SIEMENS

VHF/UHF Tuner IC

TUA 2017-X

Preliminary Data

Bipolar IC

Features

- Combined UHF/Hyperband/VHF-Tuner-IC
- 3 oscillators and 3 mixers
- Only 3 frequency bands for the complete frequency range required
- Few external components
- Frequency and amplitude-stable unbalanced oscillator for the frequency range VHF.
- Frequency and amplitude-stable balanced oscillators for the frequency ranges HYPER-band and UHF.
- Optimum suppression of oscillator and input frequency at IF output
- Optimum decoupling of input frequency from oscillator
- Balanced mixer with large dynamic range and high-impedance inputs for the VHF range
- Balanced mixer with large dynamic range and low-impedance inputs for the hyperband and UHF range
- High-impedance balanced SAW driver input
- Low-impedance SAW filter output
- SAW driver with high signal-handling capability
- High decoupling of SAW driver input from output
- Internal band switch
- Low-noise, internal reference voltage

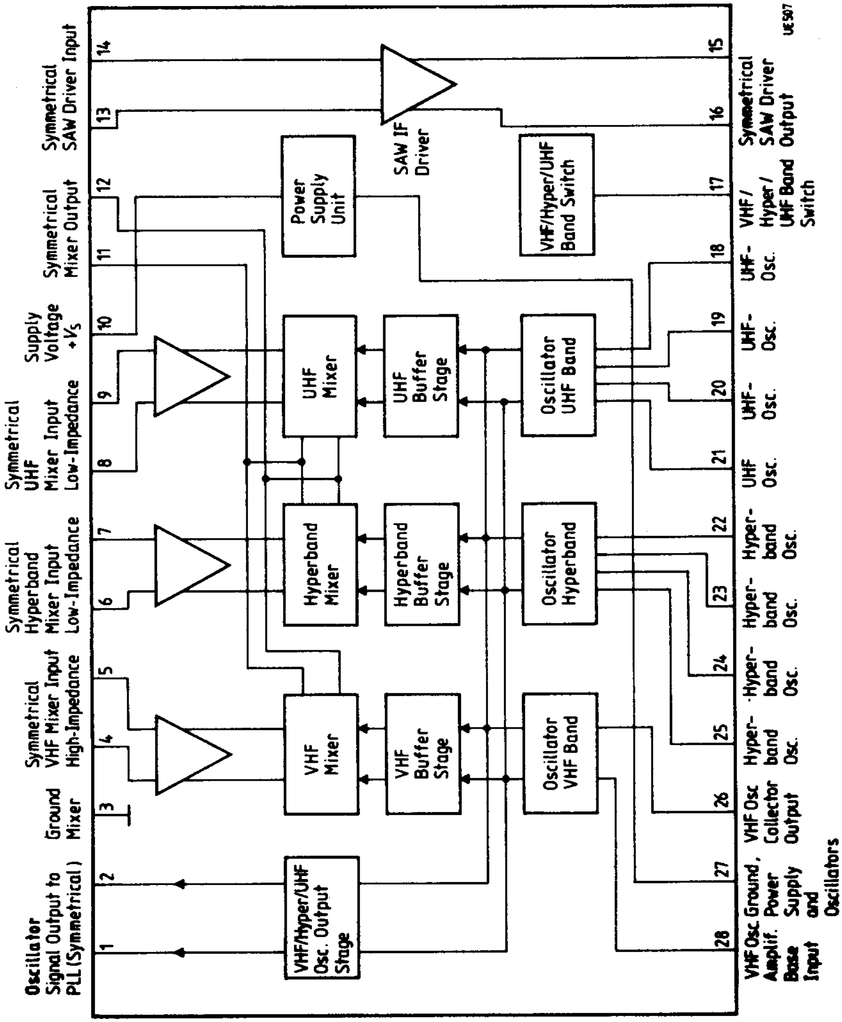
Type	Ordering Code	Package
TUA 2017-X	Q67000-A8239	P-DSO-28 (SMD)

Circuit Description

This integrated circuit permits the design of TV tuners covering the entire frequency range from 48...860 MHz with a division into 3 bands. The application is suitable for all tuners in TV- and VCR-sets.

The IC includes 3 balanced mixers (double push-pull mixer/ring mixer), one unbalanced oscillator for VHF and two balanced oscillators for HYPER and UHF, a SAW driver as well as a reference voltage source and a band switch. A frequency separating filter at the tuner input assigns the TV signal to one of the three bands. The band switch ensures that only one band at a time is activated. In the activated band the signal passes a frontend stage with MOSFET amplifier, a double-tuner bandpass filter and is then fed to the activated balanced mixer input of the TUA 2017, which is a high-impedance stage for the VHF range and a low-impedance stage for the hyperband and UHF range, respectively. The signal is mixed there with the oscillator signal from the activated oscillator section and fed to a common IF stage for all bands. After passing the IF intermediate circuit filter the IF signal is amplified further by a SAW driver section to drive the low-impedance SAW filter.

Block Diagram



Pin Definitions and Functions

Pin No.	Function	Definition
1	Osc. output 1	VHF/HYPER/UHF oscillator signal output to PLL, symmetrical to pin 2
2	Osc. output 2	VHF/HYPER/UHF oscillator. signal output to PLL, symmetrical to pin 1
3	GND mixer	Ground mixer inputs
4	VHF input 1	VHF mixer input high-impedance, symmetrical to pin 5
5	VHF input 2	VHF mixer input high-impedance, symmetrical to pin 4
6	Hyper input 1	Hyper mixer input low-impedance, symmetrical to pin 7
7	Hyper input 2	Hyper mixer input low-impedance, symmetrical to pin 6
8	UHF input 1	UHF mixer input low-impedance, symmetrical to pin 9
9	UFH input 2	UHF mixer input low-impedance, symmetrical to pin 8
10	$+V_S$	Supply voltage
11	Mi. output 1	Open collector mixer output, high-impedance, symmetrical to pin 12
12	Mi. output 2	Open collector mixer output, high-impedance, symmetrical to pin 11
13	OFW driver input 1	SAW driver amplifier input, symmetrical to pin 14
14	OFW driver input 2	SAW driver amplifier input, symmetrical to pin 13
15	OFW driver output 1	SAW driver amplifier output, low-impedance, symmetrical to pin 16
16	OFW driver output 2	SAW driver amplifier output, low-impedance, symmetrical to pin 15
17	Band switching	VHF / HYPER / UHF band switching
18	UHF osc. input 1	UHF oscillator amplifier, high-impedance base input, symmetrical to pin 21
19	UHF osc. output 1	UHF oscillator amplifier, high-impedance collector output, symmetrical to pin 20
20	UHF osc. input 2	UHF oscillator amplifier, high-impedance collector output, symmetrical to pin 19
21	UHF osc. input 2	UHF oscillator amplifier, high-impedance base input, symmetrical to pin 18
22	Hyp. osc. input 1	Hyp. oscillator amplfier, high-impedance base input, symmetrical to pin 25
23	Hyp. osc. output 1	Hyp.-oscillator amplifier, high-impedance collector output, symmetrical to pin 24
24	Hyp. osc. output 2	Hyp. oscillator amplifier, high-impedance collector output, symmetrical to pin 23
25	Hyp. osc. input 2	Hyp. oscillator amplifier, high-impedance base input, symmetrical to pin 22
26	VHF osc. coupl. 1	VHF oscillator coupling , collector output
27	GND	Ground SAW driver, power supply unit, band switch and oscillators
28	VHF osc. coupl. 2	VHF oscillator coupling, base input

Absolute Maximum Ratings

T_A = 25 °C

Parameter	Symbol	Limit Values		Unit	Remarks
		min.	max.		
Supply voltage V_S	$V_{10,11,12,27,3}$	– 0.3	14	V	
Current	$I_{10,11,12}$		60	mA	
Switching voltage	V_{17}	– 0.3	+ V_S	V	

Only the considered external circuitry, conform to the measurement circuit 1, can be applied at the pins1,3,4,5,6,7,8,9,10,11,13,14,15,16,20,21,22,23,24,25,27,28

Junction temperature	T_j		150	°C	
Storage temperature	T_{stg}	– 40	125	°C	
Thermal resistance (system air)	$R_{th\,SA}$			K/W	typ. value 75

Operational Range

Supply voltage	V_S	10	13.2	V	
Current consumption	$I_{10,11,12}$	25	53	mA	
VHF mixer input frequency range	f_{VHF}	30	500	MHz	
HYPER mixer input frequency range	f_{HYPER}	30	900	MHz	
UHF mixer input frequency range	f_{VHF}	30	900	MHz	
VHF oscillator-frequency range	f_{OVHF}	30	500	MHz	
HYPER oscillator-frequency range	f_{OHYPER}	30	900	MHz	
UHF oscillator-frequency range	f_{OUHF}	30	900	MHz	
Ambient temperature	T_A	0	70	°C	

Characteristics
V_S = 12 V; T_A = 25 °C

Parameter	Symbol	Limit Values			Unit	Test Condition	Test Circuit
		min.	typ.	max.			
Current consumption	I_{10}	25	34	43	mA	$V_{11,12} = V_S$; $V_{17} > 1.6$ V	1
Current consumption	I_{10}	19	28	37	mA	$V_{11,12} = V_S$; $V_{17} < 0.9$ V	1
Current consumption	$I_{11/12}$	5	8	11	mA	$V_{11,12} = V_S$	1

VHF Circuit Section

Parameter	Symbol	min.	typ.	max.	Unit	Test Condition	Test Circuit
Switching voltage	V_{17}	0		1	V		1
Switching current	I_{17}			10	μA	V_{17} = 0.5V	1
Oscillator frequency range	f_{VHF}	80		216	MHz	Vd = 0...28 V	1
Oscillator drift	Δf_{VHF}			200	kHz	V_S = 12 V ± 10%	1
Oscillator drift	Δf_{VHF}			400	kHz	ΔT = 25 °C	1
Oscillator drift	Δf_{VHF}			200	kHz	t = 5 sec. to 15 min. after switching on	1
Oscillator level	$V_{1,2}$		700		mV$_{rms.}$	K2 at hot end	1
Oscillator level	$V_{1,2}$		700		mV$_{rms.}$	S10 at hot end	1
Oscillator Output impedance	$R_{1,2}$ $C_{1,2}$		100 2		Ω pF	parallel equivalent circuit	2
Harmonic ratio	$a_{1,2}$			– 10	dB		1
Interference ratio	$a_{1,2}$			– 10	dB	V_{HF} = 1 V$_{rms}$	1
Oscillator pulling	$V_{4,5}$	100	108		dB/μV	Δf=10 kHz in channel K2	1
Oscillator pulling	$V_{4,5}$	100	108		dB/μV	Δf=10 kHz in channel S10	1
Oscillator pulling	$V_{4,5}$	80	88		dB/μV	Δf_{int} = K2 + (N + 5 – 1M Hz)	1
Oscillator pulling	$V_{4,5}$	80	88		dB/μV	Δf_{int} = S10 + (N + 5 – 1 MHz)	1
Mixer gain	G_{VHF}		5		dB	channel 2	1
Mixer gain	G_{VHF}		5		dB	channel S10	1
Mixer noise figure	NF_{VHF}		7.5	9	dB	channel 2	1
Mixer noise figure	NF_{VHF}		7.5	9	dB	channel S10	1
Interference voltage	V_{int}		70		dB/μV	1% cross mod.; K2 ± 2	1
Interference voltage	V_{int}		70		dB/μV	1% cross mod.; S10 ± 2	1
Mixer input impedance	$R_{4,5}$ $C_{4,5}$		1 2		kΩ pF	parallel equivalent circuit	3
Mixer output impedance	$R_{11,12}$ $C_{11,12}$		10 2		kΩ pF	parallel equivalent circuit	4
IF-suppression	a_{IF}		20		dB	channel 2	1
IF-suppression	a_{IF}		20		dB	channel S10	1

Characteristics (cont'd)
V_S = 12 V; T_A = 25 °C

Parameter	Symbol	Limit Values			Unit	Test Condition	Test Circuit
		min.	typ.	max.			
Hyper Circuit Section							
Switching voltage	V_{17}	1.6		2.3	V		1
Switching current	I_{17}		10	30	µA	V_{17} = 2.1 V	1
Oscillator frequency range	f_{HYPER}	190		485	MHz	Vd = 0...28 V	1
Oscillator drift	Δf_{HYPER}			400	kHz	V_S = 12 V ± 10 %	1
Oscillator drift	Δf_{HYPER}			500	kHz	ΔT = 25 °C	1
Oscillator drift	Δf_{HYPER}			200	kHz	t = 5 sec. to 15 min. after switching on	1
Oscillator level	$V_{1,2}$		100		mV_{rms}	K5 symmetrical tested	1
Oscillator level	$V_{1,2}$		80		mV_{rms}	S37 symmetrical tested	1
Oscillator Output impedance	$R_{1,2}$ $C_{1,2}$		100 2		Ω pF	parallel equivalent circuit	2
Harmonic ratio	$a_{1,2}$			– 10	dB		1
Interference ratio	$a_{1,2}$			– 10	dB	V_{HF} = 1 V_{rms}	1
Oscillator pulling	$V_{6,7}$	100	108		dB/µV	Δf=10 kHz in channel K5	1
Oscillator pulling	$V_{6,7}$	100	108		dB/µV	Δf=10 kHz in channel S37	1
Oscillator pulling	$V_{6,7}$	80	88		dB/µV	Δf_{int} = K5 + (N + 5 – 1 MHz)	1
Oscillator pulling	$V_{6,7}$	80	88		dB/µV	Δf_{int} = S37+ (N + 5 – 1 MHz)	1
Mixer gain	G_{HYPER}		5		dB	channel 5	1
Mixer gain	G_{HYPER}		5		dB	channel S37	1
Mixer noise figure	NF_{HYPER}		7.5	9	dB	channel 5	1
Mixer noise figure	NF_{HYPER}		7.5	9	dB	channel S37	1
Interference voltage	V_{int}	97	100		dB/µV	1% cross mod.; K5 ± 2	1
Interference voltage	V_{int}	97	100		dB/µV	1% cross mod.; S37 ± 2	1
Mixer input impedance	$R_{6,7}$ $C_{6,7}$		125 10		Ω nH	serial equivalent circuit	3
Mixer output impedance	$R_{11,12}$ $C_{11,12}$		10 2		kΩ pF	parallel equivalent circuit	4
IF-suppression	a_{IF}		20		dB	channel 5	1
IF-suppresion	a_{IF}		20		dB	channel S37	1

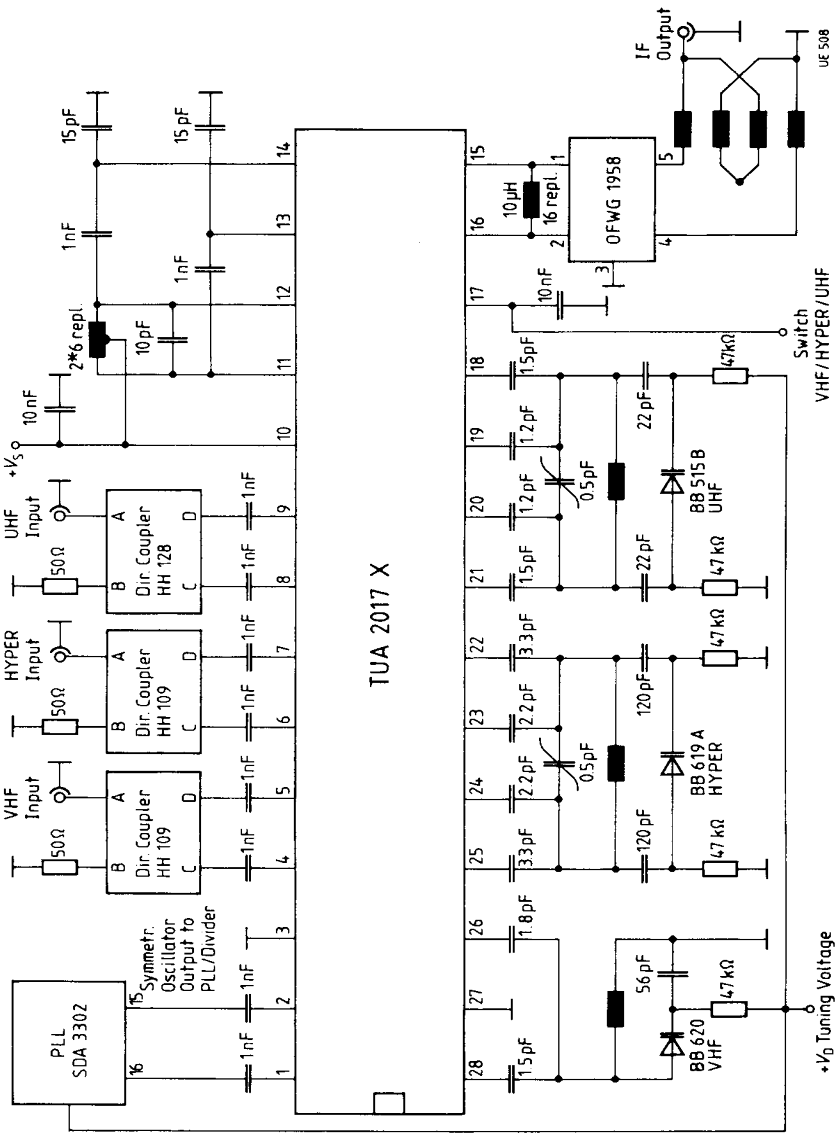
Characteristics (cont'd)
V_S = 12 V; T_A = 25 ˚C

Parameter	Symbol	Limit Values			Unit	Test Condition	Test Circuit
		min.	typ.	max.			
UHF-Circuit Section							
Switching voltage	V_{17}	3.2		$\leq V_S$	V		1
Switching current	I_{17}		60	300	µA	$V_{17} = V_S$	1
Oscillator frequency range	f_{VHF}	470		900	MHz	Vd = 0...28 V	1
Oscillator drift Oscillator drift Oscillator drift	Δf_{UHF} Δf_{UHF} Δf_{UHF}			400 800 200	kHz kHz kHz	V_S = 12 V ± 10% ΔT = 25 ˚C t = 5 sec. to 15 min. after switching on	1 1 1
Oscillator level Oscillator level	$V_{1,2}$ $V_{1,2}$		80 50		mV_{rms} mV_{rms}	K21 symmetrical tested K68 symmetrical tested	1 1
Oscillator Output impedance	$R_{1,2}$ $C_{1,2}$		100 2		Ω pF	parallel equivalent circuit	2
Harmonic ratio	$a_{1,2}$			– 10	dB		1
Interference ratio	$a_{1,2}$			– 10	dB	$V_{HF} = 1 V_{rms}$	1
Oscillator pulling Oscillator pulling Oscillator pulling Oscillator pulling	$V_{8,9}$ $V_{8,9}$ $V_{8,9}$ $V_{8,9}$	100 100 80 80	108 108 88 88		dBµV dBµV dBµV dBµV	Δf=10 kHz in channel K21 Δf=10 kHz in channel K68 Δf_{int} = K21 +(N+5–1 MHz) Δf_{int} = K68 +(N+5–1 MHz)	1 1 1 1
Mixer gain Mixer gain	G_{UHF} G_{UHF}		5 5		dB dB	channel 21 channel K68	1 1
Mixer noise figure Mixer noise figure	NF_{UHF} NF_{UHF}		8 9	10 11	dB dB	channel 21 channel K68	1 1
Interference voltage Interference voltage	V_{int} V_{int}	97 97	100 100		dB/µV dB/µV	1% cross mod.; K21 ± 2 1% cross mod.; K68 ± 2	1 1
Mixer input impedance	$R_{8,9}$ $C_{8,9}$		125 10		Ω nH	serial equivalent circuit	3
Mixer output impedance	$R_{11,12}$ $C_{11,12}$		10 2		kΩ pF	parallel equivalent circuit	4
IF-suppression IF-suppression	a_{IF} a_{IF}		20 20		dB dB	channel 21 channel 68	1 1

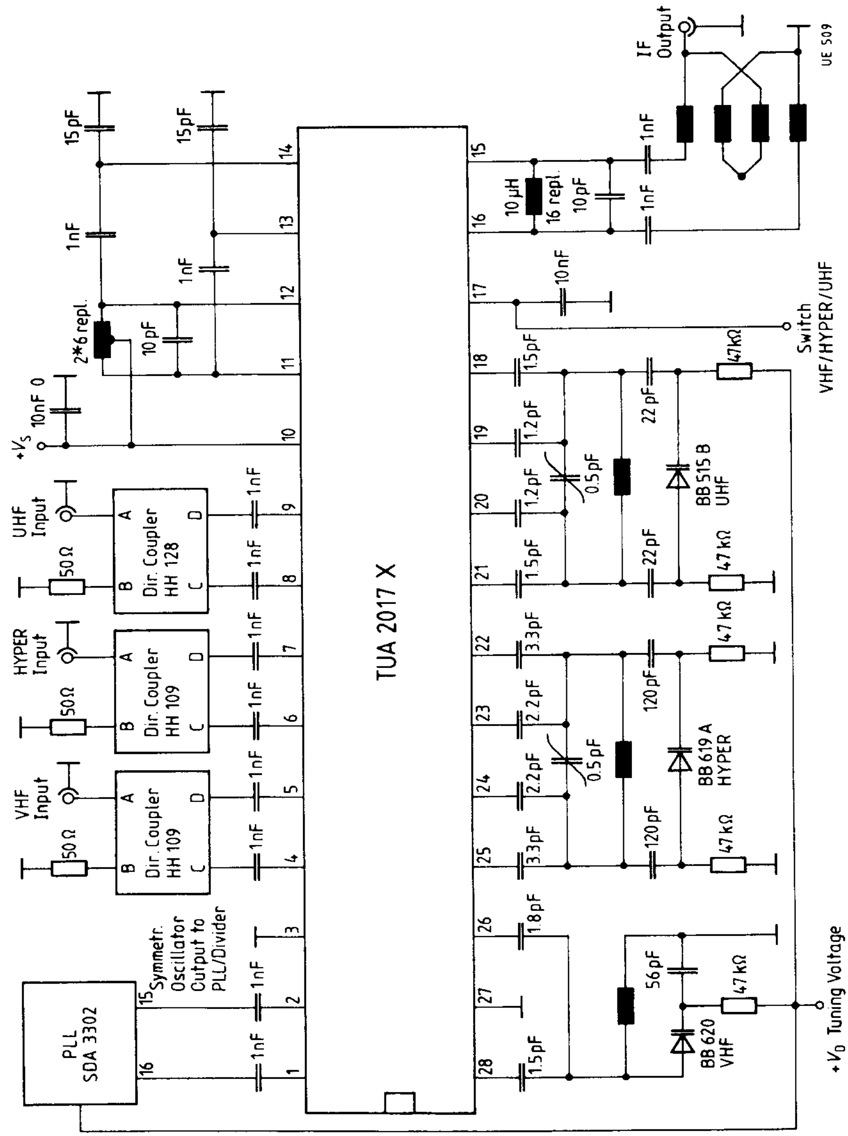
Characteristics (cont'd)
V_S = 12 V; T_A = 25 °C

Parameter	Symbol	Limit Values			Unit	Test Condition	Test Circuit
		min.	typ.	max.			
SAW-Driver Section							
SAW driver Input impedance	$R_{13,14}$ $C_{13,14}$		300 2.5		Ω pF	parallel equivalent circuit	5
SAW driver Output impedance	$R_{15,16}$ $C_{15,16}$		100 2.5		Ω pF	parallel equivalent circuit	6
Transmission gain	G_{SD}		16		dB		8
Noise figure	NF_{SD}		10		dB		8
Output voltage linearity	V_{SDO}		26		dBm	total harmonic distortion factor THD = 5%	7
Permissible input voltage	V_{SDI}		3		dBm	for 1 dB compression at the output	7

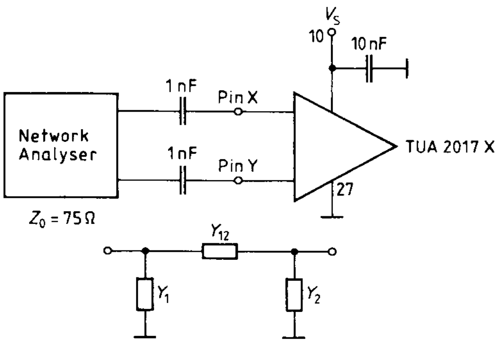
Test Circuit 1



Test Circuit 2



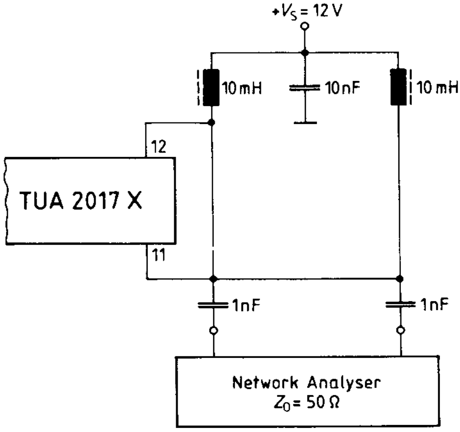
Test Circuit 3



Measurement of the 4-pole matrix S_{11}, S_{12}, S_{21}, S_{22} and calculation of the π-equivalent circuit, which follows from that.

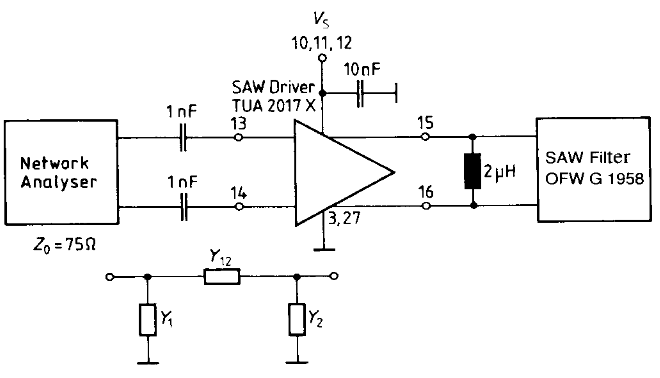
Test Point	Test Frequency in MHz	Pin x	Pin y
Oscillator output impedance	100	1	2
Mixer input impedance VHF	100	4	5
Mixer input impedance HYPER	300	6	7
Mixer input impedance UHF	600	8	9

Test Circuit 4



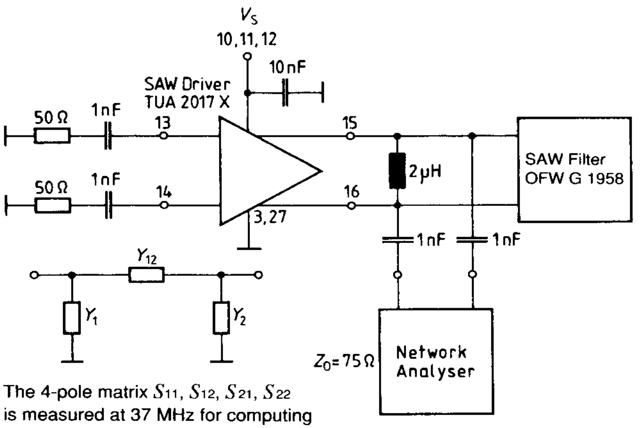
The output capacitance is computed by measuring the 4-pole matrix S_{11}, S_{12}, S_{21}, S_{22} at 37 MHz

Test Circuit 5



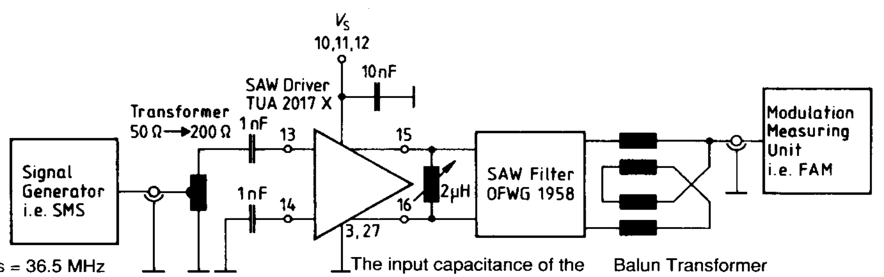
The 4-pole matrix S_{11}, S_{12}, S_{21}, S_{22} is measured at 37 MHz for computing the π-equivalent circuit

Test Circuit 6



The 4-pole matrix S_{11}, S_{12}, S_{21}, S_{22} is measured at 37 MHz for computing the π-equivalent circuit

Test Circuit 7



f_S = 36.5 MHz
f_T = 1 kHz
m_S = 80 %
$THD \leq 0.4$ %
R_a = 50 Ω

The input capacitance of the SAW filter is compensated with this coil

Balun Transformer
200 Ω → 50 Ω

Test Circuit 8