N-P-N 1 GHz WIDEBAND TRANSISTOR

N-P-N transistor in a TO-72 metal envelope, with insulated electrodes and a shield lead connected to the case. The transistor has a low noise, a very high power gain and good intermodulation properties. It is primarily intended for:
- Channel aerial amplifiers for bands I, II, III and IV/V (40–860 MHz).
- Wideband aerial amplifiers (40–860 MHz).

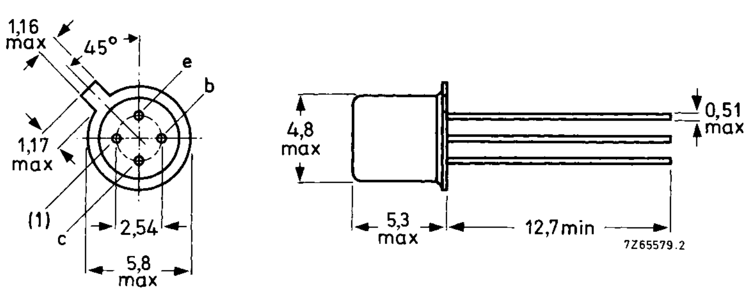
QUICK REFERENCE DATA

Collector-base voltage (open emitter; peak value)	V_{CBOM}	max.	30		V
Collector-emitter voltage (open base)	V_{CEO}	max.	15		V
Collector current (peak value; f > 1 MHz)	I_{CM}	max.	50		mA
Total power dissipation up to T_{amb} = 25 °C	P_{tot}	max.	200		mW
Junction temperature	T_j	max.	200		°C
Transition frequency I_C = 25 mA; V_{CE} = 5 V; f = 500 MHz	f_T	typ.	1.2		GHz
Feedback capacitance I_C = 2 mA; V_{CE} = 5 V; f = 1 MHz	C_{re}	typ.	0,6		pF
			f = 200	800	MHz
Noise figure at optimum source impedance I_C = 2 mA; V_{CE} = 5 V	F	typ.	3.3	7	dB
Power gain (not neutralized) I_C = 8 mA; V_{CE} = 10 V	G_p	typ.	22	7	dB
Output power d_{im} = −30 dB; VSWR at output < 2; I_C = 8 mA; V_{CE} = 10 V	P_o	typ.	6	6	mW

MECHANICAL DATA

Dimensions in mm

Fig. 1 TO-72.



(1) = shield lead (connected to case).

Accessories: 56246 (distance disc).

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Collector-base voltage (open emitter; peak value)	V_{CBOM}	max.	30	V
Collector-emitter voltage (peak value) $R_{BE} \leqslant 50\ \Omega$	V_{CERM}	max.	30	V
Collector-emitter voltage (open base)	V_{CEO}	max.	15	V
Emitter-base voltage (open collector)	V_{EBO}	max.	2.5	V
Collector current (DC)	I_C	max.	25	mA
Collector current (peak value; $f > 1$ MHz)	I_{CM}	max.	50	mA
Total power dissipation up to $T_{amb} = 25\ ^{o}C$	P_{tot}	max.	200	mW
Storage temperature	T_{stg}	−65 to + 200		^{o}C
Junction temperature	T_j	max.	200	^{o}C

THERMAL RESISTANCE

From junction to ambient in free air	$R_{th\ j\text{-}a}$	=	880	K/W
From junction to case	$R_{th\ j\text{-}c}$	=	580	K/W

CHARACTERISTICS

T_j = 25 °C unless otherwise specified

Collector cut-off current			
I_E = 0; V_{CB} = 15 V	I_{CBO}	max.	10 nA
Knee voltage			
I_C = 20 mA; I_B = value for which I_C = 22 mA at V_{CE} = 1 V	V_{CEK}	max.	0.75 V

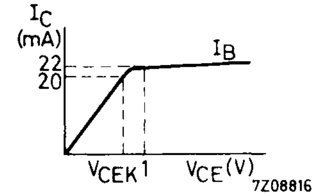


Fig. 2.

DC current gain			
I_C = 2 mA; V_{CE} = 1 V	h_{FE}		20 to 150
I_C = 25 mA; V_{CE} = 1 V	h_{FE}		20 to 125
Transition frequency*			
I_C = 2 mA; V_{CE} = 5 V; f = 500 MHz	f_T	typ.	1.0 GHz
I_C = 25 mA; V_{CE} = 5 V; f = 500 MHz	f_T	typ.	1.2 GHz
Collector capacitance at f = 1 MHz**			
$I_E = I_e$ = 0; V_{CB} = 10 V	C_c	max.	1.7 pF
Feedback capacitance at f = 1 MHz*			
I_C = 2 mA; V_{CE} = 5 V; T_{amb} = 25 °C	C_{re}	typ.	0.6 pF
Noise figure*			
I_C = 2 mA; V_{CE} = 5 V; T_{amb} = 25 °C			
f = 200 MHz; optimum source impedance	F	max.	4.0 dB
f = 500 MHz; Z_S = 50 Ω	F	max.	6.5 dB
f = 800 MHz; optimum source impedance	F	typ.	7.0 dB

Power gain (not neutralized)*			f = 200	800 MHz
I_C = 8 mA; V_{CE} = 10 V; T_{amb} = 25 °C	G_p	min.	19	– dB
		typ.	22	7.0 dB

* Shield lead grounded.
** Shield lead not connected.

CHARACTERISTICS (continued)

Intermodulation characteristics*

1. Output power at f = 200 MHz; T_{amb} = 25 ^oC
   I_C = 8 mA; V_{CE} = 10 V; V.S.W.R. at output < 2
   f_p = 202 MHz; f_q = 205 MHz; d_{im} = −30 dB
   measured at $f_{(2q-p)}$ = 208 MHz (Channel 9) — P_o typ. 6 mW

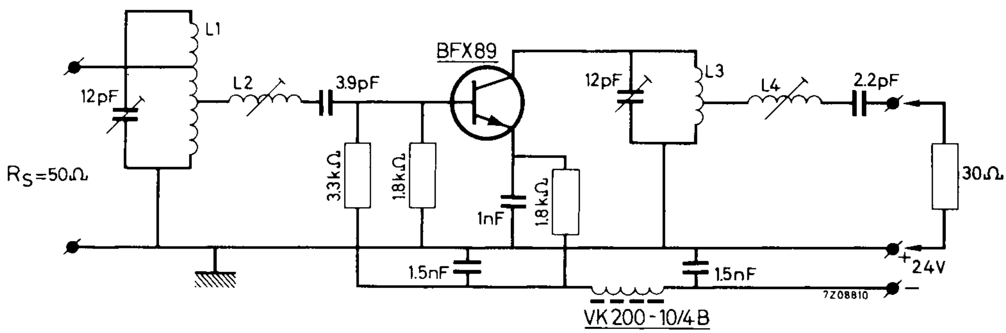


Fig. 3 Test circuit.

Coil data:

L1 = 3 turns silver plated Cu wire (1.4 mm); winding pitch 2.7 mm; int. diam. 8 mm; taps at 0.5 turn and 1.5 turns from earth.
L2 = 5.5 turns silver plated Cu wire (1.4 mm); winding pitch 2.2 mm; int. diam. 8 mm.
L3 = 3 turns silver plated Cu wire (1.4 mm); winding pitch 3.3 mm; int. diam. 8 mm.
L4 = 5.5 turns silver plated Cu wire (1.4 mm); winding pitch 2.2 mm; int. diam. 11 mm.

* Shield lead grounded.

CHARACTERISTICS

Basis of adjustment

The intermodulation at an intermodulation distortion of –30 dB is caused by h.f. output current – voltage clipping.
The maximum undistorted output power is realised, if

a. Current and voltage clipping take place concurrently.
   This occurs if

$$R_L = \frac{V_{CE} - V_{CEK}}{I_C},$$

   in which V_{CEK} is the high frequency knee voltage.

b. The h.f. collector current is as small as possible.
   This is so if $-C_L = +C_{oe}$,
   in which C_{oe} is the output capacitance of the transistor at short circuited input.

For maximum output power at an intermodulation distortion of –30 dB, the (experimentally found) values of R_L and C_L are:
$R_L = 1\ k\Omega$; $C_L = -1.8\ pF$

Adjustment procedure

1. Remove the transistor and connect a dummy consisting of a 1 kΩ resistor in parallel with a 1.8 pF capacitor between the collector and emitter connections of the output circuit.
2. Tune and match the output circuit for zero reflection at 205 MHz (V.S.W.R. = 1). After this adjustment, no further change may be made in the output circuit.
3. Replace the dummy by the transistor. Tune and match the input circuit for maximum power gain and good band pass curve.
   The V.S.W.R. of the output will then, in most cases, be ⩽ 2 over the whole channel.
   Corrections can be made by tuning L2; this will not disturb the band pass curve.

CHARACTERISTICS (continued)

Intermodulation characteristics*

2. Output power at f = 800 MHz; T_{amb} = 25 °C
   I_C = 8 mA; V_{CE} = 10 V; V.S.W.R. at output < 2
   f_p = 798 MHz; f_q = 802 MHz; d_{im} = −30 dB
   measured at $f_{(2q-p)}$ = 806 MHz (Channel 62) P_o typ. 6 mW

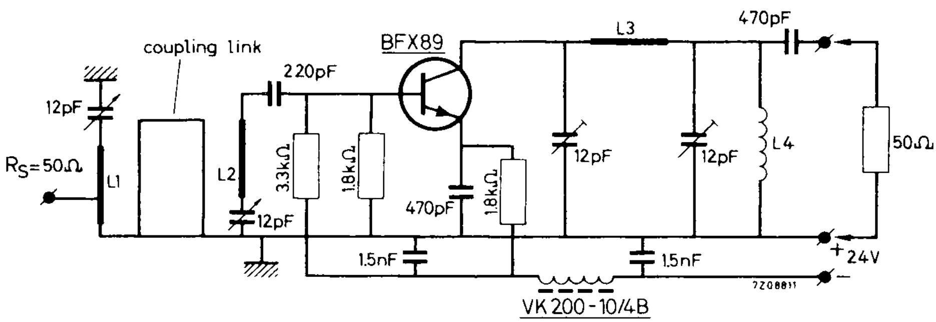


Fig. 4 Test circuit.

Coil data:

L1 = 24 mm x 6 mm x 0,5 mm silver plated Cu strip.
Tap of the input at 5 mm from earth.
L2 = 15 mm x 6 mm x 0,5 mm silver plated Cu strip.
L3 = 20 mm x 8 mm x 0,5 mm silver plated Cu strip.
L4 = 4 turns enamelled Cu wire (0.5 mm); winding pitch 1.5 mm; int. diam. 4 mm.
Coupling link: 42 mm silver plated Cu wire (1 mm).

Basis of adjustment

At 800 MHz no dummy can be used to adjust for optimum collector load because at these frequencies the impedance transformations of a dummy are too high. A small signal at the mid-channel frequency of 802 MHz is fed to the input and increased until clipping occurs; that is, until the output power no longer increases linearily with the input signal. This clipping can be eliminated by tuning the output circuit, thereby making the output power equal to

$$P_o = \frac{I_C\,(V_{CE} - V_{CEK})}{2} = 35\ \text{mW}$$

The output circuit is adjusted for minimum intermodulation if the input signal is as small as possible at P_o = 35 mW.
After this adjustment has been made no further change may be made in the output circuit.
Adjust the input circuit for maximum power gain and good band pass curve.
The V.S.W.R. of the output is then ⩽ 2 over the whole channel.

* Shield lead grounded.

CHARACTERISTICS

Intermodulation characteristics*

3. Intermodulation distortion
   I_C = 8 mA; V_{CE} = 6 V; R_L = 37.5 Ω; T_{amb} = 25 °C
   V_o = 100 mV at f_p = 183 MHz
   V_o = 100 mV at f_q = 200 MHz
   measured at $f_{(2q-p)}$ = 217 MHz — d_{im} typ. −40 dB

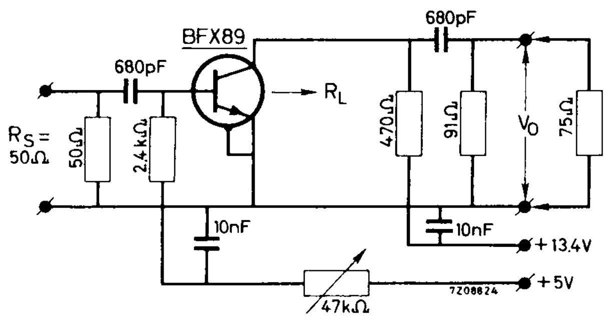


Fig. 5 Test circuit.

* Shield lead grounded.

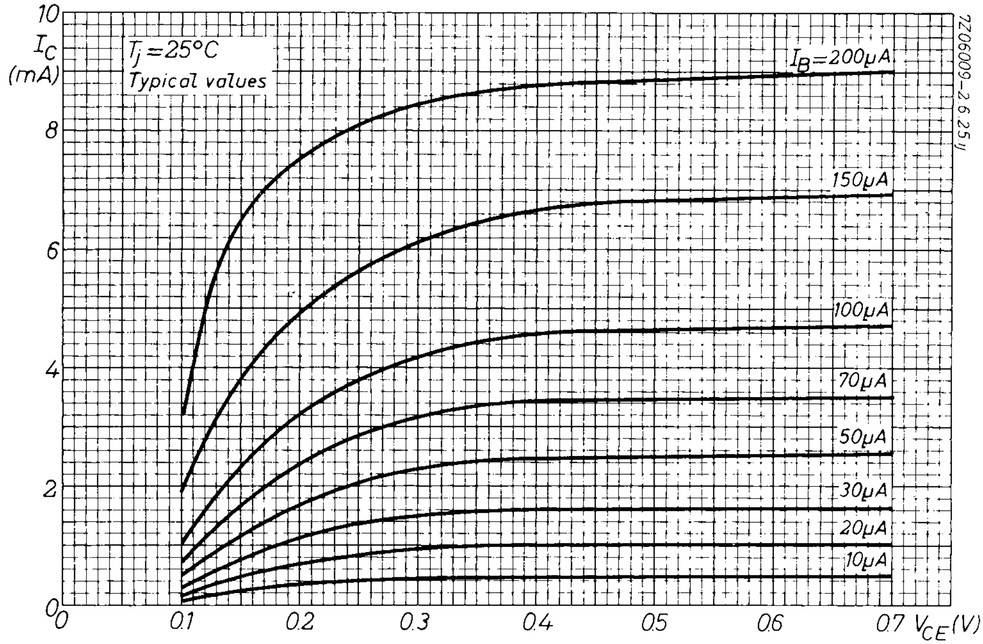


Fig. 6 T_j = 25 °C; typical values.

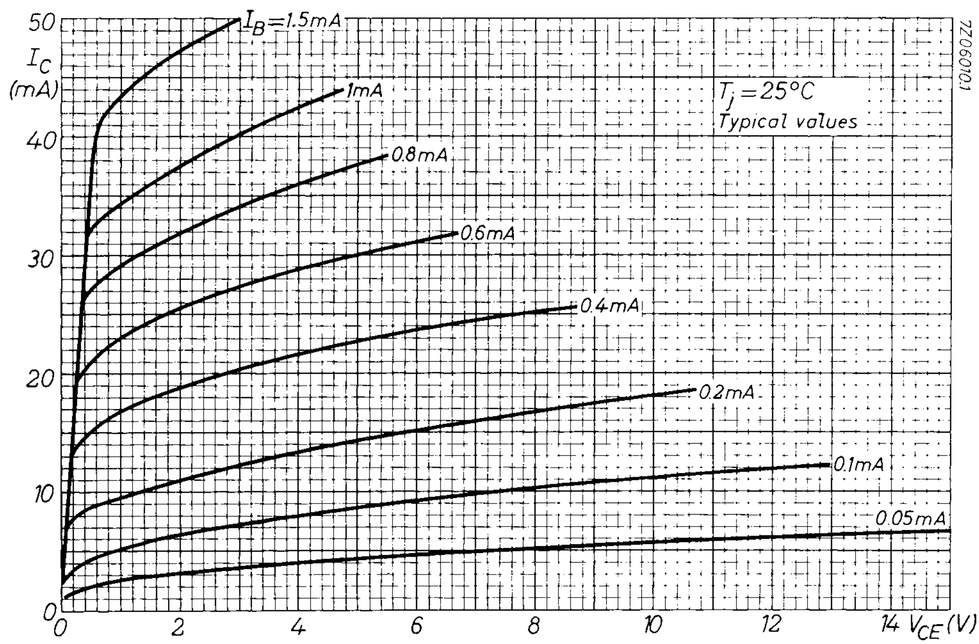


Fig. 7 T_j = 25 °C; typical values.

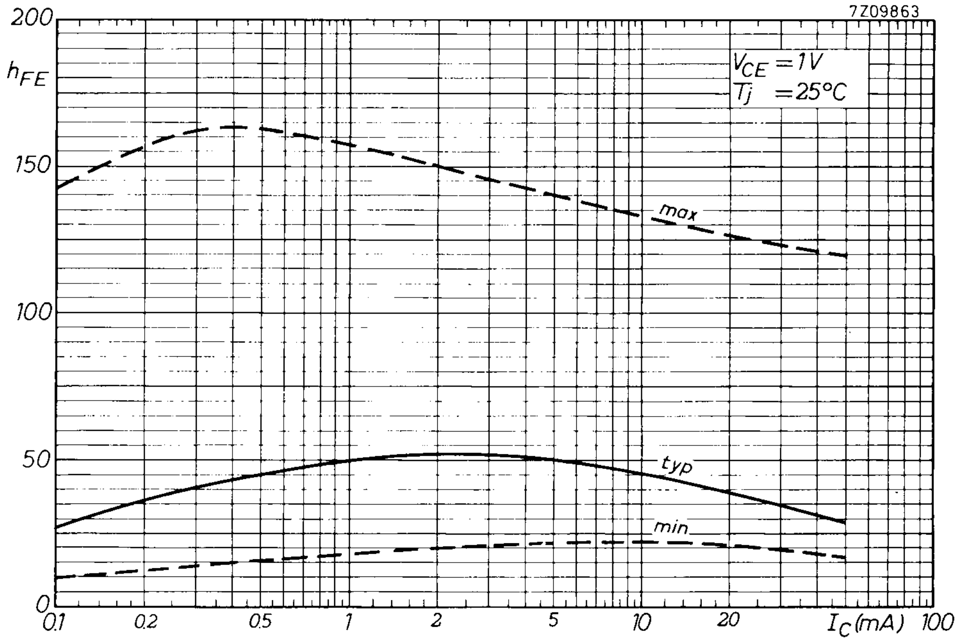


Fig. 8 V_{CE} = 1 V; T_j = 25 °C.

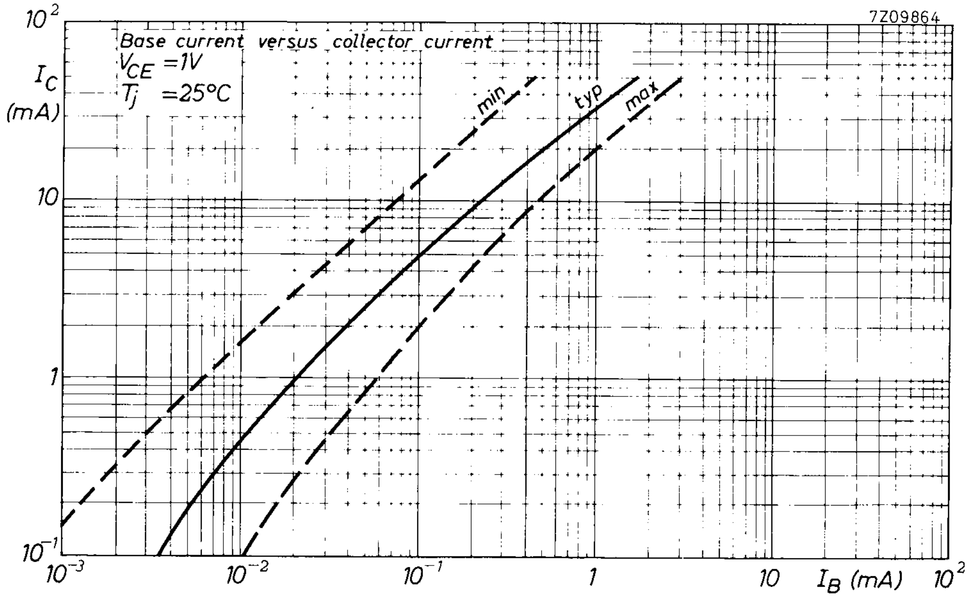


Fig. 9 V_{CE} = 1 V; T_j = 25 °C.

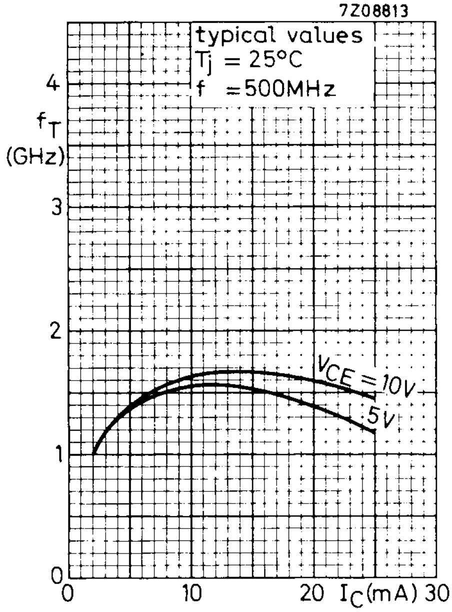


Fig. 10 f = 500 MHz; T_j = 25 °C; typical values.

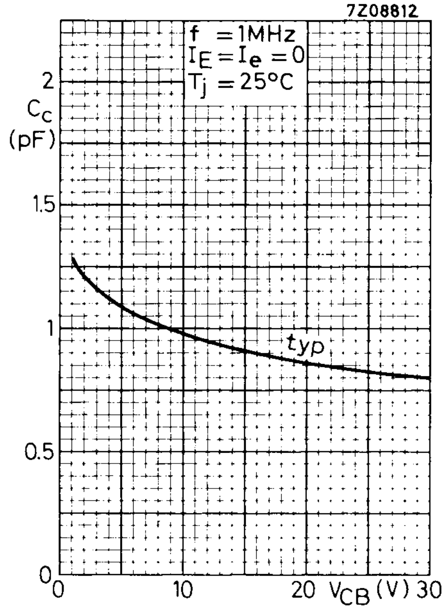


Fig. 11 $I_E = i_e = 0$; f = 1 MHz; T_j = 25 °C; typical values.

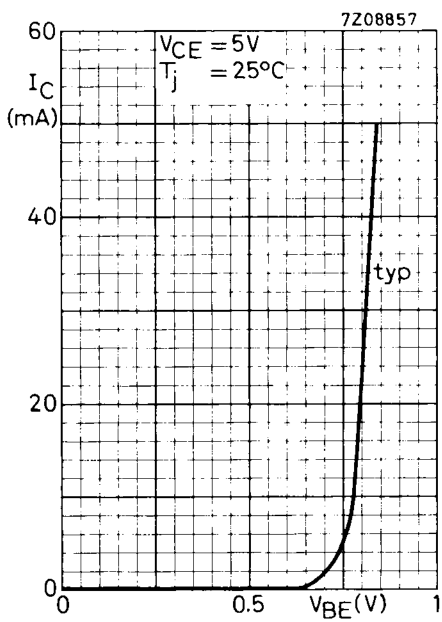


Fig. 12 V_{CE} = 5 V; T_j = 25 °C; typical values.

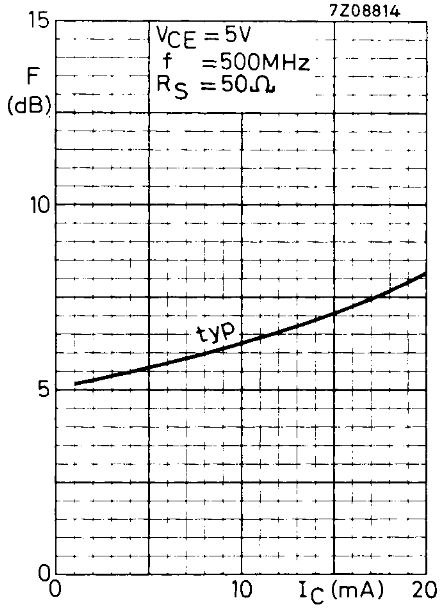


Fig. 13 V_{CE} = 5 V; f = 500 MHz; Z_S = 50 Ω; T_{amb} = 25 °C; typical values.

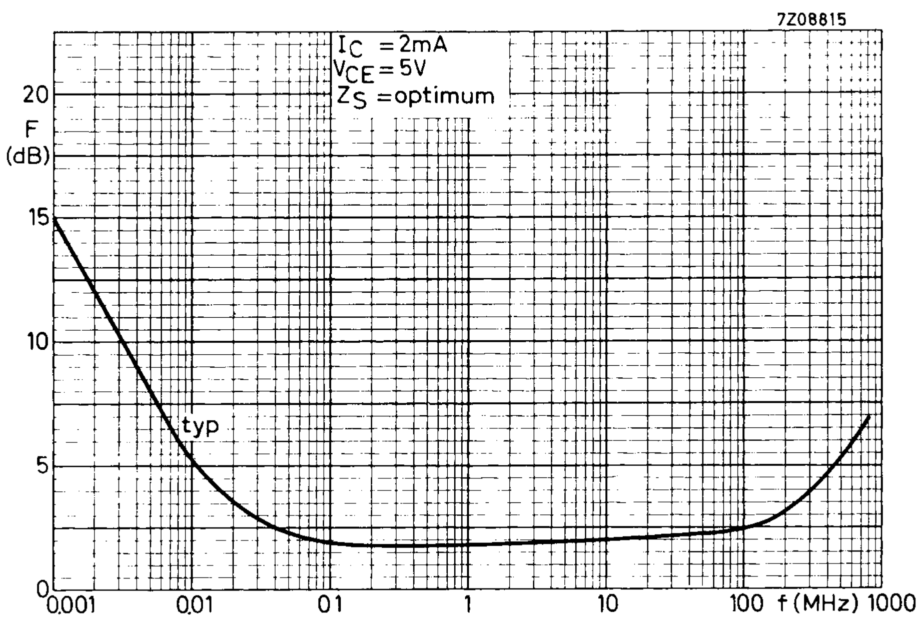


Fig. 14 V_{CE} = 5 V; I_C = 2 mA; Z_S = opt.; T_{amb} = 25 °C; typical values.