TEMIC
Semiconductors

U4062B

HF Front End for Car Radios and HiFi Receivers

Description

Technology: Bipolar

Features

- Completely integrated FM front end increases quality level and reliability
- High performance due to three AGC loops allow extreme large signal handling
- Fulfils FTZ rules
- Double-balanced high linear mixer with low-noise figure
- Oscillator with low phase noise and excellent frequency stability
- IF preamplifier with dB-linear gain control
- Low noise and high stability of the reference voltage circuit for internal and auxiliary functions

Block Diagram

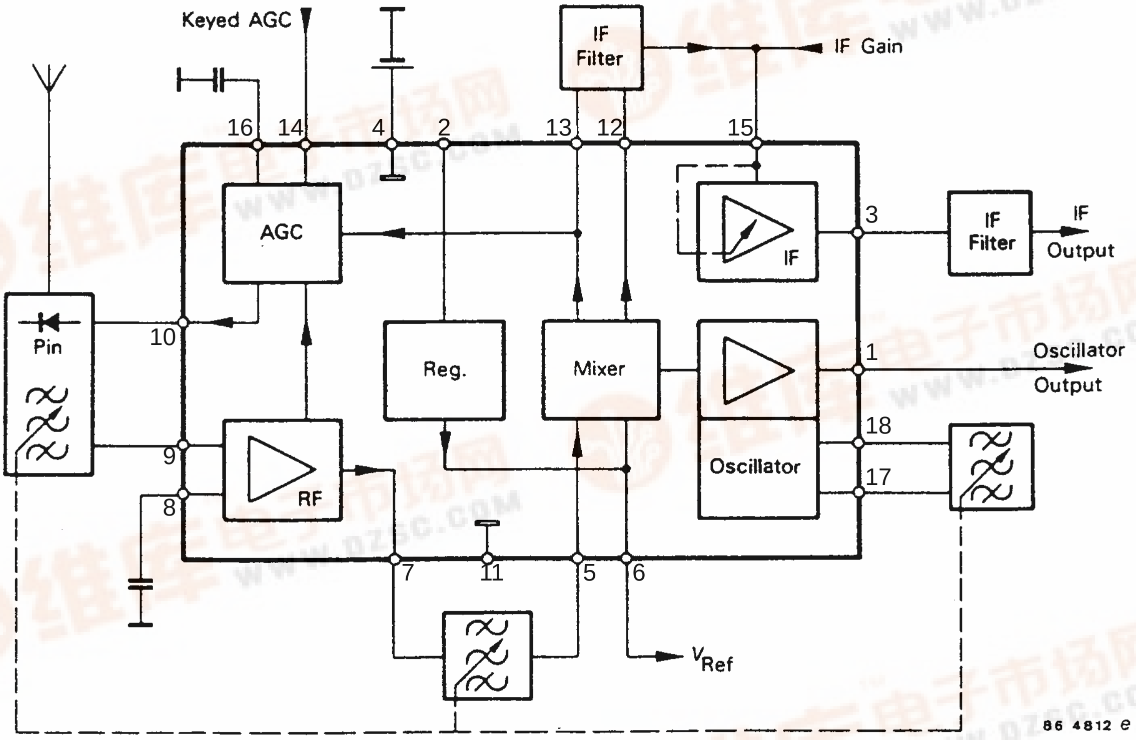


Figure 1. Block diagram

Ordering Information

Extended Type Number	Package	Remarks
U4062B-B	DIP18	

Pin Description

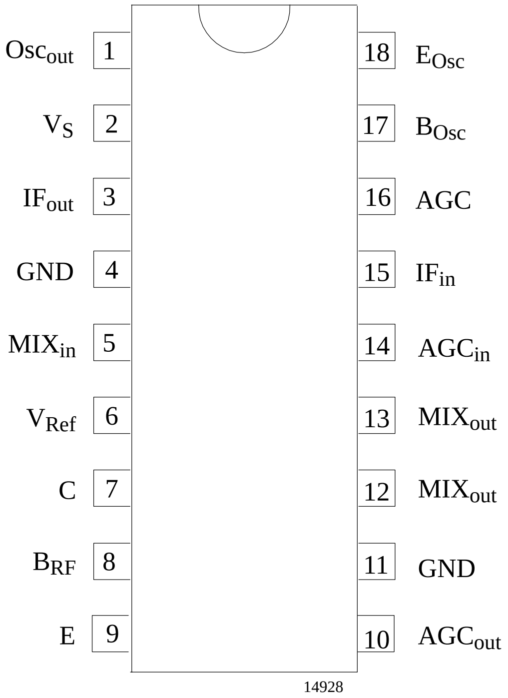


Figure 2. Pinning DIP18

Pin	Symbol	Function
1	Osc_{out}	Oscillator output
2	V_S	Supply voltage
3	IF_{out}	IF output
4	GND	Ground
5	MIX_{in}	Mixer input
6	V_{Ref}	Reference voltage output
7	C	Collector
8	B_{RF}	Base, RF preamplifier
9	E	Emitter
10	AGC_{out}	AGC output
11	GND	Ground
12	MIX_{out}	Mixer output
13	MIX_{out}	Mixer output
14	AGC_{in}	AGC input (IF strip)
15	IF_{in}	IF input / IF gain control
16	AGC	AGC time constant
17	B_{Osc}	Base oscillator
18	E_{Osc}	Emitter oscillator

Absolute Maximum Ratings

Reference point ground, Pins 4 and 11

Parameters		Symbol	Value	Unit
Supply voltage	Pins 2, 12 and 13	V_S	18	V
Power dissipation	T_{amb} = 85°C	P_{tot}	450	mW
Junction temperature		T_j	125	°C
Storage temperature range		T_{stg}	–50 to +125	°C
Ambient temperature range		T_{amb}	–25 to +85	°C

Thermal Resistance

Parameters	Symbol	Value	Unit
Junction ambient	R_{thJA}	90	K/W

Electrical Characteristics

V_S = 10 V, f_{iRF} = 50.3 MHz, $f_{Osc} \approx$ 100 MHz, $f_{IF} = f_{Osc} - f_{iRF} \approx$ 49.7 MHz, reference point Pins 4 and 11, T_{amb} = +25°C, unless otherwise specified, see test circuit figure 4.

Parameters	Test Conditions / Pins	Symbol	Min.	Typ.	Max.	Unit
Supply voltage range		V_S	7		16	V
Supply currents						
Supply current	Pin 2	I_S		11.5		mA
Mixer	Pins 12 and 13	$I_{12} + I_{13}$		9		mA
RF stage	R_4 = 470 Ω Pin 7	I_7		9		mA
RF preamplifier (R_{g9} = 50 Ω, R_{L7} = 200 Ω)						
DC voltage	Pin 7	V_7		5.7		V
	Pin 8	V_8		0.77		V
Power gain		G_{RF}		10.5		dB
Third order intercept		IP_3		12		dBm
Dynamic characteristics, f = 100 MHz						
Input impedance		Z_9			5	Ω
Forward current gain	$\mid i_7/i_9 \mid$	h_{fb}		1		A/A
Parallel output resistance		R_7		3		kΩ
Parallel output capacitance		C_1		3.8		pF
Noise figure		NF_{RF}		2		dB
Oscillator (f_{Osc} = 100 MHz, unloaded Q = 80, resonance resistance R_{g17} = 250 Ω)						
DC voltage	Pin 17	V_{17}		3.2		V
	Pin 18	V_{18}		2.5		V
Oscillator voltage	Pin 17	V_{Osc17}	100	130		mV
Frequency drift	By supply voltage change d_{fo}/dV_S	$\Delta f_{Osc}(V_S)$		1.3		kHz/V
	By temperature change d_{fo}/d_K	$\Delta f_{Osc}(T_j)$		2		kHz/K
FM noise equivalent deviation, (Ripple voltage < 0.5 mV)	Frequency band 300 Hz to 20 kHz, unweighted	Δf_{noise}		5		Hz
	Peak CCIR	Δf_{noise}		10.5		Hz
	Peak CCIR, weighted with 75 µs, deemphasis	Δf_{noise}		4.2		Hz
FM by AM signal at mixer input	f_{iRF} = 90 MHz, m = 0.8, f_M = 1 kHz, V_{iRF} = 106 dBµV	Δf_{Osc} (V_{iRF})		160		Hz
Oscillator output buffer (R_{L1} = 520 Ω)						
DC current load limitation	Pin 1	I_1			0.2	mA
DC voltage	Pin 1	V_1		1.7		V
Voltage gain	$V_{Osc17} \leqq$ 200 mV V_{Osc1}/V_{Osc17} Pin 1	G_{buffer}		0.86		
Harmonics				<–30		dBC
Output impedance	Pin 1	Z_1		80		Ω

Electrical Characteristics (continued)

V_S = 10 V, f_{iRF} = 50.3 MHz, $f_{Osc} \approx$ 100 MHz, $f_{IF} = f_{Osc} - f_{iRF} \approx$ 49.7 MHz, reference point Pins 4 and 11, T_{amb} = 25°C, unless otherwise specified, see test circuit figure 4.

Parameters	Test Conditions / Pins	Symbol	Min.	Typ.	Max.	Unit
Mixer (R_{g5} = 200 Ω, $R_{L12–13}$ = 200 Ω)						
Conversion power gain		G_C		7.5		dB
Third order intercept		IP_3		3.5		dBm
Parallel input resistance	f = 100 MHz Pin 5	R_5		5		kΩ
Parallel input capacitance	f = 100 MHz Pin 5	C_5		3		pF
Parallel output resistance	f = 10.7 MHz, Pins 12, 13 parallel connected	R_{12+13}		55		kΩ
Effective output capacitance between Pin 12 and 13	f = 10.7 MHz $V_{12, 13}$ = 10 V $V_{12, 13}$ = 7 V $V_{12, 13}$ = 16 V	$C_{12–13}$ $C_{12–13}$ $C_{12–13}$	2.9 3.25 2.5	3.1 3.5 2.7	3.3 3.75 2.9	pF pF pF
Conversion transconductance	$\vert i_{12}/u_5 \vert, \vert i_{13}/u_5 \vert$	g_c		5.8		m–mho
Maximum available conversion power gain	f_{iRF} = 100 MHz, f_{IF} = 10.7 MHz	MACG		43		dB
Noise figure (f_{IF} = 10.7 MHz) Single side band	$R_{g5}(f_{iRF})$ = 450 Ω, $f_{iRF} = f_{Osc} - f_{IF}$	NF_{CSSB}		5.6		dB
IF preamplifier (f = 10.7 MHz, $R_{L3} = R_{g15}$ = 200 Ω)						
DC voltage	Pin 3	V_3		7.6		V
Power gain	Maximum control voltage of V_{15} = 1.6 V is recommended V_{15} = 1.6 V V_{15} < 0.8 V	G_{maxIF} G_{minIF}		24 –4		dB dB
Gain control deviation by V_{15}		ΔG_{IF}		28		dB
External control current	at G_{maxIF} at G_{minIF} Pin 15	I_{15max} I_{15min}		20 0		µA µA
Gain control slope	dG_{IF}/dI_{15} dG_{IF}/dV15 Pin 15	S_{I15} S_{V15}		1.3 35		dB/µA dB/V
Temperature coefficient of voltage gain	dG_{IF}/d_{Tj} at V_{15} 1.6 V V_{15} < 0.8 V I_{15} = constant	TCG		0 0.04 –0.02		dB/K dB/K dB/K
Parallel input resistance	Pin 15	R_{15}		2.4		kΩ
Parallel input capacitance	Pin 15	C_{15}		5.9		pF
Parallel output resistance	Pin 3	R_3		350		Ω
Parallel output capacitance	Pin 3	C_3		4.1		pF
Noise figure	V_{15} = 1.6 V	NF_{IF}		11		dB

Electrical Characteristics (continued)

V_S = 10 V, f_{iRF} = 50.3 MHz, $f_{Osc} \approx$ 100 MHz, $f_{IF} = f_{Osc} - f_{iRF} \approx$ 49.7 MHz, reference point Pins 4 and 11, T_{amb} = 25°C, unless otherwise specified, see test circuit figure 4.

Parameters	Test Conditions / Pins	Symbol	Min.	Typ.	Max.	Unit
AGC circuit (no signal at Pins 5 and 9)						
DC voltage	Pin 16	V_{16}		1.0		V
Saturation voltage	Pin 10	V_{10min}		0.08	0.2	V
Input current	$V_{14} \leqq V_6$ Pin 14	$-I_{14}$		0.01	0.1	µA
Maximum allowable current	Pin 14	$\lvert \pm I_{14} \rvert_{max}$			50	µA
Maximum control current for external PIN-diode	$I_{10} = 0$	I_{diode}			I_7	
AGC threshold voltages (respecting V_{10} = 0.25 V)						
RF stage output	Pin 7	V_{RF7}		450		mV
Mixer-stage output	$V_{14} = V_6$ Pin 13	V_{IF13}		300		mV
External AGC voltage	V_{IF13} = 1 V Pin 14	V_{14min}		0.9		V
Internal AGC voltage	Pin 16	V_{16min}		1.4		V
Reference voltage source						
Output voltage, without load	$I_6 = 0$ Pin 6	V_6	1.6	1.7	1.8	V
Temperature dependence of V_6	$\lvert V_6 \rvert$ T_{amb} = –25 to +85°C	ΔV_6 (T)		20		mV
Internal differential resistance	dV_6/dI_6 when I_6 = 0 mA	r_{d6}		50		Ω
Ripple rejection	20 log (d_{Vs}/d_{V6}) when I_6 = 0 mA	α_6		65		dB
Noise voltage / $\sqrt{Hz}$	when I_6 = 0 and f = 25 Hz f = 125 Hz f = 1 kHz f = 10 kHz			 0.6 0.37 0.1 0.1		 µV µV µV µV

Test Circuit

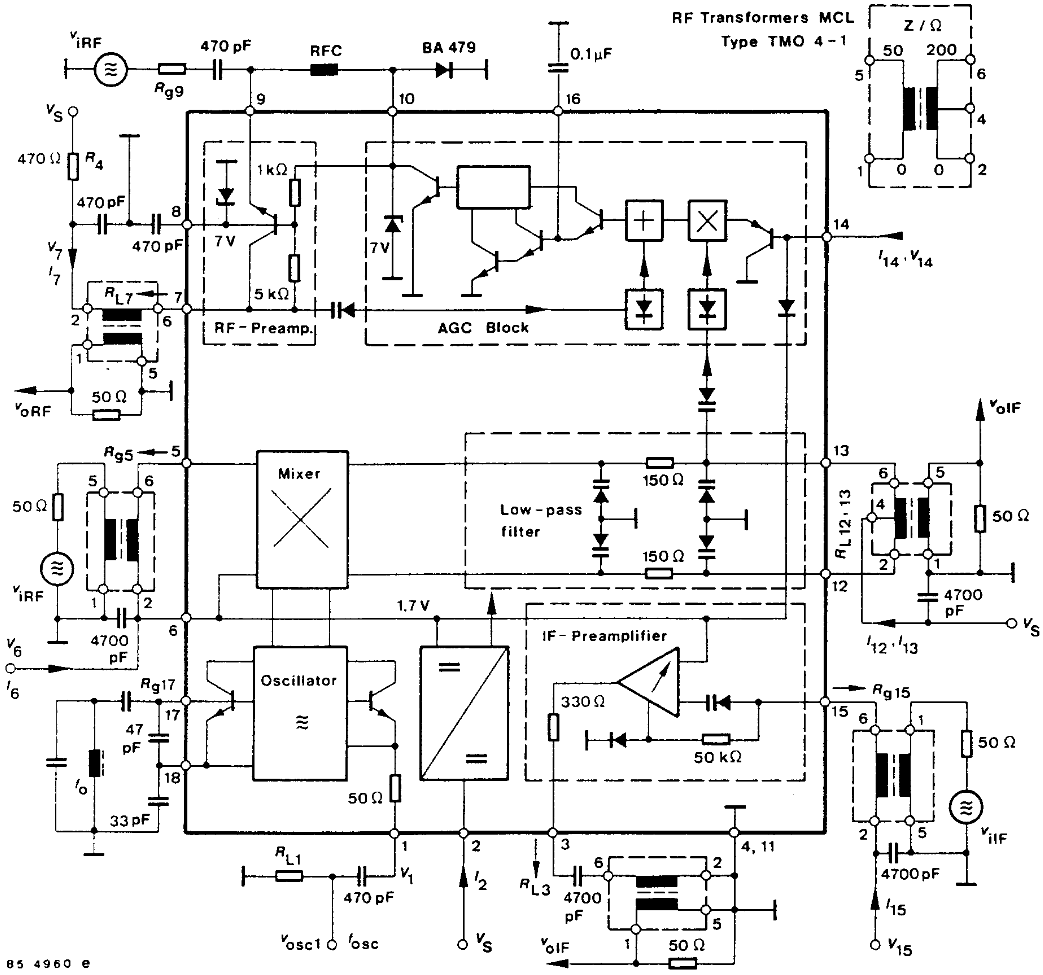


Figure 3. Test circuit

RF Preamplifier

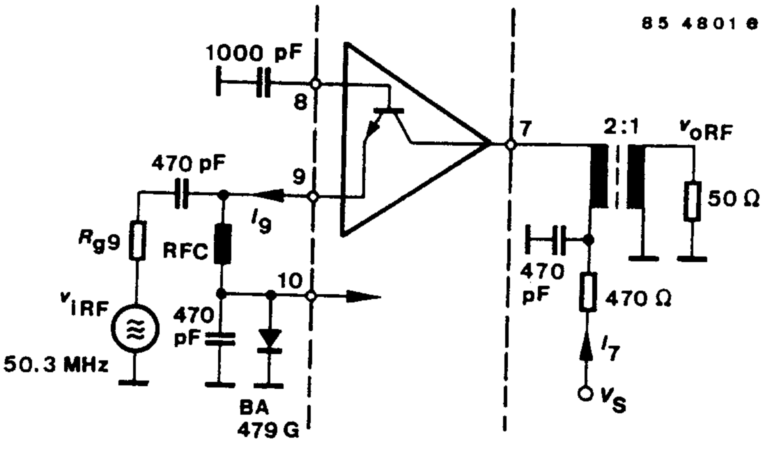


Figure 4. Test circuit

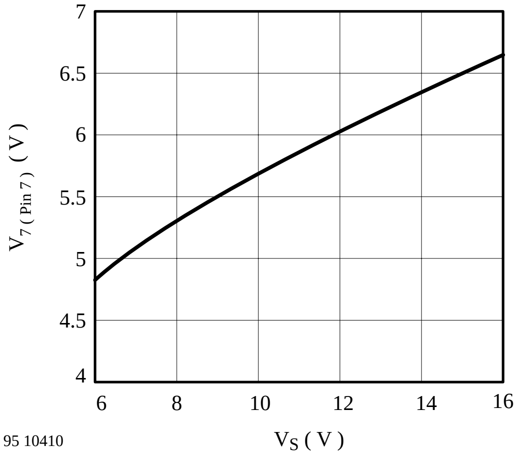


Figure 5. V_7 vs. V_S

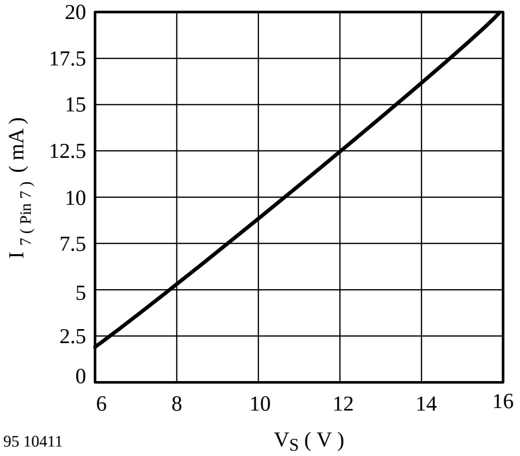


Figure 6. I_7 vs. V_S

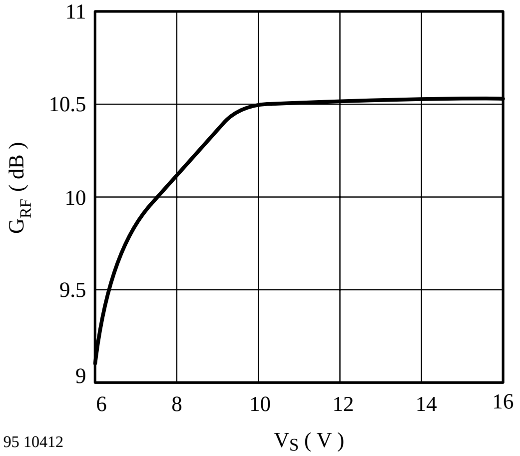


Figure 7. G_{RF} vs. V_S

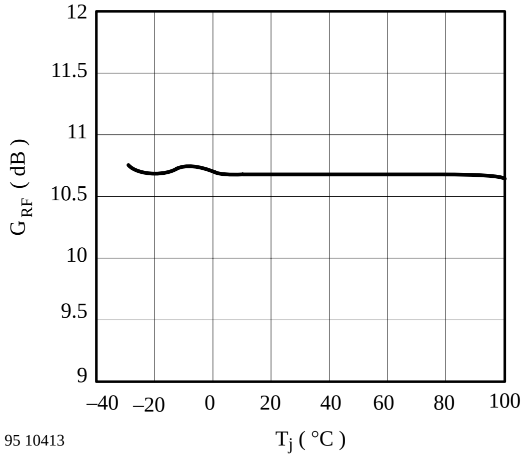


Figure 8. G_{RF} vs. T_j

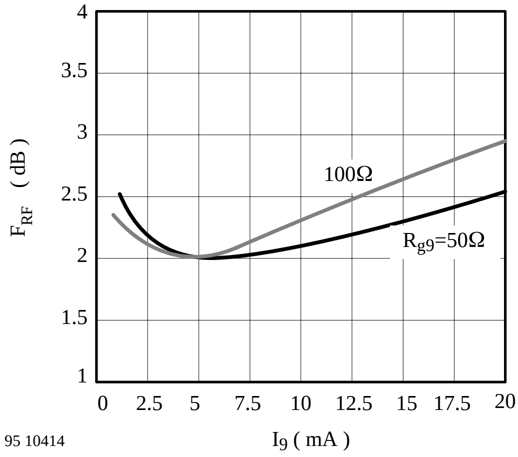


Figure 9. F_{RF} vs. I_g

Oscillator/ Oscillator Output Buffer

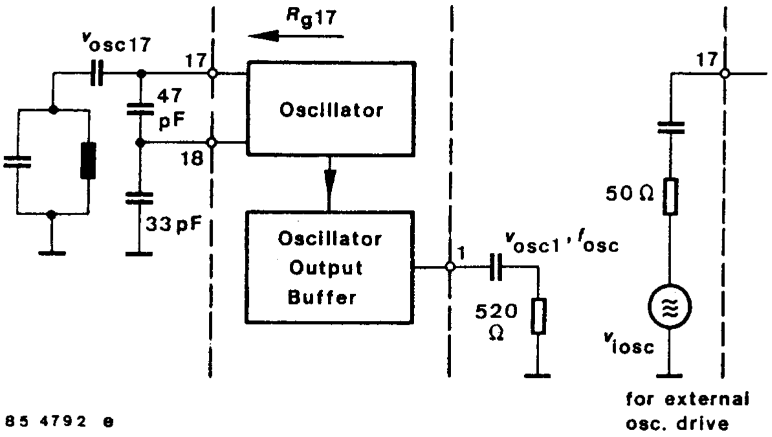


Figure 10. Test circuit – free running oscillator frequency $f_{Osc} \approx 100$ MHz

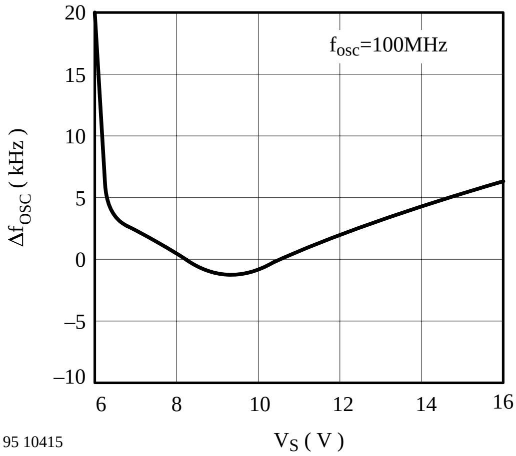


Figure 11. Δf_{Osc} vs. V_S

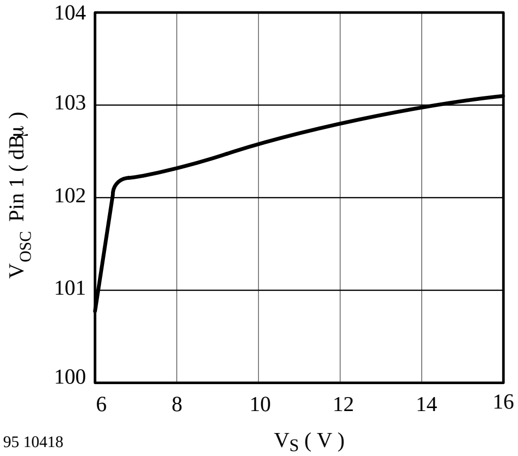


Figure 13. V_{Osc} vs. V_S

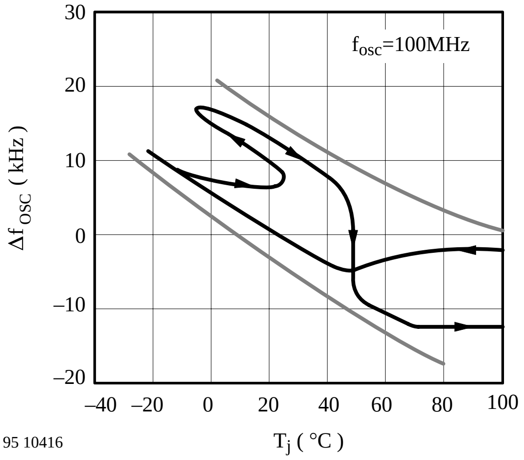


Figure 12. Δf_{Osc} vs. T_j

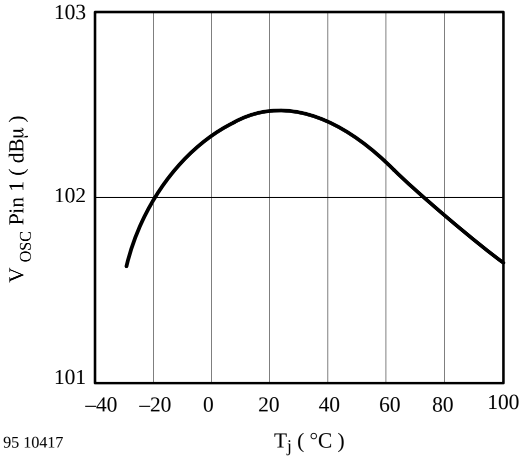


Figure 14. V_{Osc} vs. T_j

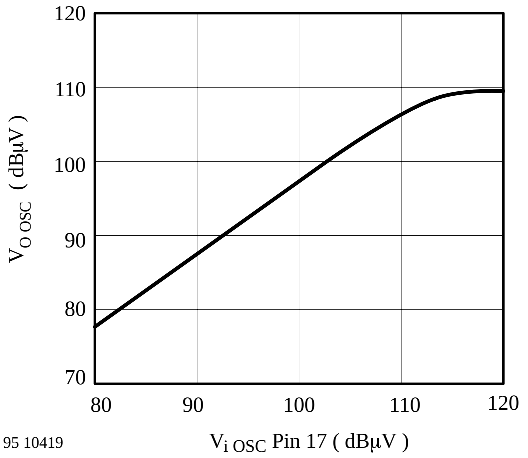


Figure 15. V_{Osc} vs. $V_{i\ Osc}$

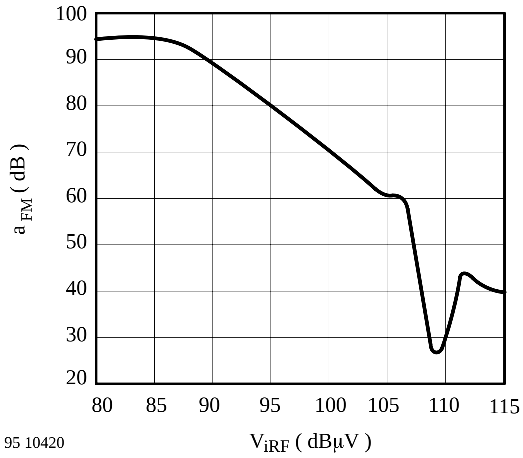


Figure 16. a_{FM} vs. V_{iRF}

Mixer

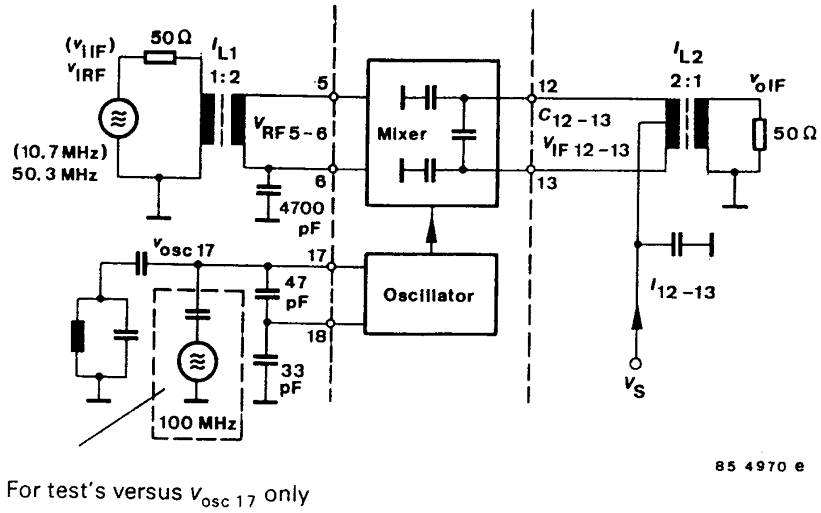


Figure 17. Test circuit

I_{L1}, I_{L2} = Insertion loss of the RF transformers
Conversion power gain $G_C = 20 \log (2\ V_{oIF}/V_{iRF}) + I_{L1}$ (dB) + I_{L2} (dB)
$V_{RF5–6}$ (dBµV) = V_{iRF} (dBµV) – I_{L1} (dB) + 6
$V_{IF12–13}$ (dBµV) = V_{oIF} (dBµV) – I_{L2} (dB) + 6
$\Delta G_C = G_C (V_{OSC17}) – G_C$ (nominal)
Input to output IF isolation
$a_{IF} = 20 \log (2\ V_{oIF}/V_{iIF}) + I_{L1}$ (dB) + I_{L2} (dB) – G_C (nominal)

Characteristics α_{FM} versus v_{iRF}, see previous page

Oscillator frequency immunity against amplitude modulated signal at mixer input (Pin 5–6) related to FM standard modulation:

$\alpha_{FM} = 20 \log [75 \text{ kHz}/\Delta f_{OSC}(v_{iRF})]$ whereas
v_{iRF} = mixer input signal (f_{iRF} = 89.3 MHz, m = 0.8, f_M = 1 kHz)

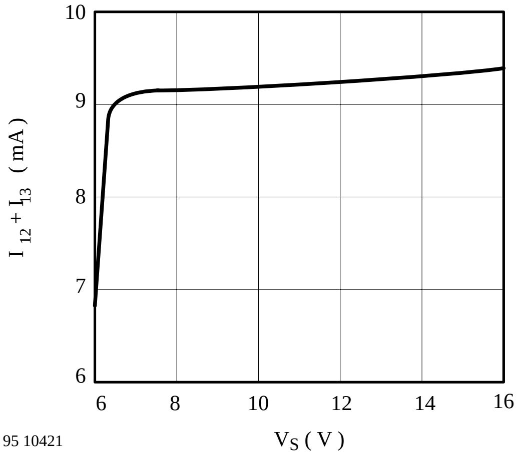


Figure 18. $I_{12} + I_{13}$ vs. V_S

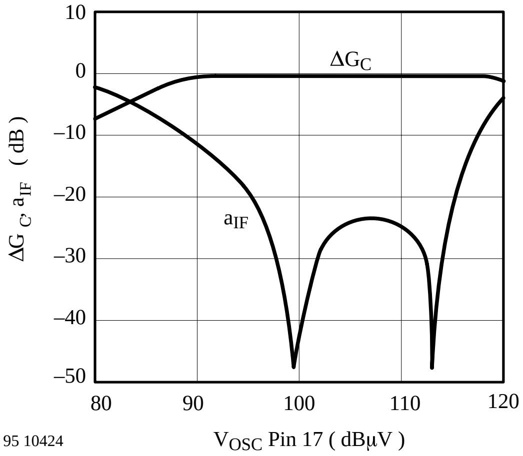


Figure 21. ΔG_c, a_{IF} vs. $V_{Osc\ Pin\ 17}$

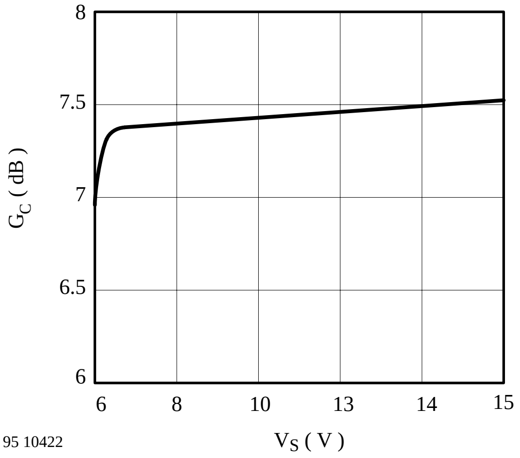


Figure 19. G_C vs. V_S

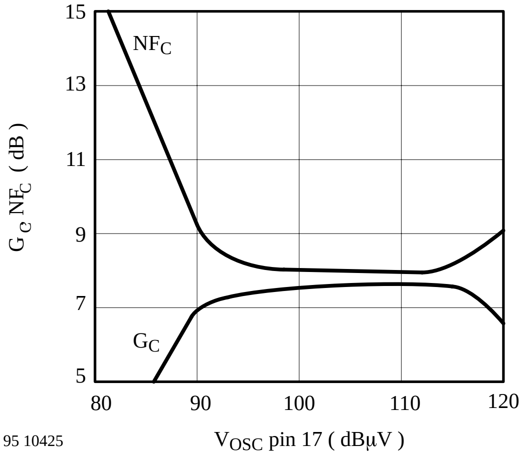


Figure 22. G_C NF_C vs. $V_{Osc\ Pin\ 17}$

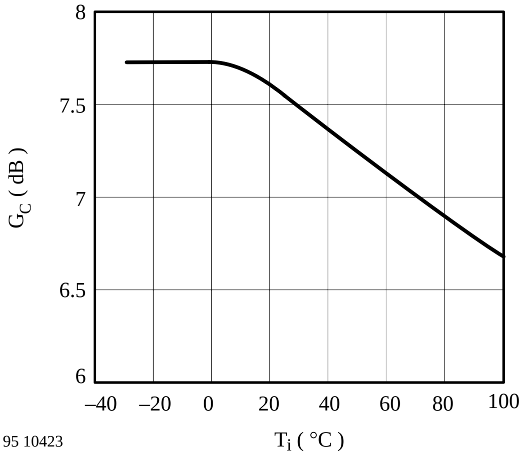


Figure 20. G_C vs. T_j

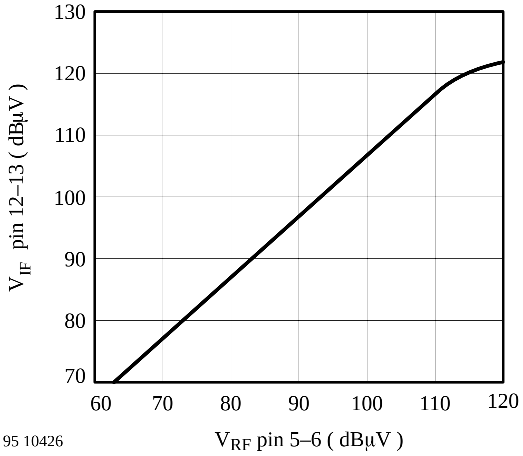
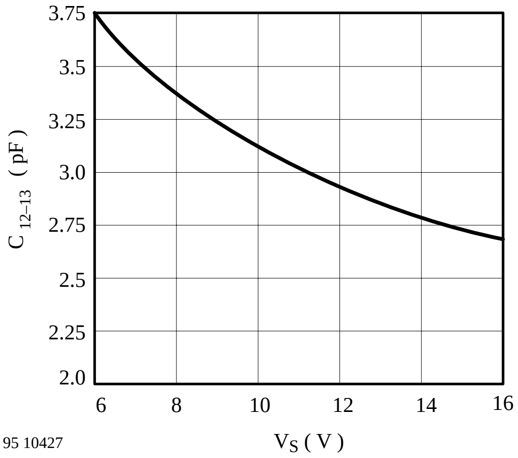


Figure 23. $V_{IF\ Pin\ 5–6}$ vs. $V_{RF\ Pin\ 5–6}$



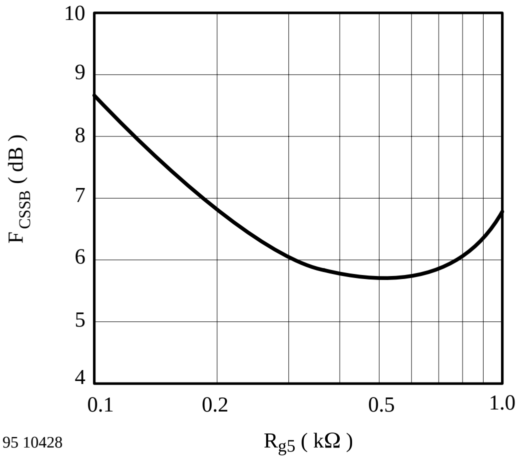


Figure 24. $C_{12–13}$ vs. V_S

Figure 25.
F_{CSSB} = Noise figure reading /dB-I_L/dB
I_L = Insertion loss of the tuned transformer network

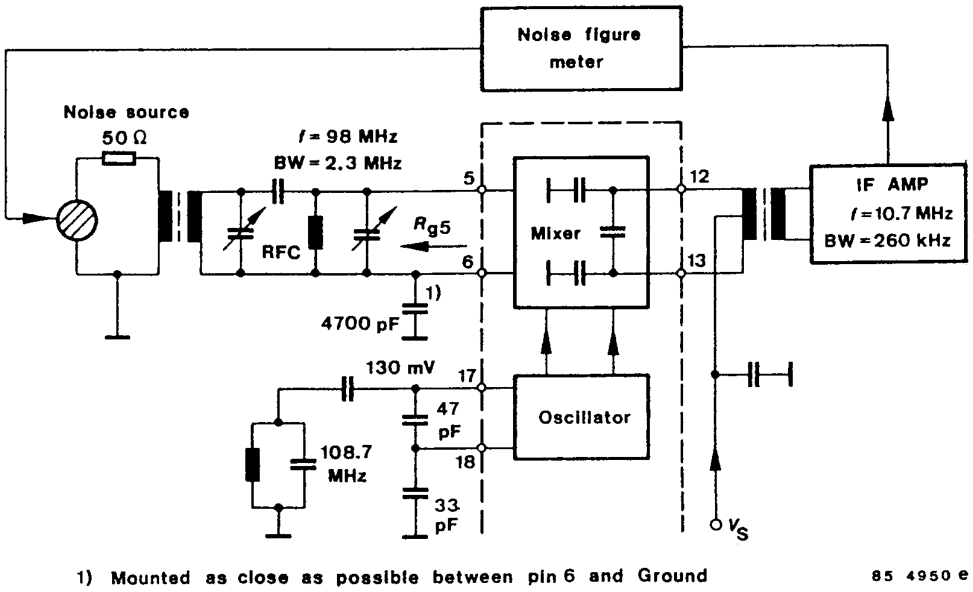


Figure 26. Test circuit for single sideband noise (F_{CSSB})

AGC Circuit

I_{L1}, I_{L2} = Insertion loss of the RF transformers,
V_{RF7} (dBµV) = V_{IRF} (dBµV) – I_{L1} (dB)+ 6
V_{IF13} (dBµV) = V_{iIF} (dBµV) – I_{L2} (dB)

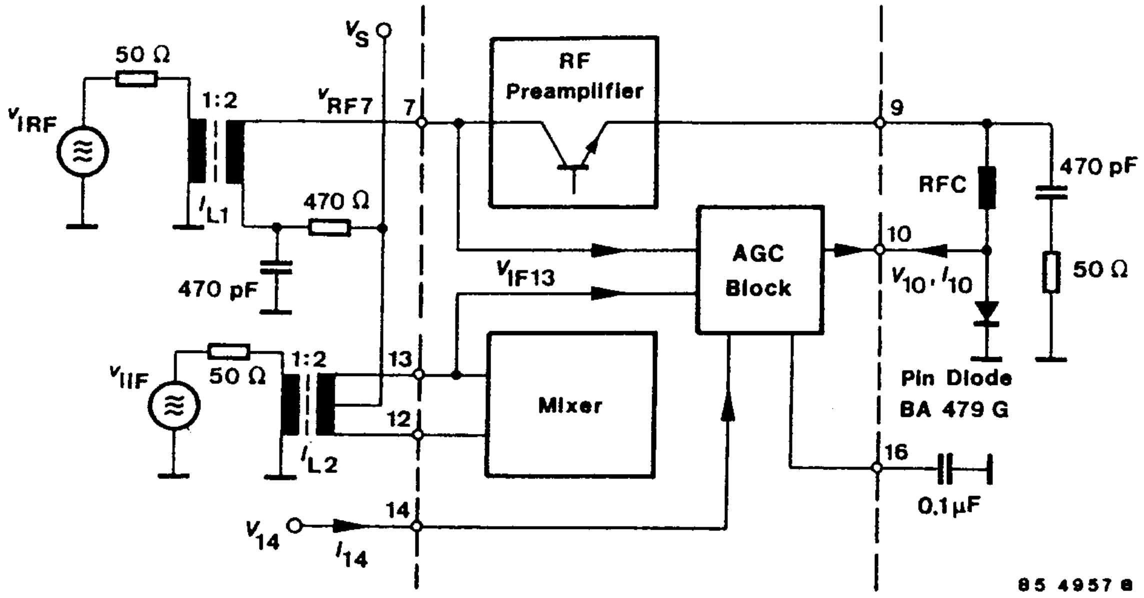


Figure 27. Test circuit

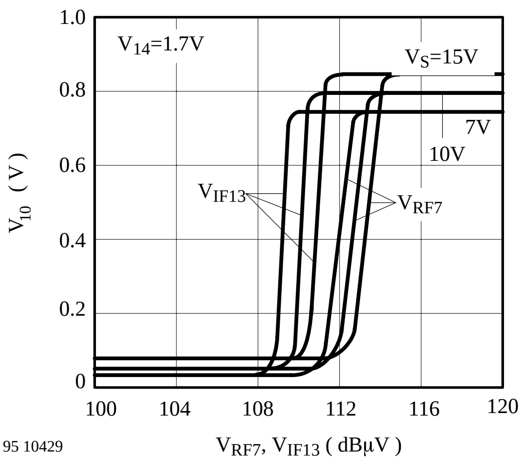


Figure 28. V_{10} vs. V_{RF7}, V_{IF13}

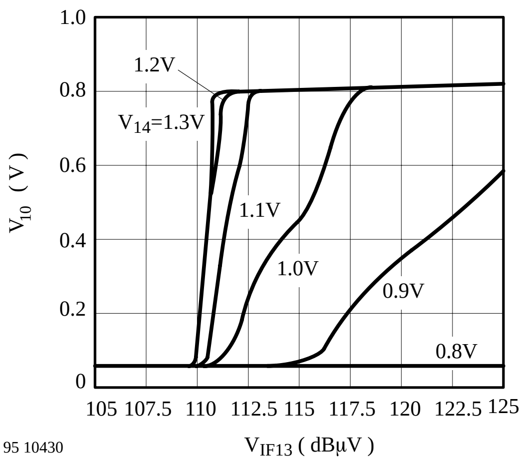


Figure 29. V_{10} vs. V_{IF13}

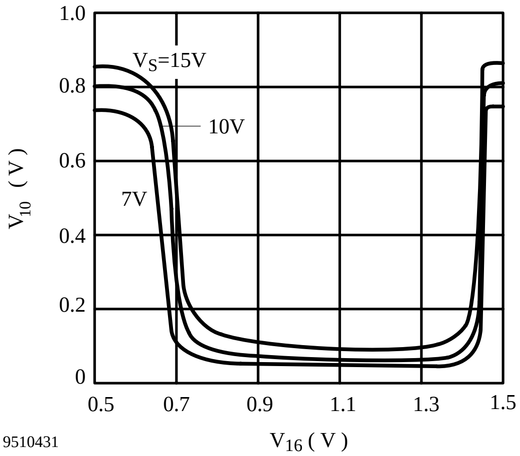


Figure 30. V_{10} vs. V_{16}

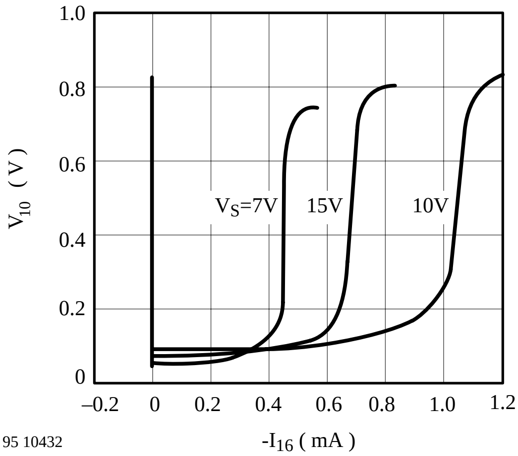


Figure 31. V_{10} vs. $-I_{16}$

IF Preamplifier

I_{L1}, I_{L2} = Insertion loss of the RF transformers
Power gain $G_F = 20 \log (2\, V_{oIF}/V_{iRF}) + I_{L1}\,(dB) + I_{L2}\,(dB)$
$V_{iIF15}\,(dB\mu V) = V_{iIF}\,(dB\mu V) - I_{L1}\,(dB) + 6$
$V_{oIF3}\,(dB\mu V) = V_{oIF}\,(dB\mu V) - I_{L2}\,(dB) + 6$

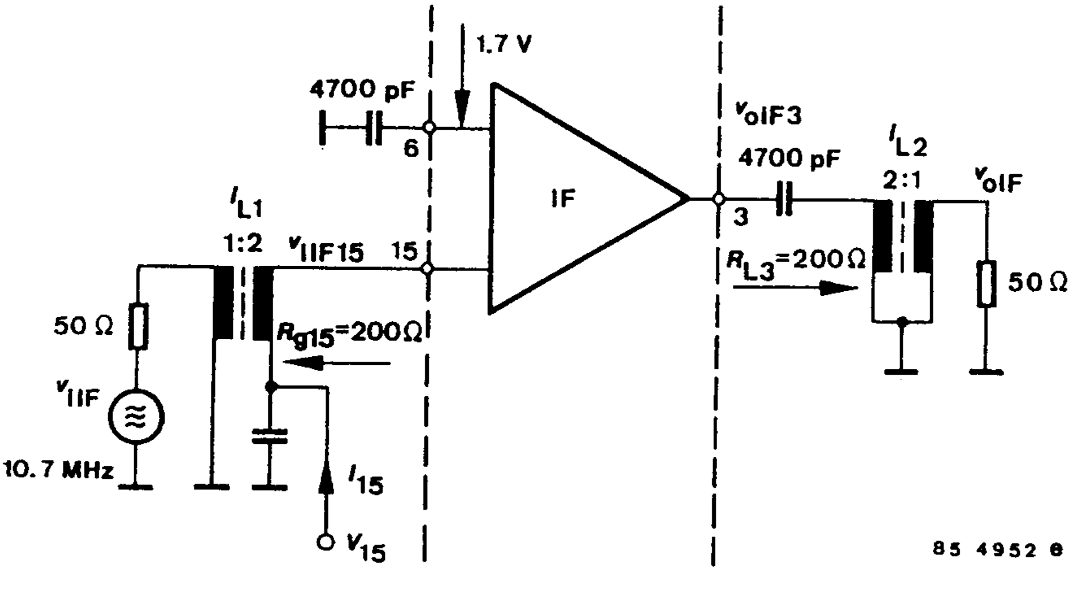


Figure 32. Test circuit

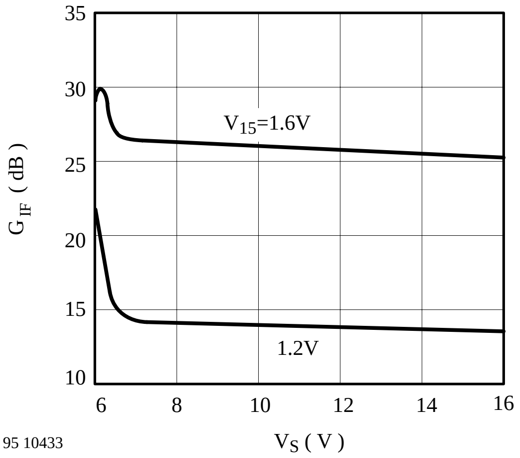


Figure 33. G_{IF} vs. V_S

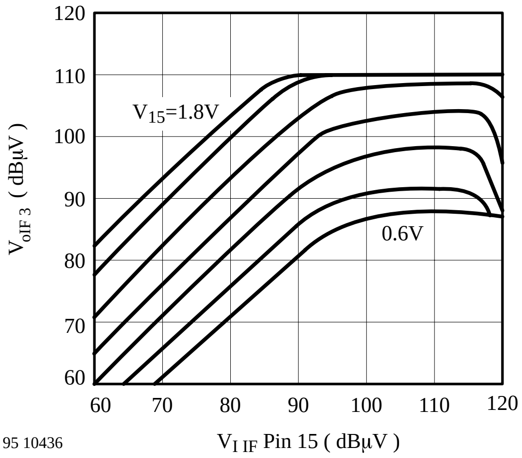


Figure 36. V_{oIF3} vs. $V_{I\,IF\,Pin\,15}$

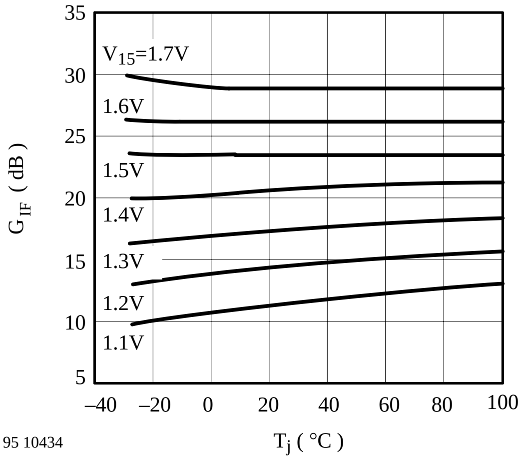


Figure 34. G_{IF} vs. T_j

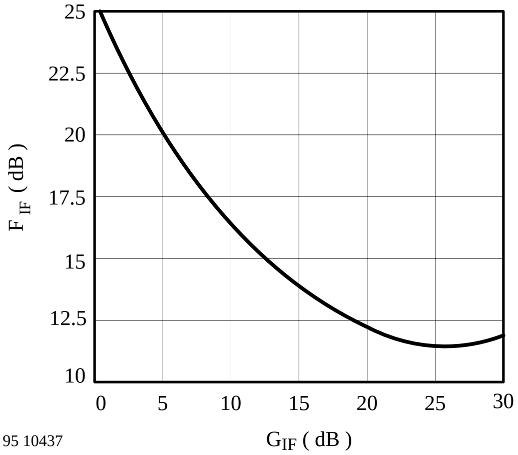


Figure 37. F_{IF} vs. G_{IF}

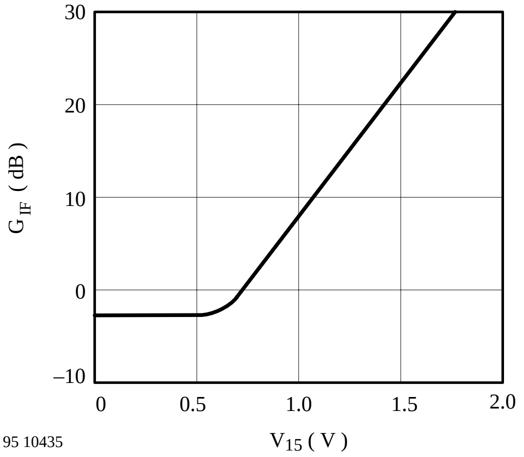


Figure 35. G_{IF} vs. V15

Reference Voltage

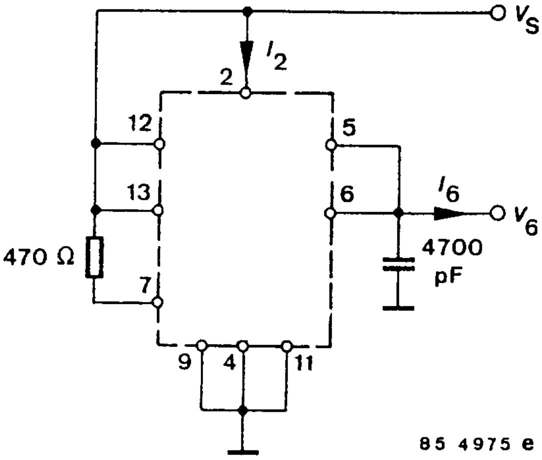


Figure 38. Test circuit

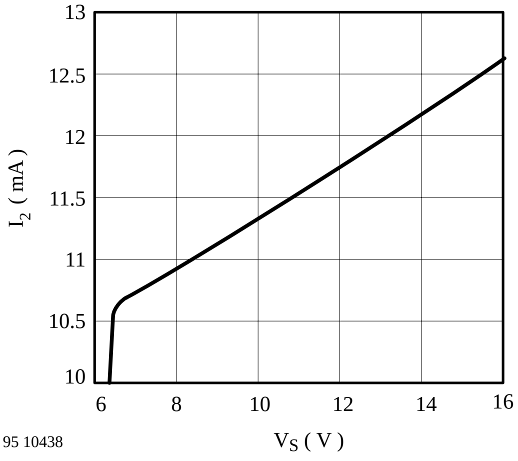


Figure 39. I_2 vs. V_S

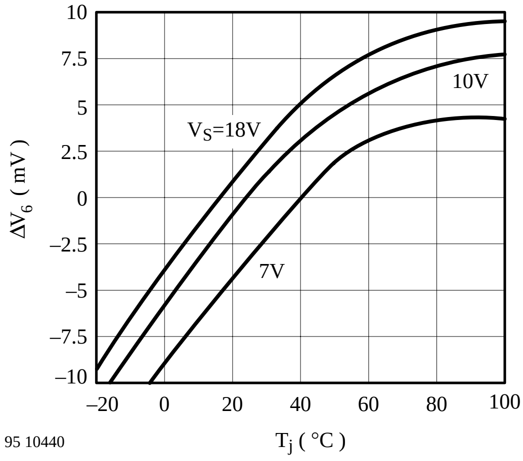


Figure 41. ΔV_6 vs. T_j

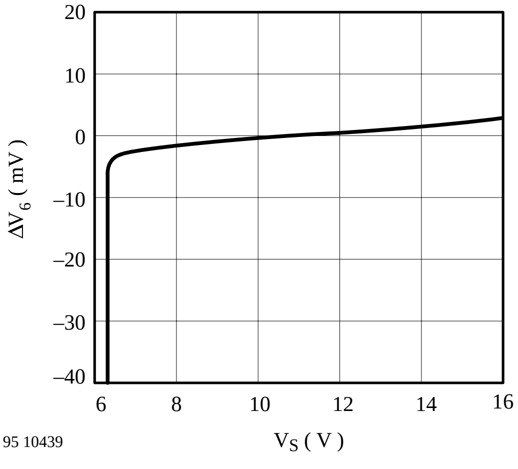


Figure 40. ΔV_6 vs. V_S

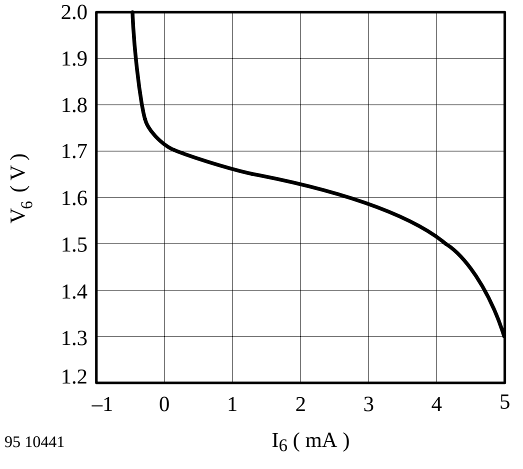
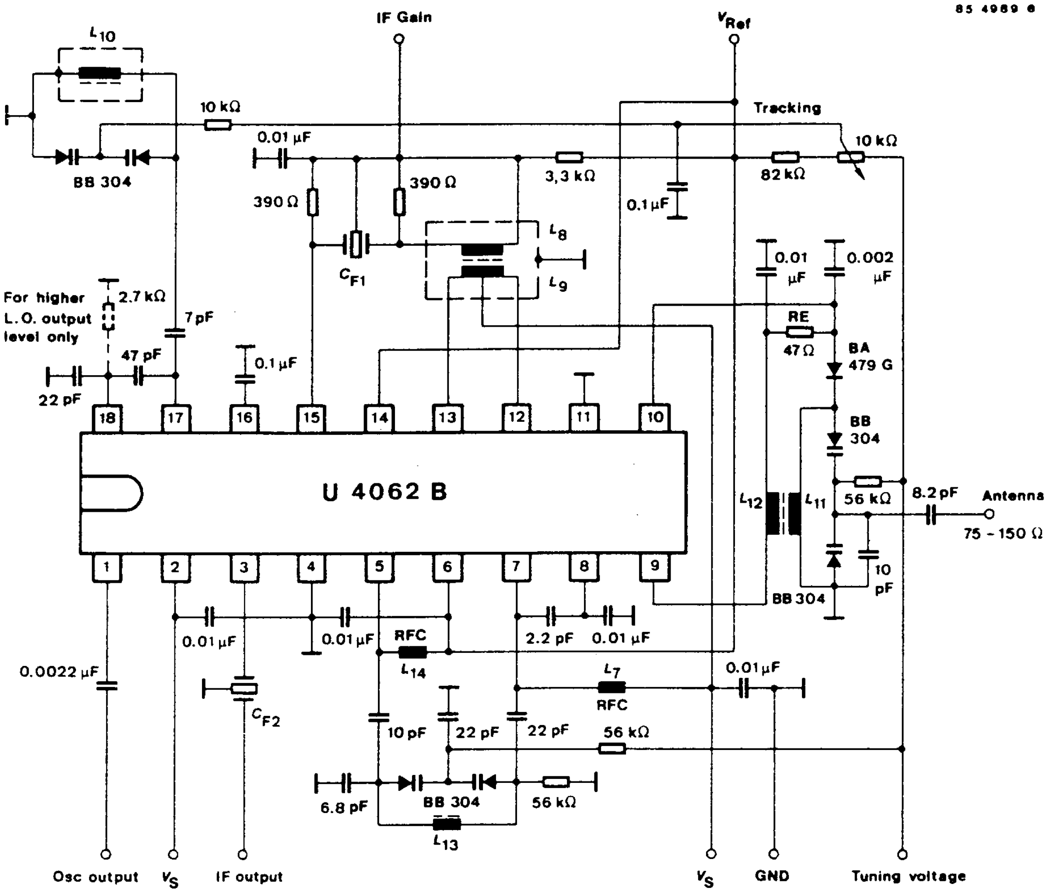
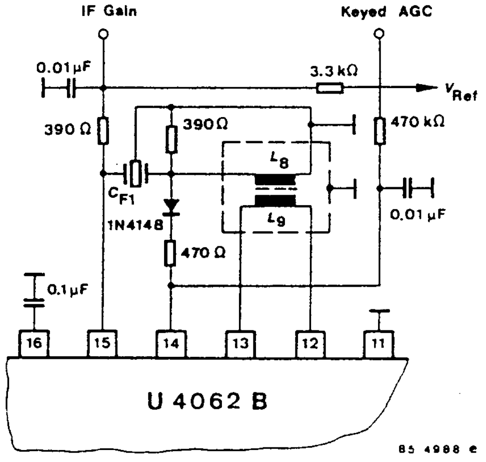


Figure 42. V_6 vs. I_6

Application Circuit





Circuit (section) from above
diagram with keyed AGC

Figure 43. Typical Application circuit for high performance FM front end using non-repetitive alignment concept

Coils Specifications

L_8/L_9	Toko 7 PL9/ (18 + 18) turns Nr. 218 ANS – 788 N
L_{10}	Toko 7 Kl 3 turns Nr. 291 ENS – 2054 IB or Toko MC 122 Nr. E528 SNAS – 100075
L_{11}/L_{12}	Toko 7 Kl without case 4/8 turns Nr. 291 ENF – 2342 x
L_{13}	Toko 7 Kl 4 turns Nr. 291 ENS – 2341 IB or Toko MC 122 Nr. E528 SNAS – 100076
L_{14}/L_{17}	Choke 1.5 μH Toko 348 LS – 1R5 or similar
CF1; CF2	Toko CFSK – 107M3 or similar

V_S = 8.5 V, T_{amb} = 25°C

Electrical Connections	Pin DIP18	Voltage (DC) in V
LO output	1	1.73
V_S	2	8.5
IF output	3	6.1
Ground	4	0
Mixer input	5	1.7
Reference output voltage	6	1.7
RF preamplifier (collector)	7	8.5
RF preamplifier (base)	8	1.3
RF preamplifier (emitter)	9	0.53
AGC output	10	0.07
Ground	11	0
Mixer output	12	8.5
Mixer output	13	8.5
AGC input	14	1.7
IF input, IF gain control	15	1.54
AGC time constant	16	1.06
LO (base)	17	3.2
LO (emitter)	18	2.51

FM Front End Data Using Application Circuit

Antenna impedance 75 Ω, $Z_{load\ IF}$ = 330 Ω, V_S = 8.5 V, T_{amb} = 25°C

Characteristics	Symbol	Min.	Typ.	Max.	Unit
Supply current	I_S		32		mA
Tuning range	f	88		108	MHz
Tuning voltage – at 88 MHz (equal IC's reference voltage) – at 108 MHz	 V_{tune} V_{tune}		 1.7 6.5		 V V
Center IF	f		10.7*		MHz
IF output bandwidth at –3 dB	B_{IF}		130*		kHz
Power gain	G		46*		dB
Gain variation versus the band	ΔG		1		dB
Noise figure	NF		6		dB
Image rejection		57	70		dB
RF intermodulation			70		dB
1/2 IF rejection			90		dB
Spurious response, second osc. harmonic			90		dB
IF rejection		85			dB
Osc. output voltage at 520 Ω load	V_{OSC}		200		mV

* Depending on ceramic IF filters to be used

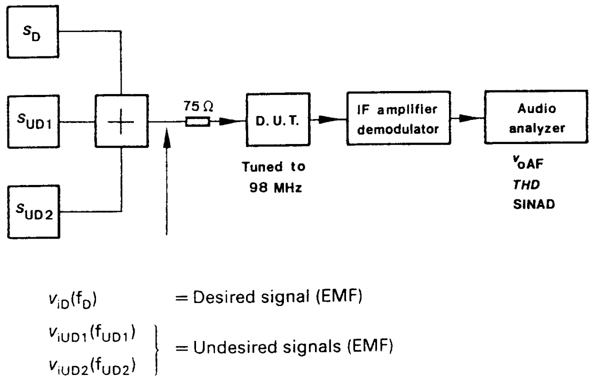


Figure 44. Block diagram of the test set up

Test conditions

- De-emphasis - 75µs
- AF bandwidth 30 to 20 kHz
- RMS, unweighted

Setup for one signal measurement

- f_D = 98 MHz

Note: V_{oAF} related to 75 kHz dev., 1 kHz, V_{iD} = 66 dB µV

Setup for three signals intermodulation measurement

- S_D : f_D = 98 MHz, FM: 1 kHz, 22.5 kHz dev.
- S_{UD1} : FM: 0.15 kHz, 22.5 kHz dev.
- S_{UD2} : Unmodulated
- V_{iD} : for 35 dB SINAD

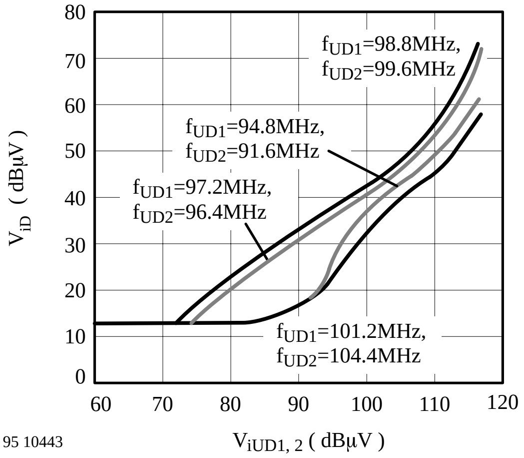


Figure 45. V_{ID} vs. $V_{iUD1,2}$
V_{ID} = input desired, V_{iUD} = input undesired

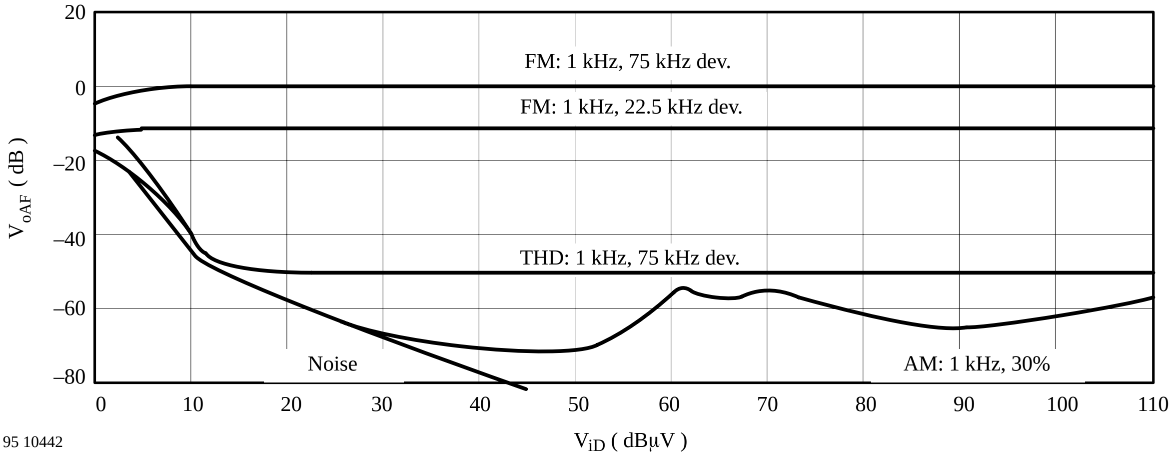
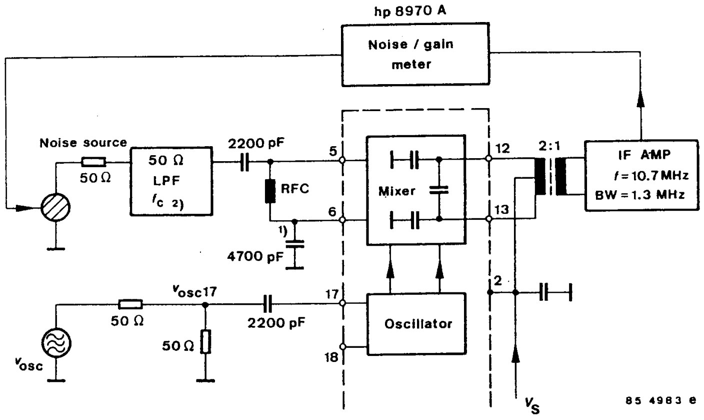


Figure 46. V_{oAF} vs. V_{iD}

VHF/UHF-Application



1) Mounted as close as possible between Pin 6 and Ground

2) Cut off frequency, f_c adjustment: $(f_{osc} + f_{IF}) < f_c < (2\ f_{osc} - f_{IF})$

Figure 47. Test circuit for conversion gain and noise measurement

Mixer, VHF Characteristics

Test conditions: R_{g5} = 50 Ω, R_{L12-13} = 200 Ω, V_S = 10 V
f_{IF} = 10.7 MHz, f_{iRF} = 200 MHz, $f_{OSC} = f_{iRF} + f_{IF}$, V_{OSC17} = 140 mV

Parameter	Symbol	Typ.	Unit
Conversion power gain, f_{IF} = 10.7 MHz f_{IF} = 70 MHz	G_C G_C	2.5 2.3	dB dB
Double side band noise figure f_{OSC} = 200 MHz	NF_{DSB}	8.2	dB
3rd order intercept input signal level	IP_3	5.5	dBm
Parallel input resistance, Pin 5, f = 200 MHz Parallel input capacitance, Pin 5, f= 200 MHz	Rp_5 Cp_5	1500 3.3	Ω pF
Parallel input resistance, Pin 17, f = 200 MHz Parallel input capacitance, Pin 17, f = 200 MHz	Rp_{17} Cp_{17}	4000 2.7	Ω pF
Conversion transconductance	G_C	6.4	m-mho

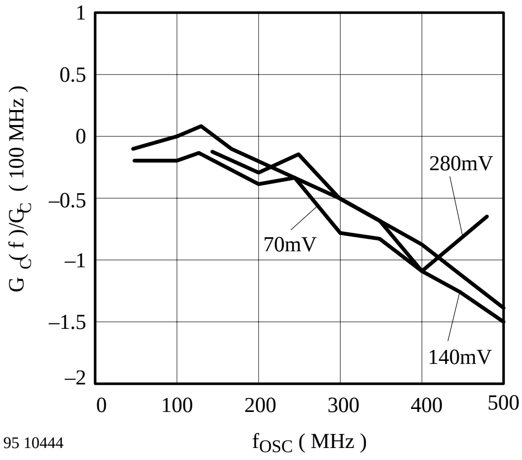


Figure 48. G_C vs. f_{OSC}

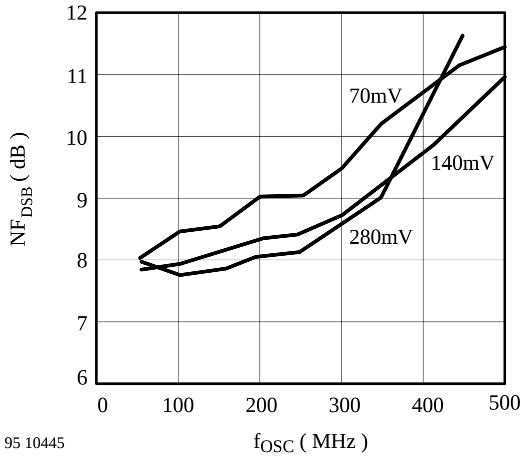
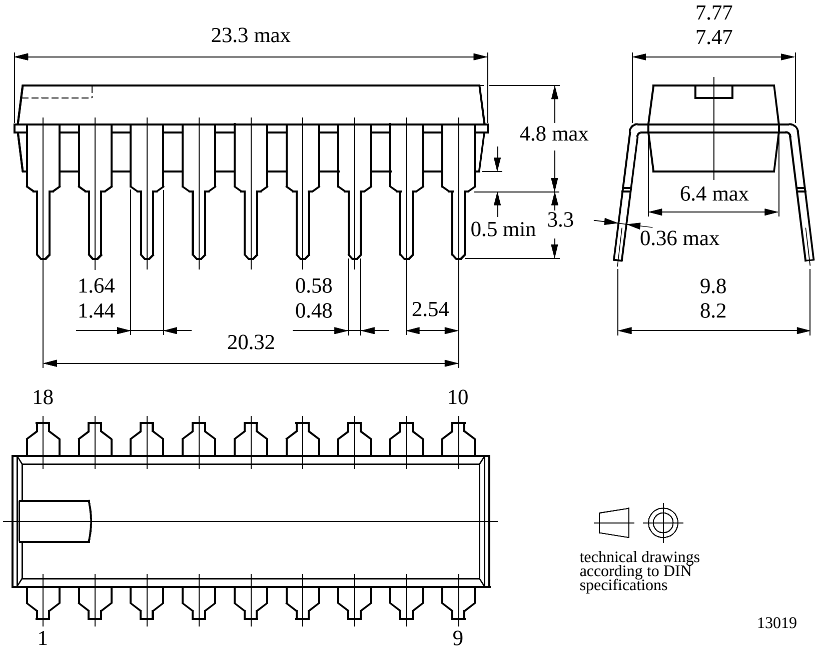


Figure 49. NF_{DSB} vs. f_{OSC}

Package Information

Package DIP18

Dimensions in mm



Ozone Depleting Substances Policy Statement

It is the policy of **TEMIC Semiconductor GmbH** to

1. Meet all present and future national and international statutory requirements.
2. Regularly and continuously improve the performance of our products, processes, distribution and operating systems with respect to their impact on the health and safety of our employees and the public, as well as their impact on the environment.

It is particular concern to control or eliminate releases of those substances into the atmosphere which are known as ozone depleting substances (ODSs).

The Montreal Protocol (1987) and its London Amendments (1990) intend to severely restrict the use of ODSs and forbid their use within the next ten years. Various national and international initiatives are pressing for an earlier ban on these substances.

TEMIC Semiconductor GmbH has been able to use its policy of continuous improvements to eliminate the use of ODSs listed in the following documents.

1. Annex A, B and list of transitional substances of the Montreal Protocol and the London Amendments respectively
2. Class I and II ozone depleting substances in the Clean Air Act Amendments of 1990 by the Environmental Protection Agency (EPA) in the USA
3. Council Decision 88/540/EEC and 91/690/EEC Annex A, B and C (transitional substances) respectively.

TEMIC Semiconductor GmbH can certify that our semiconductors are not manufactured with ozone depleting substances and do not contain such substances.

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