

# SERIES TL011, TL012, TL014A, TL021 FIXED-RATIO N-P-N CURRENT MIRRORS

D2614, FEBRUARY 1984—REVISED OCTOBER 1988

- **Wide Input Current Range:**  
1  $\mu$ A to 1 mA
- **35-Volt Output Capability**
- **High Output Impedance**
- **Current-Ratio Tolerances Over Full Temperature Range;**  
±8% for I Suffix  
±7% for C Suffix
- **Typically Less Than ±1% Error at 25°C**

LP PACKAGE  
(TOP VIEW)



TEMPERATURE RANGE	INPUT-TO-OUTPUT CURRENT RATIO			
	1:1	1:2	1:4	2:1
-40°C to 85°C	TL011I	TL012I		TL021I
0°C to 70°C	TL011C	TL012C	TL014AC	TL021C

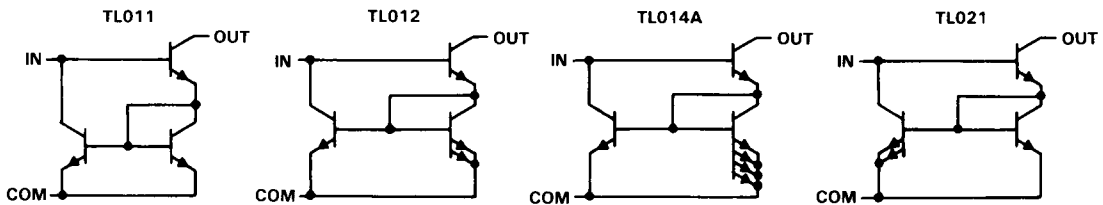
## description

The TL011, TL012, TL014A, and TL021 are Wilson current mirrors with output currents in fixed proportion to the input currents and substantially independent of changes in voltage, load, and temperature. These devices make use of the tight matching properties of identical bipolar transistors on a monolithic integrated circuit chip to achieve current-ratio accuracy typically better than 98%.

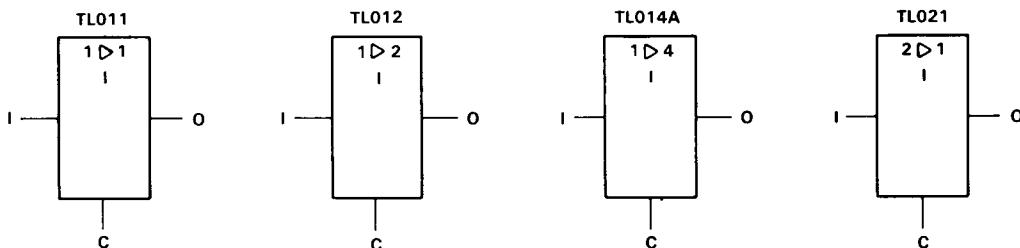
Current mirrors are used extensively in linear integrated circuit designs as active loads for operational-amplifier stages and as current sources for other stages. The TL011 family gives the designer this same capability with no sacrifice in accuracy or stability.

The TL011, TL012, and TL014A are designed to operate with input currents up to 1 mA and output voltage up to 35 V. The TL021 is designed for 2 mA and 35 V.

## schematics



## symbols



PRODUCTION DATA documents contain information current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

TEXAS  
INSTRUMENTS

POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

Copyright © 1983, Texas Instruments Incorporated

**SERIES TL011, TL012, TL014A, TL021  
FIXED-RATIO N-P-N CURRENT MIRRORS**

**absolute maximum ratings over operating free-air temperature range (unless otherwise noted)**

Output voltage (see Note 1) .....	45 V
Input current .....	5 mA
Continuous total dissipation at (or below) 25°C free-air temperature (see Note 2) .....	775 mW
Operating free-air temperature range: TL011I, TL012I, TL021I .....	-40°C to 85°C
TL011C, TL012C, TL014AC, TL021C .....	0°C to 70°C
Storage temperature range .....	-65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds .....	260°C

- NOTES: 1. Input and output voltages are with respect to the common terminal. Neither voltage should be more negative than -0.3 V.  
 2. For operation above 25°C free-air temperature, derate linearly at the rate of 6.2 mW/°C. The LP package dissipation rating was based on thermal resistance,  $R_{\theta JA}$ , measured in still air with the device mounted in an Augat socket. The bottom of the package was 10 mm (0.375 in.) above the socket.

**recommended operating conditions**

		TL0__I		TL0__C, AC		UNIT
		MIN	MAX	MIN	MAX	
Output voltage, $V_O$		5	35	5	35	V
Input current, $I_O$	TL021	0.002	2	0.002	2	mA
	All others	0.001	1	0.001	1	
Operating free-air temperature, $T_A$		-40	85	0	70	°C

**SERIES TL011, TL012, TL014A, TL021  
FIXED-RATIO N-P-N CURRENT MIRRORS**

**electrical characteristics over recommended ranges of operating free-air temperature and output voltage (unless otherwise noted)**

PARAMETER	TEST CONDITIONS	TL011		TL012		TL014A		TL021		UNIT
		MIN	TYP†	MIN	TYP†	MIN	TYP†	MIN	TYP†	
$V_i$ Input voltage		$I_i = 1 \mu\text{A}$								
		$I_i = 2 \mu\text{A}$								
		$I_i = 10 \mu\text{A}$								
		$I_i = 20 \mu\text{A}$								
		$I_i = 100 \mu\text{A}$								
		$I_i = 200 \mu\text{A}$								
$V_i$ Input voltage		$I_i = 1 \text{ mA}$								
		$I_i = 2 \text{ mA}$								
$h_F$	Current ratio	$I_i = \text{MIN to MAX}^\ddagger$								
$\alpha_{HF}$	Temperature coefficient of current ratio	$I_i = \text{MIN to MAX}^\ddagger$								
	Output-to-input isolation	$f = 1 \text{ kHz}$								
$V_O(\text{th})$	Output	$T_A = -40^\circ\text{C}$								
	threshold voltage $^\S$	$T_A = 0^\circ\text{C}$								
	All	$T_A = 25^\circ\text{C}$								
$r_o$	Output resistance	$I_i = 10 \mu\text{A}$								
		$I_i = 20 \mu\text{A}$								
		$I_i = 100 \mu\text{A}$								
		$I_i = 200 \mu\text{A}$								
		$I_i = 1 \text{ mA}$								
$f_{\text{max}}$	Maximum operating frequency $^\P$	$I_i = 2 \text{ mA}$								
		$R_L = 500 \Omega$								

†All typical values are at  $T_A = 25^\circ\text{C}$ .

‡For test conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

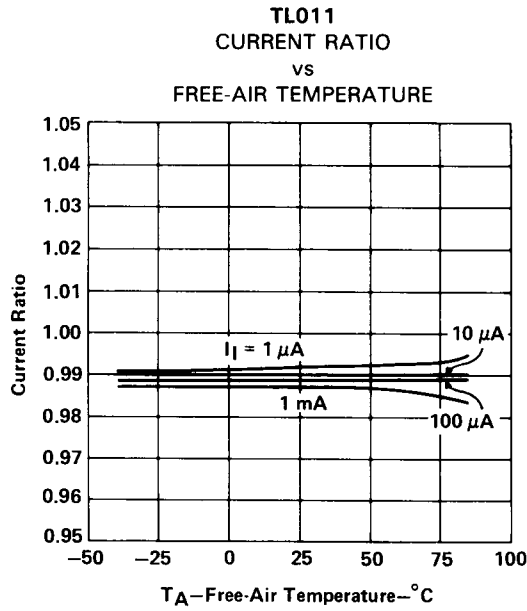
§Output threshold voltage is the voltage at which the current ratio is equal to 90% of its value at  $V_O = 15 \text{ V}$ .

¶Maximum operating frequency is the frequency at which the output current is down 3 dB from its low frequency value.

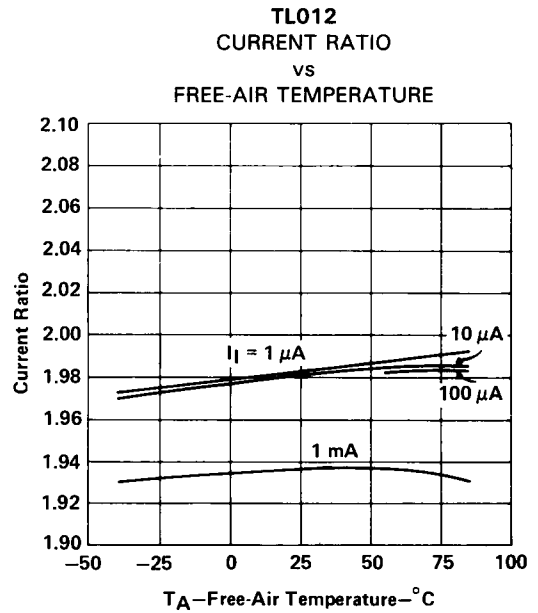


**SERIES TL011, TL012, TL014A, TL021  
FIXED-RATIO N-P-N CURRENT MIRRORS**

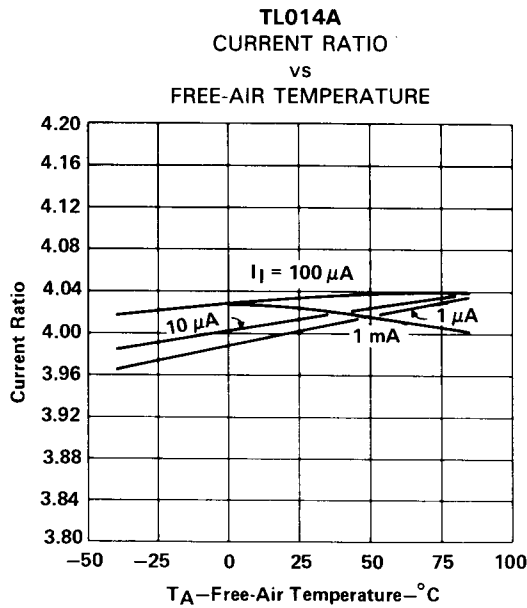
**TYPICAL CHARACTERISTICS**



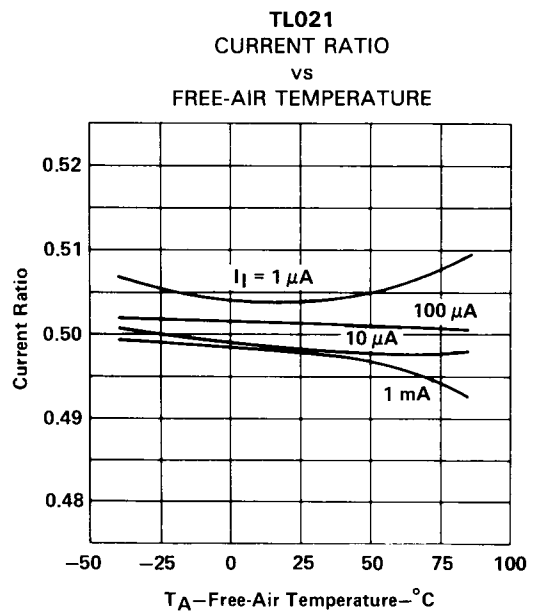
**FIGURE 1**



**FIGURE 2**



**FIGURE 3**



**FIGURE 4**

TYPICAL APPLICATIONS INFORMATION

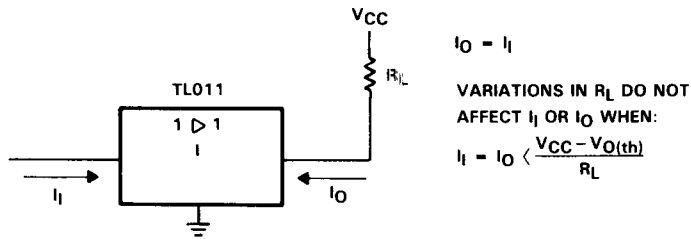
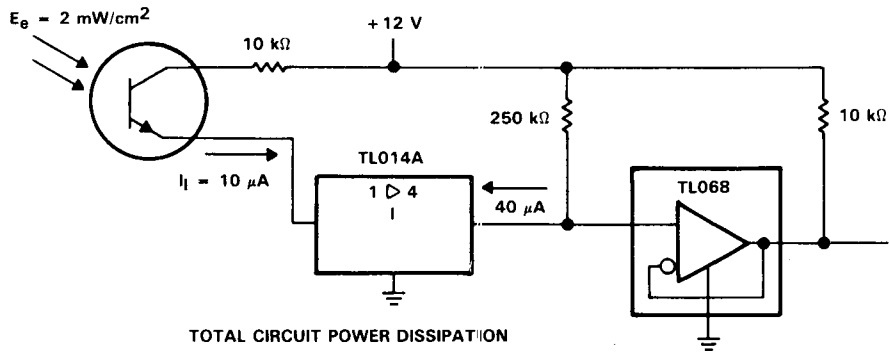


FIGURE 5. BASIC CURRENT BUFFER



Idle condition:  $P_D = 1.5 \text{ mW}$  typical  
 On condition:  $P_D = 12.5 \text{ mW}$  typical  
 $10 \mu\text{A}$  from phototransistor provides a  $V_O$  swing of 10 V at 1 mA.

FIGURE 6. PHOTOTRANSISTOR PREAMPLIFIER

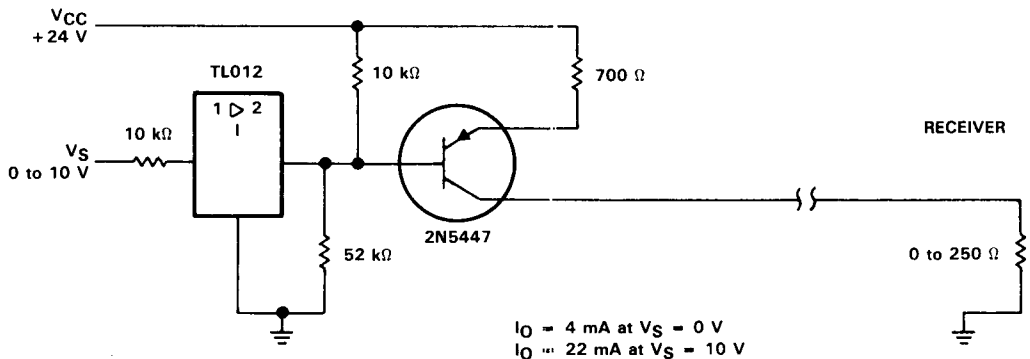


FIGURE 7. TWO-WIRE LINEAR CURRENT-MODE TRANSMITTER