Low-power VHF and UHF mixer/oscillator for TV and VCR 2-band tuners

TDA5633

FEATURES

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

DESCRIPTION

The TDA5633 is a monolithic integrated circuit that performs VHF I, VHF III, hyperband and UHF mixer/oscillator functions in TV and VCR tuners. This low-power mixer/oscillator requires a power supply of 9 V and is available in a very small package.

The device gives the designer the capability to design an economical and physically small 2-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		–	9.0	–	V
I_P	supply current		–	40	–	mA
f_R	frequency range	band A; note 1	57.5	–	357.5	MHz
		band C; note 1	469.5	–	887.5	MHz
N	noise figure	band A; R_L = 75 Ω	–	10	–	dB
		band C; R_L = 75 Ω	–	9.5	–	dB
V_i	input voltage	band A; R_L = 75 Ω; 1% cross-modulation	–	91	–	dBμV
		band C; R_L = 75 Ω; 1% cross-modulation;	–	80	–	dBμV
G_v	voltage gain	band A; R_L = 75 Ω	–	19	–	dB
		band C; R_L = 75 Ω	–	30	–	dB

Note

1. A second UHF frequency range is available by modifying the tank circuit. The modification enables the following frequency range:
   a) RF frequencies from 363.5 to 803.5 MHz.
   b) Oscillator frequencies from 407 to 847 MHz. For this UHF range, L4 = 3 turns (dia. = 3.5 mm).

ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
TDA5633T	SO20	plastic small outline package; 20 leads; body width 7.5 mm	SOT163-1
TDA5633M	SSOP20	plastic shrink small outline package; 20 leads; body width 4.4 mm	SOT266-1

BLOCK DIAGRAM

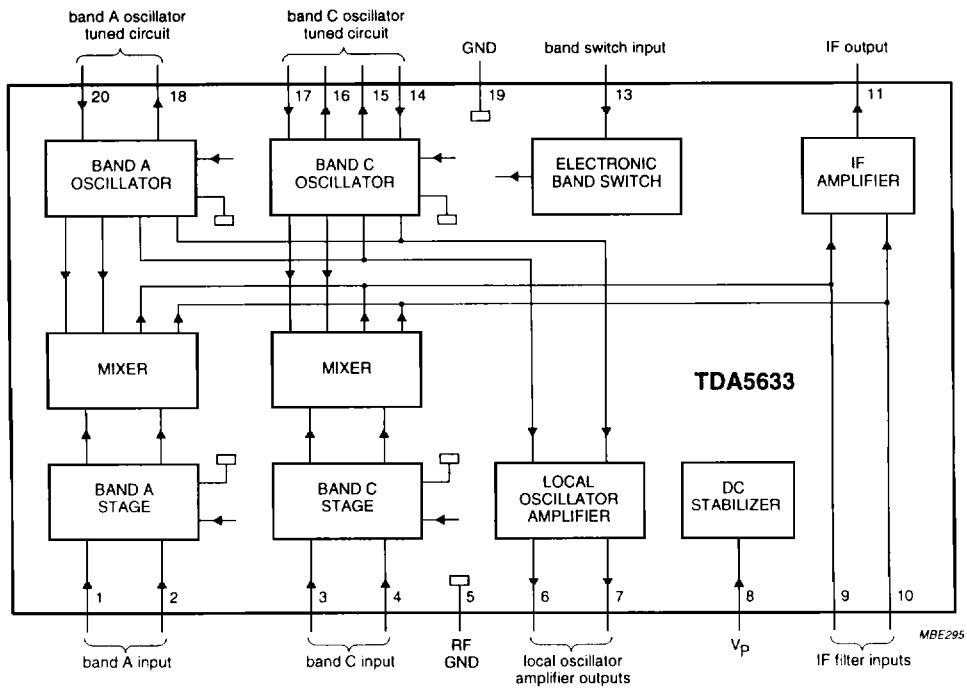

Fig.1 Block diagram.

PINNING

SYMBOL	PIN	DESCRIPTION
AIN1	1	band A input 1
AIN2	2	band A input 2
CIN1	3	band C input 1
CIN2	4	band C input 2
RFGND	5	ground for RF inputs
LOOUT1	6	local oscillator amplifier output 1
LOOUT2	7	local oscillator amplifier output 2
V_P	8	supply voltage
IFIN1	9	IF amplifier input 1
IFIN2	10	IF amplifier input 2
IFOUT	11	IF amplifier output
n.c.	12	not connected
BS	13	electronic band switch input
COSCIB1	14	band C oscillator input base 1
COSCOC1	15	band C oscillator output collector 1
COSCOC2	16	band C oscillator output collector 2
COSCIB2	17	band C oscillator input base 2
AOSCOC	18	band A oscillator output collector
GND	19	ground (0 V)
AOSCIB	20	band A oscillator input base

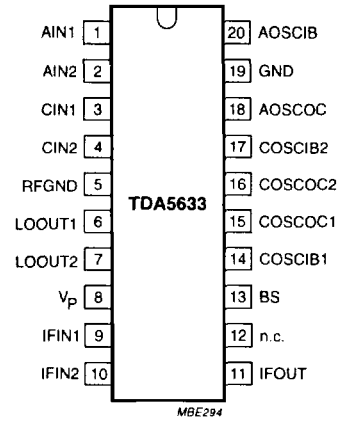

Fig.2 Pin configuration.

LIMITING VALUES

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

SYMBOL	PARAMETER	MIN.	MAX.	UNIT
V_P	supply voltage range	−0.3	+10.5	V
V_{SW}	switching voltage	0	10.5	V
I_O	output current of each pin to ground	−	−10	mA
t_{sc}	maximum short-circuit time (all pins)	−	10	s
T_{stg}	storage temperature	−55	+150	°C
T_{amb}	operating ambient temperature	−20	+85	°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		
	SOT163-1	82	K/W
	SOT266-1	120	K/W

HANDLING

Human body model: the IC withstands 2000 V in accordance with *UZW-BO-FQ-A302*; R = 1.5 kΩ; C = 100 pF.

Machine model: the IC withstands 200 V in accordance with *UZW-BO-FQ-B302*; R = 0 Ω; C = 200 pF.

IF AMPLIFIER CHARACTERISTICS

V_P = 9 V; T_{amb} = 25 °C; measured at 43.5 MHz; measured in circuit of Fig.3; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.		MAX	UNIT
				MOD.	PHASE		
S_{22}	output reflection coefficient		−	−14	−1.9	−	dB/°
Z_o	output impedance (R_s + L_s)	R_s; through 1 nF	−	75		−	Ω
		L_s; through 1 nF	−	2.8		−	nF

CHARACTERISTICS

V_P = 9 V; T_{amb} = 25 °C; measured in circuit of Fig.3; 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		–	40	48	mA
V_{SW}	switching voltage	band A	0	–	2.0	V
		band C	3.0	–	5.0	V
I_{SW}	switching current	band A; V_{SW} = 0 V	–	–	2	µA
		band C; V_{SW} = 5 V	–	–	10	µA
Band A mixer (including IF amplifier)						
f_R	frequency range		57.5	–	357.5	MHz
N	noise figure	f_i = 50 MHz; R_L = 75 Ω	–	7.5	9.5	dB
		f_i = 150 MHz; R_L = 75 Ω	–	8.5	10.5	dB
		f_i = 300 MHz; R_L = 75 Ω	–	10	12.5	dB
g_{os}	optimum source conductance for noise figure	f_i = 50 MHz; R_L = 75 Ω	–	0.5	–	mS
		f_i = 150 MHz; R_L = 75 Ω	–	1.1	–	mS
		f_i = 300 MHz; R_L = 75 Ω	–	1.9	–	mS
g_i	input conductance	f_i = 57.5 MHz	–	0.27	–	mS
		f_i = 357.5 MHz	–	0.68	–	mS
C_I	input capacitance	f_i = 57.5 to 357.5 MHz; R_L = 75 Ω	–	2	–	pF
V_i	input voltage	1% cross modulation; in channel; f_i = 57.5 MHz; R_L = 75 Ω; note 1	88	91	–	dBµV
		1% cross modulation; in channel; f_i = 357.5 MHz; R_L = 75 Ω; note 1	88	91	–	dBµV
		10 kHz pulling; in channel; R_L = 75 Ω; f_i = 357.5 MHz	–	91	–	dBµV
G_v	voltage gain	f_i = 57.5 MHz; R_L = 75 Ω	16.5	19	21.5	dB
		f_i = 357.5 MHz; R_L = 75 Ω	16.5	19	21.5	dB
Band A oscillator						
f_R	frequency range		101	–	401	MHz
f_{shift}	frequency shift	ΔV_P = 10%	–	–	200	kHz
f_{drift}	frequency drift	ΔT = 25 °C with no compensation; NPO capacitors	–	–	1200	kHz
		5 s to 15 min after switch on	–	–	400	kHz
Band C mixer (including IF amplifier)						
f_R	frequency range	note 2	469.5	–	887.5	MHz
N	noise figure (not corrected for image)	f_i = 469.50 MHz; R_L = 75 Ω	–	7.5	9.5	dB
		f_i = 887.5 MHz; R_L = 75 Ω	–	9.5	11.5	dB
Z_I	input impedance (R_s + L_s)	R_s; f_i = 469.50 MHz	–	30	–	Ω
		L_s; f_i = 887.5 MHz	–	12	–	nH

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$V_{i(av)}$	available input voltage	1% cross-modulation; in channel; f_i = 887.5 MHz; R_L = 75 Ω; note 1	77	80	–	dBμV
V_i	input voltage	10 kHz pulling; in channel; R_L = 75 Ω	–	82	–	dBμV
G_v	voltage gain	f_i = 469.50 MHz; R_L = 75 Ω	27	30	33	dB
		f_i = 887.5 MHz; R_L = 75 Ω	27	30	33	dB
Band C oscillator						
f_R	frequency range		513	–	931	MHz
f_{shift}	frequency shift	ΔV_P = 10%	–	–	500	kHz
f_{drift}	frequency drift	ΔT = 25 °C with compensation	–	–	900	kHz
		5 s to 15 min after switching on	–	–	400	kHz
LO output						
V_O	output voltage	R_L = 50 Ω	83	91	100	dBμV
SRF	spurious signal on LO output w.r.t. LO output signal	R_L = 50 Ω; note 3	–	−14	−10	dB
HLO	LO signal harmonics w.r.t. LO signal	R_L = 50 Ω	–	−11	−10	dB

Notes

1. Cross-modulation measurements:
   a) Input voltage for mixer A at f_{RF} = 57.5 MHz; wanted at 55.25 MHz (80 dBμV); unwanted at 59.75 MHz, 30%, AM modulated with 100 kHz.
   b) Input voltage for mixer A at f_{RF} = 357.5 MHz; wanted at 355.25 MHz (80 dBμV); unwanted at 359.75 MHz, 30%, AM modulated with 100 kHz.
   c) Input voltage for mixer A at f_{RF} = 887.5 MHz; wanted at 885.25 MHz (69 dBμV); unwanted at 889.75 MHz, 30%, AM modulated with 50 kHz.
2. A second UHF frequency range is available by modifying the tank circuit. The modification enables the following frequency range:
   a) RF frequencies from 363.5 to 803.5 MHz.
   b) Oscillator frequencies from 407 to 847 MHz. For this UHF range, L4 = 3 turns (dia. = 3.5 mm).
3. SRF: spurious signal on LO with respect to LO output signal;
   a) RF voltage level = 1 V at f_i = 57.5 to 225 MHz.
   b) RF level = 2.5 dBm at f_i = 225 to 357.5 MHz.
   c) RF level = −10 dBm at f_i = 469.5 to 887.5 MHz.

APPLICATION INFORMATION

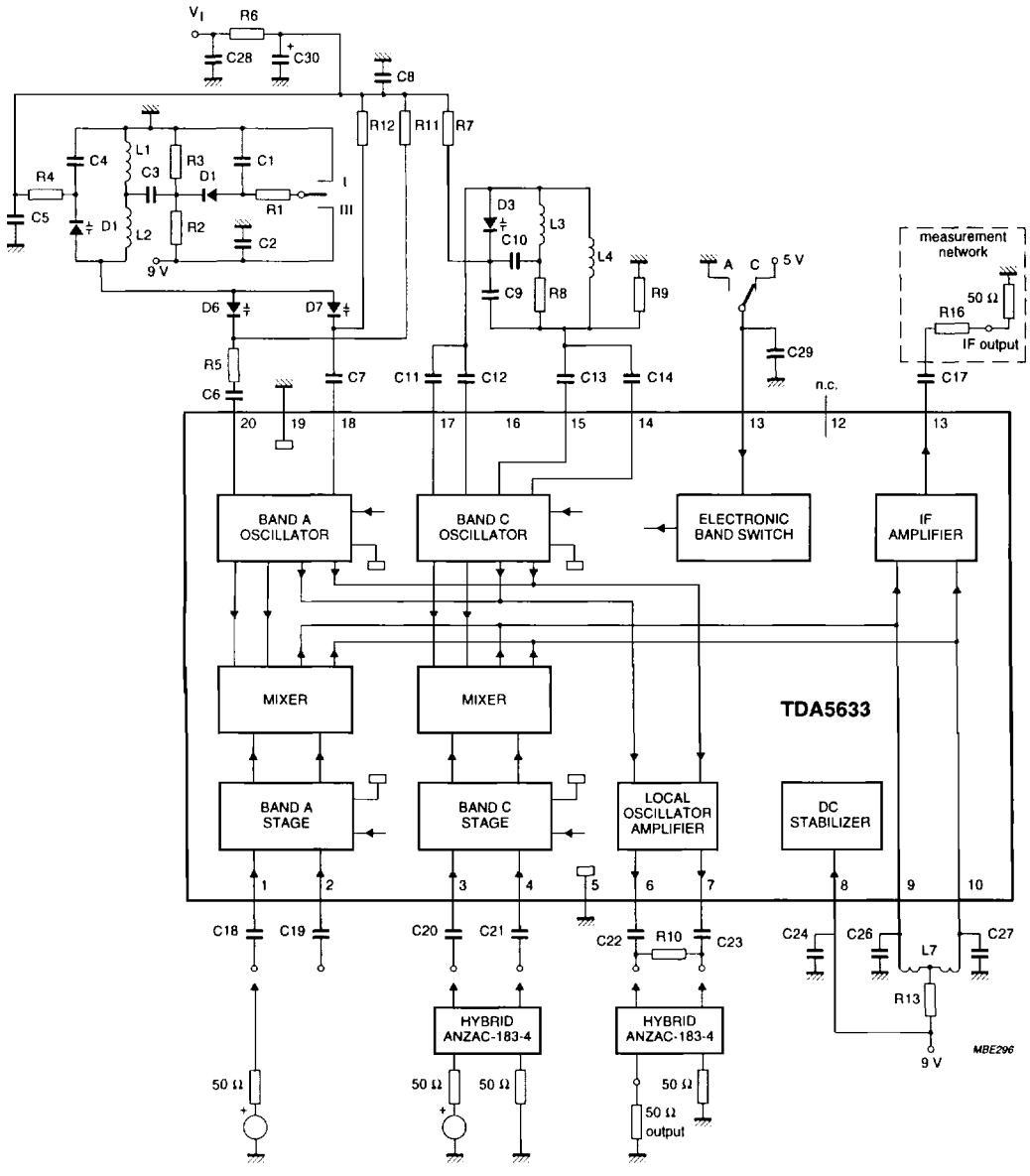

Fig.3 Test circuit.

Application diagram components values

Table 1 Capacitors (all SMD and NP0 except C5 to C9 and C29)

NUMBER	VALUE
C1	1 nF
C2	1 nF
C3	1 nF
C4	56 pF
C5	2.2 nF
C6	2 pF
C7	4 pF
C8	2.2 nF
C9	6 pF (N470)
C10	100 pF
C11	1 pF (N750)
C12	1 pF (N750)
C13	1 pF (N750)
C14	1 pF (N750)
C17	1 nF
C18	1 nF
C19	1 nF
C20	1 nF
C21	1 nF
C22	1 nF
C23	1 nF
C24	1 nF
C26	15 pF
C27	15 pF
C28	2.2 nF
C29	1 nF
C30	1 µF (40 V electrolytic capacitor)

Table 2 Resistors (all SMD)

NUMBER	VALUE
R1	10 Ω
R2	12 kΩ
R3	2.7 kΩ
R4	47 kΩ
R5	56 Ω
R6	47 kΩ
R7	22 kΩ
R8	2.2 kΩ
R9	22 kΩ
R10	100 Ω
R11	47 kΩ
R12	47 kΩ
R13	150 Ω
R16	27 Ω

Table 3 Diodes and coils

NUMBER	VALUE
Diodes	
D1	BA682
D2	BB133
D3	BB146
D6	BB131
D7	BB131
Coils(1)	
L1	6 t (4 mm)
L2	3 t (3.5 mm)
L3	2 t (2.5 mm)
L4	3 t (2.5 mm)

Note

1. Wire size for L1 to L4 is 0.4 mm

Transformer (L7 = 2 × 5 t)

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

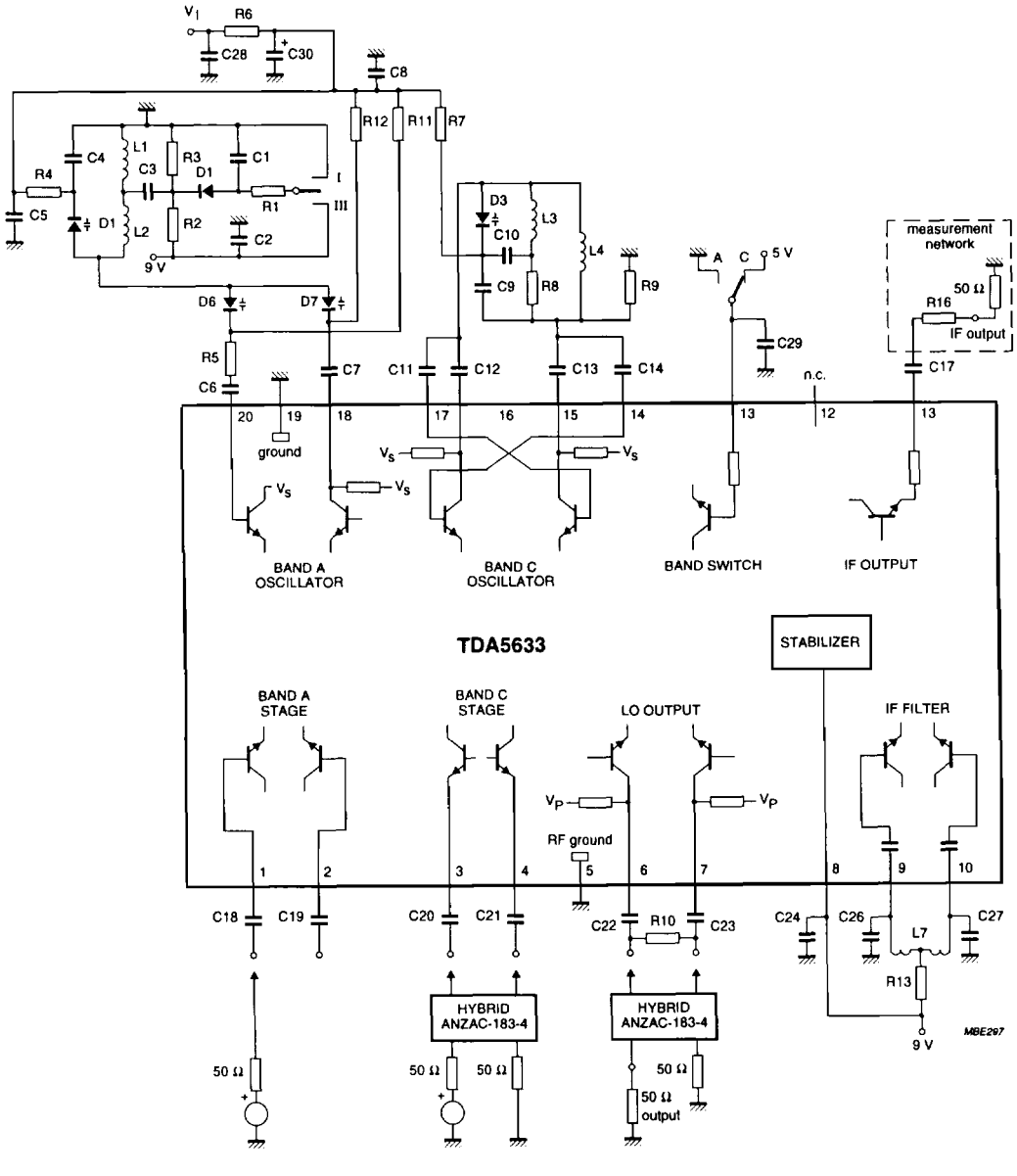

Fig.4 Electrical test circuit.

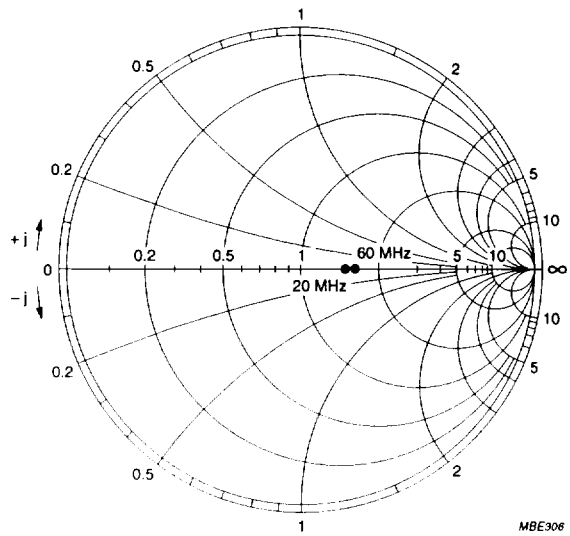

Fig.5 Output reflection coefficient (S_{22}) of the IF amplifier (20 to 60 MHz) (Z chart).