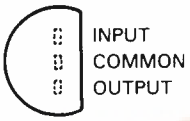
SERIES TL011, TL012, TL014A, TL021
FIXED-RATIO N-P-N CURRENT MIRRORS

D2614, FEBRUARY 1984—REVISED OCTOBER 1988

- **Wide Input Current Range:**
  1 μA 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

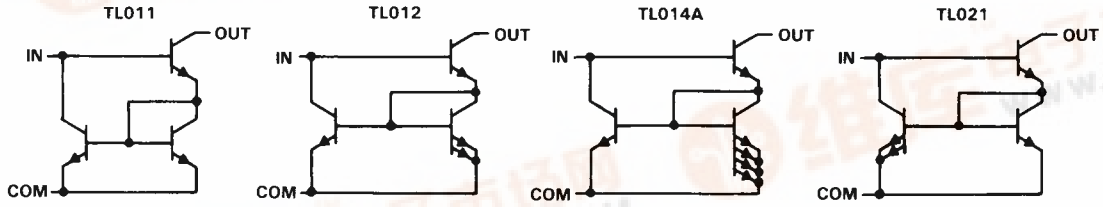
description

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%.

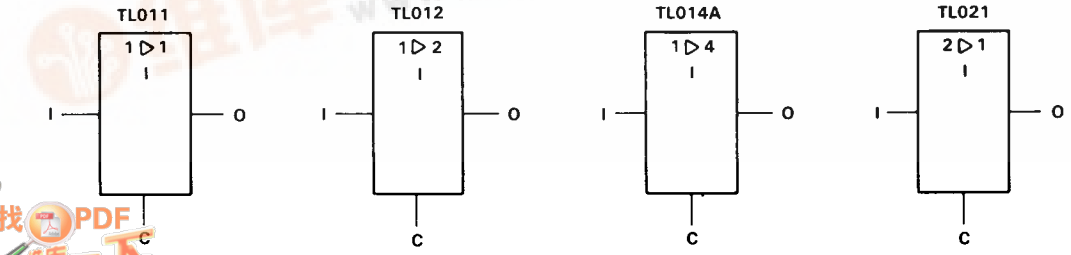
Current mirrors are used extensively in linear integrated circuit designs as active loads for operational-amplifier stages and as current sources for other stages. The TL011 family gives the designer this same capability with no sacrifice in accuracy or stability.

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



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

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†	MAX	MIN	TYP†	MAX	MIN	TYP†	MAX	MIN	TYP†	MAX	
V_I	Input voltage		I_I = 1 μA			1			1			1					V
			I_I = 2 μA												1		
			I_I = 10 μA			1.1			1.1			1.1					
			I_I = 20 μA												1.1		
			I_I = 100 μA			1.25			1.25			1.25					
			I_I = 200 μA												1.25		
			I_I = 1 mA			1.4			1.4			1.4					
			I_I = 2 mA												1.4		
h_F	Current ratio (I_O/I_I)	TLO_I	I_I = MIN to MAX‡		0.92	1	1.08	1.84	2	2.16	3.68	4	4.32	0.46	0.5	0.54	
		TLO_C, AC			0.93	1	1.07	1.86	2	2.14	3.72	4	4.28	0.465	0.5	0.535	
α_{hF}	Temperature coefficient of current ratio		I_I = MIN to MAX			50			100			200			200		ppm/°C
	Output-to-input isolation		I_I = MIN to MAX,	f = 1 kHz	80			80			80			80			dB
$V_{O(th)}$	Output threshold voltage§	TLO_I	I_I = MIN to MAX	T_A = −40°C			1.35			1.35			1.35			1.35	V
		TLO_C, AC		T_A = 0°C			1.25			1.25			1.25			1.25	
		All		T_A = 25°C			1.2			1.2			1.2			1.2	
r_o	Output resistance		f = 1 kHz	I_I = 10 μA		200			100			50					MΩ
				I_I = 20 μA											200		
				I_I = 100 μA		20			10			5					
				I_I = 200 μA											20		
				I_I = 1 mA		2			1			0.5					
				I_I = 2 mA											2		
f_{max}	Maximum operating frequency¶		I_I = MAX	R_L = 500 Ω		10			10			10			10		MHz

†All typical values are at T_A = 25°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 V.
¶Maximum operating frequency is the frequency at which the output current is down 3 dB from its low frequency value.

TYPICAL CHARACTERISTICS

TL011
CURRENT RATIO
vs
FREE-AIR TEMPERATURE

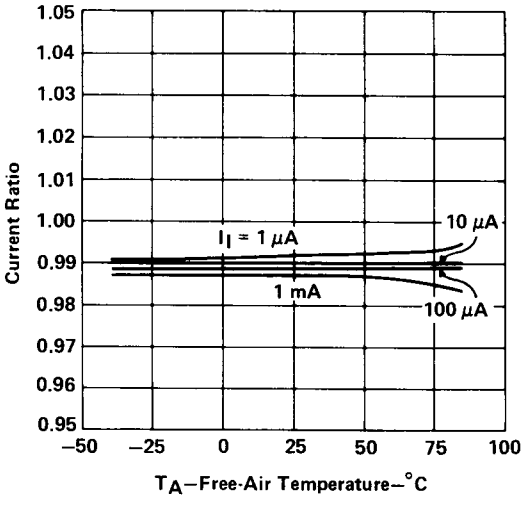


FIGURE 1

TL012
CURRENT RATIO
vs
FREE-AIR TEMPERATURE

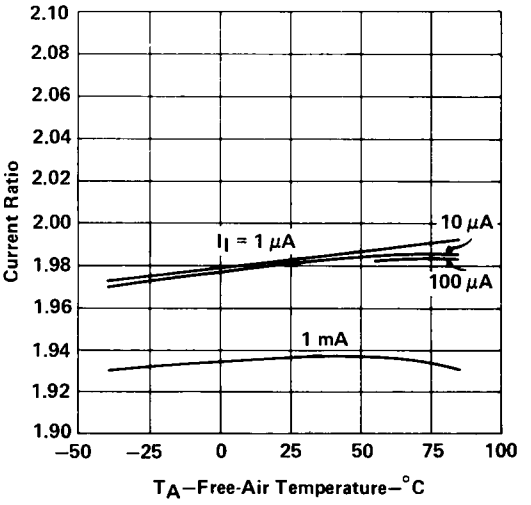


FIGURE 2

TL014A
CURRENT RATIO
vs
FREE-AIR TEMPERATURE

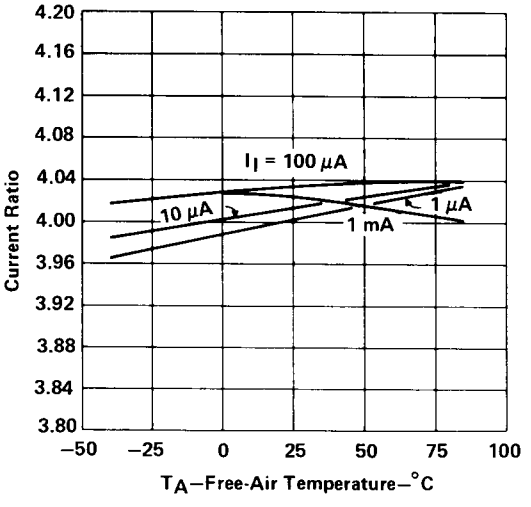


FIGURE 3

TL021
CURRENT RATIO
vs
FREE-AIR TEMPERATURE

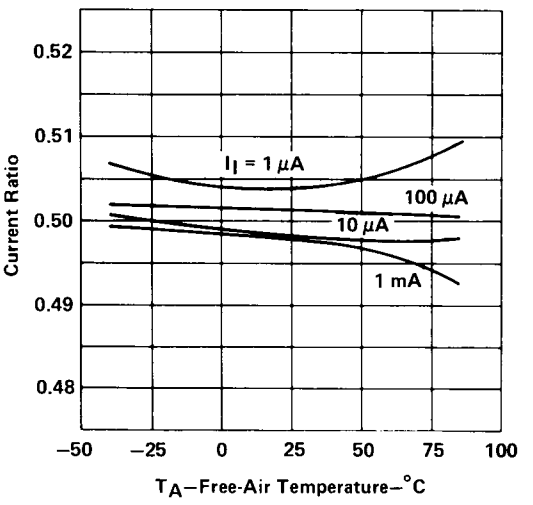


FIGURE 4

TYPICAL APPLICATIONS INFORMATION

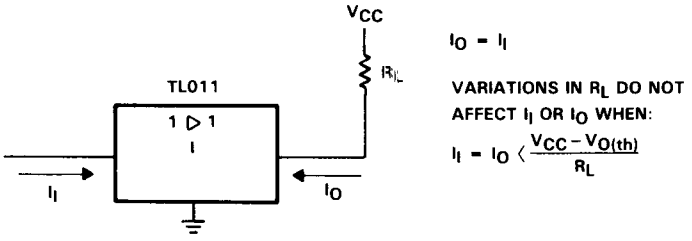
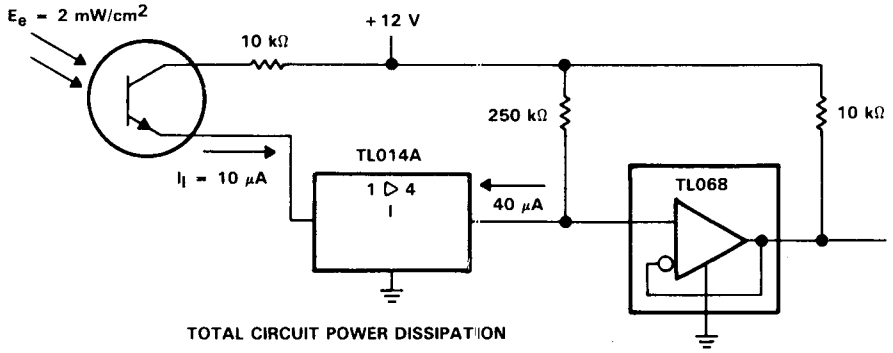


FIGURE 5. BASIC CURRENT BUFFER



TOTAL CIRCUIT POWER DISSIPATION

Idle condition: P_D = 1.5 mW typical
On condition: P_D = 12.5 mW typical
10 μA from phototransistor provides a V_O swing of 10 V at 1 mA.

FIGURE 6. PHOTOTRANSISTOR PREAMPLIFIER

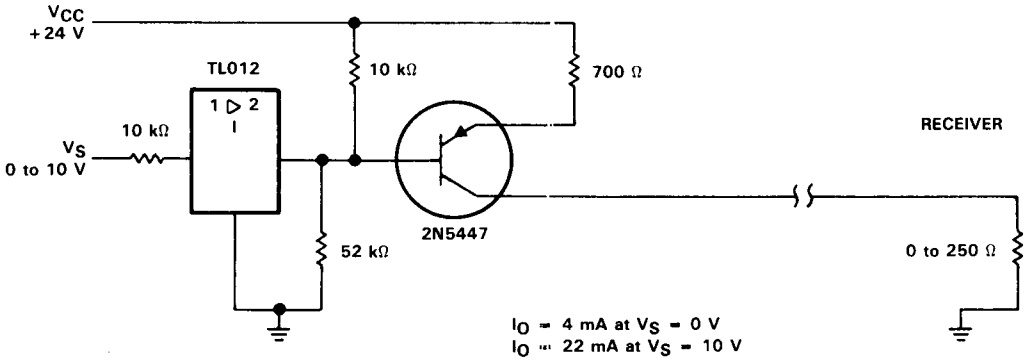


FIGURE 7. TWO-WIRE LINEAR CURRENT-MODE TRANSMITTER