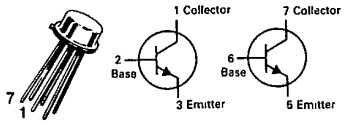
T-29-27

2N2060
2N2223,A
2N2480A

2N2060 JAN, JTX, JTXV AVAILABLE
CASE 654-07, STYLE 1



DUAL AMPLIFIER TRANSISTOR

NPN SILICON

Refer to MD2218 for graphs.

MAXIMUM RATINGS

Rating	Symbol	2N2060 2N2223,A	2N2480	2N2480A	Unit
Collector-Emitter Voltage	V_{CEO}	60	40	40	Vdc
Collector-Emitter Voltage	V_{CER}	80	—	—	Vdc
Collector-Base Voltage	V_{CBO}	100	75	80	Vdc
Emitter-Base Voltage	V_{EBO}	7.0	5.0	5.0	Vdc
Collector Current — Continuous	I_C	500			mAdc
		One Die	All Die Equal Power		
Total Device Dissipation @ T_A = 25°C	P_D				mW
2N2060,A		0.5	0.6		
2N2223,A		0.5	0.6		
2N2480,A		0.3	0.6		
Derate above 25°C					mW/°C
2N2060,A		2.86	3.43		
2N2223,A		2.86	3.43		
2N2480,A		1.72	3.43		
Total Device Dissipation @ T_C = 25°C	P_D				Watts
2N2060,A		1.5	3.0		
2N2223,A		1.6	3.0		
2N2480,A		1.0	2.0		
Derate above 25°C					mW/°C
2N2060,A		8.6	17.2		
2N2223,A		9.1	11.4		
2N2480,A		5.7	11.4		
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200			°C

5

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) (I_C = 100 mAdc, R_{BE} ≤ 10 ohms)	2N2060, 2N2223, 2N2223A	$V_{CER(sus)}$	80	—	Vdc
Collector-Emitter Sustaining Voltage(1)		$V_{CEO(sus)}$			Vdc
(I_C = 20 mAdc, I_B = 0)	2N2480A		40	—	
(I_C = 30 mAdc, I_B = 0)	2N2060, 2N2223, 2N2223A		60	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$			Vdc
(I_C = 100 μAdc, I_E = 0)	2N2060, 2N2223, 2N2223A		100	—	
	2N2480A*		80	—	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$			Vdc
(I_E = 100 μAdc, I_C = 0)	2N2060, 2N2223, 2N2223A		7.0	—	
	2N2480A		5.0	—	
Collector Cutoff Current		I_{CBO}			μAdc
(V_{CB} = 30 Vdc, I_E = 0, T_A = 150°C)	2N2480A		—	15	
(V_{CB} = 60 Vdc, I_E = 0)	2N2480A		—	0.02	
(V_{CB} = 80 Vdc, I_E = 0)	2N2060		—	0.002	
	2N2223, 2N2223A		—	0.01	
(V_{CB} = 80 Vdc, I_E = 0, T_A = 150°C)	2N2060		—	10	
	2N2223, 2N2223A		—	15	
Emitter Cutoff Current		I_{EBO}			nAdc
(V_{BE} = 5.0 Vdc, I_C = 0)	2N2060		—	2.0	
	2N2223, 2N2223A		—	10	
	2N2480A		—	20	

2N2060, 2N2223,A, 2N2480A

T-29-27

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 10 μAdc, V_{CE} = 5.0 Vdc)	2N2060 2N2223, 2N2223A	h_{FE}	25 15	75 —	—
(I_C = 100 μAdc, V_{CE} = 5.0 Vdc)	2N2060 2N2223, 2N2223A 2N2480A		30 25 35	90 150 —	
(I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc)	2N2060 2N2480A		40 50	120 200	
(I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	2N2060 2N2223, 2N2223A		50 50	150 200	
Collector-Emitter Saturation Voltage (I_C = 50 mAdc, I_B = 5.0 mAdc)	2N2060A 2N2060, 2N2223, 2N2223A, 2N2480A	$V_{CE(sat)}$	— —	0.6 1.2	Vdc
Base-Emitter Saturation Voltage (I_C = 50 mAdc, I_B = 5.0 mAdc)	2N2060, 2N2223, 2N2223A, 2N2480A	$V_{BE(sat)}$	—	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 20 MHz)	2N2223, 2N2223A, 2N2480A 2N2060	f_T	50 60	— —	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	2N2060, 2N2060A, 2N2223, 2N2223A 2N2480A	C_{obo}	— —	15 18	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	2N2060, 2N2223A, 2N2480A	C_{ibo}	—	85	pF
Input Impedance (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	2N2060 2N2480A	h_{ie}	1000 1000	4000 5000	ohms
Input Impedance (I_C = 1.0 mAdc, V_{CB} = 5.0 Vdc, f = 1.0 kHz)	2N2060, 2N2223, 2N2223A 2N2480A	h_{ib}	20 20	30 35	ohms
Voltage Feedback Ratio (I_C = 1.0 mAdc, V_{CB} = 5.0 Vdc, f = 1.0 kHz)	2N2223, 2N2223A	h_{rb}	—	3.0	X 10^{-4}
Small-Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	2N2060 2N2223, 2N2223A 2N2480A	h_{fe}	50 40 50	150 200 300	—
Output Admittance (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	2N2060, 2N2480A	h_{oe}	—	16	μmhos
Output Admittance (I_C = 1.0 mAdc, V_{CB} = 5.0 Vdc, f = 1.0 kHz)	2N2223, 2N2223A	h_{ob}	—	0.5	μmhos

5

2N2060, 2N2223,A, 2N2480A

T-29-07

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
Noise Figure (I_C = 0.3 mAdc, V_{CE} = 10 Vdc, R_S = 510 Ω, f = 1.0 kHz, BW = 1.0 Hz)	2N2480A	NF	—	8.0	dB
(I_C = 0.3 mAdc, V_{CE} = 10 Vdc, R_S = 510 Ω, f = 1.0 kHz, BW = 200 Hz)	2N2060		—	8.0	
(I_C = 0.3 mAdc, V_{CE} = 10 Vdc, R_S = 1.0 kΩ, f = 1.0 kHz, BW = 15.7 kHz)(2)			—	8.0	
MATCHING CHARACTERISTICS					
DC Current Gain Ratio(3)		h_{FE1}/h_{FE2}			—
(I_C = 100 μAdc, V_{CE} = 5.0 Vdc)	2N2060, 2N2223A		0.9	1.0	
	2N2223, 2N2480A		0.8	1.0	
(I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc)	2N2060		0.9	1.0	
	2N2480		0.8	1.0	
Base-Emitter Voltage Differential		$\lvert V_{BE1}-V_{BE2}\rvert$			mVdc
(I_C = 100 μAdc, V_{CE} = 5.0 Vdc)	2N2060, 2N2223A, 2N2480A		—	5.0	
	2N2223		—	15	
(I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc)	2N2060, 2N2060A, 2N2480A		—	5.0	
	2N2480		—	10	
Base-Emitter Voltage Differential Change Due to Temperature (I_C = 100 μAdc, V_{CE} = 5.0 Vdc, T_A = −55°C to +125°C)		$\frac{\Delta(V_{BE1}-V_{BE2})}{\Delta T}$			μV/°C
	2N2060		—	10	
	2N2223, 2N2223A		—	25	
	2N2480A		—	15	

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
(2) Amplifier: 3.0 dB points at 25 Hz and 10 kHz with a roll-off of 6.9 dB per octave.
(3) The lowest h_{FE} reading is taken as h_{FE1} for this ratio.

5

FIGURE 1 — DC CURRENT GAIN versus COLLECTOR CURRENT

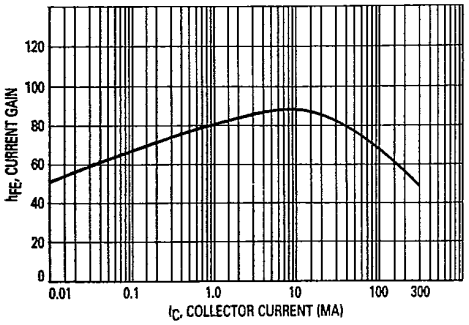


FIGURE 2 — "ON" VOLTAGES