

MDC5000T1

SMALLBLOCK™
Low Voltage Bias Stabilizer

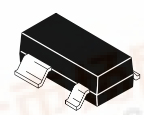
SILICON SMALLBLOCK™ INTEGRATED CIRCUIT

- Maintains Stable Bias Current in Various Discrete Bipolar Junction and Field Effect Transistors
- Provides Stable Bias Using a Single Component Without Use of Emitter Ballast and Bypass Components
- Operates Over a Wide Range of Supply Voltages Down to 1.8 Vdc
- Reduces Bias Current Variation Due to Temperature and Unit–to–Unit Parametric Changes
- Consumes < 0.5 mW at V_{CC} = 2.75 V

This device provides a reference voltage and acts as a DC feedback element around an external discrete, NPN BJT or N–Channel FET. It allows the external transistor to have its emitter/source directly grounded and still operate with a stable collector/drain DC current. It is primarily intended to stabilize the bias of discrete RF stages operating from a low voltage regulated supply, but can also be used to stabilize the bias current of any linear stage in order to eliminate emitter/source bypassing and achieve tighter bias regulation over temperature and unit variations. This device is intended to replace a circuit of three to six discrete components and is available in a SOT–143 package.

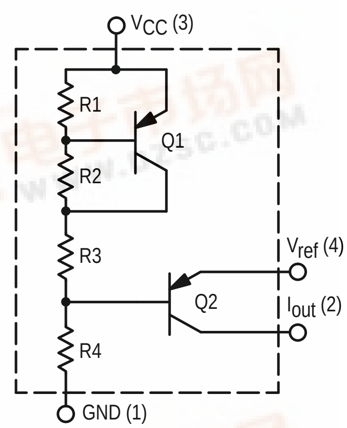
The combination of low supply voltage, low quiescent current drain, and small package make it ideal for portable communications applications such as:

- Cellular Telephones
- Pagers
- PCN/PCS Portables
- PCMCIA RF Modems
- Cordless Phones
- Broadband Transceivers and Other Portable Wireless Products



CASE 318A–05, Style 9
SOT–143

INTERNAL CIRCUIT DIAGRAM



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Power Supply Voltage	V_{CC}	15	Vdc
Ambient Operating Temperature Range	T_A	–40 to +85	°C
Storage Temperature Range	T_{stg}	–65 to +150	°C
Junction Temperature	T_J	150	°C
Collector Emitter Voltage (Q2)	V_{CEO}	–15	V

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Power Dissipation (FR–5 PCB of 1″ × 0.75″ × 0.062″, T_A = 25°C)	P_D	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	556	°C/W

DEVICE MARKING

MDC5000T1 = E5

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

Characteristic	Symbol	Min	Typ	Max	Unit
Recommended Operating Supply Voltage	V_{CC}	1.8	2.75	10	Volts
Power Supply Current (V_{CC} = 2.75 V) V_{ref}, I_{out} are unterminated See Figure 8	I_{CC}	—	110	200	μA
Q2 Collector Emitter Breakdown Voltage (I_{C2} = 10 μA, I_{B2} = 0)	$V_{(BR)CEO2}$	–15			Volts
Reference Voltage (V_{CC} = 2.75 V, V_{out} = 0.7 V) (I_{out} = 30 μA) (I_{out} = 150 μA) See Figure 9	V_{ref}	 2.010 2.075	 2.035 2.100	 2.060 2.125	Volts
Reference Voltage (V_{CC} = 2.75 V, V_{out} = 0.7 V, –40°C ≤ T_A ≤ +85°C) V_{CC} Pulse Width = 10 mS, Duty Cycle = 1.0% (I_{out} = 10 μA) (I_{out} = 30 μA) (I_{out} = 100 μA) See Figure 9	ΔV_{ref}		 ±5 ±12 ±25	 ±10 ±25 ±50	mV

TYPICAL OPEN LOOP CHARACTERISTICS

(Refer to Circuit of Figure 9)

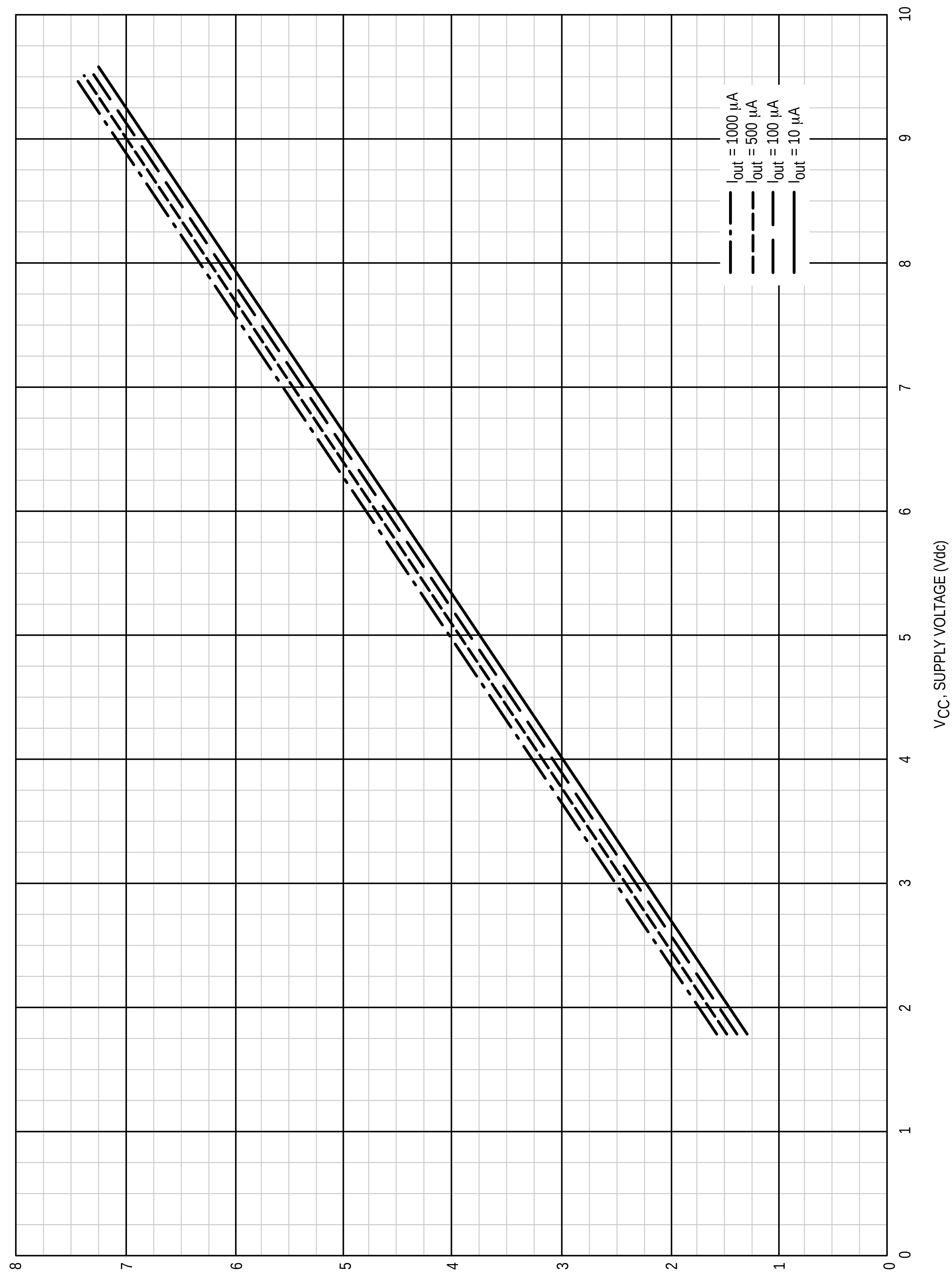


Figure 1. V_{ref} versus V_{CC} @ I_{out}

TYPICAL OPEN LOOP CHARACTERISTICS

(Refer to Circuits of Figures 8, 10 & 11)

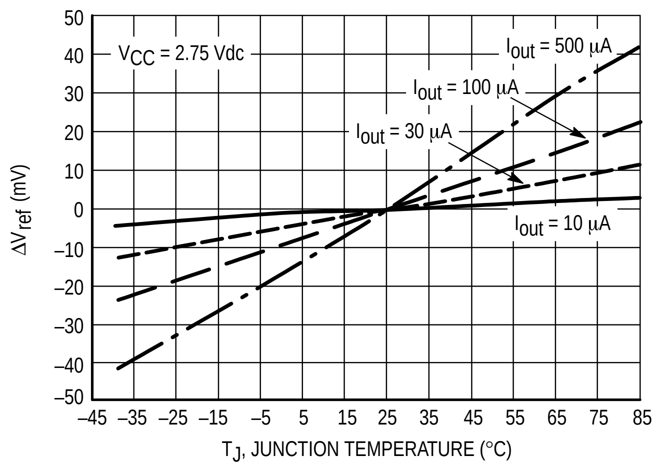


Figure 2. ΔV_{ref} versus T_J @ I_{out}

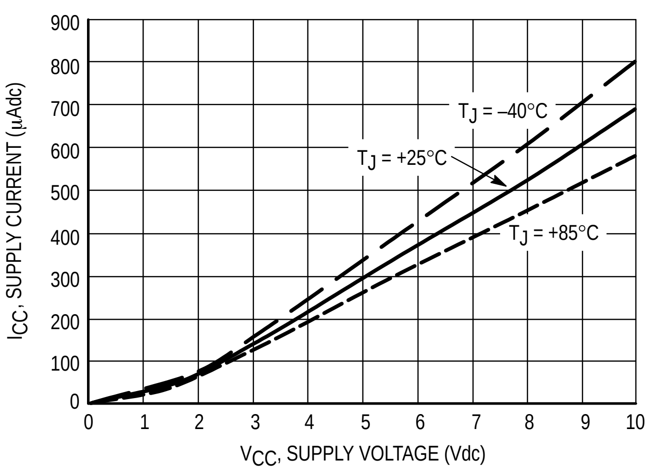


Figure 3. I_{CC} versus V_{CC} @ T_J

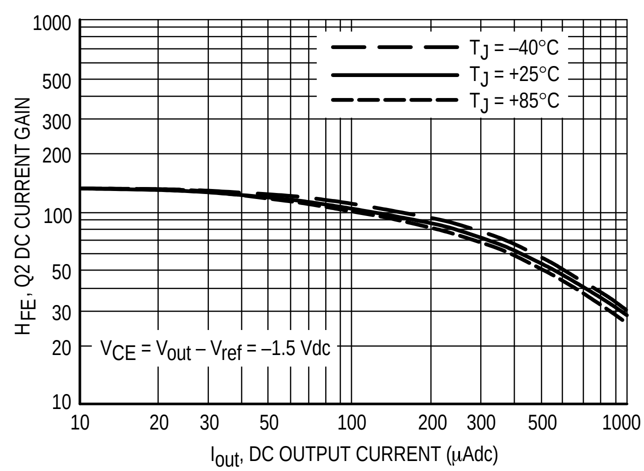


Figure 4. Q2 Current Gain versus Output Current

TYPICAL CLOSED LOOP PERFORMANCE

(Refer to Circuits of Figures 12 & 13)

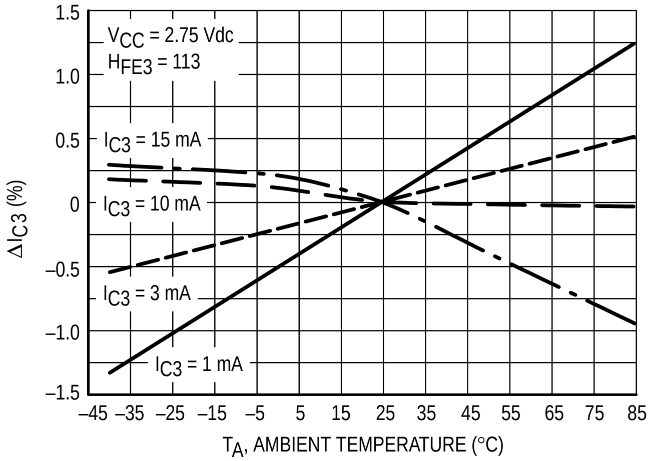


Figure 5. ΔI_{C3} versus T_A @ I_{C3}

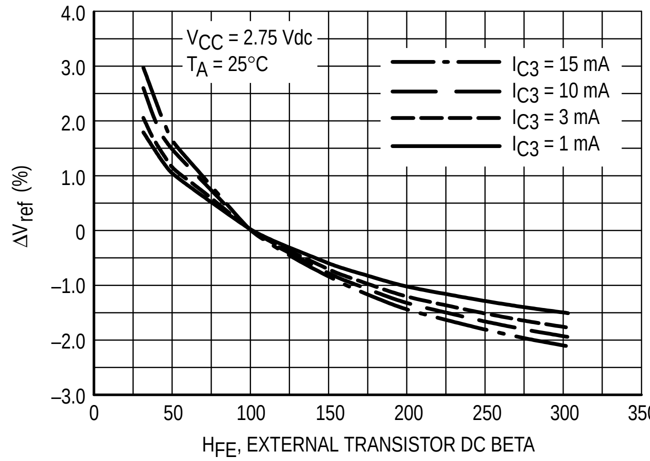


Figure 6. ΔV_{ref} versus External Transistor DC Beta @ I_{C3}

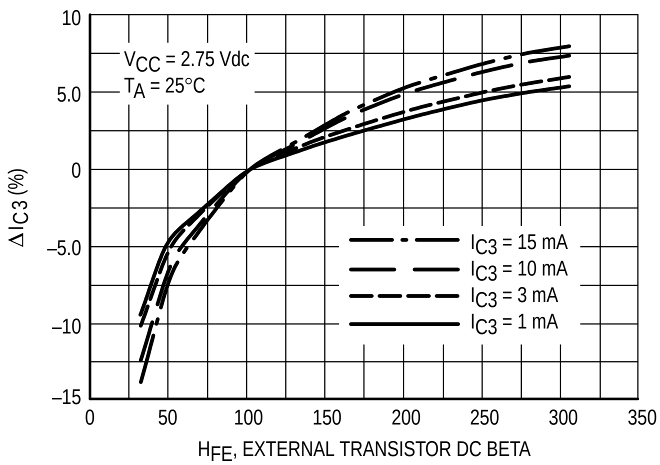


Figure 7. ΔI_{C3} versus External Transistor DC Beta @ I_{C3}

OPEN LOOP TEST CIRCUITS

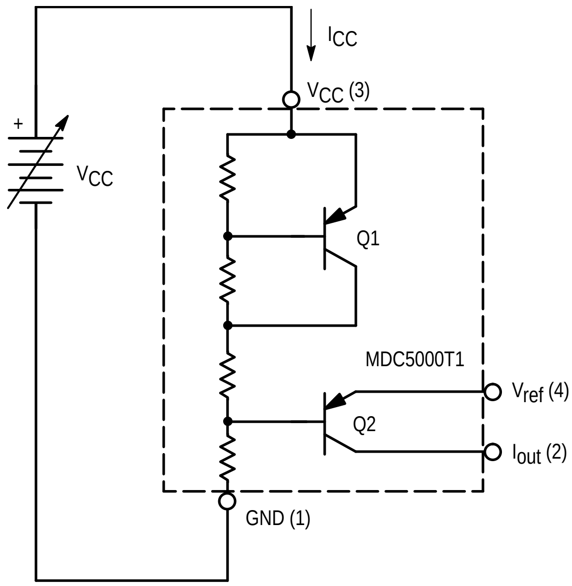
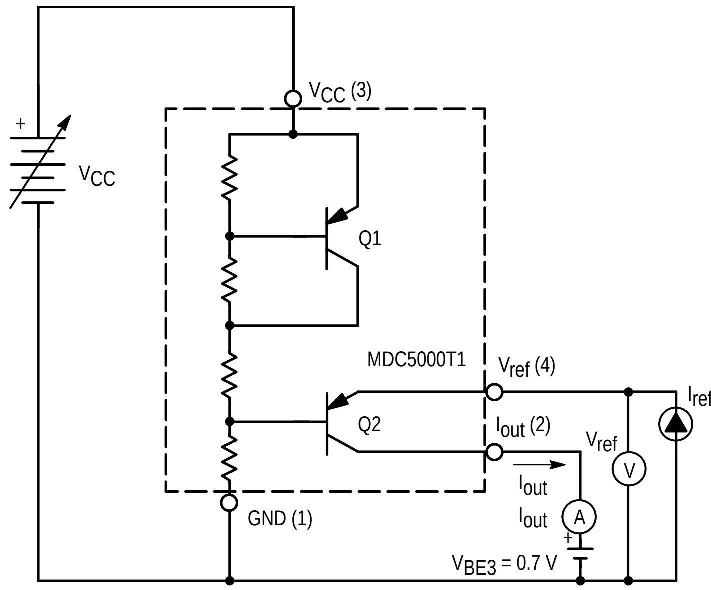
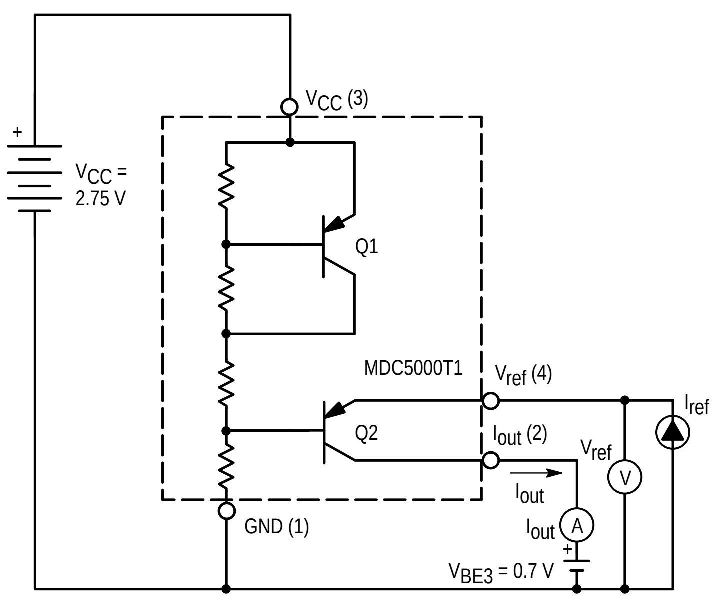


Figure 8. I_{CC} versus V_{CC} Test Circuit



NOTE: V_{BE3} is used to simulate actual operating conditions that reduce V_{CE2} & H_{FE2}, and increase I_{B2} & V_{ref}.

Figure 9. V_{ref} versus V_{CC} Test Circuit



NOTE: V_{BE3} is used to simulate actual operating conditions that reduce V_{CE2} & H_{FE2}, and increase I_{B2} & V_{ref}.

Figure 10. V_{ref} versus T_J Test Circuit

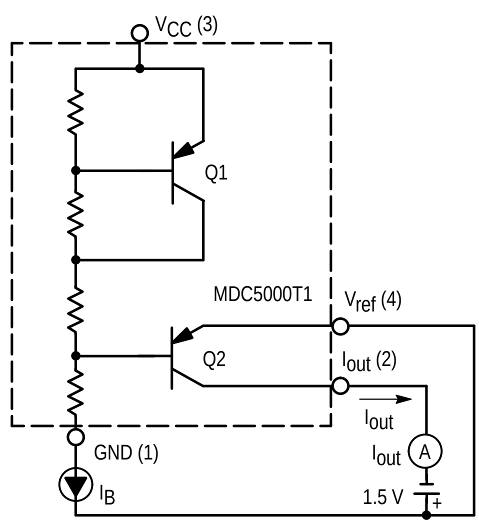


Figure 11. H_{FE} versus I_{out} Test Circuit

CLOSED LOOP TEST CIRCUITS

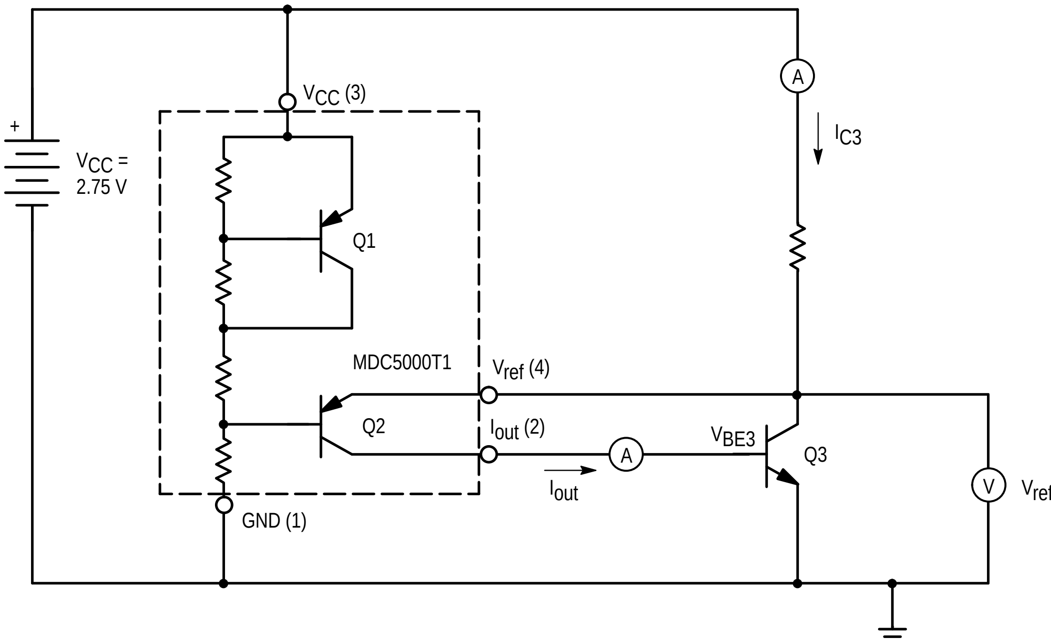
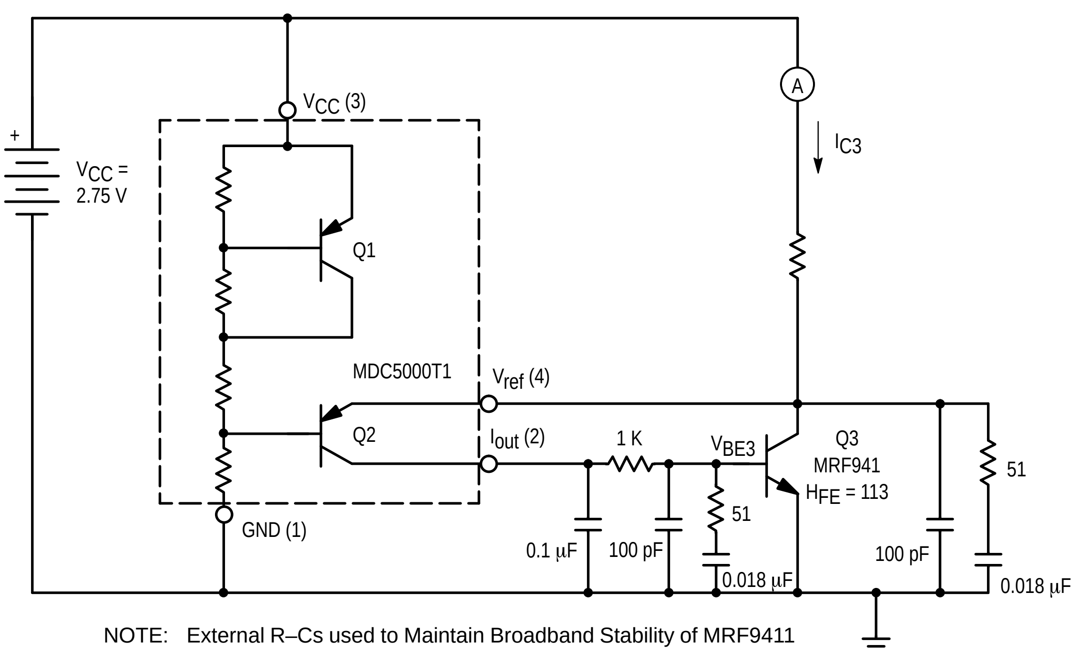
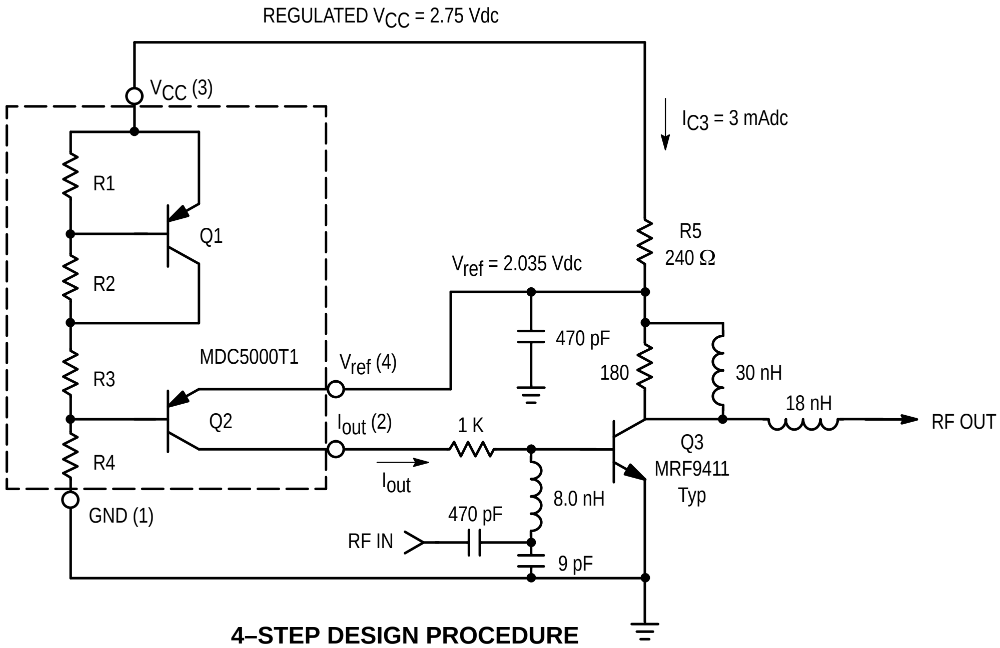


Figure 12. RF Stage I_{C3} versus H_{FE3} Test Circuit



NOTE: External R–Cs used to Maintain Broadband Stability of MRF9411

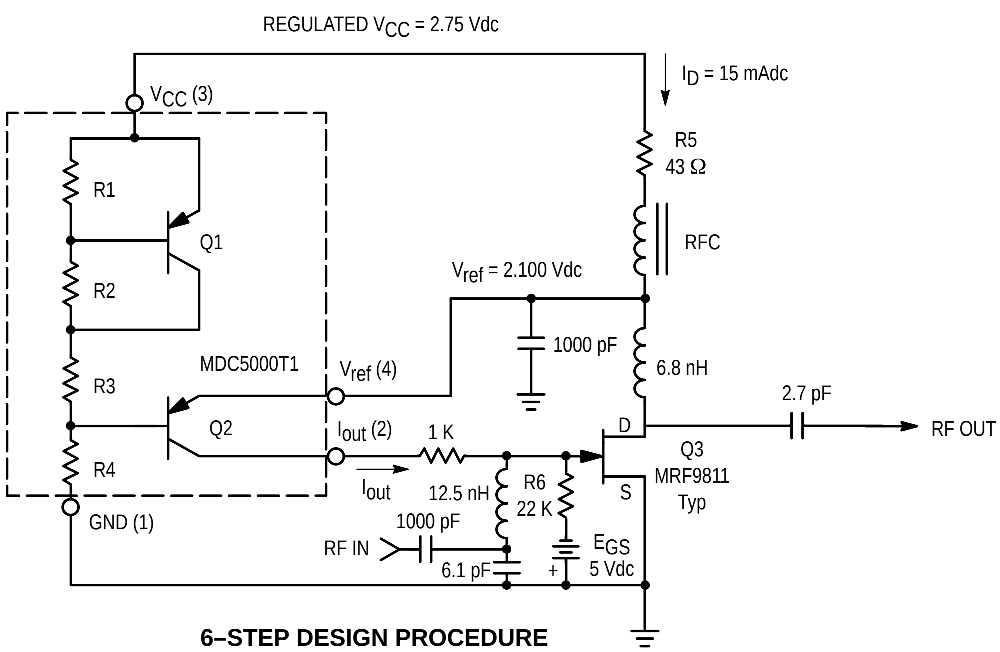
Figure 13. RF Stage I_{C3} versus T_A Test Circuit



4–STEP DESIGN PROCEDURE

Step 1: Choose V_{CC} (1.8 V Min to 10 V Max)
Step 2: Choose bias current, I_{C3}, and calculate needed I_{out} from typ H_{FE3}
Step 3: From Figure 1, read V_{ref} for V_{CC} & I_{out} calculated.
Step 4: Calculate Nominal R5 = $(V_{CC} - V_{ref}) \div (I_{C3} + I_{out})$. Tweak as desired.

Figure 14. Class A Biasing of a Typical 900 MHz BJT Amplifier



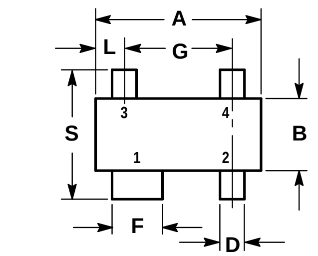
6–STEP DESIGN PROCEDURE

Step 1: Choose V_{CC} (1.8 V Min to 10 V Max)
Step 2: Choose bias current, I_D, and determine needed gate–source voltage, V_{GS}.
Step 3: Choose I_{out} keeping in mind that too large an I_{out} can impair MDC5000T1 $\Delta V_{ref}/\Delta T_J$ performance (Figure 2) but too large an R6 can cause I_{DGO} & I_{GSO} to bias on the FET.
Step 4: Calculate R6 = $(V_{GS} + E_{GS}) \div I_{out}$
Step 5: From Figure 1, read V_{ref} for V_{CC} & I_{out} chosen
Step 6: Calculate Nominal R5 = $(V_{CC} - V_{ref}) \div (I_D + I_{out})$. Tweak as desired.

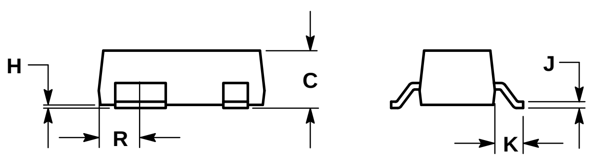
Figure 15. Class A Biasing of a Typical 890 MHz Depletion Mode GaAs FET Amplifier

PACKAGE DIMENSIONS

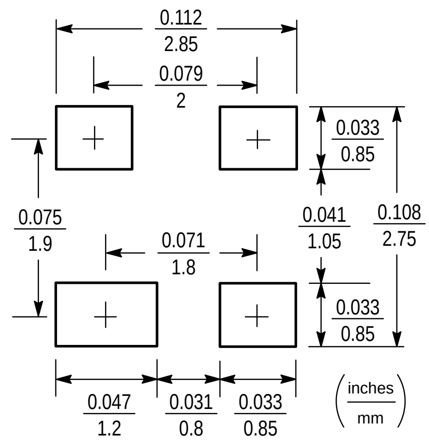
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.



DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	2.80	3.04	0.110	0.120
B	1.20	1.39	0.047	0.055
C	0.84	1.14	0.033	0.045
D	0.39	0.50	0.015	0.020
F	0.79	0.93	0.031	0.037
G	1.78	2.03	0.070	0.080
H	0.013	0.10	0.0005	0.004
J	0.08	0.15	0.003	0.006
K	0.46	0.60	0.018	0.024
L	0.445	0.60	0.0175	0.024
R	0.72	0.83	0.028	0.033
S	2.11	2.48	0.083	0.098



STYLE 9:
PIN 1. GND
2. IOUT
3. VCC
4. VREF



SOT–143 FOOTPRINT

CASE 318A–05
ISSUE M

How to reach us:
USA / EUROPE / Locations Not Listed: Motorola Literature Distribution;
P.O. Box 20912; Phoenix, Arizona 85036. 1–800–441–2447 or 602–303–5454

MFAX: RMFAX0@email.sps.mot.com – TOUCHTONE 602–244–6609
INTERNET: http://Design–NET.com

JAPAN: Nippon Motorola Ltd.; Tatsumi–SPD–JLDC, 6F Seibu–Butsuryu–Center,
3–14–2 Tatsumi Koto–Ku, Tokyo 135, Japan. 03–81–3521–8315

ASIA / PACIFIC: Motorola Semiconductors H.K. Ltd.; 8B Tai Ping Industrial Park,
51 Ting Kok Road, Tai Po, N.T., Hong Kong. 852–26629298