



AM/FM TUNER FOR CAR RADIO AND HIFI APPLICATIONS

FM-PART

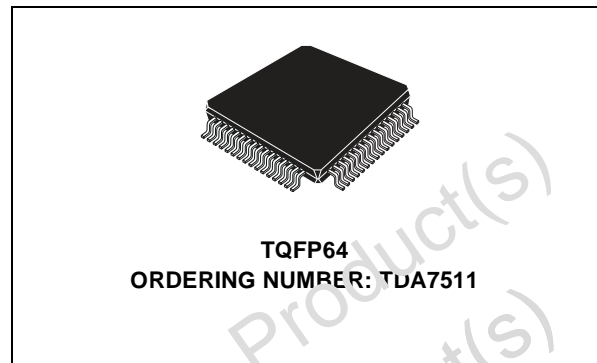
- RF AGC GENERATION BY RF AND IF DETECTION FOR PIN DIODES AND MOSFET (PRESTAGE)
- 1ST MIXER FOR 1ST FM IF 10.7MHz WITH PROGRAMMABLE IF TANK ADJUST FOR FM AND AM UPCONVERSION
- 2 PROGRAMMABLE IF-GAIN STAGES
- 2ND MIXER FOR 2ND IF 450KHz
- INTERNAL IF BANDPASS FILTER WITH THREE BANDWIDTHS CONTROLLED BY ISS (INCLUDING WEATHER BAND)
- FULLY INTEGRATED FM-DEMODULATOR

AM-PART

- WIDE AND NARROW AGC GENERATION
- PREAMPLIFIER AND MIXER FOR 1ST IF 10.7MHz, AM UPCONVERSION
- 2ND MIXER FOR 2ND IF 450 KHz
- INTEGRATED AM-DEMODULATOR
- OUTPUT FOR AM-STEREO-DECODER

ADDITIONAL FEATURES

- HIGH PERFORMANCE FAST PLL FOR RDS-SYSTEM
- IF COUNTER FOR FM AND AM UPCONVERSION WITH SEARCH STOP SIGNAL
- QUALITY DETECTOR FOR LEVEL, DEVIATION, ADJACENT CHANNEL AND



MULTIPATH

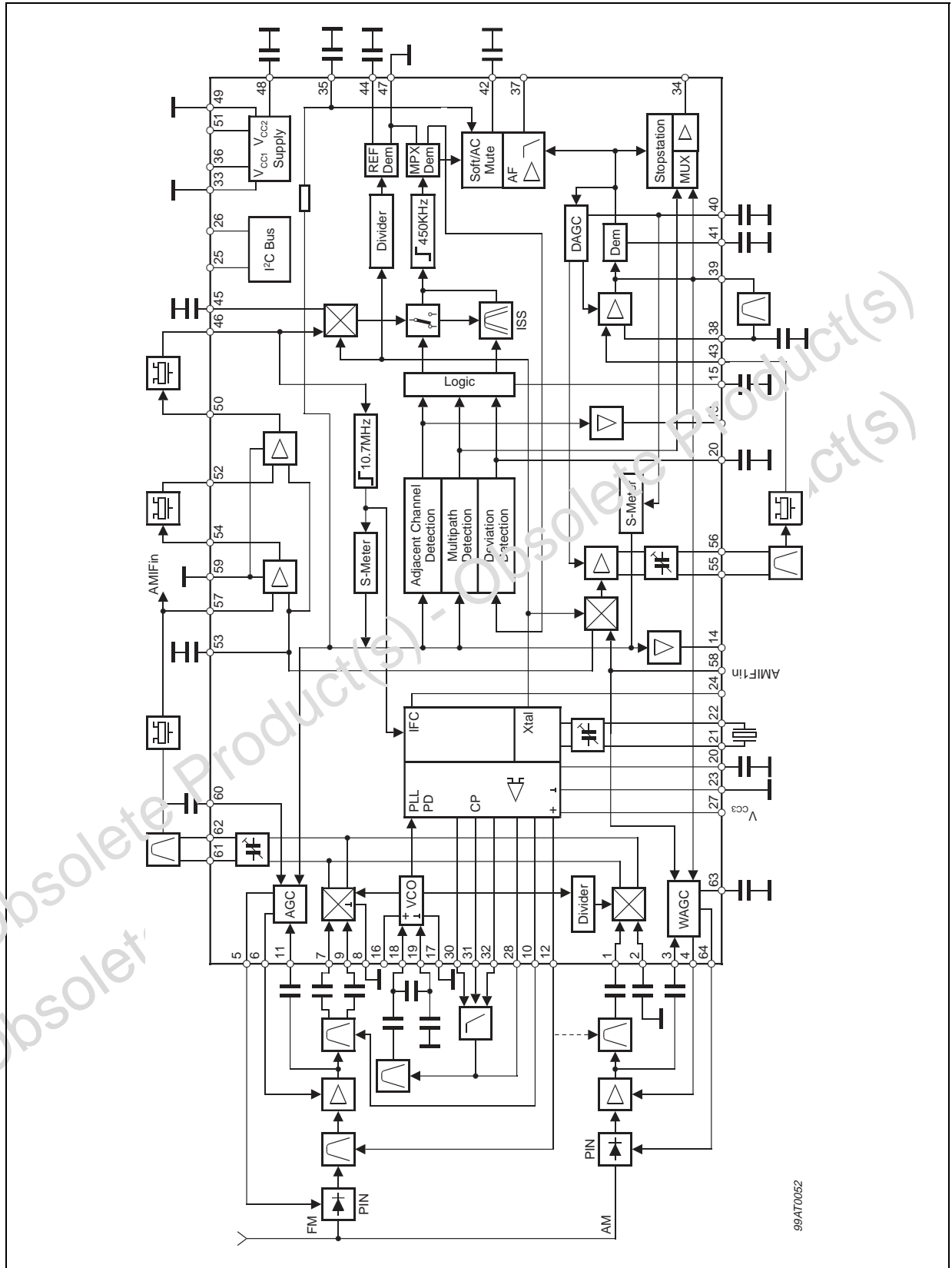
- QUALITY DETECTION INFORMATIONS AS ANALOG SIGNALS EXTERNAL AVAILABLE
- ISS (INTELLIGENT SELECTIVITY SYSTEM) FOR CANCELLATION OF ADJACENT CHANNEL AND NOISE INFLUENCES
- ADJACENT CHANNEL MUTE
- FULLY ELECTRONIC ALIGNMENT
- ALL FUNCTIONS I²C-BUS CONTROLLED
- ISS FILTER STATUS INFORMATION I²C-BUS READABLE

DESCRIPTION

The TDA 7511 is a high performance tuner circuit for AM/FM car radio. It contains mixers, IF amplifiers, demodulators for AM and FM, quality detection, ISS filter and PLL synthesizer with IF counter on a single chip.

Use of BICMOS technology allows the implementation of several tuning functions and a minimum of external components.

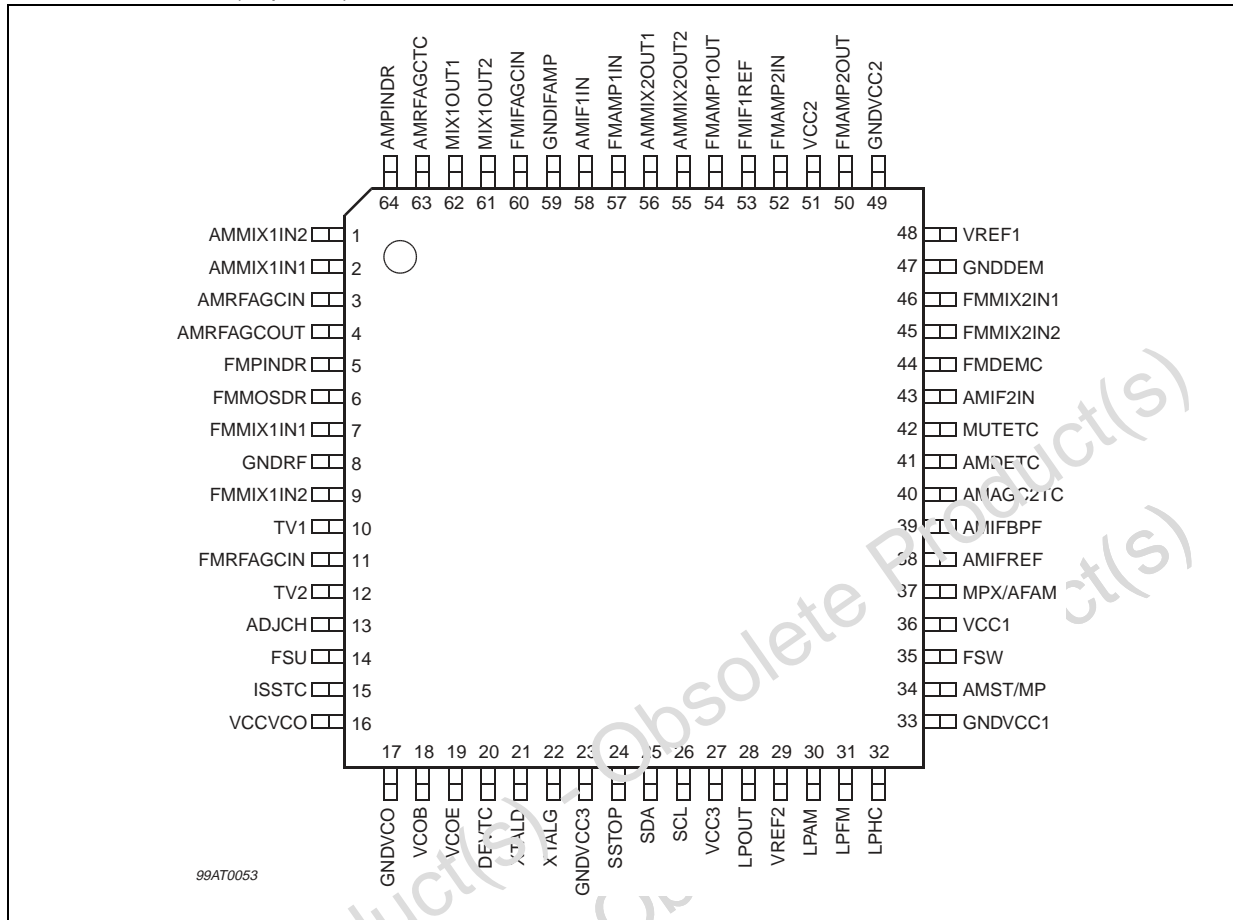
BLOCK DIAGRAM



99AT0052



PIN CONNECTION (Top view)



PIN DESCRIPTION (continued)

| N° | Pin | Function |
|----|------------|---------------------------------|
| 1 | AMMIX1IN2 | AM Input2 Mixer1 |
| 2 | AMMIX1IN1 | AM Input1 Mixer1 Reference |
| 3 | AMRFAGCIN | Input AM RF AGC |
| 4 | AMRFAGCOUT | Output AM RF AGC |
| 5 | FMPINDR | FM PIN Diode Driver Output |
| 6 | FMMOSDR | FM MOS Driver Output |
| 7 | FMMIX1IN1 | FM Input1 Mixer1 |
| 8 | GNDRF | RF Ground |
| 9 | FMMIX1IN2 | FM Input2 Mixer1 |
| 10 | TV1 | Tuning Voltage 1 |
| 11 | FMRFAGCIN | FM RF AGC Input |
| 12 | TV2 | Tuning Voltage 2 |
| 13 | ADJCH | Ident. Adjacent Channel Output |
| 14 | FSU | Unweighted Fieldstrength Output |

PIN DESCRIPTION (continued)

| N° | Pin | Function |
|----|-----------|---|
| 15 | ISSTC | Time Constant for ISS Filter Switch |
| 16 | VCCVCO | VCO Supply |
| 17 | GNDVCO | VCO Ground |
| 18 | VCOB | VCO Input Base |
| 19 | VCOE | VCO Output Emitter |
| 20 | DEVTC | Deviation Detector Time Constant |
| 21 | XTALD | Xtal Oscillator to MOS Drain |
| 22 | XTALG | Xtal Oscillator to MOS Gate |
| 23 | GNDVCC3 | VCC3 Ground |
| 24 | SSTOP | Search Stop Output |
| 25 | SDA | I ² C-Bus Data |
| 26 | SCL | I ² C-Bus Clock |
| 27 | VCC3 | Supply Tuning Voltage |
| 28 | LPOUT | Op Amp Output to PLL Loop Filters |
| 29 | VREF2 | Voltage Reference for PLL Op Amp |
| 30 | LPAM | Op Amp Input to PLL Loop Filters AM |
| 31 | LPFM | Op Amp Input to PLL Loop Filters FM |
| 32 | LPHC | High Current PLL Loop Filter Input |
| 33 | GNDVCC1 | Digital Ground |
| 34 | AMST/MP | AM Stereo Out / Ident. Multipath Output |
| 35 | FSW | Weighted Fieldstrength Output |
| 36 | VCC1 | Digital Supply |
| 37 | MPX/AFAM | MPX Output / AM AF Output |
| 38 | AMIFREF | Reference Voltage AM IF Amp |
| 39 | AMIFBPF | AM IF Filter |
| 40 | AMAGC2TC | AM AGC2 Time Constant |
| 41 | AMDETC | AM Detector Capacitor |
| 42 | MUTETC | Softmute Time Constant |
| 43 | AMIF2IN | Input AM IF2 |
| 44 | FMDEMC | FM Demodulator Reference |
| 45 | FMMIX2IN2 | FM IF1 MIX2 Input1 |
| 46 | FMMIX2IN1 | FM IF1 MIX2 Input2 |
| 47 | GNDDEM | Ground FM Demodulator |
| 48 | VREF1 | Reference 5V |
| 49 | GNDVCC2 | Analog Ground |
| 50 | FMAMP2OUT | FM IF1 Amplifier2 Output |

PIN DESCRIPTION (continued)

| N° | Pin | Function |
|----|------------|----------------------------|
| 51 | VCC2 | Analog Supply |
| 52 | FMAMP2IN | FM IF1 Amplifier2 Input |
| 53 | FMIF1REF | FM IF1 Amplifier Reference |
| 54 | FMAMP1OUT | FM IF1 Amplifier1 Output |
| 55 | AMMIX2OUT2 | AM Tank 450kHz |
| 56 | AMMIX2OUT1 | AM Tank 450kHz |
| 57 | FMAMP1IN | FM IF1 Amplifier1 Input |
| 58 | AMIF1IN | AM IF1 Input |
| 59 | GNDIF1AMP | FM IF1 Amplifier Ground |
| 60 | FMIF1AGCIN | FM IF1 AGC Input |
| 61 | MIX1OUT2 | MIX Tank 10.7MHz |
| 62 | MIX1OUT1 | MIX Tank 10.7MHz |
| 63 | AMRFAGCTC | AM RF AGC Time Constant |
| 64 | AMPINDR | AM PIN Diode Driver Output |

ABSOLUTE MAXIMUM RATINGS

| Symbol | Parameter | Value | Unit |
|------------------|---------------------|-------------|------|
| V _S | Supply Voltage | 10.5 | V |
| T _{amb} | Ambient Temperature | -40 to 85 | °C |
| T _{stg} | Storage Temperature | -55 to +150 | °C |

THERMAL DATA

| Symbol | Parameter | Value | Unit |
|------------------------|--------------------|-------|------|
| R _{Th(j-amb)} | Thermal resistance | 68 | °C/W |

ELECTRICAL CHARACTERISTICS

T_{amb} = +25°C, V_{CC1} = V_{CC2} = V_{CC3} = V_{CCVCO} = V_{CCMIX1} = 8.5V, f_{RF} = 98MHz, dev. = 40kHz, f_{MOD} = 1kHz, f_{IF1} = 10.7MHz, f_{IF2} = 450KHz, f_{Xtal} = 10.25MHz, in test or application circuit, unless otherwise specified.

| Symbol | Parameter | Test Condition | Min. | Typ. | Max. | Unit |
|--------------------|------------------------|----------------|------|------|------|------|
| Supply | | | | | | |
| V _{CC1} | Digital supply voltage | | 7.5 | 8.5 | 10 | V |
| V _{CC2} | Analog supply voltage | | 7.5 | 8.5 | 10 | V |
| V _{CC3} | Analog tuning voltage | | 7.5 | 8.5 | 10 | V |
| V _{CCVCO} | VCO supply voltage | | 7.5 | 8.5 | 10 | V |

ELECTRICAL CHARACTERISTICS (continued)

$T_{amb} = +25^{\circ}\text{C}$, $V_{CC1} = V_{CC2} = V_{CC3} = V_{CCVCO} = V_{CCMIX1} = 8.5\text{V}$, $f_{RF} = 98\text{MHz}$, dev. = 40kHz,
 $f_{MOD} = 1\text{kHz}$, $f_{IF1} = 10.7\text{MHz}$, $f_{IF2} = 450\text{kHz}$, $f_{Xtal} = 10.25\text{MHz}$, in test or application circuit, unless otherwise specified.

| Symbol | Parameter | Test Condition | Min. | Typ. | Max. | Unit |
|---|----------------------------|---|-------------------------|-------|------|------------------------|
| V_{CCMIX1} | MIX1 supply voltage | | 7.5 | 8.5 | 10 | V |
| V_{CCMIX2} | MIX2 supply voltage | | 7.5 | 8.5 | 10 | V |
| I_{CC1} | Supply current | FM ON | | 7.5 | | mA |
| I_{CC1} | Supply current | AM ON | | 10 | | mA |
| I_{CC2} | Supply current | FM ON | | 50 | | mA |
| I_{CC2} | Supply current | AM ON | | 60 | | mA |
| I_{CC3} | Supply current | | | 2 | | mA |
| I_{CCVCO} | Supply current | | | 2.5 | | mA |
| I_{CCMIX1} | Supply current | FM ON | | 6 | | mA |
| I_{CCMIX1} | Supply current | AM ON | | 5 | | mA |
| I_{CCMIX2} | Supply current | AM ON | | 5 | | mA |
| Reference Voltages | | | | | | |
| V_{REF1} | Internal reference voltage | $I_{REF1} = 0\text{mA}$ | | 5 | | V |
| V_{REF2} | Internal reference voltage | $I_{REF2} = 0\text{nA}$ | | 2.5 | | V |
| Wide Band RF AGC | | | | | | |
| V_{11} | Threshold AGC start | $V_6 = V_{CC2}/2$ | | 80 | | $\text{dB}\mu\text{V}$ |
| R_{IN} | Input resistance | | | 500 | | Ω |
| C_{IN} | Input capacitance | | | 2.5 | | pF |
| Narrow Band RF & Kevir g A C C | | | | | | |
| V_{60} | Lower threshold | FMAGC, $V_{11} = 0\text{mV}_{RMS}$ | | 82 | | $\text{dB}\mu\text{V}$ |
| V_{60} | Upper threshold | FMAGC, $V_{11} = 0\text{mV}_{RMS}$ | | 92 | | $\text{dB}\mu\text{V}$ |
| R_{IN} | Input resistance | | | 10 | | $\text{k}\Omega$ |
| C_{IN} | Input capacitance | | | 2.5 | | pF |
| AGC MOSFET Driver Output | | | | | | |
| V_6 | Max. AGC output voltage | $V_{11} = 0\text{mV}_{RMS}$ | $V_{CC2} - 0.5\text{V}$ | | | V |
| V_6 | Min. AGC output voltage | $V_{11} = 50\text{mV}_{RMS}$ | | | 0.5 | V |
| I_6 | Min. AGC charge current | $V_{11} = 0\text{mV}_{RMS}, V_6 = V_{CC2}/2$ | | -12.5 | | μA |
| I_6 | Max. AGC discharge current | $V_{11} = 50\text{mV}_{RMS}, V_6 = V_{CC2}/2$ | | 1.25 | | mA |
| AGC PIN Diode Driver Output | | | | | | |
| I_5 | AGC OUT, current min. | $V_{11} = 0\text{mV}_{RMS}, V_5 = 2\text{V}$ | | 50 | | μA |
| I_5 | AGC OUT, current max. | $V_{11} = 50\text{mV}_{RMS}, V_5 = 2\text{V}$ | | -6 | | mA |
| Mixer1 (10.7MHz) | | | | | | |
| R_{IN} | Input impedance | Balanced, $f = 98\text{MHz}$ | | 9 | | Ω |

ELECTRICAL CHARACTERISTICS (continued)

$T_{amb} = +25^{\circ}\text{C}$, $V_{CC1} = V_{CC2} = V_{CC3} = V_{CCVCO} = V_{CCMIX1} = 8.5\text{V}$, $f_{RF} = 98\text{MHz}$, dev. = 40kHz,
 $f_{MOD} = 1\text{kHz}$, $f_{IF1} = 10.7\text{MHz}$, $f_{IF2} = 450\text{kHz}$, $f_{Xtal} = 10.25\text{MHz}$, in test or application circuit, unless otherwise specified.

| Symbol | Parameter | Test Condition | Min. | Typ. | Max. | Unit |
|--|---------------------------|--|------|------|------|-------------------|
| IP3 | 3rd order intercept point | | | 122 | | dB μV |
| F | Noise figure | | | 6 | | dB |
| A _C | Conversion gain | | | 120 | | mS |
| IF1 Amplifier1 & 2 (10.7MHz) | | | | | | |
| A _{min} | Min. gain | IFG | | 9 | | dB |
| A _{max} | Max. gain | IFG | | 15 | | dB |
| R _{IN} | Input resistance | | | 330 | | Ω |
| R _{OUT} | Output resistance | | | 300 | | Ω |
| P _{1dB} | 1dB compression point | Output referred | | 120 | | dB μV |
| IP3 | 3rd order Intercept Point | Output referred | | 132 | | dB μV |
| Mixer2 (450kHz) | | | | | | |
| R _{IN} | Input impedance | | | 330 | | Ω |
| V ₄₆ | Max. input voltage | | | 900 | | mV _{RMS} |
| V ₄₈ | Limiting sensitivity | S/N = 20dB | | 25 | | μV |
| A | Mixer gain | | | 18 | | dB |
| Limiter 1 (450kHz) | | | | | | |
| G _{Limiter} | Gain | | | 80 | | dB |
| Demodulator, Audio Output | | | | | | |
| THD | | Dev.= 75kHz, V ₄₆ = 10mV _{RMS} | | | 0.1 | % |
| V _{MPX} | MPX output signal | Dev.= 75kHz | | 500 | | mV _{RMS} |
| R _{OUT} | Output resistance | | | 350 | | Ω |
| $ \Delta V _{min}$ | DC offset fine adjust | DEM, MENA=1 | | 6 | | mV |
| $ \Delta V _{max}$ | DC offset fine adjust | DEM, MENA=1 | | 186 | | mV |
| S/N | | Dev.= 40kHz, V ₄₆ = 10mV _{RMS} | | 75 | | dB |
| Quality Detection | | | | | | |
| S-meter, Unweighted Fieldstrength | | | | | | |
| V ₄₆ | Min. input voltage MIX2 | | | 10 | | μV |
| ΔV | Per decade | SMSL = 0 | | 1 | | V |
| ΔV | Per decade | SMSL = 1 | | 1.5 | | V |
| V ₁₄ | Fieldstrength output | V ₄₆ = 0V _{RMS} | | 0.1 | | V |
| V ₁₄ | Fieldstrength output | V ₄₆ = 1V _{RMS} | | 4.9 | | V |
| R _{OUT} | Output resistance | | | 4 | | k Ω |

ELECTRICAL CHARACTERISTICS (continued)

T_{amb} = +25°C, V_{CC1} = V_{CC2} = V_{CC3} = V_{CCVCO} = V_{CCMIX1} = 8.5V, f_{RF} = 98MHz, dev. = 40kHz, f_{MOD} = 1kHz, f_{IF1} = 10.7MHz, f_{IF2} = 450kHz, f_{Xtal} = 10.25MHz, in test or application circuit, unless otherwise specified.

| Symbol | Parameter | Test Condition | Min. | Typ. | Max. | Unit |
|---|-------------------------|-------------------------------------|------|------|------|-------|
| ΔV ₁₄ | S-meter shift voltage | SL | -1.8 | | 1.8 | V |
| TK | Temp coeff. | | | 0 | | ppm/K |
| S-meter, Weighted Fieldstrength | | | | | | |
| V ₃₅ | Fieldstrength output | V ₄₆ = 0V _{RMS} | | 2.5 | | V |
| V ₃₅ | Fieldstrength output | V ₄₆ = 1V _{RMS} | | 4.9 | | V |
| R _{OUT} | Output resistance | | | 12 | | Ω |
| Adjacent Channel Gain | | | | | | |
| A _{min} | Gain minimum | ACG | | 32 | | dB |
| A _{max} | Gain maximum | ACG | | 36 | | dB |
| Adjacent Channel Filter | | | | | | |
| f _{HP} | -3dB frequency highpass | ACF | | 100 | | kHz |
| f _{BP} | Centre frequency | ACF | | 100 | | kHz |
| f _{-20dB} | Attenuation 20dB | | | 70 | | kHz |
| Adjacent Channel Output | | | | | | |
| V ₁₃ | Output voltage low | | | 0.1 | | V |
| V ₁₃ | Output voltage high | | | 4.9 | | V |
| R _{OUT} | Output resistance | | | 4 | | kΩ |
| Multipath Channel Gain | | | | | | |
| A _{min} | Gain minimum | MPG | | 12 | | dB |
| A _{max} | Gain maximum | MPG | | 23 | | dB |
| Multipath Bandpass Filter | | | | | | |
| f _{Lower} | Centre frequency low | MPF | | 19 | | kHz |
| f _{Upper} | Centre frequency up | MPF | | 31 | | kHz |
| Q | Quality factor | | 5 | | 10 | |
| Multipath Output | | | | | | |
| V ₃₄ | Output voltage low | | | 0.1 | | V |
| V ₃₄ | Output voltage high | | | 4.9 | | V |
| R _{OUT} | Output resistance | | | 2.5 | | kΩ |
| ISS (intelligent Selectivity System) | | | | | | |
| Filter 450kHz | | | | | | |
| f _{centre} | Centre frequency | f _{REF_intern} = 450kHz | | 450 | | kHz |
| BW 3dB | Bandwidth, -3dB | ISS80 = 1 | | 80 | | kHz |
| BW 20dB | Bandwidth, -20dB | ISS80 = 1 | | 150 | | kHz |

ELECTRICAL CHARACTERISTICS (continued)

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 $f_{MOD} = 1\text{kHz}$, $f_{IF1} = 10.7\text{MHz}$, $f_{IF2} = 450\text{kHz}$, $f_{Xtal} = 10.25\text{MHz}$, in test or application circuit, unless otherwise specified.

| Symbol | Parameter | Test Condition | Min. | Typ. | Max. | Unit |
|--|----------------------------|------------------|------|------|------|---------------|
| BW 3dB | Bandwidth, -3dB | ISS80 = 0 | | 120 | | kHz |
| BW 20dB | Bandwidth, -20dB | ISS80 = 0 | | 250 | | kHz |
| BW 3dB | Bandwidth weather band | ISS30 = 1 | | 30 | | kHz |
| BW 20dB | -20dB weather band | ISS30 = 1 | | 80 | | kHz |
| Δf_{min} | Fine adjust | AISS | | -20 | | kHz |
| Δf_{max} | Fine adjust | AISS | | 10 | | kHz |
| Adjacent Channel ISS Filter Threshold | | | | | | |
| V_{NTH} | Internal low threshold | ACNTH | | 0 | | V |
| V_{NTH} | Internal high threshold | ACNTH | | 0.3 | | V |
| V_{WTH} | Internal low threshold | ACWTH | | 0.25 | | V |
| V_{WTH} | Internal high threshold | ACWTH | | 0.95 | | V |
| Multipath Threshold | | | | | | |
| V_{THMP} | Internal low threshold | MPTH | | 0.50 | | V |
| V_{THMP} | Internal high threshold | MPTH | | 1.25 | | V |
| ISS Filter Time Constant | | | | | | |
| I_{15} | Charge current low mid | TISS, ISSCTL = 1 | | -74 | | μA |
| I_{15} | Charge current high mid | TISS, ISSCTL = 1 | | -60 | | μA |
| I_{15} | Charge current low narrow | TISS, ISSCTL = 1 | | -124 | | μA |
| I_{15} | Charge current high narrow | TISS, ISSCTL = 1 | | -110 | | μA |
| I_{15} | Discharge current low | TISS, ISSCTL = 0 | | 1 | | μA |
| I_{15} | Discharge current high | TISS, ISSCTL = 0 | | 15 | | μA |
| V_{15} | Low voltage | ISSCTL = 0 | | 0.1 | | V |
| V_{15} | High voltage | ISSCTL = 1 | | 4.9 | | V |
| ISS Filter Switch Threshold | | | | | | |
| V_{15} | Threshold ISS on | ISSCTL = 0 | | 3 | | V |
| V_{15} | Threshold ISS off | ISSCTL = 0 | | 1 | | V |
| V_{15} | Threshold ISS narrow on | ISSCTL = 0 | | 4 | | V |
| V_{15} | Threshold ISS narrow off | ISSCTL = 0 | | 2 | | V |
| I_{20} | Charge current low | TDEV | | -20 | | μA |
| I_{20} | Charge current high | TDEV | | -34 | | μA |
| I_{20} | Discharge current low | TDEV | | 6 | | μA |
| I_{20} | Discharge current high | TDEV | | 20 | | μA |

TDA7511

ELECTRICAL CHARACTERISTICS (continued)

$T_{amb} = +25^{\circ}\text{C}$, $V_{CC1} = V_{CC2} = V_{CC3} = V_{CCVCO} = V_{CCMIX1} = 8.5\text{V}$, $f_{RF} = 98\text{MHz}$, dev. = 40kHz, $f_{MOD} = 1\text{kHz}$, $f_{IF1} = 10.7\text{MHz}$, $f_{IF2} = 450\text{kHz}$, $f_{xtal} = 10.25\text{MHz}$, in test or application circuit, unless otherwise specified.

| Symbol | Parameter | Test Condition | Min. | Typ. | Max. | Unit |
|----------------------|--|--|------|-------|------|------------|
| DEV _{WTH} | Internal low threshold | DWTH | | 30 | | kHz |
| DEV _{WTH} | Internal high threshold | DWTH | | 75 | | kHz |
| RATIO _{min} | Referred to threshold | DTH | | 1 | | |
| RATIO _{max} | Referred to threshold | DTH | | 1.5 | | |
| Softmute | | | | | | |
| V _{ANT} | Upper startpoint | SMTH, SMD, SLOPE = 0 | | 16 | | dB μ V |
| V _{ANT} | lower startpoint | SMTH, SMD, SLOPE = 0 | | | | dB μ V |
| aSM _{min} | Min. softmute depth | SMD, SLOPE = 0, SMTH _{Upper} | | 18 | | dB |
| aSM _{max} | Max. softmute depth | SMD, SLOPE = 0, SMTH _{Upper} | | 36 | | dB |
| aSM _{THIS} | Mute depth threshold for ISS filter on | SMCTH | 0.2 | | 2 | dB |
| V _{ACTH} | Internal AC mute threshold | ACM | 60 | | 220 | mV |
| aSMAC | AC mute depth | | | 6 | | dB |
| I ₄₂ | Charge current | | | -47.5 | | μ A |
| I ₄₂ | Discharge current | | | 2.5 | | μ A |
| S/N Over All | | | | | | |
| S/N | | V _{IN_min} = 60dB μ V, dev. = 40kHz, LP=15kHz deemphasis t = 50 μ s | | 66 | | dB |

ELECTRICAL CHARACTERISTICS

$T_{amb} = +25^{\circ}\text{C}$, $V_{CC1} = V_{CC2} = V_{CC3} = V_{CCVCO} = V_{CCMIX1} = V_{CCMIX2} = 8.5\text{V}$, $f_{RF} = 1\text{MHz}$, $f_{MOD} = 400\text{Hz}$ at 30% AM $f_{IF1} = 10.7\text{MHz}$, $f_{IF2} = 450\text{kHz}$, $f_{xtal} = 10.25\text{MHz}$, in test or application circuit, (unless otherwise noted, V_{inRF} antenna input).

| Symbol | Parameter | Test Condition | Min. | Typ. | Max. | Unit |
|-----------------------|-----------------------|---|------|------|------|------------|
| AM SECTION | | | | | | |
| Global | | | | | | |
| V _{INRF_min} | Max. sensitivity | Ref.: V _{INRF} = 74dB μ V, $\Delta V_{37} = -10\text{dB}$ | | 19 | | dB μ V |
| V _{INRF_US} | Usable sensitivity | (S+N)/N = 20 dB | 30 | 26 | | dB μ V |
| ΔV_{INRF} | AGC Range | Ref.: V _{INRF} = 74dB μ V, $\Delta V_{37} = -10\text{dB}$ | 51 | | | dB |
| (S+N)/N | Signal to Noise Ratio | Ref.: V _{INRF} = 74dB μ V | 49 | 56 | | dB |

ELECTRICAL CHARACTERISTICS (continued)

$T_{amb} = +25^{\circ}\text{C}$, $V_{CC1} = V_{CC2} = V_{CC3} = V_{CCVCO} = V_{CCMIX1} = V_{CCMIX2} = 8.5\text{V}$, $f_{RF} = 1\text{MHz}$, $f_{MOD} = 400\text{Hz}$ at 30% AM, $f_{IF1} = 10.7\text{MHz}$, $f_{IF2} = 450\text{kHz}$, $f_{xtal} = 10.25\text{MHz}$, in test or application circuit, (unless otherwise noted, V_{inRF} antenna input).

| Symbol | Parameter | Test Condition | Min. | Typ. | Max. | Unit |
|------------------------------------|--|---|------------|--------------------------|------|--------------------------------------|
| a_{IF} | IF rejection | Ref: $V_{inRF} = 74\text{dB}\mu\text{V}$, IF1 = 10.7MHz IF2 = 450kHz $\Delta V_{37} = -10\text{dB}$ | 100 100 | | | dB dB |
| a_{TW} | Tweet | $C_{28} = 22\mu\text{F}$ | -3 | -0.7 | | dB |
| f_{AF} | Frequency response | Ref.: $V_{inRF} = 74\text{dB}\mu\text{V}$, $\Delta V_{AF} = -3\text{dB}$ | | 3.6 | | kHz |
| V_{inRFSS} | Seek Stop Sensitivity | AMSS | 20 | 35 | 45 | dB μV |
| THD | Total Harmonic Distortion | $V_{inRF} = 74\text{dB}\mu\text{V}$, $m = 0.8$ $m = 0.3$ $V_{inRF} = 120\text{dB}\mu\text{V}$, $m = 0.8$ $m = 0.3$ | | 0.5 0.3 1.0 0.3 | | % |
| V_{37} | Output level | $V_{inRF} = 74\text{dB}\mu\text{V}$ | | 220 | | mV $_{RMS}$ |
| V_{34} | Output level | $V_{inRF} = 74\text{dB}\mu\text{V}$ | | 190 | | mV $_{RMS}$ |
| V_3 | Min. RF AGC threshold Max. RF AGC threshold | AMAGC Wide | | 82 98.8 | | dB μV dB μV |
| V_{58} | Min. IF AGC threshold Max. IF AGC threshold | AMAGC Middle | | 80.1 96.8 | | dB μV dB μV |
| V_3 | Min. IF AGC threshold Max. IF AGC threshold | DAGC Narrow | | 32.6 80.7 | | dB μV dB μV |
| R_{63OUT} | Output impedance | | | 100 | | k Ω |
| R_{40OUT} | Output impedance | AMSEEK = 0 | | 150 | | k Ω |
| R_{40JT} | Output impedance | AMSEEK = 1 | | 5 | | k Ω |
| A3C Voltage Driver Output | | | | | | |
| V_4 | Max. AGC output voltage | | 3.5 | | | V |
| V_4 | Min. AGC output voltage | | | | 0.5 | V |
| $ I_4 $ | AGC current | | | 100 | | μA |
| AGC PIN Diode Driver Output | | | | | | |
| I_{64} | AGC driver current | | | 1.5 | | mA |
| AM Mixer1 (10.7MHz) | | | | | | |
| R_{IN} | Input impedance | | | 1.2 | | k Ω |
| IP3 | 3rd order intercept point | | | 140 | | dB μV |
| F | Noise figure | | | 7 | | dB |

TDA7511

ELECTRICAL CHARACTERISTICS (continued)

$T_{amb} = +25^{\circ}\text{C}$, $V_{CC1} = V_{CC2} = V_{CC3} = V_{CCVCO} = V_{CCMIX1} = V_{CCMIX2} = 8.5\text{V}$, $f_{RF} = 1\text{MHz}$, $f_{MOD} = 400\text{Hz}$ at 30% AM, $f_{IF1} = 10.7\text{MHz}$, $f_{IF2} = 450\text{kHz}$, $f_{xtal} = 10.25\text{MHz}$, in test or application circuit, (unless otherwise noted, V_{inRF} antenna input).

| Symbol | Parameter | Test Condition | Min. | Typ. | Max. | Unit |
|---------------------------|---------------------------|--------------------------|------|------|------|------------|
| A | Gain | | | 6 | | dB |
| C_{min} | Min. capacitance step | IF1T | | 0.55 | | pF |
| C_{max} | Max. capacitance | IF1T | | 8.25 | | pF |
| C_{61-62} | | IF1T | | 2 | | pF |
| AM Mixer2 (450kHz) | | | | | | |
| R_{IN} | Input impedance | Dependent on application | | 5 | | k Ω |
| IP3 | 3rd order intercept point | | | 15.0 | | dB μ V |
| F | Noise figure | | | 12 | | dB |
| A | Max. gain | Mixer2 tank output | | 15 | | dB |
| ΔA | Gain control range | | | 20 | | dB |
| C_{min} | Min. cap step | IF2T | | 1.6 | | pF |
| C_{max} | Max. cap | IF2T | | 24 | | pF |
| C_{55-56} | | IF2T | | 2 | | pF |

ELECTRICAL CHARACTERISTICS

| Symbol | Parameter | Test Condition | Min. | Typ. | Max. | Unit |
|--|----------------------------------|---|------|-------|---------------------|------------|
| ADDITIONAL PARAMETERS | | | | | | |
| Outputs of Tuning Voltage(TV1, TV2) | | | | | | |
| V_{OUT} | Output voltage | TVR, TVO | 1 | | $V_{CC3}-1\text{V}$ | V |
| R_{OUT} | Output impedance | | | 20 | | k Ω |
| Xtal Reference Oscillator | | | | | | |
| f_{LO} | Reference frequency | $C_{Load} = 15\text{pF}$ | | 10.25 | | MHz |
| C_{Step} | Min. cap step | XTAL | | 0.6 | | pF |
| C_{max} | Max. cap | XTAL | | 19.4 | | pF |
| $\Delta f/f$ | Freq. deviation versus V_{CC2} | $\Delta V_{CC2} = 1\text{V}$ | | 1.5 | | ppm/V |
| $\Delta f/f$ | Freq. deviation versus temp | $-40^{\circ}\text{C} < T < +85^{\circ}\text{C}$ | | 0.2 | | ppm/K |
| I²C-Bus interface | | | | | | |
| f_{SCL} | Clock frequency | | | | 400 | kHz |
| V_{IL} | Input low voltage | | | | 1 | V |

ELECTRICAL CHARACTERISTICS (continued)

| Symbol | Parameter | Test Condition | Min. | Typ. | Max. | Unit |
|--|--------------------------------|--|-----------------|------------------|------|------------|
| V_{IH} | Input high voltage | | 3 | | | V |
| I_{IN} | Input current | | -5 | | 5 | μ A |
| V_O | Output voltage SDA acknowledge | $I_O = 1.6\text{mA}$ | | | 0.4 | V |
| Loop Filter Input/Output | | | | | | |
| $-I_{IN}$ | Input leakage current | $V_{IN} = \text{GND}, \text{PD}_{OUT} = \text{Tristate}$ | -0.1 | | 0.1 | μ A |
| I_{IN} | Input leakage current | $V_{IN} = V_{REF1}$ $\text{PD}_{OUT} = \text{Tristate}$ | -0.1 | | 0.1 | μ A |
| V_{OL} | Output voltage Low | $I_{OUT} = -0.2\text{mA}$ | | 0.05 | 0.5 | V |
| V_{OH} | Output voltage High | $I_{OUT} = 0.2\text{mA}$ | $V_{CC3} - 0.5$ | $V_{CC3} - 0.05$ | | V |
| I_{OUT} | Output current, sink | $V_{OUT} = 1\text{V to } V_{CC3} - 1\text{V}$ | | | 10 | mA |
| I_{OUT} | Output current, source | $V_{OUT} = 1\text{V to } V_{CC3} - 1\text{V}$ | -10 | | | mA |
| Voltage Controlled Oscillator (VCO) | | | | | | |
| f_{VCOmin} | Minimum VCO frequency | | 50 | | | MHz |
| f_{VCOmax} | Maximum VCO frequency | | | | 200 | MHz |
| C/N | Carrier to Noise | 1% Hz offset | | 85 | | dBc |
| SSTOP Output | | | | | | |
| V_{24} | Output voltage low | $I_{24} = -20\mu\text{A}$ | | | 0.2 | V |
| V_{24} | Output voltage high | $I_{24} = 20\mu\text{A}$ | 3 | | | V |
| V_{46} | IF counter sensitivity | Antenna input | | 6 | | dB μ V |

1 FUNCTIONAL DESCRIPTION

1.1 FM Section

1.2 Mixer1, AGC and 1.IF

Mixer1 is a wide dynamic range stage with low noise and large input signal performance. The mixer1 tank can be adjusted by software (IF1T). The AGC operates on different sensitivities and bandwidths (FMAGC) in order to improve the input sensitivity and dynamic range (keying AGC). The output signals of AGC are controlled voltage and current for preamplifier and prestage pin diode attenuator. (look at Figure 4)

Two 10.7MHz programmable amplifiers (IFG1, IFG2) correct the IF ceramic insertion loss and the customer level plan application.

1.3 Mixer2, Limiter and Demodulator

In this 2. mixer stage the first 10.7MHz IF is converted into the second 450kHz IF. A multi-stage limiter generates signals for the complete integrated demodulator without external tank. MPX output DC offset compensation is possible by software (DEM).

1.4 Quality Detection and ISS (look at Figure 2)

Fieldstrength

Parallel to mixer2 input a 10.7MHz limiter generates a signal for digital IF counter and a fieldstrength output signal. This internal unweighted fieldstrength is used for keying AGC, adjacent channel and multipath detection and is available at PIN14 (FSU) after +6dB buffer stage. The behaviour of this output signal can be corrected for DC offset (SL) and slope (SMSL). The internal generated unweighted fieldstrength is filtered at PIN35 and used for softmute function and generation of ISS filter switching signal for weak input level (sm).

Adjacent Channel Detector

The input of the adjacent channel detector is AC coupled from internal unweighted fieldstrength. A programmable highpass or bandpass (ACF) and amplifier (ACG) as well as rectifier determines the influences. This voltage is compared with adjustable comparator1 thresholds (ACWTH, ACNTH). The output signal of this comparator generates a DC level at PIN15 by programmable time constant. Time control (TISS) for a present adjacent channel is made by charge and discharge current after comparator1 in an external capacitance. The charge current is fixed and the discharge current is controlled by I²C Bus. This level produces digital signals (ac, ac+) in an additional comparator1. The adjacent channel information is available as analog output signal after rectifier and +8dB output buffer.

Multipath Detector

The input of the multipath detector is AC coupled from internal unweighted fieldstrength. A programmable bandpass (MPF) and amplifier (MPG) as well as rectifier determines the influences. This voltage is compared with an adjustable comparator2 thresholds (MPTH). The output signal of this comparator2 is used for the "Milano" effect. In this case the adjacent channel detection is switched off. The "Milano" effect is selectable by I²C Bus (MPOFF). The multipath information is available as analog output signal after rectifier and +8dB output buffer.

450kHz IF Narrow Bandpass Filter (ISS filter)

The device gets an additional second IF narrow bandpass filter for suppression noise and adjacent channel signal influences. This narrow filter has three switchable bandwidths, narrow range of 80kHz, mid range of 120kHz and 30kHz for weather band information. Without ISS filter the IF bandwidth (wide range) is defined only by ceramic filter chain. The filter is switched in after mixer2 before 450kHz limiter stage. The centre frequency and matching to the demodulator center frequency can be fine adjusted (AISS) by software..

Deviation Detector

In order to avoid distortion in audio output signal the narrow ISS filter is switched OFF for present overdeviation.

Hence the demodulator output signal is detected. A lowpass filtering and peak rectifier generates a signal that is defined by software controlled current (TDEV) in an external capacitance. This value is compared with a programmable comparator3 thresholds (DWTH, DTH) and generates two digital signals (dev, dev+).

ISS Switch Logic

All digital signals coming from adjacent channel detector, deviation detector and softmute are acting via switching matrix on ISS filter switch. The IF bandpass switch mode is controlled by software (ISSON, ISS30, ISS80, ISSCTL). The switch ON of the IF bandpass is also available by manipulation of the voltage at PIN15. Two application modes are available (APPM). The conditions are described in table 37.

1.5 Soft Mute Control

The external fieldstrength signal at PIN 35 is the reference for mute control. The startpoint, mute depth and slope are programmable (SMTH, SMD, SLOPE) in a wide range. The time constant is defined by external capacitance. Additional adjacent channel mute function is supported. A highpass filter with -3dB threshold frequency of 100kHz, amplifier and peak rectifier generates an adjacent noise signal from MPX output with the same time constant for softmute. This value is compared with comparator5 thresholds (ACM). For present strong adjacent channel the MPX signal is attenuated typical 6dB.

1.6 AM Section

The upconversion mixer1 is combined with a gain control circuit 1 sensing three input signals, narrow band information at PIN 39, upconversion signal at PIN 58 and wide band information at PIN 3. This gain control circuit gives two output signals. The first one is a current for pin diode attenuator and the second one is a voltage for preamplifier. It is possible to put in a separate narrow bandpass filter before mixer2 at PIN 58. The intervention point for first AGC (AMAGC) is programmable by software.

The oscillator frequency for mixer1 is generated by dividing the FM VCO frequency (AMD).

In mixer2 the IF1 is downconverted into the IF2 450kHz. Before the output signal reaches the 450kHz tank an attenuator for IF gain control 2 is passed. Mixer 1 and mixer2 tanks are software controlled adjustable (IF1T, IF2T).

After filtering by ceramic filter a 450kHz amplifier with a gain control 3 is included. The gain control 2 and 3 are the second AGC and programmable too by software (DAGC). In order to avoid an oscillation in intervention point it is important to know that the DAGC threshold has to be smaller than AMAGC!

The demodulator is a peak detector. A further time constant with capacitor at pin40 produces a DC AGC reference voltage dependent on input signal. The time constant is switchable by ratio of 30. This is necessary for the station search function. The switching is software controlled (AMSEEK).

An internal comparator compares the AGC voltage with a programmable reference (AMSS). Consequently it is possible to generate a seekstop impulse over a defined range.

A separate output is available for AMIF stereo or a permanent seek stop signal(SSTSEL).

1.7 PLL and IF Counter Section

PLL Frequency Synthesizer Block

This part contains a frequency synthesizer and a loop filter for the radio tuning system. Only one VCO is required to build a complete PLL system for FM and AM upconversion. For auto search stop operation an IF counter system is available.

The counter works in a two stages configuration. The first stage is a swallow counter with a two modulus (32/33) precounter. The second stage is an 11-bit programmable counter.

The circuit receives the scaling factors for the programmable counters and the values of the reference frequencies via an I²C-Bus interface. The reference frequency is generated by an adjustable internal (XTAL) oscillator followed by the reference divider. The reference and step-frequencies are free selectable (RC, PC).

Output signals of the phase detector are switching the programmable current sources. The loop filter integrates

their currents to a DC voltage.

The values of the current sources are programmable by 6 bits also received via the I²C Bus (A, B, CURRH, LPF).

To minimize the noise induced by the digital part of the system, a special guard area is implemented.

The loop gain can be set for different conditions by setting the current values of the chargepump generator.

Frequency Generation for Phase Comparison

The RF signals applies a two modulus counter (32/33) pre-scaler, which is controlled by a 5-bit divider(A). The 5-bit register (PC0 to PC4) controls this divider. In parallel the output of the prescaler connects to an 11-bit divider(B). The 11-bit PC register (PC5 to PC15) controls this divider

Dividing range:

$$f_{OSC} = (R+1) \times f_{REF}$$

$$f_{VCO} = [33 \times A + (B + 1 - A) \times 32] \times f_{REF}$$

$$f_{VCO} = (32 \times B + A + 32) \times f_{REF}$$

Important: For correct operation: $A \leq 32$; $B \geq A$

Three State Phase Comparator

The phase comparator generates a phase error signal according to phase difference between f_{SYN} and f_{REF} . This phase error signal drives the charge pump current generator.

Charge Pump Current Generator

This system generates signed pulses of current. The phase error signal decides the duration and polarity of those pulses. The current absolute values are programmable by A register for high current and B register for low current.

Inlock Detector

Switching the chargepump in low current mode can be done either via software or automatically by the inlock detector, by setting bit LDENA to "1"

After reaching a phase difference of 10 - 40nsec and a delay of some times $1/f_{REF}$, the chargepump is forced in low current mode. A new PLL divider alternation by I²C-Bus will switch the chargepump in the high current mode.

Few programmable phase errors (D0, D1) are available for inlock detection

The count of detected inlock informations, to release the inlock signal is adjustable (D2, D3), to avoid a switching to low current during a frequency jump.

Low Noise CMOS Op-amp

An internal voltage divider at pin VREF2 connects the positive input of the low noise op-amp. The charge pump output connects the negative input. This internal amplifier in cooperation with external components can provide an active filter. The negative input is switchable to three input pins, to increase the flexibility in application. This feature allows two separate active filters for different applications.

A logical "0" in the LPF register activates PIN LPFM, otherwise PIN LPAM is active. While the high current mode is activated LPHC is switched on.

IF Counter Block

The input signal for FM and AM upconversion is the same 10.7MHz IF level after limiter. The grade of integration is adjustable by eight different measuring cycle times. The tolerance of the accepted count value is adjustable, to reach an optimum compromise for search speed and precision of the evaluation.

For the FM range the center frequency of the measured count value is adjustable in 32 steps, to get the possibility of fitting the IF-filter tolerance. In the AM upconversion range an IF frequency of 10.689MHz to 10.720MHz with 1kHz steps is available.

The IF-Counter Mode

The IF counter works in 2 modes controlled by IFCM register.

Sampling Timer

A sampling timer to generate the gate signal for the main counter is build with a 14-bit programmable counter (IRC). In FM mode a 6.25kHz, in AM mode a 1kHz basically signal is generated. This is followed by an asynchronous divider to generate several sampling times.

Intermediate Frequency Main Counter

This counter is a 11 - 21-bit synchronous autoreload down counter. Five bits (CF) are programmable to have the possibility for an adjust to the frequency of the IF-filter. The counter length is automatic adjusted to the chosen sampling time and the counter mode (FM, AM-UPC).

At the start the counter will be loaded with a defined value which is an equivalent to the divider value ($t_{\text{Sample}} \times f_{\text{IF}}$).

If a correct frequency is applied to the IF counter frequency input at the end of the sampling time the main counter is changing its state from 0h to 1FFFFFFh.

This is detected by a control logic and an external search stop output is changing from LOW to HIGH. The frequency range inside which a successful count result is adjustable by the EW bits.

$$t_{\text{TIM}} = (\text{IRC} + 1) / f_{\text{OSC}}$$

$$t_{\text{CNT}} = (\text{CF} + 1697) / f_{\text{IF}} \quad \text{FM mode}$$

$$t_{\text{CNT}} = (\text{CF} + 10689) / f_{\text{IF}} \quad \text{AM up conversion mode}$$

Counter result succeeded:

$$t_{\text{TIM}} \geq t_{\text{CNT}} - t_{\text{ERR}}$$

$$t_{\text{TIM}} \leq t_{\text{CNT}} + t_{\text{ERR}}$$

Counter result failed:

$$t_{\text{TIM}} > t_{\text{CNT}} + t_{\text{ERR}}$$

$$t_{\text{TIM}} < t_{\text{CNT}} - t_{\text{ERR}}$$

$$t_{\text{TIM}} = \text{IF timer cycle time}$$

$$t_{\text{CNT}} = \text{IF counter cycle time}$$

$$t_{\text{ERR}} = \text{discrimination window (controlled by the EW registers)}$$

The IF counter is only started by inlock information from the PLL part. It is enabled by software (IFENA).

Adjustment of the Measurement Sequence Time

The precision of the measurements is adjustable by controlling the discrimination window. This is adjustable by programming the control registers EW0 to EW2.

The measurement time per cycle is adjustable by setting the Register IFS0 - IFS2.

Adjust of the Frequency Value

The center frequency of the discrimination window is adjustable by the control register CF0 to CF4.

1.8 I²C-Bus Interface

The TDA 7511 supports the I²C-Bus protocol. This protocol defines any device that sends data onto the bus as a transmitter, and the receiving device as the receiver. The device that controls the transfer is a master and device being controlled is the slave. The master will always initiate data transfer and provide the clock to transmit or receive operations.

Data Transition

Data transition on the SDA line must only occur when the clock SCL is LOW. SDA transitions while SCL is HIGH will be interpreted as START or STOP condition.

Start Condition

A start condition is defined by a HIGH to LOW transition of the SDA line while SCL is at a stable HIGH level. This "START" condition must precede any command and initiate a data transfer onto the bus. The TDA 7511 continuously monitors the SDA and SCL lines for a valid START and will not response to any command if this condition has not been met.

Stop Condition

A STOP condition is defined by a LOW to HIGH transition of the SDA while the SCL line is at a stable HIGH level. This condition terminates the communication between the devices and forces the bus-interface of the TDA 7511 into the initial condition.

Acknowledge

Indicates a successful data transfer. The transmitter will release the bus after sending 8 bits of data. During the 9th clock cycle the receiver will pull the SDA line to LOW level to indicate it receive the eight bits of data.

Data Transfer

During data transfer the TDA 7511 samples the SDA line on the leading edge of the SCL clock. Therefore, for proper device operation the SDA line must be stable during the SCL LOW to HIGH transition.

Device Addressing

To start the communication between two devices, the bus master must initiate a start instruction sequence, followed by an eight bit word corresponding to the address of the device it is addressing.

The most significant 6 bits of the slave address are the device type identifier.

The TDA 7511 device type is fixed as "110001".

The next significant bit is used to address a particular device of the previous defined type connected to the bus.

The state of the hardwired PIN 41 defines the state of this address bit. So up to two devices could be connected on the same bus. When PIN 41 is connected to VCC2 the address bit "1" is selected. In this case the AM part doesn't work. Otherwise the address bit "0" is selected (FM and AM is working). Therefore a double FM tuner concept is possible.

The last bit of the start instruction defines the type of operation to be performed:

- When set to "1", a read operation is selected
- When set to "0", a write operation is selected

The TDA 7511 connected to the bus will compare their own hardwired address with the slave address being transmitted, after detecting a START condition. After this comparison, the TDA 7511 will generate an "acknowledge" on the SDA line and will do either a read or a write operation according to the state of R/W bit.

Write Operation

Following a START condition the master sends a slave address word with the R/W bit set to "0". The TDA 7511 will generate an "acknowledge" after this first transmission and will wait for a second word (the word address field). This 8-bit address field provides an access to any of the 32 internal addresses. Upon receipt of the word address the TDA 7511 slave device will respond with an "acknowledge". At this time, all the following words transmitted to the TDA 7511 will be considered as Data. The internal address will be automatically incremented. After each word receipt the TDA 7511 will answer with an "acknowledge".

Read Operation

IF the master sends a slave address word with the R/W bit set to "1", the TDA 7511 will transit one 8-bit data word. This data word includes the following informations:

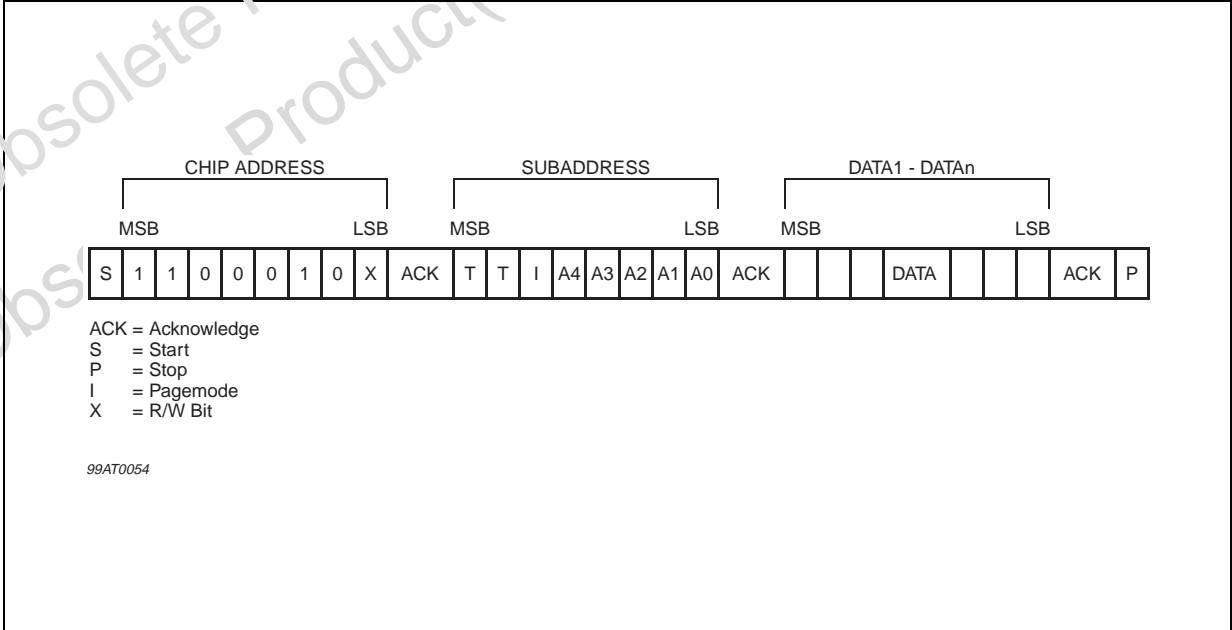
- bit0 (ISS filter, 1 = ON, 0 = OFF)
- bit1 (ISS filter bandwidth, 1 = 80kHz, 0 = 120kHz)
- bit2 (MPOUT, 1 = multipath present, 0 = no multipath)
- bit3 (1 = PLL is locked in , 0 = PLL is locked out).
- bit4 (fieldstrength indicator, 1 = lower as softmute threshold, 0 = higher as softmute threshold)
- bit5 (adjacent channel indicator, 1 = adjacent channel present, 0 = no adjacent channel)
- bit6 (deviation indicator, 1 = strong overdeviation present, 0 = no strong overdeviation)
- bit7 (deviation indicator, 1 = overdeviation present, 0 = no overdeviation)

2 Software Specification

The interface protocol comprises:

- start condition (S)
- chip address byte
- subaddress byte
- sequence of data (N bytes + Acknowledge)
- stop condition (P)

Figure 1.



2.1 Address Organization

Table 1.

| Function | Addr | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|--------------------|------|--------|--------|--------|---------|--------|---------|---------|--------|
| CHARGEPU MP | 0 | LPF | CURRH | B1 | B0 | A3 | A2 | A1 | A0 |
| LOCKDET | 1 | LDENA | D3 | D2 | D1 | D0 | AMON | TEST3 | RES2 |
| PLL COUNTER | 2 | PC7 | PC6 | PC5 | PC4 | PC3 | PC2 | PC1 | PC0 |
| | 3 | PC15 | PC14 | PC13 | PC12 | PC11 | PC10 | PC9 | PC8 |
| PLL REF COUNTER | 4 | RC7 | RC6 | RC5 | RC4 | RC3 | RC2 | RC1 | RC0 |
| | 5 | RC15 | RC14 | RC13 | RC12 | RC11 | RC10 | RC9 | RC8 |
| TV1 | 6 | TV011 | TV010 | TVR15 | TVR14 | TVR13 | TVR12 | TVR11 | TVR10 |
| TV2 | 7 | TV021 | TV020 | TVR25 | TVR24 | TVR23 | TVR22 | TVR21 | TVR20 |
| IFC CTRL 1 | 8 | TV013 | TV012 | TV023 | TV022 | IFENA | EW2 | EV1 | EW0 |
| IFC CTRL 2 | 9 | IFS2 | IFS1 | IFS0 | CF4 | CF3 | CF2 | CF1 | CF0 |
| IF REF CNT1 | 10 | IRC7 | IRC6 | IRC5 | IRC4 | IRC3 | IRC2 | IRC1 | IRC0 |
| IF REF CNT2 | 11 | IFCM1 | IFCM0 | IRC13 | IRC12 | IRC11 | IRC10 | IRC9 | IRC8 |
| IF1/FMAGC | 12 | - | FMAGC2 | FMAGC1 | FMAGC0 | IFG21 | IFG20 | IFG11 | IFG10 |
| DEM ADJ | 13 | DNB1 | DNB0 | DEM5 | DEM4 | DEM3 | DEM2 | DEM1 | DEM0 |
| QUALITY AC | 14 | ACNTH1 | ACNTH0 | ACWTH2 | ACWTH1 | ACWTH0 | ACG | ACF | ISS30 |
| QUALITY MP | 15 | MPAC | APPM2 | APPM1 | MPTH1 | MPTH0 | MPG | MPF | MPOFF |
| QUALITYDEV | 16 | - | DTH1 | DTH0 | DWTH1 | DWTH0 | TDEV2 | TDEV1 | TDEV0 |
| QUALITYISS | 17 | AISS1 | AISS0 | TISS2 | TISS1 | TISS0 | ISS80 | ISSON | ISSCTL |
| AM CTL1 | 18 | DAGC3 | DAGC2 | DAGC1 | DAGC0 | AMD1 | AMD0 | AMST | AMSEEK |
| AM CTL2 | 19 | AMSS3 | AMSS2 | AMSS1 | AMSS0 | AMAGC3 | AMAGC2 | AMAGC1 | AMAGC0 |
| MUTE1 | 20 | SMCTH1 | SMCTH0 | SLOPE | MENA | SMD3 | SMD2 | SMD1 | SMD0 |
| MUTE2 | 21 | ACM3 | ACM2 | ACM1 | ACM0 | SMTH3 | SMTH2 | SMTH1 | SMTH0 |
| SLIDER | 22 | - | - | SL5 | SL4 | SL3 | SL2 | SL1 | SL0 |
| TANK ADJ | 23 | IF1T3 | IF1T2 | IF1T1 | IF1T0 | IF2T3 | IF2T2 | IF2T1 | IF2T0 |
| XTAL ADJ | 24 | - | - | CLKSEP | XTAL4 | XTAL3 | XTAL2 | XTAL1 | XTAL0 |
| TESTCNTRL | 25 | ISSIN | SMSL | SSTSEL | ISSCOFF | DEMOFF | 450LOFF | TESTOUT | TESTIN |
| TEST | 26 | - | - | - | - | - | DIV2 | DIV1 | DIV0 |
| TEST MODE1 | 27 | OUT7 | OUT6 | OUT5 | OUT4 | OUT3 | OUT2 | OUT1 | OUT0 |
| TEST MODE2 | 28 | - | - | TINMP | TINAC | OUT11 | OUT10 | OUT9 | OUT8 |

2.2 Control Register Function

Table 2.

| Register Name | Function |
|---------------|--|
| A | Charge pump high current |
| ACF | Adjacent channel filter select |
| ACG | Adjacent channel filter gain |
| ACM | Threshold for startpoint adjacent channel mute |
| ACNTH | Adjacent channel narrow band threshold |
| ACWTH | Adjacent channel wide band threshold |
| AISS | ISS filter fine adjust |

Table 2. (continued)

| Register Name | Function |
|---------------|--|
| AMAGC | AM wide band AGC threshold |
| AMD | AM prescaler |
| AMON | AM-FM switch |
| AMSEEK | Switch time constant for AM seek |
| AMSS | AM seek stop threshold |
| AMST | AM stereo select |
| APPM | Application mode quality detection |
| B | Charge pump low current |
| CF | Center frequency IF counter |
| CLKSEP | Clock separation (only for testing) |
| CURRH | Set current high charge pump |
| D | Inlock phase error and delay time for lock detector |
| DAGC | AM narrow band AGC threshold |
| DEM | Demodulator offset |
| DEMOFF | Demodulator clock "OFF" (only for testing) |
| DNB | Demodulator noise blanking |
| DIV | Divider ratio for reference frequency (only for testing) |
| DTH | Deviation detector threshold for ISS filter "OFF" |
| DWTH | Deviation detector threshold for ISS filter narrow/wide |
| EW | Frequency error window IF counter |
| FMAGC | FM AGC threshold |
| IF1T | FM/AM mixer1 tank adjust |
| IF2T | AM mixer2 tank adjust |
| IFCM | IF counter mode |
| IFENA | IF counter enable |
| IFG | IF1 amplifier gain (10.7MHz) |
| IFS | IF counter sampling time |
| IRC | IF reference counter |
| ISSCOFF | ISS filter clock "OFF" (only for testing) |
| ISSCT | ISS filter control |
| ISSIN | Test input for ISS filter |
| ISSON | ISS filter "ON" |
| ISS30 | ISS filter 30KHz weather band |
| ISS80 | ISS filter narrow/mid switch |
| LDENA | Lock detector enable |
| LPF | Loop filter input select |
| MENA | Softmute enable |
| MPAC | Adjacent channel control by multipath |
| MPOFF | Multipath control "OFF" |
| MPF | Multipath filter frequency |
| MPG | Multipath filter gain |
| MPTH | Multipath threshold |
| OUT | Test output (only for testing) |

Table 2. (continued)

| Register Name | Function |
|---------------|--|
| PC | Counter for PLL (VCO frequency) |
| RC | Reference counter PLL |
| RES | Reservation |
| SL | S meter slider threshold |
| SLOPE | Softmute slope select |
| SMCTH | Softmute capacitor threshold for ISS "ON" |
| SMD | Softmute depth threshold |
| SMSL | S meter slope |
| SMTH | Softmute startpoint threshold |
| SSTSEL | Search stop select for continuous signal |
| TEST3 | Testing PLL/IFC (only for testing) |
| TESTOUT | Switch FSW output to TEST output (only for testing) |
| TESTIN | Switch FSU input to TEST input (only for testing) |
| TDEV | Time constant for deviation detector |
| TINAC | Test input adjacent channel (only for testing) |
| TINMP | Test input multipath(only for testing) |
| TISS | Time constant for ISS filter "ON"/"OFF" |
| TVR | Tuning voltage for prestage proportional referred to PLL |
| TVO | Tuning voltage offset for prestage |
| XTAL | Xtal frequency adjust |
| 450LOFF | 450kHz limiter "OFF" (only for testing) |

Subaddress

Table 3.

| MSB | | | | | | | | LSB | Function |
|-----|----|---|----|----|----|----|----|---------------------|----------|
| T2 | T1 | I | A4 | A3 | A2 | A1 | A0 | | |
| | | | 0 | 0 | 0 | 0 | 0 | Charge pump control | |
| | | | 0 | 0 | 0 | 0 | 1 | PLL lock detector | |
| | | | - | - | - | - | - | - | |
| | | | 1 | 1 | 1 | 0 | 0 | Test mode 2 | |
| | | 0 | | | | | | Page mode "OFF" | |
| | | 1 | | | | | | Page mode enable | |

Note: 1. T1, T2 used for testing, in application mode they have to be "0".

2.3 Data Byte Specification

Addr 0 Charge Pump Control

Table 4.

| MSB | | | | LSB | | | | Function |
|-----|----|----|----|-----|----|----|----|----------------------|
| d7 | d6 | d5 | d4 | d3 | d2 | d1 | d0 | |
| | | | | 0 | 0 | 0 | 0 | High current = 0mA |
| | | | | 0 | 0 | 0 | 1 | High current = 0.5mA |
| | | | | 0 | 0 | 1 | 0 | High current = 1mA |
| | | | | 0 | 0 | 1 | 1 | High current = 1.5mA |
| | | | | - | - | - | - | - |
| | | | | 1 | 1 | 1 | 1 | High current = 7.5mA |
| | | 0 | 0 | | | | | Low current = 0μA |
| | | 0 | 1 | | | | | Low current = 50μA |
| | | 1 | 0 | | | | | Low current = 100μA |
| | | 1 | 1 | | | | | Low current = 150μA |
| | 0 | | | | | | | Select low current |
| | 1 | | | | | | | Select high current |
| 0 | | | | | | | | Select LPFM |
| 1 | | | | | | | | Select LPAM |

Addr 1 PLL Lock Detector

Table 5.

| MSB | | | | LSB | | | | Function |
|-----|----|----|----|-----|----|----|----|---|
| d7 | d6 | d5 | d4 | d3 | d2 | d1 | d0 | |
| | | | | | | 0 | 0 | Not used, have to be 0, d1 only for testing |
| | | | | | | 0 | | Select FM mode |
| | | | | | | 1 | | Select AM mode |
| | | | 0 | 0 | | | | PD phase difference threshold 10ns |
| | | | 0 | 1 | | | | 20ns |
| | | | 1 | 0 | | | | 30ns |
| | | | 1 | 1 | | | | 40ns |
| | 0 | 0 | | | | | | Not valid |
| | 0 | 1 | | | | | | Activation delay 4 x 1/f _{REF} |
| | 1 | 0 | | | | | | 6 x 1/f _{REF} |
| | 1 | 1 | | | | | | 8 x 1/f _{REF} |
| 0 | | | | | | | | Lock detector doesn't control charge pump |
| 1 | | | | | | | | Lock detector controls charge pump |

Addr 2 PLL Counter 1 (LSB)

Table 6.

| MSB | | | | | | | LSB | Function |
|-----|----|----|----|----|----|----|-----|-----------|
| d7 | d6 | d5 | d4 | d3 | d2 | d1 | d0 | |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | LSB = 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | LSB = 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | LSB = 2 |
| - | - | - | - | - | - | - | - | - |
| 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | LSB = 252 |
| 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | LSB = 253 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | LSB = 254 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | LSB = 255 |

Addr 3 PLL Counter 2 (MSB)

Table 7.

| MSB | | | | | | | LSB | Function |
|-----|----|----|----|----|----|----|-----|-------------|
| d7 | d6 | d5 | d4 | d3 | d2 | d1 | d0 | |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | MSB = 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | MSB = 255 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | MSB = 512 |
| - | - | - | - | - | - | - | - | - |
| 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | MSB = 64768 |
| 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | MSB = 65024 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | MSB = 65280 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | MSB = 65536 |

Note: 1. Swallow mode: $fvco/fs_{PLL} = 1LSB + MSB + 32$

Addr 4 PLL Reference Counter 1 (LSB)

Table 8.

| MSB | | | | | | | LSB | Function |
|-----|----|----|----|----|----|----|-----|-----------|
| d7 | d6 | d5 | d4 | d3 | d2 | d1 | d0 | |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | LSB = 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | LSB = 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | LSB = 2 |
| - | - | - | - | - | - | - | - | - |
| 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | LSB = 252 |
| 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | LSB = 253 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | LSB = 254 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | LSB = 255 |

Addr 5 PLL Reference Counter 2 (MSB)**Table 9.**

| MSB | | | | | | | LSB | Function |
|-----|----|----|----|----|----|----|-----|-------------|
| d7 | d6 | d5 | d4 | d3 | d2 | d1 | d0 | |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | MSB = 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | MSB = 256 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | MSB = 512 |
| - | - | - | - | - | - | - | - | - |
| 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | MSB = 64768 |
| 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | MSB = 65024 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | MSB = 65280 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | MSB = 65536 |

Note: 1. $f_{OSC}/f_{REF} = LSB + MSB + 1$

Addr 6, Addr7, Addr 8 TV1,2 (proportional and offset control referred to tuning voltage V28)**Table 10.**

| addr8 | | addr6 | | | | | | | | Function TV1 |
|-------|----|-------|----|----|----|----|----|----|----|--------------|
| d7 | d6 | d7 | d6 | d5 | d4 | d3 | d2 | d1 | d0 | |
| addr8 | | addr7 | | | | | | | | Function TV2 |
| d5 | d4 | d7 | d6 | d5 | d4 | d3 | d2 | d1 | d0 | |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | TVR = 0 |
| | | | | 0 | 0 | 0 | 0 | 0 | 1 | TVR = -1 |
| | | | | 0 | 0 | 0 | 0 | 1 | 0 | TVR = -2 |
| - | - | - | - | - | - | - | - | - | - | - |
| | | | | 0 | 1 | 1 | 1 | 1 | 1 | TVR = -31 |
| | | | | 1 | 0 | 0 | 0 | 0 | 1 | TVR = +1 |
| | | | | 1 | 0 | 0 | 0 | 1 | 0 | TVR = +2 |
| - | - | - | - | - | - | - | - | - | - | - |
| | | | | 1 | 1 | 1 | 1 | 1 | 1 | TVR = +31 |
| 0 | 0 | 0 | 0 | | | | | | | TVO = 0 |
| 0 | 0 | 0 | 1 | | | | | | | TVO = -1 |
| 0 | 0 | 1 | 0 | | | | | | | TVO = -2 |
| - | - | - | - | - | - | - | - | - | - | - |
| 0 | 1 | 1 | 1 | | | | | | | TVO = -7 |
| 1 | 0 | 0 | 1 | | | | | | | TVO = +1 |
| 1 | 0 | 1 | 0 | | | | | | | TVO = +2 |
| - | - | - | - | - | - | - | - | - | - | - |
| 1 | 1 | 1 | 1 | | | | | | | TVO = +7 |

Note: 1. $TV_{1,2} = V_{28} + V_{28} * TVR/128 + TVO * 50mV$
 TVR: -31, -30, ... 0 ... 30, 31
 TVO: -7, -6, ... 0 ... 6, 7

Addr 8 IF Counter Control 1

Table 11.

| MSB | | | | | | | LSB | Function |
|-----|----|----|----|----|----|----|-----|--|
| d7 | d6 | d5 | d4 | d3 | d2 | d1 | d0 | |
| | | | | | 0 | 0 | 0 | Not valid |
| | | | | | 0 | 0 | 1 | Not valid |
| | | | | | 0 | 1 | 0 | Not valid |
| | | | | | 0 | 1 | 1 | $\Delta f = 6.25\text{kHz}$ (FM)1kHz (AM UPC) |
| | | | | | 1 | 0 | 0 | $\Delta f = 12.5\text{kHz}$ (FM) 2kHz (AM UPC) |
| | | | | | 1 | 0 | 1 | $\Delta f = 25\text{kHz}$ (FM) 4kHz (AM UPC) |
| | | | | | 1 | 1 | 0 | $\Delta f = 50\text{kHz}$ (FM) 8kHz (AM UPC) |
| | | | | | 1 | 1 | 1 | $\Delta f = 100\text{kHz}$ (FM)16kHz (AM UPC) |
| | | | | 0 | | | | IF counter disable / stand by |
| | | | | 1 | | | | IF counter enable |

Addr 9 IF Counter Control 2

Table 12.

| MSB | | | | | | | LSB | Function |
|-----|----|----|----|----|----|----|-----|---|
| d7 | d6 | d5 | d4 | d3 | d2 | d1 | d0 | |
| | | | 0 | 0 | 0 | 0 | 0 | $f_{\text{Center}} = 10.60625\text{MHz}$ (FM)10.689MHz (AM UPC) |
| | | | 0 | 0 | 0 | 0 | 1 | $f_{\text{Center}} = 10.61250\text{MHz}$ (FM)10.690MHz (AM UPC) |
| - | - | - | - | - | - | - | - | - |
| | | | 0 | 1 | 0 | 0 | 0 | $f_{\text{Center}} = 10.66875\text{MHz}$ (FM)10.699MHz (AM UPC) |
| | | | 0 | 1 | 0 | 0 | 1 | $f_{\text{Center}} = 10.67500\text{MHz}$ (FM)10.700MHz (AM UPC) |
| | | | 0 | 1 | 1 | 0 | 0 | $f_{\text{Center}} = 10.68125\text{MHz}$ (FM)10.701MHz (AM UPC) |
| | | | 0 | 1 | 1 | 0 | 1 | $f_{\text{Center}} = 10.68750\text{MHz}$ (FM)10.702MHz (AM UPC) |
| | | | 0 | 1 | 1 | 1 | 0 | $f_{\text{Center}} = 10.69375\text{MHz}$ (FM)10.703MHz (AM UPC) |
| | | | 0 | 1 | 1 | 1 | 1 | $f_{\text{Center}} = 10.70000\text{MHz}$ (FM)10.704MHz (AM UPC) |
| | | | 1 | 0 | 0 | 0 | 0 | $f_{\text{Center}} = 10.70625\text{MHz}$ (FM)10.705MHz (AM UPC) |
| | | | 1 | 0 | 0 | 0 | 1 | $f_{\text{Center}} = 10.71250\text{MHz}$ (FM)10.706MHz (AM UPC) |
| - | - | - | - | - | - | - | - | - |
| | | | 1 | 1 | 1 | 1 | 1 | $f_{\text{Center}} = 10.80000\text{MHz}$ (FM)10.720MHz (AM UPC) |
| 0 | 0 | 0 | | | | | | $t_{\text{Sample}} = 20.48\text{ms}$ (FM)128ms (AM UPC) |
| 0 | 0 | 1 | | | | | | $t_{\text{Sample}} = 10.24\text{ms}$ (FM)64ms (AM UPC) |
| 0 | 1 | 0 | | | | | | $t_{\text{Sample}} = 5.12\text{ms}$ (FM)32ms (AM UPC) |
| 0 | 1 | 1 | | | | | | $t_{\text{Sample}} = 2.56\text{ms}$ (FM)16ms (AM UPC) |
| 1 | 0 | 0 | | | | | | $t_{\text{Sample}} = 1.28\text{ms}$ (FM)8ms (AM UPC) |
| 1 | 0 | 1 | | | | | | $t_{\text{Sample}} = 640\mu\text{s}$ (FM)4ms (AM UPC) |
| 1 | 1 | 0 | | | | | | $t_{\text{Sample}} = 320\mu\text{s}$ (FM)2ms (AM UPC) |
| 1 | 1 | 1 | | | | | | $t_{\text{Sample}} = 160\mu\text{s}$ (FM)1ms (AM UPC) |

Addr 10 IF Counter Reference (LSB)

Table 13.

| MSB | | | | | | | | LSB | Function |
|-----|----|----|----|----|----|----|----|-----------|----------|
| d7 | d6 | d5 | d4 | d3 | d2 | d1 | d0 | | |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | LSB = 0 | |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | LSB = 1 | |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | LSB = 2 | |
| - | - | - | - | - | - | - | - | - | |
| 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | LSB = 252 | |
| 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | LSB = 253 | |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | LSB = 254 | |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | LSB = 255 | |

Addr 11 IF Counter Reference (MSB) and IF Counter Mode Select

Table 14.

| MSB | | | | | | | | LSB | Function |
|-----|----|----|----|----|----|----|----|---------------------------------|----------|
| d7 | d6 | d5 | d4 | d3 | d2 | d1 | d0 | | |
| | | 0 | 0 | 0 | 0 | 0 | 0 | MSB = 0 | |
| | | 0 | 0 | 0 | 0 | 0 | 1 | MSB = 256 | |
| | | 0 | 0 | 0 | 0 | 1 | 0 | MSB = 512 | |
| | | - | - | - | - | - | - | - | |
| | | 1 | 1 | 1 | 1 | 0 | 1 | MSB = 15616 | |
| | | 1 | 1 | 1 | 1 | 1 | 0 | MSB = 15872 | |
| | | 1 | 1 | 1 | 1 | 1 | 1 | MSB = 16128 | |
| 0 | 0 | | | | | | | Not valid | |
| 0 | 1 | | | | | | | IF counter FM mode | |
| 1 | 0 | | | | | | | Not valid | |
| 1 | 1 | | | | | | | IF counter AM upconversion mode | |

Note: 1. $f_{osc}/f_{FM} = LSB + MSB + 1$

Addr 12 IF 1 and FM AGC

Table 15.

| MSB | | | | | | | LSB | | Function |
|-----|----|----|----|----|----|----|-----|----------------------------|----------|
| d7 | d6 | d5 | d4 | d3 | d2 | d1 | d0 | | |
| | | | | | | 0 | 0 | IF1 gain1 9dB | |
| | | | | | | 0 | 1 | IF1 gain1 11dB | |
| | | | | | | 1 | 0 | IF1 gain1 13dB | |
| | | | | | | 1 | 1 | IF1 gain1 15dB | |
| | | | | 0 | 0 | | | IF1 gain2 9dB | |
| | | | | 0 | 1 | | | IF1 gain2 11dB | |
| | | | | 1 | 0 | | | IF1 gain2 13dB | |
| | | | | 1 | 1 | | | IF1 gain2 15dB | |
| | 0 | 0 | 0 | | | | | AGC threshold 80dB μ V | |
| | 0 | 0 | 1 | | | | | AGC threshold 82dB μ V | |
| | 0 | 1 | 0 | | | | | AGC threshold 84dB μ V | |
| | 0 | 1 | 1 | | | | | AGC threshold 86dB μ V | |
| | 1 | 0 | 0 | | | | | AGC threshold 88dB μ V | |
| | 1 | 0 | 1 | | | | | AGC threshold 90dB μ V | |
| | 1 | 1 | 0 | | | | | AGC threshold 92dB μ V | |
| | 1 | 1 | 1 | | | | | Keving AGC OFF" | |
| 0 | | | | | | | | has to be "0" | |

Addr 13 Demodulator Fine Adjust

Table 16.

| MSB | | | | | | | LSB | | Function |
|-----|----|----|----|----|----|----|-----|----------------|----------|
| d7 | d6 | d5 | d4 | d3 | d2 | d1 | d0 | | |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0mV | |
| | | 0 | 0 | 0 | 0 | 0 | 1 | +6mV | |
| | | 0 | 0 | 0 | 0 | 1 | 0 | +12mV | |
| | | - | - | - | - | - | - | - | |
| | | 0 | 1 | 1 | 1 | 1 | 1 | +186mV | |
| | | 1 | 0 | 0 | 0 | 0 | 0 | 0mV | |
| | | 1 | 0 | 0 | 0 | 0 | 1 | -6mV | |
| | | 1 | 0 | 0 | 0 | 1 | 0 | -12mV | |
| | | - | - | - | - | - | - | - | |
| | | 1 | 1 | 1 | 1 | 1 | 1 | -186mV | |
| 1 | 1 | | | | | | | have to be "1" | |

Addr 14 Quality Detection Adjacent Channel

Table 17.

| MSB | | | | | | | LSB | | Function |
|-----|----|----|----|----|----|----|-----|---------------------------------------|----------|
| d7 | d6 | d5 | d4 | d3 | d2 | d1 | d0 | | |
| | | | | | | | 1 | ISS filter 30KHz "ON"for weather band | |
| | | | | | | | 0 | AC highpass frequency 100kHz | |
| | | | | | | | 1 | AC bandpass frequency 100kHz | |
| | | | | | 0 | | | AC gain 32dB | |
| | | | | | 1 | | | AC gain 38dB | |
| | | 0 | 0 | 0 | | | | AC wide band threshold 0.25V | |
| | | 0 | 0 | 1 | | | | AC wide band threshold 0.35V | |
| | | 0 | 1 | 0 | | | | AC wide band threshold 0.45V | |
| | | - | - | - | | | | - | |
| | | 1 | 1 | 1 | | | | AC wide band threshold 0.95V | |
| 0 | 0 | | | | | | | AC narrow band threshold 0.0V | |
| 0 | 1 | | | | | | | AC narrow band threshold 0.1V | |
| 1 | 0 | | | | | | | AC narrow band threshold 0.2V | |
| 1 | 1 | | | | | | | AC narrow band threshold 0.3V | |

Addr 15 Quality Detection Multipath

Table 18.

| MSB | | | | | | | LSB | | Function |
|-----|----|----|----|----|----|----|-----|---------------------------------|----------|
| d7 | d6 | d5 | d4 | d3 | d2 | d1 | d0 | | |
| | | | | | | | 0 | Multipath control "ON" | |
| | | | | | | | 1 | Multipath control "OFF" | |
| | | | | | | | 0 | MP bandpass frequency 19KHz | |
| | | | | | | | 1 | MP bandpass frequency 31KHz | |
| | | | | | 0 | | | MP gain 12dB | |
| | | | | | 1 | | | MP gain 23dB | |
| | | | 0 | 0 | | | | MP threshold 0.50V | |
| | | | 0 | 1 | | | | MP threshold 0.75V | |
| | | | 1 | 0 | | | | MP threshold 1.00V | |
| | | | 1 | 1 | | | | MP threshold 1.25V | |
| | 0 | 0 | | | | | | Application mode 1 | |
| | 0 | 1 | | | | | | Application mode 2 | |
| 0 | | | | | | | | Multipath eliminates ac | |
| 1 | | | | | | | | Multipath eliminates ac and ac+ | |

Addr 16 Quality Deviation Detection

Table 19.

| MSB | | | | | | | LSB | Function |
|-----|----|----|----|----|----|----|-----|--|
| d7 | d6 | d5 | d4 | d3 | d2 | d1 | d0 | |
| | | | | | 0 | 0 | 0 | charge current 34µA, discharge current 6µA |
| | | | | | 0 | 0 | 1 | charge current 32µA, discharge current 8µA |
| | | | | | 0 | 1 | 0 | charge current 30µA, discharge current 10µA |
| | | | | | 0 | 1 | 1 | charge current 28µA, discharge current 12µA |
| | | | | | - | - | - | - |
| | | | | | 1 | 1 | 1 | charge current 20µA, discharge current 20µA |
| | | | 0 | 0 | | | | DEV threshold for ISS narrow/wide 30kHz |
| | | | 0 | 1 | | | | DEV threshold for ISS narrow/wide 45kHz |
| | | | 1 | 0 | | | | DEV threshold for ISS narrow/wide 60kHz |
| | | | 1 | 1 | | | | DEV threshold for ISS narrow/wide 75kHz |
| | 0 | 0 | | | | | | DEV threshold for ISS filter "OFF" ratio 1 |
| | 0 | 1 | | | | | | DEV threshold for ISS filter "OFF" ratio 1.3 |
| | 1 | 0 | | | | | | DEV threshold for ISS filter "OFF" ratio 1.4 |
| | 1 | 1 | | | | | | DEV threshold for ISS filter "OFF" ratio 1.5 |
| 0 | | | | | | | | has to be 0 |

Addr 17 Quality ISS Filter

Table 20.

| MSB | | | | | | | LSB | Function |
|-----|----|----|----|----|----|----|-----|--|
| d7 | d6 | d5 | d4 | d3 | d2 | d1 | d0 | |
| | | | | | | | 0 | ISS filter control "ON" |
| | | | | | | | 1 | ISS filter control "OFF" |
| | | | | | | | 0 | Switch ISS filter "OFF" |
| | | | | | | | 1 | Switch ISS filter "ON" |
| | | | | | 0 | | | Switch ISS filter 120kHz |
| | | | | | 1 | | | Switch ISS filter 80kHz |
| | | 0 | 0 | 0 | | | | discharge current 1µA, charge current mid 74µA narrow 124µA |
| | | 0 | 0 | 1 | | | | discharge current 3µA, charge current mid 72µA narrow 122µA |
| | | 0 | 1 | 0 | | | | discharge current 5µA, charge current mid 70µA narrow 120µA |
| | | 0 | 1 | 1 | | | | discharge current 7µA, charge current mid 68µA narrow 118µA |
| | | - | - | - | | | | - |
| | | 1 | 1 | 1 | | | | discharge current 15µA, charge current mid 60µA narrow 110µA |
| 0 | 0 | | | | | | | ISS filter fine adjust -20kHz |
| 0 | 1 | | | | | | | ISS filter fine adjust -10kHz |
| 1 | 0 | | | | | | | ISS filter fine adjust 0kHz |
| 1 | 1 | | | | | | | ISS filter fine adjust +10kHz |

Addr 18 AM Control1

Table 21.

| MSB | | | | | | | LSB | Function |
|-----|----|----|----|----|----|----|-----|--|
| d7 | d6 | d5 | d4 | d3 | d2 | d1 | d0 | |
| | | | | | | | 0 | Normal AGC time constant |
| | | | | | | | 1 | Short time constant for AM seek stop |
| | | | | | | 0 | | Multipath information available FM |
| | | | | | | 1 | | AM stereo output available |
| | | | | 0 | 0 | | | Prescaler ratio 10 |
| | | | | 0 | 1 | | | Prescaler ratio 8 |
| | | | | 1 | 0 | | | Prescaler ratio 6 |
| | | | | 1 | 1 | | | Prescaler ratio 4 |
| 0 | 0 | 0 | 0 | | | | | Narrow band AGC threshold 74.4dB μ V |
| 0 | 0 | 0 | 1 | | | | | Narrow band AGC threshold 78.8dB μ V |
| 0 | 0 | 1 | 0 | | | | | Narrow band AGC threshold 80.0dB μ V |
| 0 | 0 | 1 | 1 | | | | | Narrow band AGC threshold 80.7dB μ V |
| 0 | 1 | 0 | 0 | | | | | Narrow band AGC threshold 53.2dB μ V |
| 0 | 1 | 0 | 1 | | | | | Narrow band AGC threshold 77.1dB μ V |
| 0 | 1 | 1 | 0 | | | | | Narrow band AGC threshold 78.5dB μ V |
| 0 | 1 | 1 | 1 | | | | | Narrow band AGC threshold 79.4dB μ V |
| 1 | 0 | 0 | 0 | | | | | Narrow band AGC threshold 42.7dB μ V |
| 1 | 0 | 0 | 1 | | | | | Narrow band AGC threshold 65.8dB μ V |
| 1 | 0 | 1 | 0 | | | | | Narrow band AGC threshold 77.6dB μ V |
| 1 | 0 | 1 | 1 | | | | | Narrow band AGC threshold 78.5dB μ V |
| 1 | 1 | 0 | 0 | | | | | Narrow band AGC threshold 32.6dB μ V |
| 1 | 1 | 0 | 1 | | | | | Narrow band AGC threshold 55.0dB μ V |
| 1 | 1 | 1 | 0 | | | | | Narrow band AGC threshold 73.3dB μ V |
| 1 | 1 | 1 | 1 | | | | | Narrow band AGC threshold 77.6dB μ V |

Addr 19 AM Control2

Table 22.

| MSB | | | | | | | LSB | Function |
|-----|----|----|----|----|----|----|-----|---|
| d7 | d6 | d5 | d4 | d3 | d2 | d1 | d0 | |
| | | | | 0 | 0 | 0 | 0 | AGC Threshold 82.0dB μ V 80.1dB μ V |
| | | | | 0 | 0 | 0 | 1 | AGC Threshold 85.4dB μ V 83.4dB μ V |
| | | | | 0 | 0 | 1 | 0 | AGC Threshold 87.5dB μ V 85.5dB μ V |
| | | | | 0 | 0 | 1 | 1 | AGC Threshold 89.2dB μ V 87.2dB μ V |
| | | | | 0 | 1 | 0 | 0 | AGC Threshold 90.6dB μ V 88.6dB μ V |
| | | | | 0 | 1 | 0 | 1 | AGC Threshold 91.9dB μ V 89.8dB μ V |
| | | | | 0 | 1 | 1 | 0 | AGC Threshold 92.9dB μ V 90.8dB μ V |
| | | | | 0 | 1 | 1 | 1 | AGC Threshold 93.8dB μ V 91.8dB μ V |
| | | | | 1 | 0 | 0 | 0 | AGC Threshold 94.6dB μ V 92.6dB μ V |
| | | | | 1 | 0 | 0 | 1 | AGC Threshold 95.4dB μ V 93.3dB μ V |
| | | | | 1 | 0 | 1 | 0 | AGC Threshold 96.1dB μ V 94.0dB μ V |

Table 22. (continued)

| MSB | | | | | | | | LSB | Function |
|-----|----|----|----|----|----|----|----|---|----------|
| d7 | d6 | d5 | d4 | d3 | d2 | d1 | d0 | | |
| | | | | 1 | 0 | 1 | 1 | AGC Threshold 96.7dB μ V 94.6dB μ V | |
| | | | | 1 | 1 | 0 | 0 | AGC Threshold 97.3dB μ V 95.2dB μ V | |
| | | | | 1 | 1 | 0 | 1 | AGC Threshold 97.8dB μ V 95.7dB μ V | |
| | | | | 1 | 1 | 1 | 0 | AGC Threshold 98.4dB μ V 96.3dB μ V | |
| | | | | 1 | 1 | 1 | 1 | AGC Threshold 98.8dB μ V 96.8dB μ V | |
| 0 | 0 | 0 | 0 | | | | | Seek stop threshold 20.3dB μ V | |
| 0 | 0 | 0 | 1 | | | | | Seek stop threshold 20.8dB μ V | |
| 0 | 0 | 1 | 0 | | | | | Seek stop threshold 21.3dB μ V | |
| 0 | 0 | 1 | 1 | | | | | Seek stop threshold 22.0dB μ V | |
| 0 | 1 | 0 | 0 | | | | | Seek stop threshold 22.8dB μ V | |
| 0 | 1 | 0 | 1 | | | | | Seek stop threshold 23.7dB μ V | |
| 0 | 1 | 1 | 0 | | | | | Seek stop threshold 24.7dB μ V | |
| 0 | 1 | 1 | 1 | | | | | Seek stop threshold 25.9dB μ V | |
| 1 | 0 | 0 | 0 | | | | | Seek stop threshold 27.0dB μ V | |
| 1 | 0 | 0 | 1 | | | | | Seek stop threshold 28.6dB μ V | |
| 1 | 0 | 1 | 0 | | | | | Seek stop threshold 30.4dB μ V | |
| 1 | 0 | 1 | 1 | | | | | Seek stop threshold 32.5dB μ V | |
| 1 | 1 | 0 | 0 | | | | | Seek stop threshold 35.2dB μ V | |
| 1 | 1 | 0 | 1 | | | | | Seek stop threshold 37.6dB μ V | |
| 1 | 1 | 1 | 0 | | | | | Seek stop threshold 40.2dB μ V | |
| 1 | 1 | 1 | 1 | | | | | Seek stop threshold 43.0dB μ V | |

Addr 20 Softmute Control

Table 23.

| MSB | | | | | | | | LSB | Function |
|-----|----|----|----|----|----|----|----|--|----------|
| d7 | d6 | d5 | d4 | d3 | d2 | d1 | d0 | | |
| | | | | 0 | 0 | 0 | 0 | Mute depth 0 in application 18dB | |
| | | | | 0 | 0 | 0 | 1 | Mute depth 1 in application 20dB | |
| | | | | 0 | 0 | 1 | 0 | Mute depth 2 in application 22dB | |
| | | | | 0 | 0 | 1 | 1 | Mute depth 3 in application 24dB | |
| | | | | - | - | - | - | - (logarithmically behaviour) | |
| | | | | 1 | 1 | 1 | 1 | Mute depth 15 in application 36dB | |
| | | | 0 | | | | | Mute disable | |
| | | | 1 | | | | | Mute enable | |
| | | 0 | | | | | | Sharp slope | |
| | | 1 | | | | | | Smooth slope | |
| 0 | 0 | | | | | | | Function "OFF" | |
| 0 | 1 | | | | | | | Mute depth threshold for ISS filter "ON" 2dB | |
| 1 | 0 | | | | | | | Mute depth threshold for ISS filter "ON" 1dB | |
| 1 | 1 | | | | | | | Mute depth threshold for ISS filter "ON" 0.2dB | |

Addr 21 Softmute Control 2

Table 24.

| MSB | | | | | | | LSB | Function |
|-----|----|----|----|----|----|----|-----|--|
| d7 | d6 | d5 | d4 | d3 | d2 | d1 | d0 | |
| | | | | 0 | 0 | 0 | 0 | Startpoint mute 0 in application 3dB μ V |
| | | | | 0 | 0 | 0 | 1 | Startpoint mute 1 in application 4dB μ V |
| | | | | 0 | 0 | 1 | 0 | Startpoint mute 2 in application 5dB μ V |
| | | | | 0 | 1 | 0 | 0 | Startpoint mute 3 in application 6dB μ V |
| | | | | - | - | - | - | - |
| | | | | 1 | 1 | 1 | 1 | Startpoint mute 15 in application 18dB μ V |
| 0 | 0 | 0 | 0 | | | | | AC mute threshold 60mV |
| 0 | 0 | 0 | 1 | | | | | AC mute threshold 80mV |
| 0 | 0 | 1 | 1 | | | | | AC mute threshold 100mV |
| - | - | - | 0 | | | | | - |
| 1 | 0 | 0 | 0 | | | | | AC mute threshold 220mV |
| 1 | 1 | 1 | 1 | | | | | AC mute "OFF" |

Addr 22 S-Meter Slider

Table 25.

| MSB | | | | | | | LSB | Function |
|-----|----|----|----|----|----|----|-----|------------------------|
| d7 | d6 | d5 | d4 | d3 | d2 | d1 | d0 | |
| | | 0 | 0 | 0 | 0 | 0 | 0 | S meter offset 0mV |
| | | 0 | 0 | 0 | 0 | 0 | 1 | S meter offset -58mV |
| | | 0 | 0 | 0 | 0 | 1 | 0 | S meter offset -116mV |
| | | - | - | - | - | - | - | - |
| | | 0 | 1 | 1 | 1 | 1 | 1 | S meter offset -1798mV |
| | | 1 | 0 | 0 | 0 | 0 | 0 | S meter offset 0mV |
| | | 1 | 0 | 0 | 0 | 0 | 1 | S meter offset +58mV |
| | | 1 | 0 | 0 | 0 | 1 | 0 | S meter offset +116mV |
| | | - | - | - | - | - | - | - |
| | | 1 | 1 | 1 | 1 | 1 | 1 | S meter offset +1798mV |
| | x | | | | | | | Not used |

TDA7511

Addr 23 Tank Adjust

Table 26.

| MSB | | | | | | | LSB | | Function |
|-----|----|----|----|----|----|----|-----|----------------|----------|
| d7 | d6 | d5 | d4 | d3 | d2 | d1 | d0 | | |
| | | | | 0 | 0 | 0 | 0 | 450kHz 0pF | |
| | | | | 0 | 0 | 0 | 1 | 450kHz 1.6pF | |
| | | | | 0 | 0 | 1 | 0 | 450kHz 3.2pF | |
| | | | | 0 | 0 | 1 | 1 | 450kHz 4.8pF | |
| | | | | - | - | - | - | - | |
| | | | | 1 | 1 | 1 | 1 | 450kHz 24pF | |
| 0 | 0 | 0 | 0 | | | | | 10.7MHz 0pF | |
| 0 | 0 | 0 | 1 | | | | | 10.7MHz 0.55pF | |
| 0 | 0 | 1 | 0 | | | | | 10.7MHz 1.1pF | |
| 0 | 0 | 1 | 1 | | | | | 10.7MHz 1.65pF | |
| - | - | - | - | | | | | - | |
| 1 | 1 | 1 | 1 | | | | | 10.7MHz 8.25pF | |

Addr 24 XTAL Adjust

Table 27.

| MSB | | | | | | | LSB | | Function |
|-----|----|----|----|----|----|----|-----|--------------------------------|----------|
| d7 | d6 | d5 | d4 | d3 | d2 | d1 | d0 | | |
| | | | 0 | 0 | 0 | 0 | 0 | C _{Load} 0pF | |
| | | | 0 | 0 | 0 | 0 | 1 | C _{Load} 0.625pF | |
| | | | 0 | 0 | 0 | 1 | 0 | C _{Load} 1.25pF | |
| | | | 0 | 0 | 0 | 1 | 1 | C _{Load} 1.875pF | |
| | | | 0 | 0 | 1 | 0 | 0 | C _{Load} 2.5pF | |
| | | | - | - | - | - | - | - | |
| | | | 1 | 1 | 1 | 1 | 1 | C _{Load} 19.4pF | |
| | | 0 | | | | | | Only for testing has to be "0" | |
| x | x | | | | | | | Not used | |

Addr 25 Test Control

Table 28.

| MSB | | | | | | | LSB | | Function |
|-----|----|----|----|----|----|----|-----|--|----------|
| d7 | d6 | d5 | d4 | d3 | d2 | d1 | d0 | | |
| | | | 0 | 0 | 0 | 0 | 0 | Only for testing (bits have to be "0") | |
| | | 0 | | | | | | AMIF select | |
| | | 1 | | | | | | Permanent search stop select for AM | |
| | 0 | | | | | | | S meter slope 1V/decade | |
| | 1 | | | | | | | S meter slope 1.5V/decade | |
| 0 | | | | | | | | Only for testing (has to be "0") | |

Addr 26 Test**Table 29.**

| MSB | | | | | | | LSB | Function |
|-----|----|----|----|----|----|----|-----|--|
| d7 | d6 | d5 | d4 | d3 | d2 | d1 | d0 | |
| x | x | x | x | x | 1 | 1 | 0 | Only for testing (bits have to be set) |

Addr 27 Test Mode1**Table 30.**

| MSB | | | | | | | LSB | Function |
|-----|----|----|----|----|----|----|-----|--|
| d7 | d6 | d5 | d4 | d3 | d2 | d1 | d0 | |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Only for testing (bits have to be set) |

Addr 28 Test Mode2**Table 31.**

| MSB | | | | | | | LSB | Function |
|-----|----|----|----|----|----|----|-----|--|
| d7 | d6 | d5 | d4 | d3 | d2 | d1 | d0 | |
| x | x | 0 | 0 | 0 | 0 | 0 | 0 | Only for testing (bits have to be set) |

APPENDIX

Figure 2.

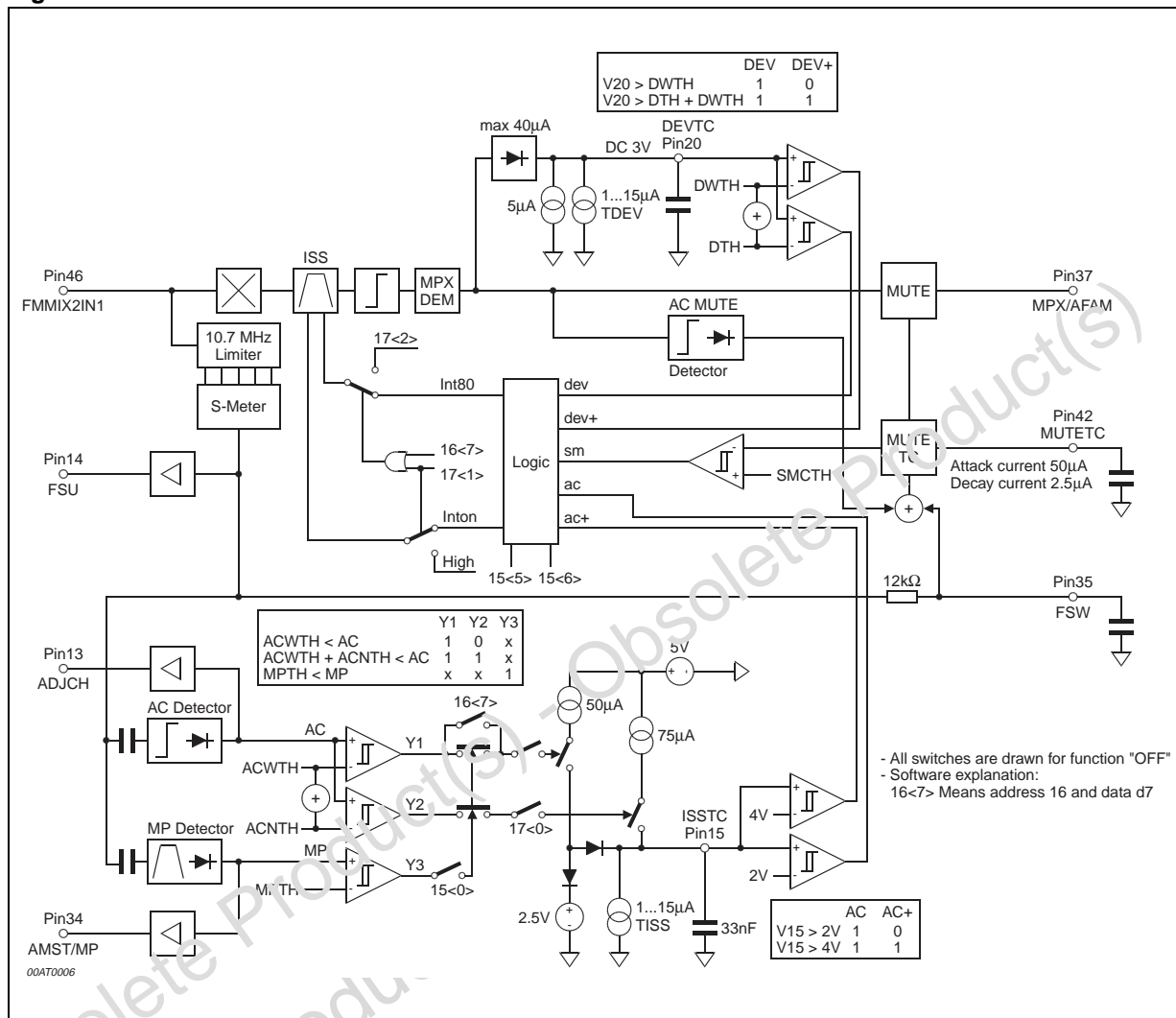
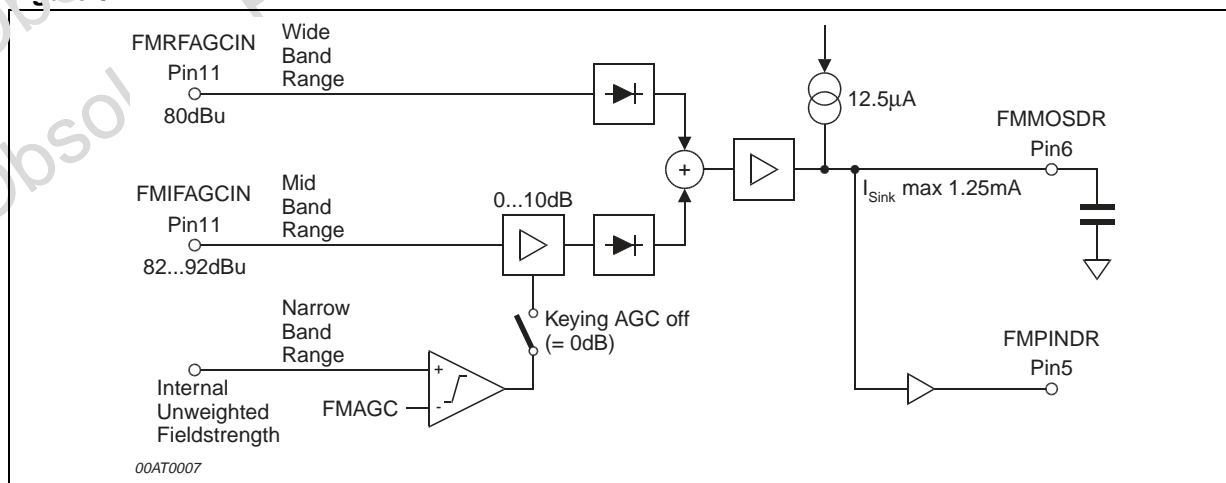


Figure 3.



Block Diagram Quality Detection Principle

Table 32.

| Signal | LOW | HIGH |
|--------|--|---|
| ac | No adjacent channel | Adjacent channel present |
| ac+ | No strong adjacent channel | Adjacent channel higher as ac |
| sm | Fieldstrength higher as softmute threshold | Fieldstrength lower as softmute threshold |
| dev | Deviation lower as threshold DWTH | Deviation higher as threshold DWTH |
| dev+ | Deviation lower as threshold DTH*DWTH | Deviation higher as threshold DTH*DWTH |
| inton | ISS filter off by logic (wide) | ISS filter on by logic |
| int80 | ISS filter 120kHz (mid) | ISS filter 80kHz (narrow) |

Table 33.

| Input Signals | | | | | Mode1 | | | Mode2 | | |
|---------------|-----|----|-----|------|-------|-------|----------|-------|-------|----------|
| ac | ac+ | sm | dev | dev+ | inton | int80 | Function | inton | int80 | Function |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | wide | 0 | 0 | wide |
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | wide | 0 | 0 | wide |
| 0 | 0 | 0 | 1 | 1 | 0 | 0 | wide | 0 | 0 | wide |
| 0 | 0 | 1 | 0 | 0 | 1 | 1 | narrow | 1 | 1 | narrow |
| 0 | 0 | 1 | 1 | 0 | 0 | 0 | wide | 1 | 0 | mid |
| 0 | 0 | 1 | 1 | 1 | 0 | 0 | wide | 0 | 0 | wide |
| 1 | 0 | 0 | 0 | 0 | 1 | 1 | narrow | 1 | 0 | mid |
| 1 | 1 | 0 | 0 | 0 | 1 | 1 | narrow | 1 | 1 | narrow |
| 1 | 0 | 0 | 1 | 0 | 1 | 0 | mid | 1 | 0 | mid |
| 1 | 1 | 0 | 1 | 1 | 1 | 0 | mid | 1 | 1 | narrow |
| 1 | 0 | 1 | 0 | 0 | 1 | 1 | narrow | 1 | 1 | narrow |
| 1 | 1 | 1 | 0 | 0 | 1 | 1 | narrow | 1 | 1 | narrow |
| 1 | 0 | 1 | 1 | 0 | 1 | 0 | mid | 1 | 0 | mid |
| 1 | 1 | 1 | 1 | 0 | 1 | 0 | mid | 1 | 1 | narrow |
| 1 | 0 | 1 | 1 | 1 | 1 | 0 | mid | 1 | 0 | mid |
| 1 | 1 | 1 | 1 | 1 | 1 | 0 | mid | 1 | 1 | narrow |

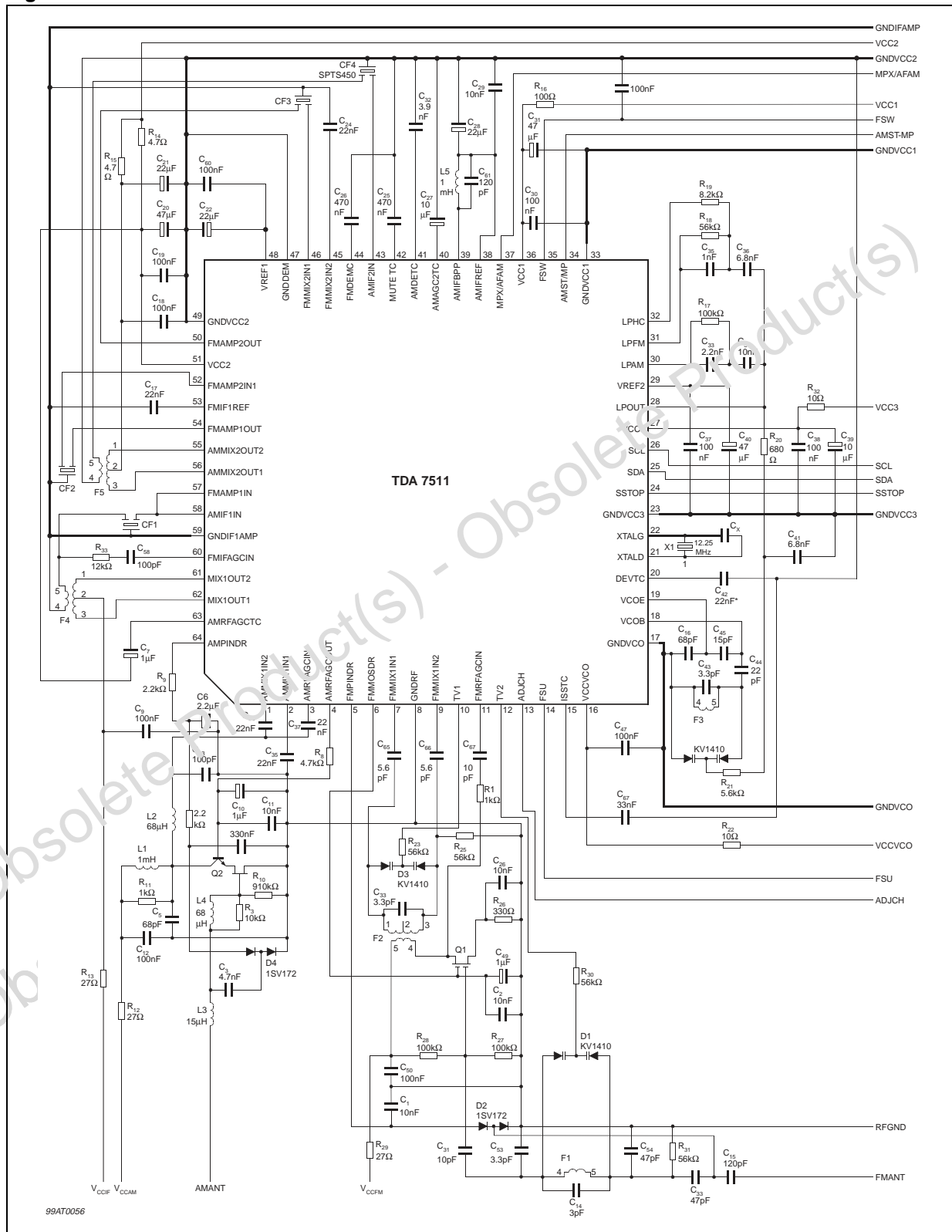
Part List (Application- and Measurement Circuit)

Table 34.

| Item | Description |
|----------|--|
| F1 | TOKO 7KL 600ENS-9132NK |
| F2 | TOKO 7KL 600ENS-9390AQ |
| F3 | TOKO 7KL V600ENS-9469BS |
| F4 | TOKO 7PSG 628AC-5022N |
| F5 | TOKO PGL 5PGLC-5103N |
| L1,L5 | SIEMENS SIMID03 B82432 1mH |
| L2,L4 | TOKO FSLU 2520-680 68µH |
| L3 | TOKO FSLU 2520-150 15µH |
| CF1,CF2 | MURATA SFE10.7MS3A10-A 180KHz or (TOKO CFSK107M3-AE-20X) |
| CF3 | MURATA SFE10.7MJA10-A 150KHz or (TOKO CFSK107M4-AE-20X) |
| CF4 | MURATA SFPS 450H 6KHz or (TOKO ARLFC450T) |
| T1,T2 | COMPONEX B4F 617PT-1026 |
| D1,D3,D5 | TOKO KV1410 |
| D2,D4 | TOSHIBA 1SV172 |
| Q1 | TOSHIBA 3SK126 |
| Q2 | TOSHIBA HN3G01J |

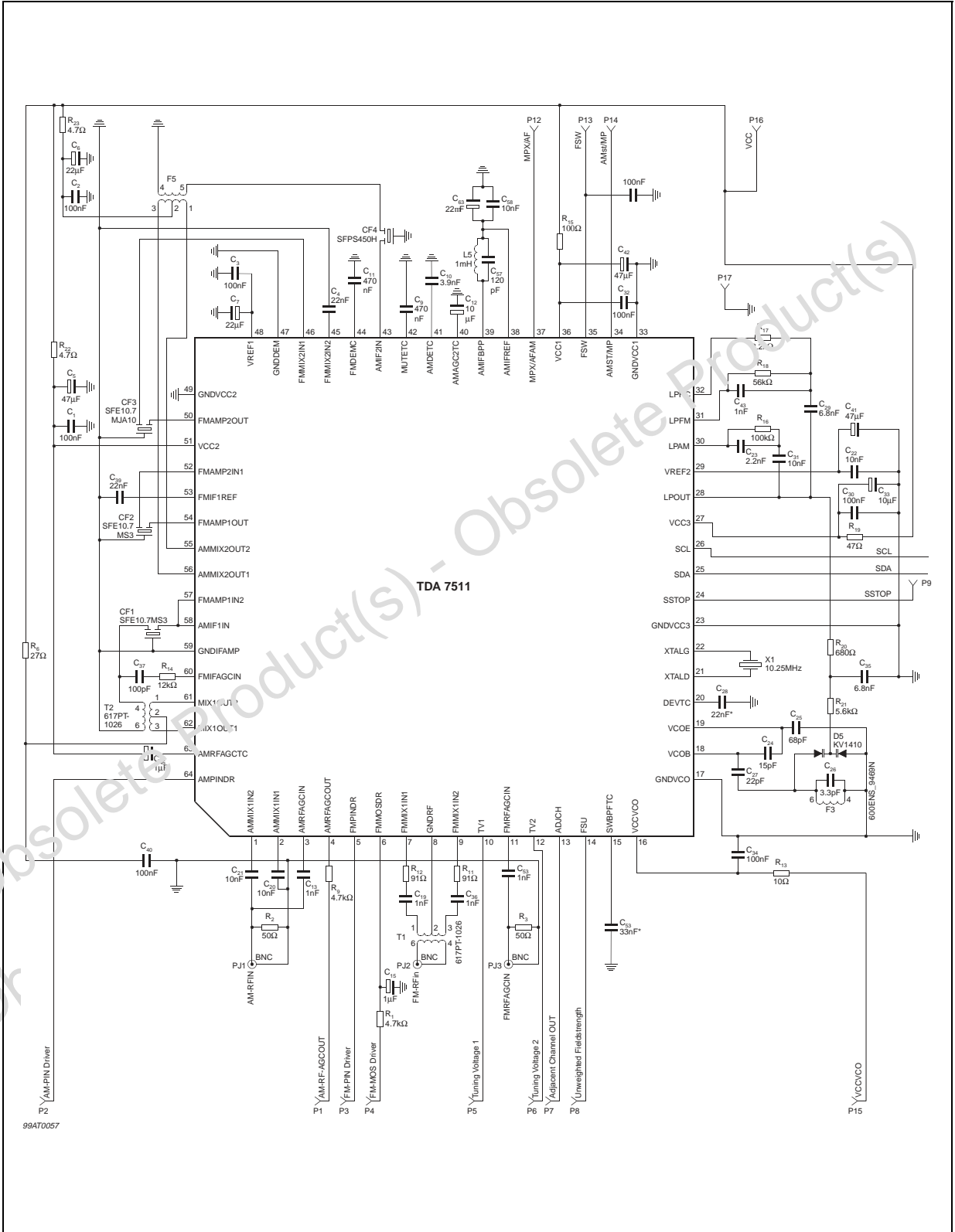
3 APPLICATION CIRCUIT

Figure 4.



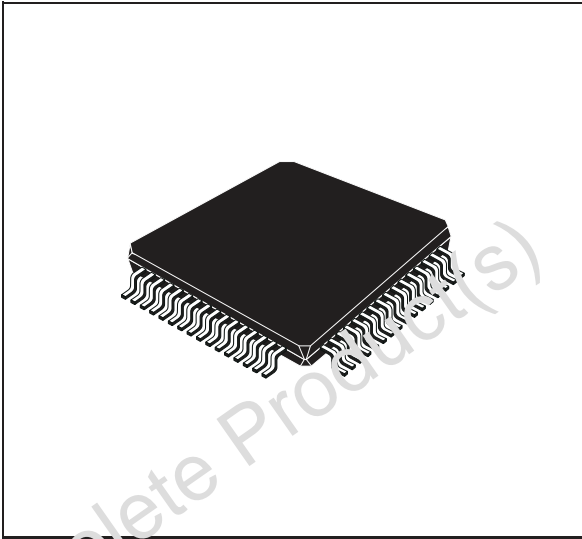
4 MEASUREMENT CIRCUIT

Figure 5.

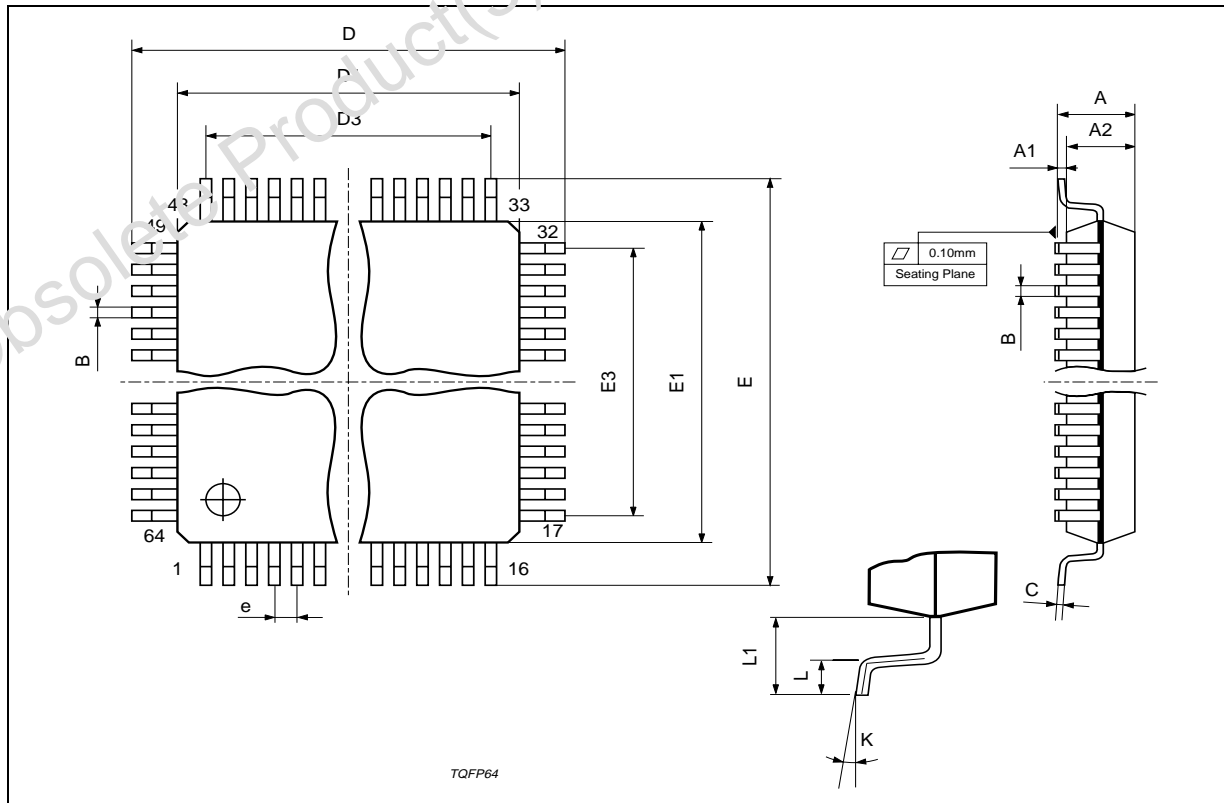


| DIM. | mm | | | inch | | |
|------|--------------------|-------|------|--------|--------|--------|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | | | 1.60 | | | 0.063 |
| A1 | 0.05 | | 0.15 | 0.002 | | 0.006 |
| A2 | 1.35 | 1.40 | 1.45 | 0.053 | 0.055 | 0.057 |
| B | 0.18 | 0.23 | 0.28 | 0.007 | 0.009 | 0.011 |
| C | 0.12 | 0.16 | 0.20 | 0.0047 | 0.0063 | 0.0079 |
| D | | 12.00 | | | 0.472 | |
| D1 | | 10.00 | | | 0.394 | |
| D3 | | 7.50 | | | 0.295 | |
| e | | 0.50 | | | 0.0197 | |
| E | | 12.00 | | | 0.472 | |
| E1 | | 10.00 | | | 0.394 | |
| E3 | | 7.50 | | | 0.295 | |
| L | 0.40 | 0.60 | 0.75 | 0.0157 | 0.0236 | 0.0295 |
| L1 | | 1.00 | | | 0.0393 | |
| K | 0°(min.), 7°(max.) | | | | | |

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