Wireless Components

1-Chip Car Radio

TUA 4307 Version 2.0 (A5)

Specification September 1999

Revision History: Current Version: 09.99

Previous Version:Specification 11.12.1998

Page (in previous Version)	Page (in current Version)	Subjects (major changes since last revision)
19	3-11	Capacitor pin 65 removed (redesign related)
33	5-7	Pos. 22: Limits changed due to incorrect load condition of the tester, no IC change behaviour (No redesign related)
-	5-10	Tests Total audio voltage added (No redesign related)
35	5-8	VCO gain values changed (Redesign related)

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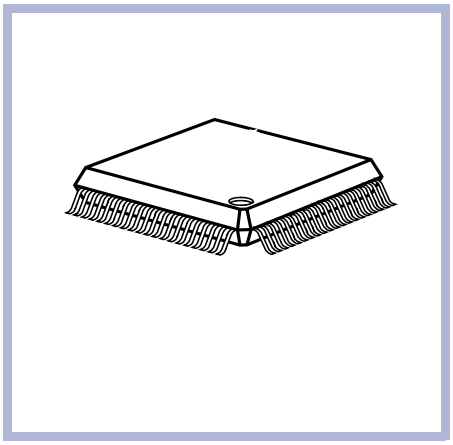
Product Info

General Description

The TUA 4307 is a one chip car radio system consisting of AM/FM receiver, AM-Up/Down conversion, AGC amplifier / demodulator, FM-IF limiter amplifier / demodulator and stereodecoder / noiseblanker.

Package



Features

AM/FM-Receiver

- Only one 2-pin-oscillator for the 1st LO; in AM mode the oscillator frequency is divided
- FM/AM field strength output combined

FM-Mode

- Integrated AGC generation for PIN Diodes and MOSFETs
- High input/output 3rd order interceptpoint

FM-IF Demodulator

- IF counter output with request function pin
- Station detector with S curve criterion and adjustable field-strength threshold (Output combined with AM)

Stereodecoder

- Adjustment free oscillator with ceramic resonator 912 kHz
- Interference noise detector with integrated high-pass filter (IF level signal or MPX input)
- Noise blanking at MPX -demodulator outputs- L, R audio is common to AM Mode

AM Mode

- 2nd mixer with 10.25 MHz crystal oscillator or external force mode for mixing frequency
- Output for AM stereodecoder (CQAM)
- Station detector with adjustable fieldstrength threshold (Output with FM)

Application

- AM/FM car radio receiver with analog/digital STS (search tuning stop)

Ordering Information

Type	Ordering Code	Package
TUA 4307	Q66000-S-T-xxxx	MQFP-80-1

1 Table of Contents

2 Product Description

Contents of this Chapter

2.1 Overview

The TUA 4307 is a one chip car radio system consisting of AM/FM receiver, AM-Up/Down conversion, AGC amplifier / demodulator, FM-IF limiter amplifier / demodulator and stereodecoder / noiseblanker.

2.2 Features

2.2.1 AM/FM-Receiver

- High flexibility with an external preamplifier stage for AM and FM
- Strictly symmetrical RF parts
- Separate mixers for AM and FM mode
- Sym. or asym. mixer inputs
- Only one 2-pin-oscillator for the 1st LO; in AM mode the oscillator frequency is divided
- 1st LO with LC-tank circuit
- 1st LO at 100 MHz range
- 1st LO decoupled counter output
- 1st LO decoupled divided counter output
- Improved low phase noise
- FM/AM field strength output combined

2.2.2 FM-Mode

1. FM-Receiver

In this mode, the receiverpart is comprised of a mixer, an oscillator, a prestage control and an IF post amplification.

- Integrated AGC generation for PIN Diodes and MOSFETs
- High level mixer input
- High input/output 3rd order interceptpoint

2. FM-IF Demodulator

The FM-IF-demodulator has been developed especially for car radio applications.

- 7stage limiter amplifier
- Quadrature demodulator
- IF counter output with request function pin
- Station detector with S curve criterion and adjustable fieldstrength threshold (Output combined with AM)
- Field strength output (combined with AM)
- Soft mute with adjustable mute depth (with full muting typ 80dB)
- Multipath detector with analog output

2.2.3 Stereodecoder

This part provides the stereo decoder function and noise blanking for FM car radio applications.

- Internal reference voltage source
- Adjustment free oscillator with ceramic resonator 912 kHz
- Pilot dependent mono/stereo switching with hysteresis
- Stereo indicator output
- Analog mono/stereo blend control (stereo noise control, SNC)
- Pilot canceller (19 kHz)
- Adjacent channel noise suppression (114 kHz)
- Mute facility
- Analog deemphasis control (high cut control, HCC)
- Interference noise detector with integrated high-pass filter (IF level signal or MPX input)
- MPX-input low-pass filter
- Noise blanking at MPX -demodulator outputs- L, R audio is common to AM Mode

2.2.4 AM Mode

In this mode, the IC is comprised of a mixer, an oscillator with a divider by 4, 6, 8 or 10, a prestage control, 2nd mixer to convert the 1st IF to the 2nd IF, 2nd local force oscillator (buffer for external source), automatic gain controlled amplifier and quasisynchronous demodulator.
The same oscillator is used in AM and FM mode.

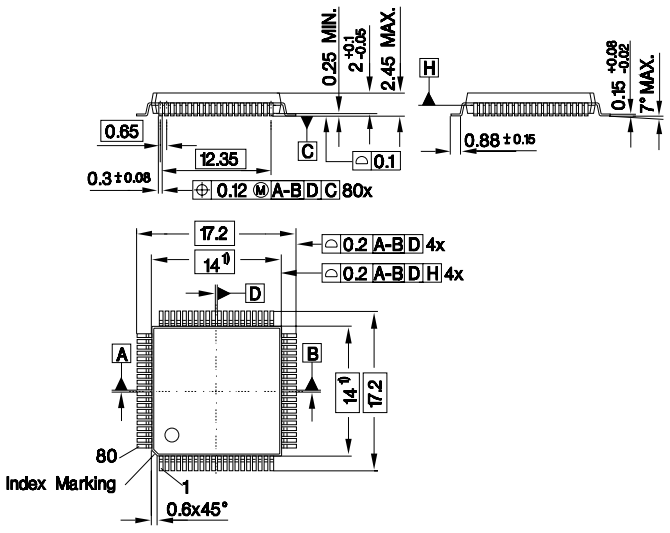
- 2nd mixer with 10.25 MHz crystal oscillator or external force mode for mixing frequency
- Output for AM IF counter
- Output for AM stereodecoder (CQAM)
- Wide range 2nd IF AGC amplifier
- Quasi synchronous demodulator for AM mode
- Station detector with adjustable fieldstrength threshold (Output with FM)
- Fast AM search tuning stop feature
- HCC for AM

2.3 Applications

- AM/FM Car radio receiver with analog/digital STS (search tuning stop)

2.4 Package Outlines

M-QFP-80-1

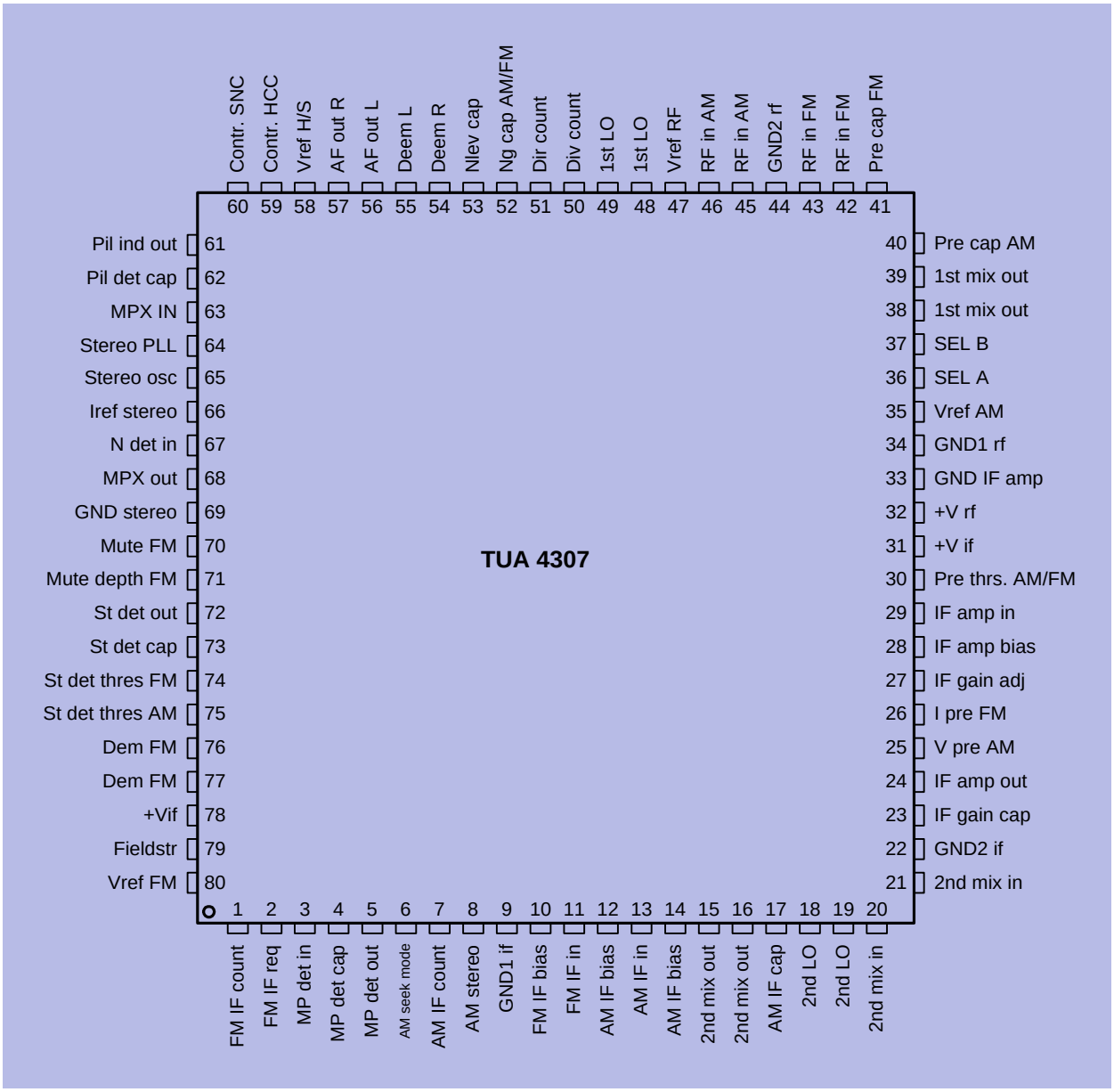


1) Does not include plastic or metal protrusion of 0.25 max. per side

3 Functional Description

Contents of this Chapter

3.1 Pin Configuration

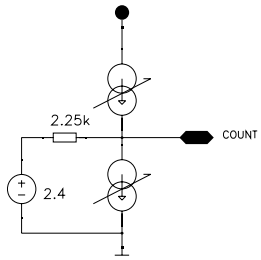
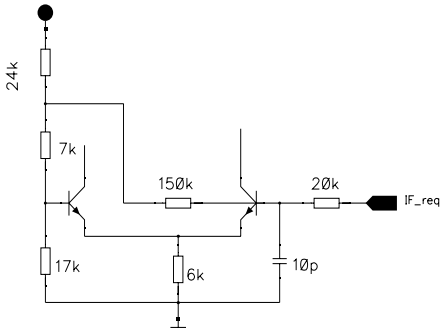
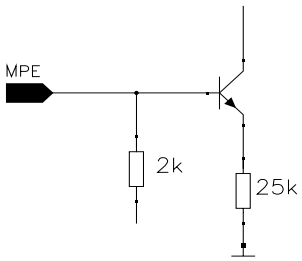
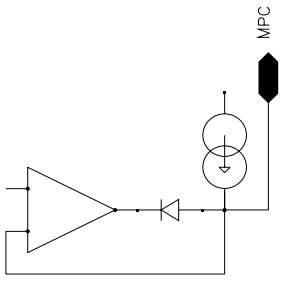


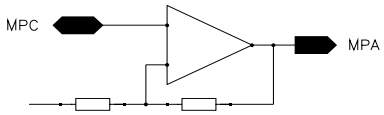
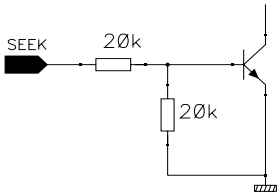
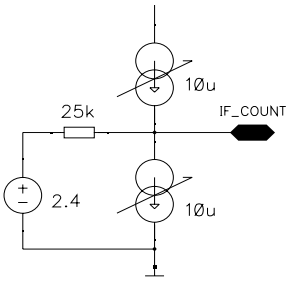
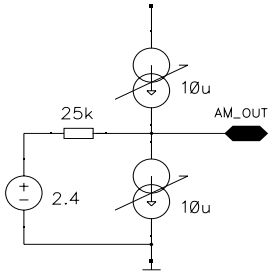
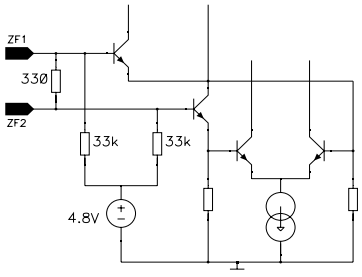
Pin_config.wmf

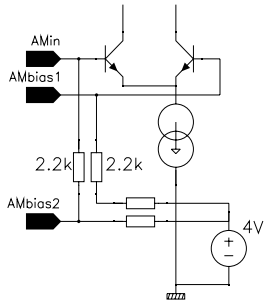
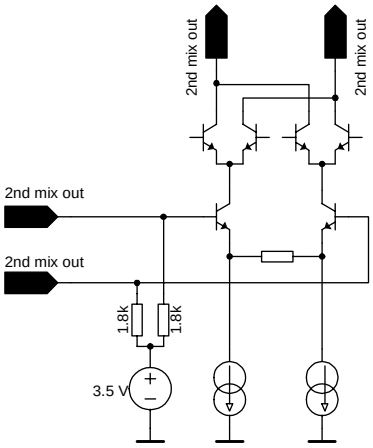
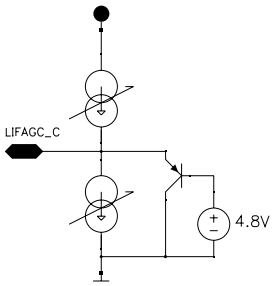
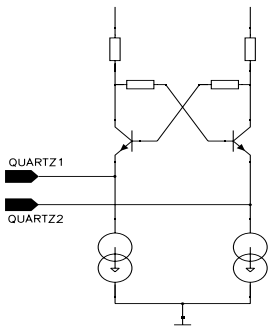
Figure 3-1 Pin Configuration

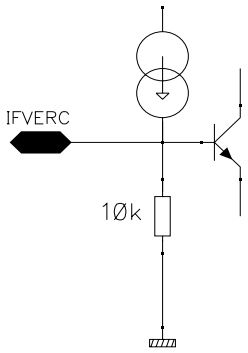
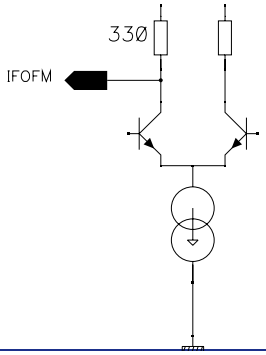
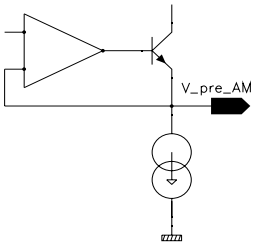
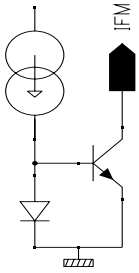
3.2 Pin Definition and Function

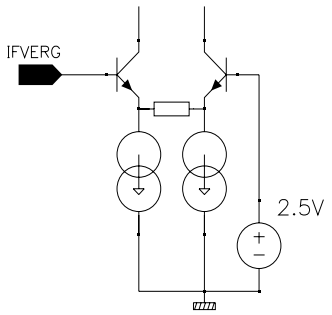
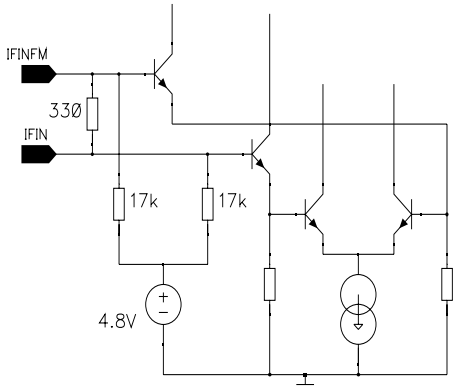
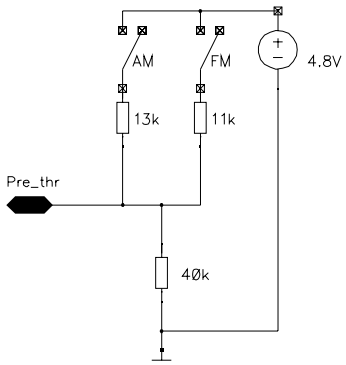
Table 3-1 Pin Definition and Function

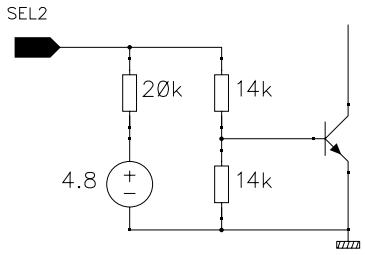
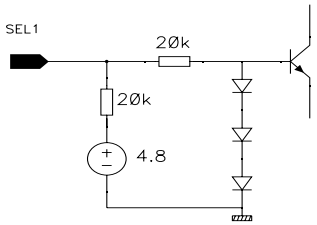
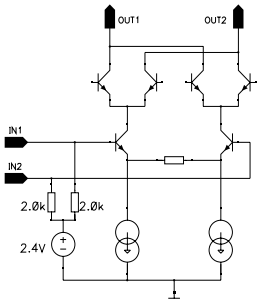
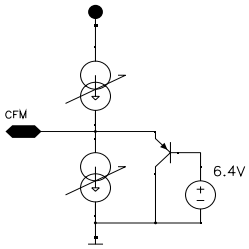
Pin No.	Symbol	Equivalent I/O-Schematic	Function
1	FM IF count		FM IF counter output
2	FM IF req		FM IF counter request
3	MP det in		Auxiliary multipath detector input (in parallel to internal connection)
4	MP det cap		Multipath detector rectifier capacitor

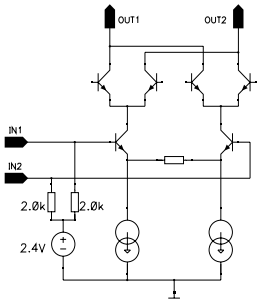
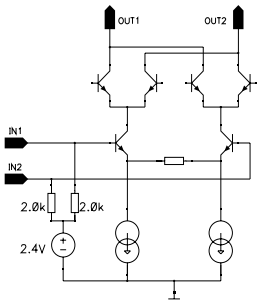
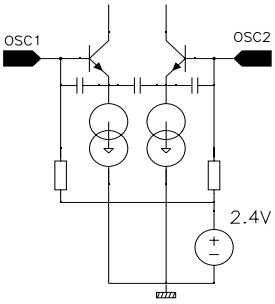
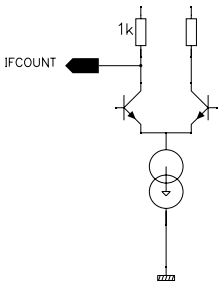
5	MP det out		Analog multipath detector output
6	AM seek mode		AM seek mode switch; AM IF counter on, AM-AGC fast and AF-mute
7	AM IF count		AM-IF counter output for search tuning
8	AM stereo		AM-IF out for AM stereo decoder
9	GND1 IF		Ground 1 AM/FM IF
10 11	FM IF bias FM IF in		FM limiter input bias decoupling capacitor FM limiter input

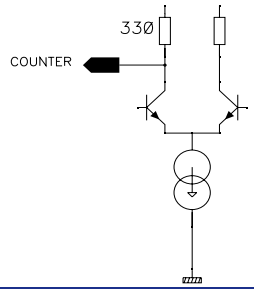
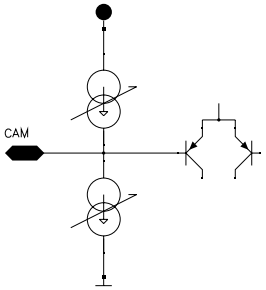
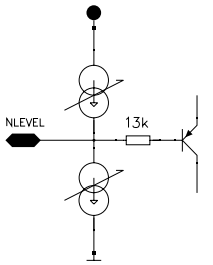
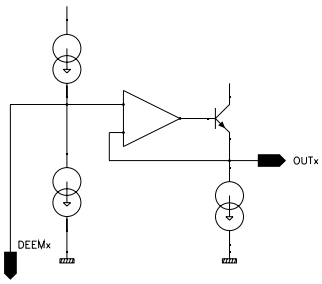
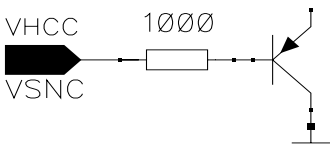
12 13 14	AM IF bias AM IF in AM IF bias		AM AGC amplifier bias decoupling capacitor AM AGC amplifier input AM AGC amplifier bias decoupling capacitor
15 16 20 21	2nd mix out 2nd mix out 2nd mix in 2nd mix in		2nd AM mixer output (open collector) 2nd AM mixer output (open collector) 2nd AM mixer bias decoupling capacitor 2nd AM mixer input
17	AM IF cap		AM AGC amplifier time constant capacitor
18 19	2nd LO 2nd LO		Crystal oscillator input for 2nd mixer Crystal oscillator input for 2nd mixer

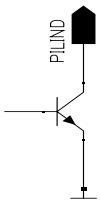
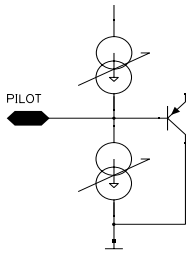
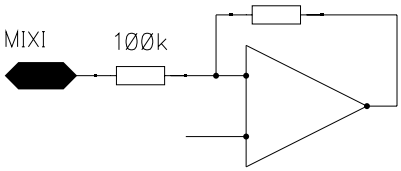
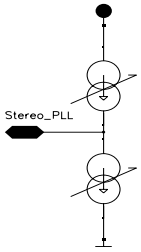
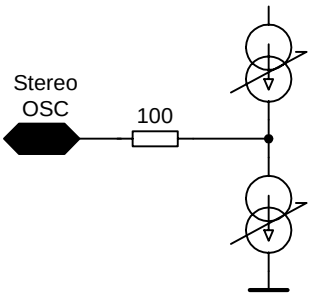
20 21	2nd mix in 2nd mix in	seePIN15/16	2nd AM mixer bias decoupling capacitor 2nd AM mixer input
22	GND2 IF		Ground 2 AM/FM IF
23	IF gain cap		10.7 MHz FM IF amplifier gain adjust blocking capacitor
24	IF amp out		10.7 MHz FM IFamplifier output
25	V pre AM		AM prestage AGC buff-ered voltage output
26	I pre FM		FM prestage AGC current output for PIN diode

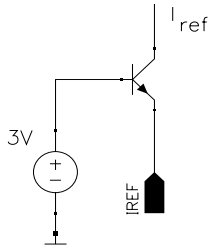
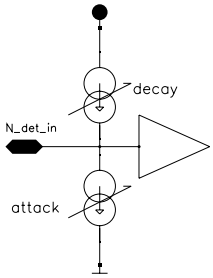
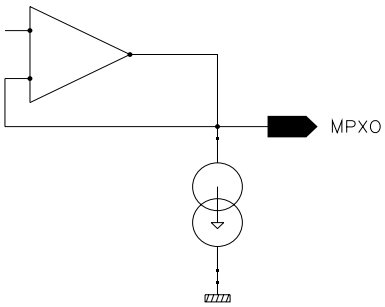
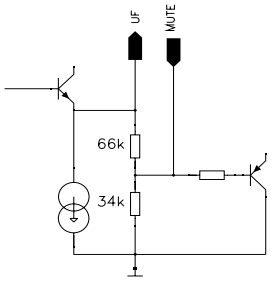
27	IF gain adj		10.7 MHz FM IF amplifier DC controlled gain adjust
28 29	IF amp bias IF amp in		10.7 MHz FM IF amplifier operation point 10.7 MHz FM IF amplifier input
30	Pre thrs. AM/ FM		Prestage AGC threshold voltage AM/FM
31	+V IF		Supply voltage IF AMP
32	+V RF		Supply voltage RF section
33	GND IF		Ground FM IF AMP
34	GND1 RF		Ground 1 RF section
35	Vref AM		Reference voltage AM section (4.8) V

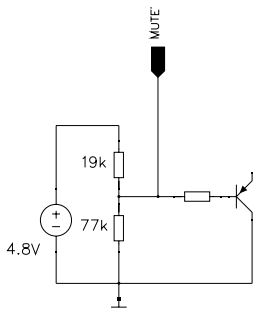
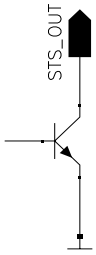
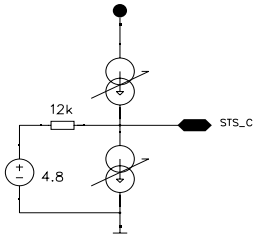
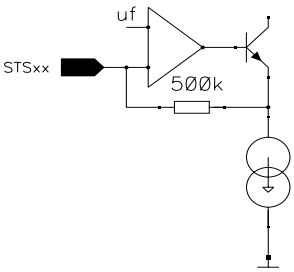
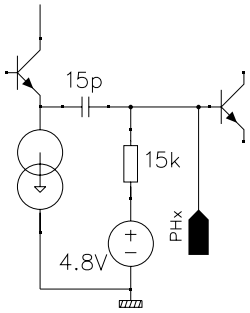
36	SEL A		AM divided counter ratio select A
37	SEL B		AM divided counter ratio select B
38 39	1st mix out 1st mix out		1st mixer output (open collector) 1st mixer output (open collector)
40 41	Pre cap AM Pre cap FM		AM prestage AGC time constant capacitor FM prestage AGC time constant capacitor; output for MOS FET Gate 2

42 43	RF in FM RF in FM		FM 1st mixer symmetrical inputs FM 1st mixer symmetrical inputs
44	GND2 RF		GND 2 RF section
45 46	RF in AM RF in AM		AM 1st mixer symmetrical inputs
47	Vref RF		
48 49	1st LO		1st local AM/FM oscillator circuit
50	Div count		1st local oscillator divided by 4, 6, 8 or 10 counter output (disabled in FM mode)

51	Dir count		1st local oscillator counter output
52	Ng cap AM/FM		Timing capacitor for Noisedetector monoflop (gate time) AM/FM mode control; low voltage activates AM section and disables stereodecoder VCO, Phase detector, Pilot detector, SNC and FM section
53	Nlev cap		Hold capacitor for Noise detector average level low voltage applied mutes the stereo decoder outputs
54 55 56 57	Deem R Deem L AF out L AF out R		HCC timing / hold capacitor, deemphasis righ HCC timing / hold capacitor, deemphasis left AF output left AF output right
58	Vref H/S		Reference voltage SNC / HCC
59 60	Contr. HCC Contr. SNC		Control voltage HCC (high cut control) Control voltage SNC (stereo noise control), external decreasing of stereo separation possible

61	Pil ind out		Pilot indicator output, active high (open collector)
62	Pil det cap		Pilot detector capacitor, low voltage activates mono state
63	MPX in		Stereo decoder MPX signal input
64	Stereo PLL		Stereo decoder PLL phasedetector, loop filter
65	Stereo osc		VCO pin for ceramic resonator

66	Iref stereo		Reference current pin, external reference resistor
67	N det in		Noise detector input
68	MPX out		FM MPX signal and AM demodulator signal output
69	GND stereo		Ground stereodecoder
70 79	Mute FM Fieldstr out		Dynamic FM mute control blocking capacitor

71	Mute Depth		Adjustment mute depth FM mute
72	St det out		AM/FM Station detector output
73	St det cap		FM Station detector capacitor
74 75	St det thresh		FM station detector threshold AM station detector threshold
76 77	Dem FM		Demodulator circuit FM

78	+Vif		Supply voltage IF and stereodecoder section
79	Fieldstr out	see PIN 70	AM/FM fieldstrength combined output
80	Vref FM		Reference voltage FM section (4.8 V)

3.3 Circuit Description

3.3.1 AM/FM-Receiver

The AM/FM-receiver part includes a 2-pin varactor tuned oscillator. In the FM mode the direct oscillator frequency is fed into the double balanced FM mixer, in the AM mode the divided by 4, 6, 8 or 10 oscillator frequency is fed into the AM mixer.

The two separate symmetrical input stages of the IC, one optimized for FM-, the other for AM- mode allow symmetrical and unsymmetrical prestage configuration.

The AM and FM input frequencies are converted to a fix 1st IF in the 10.7 MHz range. The FM-IF is post amplified in a separate IF amplifier with DC adjustable gain, the AM-IF is fed directly to the 2nd mixer.

The TUA 4307 has been designed to work with a PLL in the 100MHz range in both modes or in the AM- mode with the divided frequency.
Depending on the input signal strength, the integrated AGC stage for prestage control drives PIN-Diodes as well as MOSFETs.

3.3.2 FM-MODE

FM-IF Demodulator
The FM-IF amplifier includes a 7 stage capacitive coupled limiter amplifier with coincidence demodulator and AF output. The AF output signal can be continuously attenuated to decrease the noise.
There is a field strength output (with min. 76 dB dynamic range, typ. ±1 dB nonlinearity and typ. ±3 dB temperature drift) and a soft mute function with adjustable mute depth (with full muting typ 80 dB).
An IF counter output with request function and a station detector with S curve criterion and adjustable fieldstrength threshold are available
A multipath detector with analog output is available. Its input signal is fed from the high pass filter of the stereo-decoder/noiseblanker and a second 80 kHz 1-pole high pass filter.

3.3.3 Stereodecoder

Power supply, reference current:
A temperature-stable, low noise reference voltage generator is used for better ripple rejection and to generate a reference current. This current is used as a time base for the deemphasis, the gate time of the pulse former, and the pilot cancellation, avoiding temperature and tolerance effects.

MPX input, MPX filter:
A 4-pole low-pass filter determines the bandwidth of the MPX signal.

Voltage Controlled Oscillator, Phase Detector:
The 912kHz oscillator and the frequency dividers are used as walsh function generators (suppression of 3rd order harmonics) for:
38 kHz for the stereo decoder
19 kHz inphase for phase detector and pilot cancellation
19 kHz quadrature for the phase detector.

The phase detector locks the on chip 19 kHz signal to the pilot tone in the MPX signal at 90 deg phase.

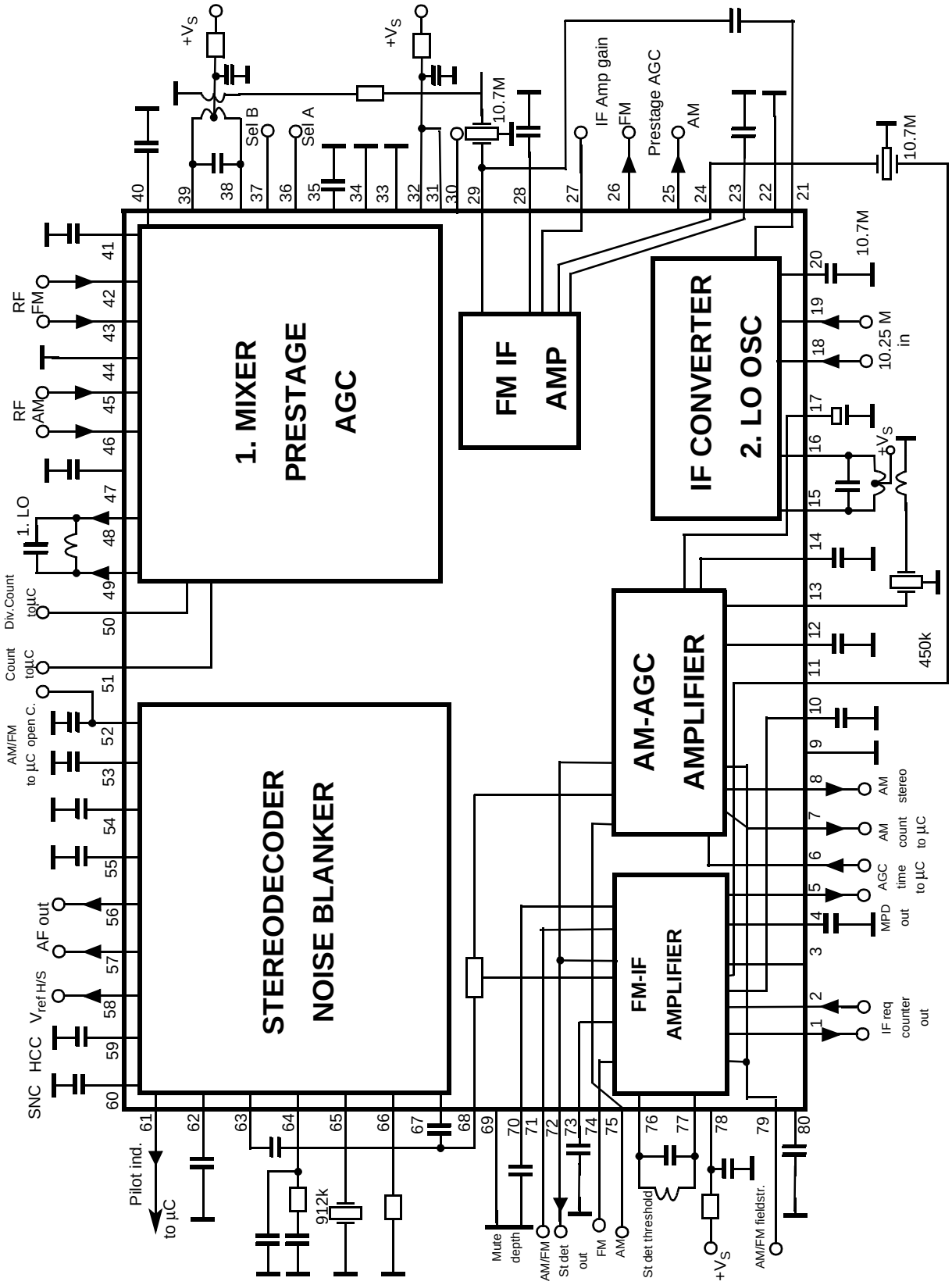
Pilot Detector, Pilot Indicator, Pilot Cancellation:
The voltage at the pilot detector output is proportional to the pilot tone input level. If that level is high enough, the pilot indicator output is activated and the pilot cancellation turned on: a 19 kHz signal proportional to the voltage at the pilot detector output is added to the MPX signal with inverse polarity, cancelling the 19 kHz pilot tone.

Interference Detector , Noise Detector, Pulse Former:
The signal from the interference input (MPX or field strength signal) passes a 4-pole high-pass filter to the noise blanking circuitry. The average noise level is stored in an external capacitor. The interference detector compares the actual noise level with that stored on the capacitor and triggers the pulse former if there is a significant difference. The pulse former generates a gate pulse for the HCC block. During that pulse time the outputs of the deemphasis circuit are switched to hold mode.

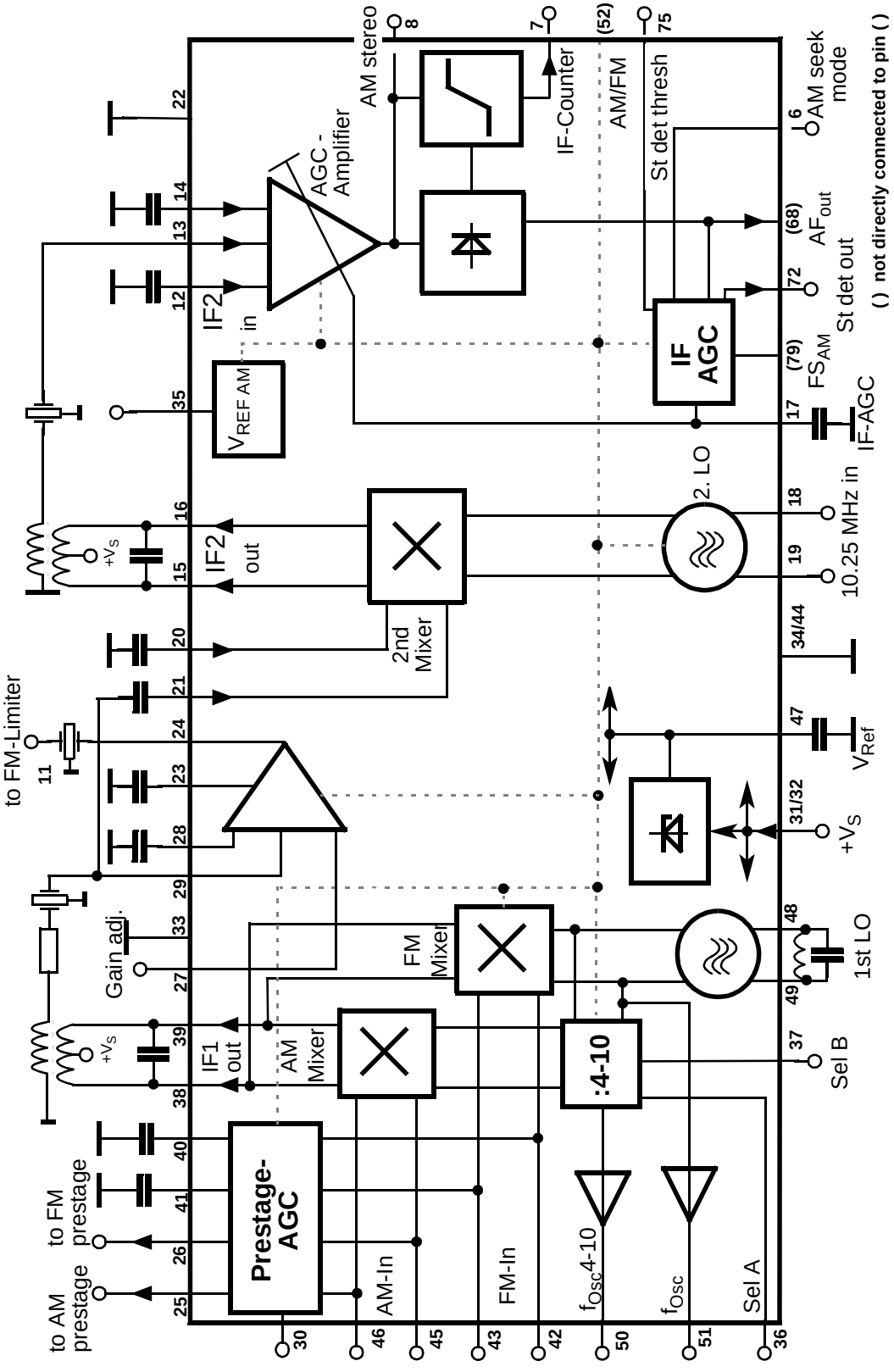
3.3.4 AM - MODE

In the AM mode the 1st IF is converted by the 2nd mixer into the 2nd IF in the 450 kHz range. Therefore a 2nd LO crystal oscillator, which can be also used as force input is part of the IC. The 2nd IF signal passes an automatic gain controlled IF amplifier and is then demodulated to the AF in a quasisynchronous demodulator. Switching to seek mode, the AGC time constant is reduced by a factor of 5, the AM IF counter output is switched on and the AF is muted. The AGC voltage is used as AM field strength and is fed to the combined field strength output. The fieldstrength voltage is also used for an station detector with adjustable threshold. The output is combined with the FM station detector. An output for an AM stereodecoder (CQAM) is also available (450 kHz AGC amp output).

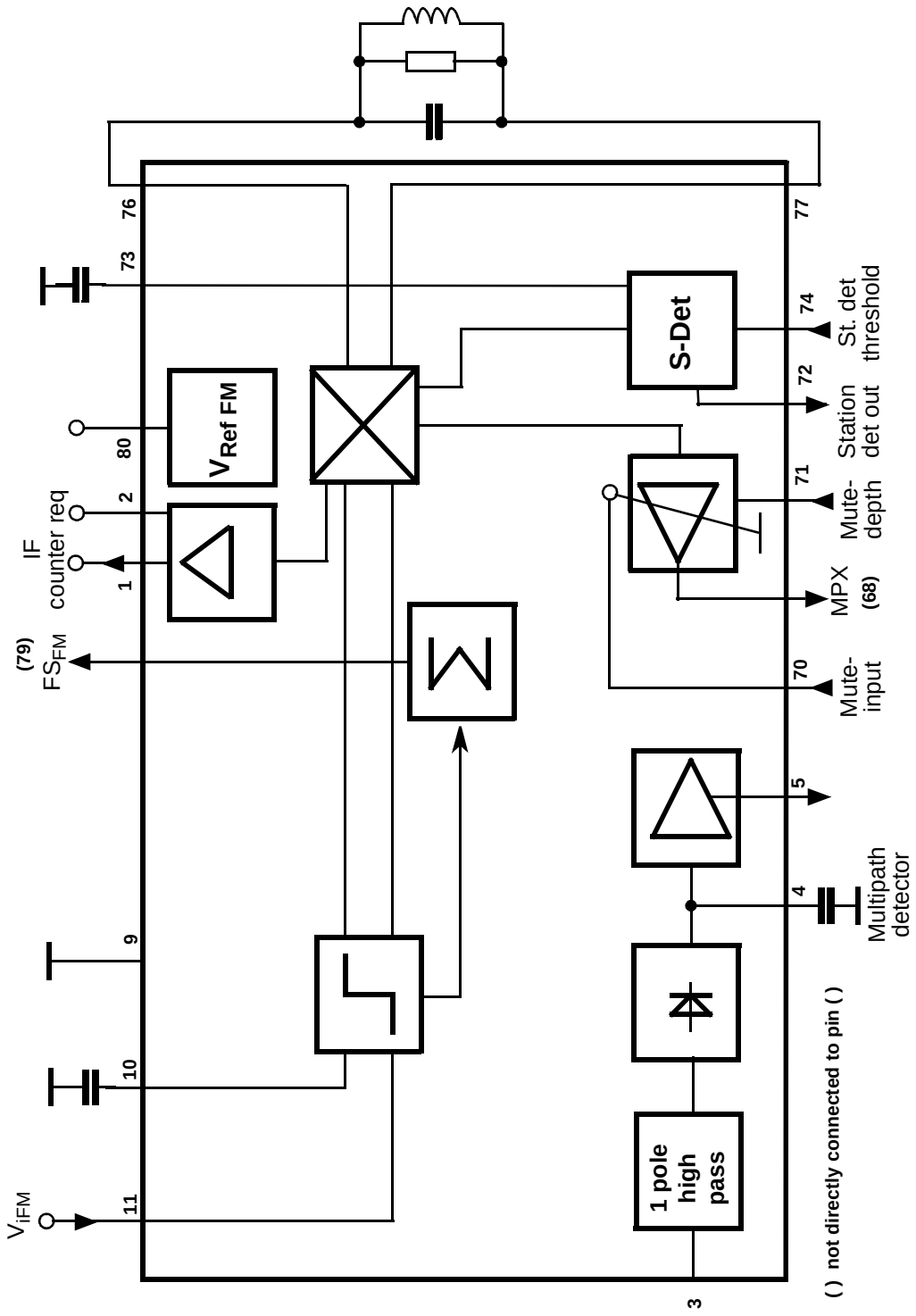
3.4 Blockdiagram 1



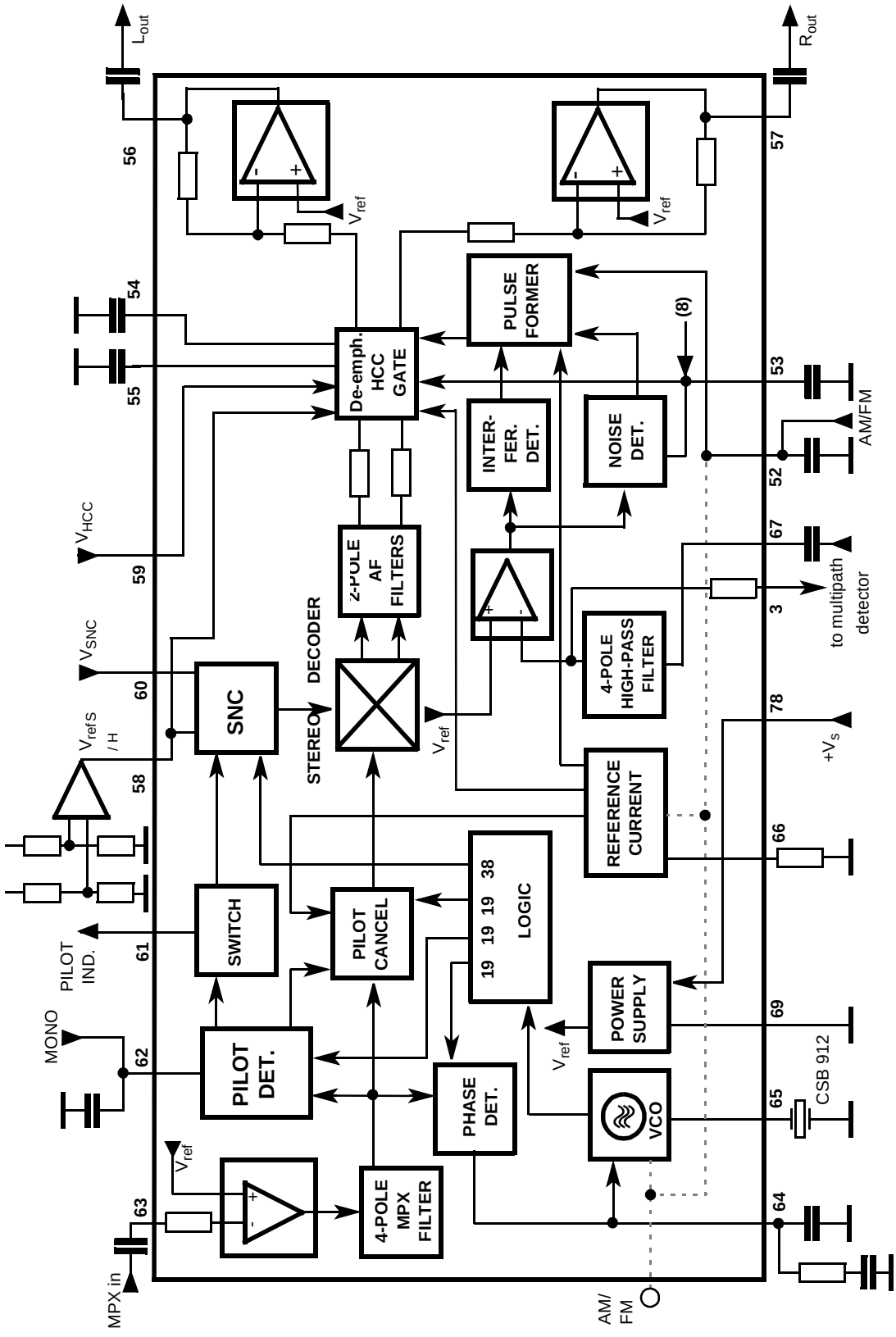
3.5 Blockdiagram 2



3.6 Blockdiagram 3



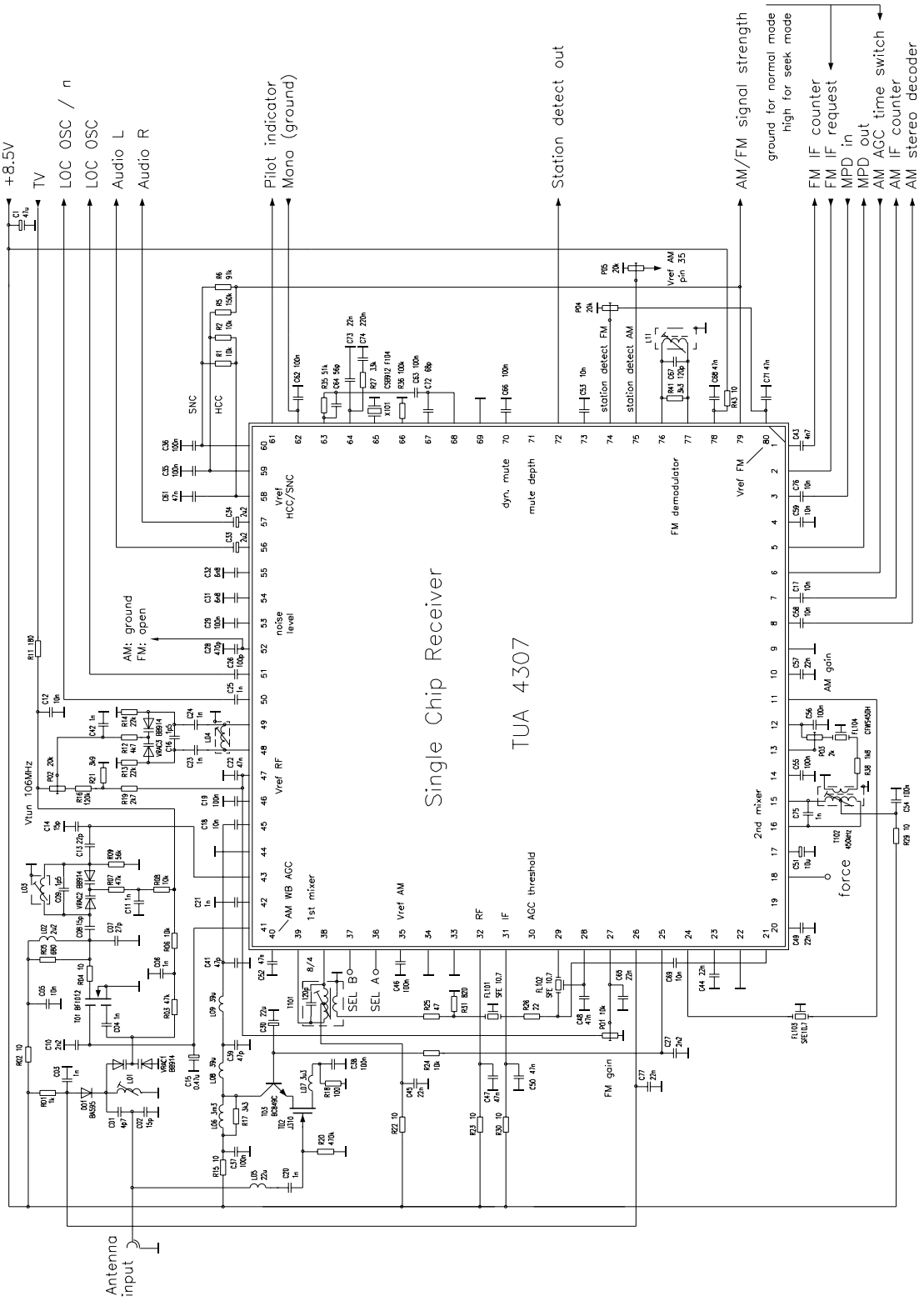
3.7 Blockdiagram 4



4 Applications

Contents of this Chapter

4.1 Application Circuit



4.2 Hints

See separate available **Application Note TUA 4307**.

5 Reference

Contents of this Chapter

5.1 Electrical Data

5.1.1 Absolute Maximum Ratings

WARNING

The maximum ratings may not be exceeded under any circumstances, not even momentarily and individually, as permanent damage to the IC will result.

Table 5-1 Absolute Maximum Ratings, Ambient temperature T_{AMB}=-40°C ... + 85°C

Parameter	Symbol	Limit Values		Unit	Remarks
		min	max		
Junction temperature	T_J	-40	150	°C	
Storage temperature	T_S	-40	125	°C	
Thermal resistance	R_{thSA}		54	K/W	
ESD-voltage, HBM	V_{ESD}	-4	+4	kV	100pF, 1500 Ω

5.1.2 Operating Range

Within the operating range the IC operates as described in the circuit description. The AC / DC characteristic limits are not guaranteed.

Table 5-2 Operating Range

Parameter	Symbol	Limit Values		Unit	Test Conditions	L	Item
		min	max				
Supply voltage	V_S	8	9	V			
Ambient temperature	T_A	-40	85	°C			

5.1.3 AC/DC Characteristics

AC / DC characteristics involve the spread of values guaranteed within the specified supply voltage and ambient temperature range. Typical characteristics are the median of the production.

Table 5-3 AC/DC Characteristics with T_{amb} 25 °C, V_s = 8.5 V

Parameter	Symbol	Limit Values			Unit	Test Conditions	L	Item
		min	typ	max				
Current consumption	I_{SFM}	90	105	125	mA	FM mode	1	1
	I_{SAM}	65	90	105	mA	AM mode	1	
1. AM/FM - Receiver								
1st LO								
Frequency range	$f_{1st\ LO}$	80		140	MHz		1	1
Frequency range	$f_{1st\ LO}$	50		150	MHz	$Q_{factor\ of\ coil}$ >90	■	2
Counter output	V_{51}	70	100		mV_{rms}	R_{L51}=330Ω; Ref. Appl. board	1	3
Divided counter output	V_{50}	28	40		mV_{rms}	R_{L50}=330Ω; Ref. Appl. board	1	4
Divided counter output	V_{50}		150		mV_{rms}	R_{L50}=10kΩ; Ref. Appl. board	■	4a
Output impedance	R_{50}	0.8	1	1.2	kΩ		■	5
Output impedance	R_{51}	240	300	360	Ω		■	6
Frequency	$f_{1st\ LO}$	10			MHz	V_{tuning}=0V	1	7
Reference voltage RF	V_{47}	4.5	4.8	5.1	V		1	8
Output Current	I_{47}			1	mA		1	9
10.7 MHz IF amplifier fIF1= 10.7 MHz								
DC input voltage	V_{29}	3.5	3.9	4.3	V		1	10
Input resistance	R_{29}	270	330	390	Ω	AM	1	11
Output resistance	R_{24}	270	330	390	Ω		1	12
Max. voltage gain	A_{29-24}	23	26	29	dB	V_{27}=1.5V	1	13
Min. voltage gain	A_{29-24}	13	16	19	dB	V_{27}=3.5V	1	14
Noise figure	F_{FM}		7		dB	RG=330Ω	■	15

Table 5-3 AC/DC Characteristics with T_{amb} 25 °C, V_S = 8.5 V (continued)

Parameter	Symbol	Limit Values			Unit	Test Conditions	L	Item
		min	typ	max				
AM mode f_{IF1}= 10.7 MHz; f_{IF2}= 450kHz; f_{45-46}= 1 MHz; V_{52}=1V								
Mixer 1								
Interceptpoint 3rd order	I_{P3}		134		dBµV	Special testcircuit necessary	■	1
Mixer gain	A_{M1}	2	6	10	dB	$V_{45,46}$=80mVrms (RL=330Ω)	1	2
RF/IF gain (mix1 + mix2)	$A_{RF/IF}$	12	16	20	dB		calc	3
Max. input voltage	V_{45-46}	1100	1400		mVpp	SINAD> 34dB;m=80%	1	4
Noise figure (10 MHz)	F		7		dB	Rg opt=700Ω	■	5
Input impedance	R_{45-46}	3.2	4	4.8	kΩ	sym.	■	6
Input impedance	C_{45-46}	1.6	2	2.4	pF	sym.	■	7
Input impedance	R_{45-46}	1.6	2	2.4	kΩ	asym.	■	8
Input impedance	C_{45-46}	3.2	4	4.8	pF	asym.	■	9
Divider select low	$V_{36,37L}$	0		1.3	V		1	10
Divider select high	$V_{36,37H}$	3.0		V_S	V		1	11
Prestage AGC output								
AGC-voltage AM	V_{25}	6.5	7.5		V	$V_{45,46}$ =50mV_{rms}	1	12
AGC-voltage AM	V_{25}	0		0.5	V	$V_{45,46}$ =200mV_{rms}	1	13
AGC-voltage FM	V_{41}	0		0.15	V	$V_{45,46}$=50mV_{rms}	1	14
AGC-current FM	I_{26}	0		0.1	mA	$V_{45,46}$=50mV_{rms}	1	15
Integrator Current	I_{40*}	-12	-25	-45	µA	$V_{45,46}$=50mV_{rms} Vm=3V	1	16
Integrator Current	I_{40*}	+10	+25	+40	µA	$V_{45,46}$=150mV_{rms} Vm=3V	1	17
Integrator Current	I_{40*}	-17	-35	-55	µA	$V_{45,46}$=0mV_{rms} Vm=3V	1	18
Integrator Current	I_{40*}	+50	+70	+90	µA	$V_{45,46}$=400mV_{rms} Vm=3V	1	19
Prestage AGC threshold volt.	V_{30AM}		3.4		V		1	20

Table 5-3 AC/DC Characteristics with T_{amb} 25 °C, V_S = 8.5 V (continued)

Parameter	Symbol	Limit Values			Unit	Test Conditions	L	Item
		min	typ	max				
2nd AM IF section Mixer 2								
Mixer gain	A_{M2}	7	10	13	dB	V_{21} =1mV; $V_{out}=V_{IF450}$ f_{21}=10.7 MHz; $f_{18/19}$=10.25 MHz	1	1
Noise figure	F		10		dB		■	2
Max Input Voltage	V_{20-21}		1400		mV_{pp}	SINAD> 34dB;m=80%	1	3
Input impedance	R_{20-21}		1.8		kΩ		■	4
2nd LO								
Operational frequency	f_{18-19}	10	10.25	25	MHz		■	5
External force voltage	V_{18}	60			mV_{rms}	Rg=600Ω; Ck= 100pF	1	6
Input Imp. Crystal Osc	Z_{18-19}	-500	-600	-400	Ω		■	7
Crystal Resistance	R_{C1}			100	Ω	P_{TOTC}=50µW Fundamental	■	8
Spurious Harmonics Crystal	a_{SP}	-20			dB	P_{TOTC}=50µW f < 30 MHz	■	9

FM mode

f_{IF}=10.7 MHz; f_{42-43}=100 MHz; V_{52}=open

Mixer 1								
Interceptpoint 3rd order	I_{P3}		125		dB µV	special testcircuit necessary	■	1
Noise figure (10 MHz)	F		6		dB	Rg opt=500Ω	■	2
Mixer gain	A_{M1}	5	9	12	dB	V_{42-43}=10mV_{rms}; RL=330Ω	1	3
RF/IF gain (mixer1 + IFamp)	A_{M1}	31	35	39	dB	V_{27}=1.5V	calc	4
Input impedance	R_{42-43}	3.2	4	4.8	kΩ	sym.	■	5
Input impedance	C_{42-43}	1.6	2	2.4	pF	sym.	■	6
Input impedance	R_{42-43}	1.6	2	2.4	kΩ	asym.	■	7
Input impedance	C_{42-43}	3.2	4	4.8	pF	asym.	■	8
Prestage AGC output								
AGC voltage FM	V_{41}	5.6	6.4	7.2	V	$V_{42,43}$=0mV_{rms}	1	9
AGC voltage FM	V_{41}	0		0.1	V	$V_{42,43}$=50mV_{rms}	1	10
AGC current FM	I_{26}	9.5	12	14.5	mA	$V_{42,43}$=0 mV_{rms} Vm=0.7V	1	11

Table 5-3 AC/DC Characteristics with T_{amb} 25 °C, V_S = 8.5 V (continued)

Parameter	Symbol	Limit Values			Unit	Test Conditions	L	Item
		min	typ	max				
AGC current FM	I_{26}	0		0.1	mA	$V_{42,43}$=50mV$_{rms}$ Vm=0.7V	1	12
AGC voltage AM	V_{25}	0		0.5	V	$V_{42,43}$=0	1	13
AGC voltage AM integrator	V_{40}		6	7.5	V	$V_{42,43}$=0	1	14
Integrator Current	I_{41}*	- 12	- 25	- 46	µA	$V_{42,43}$=0 Vm=4.8V	1	15
Integrator Current	I_{41}*	+15	+30	+50	µA	$V_{42,43}$=60mV$_{rms}$ Vm=4.8V	1	16
Integrator Current	I_{41}*	+50	+70	+90	µA	V42,43=150mV$_{rms}$ Vm=4.8V	1	17
Prestage AGC threshold volt.	V_{30FM}		3.6		V		1	18

*) Integrator currents are measured between the output pin (- Pole of the measurement equipment) and a voltage source V_m (+ Pole)

2.FM Demodulator

Measuring condition:

f_{IIF}=10.7 MHz; Δf= ±75 kHz; f_{mod}= 1 kHz;V_{11} =10 mV$_{rms}$; V_{52}=open; Deemphasis= 100 µs

Fieldstrength dynamic range	V_{79}	66	72		dB	see Diagram D1	1	
Fieldstrength nonlinearity	V_{79}		±1		dB	see Diagram D2	1	
Fieldstrength temperature drift	V_{79}			±3	dB	see Diagram D3	1	
Fieldstrength load capacitance				50	pF		■	
Fieldstrength load resistance		1			kΩ		■	
Fieldstrength voltage	V_{79}	4	4.6	5.2	V	V_{11}=200mV$_{rms}$	1	
Fieldstrength voltage	V_{79}	1.5	1.9	2.3	V	V_{11}=1mV$_{rms}$	1	
Fieldstrength voltage	V_{79}	0		1	V	V_{11}=0mV$_{rms}$	1	
AF-output voltage	V_{68}	450	550	650	mV$_{rms}$	R_L>10kΩ; Deemph.=100 µs	1	2
AF-output voltage	V_{68}		650		mV$_{rms}$	R_L>10kΩ; no Deemph.	■	3
Input voltage for limiter threshold	V_{11}		33	45	µV$_{rms}$	V_{68}=V_{68} - 3dB	1	4
Total harmonic distortion	THD_{68}		0.4	0.8	%		1	5
AM-suppression	a_{AM}	70	80		dB	m=30 %	1	6
Signal-to-noise ratio	$a_{S/N}$	72	80		dB		1	7
AF mute	a_{AF}	14	17	20	dB	V_{70}=0; V_{71}=open	1	8

Table 5-3 AC/DC Characteristics with T_{amb} 25 °C, V_S = 8.5 V (continued)

Parameter	Symbol	Limit Values			Unit	Test Conditions	L	Item
		min	typ	max				
IF counter output voltage	V_1	70	100		mV_{rms}	R_L = 100kΩ; Ref. Appl. board	1	9
IF counter output disable	V_2			0.5	V		1	10
Station detector stop window	f_{St72}		±30		kHz		1	11
Station detector non stop	V_{72}			0.5	V	V_{74}=2.4V; V_{11}=1mV_{rms}	1	12
Station detector stop	V_{72}	3			V	V_{74}=1.4V; V_{11}=1mV_{rms}	1	13
Station det. inside window	I_{72}			10	µA		1	14
Station det. outside window	V_{72}			0.5	V	I_{72}=1mA	1	15
Reference Voltage FM	V_{80}	4.5V	4.9	5.3	V		1	16
Output Current	I_{80}			1	mA		1	17
Multipath detector, f_{67}=200 kHz								
Attack current	I_4*)	600	800	1070	µA	V_{67AC}=1V_{pp} , V_m=5.0 V	1	18
Recovery current	I_4*)	- 6	- 9	-12	µA	V_{67AC}=0; V_m=3.6V	1	19
Start voltage	V_{5Def}	4.4	4.7		V	V_{67AC}=0V	1	20
Detector characteristic	V_5	$V_{5Def0.14V}$	$V_{5Def-0.1V}$	V_{5Def}	V	f_{67}=25kHz; V_{67}=160mV_{pp}	1	21
Detector characteristic	V_5	V_{5Def} -3.3	V_{5Def} -2.8	V_{5Def} -2.3	V	f_{67}=200kHz; V_{67}=160mV_{pp}	1	22

*) Integrator currents are measured between the output pin (- Pole of the measurement equipment) and a voltage source V_m (+ Pole)

3.Stereodecoder

Measuring condition: V_{63}=600mV_{rms}; f=1 kHz; 15kHz LP with 19kHz Notch

Total harmonic distortion	$THD_{56,57}$		0.1	0.3	%	f= 1 kHz	1	1
Signal to noise ratio	$S/N_{56,57}$	65	75		dB	Stereo	1	2
Channel separation	a_{Sep}	28	40		dB		1	3
AF output voltage	$V_{56,57}$	650	780	900	mV_{rms}	Stereo;Mono	1	4
Overdrive margin	$V_{56,57\ max}$		2		dB	THD= 1%	1	5
AF output DC voltage	$V_{DC\ 56,57}$	2.5	3	3.5	V		1	6
Difference of output voltage levels	$\Delta V_{56,57}$			2	dB		1	7
Muting depth	$A_{56,57}$	70	75		dB	V_{53}=0	1	8

Table 5-3 AC/DC Characteristics with T_{amb} 25 °C, V_S = 8.5 V (continued)

Parameter	Symbol	Limit Values			Unit	Test Conditions	L	Item
		min	typ	max				
Muting depth	$A_{56,57}$	70	75		dB	V_6=2.4V	1	9
DC-offset at mute	$\Delta_{DC\ 56,57}$	-100	0	100	mV		1	10
DC-offset stereo on/off	$\Delta_{DC\ 56,57}$	-100	0	100	mV		1	11
Carrier and harmonic suppression (referenced to $V_{56,57}$=780 mV_{rms})								
Pilotsignal (f=19kHz) subcarrier	α_{19}	40	45		dB		1	1
(f=38kHz)	α_{38}	40	50		dB		1	2
(f=57kHz)	α_{57}	40	50		dB		1	3
Mono/Stereo control Pilot threshold voltage:								
For stereo"on"	V_{PILon}		20	30	mV_{rms}		1	1
For stereo"off"	V_{PILoff}	5	14		mV_{rms}		1	2
Hysteresis			3		dB	V_{PILon} / V_{PILoff}	■	3
Stereo-indicator output								
Pilot off	V_{61off}			0.5	V	I_{61}=1mA		4
Pilot on	I_{61on}			10	µA			5
external control voltages (active low)								
Operational voltage for external, mono control (pin 62)	$V_{64\ thr}$			1	V		1	6
Operational voltage for AM/FM (pin 52)	V_{52thr}			1	V	AM on	1	7
Deemphasis Reference frequency = 400Hz; C_{deemph}=10nF; τ_{nom}=75 µs								
Minimum FM	$A_{min\ FM}$	5	7	9	dB	V_{59}≥3.8V; f_m=5kHz	1	8
Maximum FM	$A_{max\ FM}$	12	15	18	dB	V_{59}=1.5 V; f_m=5kHz	1	9
Minimum AM	$A_{min\ AM}$	5	7	9	dB	V_{59}≥3.4V; f_m=5kHz	1	10
Maximum AM	$A_{max\ AM}$	12	15	18	dB	V_{59}=1.5V; f_m=5kHz	1	11
Stereo/Mono blend control :								
Channel separation	a_{Sep}	28			dB	V_{60}=3.8V	1	1
Channel separation	a_{Sep}			3	dB	V_{60}=3.3V	1	2
Oscillator								
Max. Osc. frequency	f_{oscmax}	0.7	1.0	2.0	%	100 % x (f_{max} /912kHz-1)	1	3
Min. Osc. frequency	f_{oscmin}	-2.0	-1.0	-0.7	%	100 % x (f_{max} /912kHz-1)	1	4
VCO-gain		-41	-32	-21	kHz/V	$\Delta f/\Delta V_{62}$	1	5
Oscillator voltage		2.5	4	5.5	V	$V_{65\ DC}$	■	6
Oscillator swing		250	350	450	mV_{rms}	$V_{65\ AC}$	1	7

Table 5-3 AC/DC Characteristics with T_{amb} 25 °C, V_S = 8.5 V (continued)

Parameter	Symbol	Limit Values			Unit	Test Conditions	L	Item
		min	typ	max				
PLL								
PD-gain	$\Delta i/\Delta\phi$	6.0	8.2	10.2	µA/rad	V_{pilot} = 54 mV_{rms}	1)	8
Noise detector								
Input resistance	R_{67}	80	99	120	kΩ		■	9
Input high-pass filter	f_{in67}	80	100	120	kHz	-3dB	■	10
Trigger threshold	$V_{67\ min}$		30	50	mV_{rms}	$V_{53} = V_{53}$ ($V_{67\ mean}$=0), f_{67}=200 kHz	1	11
Trigger threshold	$V_{67\ dyn}$	130	170	210	mV_{rms}	$V_{543}=V_{543}$($V_{67\ mean}$=50mV_{rms}), f_{67}=200 kHz	1	12
Maximum noise mean value *	$V_{67maxmean}$	65	80	115	mV_{rms}	f_{67}=200 kHz	1	13
Suppression pulse duration		34	40	46	µs		1	14
Input offset current	$I_{54,55}$	-50	0	50	nA		■	15
Attack current	I_{53att}		135		µA	V_{53}=5.5V	■	16
Recovery current	I_{53rec}		20		µA	V_{53}=4V	■	17

*) The trigger threshold is adapted to the input noise. IF max. noise mean value is exceeded, threshold is too high for any trigger of the noise blanker

4.AM Mode
AGC-Amplifier
Measuring condition: f_{iF}= 450 kHz; f_{mod} = 1 kHz; V_{13}= 10mV_{rms} , Deemphasis=100 µs

AGC-range	ΔA	60	66		dB	$V_{68}=V_{68AM}$ ±3dB	1	1
Input sensitivity	V_{13}		100		μV_{rms}	$V_{68}=V_{68AM}$ -3dB	1	2
AGC time seek mode off	$V_{6\ L}$	0		0.7	V		1	3
AGC time seek mode on	$V_{6\ H}$	2.4		5	V		1	4
Integrator Current	I_{17}*	15	25	35	µA	V_{13}=0; V_m=3V V_6=0.7V	1	5
Integrator Current	I_{17}*	- 13	- 25	-33	µA	V_{13}=100mV_{rms} ; V_m=3V; V_6=0.7V	1	6
Integrator Current	I_{17}*	400	+500	650	µA	V_{13}=0 V_m=3V; V_6=2.4 V	1	7
Integrator Current	I_{17}*	-400	- 500	-650	µA	V_{13}=100mV_{rms} ; V_m=3V; V_6=2.4 V	1	8
Field strength output	V_{79}	0	0.3	0.8	V	V_{13}=0 mV; seek mode off	1	9
Field strength output	V_{79}	1.4	1.75	2.1	V	V_{13}=500 µV; seek mode off	1	10

Table 5-3 AC/DC Characteristics with T_{amb} 25 °C, V_S = 8.5 V (continued)

Parameter	Symbol	Limit Values			Unit	Test Conditions	L	Item
		min	typ	max				
Field strength output	V_{79}	3	3.4	4	V	V_{13}=5 mV; seek mode off	1	11
Field strength output	V_{79}	4.0	4.4	5.1	V	V_{13}=30 mV; seek mode off	1	12

*) Integrator currents are measured between the output pin (- Pole of the measurement equipment) and a voltage source V_m (+ Pole)

Demodulator								
AF output voltage	V_{68AM}	360	480	600	mV_{rms}	m=0.8	1	13
AF output voltage	V_{68AM}	283	406	550	mV_{rms}	m=0.8; Deemph=100 µs	■	14
Total harm. distortion	THD_{68}		0.7	2.5	%		1	15
(S+N)/N			30		dB	m=0.8; V_{13}=20µV	■	16
(S+N)/N	$a_{S/N}$	40	50		dB	m=0.8; V_{13}=200µV	1	17
(S+N)/N	$a_{S/N}$	60	70		dB	m= 0.8; V_{13}=100mV_{rms}	1	18
AF-linearity	Δ_{V68}			3	dB		1	19
AGC output volt. for AM stereo	V_8	48	60	75	mV_{rms}	R_L = 100kΩ; Ref. Appl. board	1	20
IF - Counter								
IF - counter; Output voltage	V_7	200	270		mV_{rms}	R_L=100kΩ;V_6=2.4 V; Ref. Appl. board	1	21
IF-counter; output voltage	V_7			0.5	V_{DC}	V_6=0.7V	1	22
IF-counter; Output voltage	V_{7AC}			2	mV_{rms}	V_6=0.7V	1	23
Station detector non stop	V_{72}			0.5	V	V75=2.2V; V13=500µVrms	1	24
Station detector stop	V_{72}	3			V	V75=1.3V; V13=500µVrms	1	25
Station det. output stop	I_{72}			10	µA		1	26
Station det. output nonstop	V_{72}			0.5	V	V_{72}=1mA	1	27

■ This value is only guaranteed in lab.
1 Test Circuit 1

Total AF voltages								
Total audio voltage AM	$V_{56,57\ tot}$	455	625	855	mV_{rms}	automatic test	calc	
Total audio voltage AM	$V_{56,57\ tot}$	485	625	805	mV_{rms}	Lab test	■ calc	
Total audio voltage FM	$V_{56,57\ tot}$	565	715	900	mV_{rms}	automatic test	calc	
Total audio voltage FM	$V_{56,57\ tot}$	605	715	850	mV_{rms}	Lab test	■ calc	

The value above are calculated as follows:

Total audio level FM: AF output voltage x stereodecoder gain
Total audio level AM: AF output voltage x stereodecoder gain
Stereodecoder gain = AF output voltage / V_{63} = 600 mV_{rms} Input voltage decoder.
The automatic test values are including the additional spread of a high volume automatic testfloor tolerances.

5.2 AM 1st LO ECL divider truthtable

Table 5-4

	Sel A	Sel B
divide by 4	0	0
divide by 6	0	1
divide by 8	1	0
divide by 10	1	1

5.3 Note 1

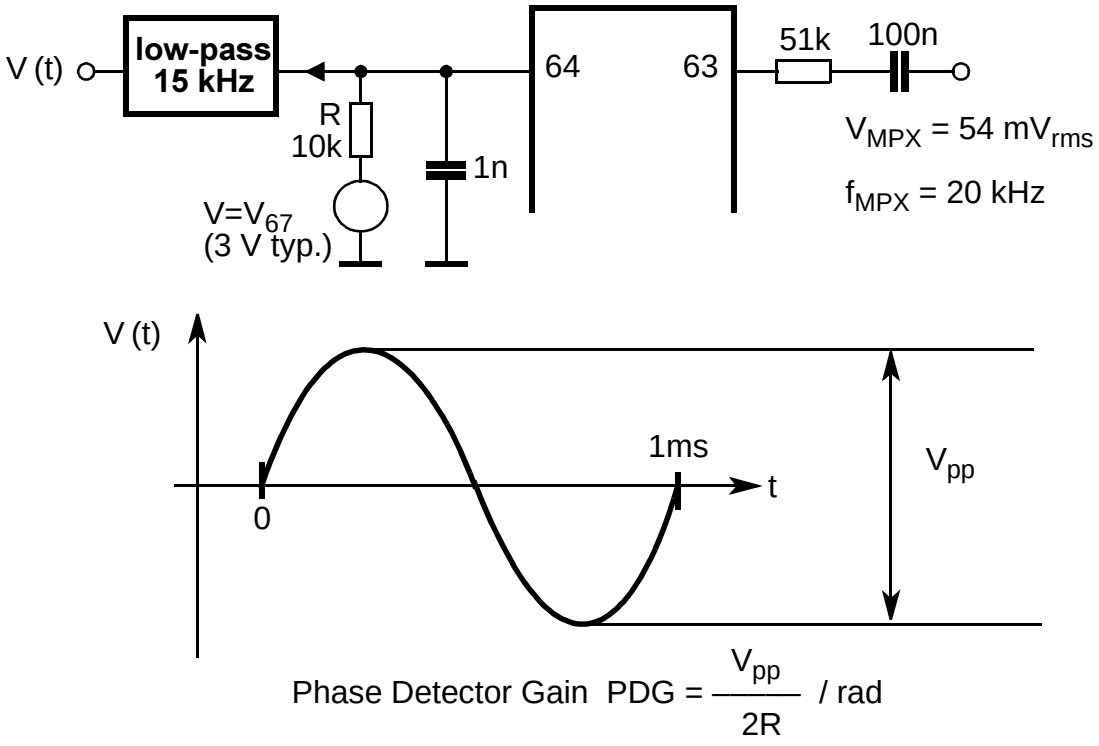
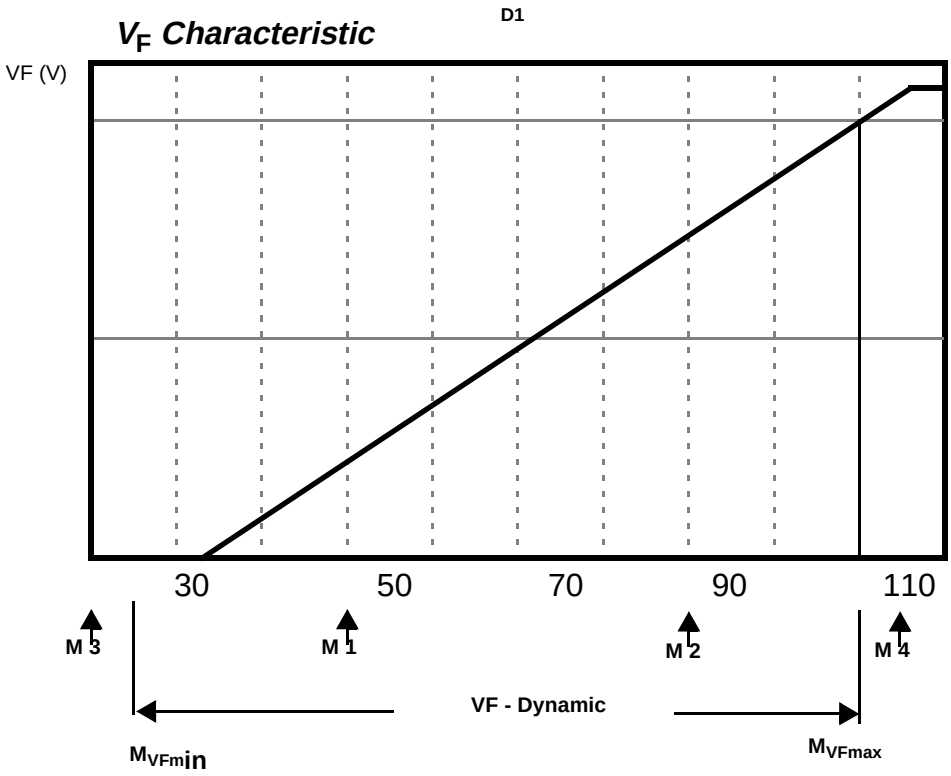


Figure 5-1 Definition of Phase Detector Gain

5.4 Diagrams

5.4.1 Diagram D1



V_F - Dynamic :

The dynamic range of VF voltage is determined by the test points M1 through M4 as follows:

M1: test point (at V_{ilF}= 50 dBµV) supplies V_F (M1)

M2: test point (at V_{ilF}= 90 dBµV) supplies V_F (M2)

M3: test point (at V_{ilF}= 20 dBµV) supplies V_F (M3)

M4: test point (at V_{ilF}=120 dBµV) supplies V_F (M4)

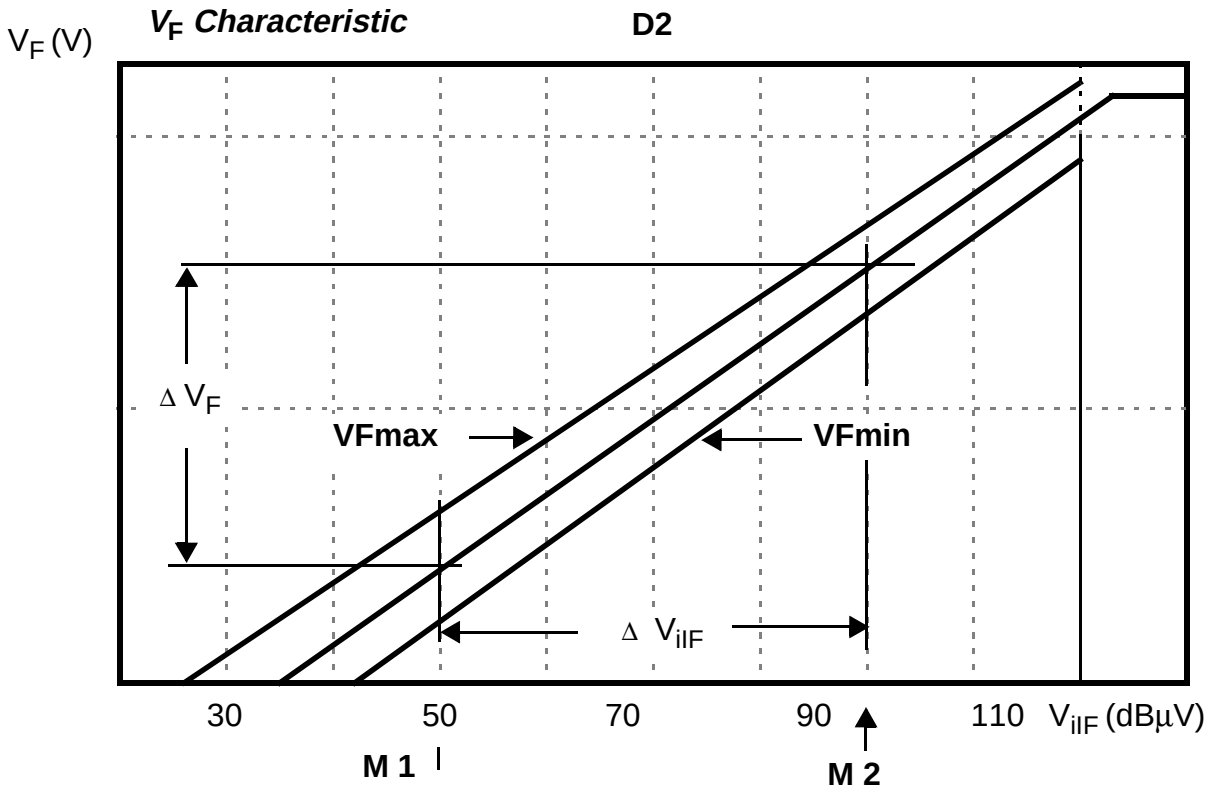
Hence follows :

$$M_{VFmax} := 90\ dB\mu V + \frac{VF(M4) - VF(M2)}{V_F(M2) - V_F(M1)} \times 40\ dB$$

$$M_{VFmin} := 50\ dB\mu V - \frac{VF(M1) - VF(M3)}{V_F(M2) - V_F(M1)} \times 40\ dB$$

VF - Dynamic = M_{VFmax} - M_{VFmin}

5.4.2 Diagram D2



Test points to determine V_F linearity

VF - Linearity: is determined at 25 °C

$$\text{Slope} \quad : m = \frac{VF(M2) - VF(M1)}{40\ dB}$$

The tolerance range of the VF - linearity is determined by two parallel lines:

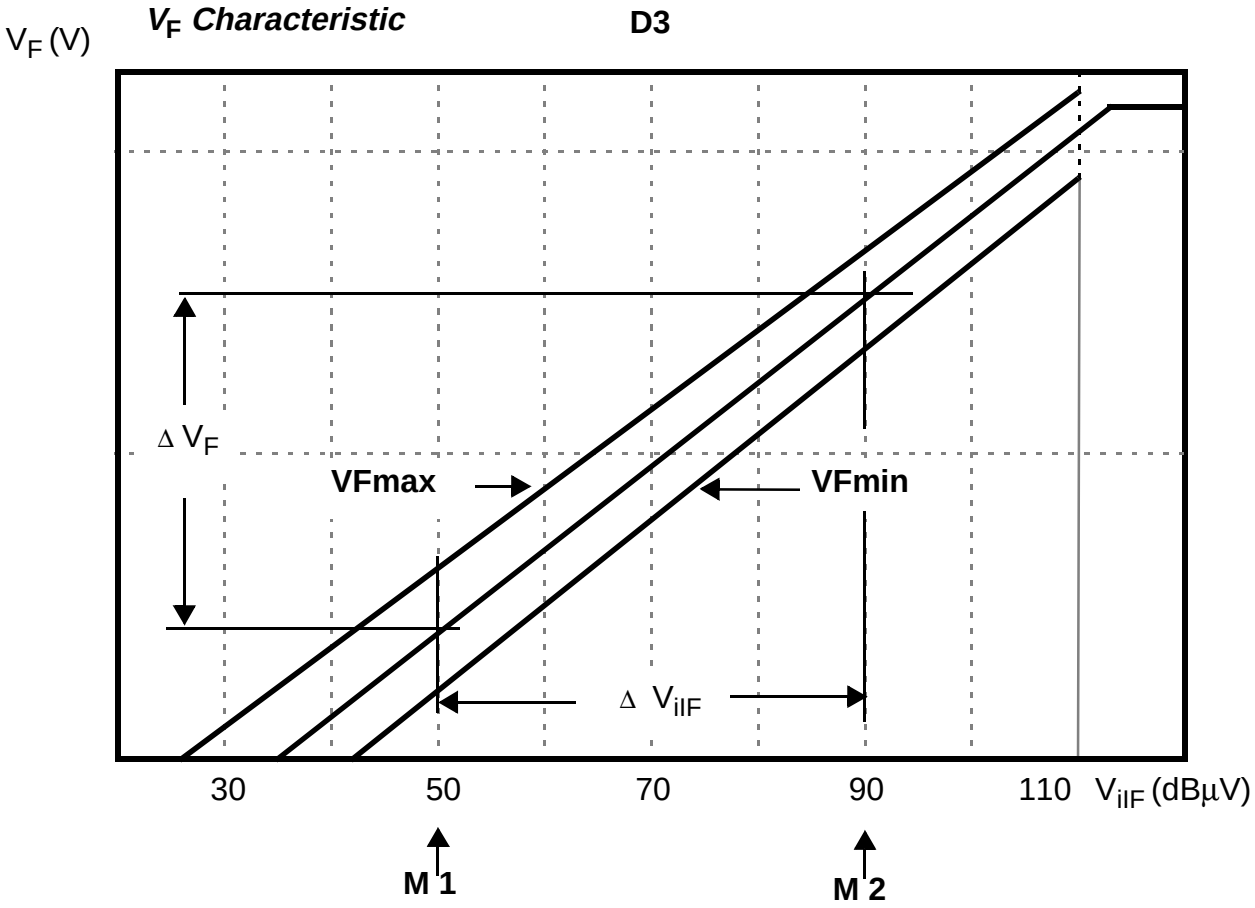
$V_{Fmax} = V_F(M1) + m\,(M + 60\ dB + 1dB)$

$V_{Fmin} = V_F(M1) + m\,(M + 60\ dB - 1dB)$

The V_F values within the V_F dynamic range ($M_{VFmin} \le M \le M_{VFmax}$) must be inside the predetermined tolerance range:

$$\mathbf{V_{Fmin} \le V_F(M) \le V_{Fmax}}$$

5.4.3 Diagram D3



V_F -Temperatur - Drift : It is determined within -40 bis +85 °C

$$\text{Slope} \quad : m = \frac{VF(M2) - VF(M1)}{40\ dB} \quad (\text{at } 25\ °C)$$

The tolerance range of the V_F temperature drift is determined by two parallel lines:

$$V_{Fmax} = V_F(M1) + m\,(M + 60\ dB + 3dB)$$

$$V_{Fmin} = V_F(M1) + m\,(M + 60\ dB - 3dB)$$

The V_F values for temperatures between -40 to +85 °C within the V_F dynamic range ($M_{VFmin} \leq VF \leq M_{VFmax}$) must be inside the predetermined tolerance field:

$$\textbf{VFmin} \leq \textbf{VF (M)} \leq \textbf{VFmax}$$

5.4.4 Diagram D4

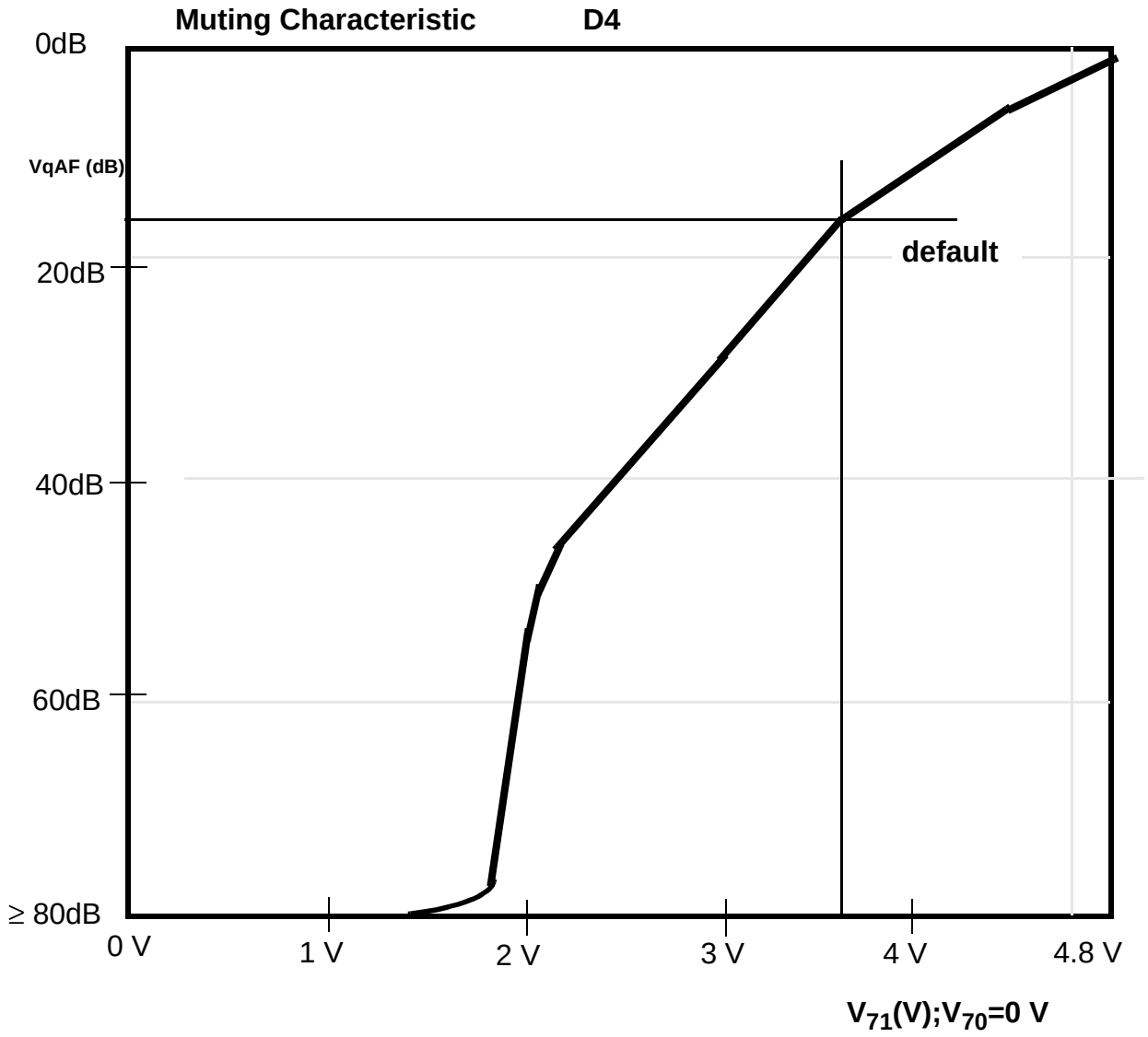


Figure 5-2 Diagram of Mute Characteristics

5.5 Test Circuits

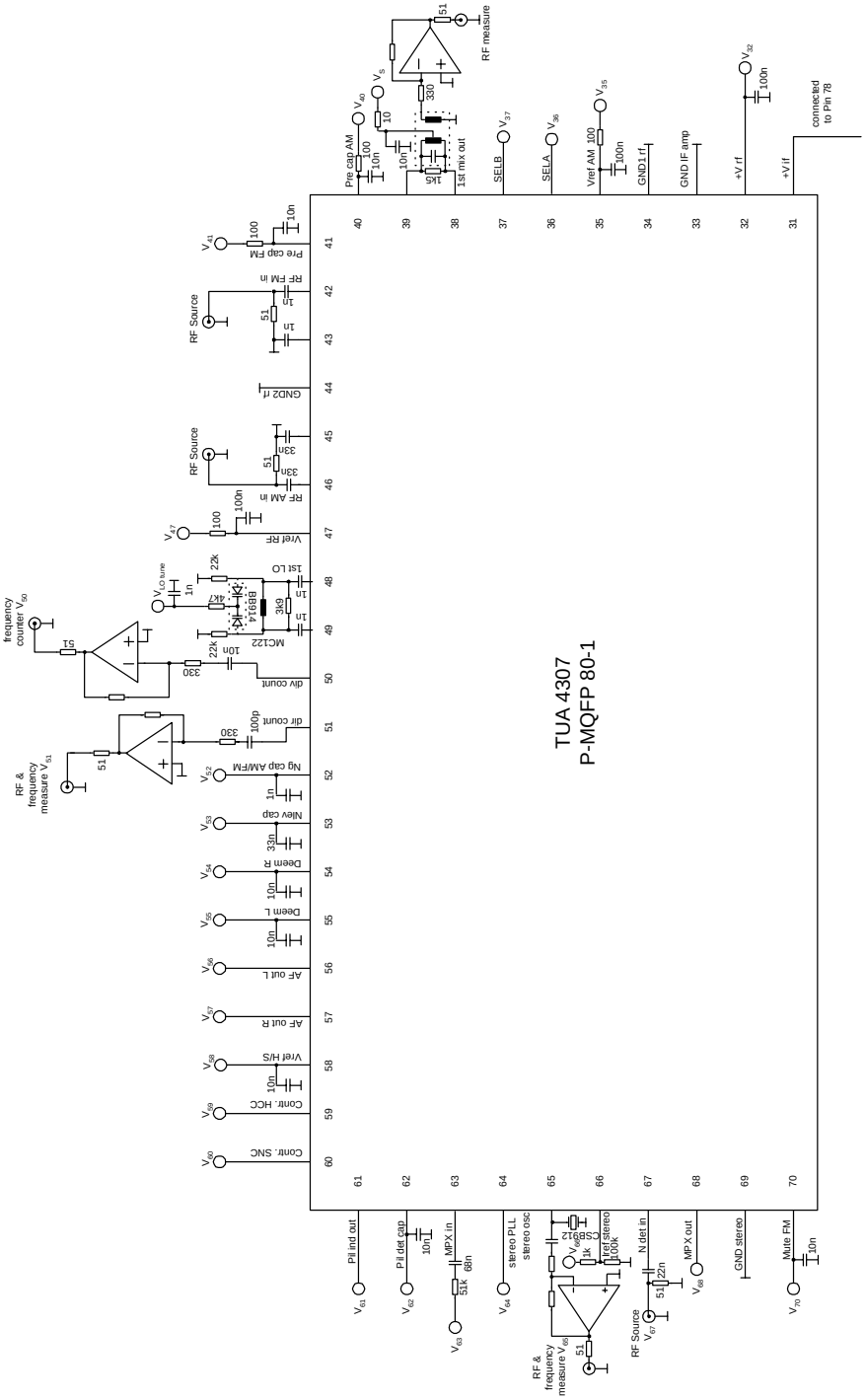


Figure 5-3 Test Circuit part 1

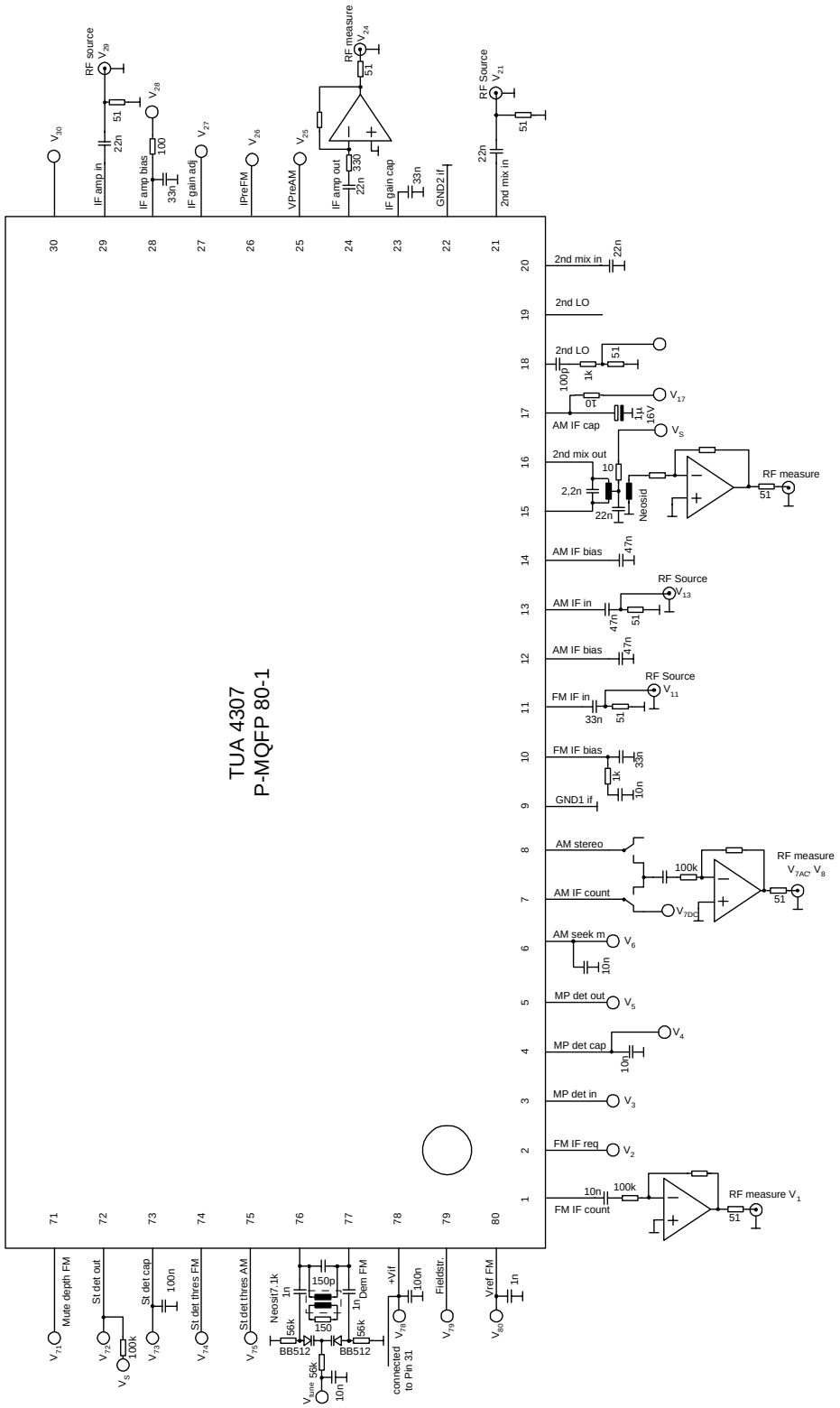


Figure 5-4 Test Circuit part 2