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INTEGRATED CIRCUITS

# DATA SHEET

# TEA6843HL
## New In Car Entertainment (NICE) extended car radio

Product specification 2003 Dec 19

Philips
Semiconductors

PHILIPS

CONTENTS

## 1 FEATURES

- FM mixer for conversion of FM RF from 65 to 108 MHz to IF of 10.7 MHz; the mixer provides inherent image rejection
- FM RF mixer can be set to receive weather band radio up to 162.55 MHz
- Buffer output for weather band flag
- AM mixer 1 for conversion of AM RF to AM IF1 of 10.7 MHz
- LC tuner oscillator providing mixer frequencies for FM mixer and AM mixer 1
- AM mixer 2 for conversion of AM IF1 to AM IF2 of 450 kHz
- Crystal oscillator providing mixer frequencies for AM mixer 2 and reference for synthesizer PLL, IF count, timing for inaudible Radio Data System (RDS) update and reference frequency for car audio signal processor ICs
- Fast synthesizer PLL tuning system with local control for inaudible RDS updating
- Timing function for RDS update algorithm and control signal output for car audio signal processor ICs (TEA688x, SAA77xx) or car radio integrated signal processor IC (TEF689x)
- Digital auto alignment circuit for conversion of LC oscillator tuning voltage to controlled alignment voltage of FM antenna tank circuit
- AGC PIN diode drive circuit for FM RF AGC; AGC detection at FM mixer input; the AGC PIN diode current can be set to a fixed value to allow local function for search tuning; AGC threshold is a programmable and keyed function switchable via the $I^2C$-bus
- FM IF linear amplifiers with high dynamic input range
- FM quadrature demodulator with automatic centre frequency adjustment and Total Harmonic Distortion (THD) compensation and level driven soft mute; soft mute characteristic is adjustable via the $I^2C$-bus
- Level detector for AM and FM with temperature compensated output voltage; starting point and slope of level output is programmable via the $I^2C$-bus
- AM RF PIN diode drive circuit; AGC threshold detection at AM mixer 1 and IF2 AGC input; threshold is programmable via the $I^2C$-bus; AM IF2 AGC and demodulator
- AM AF output switchable to provide AM IF2 for AM stereo decoder
- AM noise blanker with blanking at AM IF2
- Several test modes available for fast IC and system tests.

## 2 GENERAL DESCRIPTION

The TEA6843HL is a single IC with car radio tuner for AM, FM and Weather Band (WB) intended for microcontroller tuning with the $I^2C$-bus. It provides the following functions:

- AM double conversion receiver for LW, MW and SW (31 m, 41 m and 49 m bands) with IF1 = 10.7 MHz and IF2 = 450 kHz
- FM single conversion receiver with integrated image rejection for IF = 10.7 MHz capable of selecting US FM, US weather, Europe FM, East Europe FM and Japan FM bands
- The tuning system includes FM mixer, AM mixer 1, AM mixer 2, crystal oscillator, VCO and PLL synthesizer on one chip.

## 3 ORDERING INFORMATION

| TYPE NUMBER | PACKAGE | | |
|---|---|---|---|
| | NAME | DESCRIPTION | VERSION |
| TEA6843HL | LQFP80 | plastic low profile quad flat package; 80 leads; body 12 × 12 × 1.4 mm | SOT315-1 |

## 4 QUICK REFERENCE DATA

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| $V_{DDA(n)}$ | analog supply voltage 1 to 4 and 6 | | 8 | 8.5 | 9 | V |
| $I_{DDA(tot)}$ | total analog supply currents 1 to 4 and 6 and mixer bias currents | FM mode; data byte 5: bit TMS3 = 1 | 45 | 60 | 69 | mA |
| | | AM mode; data byte 5: bit TMS3 = 1 | 39 | 50 | 59 | mA |
| $V_{DDA5}$ | analog supply voltage 5 | | 4.75 | 5 | 5.25 | V |
| $I_{DDA5}$ | analog supply current 5 | FM mode; data byte 5: bit 5 = 0, bit 6 = 0 | 6.5 | 9.3 | 11.2 | mA |
| | | AM mode; data byte 5: bit 5 = 1, bit 6 = 1 | 12.7 | 17.4 | 22.1 | mA |
| $V_{DDD}$ | digital supply voltage | | 4.75 | 5 | 5.25 | V |
| $I_{DDD}$ | digital supply current | FM mode | 18 | 23 | 28 | mA |
| | | AM mode | 18 | 23 | 28 | mA |
| $f_{AM(ant)}$ | AM input frequency | LW | 0.144 | – | 0.288 | MHz |
| | | MW | 0.522 | – | 1.710 | MHz |
| | | SW | 5.85 | – | 9.99 | MHz |
| $f_{FM(ant)}$ | FM input frequency | | 65 | – | 108 | MHz |
| $f_{FM(WB)(ant)}$ | FM weather band input frequency | | 162.4 | – | 162.55 | MHz |
| $T_{amb}$ | ambient temperature | | –40 | – | +85 | °C |

## 5 BLOCK DIAGRAM

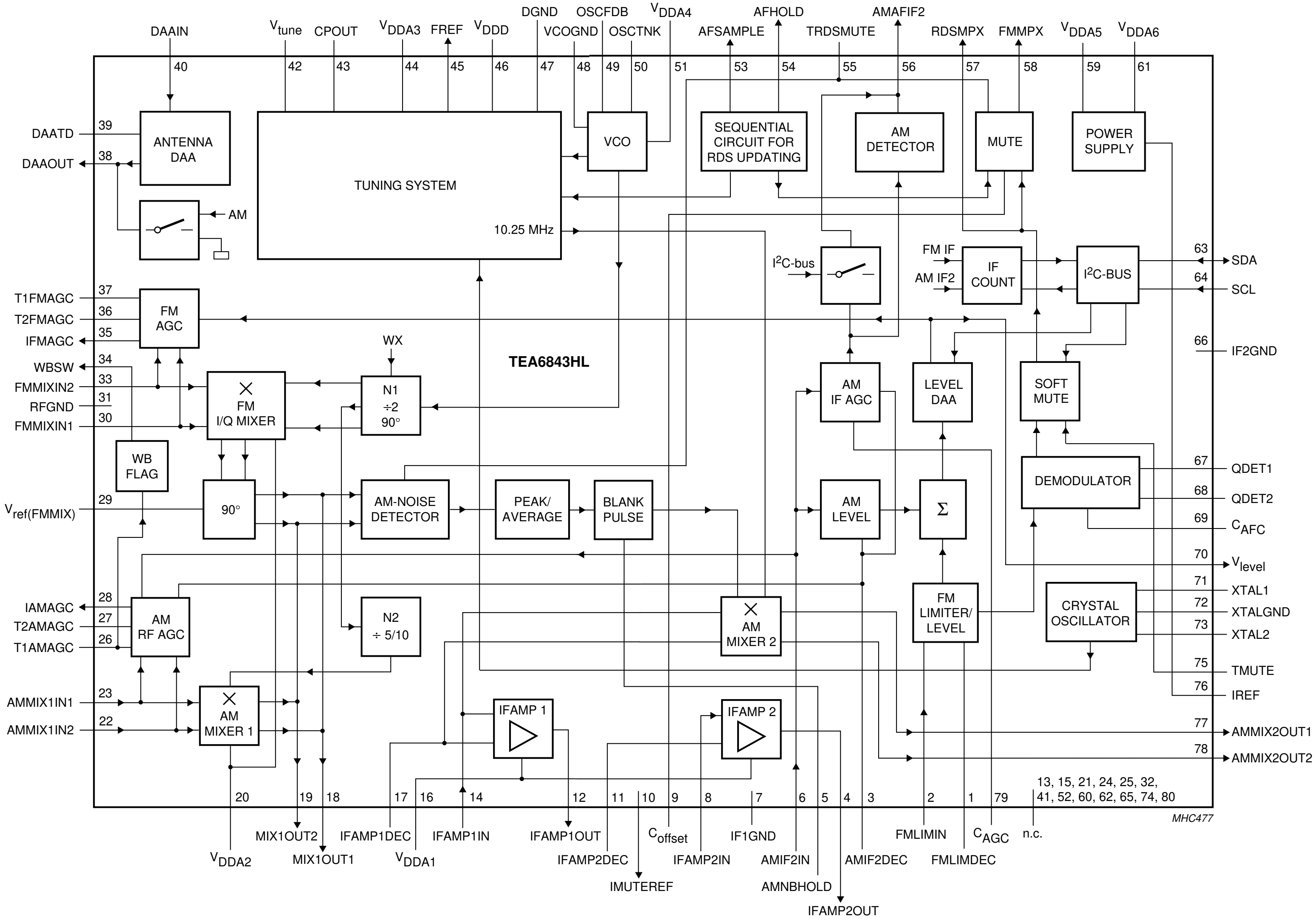


Fig.1 Block diagram

## 6 PINNING

| SYMBOL | PIN | DESCRIPTION |
|---|---|---|
| FMLIMDEC | 1 | FM limiter decoupling |
| FMLIMIN | 2 | FM limiter input (10.7 MHz) |
| AMIF2DEC | 3 | decoupling for AM IF2 input |
| IFAMP2OUT | 4 | IF amplifier 2 output (10.7 MHz) |
| AMNBHOLD | 5 | AM noise blanker threshold |
| AMIF2IN | 6 | AM IF2 input (450 kHz) for demodulator AGC and AM level detector |
| IF1GND | 7 | AM IF1 ground |
| IFAMP2IN | 8 | IF amplifier 2 input (10.7 MHz) |
| $C_{offset}$ | 9 | DC feedback for offset compensation RDS mute |
| IMUTEREF | 10 | mute reference current output for testing |
| IFAMP2DEC | 11 | IF amplifier 2 decoupling and AGC capacitor for AM noise blanker |
| IFAMP1OUT | 12 | IF amplifier 1 output (10.7 MHz) |
| n.c. | 13 | not connected |
| IFAMP1IN | 14 | IF amplifier 1 and AM mixer 2 input (10.7 MHz) |
| n.c. | 15 | not connected |
| $V_{DDA1}$ | 16 | analog supply voltage 1 (8.5 V) for IF amplifier 1 and 2 |
| IFAMP1DEC | 17 | AM mixer 2 and FM IF amplifier 1 decoupling |
| MIX1OUT1 | 18 | FM mixer and AM mixer 1 IF output 1 (10.7 MHz) |
| MIX1OUT2 | 19 | FM mixer and AM mixer 1 IF output 2 (10.7 MHz) |
| $V_{DDA2}$ | 20 | analog supply voltage 2 (8.5 V) for FM mixer and AM mixer 1 |
| n.c. | 21 | not connected |
| AMMIX1IN2 | 22 | AM mixer 1 input 2 |
| AMMIX1IN1 | 23 | AM mixer 1 input 1 |
| n.c. | 24 | not connected |
| n.c. | 25 | not connected |
| T1AMAGC | 26 | 1st time constant of AM front-end AGC |
| T2AMAGC | 27 | 2nd time constant of AM front-end AGC |
| IAMAGC | 28 | PIN diode drive current output of AM front-end AGC |
| $V_{ref(FMMIX)}$ | 29 | reference voltage for FM I/Q mixer |
| FMMIXIN1 | 30 | FM RF mixer input 1 |
| RFGND | 31 | RF ground |
| n.c. | 32 | not connected |
| FMMIXIN2 | 33 | FM RF mixer input 2 |
| WBSW | 34 | buffered weather band flag output |
| IFMAGC | 35 | PIN diode drive current output of FM front-end AGC |
| T2FMAGC | 36 | 2nd time constant of FM front-end AGC |
| T1FMAGC | 37 | 1st time constant of FM front-end AGC |
| DAAOUT | 38 | output of digital auto alignment circuit for antenna tank circuit |
| DAATD | 39 | temperature compensation diode for digital auto alignment circuit for antenna tank circuit |
| DAAIN | 40 | input of digital auto alignment circuit for antenna tank circuit |

| SYMBOL | PIN | DESCRIPTION |
|---|---|---|
| n.c. | 41 | not connected |
| $V_{tune}$ | 42 | tuning voltage |
| CPOUT | 43 | charge pump output |
| $V_{DDA3}$ | 44 | analog supply voltage 3 (8.5 V) for tuning PLL |
| FREF | 45 | reference frequency output for signal processor IC |
| $V_{DDD}$ | 46 | digital supply voltage (5 V) |
| DGND | 47 | digital ground |
| VCOGND | 48 | VCO ground |
| OSCFDB | 49 | VCO feedback |
| OSCTNK | 50 | VCO tank circuit |
| $V_{DDA4}$ | 51 | analog supply voltage 4 (8.5 V) for VCO |
| n.c. | 52 | not connected |
| AFSAMPLE | 53 | AF sample flag output for car audio signal processor IC |
| AFHOLD | 54 | AF hold flag output for car audio signal processor IC |
| TRDSMUTE | 55 | time constant for RDS update mute |
| AMAFIF2 | 56 | AM demodulator AF output or IF2 output for AM stereo (multiplexed by $I^2C$-bus) |
| RDSMPX | 57 | MPX output for RDS decoder and signal processor (not muted) |
| FMMPX | 58 | FM demodulator MPX output |
| $V_{DDA5}$ | 59 | analog supply voltage 5 (5 V) for on-chip power supply |
| n.c. | 60 | not connected |
| $V_{DDA6}$ | 61 | analog supply voltage 6 (8.5 V) for on-chip power supply |
| n.c. | 62 | not connected |
| SDA | 63 | $I^2C$-bus data line input and output |
| SCL | 64 | $I^2C$-bus clock line input |
| n.c. | 65 | not connected |
| IF2GND | 66 | AM IF2 ground |
| QDET1 | 67 | quadrature demodulator tank 1 |
| QDET2 | 68 | quadrature demodulator tank 2 |
| $C_{AFC}$ | 69 | FM demodulator AFC capacitor |
| $V_{level}$ | 70 | level voltage output for AM and FM |
| XTAL1 | 71 | crystal oscillator 1 |
| XTALGND | 72 | crystal oscillator ground |
| XTAL2 | 73 | crystal oscillator 2 |
| n.c. | 74 | not connected |
| TMUTE | 75 | time constant for mute control voltage |
| IREF | 76 | reference current for power supply |
| AMMIX2OUT1 | 77 | AM mixer 2 output 1 (450 kHz) |
| AMMIX2OUT2 | 78 | AM mixer 2 output 2 (450 kHz) |
| $C_{AGC}$ | 79 | AM IF AGC capacitor |
| n.c. | 80 | not connected |

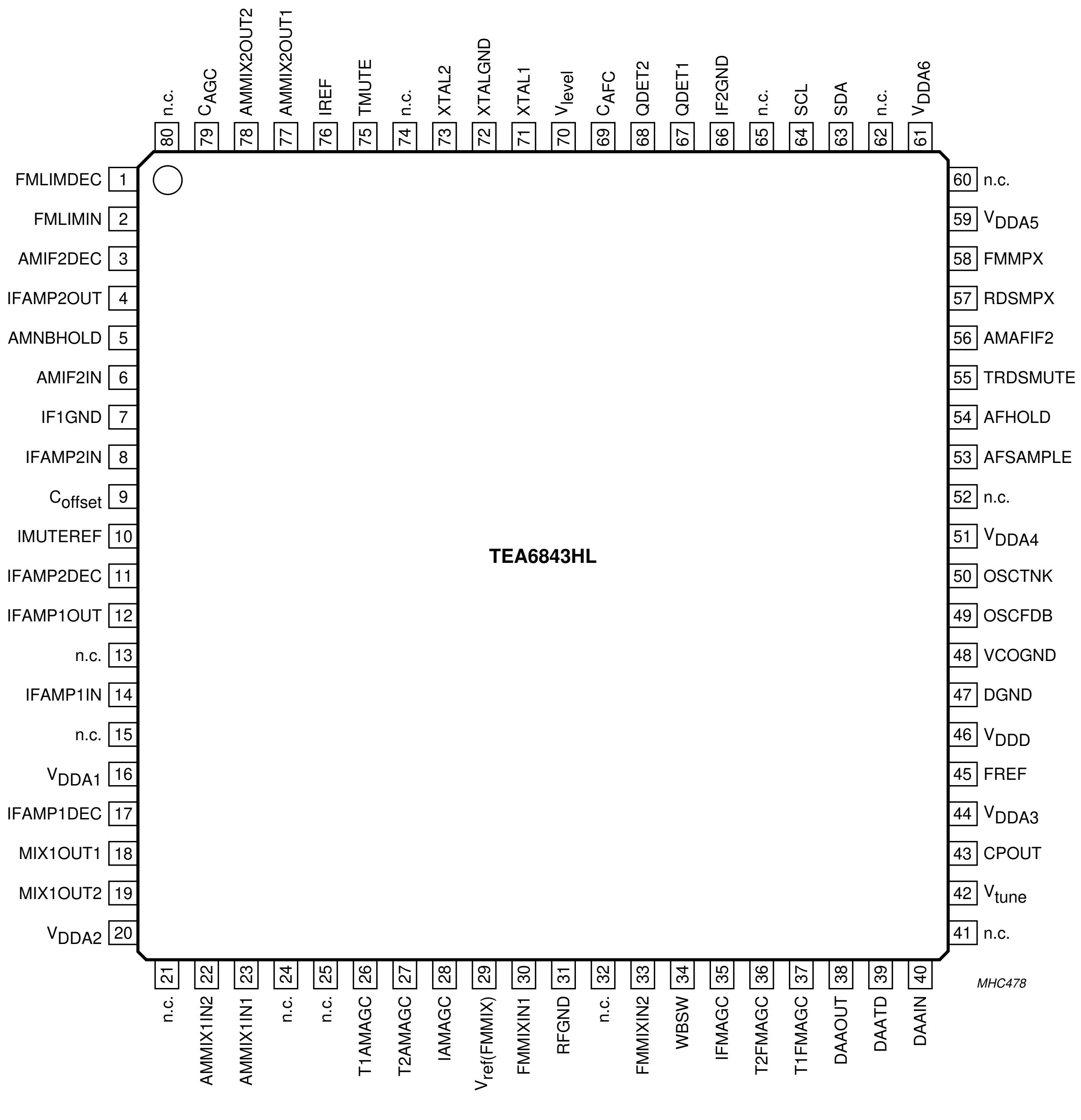


Fig.2 Pin configuration.

## 7 FUNCTIONAL DESCRIPTION

### 7.1 Oscillators

#### 7.1.1 VCO

The L and C tuned VCO provides the local oscillator signal for both FM and AM mixer 1. It has a frequency range of 151.2 to 248.2 MHz.

#### 7.1.2 CRYSTAL OSCILLATOR

The crystal oscillator provides a 20.5 MHz signal that is used for:

- Reference frequency for frequency synthesizer PLL
- Local oscillator for AM mixer 2
- Reference frequency for the IF counter
- Timing signal for the RDS update algorithm
- Reference frequency (75.368 kHz) for the TEA688x (car audio signal processor - CASP) or TEF689x (car radio integrated signal processor - CRISP).

#### 7.1.3 PLL

Fast synthesizer PLL tuning system with local control for inaudible RDS updating.

### 7.2 FM signal channel

#### 7.2.1 DAA

FM RF Digital Auto Alignment (DAA) circuitry for the conversion of the VCO tuning voltage to a controlled alignment voltage for the FM antenna tank circuit.

#### 7.2.2 FM I/Q MIXER

FM quadrature mixer converts FM RF (65 to 162.55 MHz) to IF of 10.7 MHz. The FM mixer provides inherent image rejection and high RF sensitivity.

It is capable of tuning the US FM, US weather, Europe FM, Japan FM and East Europe FM bands:

- US FM = 87.9 to 107.9 MHz
- US weather FM = 162.4 to 162.55 MHz
- Europe FM = 87.5 to 108 MHz
- Japan FM = 76 to 91 MHz
- East Europe FM = 65.8 to 74 MHz.

#### 7.2.3 FM KEYED AGC

The AGC threshold is programmable and the keyed AGC function is switchable via the $I^2C$-bus.

If the keyed AGC function is activated, the AGC function is keyed by the narrow band level (IF).

The AGC PIN diode drive can be set via the $I^2C$-bus to local function for search tuning.

#### 7.2.4 FM IF AMPLIFIERS

The two FM IF amplifiers provide 10 dB and 8.5 dB amplification with high linearity and dynamic range.

#### 7.2.5 FM DEMODULATOR

The FM quadrature demodulator includes automatic centre frequency adjustment and THD compensation.

#### 7.2.6 FM MPX SOFT MUTE

Muting depth and start of muting are adjustable via the $I^2C$-bus.

### 7.3 AM signal channel

#### 7.3.1 AM TUNER

The AM tuner is realized in a double conversion technique and is capable of selecting LW, MW and SW bands.

AM mixer 1 converts AM RF to IF1 of 10.7 MHz, while AM mixer 2 converts IF1 of 10.7 MHz to IF2 of 450 kHz:

- LW = 144 to 288 kHz
- MW = 522 to 1710 kHz (European and US AM band)
- SW = 5.85 to 9.99 MHz (including the 31 m, 41 m and 49 m bands).

#### 7.3.2 AM RF AGC AND IF2 AGC

The AM RF includes a PIN diode drive circuit. The threshold detection points for AM AGC are performed at AM mixer 1 and AM IF2. AGC thresholds are programmable at AM mixer 1 input via the $I^2C$-bus.

#### 7.3.3 AM AF OR IF2 SWITCH

The AM output provides either a demodulated AM Audio Frequency (AF) or the corresponding AM IF2 signal. The IF2 signal can be used for AM stereo decoder processing.

#### 7.3.4 AM SOFT MUTE

The AM detector output is either not muted or signal strength dependent soft muted audio. The soft mute function can be switched off via the $I^2C$-bus.

#### 7.3.5 AM NOISE BLANKER

The detection point for the AM noise blanker is the output stage of AM mixer 1, while blanking is realized at the output of the mixer 2.

Trigger sensitivity can be modified by changing the resistor value at pin AMNBHOLD.

### 7.4 FM and AM level detector

FM and AM level detectors provide the temperature compensated output voltage. The starting points and slopes of the level detector outputs are programmable via the $I^2C$-bus.

### 7.5 Buffer output for weather band flag

In weather band mode the output is HIGH.

### 7.6 Test mode

The test mode of the IC is activated by connecting pin FREF through a 100 kΩ resistor to $V_{DDA1}$.

The test mode is intended for IC test during IC and radio manufacturing.

In test mode the settling time of the AM IF2 AGC is reduced to less than 100 ms in the nominal application.

## 8 LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 60134).

| SYMBOL | PARAMETER | CONDITIONS | MIN. | MAX. | UNIT |
|---|---|---|---|---|---|
| $V_{DDA1}$ | analog supply voltage 1 for IF amplifier 1 and 2 | | −0.3 | +10 | V |
| $V_{DDA2}$ | analog supply voltage 2 for FM mixer and AM mixer 1 | | −0.3 | +10 | V |
| $V_{DDA3}$ | analog supply voltage 3 for tuning PLL | | −0.3 | +10 | V |
| $V_{DDA4}$ | analog supply voltage 4 for VCO | | −0.3 | +10 | V |
| $V_{DDA5}$ | analog supply voltage 5 for on-chip power supply | | −0.3 | +6.5 | V |
| $V_{DDA6}$ | analog supply voltage 6 for on-chip power supply | | −0.3 | +10 | V |
| $V_{DDD}$ | digital supply voltage | | −0.3 | +6.5 | V |
| $\Delta V_{DD8.5-DD5}$ | difference between any 8.5 V supply voltage and any 5 V supply voltage | note 1 | −0.3 | − | V |
| $T_{stg}$ | storage temperature | | −55 | +150 | °C |
| $T_{amb}$ | ambient temperature | | −40 | +85 | °C |
| $V_{es}$ | electrostatic handling voltage | note 2 | −200 | +200 | V |
| | | note 3 | −2000 | +2000 | V |

**Notes**

1. To avoid damages and wrong operation it is necessary to keep all 8.5 V supply voltages at a higher level than any 5 V supply voltage. This is also necessary during power-on and power-down sequences. Precautions have to be provided in such a way that interferences can not pull down the 8.5 V supply below the 5 V supply.
2. Machine model (R = 0 Ω, C = 200 pF).
3. Human body model (R = 1.5 kΩ, C = 100 pF).

## 9 THERMAL CHARACTERISTICS

| SYMBOL | PARAMETER | CONDITIONS | VALUE | UNIT |
|---|---|---|---|---|
| $R_{th(j-a)}$ | thermal resistance from junction to ambient | in free air | 54 | K/W |

## 10 DC CHARACTERISTICS

$V_{MIX1OUT} = V_{AMMIX2OUT} = V_{DDA(n)} = 8.5$ V; $V_{DDA5} = 5$ V; $V_{DDD} = 5$ V; $T_{amb} = 25$ °C; unless otherwise specified.

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| **Supply voltage** | | | | | | |
| $V_{DDA(n)}$ | analog supply voltages 1 to 4 and 6 | | 8 | 8.5 | 9 | V |
| $V_{MIX1OUT}$; $V_{AMMIX2OUT}$ | mixer supply voltages | | 8 | 8.5 | 9 | V |
| $V_{DDA5}$ | analog supply voltage 5 | | 4.75 | 5 | 5.25 | V |
| $V_{DDD}$ | digital supply voltage | | 4.75 | 5 | 5.25 | V |
| **Supply current in FM mode** | | | | | | |
| $I_{DDD}$ | digital supply current | | 18 | 23 | 28 | mA |
| $I_{DDA1}$ | analog supply current 1 for IF amplifier 1 and 2 | | 11 | 13 | 15 | mA |
| $I_{DDA2}$ | analog supply current 2 for FM mixer and AM mixer 1 | | 4.2 | 5.2 | 6.2 | mA |
| $I_{DDA3}$ | analog supply current 3 for tuning PLL | data byte 5: bit TMS3 = 1 | 2.3 | 3 | 3.6 | mA |
| $I_{DDA4}$ | analog supply current 4 for VCO | | 5.2 | 6.5 | 7.8 | mA |
| $I_{DDA5}$ | analog supply current 5 for on-chip power supply | | 6.5 | 9.3 | 11.2 | mA |
| $I_{DDA6}$ | analog supply current 6 for on-chip power supply | | 16 | 20 | 24 | mA |
| $I_{MIX1OUT1}$ | bias current of FM mixer output 1 | | 4.8 | 6 | 7.2 | mA |
| $I_{MIX1OUT2}$ | bias current of FM mixer output 2 | | 4.8 | 6 | 7.2 | mA |
| **Supply current in AM mode** | | | | | | |
| $I_{DDD}$ | digital supply current | | 18 | 23 | 28 | mA |
| $I_{DDA1}$ | analog supply current 1 for AM mixer 2 | | – | 240 | – | µA |
| $I_{DDA2}$ | analog supply current 2 for FM mixer and AM mixer 1 | | 1.6 | 2 | 2.4 | mA |
| $I_{DDA3}$ | analog supply current 3 for tuning PLL | data byte 5: bit TMS3 = 1 | 1.3 | 1.7 | 2.1 | mA |
| $I_{DDA4}$ | analog supply current 4 for VCO | | 5 | 6.5 | 8 | mA |
| $I_{DDA5}$ | analog supply current 5 for on-chip power supply | | 12.7 | 17.4 | 22.1 | mA |
| $I_{DDA6}$ | analog supply current 6 for on-chip power supply | | 15 | 19 | 23 | mA |
| $I_{MIX1OUT1}$ | bias current of AM mixer 1 output 1 | | 4.8 | 6 | 7.2 | mA |
| $I_{MIX1OUT2}$ | bias current of AM mixer 1 output 2 | | 4.8 | 6 | 7.2 | mA |
| $I_{AMMIX2OUT1}$ | bias current of AM mixer 2 output 1 | | 3.6 | 4.5 | 5.4 | mA |
| $I_{AMMIX2OUT2}$ | bias current of AM mixer 2 output 2 | | 3.6 | 4.5 | 5.4 | mA |

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| **Power supply reference current generator: pin IREF** | | | | | | |
| $V_{o(ref)}$ | output reference voltage | | 4 | 4.25 | 4.5 | V |
| $R_o$ | output resistance | | 8 | 11 | 13 | kΩ |
| $I_{o(max)}$ | maximum output current | | –100 | – | +100 | nA |

## 11 AC CHARACTERISTICS

$V_{MIX1OUT} = V_{AMMIX2OUT} = V_{DDA(n)} = 8.5$ V; $V_{DDA5} = 5$ V; $V_{DDD} = 5$ V; $T_{amb} = 25$ °C; see Figs 14 and 15; unless otherwise specified.

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| **Voltage controlled oscillator** | | | | | | |
| $f_{osc}$ | oscillator frequency | | 151.2 | – | 248.2 | MHz |
| C/N | carrier-to-noise ratio | $f_{osc}$ = 200 MHz; Δf = 10 kHz; B = 1 Hz | – | 101 | – | dBc |
| RR | ripple rejection $\frac{\Delta f_{osc}}{f_{osc}}$ | $f_{ripple}$ = 100 Hz; $V_{DDA4(ripple)}$ = 100 mV (RMS) | | | | |
| | | $f_{osc}$ = 250 MHz | 90 | 97 | – | dB |
| | | $f_{osc}$ = 200 MHz | 92 | 99 | – | dB |
| **Crystal oscillator: pins XTAL1, XTALGND and XTAL2** | | | | | | |
| $f_{osc}$ | oscillator frequency | | – | 20.5 | – | MHz |
| $R_i$ | real part of input impedance | $V_{XTAL1} - V_{XTAL2}$ = 1 mV | –500 | – | – | Ω |
| $C_i$ | input capacitance | | 8 | 10 | 12 | pF |
| $V_{o(osc)(rms)}$ | oscillator output voltage (RMS value) | | 240 | 350 | 500 | mV |
| C/N | carrier-to-noise ratio | $f_{osc}$ = 20.5 MHz (10.25 MHz); Δf = 10 kHz | – | 112 | – | $\frac{dBc}{\sqrt{Hz}}$ |
| **Oscillator divider N1** | | | | | | |
| N1 | oscillator divider ratio | FM mode | | | | |
| | | standard, East Europe and local | – | 2 | – | |
| | | weather band (WX) | – | 1 | – | |
| **Oscillator divider N2** | | | | | | |
| N2 | oscillator divider ratio | AM mode | | | | |
| | | LW and MW | – | 10 | – | |
| | | SW | – | 5 | – | |
| **Synthesizer** | | | | | | |
| PROGRAMMABLE DIVIDER | | | | | | |
| $N_{prog}$ | programmable divider ratio | | 512 | – | 32767 | |

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| $\Delta N_{step}$ | programmable divider step size | | – | 1 | – | |
| REFERENCE FREQUENCY DIVIDER | | | | | | |
| $N_{ref}$ | crystal oscillator divider ratio | $f_{osc}$ = 20.5 MHz | | | | |
| | | $f_{ref}$ = 100 kHz | – | 205 | – | |
| | | $f_{ref}$ = 50 kHz | – | 410 | – | |
| | | $f_{ref}$ = 25 kHz | – | 820 | – | |
| | | $f_{ref}$ = 20 kHz | – | 1025 | – | |
| | | $f_{ref}$ = 10 kHz | – | 2050 | – | |
| CHARGE PUMP: PIN CPOUT | | | | | | |
| $I_{sink(cp1)l}$ | low charge pump 1 sink current | 0.4 V < $V_{CPOUT}$ < 7.6 V; data byte 4: bit 0 = 0, bit 1 = 1, bit 2 = 1 for FM weather band; $f_{VCO} > f_{ref} \times$ divider ratio | – | 300 | – | µA |
| $I_{source(cp1)l}$ | low charge pump 1 source current | 0.4 V < $V_{CPOUT}$ < 7.6 V; data byte 4: bit 0 = 0, bit 1 = 1, bit 2 = 1 for FM weather band; $f_{VCO} < f_{ref} \times$ divider ratio | – | –300 | – | µA |
| $I_{sink(cp1)h}$ | high charge pump 1 sink current | 0.4 V < $V_{CPOUT}$ < 7.6 V; data byte 4: bit 0 = 1, bit 1 = 1, bit 2 = 1 for AM IF2 output; N2 = 10 (LW and MW); $f_{VCO} > f_{ref} \times$ divider ratio | – | 1 | – | mA |
| $I_{source(cp1)h}$ | high charge pump 1 source current | 0.4 V < $V_{CPOUT}$ < 7.6 V; data byte 4: bit 0 = 1, bit 1 = 1, bit 2 = 1 for AM IF2 output; N2 = 10 (LW and MW); $f_{VCO} < f_{ref} \times$ divider ratio | – | –1 | – | mA |
| $I_{sink(cp2)}$ | charge pump 2 sink current | 0.3 V < $V_{CPOUT}$ < 7.1 V; data byte 4: bit 0 = 0, bit 1 = 0, bit 2 = 0; FM standard mode; $f_{VCO} > f_{ref} \times$ divider ratio | – | 130 | – | µA |
| $I_{source(cp2)}$ | charge pump 2 source current | 0.3 V < $V_{CPOUT}$ < 7.1 V; data byte 4: bit 0 = 0, bit 1 = 0, bit 2 = 0; FM standard mode; $f_{VCO} < f_{ref} \times$ divider ratio | – | –130 | – | µA |
| CHARGE PUMP: PIN $V_{tune}$ | | | | | | |
| $I_{sink(cp3)}$ | charge pump 3 sink current | 0.4 V < $V_{tune}$ < 7.6 V; data byte 4: bit 0 = 0, bit 1 = 0, bit 2 = 0; FM standard mode; $f_{VCO} > f_{ref} \times$ divider ratio | – | 3 | – | mA |
| $I_{source(cp3)}$ | charge pump 3 source current | 0.4 V < $V_{tune}$ < 7.6 V; data byte 4: bit 0 = 0, bit 1 = 0, bit 2 = 0; FM standard mode; $f_{VCO} < f_{ref} \times$ divider ratio | – | –3 | – | mA |

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| **Antenna Digital Auto Alignment (DAA)** | | | | | | |
| DAA INPUT: PIN DAAIN | | | | | | |
| $I_{bias(cp)}$ | charge pump buffer input bias current | $V_{DAAIN}$ = 0.4 to 8 V | –10 | – | +10 | nA |
| $V_{i(cp)}$ | charge pump buffer input voltage | | 0 | – | 8.5 | V |
| DAA OUTPUT: PIN DAAOUT | | | | | | |
| $V_{o(min)}$ | minimum DAA output voltage | data byte 3 = 10000000; FM mode; $V_{DAAIN}$ = 0.5 V; $V_{DAATD}$ = 0.45 V | – | – | 0.5 | V |
| $V_{o(max)}$ | maximum DAA output voltage | data byte 3 = 11111111; FM mode; $V_{DAAIN}$ = 4 V; $V_{DAATD}$ = 0.45 V | 8 | – | 8.5 | V |
| $V_o$ | DAA output voltage | $I_{DAAOUT}$ < 100 μA; AM mode | – | – | 0.3 | V |
| | | data byte 3 = 10000000; FM mode; $V_{DAAIN}$ = 4 V; $V_{DAATD}$ = 0.45 V; note 1 | – | 1.7 | – | V |
| | | data byte 3 = 11111111; FM mode; $V_{DAAIN}$ = 3 V; $V_{DAATD}$ = 0.45 V; note 1 | 6.2 | 6.5 | 6.8 | V |
| $V_{o(n)}$ | DAA output noise voltage | data byte 3 = 11000000; FM mode; $V_{DAAIN}$ = 4 V; $V_{DAATD}$ = 0.45 V; B = 400 Hz to 30 kHz | – | 30 | 100 | μV |
| $\Delta V_{o(T)}$ | DAA output voltage variation with temperature | $T_{amb}$ = –40 to +85 °C; data byte 3 = 10101011 | –8 | – | +8 | mV |
| $\Delta V_{o(step)}$ | DAA step accuracy $V_{DAAOUT(n+1)} - V_{DAAOUT(n)}$ | n = 0 to 127; FM mode; $V_{DAAOUT}$ < 8 V; $V_{DAAIN}$ = 2 V; $V_{DAATD}$ = 0.45 V | $0.5V_{LSB}$ | $V_{LSB}$ | $1.5V_{LSB}$ | mV |
| $\Delta V_{o(sink)}$ | DAA output variation caused by sink current | $V_{DAAIN}$ = 4 V; $I_L$ = 50 μA | $-V_{LSB}$ | – | $+V_{LSB}$ | |
| $\Delta V_{o(source)}$ | DAA output variation caused by source current | $V_{DAAIN}$ = 4 V; $I_L$ = –50 μA | $-V_{LSB}$ | – | $+V_{LSB}$ | |
| $t_{st}$ | DAA output settling time | $V_{DAAOUT}$ = 0.2 to 8.25 V; $C_L$ = 270 pF | – | 20 | 30 | μs |
| RR | ripple rejection $\frac{V_{DAAOUT}}{V_{DDA3}}$ | data byte 3 = 10101011; FM mode; $V_{DAAIN}$ = 4 V; $V_{DAATD}$ = 0.45 V; $f_{ripple}$ = 100 Hz; $V_{DDA3(ripple)}$ = 100 mV | – | 50 | – | dB |
| $C_L$ | DAA output load capacitance | $V_{DAAOUT}$ < 8 V; FM mode | – | – | 270 | pF |

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| DAA TEMPERATURE COMPENSATION: PIN DAATD | | | | | | |
| $I_{source}$ | compensation diode source current | $V_{DAATD}$ = 0.2 to 1.2 V | –50 | –40 | –30 | μA |
| $TC_{source}$ | temperature coefficient of compensation diode source current | $V_{DAATD}$ = 0.2 to 1.2 V; $T_{amb}$ = –40 to +85 °C | –300 | – | +300 | $\frac{10^{-6}}{K}$ |
| **IF counter (FM IF1 or AM IF2 counter)** | | | | | | |
| $N_{IF}$ | IF counter length for AM and FM | | – | 8 | – | bit |
| $T_{count(IF)}$ | IF counter period | data byte 4: bit 7 = 1 | – | 2 | – | ms |
| | | data byte 4: bit 7 = 0 | – | 20 | – | ms |
| $R_{precount}$ | FM IF counter prescaler ratio | data byte 4: bit 3 = 1 | – | 10 | – | |
| | | data byte 4: bit 3 = 0 | – | 100 | – | |
| $V_{FMLIMIN(sens)(rms)}$ | FM sensitivity voltage (RMS value) | FM mode | – | 30 | 100 | μV |
| N | counter result (decimal) | period = 2 ms; $f_{IF1}$ = 10.7 MHz; $V_{FMLIMIN}$ = 100 μV (RMS) | | | | |
| | | prescaler ratio = 10 | – | 92 | – | |
| | | prescaler ratio = 100 | – | 214 | – | |
| | | period = 20 ms; $f_{IF1}$ = 10.7 MHz; $V_{FMLIMIN}$ = 100 μV (RMS) | | | | |
| | | prescaler ratio = 10 | – | 152 | – | |
| | | prescaler ratio = 100 | – | 92 | – | |
| $V_{AMIF2IN(sens)(rms)}$ | AM sensitivity voltage (RMS value) | AM mode; m = 0 | – | 50 | 100 | μV |
| N | counter result (decimal) | period = 2 ms; $f_{IF2}$ = 450 kHz; $V_{AMIF2IN}$ = 200 μV (RMS) | – | 133 | – | |
| | | period = 20 ms; $f_{IF2}$ = 450 kHz; $V_{AMIF2IN}$ = 200 μV (RMS) | – | 40 | – | |
| **Reference frequency for car signal processor IC;** note 2 | | | | | | |
| REFERENCE FREQUENCY DIVIDER | | | | | | |
| $N_{ref}$ | crystal oscillator divider ratio | | – | 272 | – | |
| $f_{ref}$ | reference frequency at pin FREF | $f_{osc}$ = 20.5 MHz | – | 75.368 | – | kHz |
| VOLTAGE GENERATOR: PIN FREF | | | | | | |
| $V_{o(p-p)}$ | AC output voltage (peak-to-peak value) | $R_L = \infty$ | 80 | 130 | 200 | mV |
| $V_O$ | DC output voltage | | 3.2 | 3.4 | 3.7 | V |
| $R_o$ | output resistance | | – | – | 50 | kΩ |

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| $R_{L(min)}$ | minimum load resistance for first I²C-bus address | | 1 | – | – | MΩ |
| **AM signal channel** | | | | | | |
| RF AGC STAGE INPUTS | | | | | | |
| *Pins AMMIX1IN1 and AMMIX1IN2* | | | | | | |
| $V_{i(RF)}$ | RF input voltage for AGC start level | data byte 5: bit 5 = 0, bit 6 = 0 | – | 375 | – | mV |
| | | data byte 5: bit 5 = 1, bit 6 = 0 | – | 500 | – | mV |
| | | data byte 5: bit 5 = 0, bit 6 = 1 | – | 625 | – | mV |
| | | data byte 5: bit 5 = 1, bit 6 = 1 | – | 750 | – | mV |
| *Pin AMIF2IN* | | | | | | |
| $V_{i(IF2)}$ | IF2 input voltage | AGC start level | 280 | 380 | 500 | mV |
| *PIN diode drive: pin IAMAGC* | | | | | | |
| $I_{sink(max)}$ | maximum AGC sink current | $V_o$ = 2.8 V | 11 | 15 | 19 | mA |
| $I_{sink}$ | AGC sink current | FM mode | 1 | – | – | mA |
| $R_o$ | output resistance | $I_o$ = 1 μA | 1 | – | – | MΩ |
| $C_o$ | AM AGC current generator output capacitance | | – | 5 | 7 | pF |
| AM MIXER 1 (IF1 = 10.7 MHz) | | | | | | |
| *Mixer inputs: pins AMMIX1IN1 and AMMIX1IN2* | | | | | | |
| $R_i$ | input resistance | | 15 | 25 | 35 | kΩ |
| $C_i$ | input capacitance | | 2.5 | 4 | 5.5 | pF |
| $V_I$ | DC input voltage | | 2.3 | 2.7 | 3.1 | V |
| $V_{i(max)}$ | maximum input voltage | 1 dB compression point of AM mixer 1 output (peak-to-peak value) | 500 | – | – | mV |
| $V_{i(n)(eq)}$ | equivalent input noise voltage | band limited noise; $R_{gen}$ = 750 Ω; $R_L$ = 2.8 kΩ | – | 5.8 | 8 | $\frac{nV}{\sqrt{Hz}}$ |
| *Mixer outputs: pins MIX1OUT1 and MIX1OUT2* | | | | | | |
| $R_o$ | output resistance | | 100 | – | – | kΩ |
| $C_o$ | output capacitance | | – | 5 | 7 | pF |
| $V_{o(max)(p-p)}$ | maximum output voltage (peak-to-peak value) | | 12 | 15 | – | V |
| $g_{m(conv)}$ | conversion transconductance $\frac{I_{MIX1OUT}}{V_{AMMIX1IN}}$ | | 2.0 | 2.55 | 3.2 | $\frac{mA}{V}$ |

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| $g_{m(conv)(T)}$ | conversion transconductance variation with temperature $\frac{\Delta g_{m(conv)}}{g_{m(conv)} \times \Delta T}$ | | – | $-9 \times 10^{-4}$ | – | $K^{-1}$ |
| IP3 | 3rd-order intermodulation | $R_L$ = 2.8 kΩ; Δf = 300 kHz | 135 | 138 | – | dBμV |
| IP2 | 2nd-order intermodulation | $R_L$ = 2.8 kΩ | – | 170 | – | dBμV |
| F | noise figure of AM mixer 1 | | – | 4.5 | 7.1 | dB |
| $I_{bias}$ | mixer bias current | AM mode | 4.8 | 6 | 7.2 | mA |
| AM MIXER 2 (IF2 = 450 kHz) | | | | | | |
| *Mixer inputs: pins IFAMP1IN and IFAMP1DEC* | | | | | | |
| $R_i$ | input resistance | | 270 | 330 | 390 | Ω |
| $C_i$ | input capacitance | | – | 5 | 7 | pF |
| $V_I$ | DC input voltage | | 2.4 | 2.8 | 3.2 | V |
| $V_{i(max)(p)}$ | maximum input voltage (peak value) | 1 dB compression point of AM mixer 2 output (peak-to-peak value) | 1.1 | 1.4 | – | V |
| $V_{i(n)(eq)}$ | equivalent input noise voltage | $R_{gen}$ = 330 Ω; $R_L$ = 4 kΩ | – | 15 | 22 | $\frac{nV}{\sqrt{Hz}}$ |
| *Mixer outputs: pins AMMIX2OUT1 and AMMIX2OUT2* | | | | | | |
| $R_o$ | output resistance | | 100 | – | – | kΩ |
| $C_o$ | output capacitance | | – | 5 | 7 | pF |
| $V_{o(max)(p-p)}$ | maximum output voltage (peak-to-peak value) | $V_{DDA1}$ = 8.5 V | 12 | 15 | – | V |
| $g_{m(conv)}$ | conversion transconductance $\frac{I_{AMMIX2OUT}}{V_{IFAMP1IN}}$ | | 1.3 | 1.6 | 1.9 | $\frac{mA}{V}$ |
| $g_{m(conv)(T)}$ | conversion transconductance variation with temperature $\frac{\Delta g_{m(conv)}}{g_{m(conv)} \times \Delta T}$ | | – | $-9 \times 10^{-4}$ | – | $K^{-1}$ |
| IP3 | 3rd-order intermodulation | $R_L$ = 4 kΩ; Δf = 300 kHz | 134 | 137 | – | dBμV |
| IP2 | 2nd-order intermodulation | $R_L$ = 4 kΩ | – | 170 | – | dBμV |

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| F | noise figure of AM mixer 2 | | – | 16 | 19.5 | dB |
| $I_{bias}$ | mixer bias current | AM mode | 3.6 | 4.5 | 5.4 | mA |
| $I_L$ | mixer leakage current | FM mode | – | – | 50 | μA |
| IF2 AGC STAGE: PINS AMIF2IN AND AMIF2DEC | | | | | | |
| $V_{AGC(start)}$ | AGC start voltage | input carrier voltage | – | 14 | 30 | μV |
| $V_{AGC(stop)}$ | AGC stop voltage | maximum input peak voltage | 1 | – | – | V |
| $V_{AGC(ctrl)}$ | AGC control voltage | $V_{AMIF2IN}$ = 1 mV | 4.1 | 4.3 | 4.7 | V |
| ΔAGC | AGC range | between start and stop of AGC | – | 89 | – | dB |
| $R_i$ | input resistance | | 1.8 | 2 | 2.2 | kΩ |
| $C_i$ | input capacitance | | – | – | 5 | pF |
| $V_i$ | input voltage | audio attenuation α = –10 dB | | | | |
| | | data byte 5: bit 4 = 1; mute on | 10 | 22 | 37 | μV |
| | | data byte 5: bit 4 = 0; mute off | – | 6 | 12 | μV |
| $V_{sens(rms)}$ | sensitivity voltage (RMS value) | m = 0.3; $f_{mod}$ = 400 Hz; $B_{AF}$ = 2.5 kHz; $R_{source}$ = 2 kΩ | | | | |
| | | (S+N)/N = 26 dB | – | 45 | 65 | μV |
| | | (S+N)/N = 46 dB | – | 600 | 900 | μV |
| AM DETECTOR OUTPUT: PIN AMAFIF2; see Fig.3 | | | | | | |
| $V_{o(min)(rms)}$ | minimum AM IF2 output level (RMS value) | data byte 4: bit 0 = 1, bit 1 = 1; m = 0; $V_{AMIF2IN}$ = 14 μV | 1.5 | 3 | 4.5 | mV |
| $V_{o(max)(rms)}$ | maximum AM IF2 output level (RMS value) | data byte 4: bit 0 = 1, bit 1 = 1; m = 0; $V_{AMIF2IN}$ = 5 mV | 130 | 180 | 230 | mV |
| $V_{o(rms)}$ | AM AF output voltage level (RMS value) | data byte 4: bit 0 = 1, bit 1 = 0; m = 0.3; $f_{mod}$ = 400 Hz; $V_{AMIF2IN}$ = 100 μV to 500 mV (RMS) | 235 | 285 | 340 | mV |
| $R_o$ | output resistance | data byte 4: bit 0 = 1, bit 1 = 1 | – | – | 500 | Ω |
| $C_o$ | output capacitance | data byte 4: bit 0 = 1, bit 1 = 0 | – | 5 | 7 | pF |
| $Z_L$ | load impedance | data byte 4: bit 0 = 1, bit 1 = 0 | 100 | – | – | kΩ |
| | | data byte 4: bit 0 = 1, bit 1 = 1 | 10 | – | – | kΩ |
| RR | ripple rejection | $f_{ripple}$ = 100 Hz; $V_{DDA5(ripple)}$ = 100 mV (RMS) | 30 | 40 | – | dB |
| AM DETECTOR; see Fig.3 | | | | | | |
| (S+N)/N | maximum signal plus noise-to-noise ratio | m = 0.3; $f_{mod}$ = 400 Hz; $B_{AF}$ = 2.5 kHz; $R_{source}$ = 2 kΩ | 54 | 60 | 70 | dB |

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| THD | total harmonic distortion | $B_{AF}$ = 2.5 kHz; $C_{AGC}$ = 22 μF; $V_{AMIF2IN}$ = 100 μV to 250 mV (RMS) | | | | |
| | | m = 0.8; $f_{mod}$ = 400 Hz | – | 0.5 | 1 | % |
| | | m = 0.9; $f_{mod}$ = 400 Hz | – | 1 | 2 | % |
| | | m = 0.8; $f_{mod}$ = 100 Hz | – | 1.25 | 2.5 | % |
| | | m = 0.9; $f_{mod}$ = 100 Hz | – | 1.75 | 3.5 | % |
| $t_{sw}$ | FM to AM switching time | $V_{AMIF2IN}$ = 100 μV; $C_{AGC}$ = 22 μF | – | 1000 | 1500 | ms |
| $t_{st}$ | AM demodulator AGC settling time | $C_{AGC}$ = 22 μF | | | | |
| | | $V_{AMIF2IN}$ = 100 μV to 100 mV | – | 800 | 1200 | ms |
| | | $V_{AMIF2IN}$ = 100 mV to 100 μV | – | 1200 | 1800 | ms |
| AM IF2 LEVEL DETECTOR: PIN $V_{level}$; see Fig.4 | | | | | | |
| $V_{level}$ | level output DC voltage | $V_{AMIF2IN}$ = 10 μV to 1 V | 0 | – | 5 | V |
| | | $V_{AMIF2IN}$ < 1 μV; standard setting of level DAA | 0.1 | 0.35 | 0.8 | V |
| | | $V_{AMIF2IN}$ = 1.4 mV; standard setting of level DAA | – | 2.2 | – | V |
| $\Delta V_{level}$ | step size of starting point adjustment | standard setting of level slope | 40 | 53 | 70 | mV |
| $V_{level(slope)}$ | slope of level voltage $\frac{\Delta V_{level}}{\Delta V_{AMIF2IN}}$ | $V_{AMIF2IN}$ = 140 μV to 140 mV; standard setting of level slope | 800 | 1000 | 1200 | $\frac{mV}{20\ dB}$ |
| $\Delta V_{step}$ | step size of slope adjustment | $V_{AMIF2IN}$ = 1.4 mV | 55 | 75 | 95 | $\frac{mV}{20\ dB}$ |
| $B_{level}$ | bandwidth of level output voltage | | 200 | 300 | – | kHz |
| $R_o$ | output resistance | | – | – | 500 | Ω |
| RR | ripple rejection $\frac{V_{level}}{V_{DDA6}}$ | $f_{ripple}$ = 100 Hz; $V_{DDA6(ripple)}$ = 100 mV (RMS) | – | 40 | – | dB |
| AM NOISE BLANKER; see Fig.5 | | | | | | |
| *Threshold: pin AMNBHOLD* | | | | | | |
| $V_O$ | DC output voltage | | 4.4 | 4.75 | 5.25 | V |
| $t_{sup}$ | suppression time | | 6 | 7.5 | 10 | μs |
| $f_{trigger}$ | trigger sensitivity | $V_{pulse}$ = 200 mV; $V_{level}$ < 1.8 V | – | 1000 | – | Hz |
| | | $V_{pulse}$ = 200 mV; $V_{level}$ > 2.2 V | – | – | 100 | Hz |
| | | $V_{pulse}$ = 20 mV; $V_{level}$ < 1.8 V | – | – | 100 | Hz |
| *Noise detector output: pin TRDSMUTE* | | | | | | |
| $I_{sink(AGC)}$ | AM noise blanker AGC sink current | $V_{TRDSMUTE}$ = 3 V | 30 | 45 | 60 | μA |

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| $V_{AGC}$ | AM noise blanker AGC voltage | AM mixer 1 input $V_i$ = 0 V | 2.1 | 2.45 | 2.85 | V |
| **FM signal channel** | | | | | | |
| RF AGC (FM DISTANCE MODE) | | | | | | |
| *FM mixer inputs: pins FMMIXIN1 and FMMIXIN2* | | | | | | |
| $V_{i(RF)(rms)}$ | RF input voltage for start of wideband AGC (RMS value) | data byte 5: bit 5 = 1, bit 6 = 1 | – | 4 | – | mV |
| | | data byte 5: bit 5 = 0, bit 6 = 1 | – | 8 | – | mV |
| | | data byte 5: bit 5 = 1, bit 6 = 0 | – | 12 | – | mV |
| | | data byte 5: bit 5 = 0, bit 6 = 0 | – | 16 | – | mV |
| *AGC control: pin T2FMAGC* | | | | | | |
| $R_{source}$ | source resistance | | 4 | 5 | 6 | kΩ |
| $V_{O(ref)}$ | DC output reference voltage | data byte 5: bit 5 = 0, bit 6 = 0; $V_{FMMIXIN1-FMMIXIN2}$ = 0 V | 3.8 | 4.1 | 4.4 | V |
| *PIN diode drive output: pin IFMAGC* | | | | | | |
| $I_{sink(AGC)(max)}$ | maximum AGC sink current | $V_{IFMAGC}$ = 2.5 V; $V_{T2FMAGC} = V_{O(ref)} - 0.5$ V; data byte 5: bit 5 = 0, bit 6 = 0, bit 7 = 0; data byte 4: bit 1 = 0 | 8 | 10.5 | 14 | mA |
| $I_{source(AGC)(max)}$ | maximum AGC source current | $V_{IFMAGC}$ = 2.5 V; $V_{T2FMAGC} = V_{O(ref)} + 0.5$ V; data byte 5: bit 5 = 0, bit 6 = 0, bit 7 = 0; data byte 4: bit 1 = 0 | –14 | –10.5 | –8 | mA |
| $I_{source(AGC)}$ | AGC source current | AM mode | –19 | –14 | –10 | mA |
| | | $V_{IFMAGC}$ = 2.5 V; data byte 4: bit 0 = 0, bit 1 = 1, bit 2 = 0 (FM local) | –4.4 | –3.7 | –2.7 | mA |
| *Level voltage: pin $V_{level}$* | | | | | | |
| $V_{th}$ | threshold voltage for narrow-band AGC | data byte 5: bit 5 = 0, bit 6 = 0, bit 7 = 1 | 600 | 750 | 900 | mV |
| FM RF MIXER | | | | | | |
| *FM mixer inputs: pins FMMIXIN1 and FMMIXIN2* | | | | | | |
| $V_{i(RF)(max)}$ | maximum RF input voltage | 1 dB compression point of FM mixer output voltage (peak-to-peak value) | 70 | 140 | – | mV |
| $V_{i(n)(eq)}$ | equivalent input noise voltage | $R_{gen}$ = 200 Ω; $R_L$ = 2.8 kΩ | – | 2.6 | 3.1 | $\frac{nV}{\sqrt{Hz}}$ |
| $R_i$ | input resistance | | 1.4 | 2.8 | 4.2 | kΩ |
| $C_i$ | input capacitance | | – | 5 | 7 | pF |
| *FM mixer outputs: pins MIX1OUT1 and MIX1OUT2* | | | | | | |
| $R_o$ | output resistance | | 100 | – | – | kΩ |
| $C_o$ | output capacitance | | 2 | 3.5 | 5 | pF |

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| $I_{bias}$ | mixer bias current | FM mode | 4.8 | 6 | 7.2 | mA |
| $V_{o(max)(p-p)}$ | maximum output voltage (peak-to-peak value) | | 3 | – | – | V |
| *FM mixer reference voltage: pin $V_{ref(FMMIX)}$* | | | | | | |
| $V_{ref}$ | reference voltage | FM mode | 6.5 | 7.1 | 7.9 | V |
| | | AM mode | 2.7 | 3.1 | 3.4 | V |
| *FM mixer* | | | | | | |
| $g_{m(conv)}$ | conversion transconductance $\frac{I_{MIX1OUT}}{V_{FMMIXIN}}$ | | 8.5 | 13 | 18 | $\frac{mA}{V}$ |
| $g_{m(conv)(T)}$ | conversion transconductance variation with temperature $\frac{\Delta g_{m(conv)}}{g_{m(conv)} \times \Delta T}$ | | – | $-1 \times 10^{-3}$ | – | $K^{-1}$ |
| F | noise figure | | – | 3 | 4.6 | dB |
| $R_{gen(opt)}$ | optimum generator resistance | | 180 | 240 | 300 | Ω |
| IP3 | 3rd-order intermodulation | | 116 | 119 | – | dBμV |
| IRR | image rejection ratio $\frac{V_{MIX1OUTwanted}}{V_{MIX1OUTimage}}$ | $f_{RFwanted}$ = 87.5 MHz; $f_{RFimage}$ = 108.9 MHz | 25 | 30 | – | dB |
| | | data byte 4 = X010X110; $f_{RFwanted}$ = 162.475 MHz; $f_{RFimage}$ = 183.875 MHz; weather band mode | 22 | 30 | – | dB |
| IF AMPLIFIER 1 | | | | | | |
| G | gain $\frac{V_{IFAMP1OUT}}{V_{IFAMP1IN}}$ | $R_L$ = 330 Ω; $V_{IFAMP1IN}$ = 1 mV | 8.5 | 10.5 | 12.5 | dB |
| F | noise figure | | – | 10 | 13 | dB |
| IP3 | 3rd-order intermodulation | | 117 | 120 | – | dBμV |
| *Inputs: pins IFAMP1IN and IFAMP1DEC* | | | | | | |
| $V_{i(max)(p)}$ | maximum input voltage (peak value) | 1 dB compression point of IF amplifier 1 output voltage (peak value) | 250 | – | – | mV |
| $V_{i(n)(eq)}$ | equivalent input noise voltage | $R_{gen}$ = 330 Ω; $R_L$ = 330 Ω | – | 8 | 10 | $\frac{nV}{\sqrt{Hz}}$ |

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| $R_i$ | input resistance | | 270 | 330 | 390 | Ω |
| $C_i$ | input capacitance | | – | 5 | 7 | pF |
| *Output: pin IFAMP1OUT* | | | | | | |
| $V_{o(max)(p)}$ | maximum output voltage (peak value) | | 1.2 | 1.5 | – | V |
| $R_o$ | output resistance | | 270 | 330 | 390 | Ω |
| $C_o$ | output capacitance | | – | 5 | 7 | pF |
| IF AMPLIFIER 2 | | | | | | |
| G | gain $\frac{V_{IFAMP2OUT}}{V_{IFAMP2IN}}$ | $R_L$ = 330 Ω; $V_{IFAMP2IN}$ = 1 mV | 6.5 | 8.5 | 10.5 | dB |
| F | noise figure | | – | 13 | 15 | dB |
| IP3 | 3rd-order intermodulation | | 127 | 130 | – | dBμV |
| *Inputs: pins IFAMP2IN and IFAMP2DEC* | | | | | | |
| $V_{i(max)(p)}$ | maximum input voltage (peak value) | 1 dB compression point of IF amplifier 2 output voltage (peak value) | 500 | – | – | mV |
| $V_{i(n)(eq)}$ | equivalent input noise voltage | $R_{gen}$ = 330 Ω; $R_L$ = 330 Ω | – | 10 | 13 | $\frac{nV}{\sqrt{Hz}}$ |
| $R_i$ | input resistance | | 270 | 330 | 390 | Ω |
| $C_i$ | input capacitance | | – | 5 | 7 | pF |
| *Output: pin IFAMP2OUT* | | | | | | |
| $V_{o(max)(p)}$ | maximum output voltage (peak value) | | 1.2 | 1.5 | – | V |
| $R_o$ | output resistance | | 270 | 330 | 390 | Ω |
| $C_o$ | output capacitance | | – | 5 | 7 | pF |
| **FM demodulator and level detector;** see Figs 6 and 7 | | | | | | |
| FM DEMODULATOR | | | | | | |
| *FM limiter inputs: pins FMLIMIN and FMLIMDEC* | | | | | | |
| $R_i$ | input resistance | | 10 | 12 | 14 | kΩ |
| $C_i$ | input capacitance | | – | 5 | 7 | pF |
| $V_{start(lim)(rms)}$ | start of limiting of RDS MPX output voltage (RMS value) | $\alpha_{AF}$ = –3 dB; $R_{gen}$ = 165 Ω | – | 10 | 15 | μV |
| $V_{o(sens)(rms)}$ | sensitivity for RDS MPX output voltage (RMS value) | Δf = 22.5 kHz; $f_{mod}$ = 1 kHz; de-emphasis = 75 μs | | | | |
| | | $R_{gen}$ = 165 Ω; (S+N)/N = 26 dB | – | 10 | 15 | μV |
| | | (S+N)/N = 46 dB | – | 50 | 75 | μV |

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| $V_{start(lim)(rms)}$ | start of limiting of FM MPX output voltage (RMS value) | $\alpha_{AF}$ = –3 dB; $R_{gen}$ = 165 Ω | – | 10 | 15 | μV |
| $V_{o(sens)(rms)}$ | sensitivity for FM MPX output voltage (RMS value) | Δf = 22.5 kHz; $f_{mod}$ = 1 kHz; de-emphasis = 75 μs | | | | |
| | | $R_{gen}$ = 165 Ω; (S+N)/N = 26 dB | – | 10 | 15 | μV |
| | | (S+N)/N = 46 dB | – | 50 | 75 | μV |
| *RDS MPX output: pin RDSMPX* | | | | | | |
| $V_{o(rms)}$ | RDS MPX output voltage (RMS value) | $V_{FMLIMIN}$ = 20 μV to 1 V | | | | |
| | | Δf = 5 kHz; $f_{mod}$ = 57 kHz | 40 | 50 | 60 | mV |
| | | Δf = 22.5 kHz; $f_{mod}$ = 1 kHz | 180 | 230 | 280 | mV |
| (S+N)/N | maximum signal plus noise-to-noise ratio | Δf = 22.5 kHz; $f_{mod}$ = 1 kHz; de-emphasis = 75 μs; $V_{FMLIMIN}$ = 10 mV | 70 | 73 | – | dB |
| THD | total harmonic distortion | Δf = 75 kHz; $f_{mod}$ = 1 kHz; de-emphasis = 75 μs; $V_{FMLIMIN}$ = 200 μV to 800 mV | – | 0.4 | 0.75 | % |
| $\alpha_{AM}$ | AM suppression $\frac{V_{o(rms)}}{V_{o(AM)(rms)}}$ | FM: Δf = 22.5 kHz; $f_{mod}$ = 1 kHz; AM: m = 0.3; $f_{mod}$ = 1 kHz; de-emphasis = 75 μs | | | | |
| | | $V_{FMLIMIN}$ = 30 to 70 μV | 20 | 30 | – | dB |
| | | $V_{FMLIMIN}$ = 70 to 500 μV | 30 | 40 | – | dB |
| | | $V_{FMLIMIN}$ = 500 μV to 300 mV | 50 | 60 | – | dB |
| | | $V_{FMLIMIN}$ = 300 mV to 1 V | 30 | 40 | – | dB |
| $I_{o(max)}$ | maximum output current | | – | – | 100 | μA |
| $R_o$ | output resistance | | – | – | 500 | Ω |
| $R_L$ | load resistance | | 20 | – | – | kΩ |
| $C_L$ | load capacitance | | – | – | 50 | pF |
| B | bandwidth | $C_L$ = 0; $R_L$ > 20 kΩ | 200 | 300 | – | kHz |
| PSRR | power supply ripple rejection | $f_{ripple}$ = 100 Hz to 20 kHz | – | 40 | – | dB |
| *FM MPX output: pin FMMPX* | | | | | | |
| $V_{o(rms)}$ | FM MPX output voltage (RMS value) | Δf = 22.5 kHz; $f_{mod}$ = 1 kHz; $V_{FMLIMIN}$ = 20 μV to 1 V | 180 | 230 | 280 | mV |
| | | data byte 4 = X010X110; Δf = 1.5 kHz; $f_{mod}$ = 1 kHz; $V_{FMLIMIN}$ = 20 μV to 1 V; weather band mode | 150 | 230 | 310 | mV |
| (S+N)/N | maximum signal plus noise-to-noise ratio | Δf = 22.5 kHz; $f_{mod}$ = 1 kHz; de-emphasis = 75 μs; $V_{FMLIMIN}$ = 10 mV | 66 | 70 | – | dB |

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| THD | total harmonic distortion | $\Delta f$ = 75 kHz; $f_{mod}$ = 1 kHz; de-emphasis = 75 µs; $V_{FMLIMIN}$ = 200 µV to 800 mV | – | 0.4 | 0.75 | % |
| $\alpha_{AM}$ | AM suppression $\frac{V_{o(rms)}}{V_{o(AM)(rms)}}$ | FM: $\Delta f$ = 22.5 kHz; $f_{mod}$ = 1 kHz; AM: m = 0.3; $f_{mod}$ = 1 kHz; de-emphasis = 75 µs | | | | |
| | | $V_{FMLIMIN}$ = 30 to 70 µV | 20 | 30 | – | dB |
| | | $V_{FMLIMIN}$ = 70 to 500 µV | 30 | 40 | – | dB |
| | | $V_{FMLIMIN}$ = 500 µV to 300 mV | 50 | 60 | – | dB |
| | | $V_{FMLIMIN}$ = 300 mV to 1 V | 30 | 40 | – | dB |
| $I_{o(max)}$ | maximum output current | | – | – | 100 | µA |
| $R_{o(max)}$ | maximum output resistance | | – | – | 500 | Ω |
| $R_{L(min)}$ | minimum load resistance | | 20 | – | – | kΩ |
| $C_{L(max)}$ | maximum load capacitance | | – | – | 50 | pF |
| B | bandwidth | $C_L$ = 0; $R_L$ > 20 kΩ | 200 | – | – | kHz |
| PSRR | power supply ripple rejection | $f_{ripple}$ = 100 Hz to 20 kHz | – | 40 | – | dB |
| $t_{sw}$ | AM to FM switching time | $V_{FMLIMIN}$ = 100 µV | – | 100 | 150 | ms |
| FM MPX SOFT MUTE | | | | | | |
| *Soft mute* | | | | | | |
| $\alpha_{mute}$ | mute attenuation | $V_{FMLIMIN}$ = 10 mV; $V_{TMUTE}$ = 300 mV | | | | |
| | | data byte 7 = XX000100 | – | 7 | – | dB |
| | | data byte 7 = XX001100 | – | 8 | – | dB |
| | | data byte 7 = XX010100 | – | 9.5 | – | dB |
| | | data byte 7 = XX011100 | – | 11 | – | dB |
| | | data byte 7 = XX100100 | – | 14 | – | dB |
| | | data byte 7 = XX101100 | – | 18 | – | dB |
| | | data byte 7 = XX110100 | – | 25 | – | dB |
| | | data byte 7 = XX111100 | – | 39 | – | dB |
| $\alpha_{mute(off)}$ | mute off | $V_{FMLIMIN}$ = 10 mV; $V_{TMUTE}$ = 300 mV; data byte 7 = XXXXX111 | –1 | 0 | +1 | dB |
| $V_{offset(DC)}$ | DC offset created by soft mute on pin FMMPX $\Delta V = V_{muted} - V_{notmuted}$ | | –150 | – | +150 | mV |

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| *Input: pin TMUTE* | | | | | | |
| $V_{TMUTE}$ | mute voltage | $V_{FMLIMIN}$ = 0 to 1 V | 0 | – | 5 | V |
| $V_{offset}$ | voltage offset with $V_{level}$ | $V_{FMLIMIN}$ = 0 to 1 V | –200 | – | +200 | mV |
| $I_{dch}$ | discharge current | $V_{level} < V_{TMUTE}$ | 2.5 | 3.5 | 4.5 | μA |
| $I_{ch}$ | charge current | $V_{level} > V_{TMUTE}$ | –4.5 | –3.5 | –2.5 | μA |
| $V_{TMUTE(start)}$ | mute start voltage | $\alpha_{mute}$ = 3 dB; $V_{FMLIMIN}$ = 10 mV | | | | |
| | | data byte 7 = XX111000 | 300 | 450 | 600 | mV |
| | | data byte 7 = XX111001 | 400 | 550 | 700 | mV |
| | | data byte 7 = XX111010 | 450 | 630 | 810 | mV |
| | | data byte 7 = XX111011 | 520 | 720 | 920 | mV |
| | | data byte 7 = XX111100 | 580 | 800 | 1020 | mV |
| | | data byte 7 = XX111101 | 640 | 890 | 1140 | mV |
| | | data byte 7 = XX111110 | 680 | 980 | 1280 | mV |
| *Output: pin $V_{level}$* | | | | | | |
| $R_o$ | output resistance of level output | | – | – | 500 | Ω |
| RR | ripple rejection of level output | $f_{ripple}$ = 100 Hz; $V_{DDA1(ripple)}$ = 100 mV (RMS) | – | 40 | – | dB |
| **RDS update;** see Figs 10 and 11 | | | | | | |
| *RDS mute* | | | | | | |
| $\alpha_{mute}$ | muting depth | data byte 3: bit 7 = 1 (mute) | 60 | 80 | – | dB |
| $V_{offset(DC)}$ | DC offset during RDS update mute on pin FMMPX $\Delta V = V_{muted} - V_{notmuted}$ | | –30 | – | +30 | mV |
| *Capacitor: pin TRDSMUTE* | | | | | | |
| $V_{TRDSMUTE}$ | voltage on pin TRDSMUTE | no mute | – | 5.7 | – | V |
| | | mute | – | 1.1 | – | V |
| $I_{dch}$ | discharge current | $V_o$ = 3 V; data byte 3: bit 7 = 1 | 24 | 32 | 38 | μA |
| $I_{ch}$ | charge current | $V_o$ = 3 V; data byte 3: bit 7 = 0 | –38 | –32 | –24 | μA |
| $I_{LI}$ | input leakage current | mute | –10 | – | +10 | nA |
| *Output: pin AFHOLD* | | | | | | |
| $I_{sink(max)}$ | maximum sink current | after first bus transmission with data byte 1: bit 7 = 1 (start of RDS update); $V_o$ = 0.5 V | 1.0 | 1.2 | 1.4 | mA |
| *Output: pin AFSAMPLE* | | | | | | |
| $I_{sink(max)}$ | maximum sink current | no RDS update in progress; $V_o$ = 0.5 V | 1.0 | 1.2 | 1.4 | mA |