response can not.

*Use static components with low temperature coefficients.

**The resistor can be 5 k\Omega or 10 k\Omega for $V_0 = 0V$ to 50V
but must be 15 k\Omega for $V_0 = -4V$ to 50V.

**Use low offset voltage and low offset current op amps for A1:
recommended types LM141A or LF250.

FIGURE 4. Precision Voltage-to-Frequency Converter,
100 kHz Full-Scale, ±0.03% Non-Linearity

FIGURE 5. Simple Frequency-to-Voltage Converter,
10 kHz Full-Scale, ±0.06% Non-Linearity

*Use static components with low temperature coefficients.

FIGURE 6. Precision Frequency-to-Voltage Converter,
10 kHz Full-Scale with 2-Pole Filter, ±0.01% Non-Linearity Maximum
Typical Applications (Continued)

Light Intensity to Frequency Converter

Temperature to Frequency Converter

Long-Term Digital Integrator Using VFC

Basic Analog-to-Digital Converter Using Voltage-to-Frequency Converter
Schematic Diagram
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