Low power VHF, UHF and hyperband mixer/oscillator for TV and VCR 3-band tuners

TDA5636

FEATURES

- Balanced mixer with a common emitter input for band A (single input)
- 2-pin oscillator for band A and B
- Balanced mixer with a common base input for band B and C (balanced input)
- 4-pin oscillator for band C
- Local oscillator buffer output for external prescaler
- SAW filter preamplifier with 75 Ω output impedance in application
- Band gap voltage stabilizer for oscillator stability
- Electronic band switch
- External IF filter between the mixer output and the IF amplifier input.

APPLICATIONS

- 3-band TV tuners
- 3-band TV front-ends
- 3-band VCR tuners
- 3-band VCR front-ends.

GENERAL DESCRIPTION

The TDA5636 is a monolithic integrated circuit that performs the band A, band B and band C mixer/oscillator functions in TV and VCR tuners. This low power mixer/oscillator circuit requires a power supply of 9 V and is available in a very small package outline. This device gives the designer the capability to design an economical and physically small 3-band tuner. The tuner development time can be drastically reduced by using this device.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_P	supply voltage		–	9	–	V
I_P	supply current	band A	–	45	–	mA
		band B	–	41	–	mA
		band C	–	44	–	mA
f_R	frequency range	band B; see Fig.13	45	–	180	MHz
		band A; see Fig.13	160	–	470	MHz
		band C; see Fig.13	430	–	860	MHz
N	noise figure	R_L = 75 Ω; band A	–	7.5	–	dB
		R_L = 75 Ω; band B	–	6.0	–	dB
		R_L = 75 Ω; band C	–	7.0	–	dB
V_O	output voltage	1% cross modulation; R_L = 75 Ω; band A	–	110	–	dBμV
		1% cross modulation; R_L = 75 Ω; band B	–	110	–	dBμV
		1% cross modulation; R_L = 75 Ω; band C	–	110	–	dBμV
G_v	voltage gain	R_L = 75 Ω; band A	–	20	–	dB
		R_L = 75 Ω; band B	–	31	–	dB
		R_L = 75 Ω; band C	–	31	–	dB

ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
TDA5636M	SSOP24	plastic shrink small outline package; 24 leads; body width 5.3 mm	SOT340-1
TDA5636T	SO24	plastic small outline package; 24 leads; body width 7.5 mm	SOT137-1

BLOCK DIAGRAM

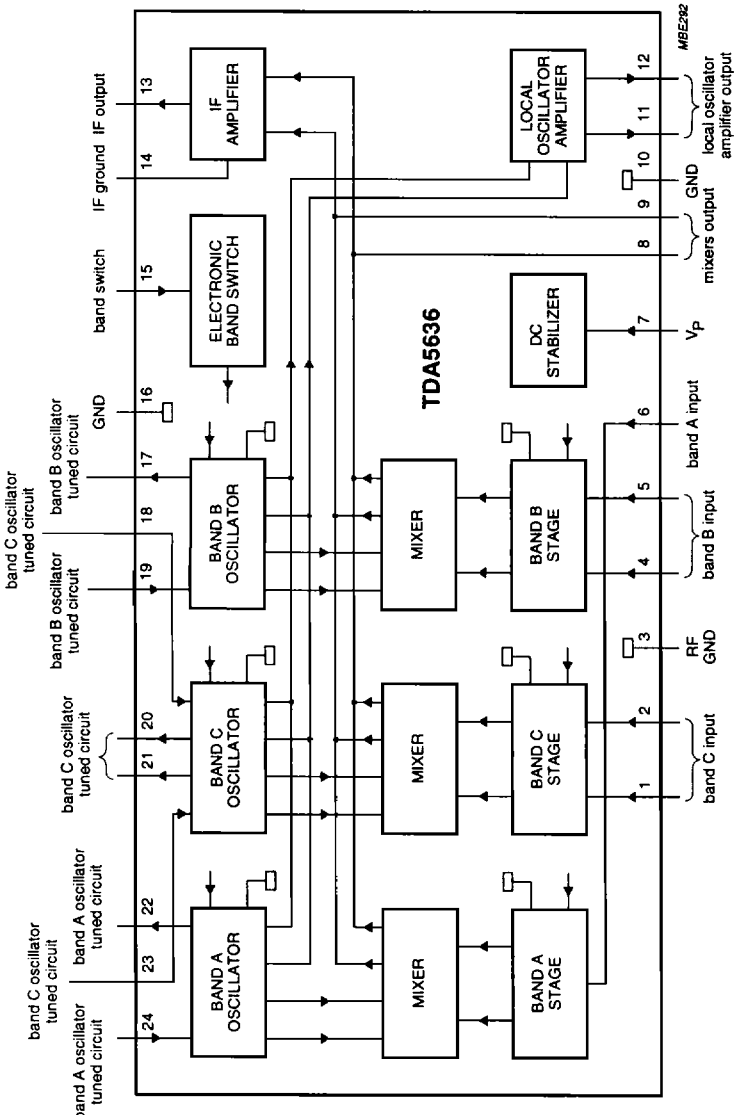


Fig.1 Block diagram.

PINNING

SYMBOL	PIN	DESCRIPTION
CIN1	1	band C input 1
CIN2	2	band C input 2
RFGND	3	ground for RF inputs
BIN1	4	band B input 1
BIN2	5	band B input 2
AIN	6	band A input
V_P	7	supply voltage
MIXOUT1	8	mixers output 1
MIXOUT2	9	mixers output 2
GND1	10	ground 1 (0 V)
LOOUT1	11	local oscillator amplifier output 1
LOOUT2	12	local oscillator amplifier output 2
IFOUT	13	IF amplifier output
IFGND	14	IF amplifier ground
BS	15	electronic band switch
GND2	16	ground 2 (0 V)
BOSCOC	17	band B oscillator output collector
COSCIB1	18	band C oscillator input base 1
BOSCIB	19	band B oscillator input base
COSCOC1	20	band C oscillator output collector 1
COSCOC2	21	band C oscillator output collector 2
AOSCOC	22	band A oscillator output collector
COSCIB2	23	band C oscillator input base 2
AOSCIB	24	band A oscillator input base

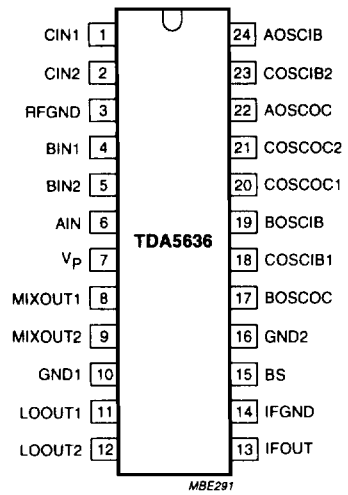


Fig.2 Pin configuration.

LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 134).

SYMBOL	PARAMETER	MIN.	MAX/	UNIT
V_P	supply voltage	−0.3	+10.5	V
$V_{SW(max)}$	maximum switching voltage	0	10.5	V
I_O	output current of each pin to ground	–	−10	mA
$t_{sc(max)}$	maximum short-circuit time (all pins)	–	10	s
T_{stg}	IC storage temperature	−55	+150	°C
T_{amb}	operating ambient temperature	−10	+80	°C
T_j	junction temperature	–	+150	°C

THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	VALUE	UNIT
$R_{th\ j\text{-}a}$	thermal resistance from junction to ambient in free air		
	SSOP	119	K/W
	SO	75	K/W

HANDLING

Human Body Model: GND (10) (16), RFGND (3), IFGND (14), VP (7) separately. All pins withstand 2000 V in accordance with the *UZW-BO/FQ-A302* specification equivalent to the *MIL-STD-883C* category B (2000 V).

Machine Model: All pins withstand 200 V.

IF AMPLIFIER CHARACTERISTICS

V_P = 9 V; T_{amb} = 25 °C; measured at 36 MHz; measured in circuit of Fig.13; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	MOD.	PHASE	MAX.	UNIT
S_{22}	output reflection coefficient	through 1 nF; see Fig.10	–	−14.5	5.5	–	dB/Ω
Z_o	output impedance (R_s + L_s)	through 1 nF	–	73	–	–	Ω
		through 1 nF	–	12	–	–	nH

CHARACTERISTICS

V_P = 9 V; T_{amb} = 25 °C; measured in circuit of Fig.13; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supply						
V_P	supply voltage		8.1	9.0	9.9	V
I_P	supply current	band A	–	45	50.5	mA
		band B	–	41	46	mA
		band C	–	44	49	mA
V_{SW}	switching voltage	band A	0	–	1.1	V
		band B	1.6	–	2.4	V
		band C	3.0	–	V_P	V
I_{SW}	switching current	band A	–	–	2	µA
		band B	–	–	5	µA
		band C; $V_{SW(C)}$ = 5 V	–	–	10	µA
Band A mixer (including IF amplifier)						
f_R	frequency range	see Fig.13	45	–	180	MHz
N	noise figure	f_i = 50 MHz; note 1	–	7.5	9.5	dB
		f_i = 180 MHz; note 1	–	7.5	9.5	dB
g_{os}	optimum source conductance	f_i = 50 MHz	–	0.5	–	mS
		f_i = 180 MHz	–	1	–	mS
Y_I	input admittance	see Fig.7	–	–	–	mS
C_I	input capacitance	f_i = 50 to 180 MHz	–	2	–	pF
V_o	output voltage	1% cross-modulation in channel; R_L = 75 Ω; f_i = 50 MHz; see Fig.5	107	110	–	dBµV
		1% cross-modulation in channel; R_L = 75 Ω; f_i = 50 MHz; see Fig.5	107	110	–	dBµV
V_i	input voltage	R_L = 75 Ω; 10 kHz pulling in channel; f_i = 180 MHz; note 2	–	100	–	dBµV
G_v	voltage gain	R_L = 75 Ω; f_i = 50 MHz; see Fig.3	17.5	20	22.5	dB
		R_L = 75 Ω; f_i = 180 MHz; see Fig.3	17.5	20	22.5	dB
Band A oscillator						
f_R	frequency range	see Fig.13	80	–	216	MHz
f_{shift}	frequency shift	ΔV_p = 10%; note 3	–	–	200	kHz
f_{drift}	frequency drift	ΔT = 25 °C without any compensation: NP0 capacitors; note 7	–	–	500	kHz
		5 s to 15 min after switching on; note 4	–	–	200	kHz

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Band B mixer (including IF amplifier)						
f_R	frequency range	see Fig.13	160	–	470	MHz
N	noise figure (not corrected for image)	f_i = 170 MHz; R_L = 75 Ω	–	6.0	8.0	dB
		f_i = 470 MHz; R_L = 75 Ω	–	7.0	9.0	dB
Z_I	input impedance (R_s + L_s)	f_i = 170 to 470 MHz; see Fig.8	–	–	–	
V_o	output voltage	1% cross-modulation in channel; R_L = 75 Ω; f_i = 170 MHz; see Fig.6	107	110	–	dBμV
		1% cross-modulation in channel; R_L = 75 Ω; f_i = 470 MHz; see Fig.6	107	110	–	dBμV
V_i	input voltage	10 kHz pulling in channel; 470 MHz; note 2	–	91	–	dBμV
		N + 5 – 1 MHz pulling; f_i = 430 MHz; note 5	–	77	–	dBμV
G_v	voltage gain	f_i = 170 MHz; R_L = 75 Ω; see Fig.4	28	31	34	dB
		f_i = 470 MHz; R_L = 75 Ω; see Fig.4	28	31	34	dB
Band B oscillator						
f_R	frequency range	see Fig.13	200	–	500	MHz
f_{shift}	frequency shift	ΔV_P = 10%; note 3	–	–	400	kHz
f_{drift}	frequency drift	ΔT = 25 °C without any compensation; NP0 capacitors; note 7	–	–	2	MHz
		5 s to 15 min after switching on; note 4	–	–	300	kHz
Band C Mixer (including IF amplifier)						
f_R	frequency range	see Fig.13	430	–	860	MHz
N	noise figure (not corrected for image)	f_i = 430 MHz; R_L = 75 Ω	–	7.0	9.0	dB
		f_i = 860 MHz; R_L = 75 Ω	–	8.0	10.0	dB
V_o	output voltage	1% cross-modulation in channel; f_i = 430 MHz; R_L = 75 Ω; see Fig.6	107	110	–	dBμV
		1% cross-modulation in channel; f_i = 860 MHz; R_L = 75 Ω; see Fig.6	107	110	–	dBμV
Z_I	input impedance (R_s + L_s)	f_i = 430 to 860 MHz; see Fig.9	–	–	–	Ω
		f_i = 430 to 860 MHz; see Fig.9	–	–	–	nH
V_i	input voltage	10 kHz pulling in channel; f_i = 860 MHz; note 2	–	93	–	dBμV
		N + 5 – 1 MHz pulling; f_i = 820 MHz; note 6	–	79	–	dBμV
G_v	voltage gain	f_i = 430 MHz; R_L = 75 Ω; see Fig.4	28	31	34	dB
		f_i = 860 MHz; R_L = 75 Ω; see Fig.4	28	31	34	dB

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Band C oscillator						
f_R	frequency range	see Fig.13	470	–	900	MHz
f_{shift}	frequency shift	ΔV_P = 10; note 3	–	–	500	kHz
f_{drift}	frequency drift	ΔT = 25 °C with compensation; note 7	–	–	900	kHz
		5 s to 15 min after switching on; note 4	–	–	400	kHz
LO output						
S_{22}	output reflection coefficient	see Fig.11	–	–	–	
Z_O	output impedance	see Fig.11	–	–	–	Ω
		see Fig.11	–	–	–	nH
V_o	output voltage	R_L = 50 Ω	83	91	100	dBμV
SRF	spurious signal on LO output with respect to LO output signal	R_L = 50 Ω; note 8	–	–	−10	dB
HLO	LO signal harmonics with respect to LO signal	R_L = 50 Ω	–	–	−10	dB

Notes

1. These measurements were made with an input circuit for optimum noise figure given in Fig.12.
2. The input level signal causing 10 kHz frequency detuning at the LO output.
3. The frequency shift is defined as a change in oscillator frequency for a variation of supply voltage. In one instance V_P = 9 to 8.1 V and in the other instance V_P = 9 to 9.9 V. In both cases, the frequency shift is below the specified value.
4. Switching on drift is the change of oscillator frequency between 5 seconds and 15 minutes after switching on.
5. The input level of a N + 5 − 1 MHz signal which gives FM sidebands 30 dB below the oscillator carrier at the LO output;

   f_{RF} = 430 MHz: frequency of the wanted channel; this signal is not applied to the RF input for this measurement

   f_{OSC} = 468.9 MHz ($f_{RF} + f_{IF}$)

   f_{N+5-1} = 469 MHz: unwanted frequency of the N + 5 channel − 1 MHz. This signal is applied to the RF input.
6. The input level of a N + 5 − 1 MHz signal which gives FM sidebands 30 dB below the oscillator carrier at the LO output;

   f_{RF} = 820 MHz: frequency of the wanted channel; this signal is not applied to the RF input for this measurement

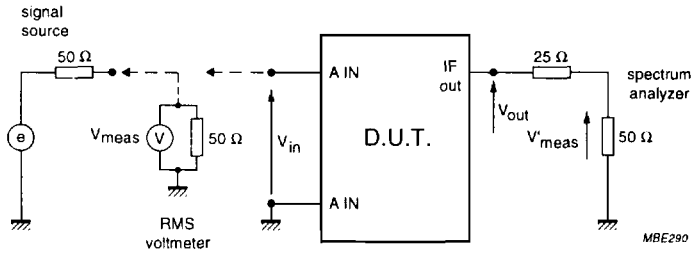
   f_{OSC} = 858.9 MHz ($f_{RF} + f_{IF}$)

   f_{N+5-1} = 859 MHz: unwanted frequency of the N + 5 channel − 1 MHz. This signal is applied to the RF input.
7. The frequency drift is defined as the change in oscillator frequency for a variation of ambient temperature, on the one hand from T_{amb} = 25 °C to T_{amb} = 0 °C and on the other hand from T_{amb} = 25 °C to T_{amb} = 50 °C.
8. SRF: spurious signal on LO with respect to LO output signal;

   RF level = 120 dBμV at f_i < 180 MHz

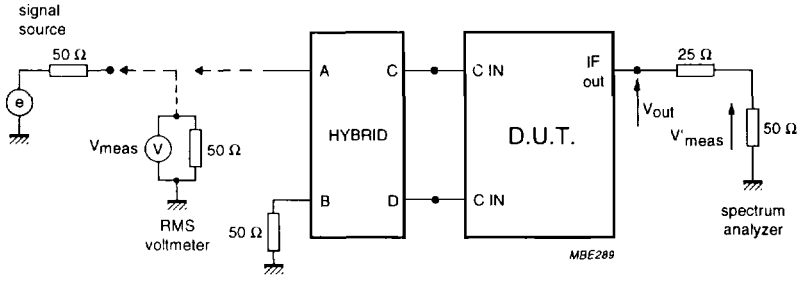
   RF level = 107 dBμV at f_i = 180 MHz to 225 MHz

   RF level = 97 dBμV at f_i = 225 MHz to 860 MHz.



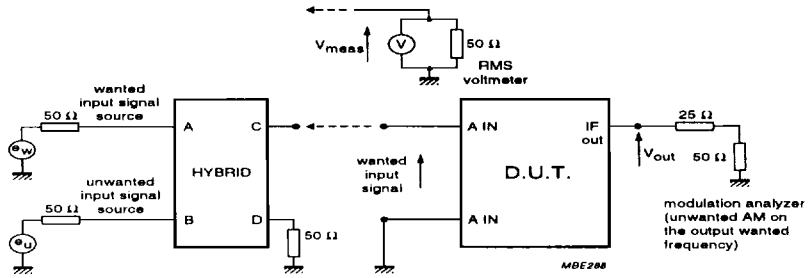
$Z_i >> 50\ \Omega \geq V_i = 2V_{meas}$; $V_o = V'_{meas} \times (50 + 25)/50$; voltage gain for band A = $20\log(V_o/V_i)$.

Fig.3 Band A gain measurement.



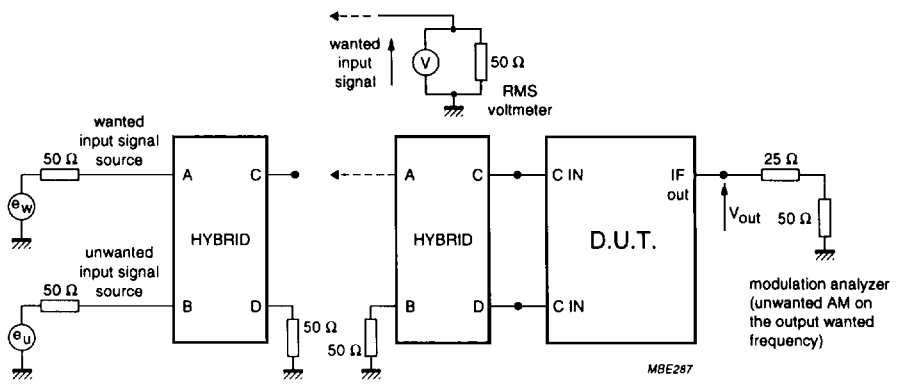
$V_i = V_{meas}$; $V_o = V_{meas} \times (50 + 25)/50$; voltage gain for band B = $20\log(V_o/V_i) + loss_{(hybrid)}$; voltage gain for band C = $20\log(V_o/V_i) + loss_{(hybrid)}$.

Fig.4 Bands B and C gain measurement.



Wanted input signal = 80 dBμV; V_o = output voltage from mixer A (including the IF amplifier) for a wanted output signal with 0.3% AM.

Fig.5 Band A 1% cross-modulation.



Wanted input signal = 70 dBμV; V_o = output voltage from mixer B (mixer C) (including the IF amplifier) for a wanted output signal with 0.3% AM.

Fig.6 Bands B and C 1% cross-modulation.

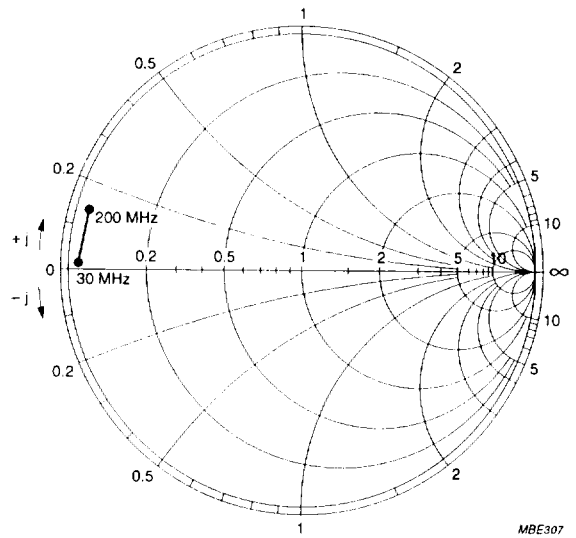


Fig.7 Input admittance (S_{11}) of the band A mixer input (30 to 200 MHz) (Y chart).

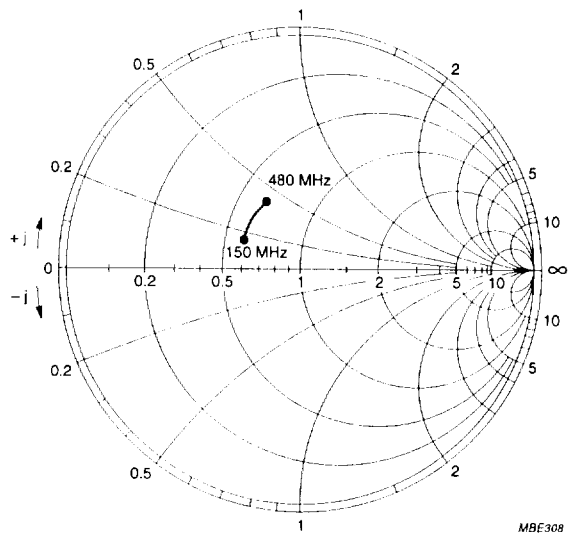


Fig.8 Input impedance (S_{11}) of the band B mixer input (150 to 480 MHz) (Z chart).

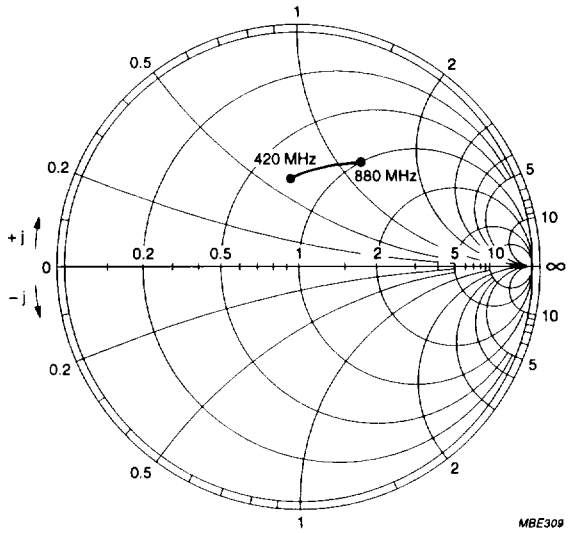


Fig.9 Input impedance (S_{11}) of the band C mixer input (430 to 880 MHz) (Z chart).

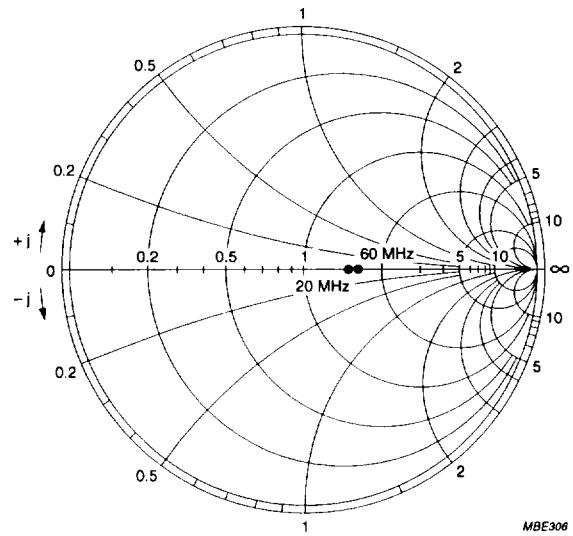


Fig.10 Output impedance (S_{22}) of the IF amplifier (20 to 60 MHz) (Z chart).

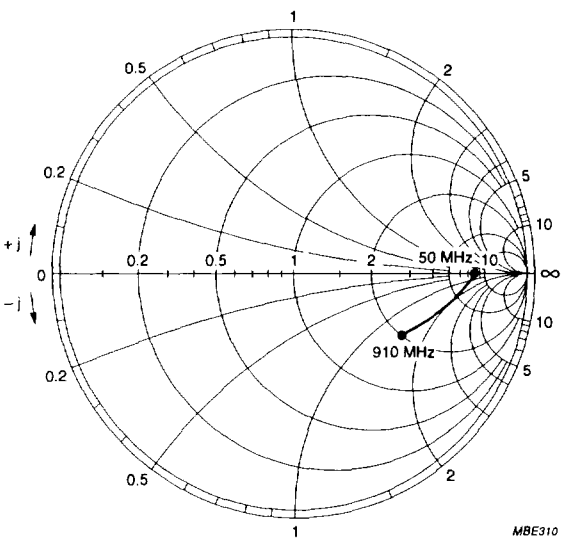
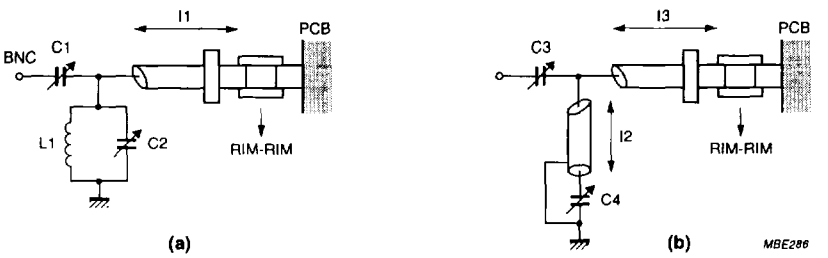


Fig.11 Output impedance (S_{22}) of the LO amplifier (50 to 910 MHz) (Z chart).

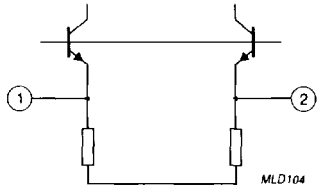
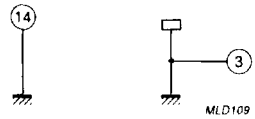
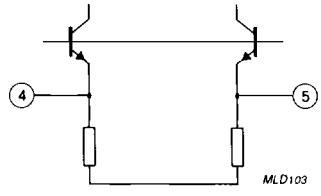
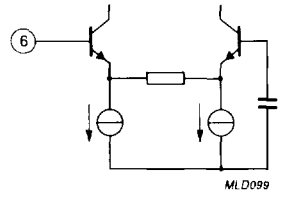


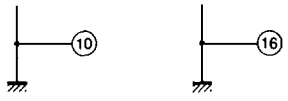
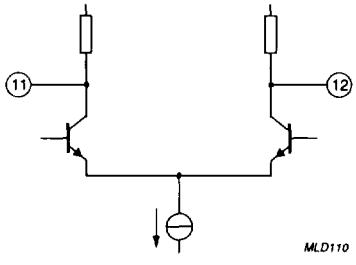
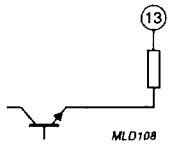
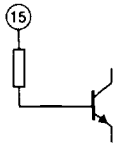
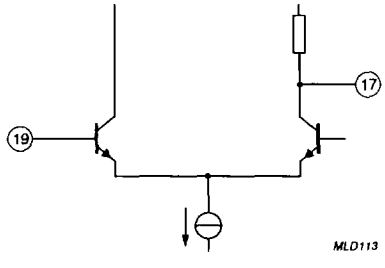
(a) For f_R = 50 MHz:
mixer A frequency response measured = 57 MHz, loss = 0 dB
image suppression = 16 dB
C1 = 9 pF
C2 = 15 pF
L1 = 7 turns (5.5 mm, wire diam. = 0.5 mm)
l1 = rigid cable (RIM): 5 cm long
(rigid cable (RIM); 33 dB/100 m; 50 Ω, 96 pF/m).

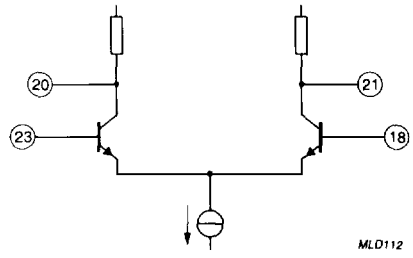
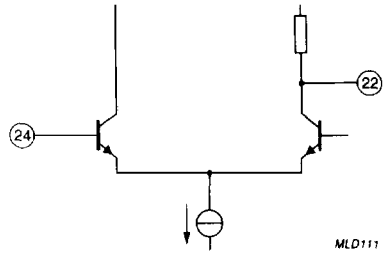
(b) For f_R = 180 MHz:
mixer A frequency response measured = 150.3 MHz, loss = 1.3 dB
image suppression = 13 dB
C3 = 5 pF
C4 = 25 pF
l2 = rigid cable (RIM): 30 cm long
l3 = rigid cable (RIM): 5 cm long
(rigid cable (RIM); 33 dB/100 m; 50 Ω; 96 pF/m).

Fig.12 Input circuit for minimum noise figure.

Table 1 Internal pin configuration

PIN	SYMBOL	CONFIGURATION	AVERAGE DC VOLTAGE		
1	CIN1		0	0	2.2
2	CIN2		0	0	2.2
3	RFGND		0	0	0
14	IFGND		0	0	0
4	BIN1		0	2.2	0
5	BIN2		0	2.2	0
6	AIN		2.2	1.2	1.2
7	V_P	supply voltage	9	9	9
8	MIXOUT1		8.4	8.4	8.4
9	MIXOUT2		8.4	8.4	8.4

PIN	SYMBOL	CONFIGURATION	AVERAGE DC VOLTAGE		
10	GND		0	0	0
16	GND		0	0	0
11	LOOUT1		5.6	5.6	5.6
12	LOOUT2		5.6	5.6	5.6
13	IFOUT		4.5	4.5	4.5
15	BS		$V_{SW(A)}$	$V_{SW(B)}$	$V_{SW(C)}$
17	BOSCOC		5.8	3.4	5.8
19	BOSCIB		1.2	2.3	1.2

PIN	SYMBOL	CONFIGURATION	AVERAGE DC VOLTAGE		
18	COSCIB1		1.4	1.4	2.3
20	COSCOC1		5.8	5.8	4.2
21	COSCOC2		5.8	5.8	4.2
23	COSCIB2		1.4	1.4	2.3
22	AOSCOC		3.8	5.8	5.8
24	AOSCIB		2.1	1.0	1.0

APPLICATION INFORMATION

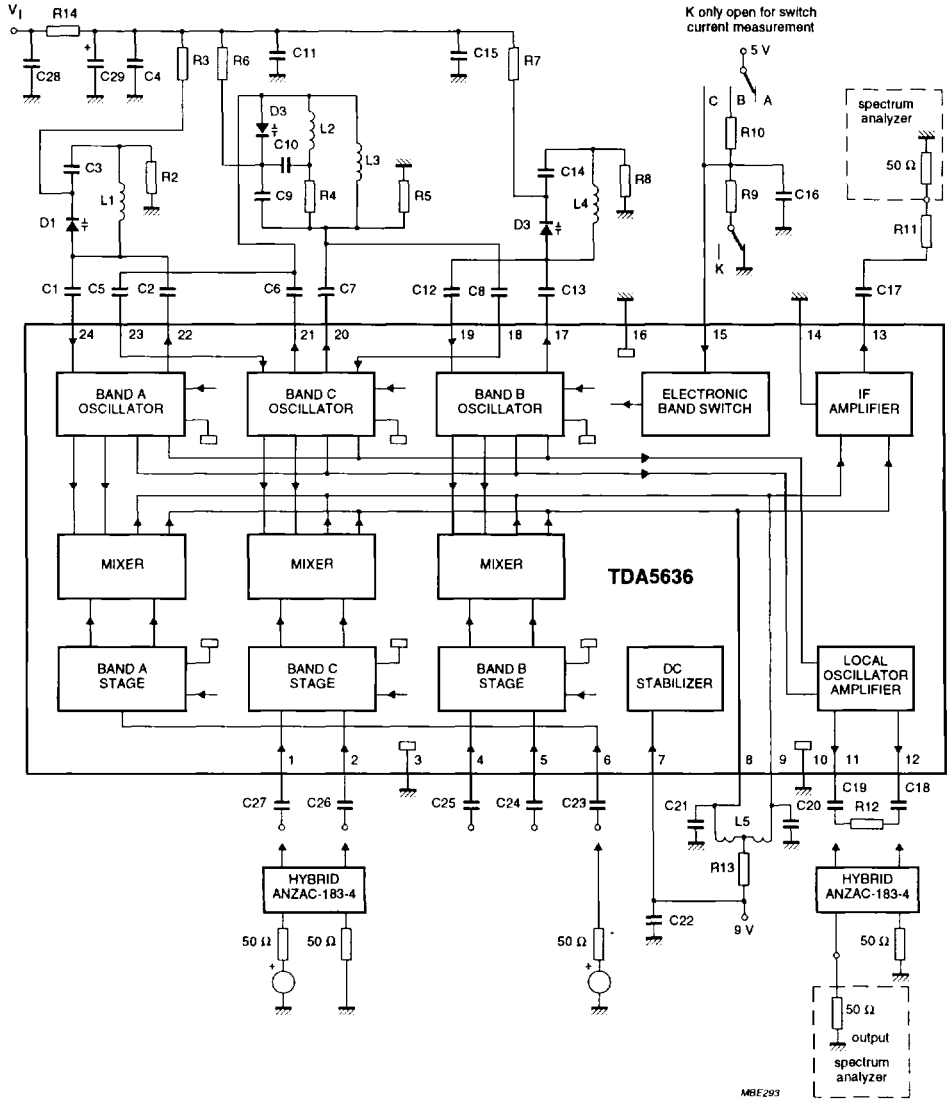


Fig.13 Application diagram.

Application diagram components values

Table 2 Capacitors (all SMD and NP0 except C5 to C9 and C29)

NUMBER	VALUE
C1	2 pF
C2	2 pF
C3	82 pF
C4	2.2 nF
C5	1 pF (N750)
C6	1 pF (N750)
C7	1 pF (N750)
C8	1 pF (N750)
C9	6 pF (N470)
C10	100 pF
C11	2.2 nF
C12	2 pF
C13	4 pF
C14	150 pF
C15	2.2 nF
C16	1.2 nF
C17	1 nF
C18	1 nF
C19	1 nF
C20	12 pF
C21	12 pF
C22	22 nF
C23	1 nF
C24	1 nF
C25	1 nF
C26	1 nF
C27	1 nF
C28	2.2 nF
C29	1 µF (40 V electrolytic capacitor)

Table 3 Resistors (all SMD)

NUMBER	VALUE
R2	22 Ω
R3	47 kΩ
R4	2.2 kΩ
R5	22 kΩ
R6	47 kΩ
R7	47 kΩ
R8	12 Ω
R9	15 kΩ
R10	33 kΩ
R11	27 Ω
R12	100 Ω
R13	150 Ω
R14	47 kΩ

Table 4 Diodes and coils

NUMBER	VALUE
Diodes	
D1	BB132
D2	BB134
D3	BB146
Coils[1]	
L1	8 t (3 mm)
L2	2 t (2.5 mm)
L3	3 t (2.5 mm)
L4	2 t (4 mm)

Note

1. Wire size for L1 to L4 is 0.4 mm

Transformer (L5 = 2 × 6)

Coil type: TOKO 7kN; material: 113kN, screw core (03-0093), pot core (04-0026).