12113104

MOTOROLA Semiconductors

BOX 955 • PHOENIX, ARIZONA 85001

MULTIPLE DEVICES

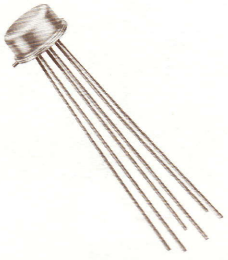
MD981 (NPN) MD982 (PNP)

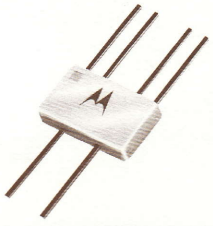
DUAL STAR* TRANSISTORS

SILICON EPITAXIAL PASSIVATED

DUAL "STAR" TRANSISTORS for HIGH-SPEED SWITCHING CIRCUITS, DC to UHF AMPLIFIER APPLICATIONS, and SPACE SAVING CONSIDERATIONS

- MD981 — two NPN transistors similar to the 2N2218
- MD982 — two PNP transistors similar to the 2N2904
- Beta Specified at Four Current Levels
- All Leads Isolated Electrically for Design Flexibility

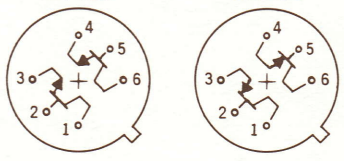




MARCH, 1964
DS 4505-R1

*Trademark of Motorola Inc.

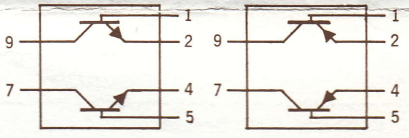
MD981 MD982



(NPN) (PNP)

PIN CONNECTIONS
BOTTOM VIEW

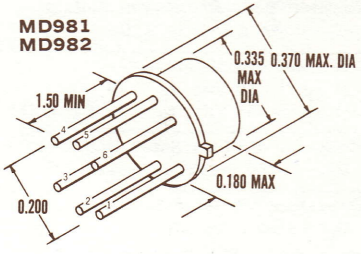
MD981F MD982F



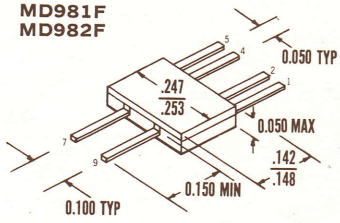
ABSOLUTE MAXIMUM RATINGS (each side)

Characteristic	Symbol	Rating		Unit
Collector-Base Voltage	V_{CBO}	60		Vdc
Collector-Emitter Voltage MD981 MD982	V_{CEO}	 30 50		Vdc
Emitter-Base Voltage	V_{EBO}	5		Vdc
Collector Current (Limited by P_D)	I_C	200		mAdc
Operating Junction Temperature	T_J	200		°C
Storage Temperature	T_{stg}	-65 to +200		°C
		ONE SIDE	BOTH SIDES	
Flat Package Total Device Dissipation (25°C Ambient Temperature) Derate above 25°C	P_D	 250 1.5	 350 2	 mW mW/°C
TO-5 Package Total Device Dissipation (25°C Ambient Temperature) Derate above 25°C	P_D	 500 2.9	 600 3.4	 mW mW/°C

MD981
MD982



MD981F
MD982F



Lead 1 identified by square impression on underside of case.

(ALL LEADS ISOLATED FROM CASE)

MD981 (NPN)

ELECTRICAL CHARACTERISTICS (each side) (at $T_A = 25°C$ unless otherwise specified)

Characteristic	Symbol	Min	Max	Unit
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	BV_{CBO}	60	—	Vdc
Collector-Emitter Breakdown Voltage * (I_C = 10 mAdc, I_B = 0)	BV_{CEO}*	30	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	BV_{EBO}	5	—	Vdc
Collector Cutoff Current (V_{CB} = 50 Vdc, I_E = 0) (V_{CB} = 50 Vdc, I_E = 0, T_A = 150°C)	I_{CBO}	— —	.010 10	μAdc
Collector-Emitter Saturation Voltage (I_C = 150 mAdc, I_B = 15 mAdc)	V_{CE} (sat)	—	0.4	Vdc
Base-Emitter Saturation Voltage (I_C = 150 mAdc, I_B = 15 mAdc)	V_{BE} (sat)	—	1.3	Vdc
DC Forward Current Transfer Ratio (I_C = 0.1 mAdc, V_{CE} = 10 Vdc) (I_C = 1 mAdc, V_{CE} = 10 Vdc) (I_C = 10 mAdc, V_{CE} = 10 Vdc) (I_C = 150 mAdc, V_{CE} = 10 Vdc)*	h_{FE}	 20 25 35 40*	 — — — —	—
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kc)	C_{ob}	—	8	pf
Small-Signal Forward Current Transfer Ratio (I_C = 20 mAdc, V_{CE} = 20 Vdc, f = 100 mc) TO-5 Package (I_C = 20 mAdc, V_{CE} = 10 Vdc, f = 100 mc) Flat Package	h_{fe}	 2.5 2.0	 — —	—
Current-Gain-Bandwidth Product (V_{CE} = 20 Vdc, I_C = 20 mAdc) TO-5 Package (V_{CE} = 10 Vdc, I_C = 20 mAdc) Flat Package	f_T	 250 200	 — —	mc —

MD982 (PNP)

ELECTRICAL CHARACTERISTICS (each side) (at $T_A = 25°C$ unless otherwise specified)

Characteristic	Symbol	Min	Max	Unit
Collector-Base Breakdown Voltage (I_C = -10 μAdc, I_E = 0)	BV_{CBO}	60	—	Vdc
Collector-Emitter Breakdown Voltage* (I_C = -10 mAdc, I_B = 0)	BV_{CEO}*	50	—	Vdc
Emitter-Base Breakdown Voltage (I_E = -10 μAdc, I_C = 0)	BV_{EBO}	5	—	Vdc
Collector Cutoff Current (V_{CB} = -50 Vdc, I_E = 0) (V_{CB} = -50 Vdc, I_E = 0, T_A = 150°C)	I_{CBO}	— —	.020 20	μAdc
Collector-Emitter Saturation Voltage (I_C = -150 mAdc, I_B = -15 mAdc)	V_{CE} (sat)	—	0.5	Vdc
Base-Emitter Saturation Voltage (I_C = -150 mAdc, I_B = -15 mAdc)	V_{BE} (sat)	—	1.4	Vdc
DC Forward Current Transfer Ratio (I_C = -0.1 mAdc, V_{CE} = -10 Vdc) (I_C = -1 mAdc, V_{CE} = -10 Vdc) (I_C = -10 mAdc, V_{CE} = -10 Vdc) (I_C = -150 mAdc, V_{CE} = -10 Vdc)*	h_{FE}	 20 25 35 40*	 — — — —	—
Output Capacitance (V_{CB} = -10 Vdc, I_E = 0, f = 100 kc)	C_{ob}	—	8	pf
Current-Gain-Bandwidth Product (V_{CE} = -20 Vdc, I_C = -20 mAdc) TO-5 Package (V_{CE} = -10 Vdc, I_C = -20 mAdc) Flat Package	f_T	 200 200	 — —	mc

*Pulse Test: Pulse Width ≦ 300 μsec, Duty Cycle ≦ 2%

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MOTOROLA

MULTIPLE DEVICES

MD990
MD984

DUAL PNP TRANSISTORS

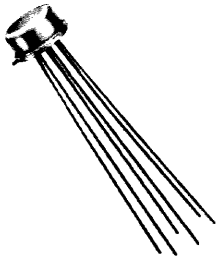
SILICON EPITAXIAL PASSIVATED

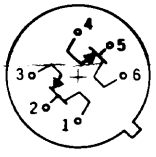
DECEMBER, 1963

DS 4506

MD990 — DUAL TRANSISTOR DEVICE for MEDIUM-SPEED SWITCHING APPLICATIONS and SPACE SAVING CONSIDERATIONS

- Low Saturation Voltage
  $V_{CE(sat)}$ $\begin{cases} = 0.16V \text{ typ at } 10 \text{ mA} \\ = 0.4 \text{ V typ at } 200 \text{ mA} \end{cases}$
- High Current-Gain–Bandwidth Product:
  $f_\tau = 120$ mc typical
- All Leads Electrically Isolated for Design Flexibility





PIN CONNECTIONS
(BOTTOM VIEW)

ABSOLUTE MAXIMUM RATINGS (each side)

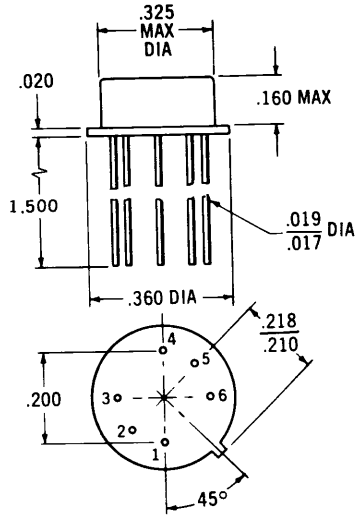
Characteristic	Symbol	Rating		Unit
Collector-Base Voltage	V_{CBO}	50		Vdc
Collector-Emitter Voltage	V_{CEO}	35		Vdc
Collector-Emitter Voltage ($R_{BE} \leqq 10\Omega$)	V_{CER}	50		Vdc
Emitter-Base Voltage	V_{EBO}	5		Vdc
Collector Current	I_C	600		mAdc
Operating Junction Temperature	T_J	+175		°C
Storage Temperature	T_{stg}	-65 to +200		°C
		One Side	Both Sides	
Total Device Dissipation (25°C Case Temperature) Derate above 25°C	P_D	1.6 10.7	3.0 20.0	W mW/°C
Total Device Dissipation (25°C Ambient Temperature Derate above 25°C	P_D	0.5 3.3	0.6 4.0	W mW/°C

ELECTRICAL CHARACTERISTICS (each side)

(at $T_A = 25°C$ unless otherwise specified)

Characteristic	Symbol	Min	Max	Unit
Collector-Base Breakdown Voltage ($I_C = -100\,\mu Adc$, $I_E = 0$)	BV_{CBO}	50	---	Vdc
Collector-Emitter Breakdown Voltage* ($I_C = -10$ mAdc, $I_B = 0$)	BV_{CEO}*	35	---	Vdc
Collector-Emitter Breakdown Voltage* ($I_C = -30$ mAdc, $I_B = 0$, $R_{BE} \leqq 10\Omega$)	BV_{CER}*	50	---	Vdc
Emitter-Base Breakdown Voltage ($I_E = -100\,\mu Adc$, $I_C = 0$)	BV_{EBO}	5	---	Vdc
Collector Cutoff Current ($V_{CB} = -30$ Vdc, $I_E = 0$) ($V_{CB} = -30$ Vdc, $I_E = 0$, $T_A = 150°C$)	I_{CBO}	--- ---	1 100	μAdc
Collector-Emitter Saturation Voltage ($I_C = -150$ mAdc, $I_B = -15$ mAdc)	$V_{CE(sat)}$	---	1.5	Vdc
Base-Emitter Saturation Voltage ($I_C = -150$ mAdc, $I_B = -15$ mAdc)	$V_{BE(sat)}$	---	1.3	Vdc
DC Forward Current Transfer Ratio* ($I_C = -150$ mAdc, $V_{CE} = -10$ Vdc)	h_{FE}*	50	300	---
Output Capacitance ($V_{CB} = -10$ Vdc, $I_E = 0$, f = 100 kc)	C_{ob}	---	45	pf
Current-Gain–Bandwidth Product ($V_{CE} = -10$ Vdc, $I_C = -50$ mAdc, f = 20 mc)	f_τ	60	---	mc

*Pulse Test: Pulse Width $\leqq 300\,\mu$sec, Duty Cycle $\leqq 2\%$



OUTLINE DIMENSIONS
6 PIN TO-5 HEADER
(ALL LEADS ISOLATED FROM CASE)

MD984 — DUAL TRANSISTOR DEVICE for HIGH-SPEED SWITCHING CIRCUITS, AMPLIFIER APPLICATIONS and SPACE-SAVING CONSIDERATIONS

- High Current-Gain–Bandwidth Product
  $f_\tau = 250$ mc minimum
- All Leads Electrically Isolated From the Case for Design Flexibility

ABSOLUTE MAXIMUM RATINGS (each side)

Characteristic	Symbol	Rating		Unit
Collector-Base Voltage	V_{CBO}	40		Vdc
Collector-Emitter Voltage	V_{CEO}	20		Vdc
Emitter-Base Voltage	V_{EBO}	5		Vdc
Collector Current	I_C	200		mAdc
Junction Temperature	T_J	+200		°C
Storage Temperature	T_{stg}	-65 to +200		°C
		One Side	Both Sides	
Total Device Dissipation (25°C Case Temperature) Derate above 25°C	P_D	1.6 9.1	3.0 17.2	W mW/°C
Total Device Dissipation (25°C Ambient Temperature) Derate above 25°C	P_D	0.5 2.9	0.6 3.4	W mW/°C

ELECTRICAL CHARACTERISTICS (each side) (at $T_A = 25°C$ unless otherwise specified)

Characteristic	Symbol	Min	Max	Unit
Collector-Base Breakdown Voltage (I_C = -10 μAdc, I_E = 0)	BV_{CBO}	40	---	Vdc
Collector-Emitter Breakdown Voltage* (I_C = -10 mAdc, I_B = 0)	BV_{CEO}*	20	---	**Vdc**
Emitter-Base Breakdown Voltage (I_E = -10 μAdc, I_C = 0)	BV_{EBO}	5	---	Vdc
Collector Cutoff Current (V_{CB} = -20 Vdc, I_E = 0) (V_{CB} = -20 Vdc, I_E = 0, T_A = 150°C)	I_{CBO}	--- ---	.025 30	μAdc
Collector-Emitter Saturation Voltage (I_C = -10 mAdc, I_B = -1 mAdc) (I_C = -50 mAdc, I_B = -5 mAdc)	$V_{CE(sat)}$	--- ---	0.3 0.5	Vdc
Base-Emitter Saturation Voltage (I_C = -10 mAdc, I_B = -1 mAdc)	$V_{BE(sat)}$	---	0.9	Vdc
DC Forward Current Transfer Ratio (I_C = -10 mAdc, V_{CE} = -10 Vdc)	h_{FE}	25	---	---
Output Capacitance (V_{CB} = -10 Vdc, I_E = 0, f = 100 kc)	C_{ob}	---	4	pf
Small-Signal Forward Current Transfer Ratio (I_C = -20 mAdc, V_{CE} = -20 Vdc, f = 100 mc)	h_{fe}	2.5	---	---
Current-Gain–Bandwidth Product (I_C = -20 mAdc, V_{CE} = -20 Vdc)	f_τ	250	---	mc

*Pulse Test: Pulse Width ≦ 300 μsec, Duty Cycle ≦ 2%

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MULTIPLE DEVICES

MD1123
MD1124
MD1125

DUAL PNP TRANSISTOR DEVICES SPECIFICALLY DESIGNED for DIFFERENTIAL AMPLIFIER and OTHER APPLICATIONS requiring a MATCHED PAIR with a HIGH DEGREE of PARAMETER UNIFORMITY under VARYING ENVIRONMENTAL CONDITIONS

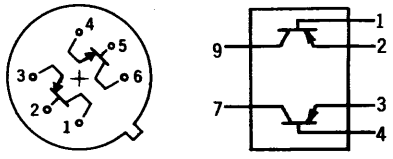
- Maximum Base-Emitter Voltage Differential as low as 5 mVdc
- Maximum Base-Emitter Voltage Differential Change : $\Delta (V_{BE1} - V_{BE2}) = 10\mu V/°C$
- Current-Gain Specified at up to Four Current Levels
- All Leads Electrically Isolated From the Case for Design Flexibility

DUAL TRANSISTORS

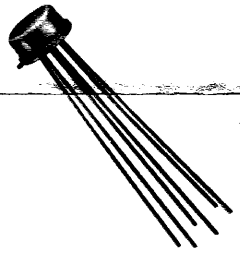
SILICON PNP
EPITAXIAL PASSIVATED

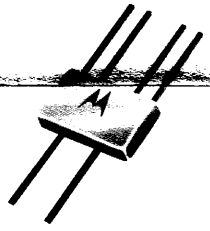
MARCH, 1964

DS 4502-R1

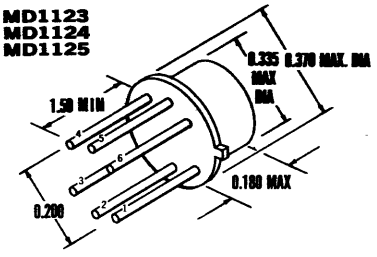


PIN CONNECTIONS
(BOTTOM VIEW)

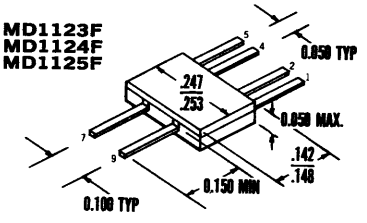




MD1123
MD1124
MD1125



MD1123F
MD1124F
MD1125F



Lead 1 identified by square impression on underside of case.

(ALL LEADS ISOLATED FROM CASE)

ABSOLUTE MAXIMUM RATINGS (each side)

Characteristics	Symbol	Rating		Unit
Collector-Base Voltage	V_{CBO}	60		Vdc
Collector- Emitter Voltage	V_{CEO}	40		Vdc
Emitter-Base Voltage	V_{EBO}	5		Vdc
D.C. Collector Current (Limited by P_D)	I_C	200		mAdc
Junction Temperature	T_J	+200		°C
Storage Temperature	T_{stg}	-65 to +200		°C
		ONE SIDE	BOTH SIDES	
Flat Package Total Device Dissipation (25°C Ambient Temperature) Derate above 25°C	P_D	250 1.5	350 2	mW mW/°C
TO-5 Package Total Device Dissipation (25°C Ambient Temperature) Derate above 25°C	P_D	500 2.9	600 3.4	mW mW/°C

ELECTRICAL CHARACTERISTICS (each side) (at $T_A = 25°C$ unless otherwise specified)

Characteristics		Symbol	Min	Max	Unit
Collector-Base Breakdown Voltage (I_C = -10 μAdc)		BV_{CBO}	60	—	Vdc
Collector-Emitter Breakdown Voltage* (I_C = -10 mAdc)		BV_{CEO}*	40	—	Vdc
Emitter-Base Breakdown Voltage (I_E = -10 μAdc)		BV_{EBO}	5	—	Vdc
Collector Cutoff Current (V_{CB} = -50 Vdc)		I_{CBO}	—	.010	μAdc
(V_{CB} = -50 Vdc, T_A = 150°C)			—	10	
Emitter Cutoff Current (V_{EB} = -3 Vdc)		I_{EBO}	—	10	nAdc
Collector-Emitter Saturation Voltage (I_C = -10 mAdc, I_B = -1 mAdc)		$V_{CE\ (sat)}$	—	0.25	Vdc
Base-Emitter Saturation Voltage (I_C = -10 mAdc, I_B = -1 mAdc)		$V_{BE\ (sat)}$	—	0.9	Vdc
DC Forward Current Transfer Ratio		h_{FE}			—
(I_C = -10 μAdc, V_{CE} = -10 Vdc)	MD1124, MD1125†		20	100	
(I_C = -100 μAdc, V_{CE} = -10 Vdc)	All Types		30	120	
(I_C = -1 mAdc, V_{CE} = -10 Vdc)	All Types		40	160	
(I_C = -10 mAdc, V_{CE} = -10 Vdc)	All Types		50	200	
DC Current Gain Ratio **		h_{FE1}/h_{FE2}**			—
(I_C = -100 μAdc, V_{CE} = -10 Vdc)	MD1123†		0.8	1.0	
	MD1124, MD1125†		0.9	1.0	
(I_C = -1 mAdc, V_{CE} = -10 Vdc)	MD1125†		0.9	1.0	
Base Voltage Differential		$\lvert V_{BE1}-V_{BE2} \rvert$			mVdc
(I_C = -100 μAdc, V_{CE} = -10 Vdc)	MD1123, MD1124†		—	10	
	MD1125†		—	5	
(I_C = -1 mAdc, V_{CE} = -10 Vdc)	MD1125†		—	5	
Base Voltage Differential Change (I_C = -100 μAdc, V_{CE} = -10 Vdc, T_A = -55°C to + 125°C)	MD1124, MD1125†	$\Delta (V_{BE1}-V_{BE2})$	—	10	μV/°C
Collector Output Capacitance (V_{CB} = -10 Vdc, f = 100 kc)		C_{ob}	—	4	pf
Small-Signal Forward Current Transfer Ratio		h_{fe}			—
(I_C = -20 mAdc, V_{CE} = -20 Vdc, f = 100 mc) TO-5			2.5	—	
(I_C = -20 mAdc, V_{CE} = -10 Vdc, f = 100mc) Flat			2.0	—	
Current-Gain-Bandwidth Product		f_T			mc
(V_{CE} = -20 Vdc, I_C = -20 mAdc) TO-5			250	—	
(V_{CE} = -10 Vdc, I_C = -20 mAdc) Flat			200	—	

*Pulse Test: Pulse Width ≤ 300 μsec, Duty Cycle ≤ 2%
**The lowest h_{FE} reading is taken as h_{FE1} for this ratio
†Applies to corresponding Flat Package device type also

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