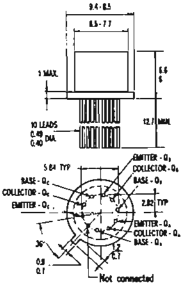
BFX 16

ULTRA LOW DRIFT DIFFERENTIAL AMPLIFIER

THREE NPN SILICON PLANAR TRANSISTORS

GENERAL DESCRIPTION - The BFX 16 is intended for ultra-low-drift compensated D.C. amplifiers. The maximum total amplifier drift is guaranteed less than 0.5 µV/°C from 0°C to 70°C. In order to ensure that this low drift does not change with life, it is advisable not to operate the device permanently much above this ambient temperature range.

PHYSICAL DIMENSIONS
similar to
JEDEC TO-5 outline



Notes: All dimensions in mm.
Leads are gold-plated Kovar.

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

T_{STG}	Storage Temperature	-55°C to +200°C
T_J	Operating Junction Temperature	+200°C Maximum
T_L	Lead Temperature (Soldering, 10 sec. time limit)	+260°C Maximum

Maximum Power Dissipations

		Each One	Total
P	Total Dissipation at 25°C Case Temperature	0.75 Watt	1,3 Watt
	at 100°C Case Temperature	0.43 Watt	0.75 Watt
	at 25°C Ambient Temperature	0.3 Watt	0.5 Watt

Maximum Voltages (25°C free air temperature unless otherwise noted)

V_{CBO}	Collector to Base Voltage	45 Volts
V_{CEO}	Collector to Emitter Voltage	45 Volts
V_{EBO}	Emitter to Base Voltage	6 Volts

ELECTRICAL CHARACTERISTICS (25°C free air temperature unless otherwise noted) Q_A, Q_B; Q_C

SYMBOL	CHARACTERISTIC	MIN.	MAX.	UNIT	TEST CONDITIONS	
V_{BE}(on)	Emitter to Base On Voltage		0.7	V	I_C = 100 µA	V_{CE} = 5 V
V_{CE} (sat)	Collector Saturation Voltage (Note 2)		0.35	V	I_C = 1 mA	I_B = 0.1 mA
BV_{CBO}	Collector to Base Breakdown Voltage	45		V	I_C = 10 µA	I_E = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	6		V	I_E = 10 µA	I_C = 0
V_{CEO} (sust)	Colleetor to Emitter Sustaining Voltage (Note 2)	45		V	I_C = 10 mA	I_B = 0
h_{fe}	High Frequency Current Gain (f = 30 MHz)	2			I_C = 500 µA	V_{CE} = 5 V
C_{ob}	Output Capacitance (f = 1 KHz)		6	pF	I_E = 0	V_{CB} = 5 V

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NOTES:

(1) These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.

(2) Pulse Conditions: length = 300 µsec; duty cycle = 1%.

(3) f = 1 KHz; R_S = 10 KΩ; Power Bandwidth of 200 Hz.

ELECTRICAL CHARACTERISTICS (25°C free air temperature unless otherwise noted) Q_A; Q_B

SYMBOL	CHARACTERISTIC	MIN.	MAX.	UNIT	TEST CONDITIONS	
h_{FE}	DC Current Gain	175			I_C = 10 µA	V_{CE} = 5 V
h_{FE1}/h_{FE2}	DC Current Gain Ratio	0.8	1		I_C = 10 µA	V_{CE} = 5 V
h_{FE1}/h_{FE2}	DC Current Gain Ratio	0.9	1		I_C = 100 µA	V_{CE} = 5 V
V_{BE1}/V_{BE2}	Base Voltage Differential		5	mV	I_C = 10 µA to 1 mA	V_{CE} = 5 V
ΔV_{in}	Equivalent Input Drift (see circuit)		0.5	µV/°C	T_A= O to 70°C	
I_{CBO}	Collector Cutoff Current		2	nA	I_E = 0	V_{CB} = 25 V
I_{CBO} (150°C)	Collector Cutoff Current		10	µA	I_E = 0	V_{CB} = 25 V
I_{EBO}	Emitter Cutoff Current		2	nA	I_C = 0	V_{EB} = 4 V
I_{CEO}	Collector to Emitter Cutoff Current		2	nA	I_B = 0	V_{CE} = 4 V
NF	Noise Figure (Note 3)		3	dB	I_C = 10 µA	V_{CE} = 5 V

ELECTRICAL CHARACTERISTICS (25°C free air temperature unless otherwise noted) Q_C

SYMBOL	CHARACTERISTIC	MIN.	MAX.	UNIT	TEST CONDITIONS	
h_{FE}	DC Current Gain	75			I_C = 100 µA	V_{CE} = 5 V
I_{CBO}	Collector Cutoff Current		10	nA	I_E = 0	V_{CB} = 25 V
I_{CBO} (150°C)	Collector Cutoff Current		15	µA	I_E = 0	V_{CB} = 25 V
I_{EBO}	Emitter Cutoff Current		10	nA	I_C = 0	V_{EB} = 4 V
I_{CEO}	Collector to Emitter Cutoff Current		10	nA	I_B = 0	V_{CE} = 4 V

APPLICATIONS INFORMATION

The BFX 16 is a compensated dc amplifier which furnishes an exceedingly low drift in a wide range of circuits. A typical circuit, which is the one used to measure the drift specified, is shown in fig. 1.

The procedure used to reduce the drift to a minimum in this amplifier is the following:

1. With "S" OPEN, R_6 is adjusted for zero output.
2. With "S" CLOSED, R_2 is adjusted for zero output independent of the position of R_9.
3. With the amplifier brought up to any temperature, R_9 is adjusted for zero output. If the drift is linear, this adjustment will be acceptable for the full temperature range. It may be that, in some cases, this zeroing procedure should be repeated.

Although the circuit looks complicated, its operation is really quite simple and can be understood in the following manner. The resistive chain of R_1 through R_5 furnishes a constant voltage on the base of Q_C. Since the V_{BE} of this transistor decreases with an increase in temperature, the current furnished to the emitters of Q_A and Q_B increases with the increase of temperature. The collectors, therefore, fall in voltage, and consequently, the current which is then furnished into resistor R_9 from the resistive chain can be fed more into one transistor than into the other by varying the position of the tap on R_9.

Since these drift phenomena are reasonably linear over a certain temperature range as is the variation of V_{BE} of the compensating transistor Q_C the drift due to all factors (ΔV_{BE}, ΔI_{CBO}, Δh_{FE}) can thus be compensated.

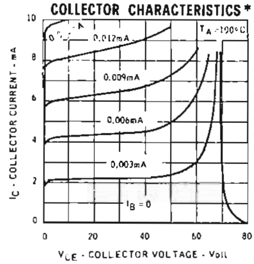
The voltage sources, e_1, e_2 can be put to ground simply by having a negative supply instead of ground on the resistors R_5 and R_{10}.

For further information, the user is referred to Ref. 1 or to our Application Service.

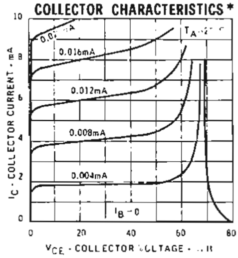
Ref. 1: " Drift Compensation in DC Amplifiers" SGS AR 121

TYPICAL ELECTRICAL CHARACTERISTICS Q_A, Q_B

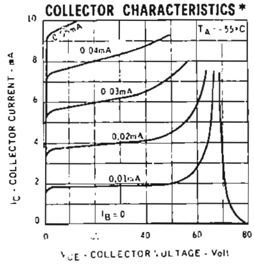
COLLECTOR CHARACTERISTICS*



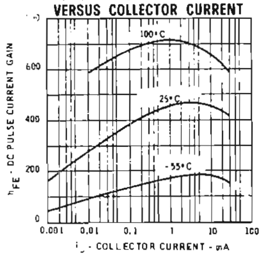
COLLECTOR CHARACTERISTICS*



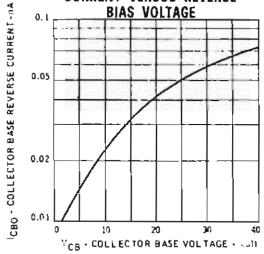
COLLECTOR CHARACTERISTICS*



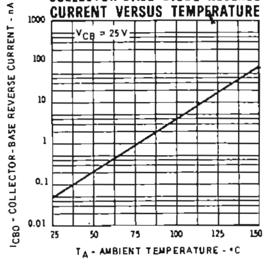
PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT



COLLECTOR BASE REVERSE CURRENT VERSUS REVERSE BIAS VOLTAGE

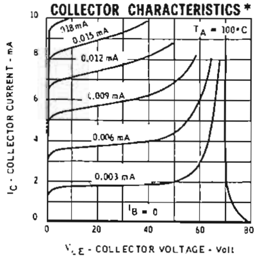


COLLECTOR-BASE DIODE REVERSE CURRENT VERSUS TEMPERATURE

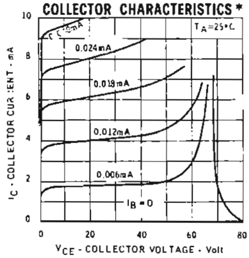


TYPICAL ELECTRICAL CHARACTERISTICS Q_C

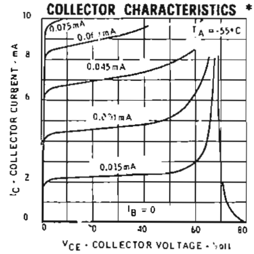
COLLECTOR CHARACTERISTICS*



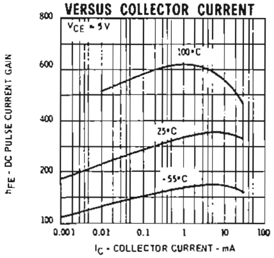
COLLECTOR CHARACTERISTICS*



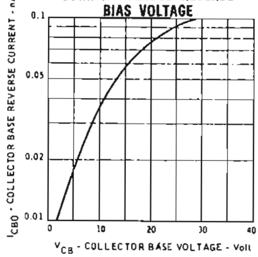
COLLECTOR CHARACTERISTICS *



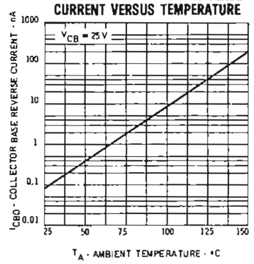
PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT



COLLECTOR BASE REVERSE CURRENT VERSUS REVERSE BIAS VOLTAGE



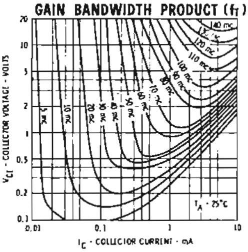
COLLECTOR-BASE DIODE REVERSE CURRENT VERSUS TEMPERATURE



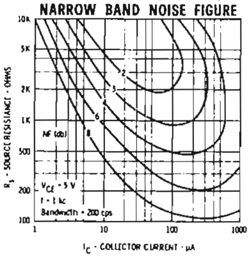
*Single family characteristics on Transistor Curve Tracer.

TYPICAL ELECTRICAL CHARACTERISTICS Q_A, Q_B, Q_C

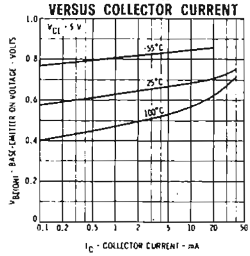
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



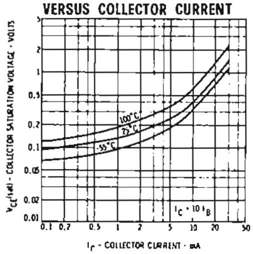
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



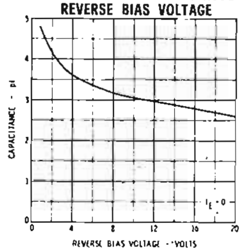
BASE-EMITTER ON VOLTAGE VERSUS COLLECTOR CURRENT



COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



COMPENSATED AMPLIFIER