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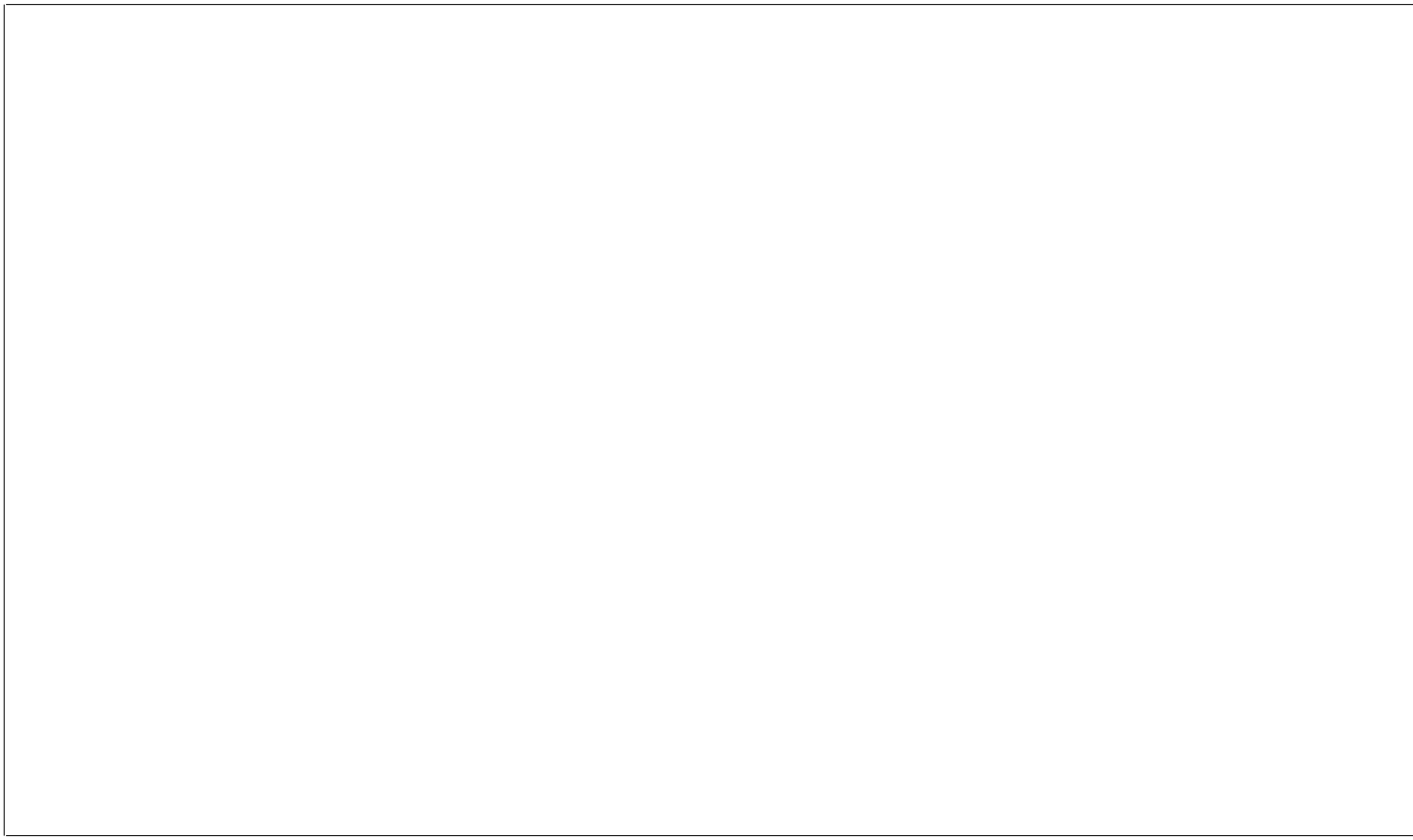

# ICs for Communications

## 1-Chip Car Radio

## TUA 4306

Specification 16.3.99

**Edition 16.3.99**
**Published by Siemens AG, Bereich Halbleiter, Marketing-Kommunikation, Balanstraße 73, 81541 München**


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Last Edition: DOK-Nr. V66047

from July 22nd 1998

# 1 Features

## 1.1 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

## 1.2 FM-Mode

### 1.2.1 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

### 1.2.2 FM-IF Demodulator

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

- 7stage limiter amplifier
- Coincidence demodulator
- Field strength output (combined with AM)
- Fixed mute depth (with full muting typ 80dB)
- Multipath detector with analog output

### 1.3 Stereodecoder

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

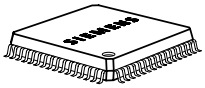
- Internal reference voltage source
- Adjustment free oscillator with ceramic resonator 456 kHz
- Pilot dependent mono/stereo switching with hysteresis
- Stereo indicator output
- Analog mono/stereo blend control (stereo noise control, SNC)
- Pilot canceller (19 kHz)
- Adjacent channel noise suppression (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

### 1.4 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 force input for mixing frequency
- Output for AM IF counter
- Wide range 2nd IF AGC amplifier
- Quasi synchronous demodulator for AM mode
- Fast AM search tuning stop feature
- HCC for AM

## 2 Pinning



MQFP64-1

| Pin | Function | Pin | Function | Pin | Function |
|---|---|---|---|---|---|
| 1 | MP det in | 23 | IF amp bias | 45 | Deem L |
| 2 | MP det cap | 24 | IF amp in | 46 | AF out L |
| 3 | MP det out | 25 | +V rf | 47 | AF out R |
| 4 | AM seek m | 26 | GND rf | 48 | Vref H/S |
| 5 | AM IF count | 27 | SEL A | 49 | Contr. HCC |
| 6 | GND IF | 28 | SEL B | 50 | Contr. SNC |
| 7 | FM IF bias | 29 | 1st mix out | 51 | Pil ind out |
| 8 | FM IF in | 30 | 1st mix out | 52 | Pil det cap |
| 9 | AM IF bias | 31 | Pre cap AM | 53 | MPX in |
| 10 | AM IF in | 32 | Pre cap FM | 54 | Stereo PLL |
| 11 | AM IF bias | 33 | RF in FM | 55 | Stereo osc |
| 12 | 2nd mix out | 34 | RF in FM | 56 | Iref stereo |
| 13 | 2nd mix out | 35 | RF in AM | 57 | N det in |
| 14 | AM IF cap | 36 | RF in AM | 58 | MPX out |
| 15 | 2nd LO | 37 | Vref RF | 59 | GND stereo |
| 16 | 2nd mix in | 38 | 1st LO | 60 | Mute FM |
| 17 | 2nd mix in | 39 | 1st LO | 61 | Dem FM |
| 18 | IF gain cap | 40 | Div count | 62 | Dem FM |
| 19 | IF amp out | 41 | Dir count | 63 | +Vif |
| 20 | V pre AM | 42 | Ng cap AM/FM | 64 | Fieldstr. |
| 21 | I pre FM | 43 | Nlev cap | | |
| 22 | IF gain adj | 44 | Deem R | | |

## 3 Ordering Information

| Type | Package | Ordering Code |
|---|---|---|
| TUA 4306 | MQFP-64-1 | Q67037-A1009 |

# 4. Circuit Description

General Description
The TUA 4306 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.

## 4.1 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 4306 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.

## 4.2 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 fixed muting (with full muting typ 80 dB).
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.

## 4.3 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 456 kHz oscillator and the frequency dividers are used as walsh function generators (suppression of 3$^{rd}$ 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.

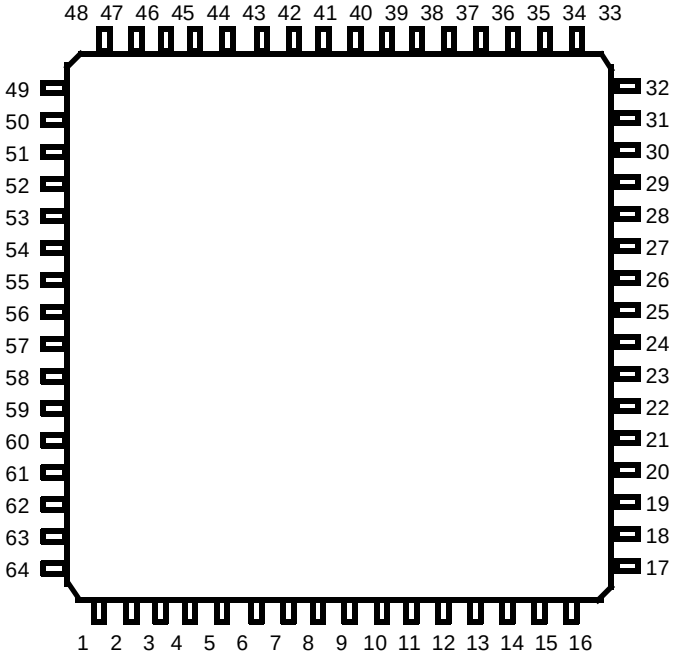
**Interference Detector , Noise Detector, Pulse Former:**
The signal from the interference input (MPX or field strength signal) passes a 4-pole high-pass filter to the noise blanking circuitry. The average noise level is stored in an external capacitor. The interference detector compares the actual noise level with that stored on the capacitor and triggers the pulse former if there is a sig-

nificant 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.

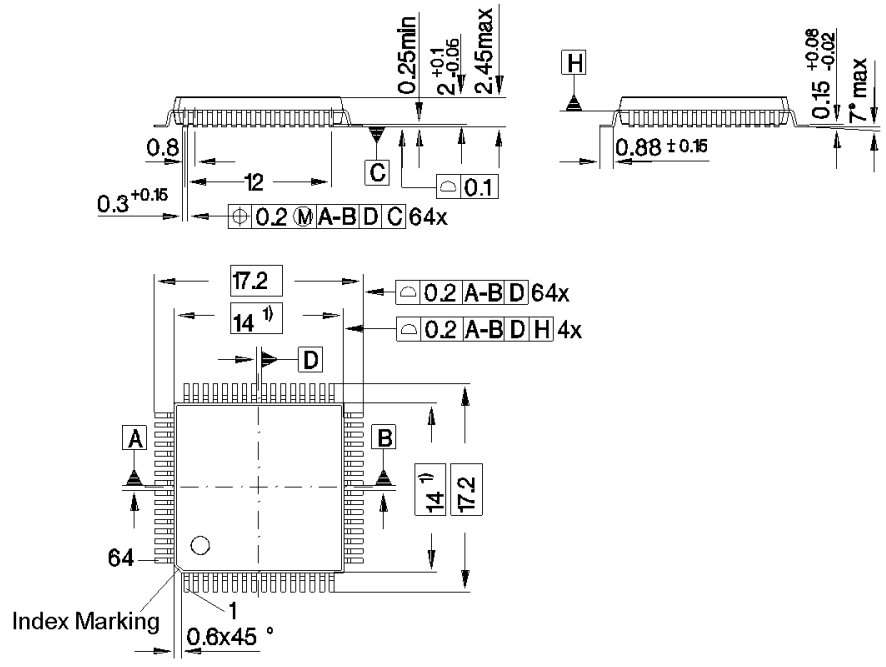
## 4.4 AM - MODE

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 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.

## 5 Pin Configuration




**P-MQFP 64-1**



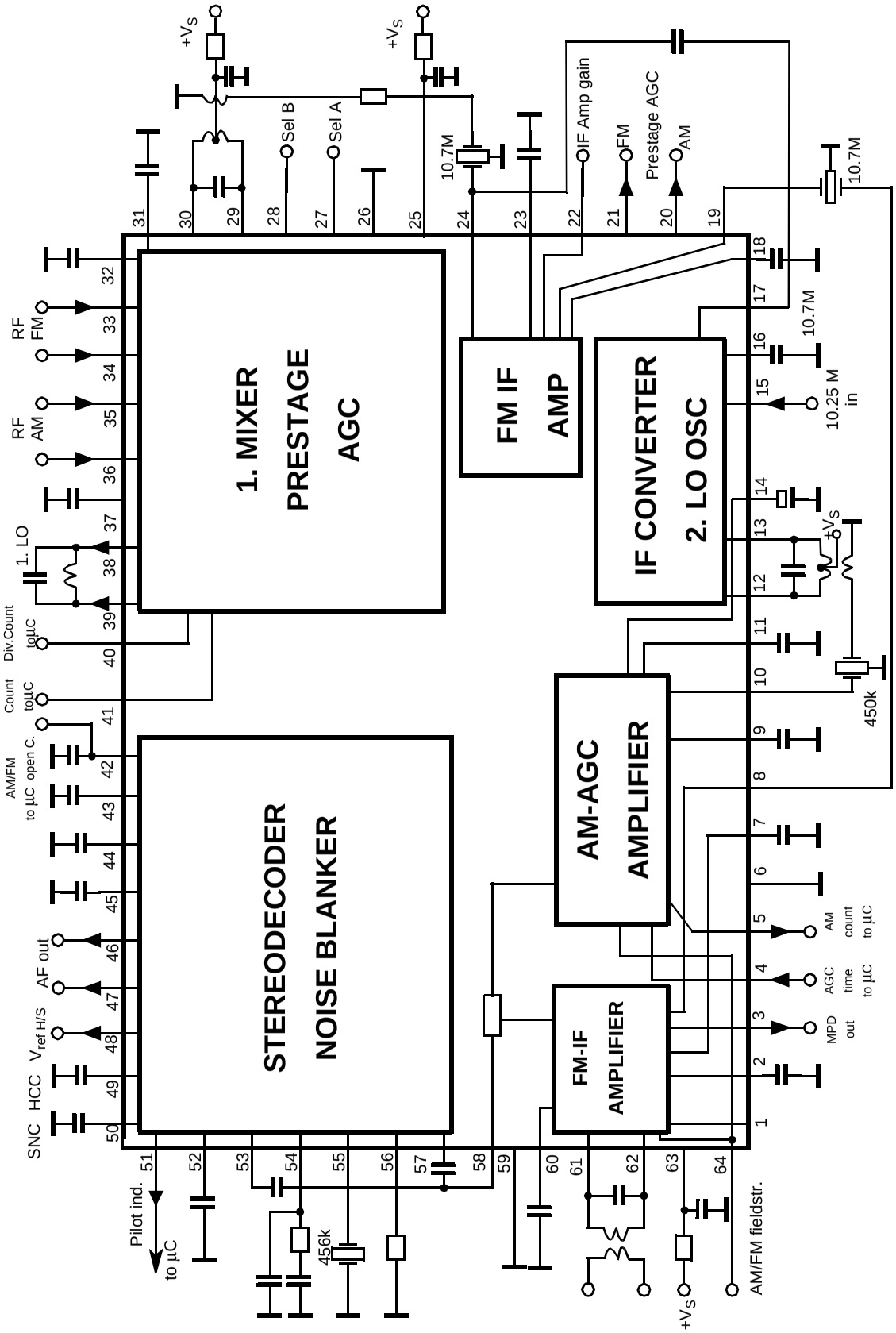

Does not include plastic or metal protrusion of 0.25 max. per side

# 6 Pin Description

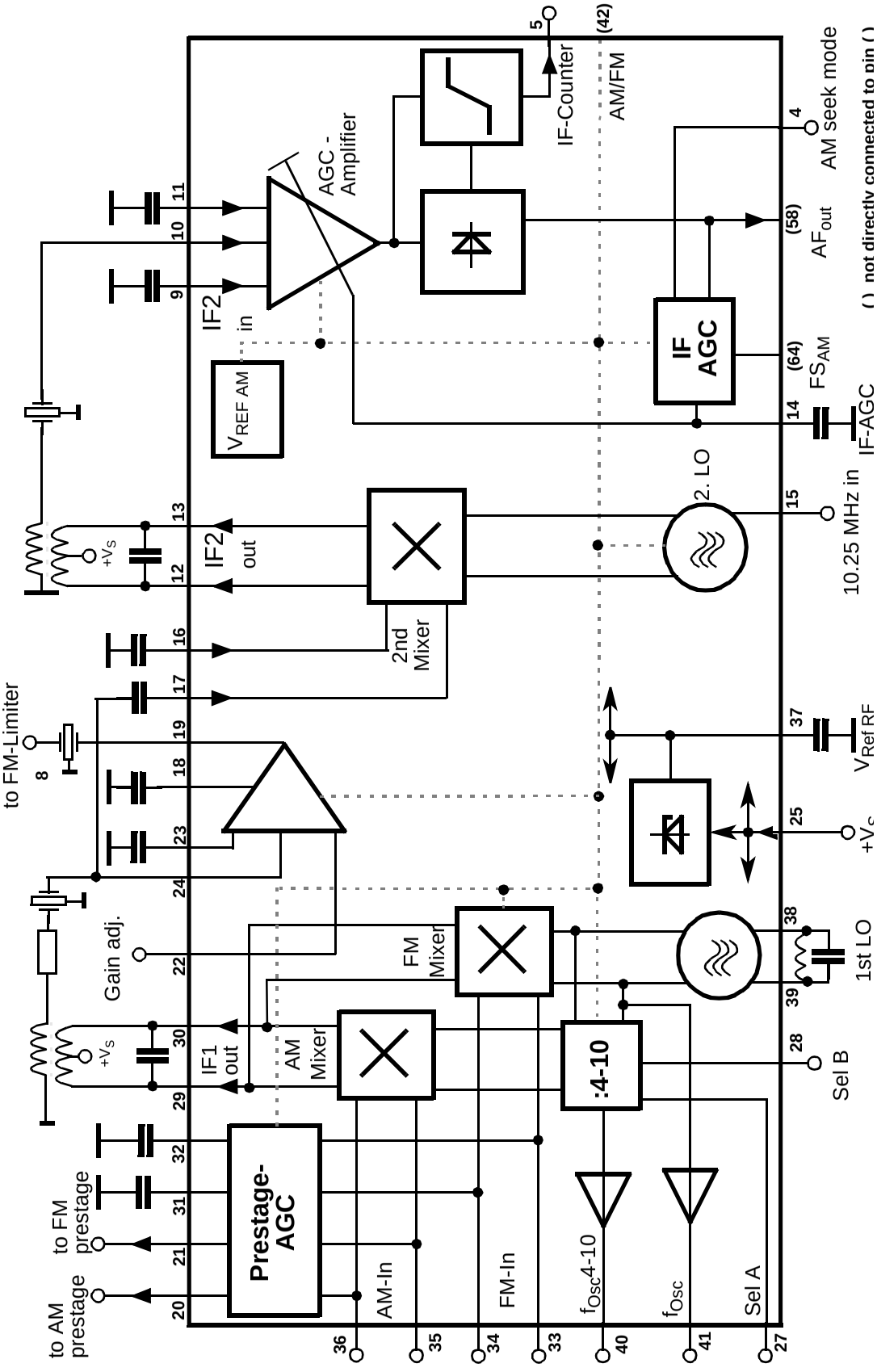
| Pin No. | Symbol | Function |
|---|---|---|
| 1 | MP det in | Auxiliary multipath detector input (in parallel to internal connection) |
| 2 | MP det cap | Multipath detector rectifier capacitor |
| 3 | MP det out | Analog multipath detector output |
| 4 | AM seek m | AM seek mode switch; AM IF counter on, AM-AGC fast and AF-mute |
| 5 | AM IF count | AM-IF counter output for search tuning |
| 6 | GND IF | Ground IF |
| 7 | FM IF bias | FM limiter input bias decoupling capacitor |
| 8 | FM IF in | FM limiter input |
| 9 | AM IF bias | AM AGC amplifier bias decoupling capacitor |
| 10 | AM IF in | AM AGC amplifier input |
| 11 | AM IF bias | AM AGC amplifier bias decoupling capacitor |
| 12 | 2nd mix out | 2nd AM mixer output (open collector) |
| 13 | 2nd mix out | 2nd AM mixer output (open collector) |
| 14 | AM IF cap | AM AGC amplifier time constant capacitor |
| 15 | 2nd LO | Frequency force input for 2nd mixer |
| 16 | 2nd mix in | 2nd AM mixer bias decoupling capacitor |
| 17 | 2nd mix in | 2nd AM mixer input |
| 18 | IF gain cap | 10.7 MHz FM IF amplifier gain adjust blocking capacitor |
| 19 | IF amp out | 10.7 MHz FM IFamplifier output |
| 20 | V pre AM | AM prestage AGC buffered voltage output |
| 21 | I pre FM | FM prestage AGC current output for PIN diode |
| 22 | IF gain adj | 10.7 MHz FM IF amplifier DC controlled gain adjust |
| 23 | IF amp bias | 10.7 MHz FM IF amplifier operation point |
| 24 | IF amp in | 10.7 MHz FM IF amplifier input |
| 25 | +V rf | Supply voltage RF section |
| 26 | GND rf | Ground RF section |
| 27 | SEL A | AM divided counter ratio select A |
| 28 | SEL B | AM divided counter ratio select B |
| 29 | 1st mix out | 1st mixer output (open collector) |
| 30 | 1st mix out | 1st mixer output (open collector |
| 31 | Pre cap AM | AM prestage AGC time constant capacitor |
| 32 | Pre cap FM | FM prestage AGC time constant capacitor; output for MOS FET Gate 2 |
| 33 | RF in FM | FM 1st mixer symmetrical inputs |

| Pin No. | Symbol | Function |
|---|---|---|
| 34 | RF in FM | FM 1st mixer symmetrical inputs |
| 35 | RF in AM | AM 1st mixer symmetrical inputs |
| 36 | RF in AM | AM 1st mixer symmetrical inputs |
| 37 | Vref RF | Reference voltage RF section (4.8 V) |
| 38 | 1st LO | 1st local AM/FM oscillator circuit |
| 39 | 1st LO | 1st local AM/FM oscillator circuit |
| 40 | Div count | 1st local oscillator divided by 4, 6, 8 or 10 counter output (disabled in FM mode) |
| 41 | Dir count | 1st local oscillator counter output |
| 42 | 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 |
| 43 | Nlev cap | Hold capacitor for Noise detector average level low voltage applied mutes the stereo decoder outputs |
| 44 | Deem R | HCC timing / hold capacitor, deemphasis right |
| 45 | Deem L | HCC timing / hold capacitor, deemphasis left |
| 46 | AF out L | AF output left |
| 47 | AF out R | AF output right |
| 48 | Vref H/S | Reference voltage SNC / HCC |
| 49 | Contr. HCC | Control voltage HCC (high cut control) |
| 50 | Contr. SNC | Control voltage SNC (stereo noise control), external decreasing of stereo separation possible |
| 51 | Pil ind out | Pilot indicator output, active high (open collector) |
| 52 | Pil det cap | Pilot detector capacitor, low voltage activates mono state |
| 53 | MPX in | Stereo decoder MPX signal input |
| 54 | Stereo PLL | Stereo decoder PLL phasedetector, loop filter |
| 55 | Stereo osc | VCO pin for ceramic resonator |
| 56 | Iref stereo | Reference current pin, external reference resistor |
| 57 | N det in | Noise detector input |
| 58 | MPX out | FM MPX signal and AM demodulator signal output |
| 59 | GND stereo | Ground stereodecoder |
| 60 | Mute FM | Dynamic FM mute control blocking capacitor |
| 61 | Dem FM | Demodulator circuit FM |
| 62 | Dem FM | Demodulator circuit FM |
| 63 | +Vif | Supply voltage IF and stereodecoder section |
| 64 | Fieldstr. | AM/FM fieldstrength combined output |

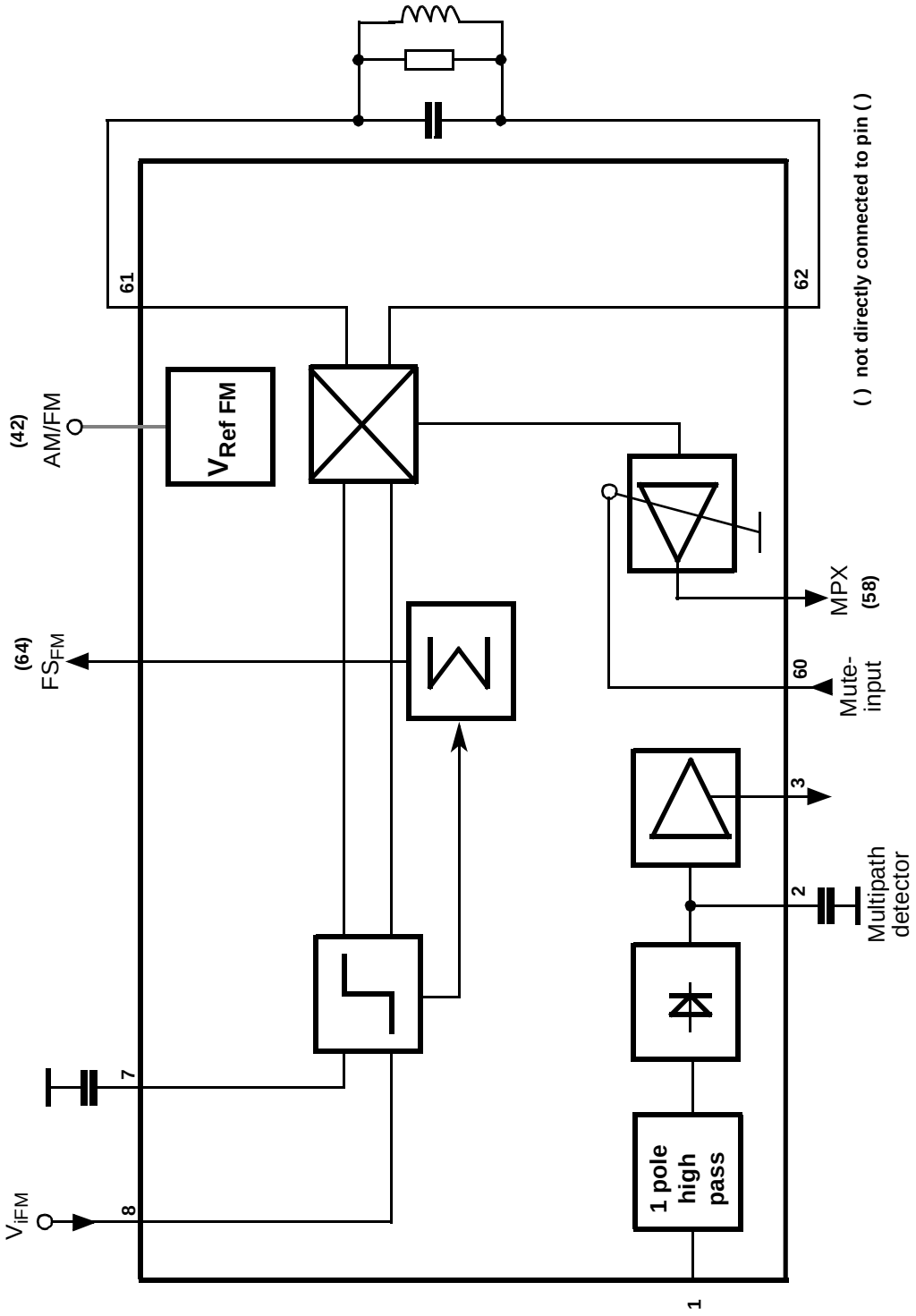
## 7 Blockdiagram 1



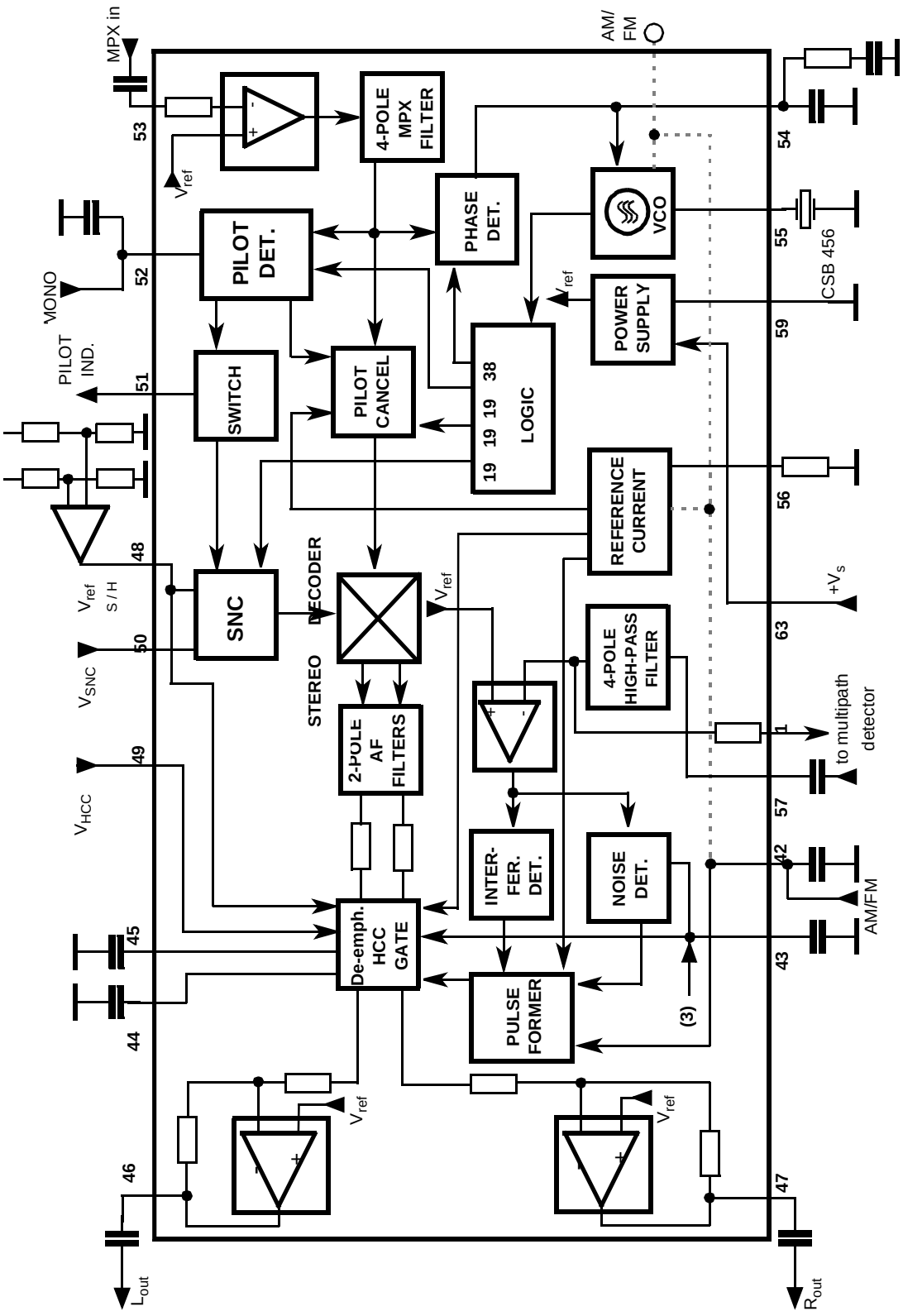
## 8 Blockdiagram 2



## 9 Blockdiagram 3



## 10 Blockdiagram 4



## 11 Absolute Maximum Ratings

*The AC / DCcharacteristic limits are not guaranteedhe maximal ratings may not be exceeded under any circumstances, not even momentary and individual, as permanent damage to the IC will result.*

| Parameter | Symbol | Limit Values | | Unit | Test Conditions |
|---|---|---|---|---|---|
| | | 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 |

Ambient Temperature under bias: $T_A$=-40 to +85°C

## 12 Operational Range

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

.

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

## 13 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.*

**Supply Voltage** $V_S$ **= 8.5 V**
**Ambient temperature** $T_{amb}$ **= 25 °C**

| Parameter | Test Circuit | Symbol | Limit Values | | | Unit | Test conditions |
|---|---|---|---|---|---|---|---|
| | | | min | typ | max | | |
| 1.Current consumption | 1 | $I_{SFM}$ | **80** | 100 | **120** | mA | **FM** mode |
| | 1 | $I_{SAM}$ | **65** | 80 | **105** | mA | **AM** mode |
| **1.AM/FM-Receiver** **1st LO** | | | | | | | |
| 1. Frequency range | 1 | $f_{1st\ LO}$ | 80 | | 140 | MHz | |
| 2. Frequency range | Lab | $f_{1st\ LO}$ | 50 | | 150 | MHz | $Q_{factor\ of\ coil}$ >90 |
| 3. Counter output | 1 | $V_{41}$ | **70** | **100** | | $mV_{rms}$ | $R_{L41}$=330Ω; Ref. Appl.board |
| 4. Divided counter output | 1 | $V_{40}$ | **28** | **40** | | $mV_{rms}$ | $R_{L40}$=330Ω; Ref. Appl. board |
| **4a. Divided counter output** | **Lab** | $\mathbf{V_{40}}$ | | **150** | | $\mathbf{mV_{rms}}$ | $R_{L40}$=10kΩ; Ref. Appl. board |
| 5. Output impedance | Lab | $R_{40}$ | 0.8 | 1 | 1.2 | kΩ | |
| 6. Output impedance | Lab | $R_{41}$ | 240 | 300 | 360 | Ω | |
| 7. Frequency | 1 | $f_{1st\ LO}$ | 10 | | | MHz | $V_{tuning}$=0V |
| | | | | | | | |
| **10.7 MHz IF amplifier** $f_{IF1}$= 10.7 MHz | | | | | | | |
| 8. DC input voltage | 1 | $V_{24}$ | **3.5** | **3.9** | **4.3** | V | |
| 9. Input resistance | 1 | $R_{24}$ | 270 | 330 | 390 | Ω | AM |
| 10. Output resistance | 1 | $R_{19}$ | 270 | 330 | 390 | Ω | |
| 11. Max. voltage gain | 1 | $A_{24\text{-}19}$ | **23** | 26 | **29** | dB | $V_{22}$=1.5V |
| 12. Min. voltage gain | 1 | $A_{24\text{-}19}$ | **13** | 16 | **19** | dB | $V_{22}$=3.5V |
| 13. Noise figure | Lab | $F_{FM}$ | | 7 | | dB | RG=330Ω |
| 14. Reference voltage | 1 | $V_{37}$ | 4.5 | 4.8 | 5.1 | V | |
| 15. Output Current | 1 | $I_{37}$ | | | 1 | mA | |

| Parameter | Test Circuit | Symbol | Limit Values | | | Unit | Test conditions |
|---|---|---|---|---|---|---|---|
| | | | min | typ | max | | |
| **AM mode**<br>$f_{IF1}$= 10.7 MHz<br>$f_{IF2}$= 450 kHz<br>$f_{35-36}$= 1 MHz<br>$V_{42}$=1V | | | | | | | |
| **Mixer 1** | | | | | | | |
| | | | | | | | |
| 1. Interceptpoint 3rd order | Lab | $I_{P3}$ | | 134 | | dBµV | Special testcircuit necessary |
| 2. Mixer gain | 1 | $A_{M1}$ | **2** | 6 | **10** | dB | $V_{35,36}$=80mV$_{rms}$ ( $R_L$=330Ω) |
| 3. Max. input voltage | 1 | $V_{35-36}$ | 1100 | 1400 | | mV$_{pp}$ | SINAD> 34dB;m=80% |
| 4. Noise figure (10 MHz) | Lab | F | | 7 | | dB | $R_{g\ opt}$=700Ω |
| 5. Input impedance | Lab | $R_{35-36}$ | 3.2 | 4 | 4.8 | kΩ | sym. |
| 6. Input impedance | Lab | $C_{35-36}$ | 1.6 | 2 | 2.4 | pF | sym. |
| 7. Input impedance | Lab | $R_{35-36}$ | 1.6 | 2 | 2.4 | kΩ | asym. |
| 8. Input impedance | Lab | $C_{35-36}$ | 3.2 | 4 | 4.8 | pF | asym. |
| 9. Divider select low | 1 | $V_{27,28L}$ | 0 | | **1.3** | V | |
| 10. Divider select high | 1 | $V_{27,28H}$ | 3.0 | | $V_S$ | V | |
| **Prestage AGC output** | | | | | | | |
| 11. AGC-voltage AM | 1 | $V_{20}$ | 6.5 | 7.5 | | V | $V_{35,36}$ =50mV$_{rms}$ |
| 12. AGC-voltage AM | 1 | $V_{20}$ | 0 | | 0.5 | V | $V_{35,36}$ =200mV$_{rms}$ |
| 13. AGC-voltage FM | 1 | $V_{32}$ | 0 | | 0.15 | V | $V_{35,36}$=50mV$_{rms}$ |
| 14. AGC-current FM | 1 | $I_{21}$ | 0 | | 0.1 | mA | $V_{35,36}$=50mV$_{rms}$ |
| 15. Integrator Current | 1 | $I_{31}$* | -12 | -25 | -45 | µA | $V_{35,36}$=50mV$_{rms}$ $V_m$=3V |
| 16. Integrator Current | 1 | $I_{31}$* | +10 | **+25** | +40 | µA | $V_{35,36}$=150mV$_{rms}$ $V_m$=3V |
| 17. Integrator Current | 1 | $I_{31}$* | -17 | -35 | -55 | µA | $V_{35,36}$=0mV$_{rms}$ $V_m$=3V |
| 18. Integrator Current | 1 | $I_{31}$* | +50 | +70 | +90 | µA | $V_{35,36}$=400mV$_{rms}$ $V_m$=3V |

| Parameter | Test Circuit | Symbol | Limit Values | | | Unit | Test conditions |
|---|---|---|---|---|---|---|---|
| | | | min | typ | max | | |
| **2 nd AM IF section Mixer 2** | | | | | | | |
| 1. Mixer gain | 1 | $A_{M2}$ | **7** | **10** | **13** | dB | $V_{17}$ =1mV; $V_{out}=V_{IF450}$ $f_{17}$=10.7 MHz; $f_{15}$=10.25 MHz |
| 2. Noise figure | Lab | F | | 10 | | dB | |
| 3. Max Input Voltage | 1 | $V_{16-17}$ | | 1400 | | $mV_{pp}$ | SINAD> 34dB;m=80% |
| 4. Input impedance | Lab | $R_{16-17}$ | | 1.8 | - | kΩ | |
| **Frequency force input** | | | | | | | |
| 5. Operational frequency | Lab | $f_{15}$ | 10 | 10.25 | 25 | MHz | |
| 6. External force voltage | 1 | $V_{15}$ | **60** | | | $mV_{rms}$ | Rg=600Ω; Ck= 100pF |

| Parameter | Test Circuit | Symbol | Limit Values | | | Unit | Test conditions |
|---|---|---|---|---|---|---|---|
| | | | min | typ | max | | |
| **FM mode**<br>$f_{IF}$=10.7 MHz<br>$f_{33-34}$=100 MHz<br>$V_{42}$=open | | | | | | | |
| **Mixer 1** | | | | | | | |
| 1.Interceptpoint 3rd order | Lab | $I_{P3}$ | | 125 | | dB µV | special testcircuit necessary |
| 2.Noise figure (10 MHz) | Lab | F | | 6 | | dB | $R_{g\ opt}$=500Ω |
| 3. Mixer gain | 1 | $A_{M1}$ | **5** | 9 | **13** | dB | $V_{33-34}$=10$mV_{rms}$; $R_L$=330Ω |
| 4.Input impedance | Lab | $R_{33-34}$ | 3.2 | 4 | 4.8 | kΩ | sym. |
| 5.Input impedance | Lab | $C_{33-34}$ | 1.6 | 2 | 2.4 | pF | sym. |
| 6.Input impedance | Lab | $R_{33-34}$ | 1.6 | 2 | 2.4 | kΩ | asym. |
| 7.Input impedance | Lab | $C_{33-34}$ | 3.2 | 4 | 4.8 | pF | asym. |
| **Prestage AGC output** | | | | | | | |
| 8. AGC voltage FM | 1 | $V_{32}$ | 5.6 | 6.4 | **7.2** | V | $V_{33,34}$=0$mV_{rms}$ |
| 9.AGC voltage FM | 1 | $V_{32}$ | 0 | | **0.1** | V | $V_{33,34}$=50$mV_{rms}$ |
| 10.AGC current FM | 1 | $I_{21}$ | 9.5 | 12 | 14.5 | mA | $V_{33,34}$=0$mV_{rms}$ $V_m$=0.7V |
| 11.AGC current FM | 1 | $I_{21}$ | 0 | | 0.1 | mA | $V_{33,34}$=50$mV_{rms}$ $V_m$=0.7V |
| 12.AGC voltage AM | 1 | $V_{20}$ | 0 | | 0.5 | V | $V_{33,34}$=0 |
| 13.AGC sink current AM | 1 | $I_{20}$ | 3 | | | mA | $V_{33,34}$=0 |
| 14.AGC voltage AM integrator | 1 | $V_{31}$ | | 6 | 7.5 | V | $V_{33,34}$=0 |
| 15.Integrator Current | 1 | $I_{32}$* | - 12 | - 25 | - 46 | µA | $V_{33,34}$=0 $V_m$=4.8V |
| 16.Integrator Current | 1 | $I_{32}$* | +15 | +30 | +50 | µA | $V_{33,34}$=60$mV_{rms}$ $V_m$=4.8V |
| 17.Integrator Current | 1 | $I_{32}$* | +50 | **+70** | +90 | µA | $V_{33,34}$=150$mV_{rms}$ $V_m$=4.8V |

*) 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;$V_8$ =10 $mV_{rms}$
$V_{42}$=open; Deemphasis= 100 µs

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Fieldstrength dynamic range | 1 | $V_{64}$ | 66 | 72 | | dB | see Diagram D1 |
| Fieldstrength nonlinearity | 1 | $V_{64}$ | | ±1 | | dB | see Diagram D2 |
| Fieldstrength temperature drift | 1 | $V_{64}$ | | | ±3 | dB | see Diagram D3 |

| Parameter | Test Circuit | Symbol | Limit Values | | | Unit | Test conditions |
|---|---|---|---|---|---|---|---|
| | | | min | typ | max | | |
| Fieldstrength load capacitance | Lab | | | | 50 | pF | |
| Fieldstrength load resistance | Lab | | 1 | | | kΩ | |
| Fieldstrength voltage | 1 | $V_{64}$ | 4 | 4.6 | 5.2 | V | $V_8$=200mV$_{rms}$ |
| Fieldstrength voltage | 1 | $V_{64}$ | 1.5 | 1.9 | 2.3 | V | $V_8$=1mV$_{rms}$ |
| Fieldstrength voltage | 1 | $V_{64}$ | 0 | | 1 | V | $V_8$=0mV$_{rms}$ |
| 2. AF-output voltage | 1 | $V_{58}$ | 400 | 500 | 600 | mV$_{rms}$ | $R_L$>10kΩ; Deemph.=100 µs |
| 3. AF-output voltage | Lab | $V_{58}$ | | 600 | | mV$_{rms}$ | $R_L$>10kΩ; no Deemph. |
| 4. Input voltage for limiter threshold | 1 | $V_8$ | | 33 | 45 | µV$_{rms}$ | $V_{58}$=$V_{58}$ - 3dB |
| 5. Total harmonic distortion | 1 | $THD_{58}$ | | **0.9** | 1.2 | % | |
| 6. AM-suppression | 1 | $a_{AM}$ | 70 | 80 | | dB | m=30 % |
| 7. Signal-to-noise ratio | 1 | $a_{S/N}$ | 72 | 80 | | dB | |
| 8. AF mute | 1 | $a_{AF}$ | **12** | 14 | **16** | dB | $V_{60}$=0 |
| **Multipath detector** $f_{57}$=200 kHz | | | | | | | |
| 10. Attack current | 1 | $I_2$ *) | 600 | 800 | 1070 | µA | $V_{57AC}$=1V$_{pp}$ , $V_m$=5.0 V |
| 11. Recovery current | 1 | $I_2$ *) | - 6 | - 9 | -12 | µA | $V_{57AC}$=0; $V_m$=3.6V |
| 12. Start voltage | 1 | $V_{3Def}$ | 4.4 | 4.7 | | V | $V_{57AC}$=0V |
| 13.Detector characteristic | 1 | $V_3$ | **$V_{3Def0.14V}$** | **$V_{3Def-0.1V}$** | **$V_{3Def}$** | V | $f_{57}$=25kHz; $V_{57}$=160mV$_{pp}$ |
| 14. Detector characteristic | 1 | $V_3$ | **$V_{3Def-3.3V}$** | **$V_{3Def-2.8V}$** | **$V_{3Def-2.3V}$** | V | $f_{57}$=200kHz; $V_{57}$=160mV$_{pp}$ |

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

| Parameter | Test Circuit | Symbol | Limit Values | | | Unit | Test conditions |
|---|---|---|---|---|---|---|---|
| | | | min | typ | max | | |
| **3.Stereodecoder**<br>Measuring condition:<br>$V_{53}$=600m$V_{rms}$; f=1 kHz; 15kHz LP with 19kHz Notch; see appendix | | | | | | | |
| 1.Total harmonic distortion | 1 | $THD_{46,47}$ | | 0.1 | 0.3 | % | f= 1 kHz |
| 2. Signal to noise ratio | 1 | $S/N_{46,47}$ | 65 | 75 | | dB | Stereo |
| 3. Channel separation | 1 | $a_{Sep}$ | 28 | 40 | | dB | |
| 4. AF output voltage | 1 | $V_{46,47}$ | **650** | 780 | **900** | $mV_{rms}$ | Stereo/Mono |
| 5. Overdrive margin | 1 | $V_{46,47\ max}$ | | 2 | | dB | THD= 1% |
| 6. AF output DC voltage | 1 | $V_{DC\ 46,47}$ | 2.5 | 3 | 3.5 | V | |
| 7. Difference of output voltage levels | 1 | $\Delta V_{46,47}$ | | | 2 | dB | |
| 8. Muting depth | 1 | $A_{46,47}$ | 70 | 75 | | dB | $V_{43}$=0 |
| 9. Muting depth | 1 | $A_{46,47}$ | 70 | 75 | | dB | $V_4$=0.7V |
| 10. DC-offset at mute | 1 | $\Delta_{DC\ 46,47}$ | -100 | 0 | 100 | mV | |
| 11. DC-offset stereo on/off | 1 | $\Delta_{DC\ 46,47}$ | -100 | 0 | 100 | mV | |
| **Carrier and harmonic suppression (referenced to $V_{46,47}$=780 $mV_{rms}$)** | | | | | | | |
| 1. Pilotsignal (f=19kHz) subcarrier | 1 | $\alpha_{19}$ | 40 | 45 | | dB | |
| 2. (f=38kHz) | 1 | $\alpha_{38}$ | 40 | 50 | | dB | |
| 3. (f=57kHz) | 1 | $\alpha_{57}$ | 40 | 50 | | dB | |
| **Mono/Stereo control Pilot threshold voltage:** | | | | | | | |
| 1. For stereo”on” | 1 | $V_{PILon}$ | | 20 | 30 | $mV_{rms}$ | |
| 2. For stereo”off” | 1 | $V_{PILoff}$ | 5 | 14 | | $mV_{rms}$ | |
| 3. Hysteresis | Lab | | | 3 | | dB | $V_{PILon}$ / $V_{PILoff}$ |
| **Stereo-indicator output** | | | | | | | |
| 4. Pilot off | | $V_{51off}$ | | | 0.5 | V | $I_{51}$=1mA |
| 5. Pilot on | | | | | 10 | µA | |
| **external control voltages (active low)** | | | | | | | |
| 6. Operational voltage for external mono control (pin 52) | 1 | $V_{52\ thr}$ | | | 1 | V | |
| 7. Operational voltage for AM/FM (pin 42) | 1 | $V_{42thr}$ | | | 1 | V | AM on |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Deemphasis**<br>Reference frequency = 400Hz<br>$C_{deemph}$=10nF; $\tau_{nom}$=75 µs | | | | | | | |
| 8. Minimum FM attenuation | 1 | $A_{min\ FM}$ | 5 | **7** | 9 | dB | $V_{49}$≥3.8V; $f_m$=5kHz |
| 9. Maximum FM attenuation | 1 | $A_{max\ FM}$ | **12** | **15** | **18** | dB | $V_{49}$=1.5 V V; $f_m$=5kHz |
| 10. Minimum AM attenuation | 1 | $A_{min\ AM}$ | 5 | **7** | 9 | dB | $V_{49}$≥3.4V; $f_m$=5kHz |
| 11. Maximum AM attenuation | 1 | $A_{max\ AM}$ | **12** | **15** | **18** | dB | $V_{49}$=1.5V; $f_m$=5kHz |
| **Stereo/Mono blend control :** | | | | | | | |
| 1. Channel separation | 1 | $a_{Sep}$ | 28 | | | dB | $V_{50}$=3.8V |
| 2. Channel separation | 1 | $a_{Sep}$ | | | 3 | dB | $V_{50}$=3.3V |
| **Oscillator** | | | | | | | |
| 3. Max. Osc. frequency | 1 | $f_{oscmax}$ | 0.7 | 1.0 | 2.0 | % | 100 % x ($f_{max}$ / 456kHz-1) |
| 4. Min. Osc. frequency | 1 | $f_{oscmin}$ | -2.0 | -1.0 | -0.7 | % | 100 % x ($f_{max}$ / 456kHz-1) |
| 5. VCO-gain | 1 | | -12 | -8 | -4 | kHz/V | $\Delta f/\Delta V_{54}$ |
| 6. Oscillator voltage | 1 | | 2.5 | 4 | 5.5 | V | $V_{55\ DC}$ |
| 7.Oscillator swing | 1 | | 260 | 370 | 470 | $mV_{rms}$ | $V_{55\ AC}$ |
| **PLL** | | | | | | | |
| 8. PD-gain | note 1 | $\Delta i/\Delta\phi$ | 6.0 | 8.2 | 10.2 | µA/rad | $V_{pilot}$ = 54 $mV_{rms}$ |
| **Noise detector** | | | | | | | |
| 9. Input resistance | Lab | $R_{57}$ | 80 | 99 | 120 | kΩ | |
| 10. Input high-pass filter | Lab | $f_{in57}$ | 80 | 100 | 120 | kHz | -3dB |
| 11.Trigger threshold | 1 | $V_{57\ min}$ | | 30 | 50 | $mV_{rms}$ | $V_{43}$ = $V_{43}$ ($V_{57\ mean}$=0), $f_{57}$=200 kHz |
| 12.Trigger threshold | 1 | $V_{57\ dyn}$ | 130 | 170 | 210 | $mV_{rms}$ | $V_{43}$ =$V_{43}$ ($V_{57\ mean}$=50$mV_{rms}$ ), $f_{57}$=200 kHz |
| 13. Maximum noise mean value * | 1 | $V_{57maxmean}$ | 65 | 80 | 115 | $mV_{rms}$ | $f_{57}$=200 kHz |
| 14. Suppression pulse duration | 1 | | 34 | 40 | 46 | µs | |
| 15. Input offset current | Lab | $I_{44,45}$ | -50 | 0 | 50 | nA | |
| 16. Attack current | Lab | $I_{43att}$ | | **880** | | µA | $V_{43}$=5.5V |
| 17. Recovery current | Lab | $I_{43rec}$ | | 20 | | µA | $V_{43}$=4V |

***)** 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; $V_{10}$ = 10m$V_{rms}$ , Deemphasis=100 µs**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1. AGC-range | 1 | ΔA | 60 | 66 | | dB | $V_{58}$=$V_{58AM}$ ±3dB |
| 2. Input sensitivity | 1 | $V_{10}$ | | 100 | | µ$V_{rms}$ | $V_{58}$=$V_{58AM}$ -3dB |
| 3. AGC time seek mode on | 1 | $V_{4\,L}$ | 0 | | 0.7 | V | |
| 4. AGC time seek mode off | 1 | $V_{4\,H}$ | 2.4 | | 5 | V | |
| 5. Integrator Current | 1 | $I_{14}$* | 15 | 25 | 35 | µA | $V_{10}$=0; $V_m$=3V |
| 6. Integrator Current | 1 | $I_{14}$* | - 13 | - 25 | -33 | µA | $V_{10}$=100m$V_{rms}$ ; $V_m$=3V |
| 7. Integrator Current | 1 | $I_{14}$* | 400 | +500 | 650 | µA | $V_{10}$=0 $V_m$=3V; $V_4$=0.7 V |
| 8. Integrator Current | 1 | $I_{14}$* | -400 | - 500 | -650 | µA | $V_{10}$=100m$V_{rms}$ ; $V_m$=3V; $V_4$=0,7 V |
| 9. Field strength output | 1 | $V_{64}$ | 0 | **0.3** | **0.8** | V | $V_{10}$=0 mV; seek mode off |
| 10. Field strength output | 1 | $V_{64}$ | **1.4** | 1.75 | **2.1** | V | $V_{10}$=500 µV; seek mode off |
| 11. Field strength output | 1 | $V_{64}$ | **3** | 3.4 | **4** | V | $V_{10}$=5 mV; seek mode off |
| 12. Field strength output | 1 | $V_{64}$ | **4** | 4.4 | **5.1** | V | $V_{10}$=30 mV; seek mode off |

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

**Demodulator**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 13. AF output voltage | 1 | $V_{58AM}$ | 360 | 480 | 600 | m$V_{rms}$ | m=0.8 |
| 14. AF output voltage | Lab | $V_{58AM}$ | 283 | 406 | 550 | m$V_{rms}$ | m=0.8; Deemph=100 µs |
| 15. Total harm. distortion | 1 | $THD_{58}$ | | 0.7 | 2.5 | % | |
| 16. (S+N)/N | 1 | | **40** | **50** | | dB | m=0.8; $V_{10}$=200µV |
| 17. (S+N)/N | 1 | | **60** | **70** | | dB | m= 0.8; $V_{10}$=100m$V_{rms}$ |
| 18. AF-linearity | 1 | $\Delta_{V58}$ | | | 3 | dB | |

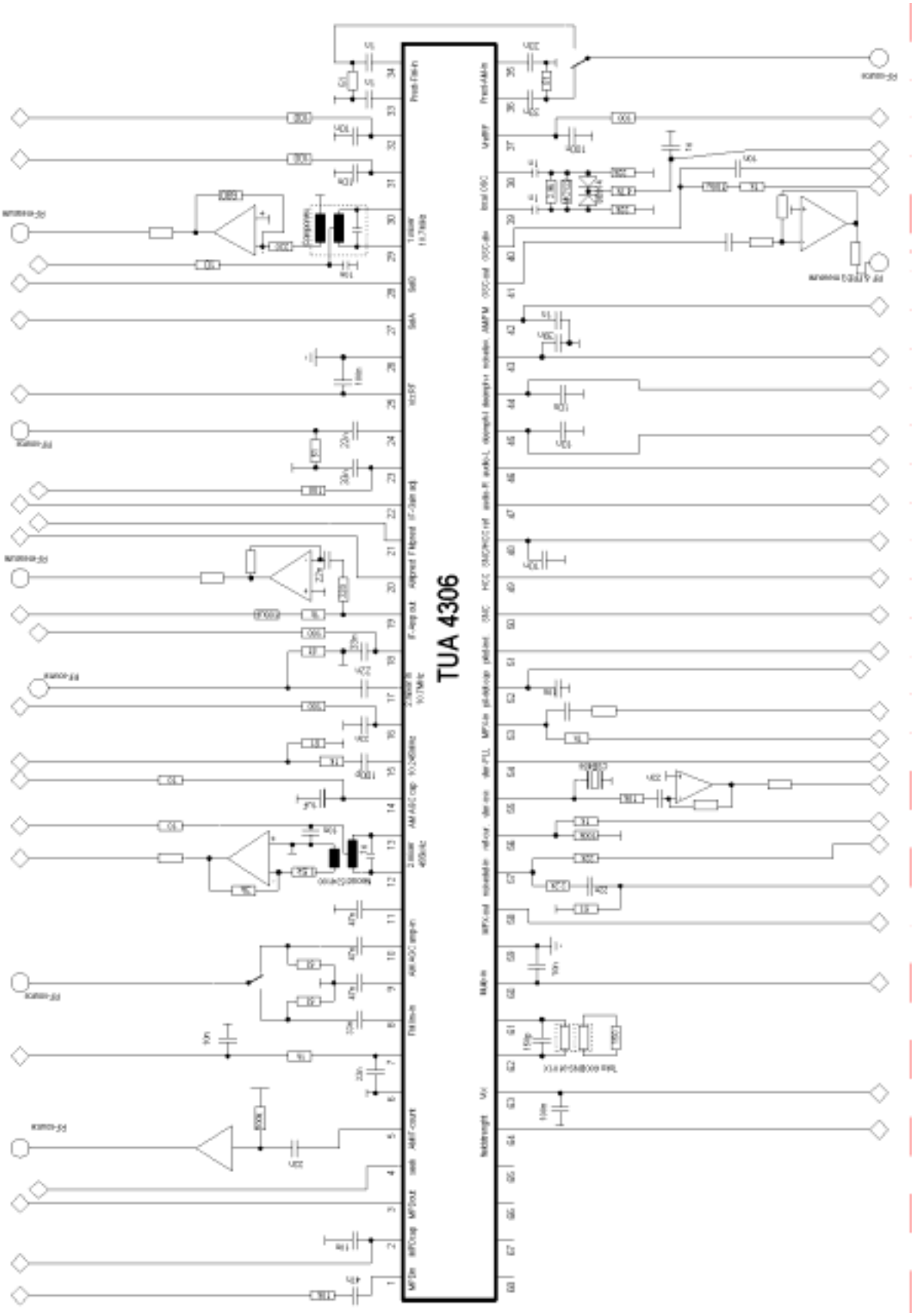
**IF - Counter**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 19. IF - counter Output voltage | 1 | $V_5$ | **220** | **270** | | $mV_{rms}$ | $R_L$=100kΩ $V_4$=0.7 V; Ref. Appl. Board |
| 20. IF-counter output voltage | 1 | $V_5$ | | | **0.5** | $V_{DC}$ | $V_4$=2.4V |
| 21. IF-counter Output voltage | 1 | $V_{5AC}$ | | | 2 | $mV_{rms}$ | $V_4$=2.4V |

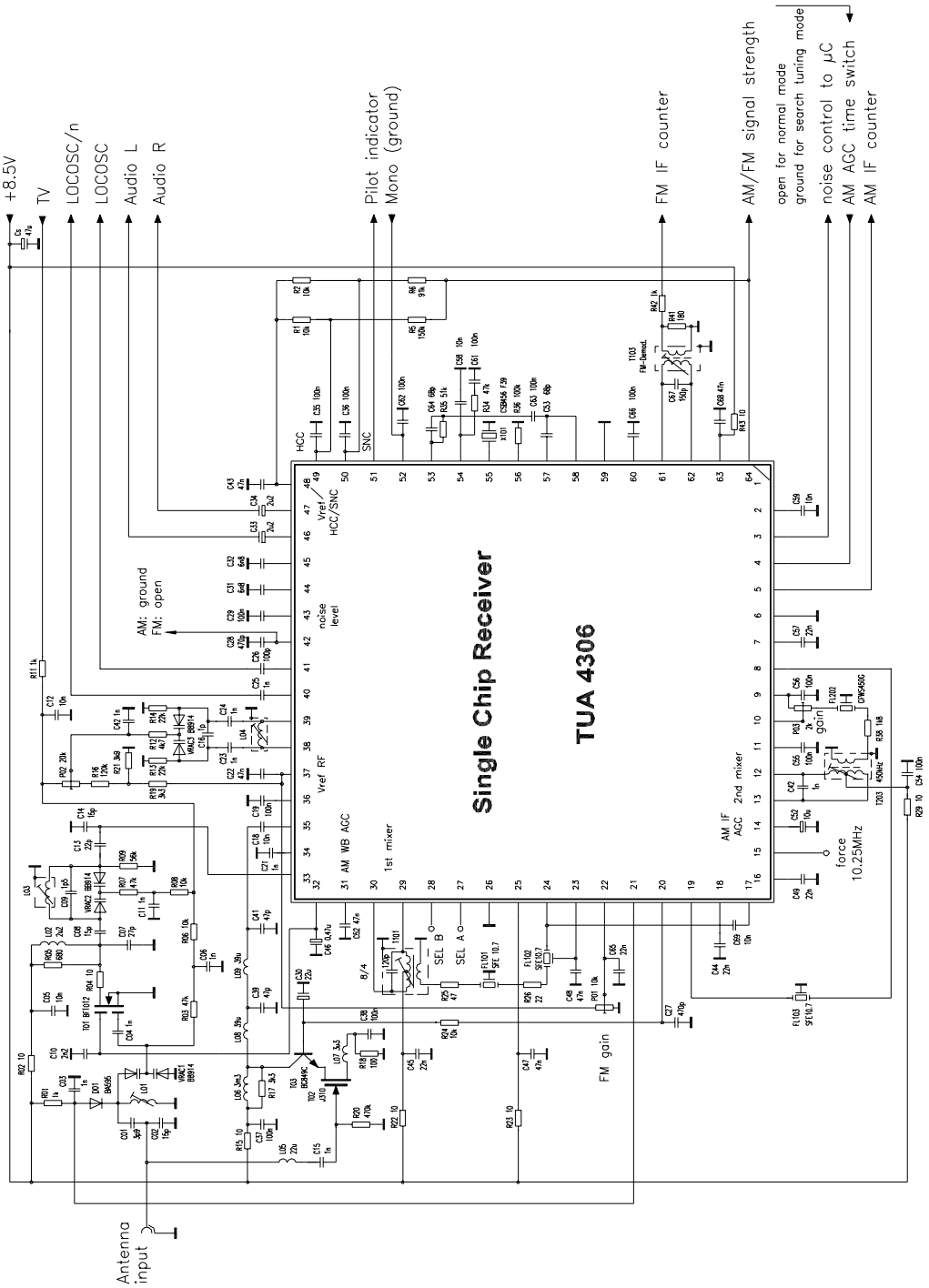
## 14 Truthtables

| AM 1st LO ECL divider truthtable | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Sel A** | **Sel B** | | | | | |
| divide by 4 | 0 | 0 | | | | | |
| divide by 6 | 0 | 1 | | | | | |
| divide by 8 | 1 | 0 | | | | | |
| divide by 10 | 1 | 1 | | | | | |

## 15 Test Circuit

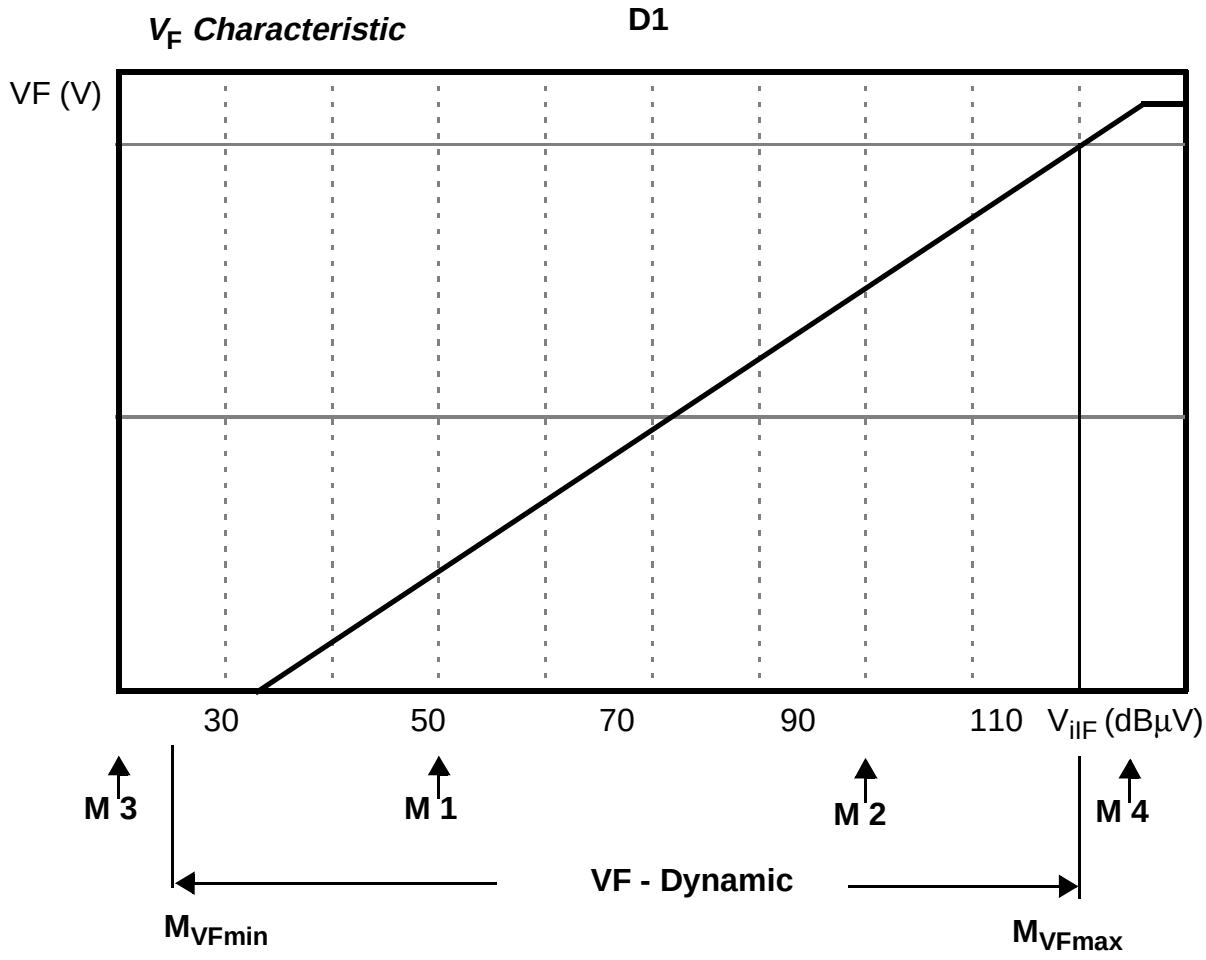


## 16 Application Circuit



Application Circuit

## 17 Diagram 1




**$V_F$ - 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)

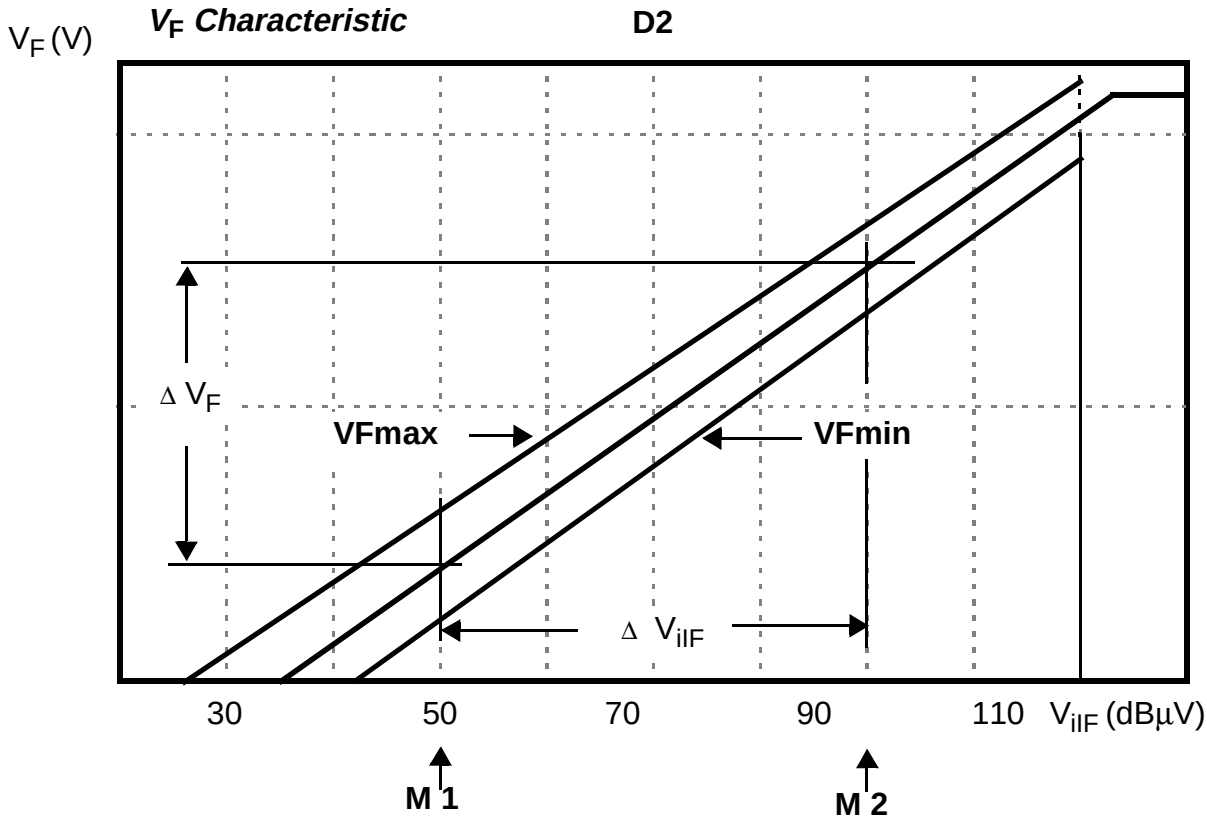
Hence follows :

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

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

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

## 18 Diagram 2




**Test points to determine $V_F$ linearity**

**VF - Linearity**: is determined at 25 °C

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

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

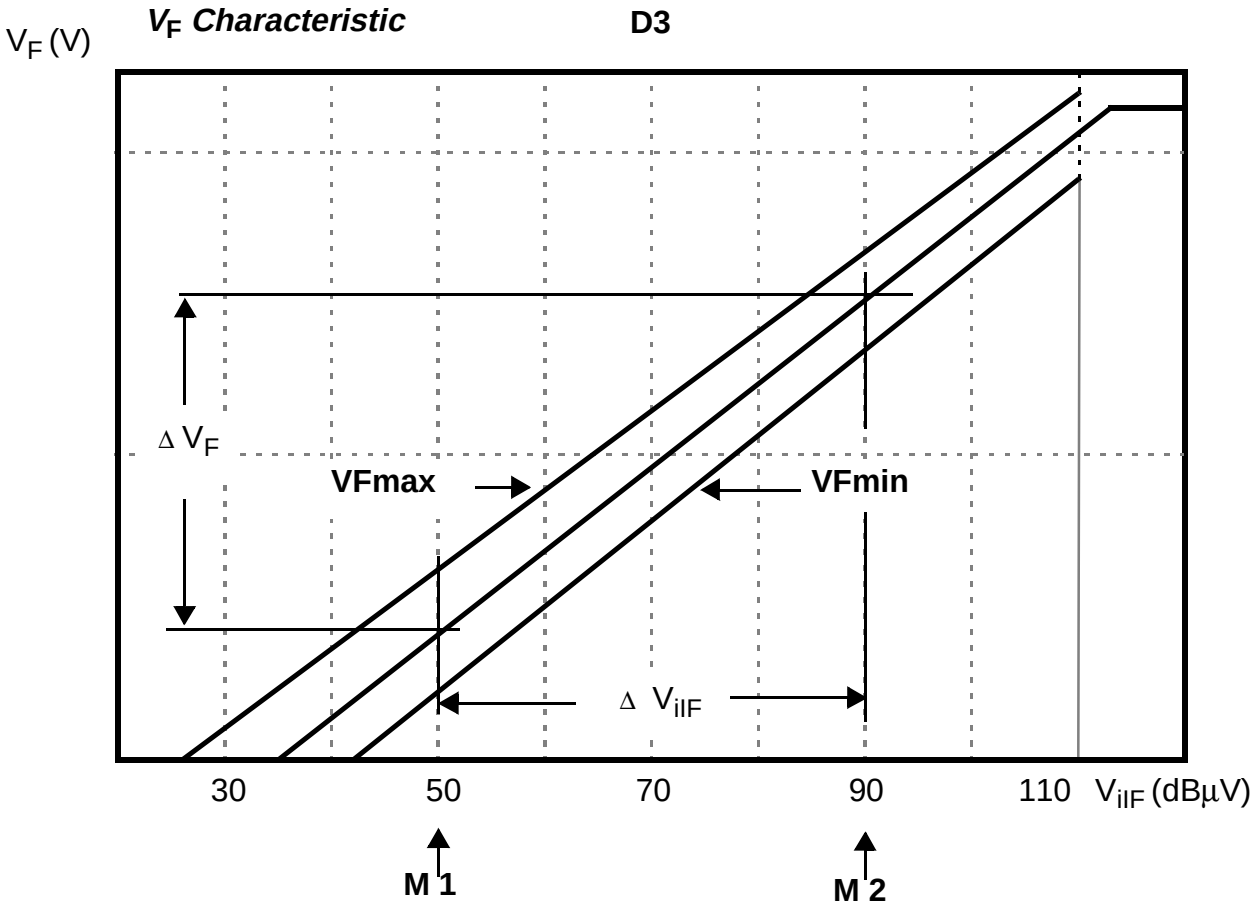
$V_{Fmax} = V_F(M1) + m\,(M + 60\ \text{dB} + 1\text{dB})$

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

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

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

## 19 Diagram 3




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

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

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

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

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

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:

**VFmin≤ VF ( M ) ≤ VFmax**