1384 UFC AM/FM Tuner
3x7660
Advance Data Sheet

Rev. 2.0

Contents

1. INTRODUCTION

This data sheet contains technical specifications and operating information for the 1384 UFC AM/FM Tuner shown in Figure 1.

Figure 1 1384 UFC AM/FM Tuner

1.1. APPLICATIONS

The 1384 UFC Tuner is designed for use in high-end car radios in USA and Europe.

1.2. FEATURES

Table 1 lists AM and FM features of the 1384 tuner.

Table 1 1384 Tuner Features

AM	FM
• Up/down conversion • Multi-pole filter for second intermediate frequency (IF) • PC Bus-controlled • AM Noise blanker at second IF • AM Dual AGC (Cascode and PIN) • AM Stereo output available	• Double down-conversion • World tuner functionality • Passive external FM stage with one prefilter • Image reject mixers • Fully integrated FM demodulator • Two-stage ceramic 10.7 MHz IF filtering • Keyed AGC selectable • Dynamic Threshold Extension for improved sensitivity • Internal variable second IF filter with hardware closed-loop control • Automatic alignment – DAC for selective prefilter – FM Detector center frequency – Frequency offset detector – Field strength output • I^2C Bus-controlled • Inaudible RDS updating • Weather band • Single-IC solution capability

2. TECHNICAL SPECIFICATIONS

This section contains technical specifications for the 1384 UFC Tuner.

2.1. OPERATING CHARACTERISTICS

The operating conditions listed in Table 2 reflect the conditions necessary for optimal performance and operating reliability.

Table 2 Operating Characteristics

Parameter	Min	Typ	Max	Unit	Pin
5 V Power Supply Voltage					3
Current AM Mode	41	42	54	mA	
Current FM Mode	30	32	40	mA	
Voltage	4.75	5	5.25	V	
8.5 V Power Supply Voltage					4
Current AM Mode		62		mA	
Current FM Mode		62		mA	
Voltage	8	8.5	9	V	
Operating Temperature					
Operating temperature (in slowly-moving air)	-40		+85	°C	
Parametric temperature range	-30		+70	°C	
Storage temperature	-40		+95	°C	

2.2. INPUT AND OUTPUT CHARACTERISTICS

Input Output	Min	Typ	Max	Unit	Pin
AF Hold					15
Maximum sink current (current mirror)	1	1.2	1.4	mA	
AF Sample					16
Maximum sink current (current mirror)	1	1.2	1.4	mA	
AM AF Output					13
AM Mono bandwidth		t.b.d.		kHz	
AM Mono load impedance	100			kΩ	
AM Mono output resistance			500	Ω	
AM Stereo bandwidth		t.b.d.		kHz	
AM Stereo load impedance	10			kΩ	
AM Stereo output resistance			500	Ω	
Antenna Input					1
AM Mode		t.b.d.		Ω	
FM Mode		50		Ω	
Field Strength (Level) Output					11
Voltage	0		7	V	

Input Output	Min	Typ	Max	Unit	Pin
FM MPX Output					12
Bandwidth	200			kHz	
Load capacitance			50	pF	
Load resistance	20			kΩ	
Output resistance			500	Ω	
IF Bandwidth Flag Output					7
AM Mode open collector with a 56 kΩ pull-up resistance			5	V	
FM Alignment Mode	3	3.1	3.4	V	
RDS MPX Output					14
Bandwidth	200	300		kHz	
Load capacitance			50	pF	
Load resistance	20			kΩ	
Output resistance			500	Ω	
Receiving Frequency Range					1
AM Mode USA	520		1720	kHz	
FM Mode USA	87.9		107.9	MHz	
AM Mode Europe	522		1602	kHz	
FM Mode Europe	87.5		108	MHz	
Software Flag Output					6
Open collector with a 10 kΩ pull-up resistance	0.1		5	V	

2.3. AM ELECTRICAL CHARACTERISTICS

All values shown in Table 3 are referred to the RF input terminal (see also Figure 4).

Table 3 AM Electrical Characteristics

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Sensitivity	10 dB S+N/N		4.0	6.5	µV
S+N/N	Audio frequency = 1000 Hz	45	50		dB
AGC Figure of merit	Audio rolloff = -10 dB Reference = normal condition (see 3.1)	47	53		dB
Interstation noise	RF Input = 0 µV		-27	-20	dB
4 kHz Audio rolloff	Reference = normal condition (see 3.1)		2.1	2.7	dB
THD+N	normal condition (see 3.1)		0.35	0.7	%
	RF Input = 104 dBµV		0.60	1.2	%
	Audio frequency = 100 Hz Modulation factor = 80%		1.6	2.3	%
Image rejection	Image = tuned frequency + 21.4 MHz	65	81		dB
IF Rejection	Intermediate frequency = 10.7 MHz	70	86		dB
Selectivity	RF Input = 2 x sensitivity level Audio = -10 dB Reference = normal condition (see 3.1)		12.5	12.8	kHz
	RF Input = 1000 x sensitivity level Audio = -10 dB Reference = normal condition (see 3.1)		18.9	20	kHz
Cross modulation	Distance = ± 40 kHz Audio = -30dBr	80	168		mV
In-band mixing	Tuned frequency = 600 kHz Undesired frequency 1 = 1000 kHz Undesired frequency 2 = 1600 kHz Audio = -10dB Reference = normal condition (see 3.1)	65	68		dBµV
Wideband AGC	Distance = ± 100 kHz RF Input = RF input for 6 dBr audio rolloff Audio = -9dB Reference = normal condition (see 3.1)	90	94		dBµV
Audio output voltage Pin 13	R_{LOAD} = 200 kΩ	270	290	310	mV
Field strength output Pin 11 (see also Figure 2)	Unmodulated carrier				
	RF Input = 20 dBµV	0.6	1.2	1.3	V
	RF Input = 60 dBµV	2.1	2.7	2.9	V
	RF Input = 100 dBµV	3.1	3.5	3.7	V

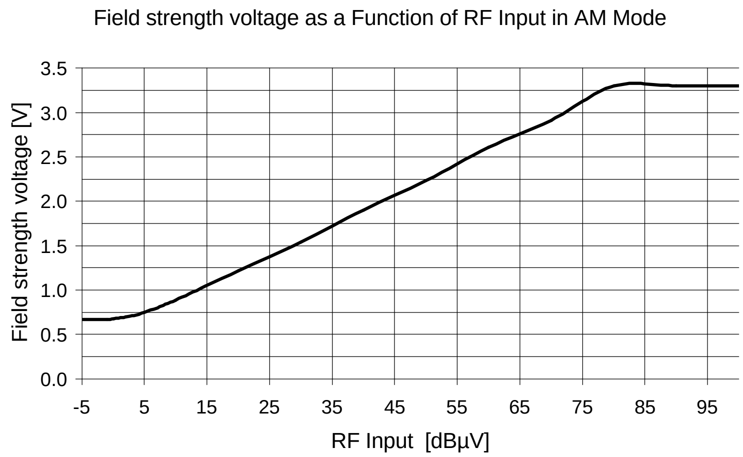


Figure 2 Field strength voltage as a Function of RF Input voltage in AM Mode

2.4. FM ELECTRICAL CHARACTERISTICS

All values shown in Table 4 are referred to the RF input terminal (see also Figure 5).

Table 4 FM Electrical Characteristics

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Sensitivity	30 dB S+N/N		1.4	3	µV
S+N/N		55	64		dB
Interstation noise	RF Input = 0 µV	-2.0	-3.9		dB
SINAD		50	63		dB
THD + N	normal condition (see 3.2)		0.07	0.3	%
	Deviation = 75 kHz		0.1	0.5	%
	RF Input = 4 µV		1.1	6	%
Image rejection	Image = tuned frequency + 21.4 MHz	51	58		dB
IF Rejection	Intermediate frequency = 10.7 MHz	85	108		dB
Adjacent channel selectivity	Distance = ± 200 kHz Audio = -30dB Reference = Audio at RF Input = 17dBµV	74	90		dB
Alternate channel selectivity	Distance = ± 400 kHz Audio = -30dB Reference = Audio at RF Input = 17dBµV	80	97		dB
Three-signal intermodulation	f_2 = tuned frequency ± 800 kHz f_3 = tuned frequency ± 1600 kHz Deviation = 22.5 kHz Audio = -1dB Reference = Audio at RF Input = 40dBµV	60	65		dB
AM Suppression	Modulation factor = 30% RF Input = 60dBµV	52	60		dB
Audio output voltage Pin 12	R_{LOAD} = 200 kΩ Deviation = 22.5 kHz	165	185	190	mV
	Deviation = 50 kHz	375	405	425	mV
	Deviation = 75 kHz	565	606	640	mV

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
	Unmodulated carrier				
Field strength output Pin 11	RF Input = 20 dBµV	0.9	1.3	1.6	V
(see also Figure 3)	RF Input = 60 dBµV	2.4	2.8	3.2	V
	RF Input = 100 dBµV	2.9	3.3	3.7	V

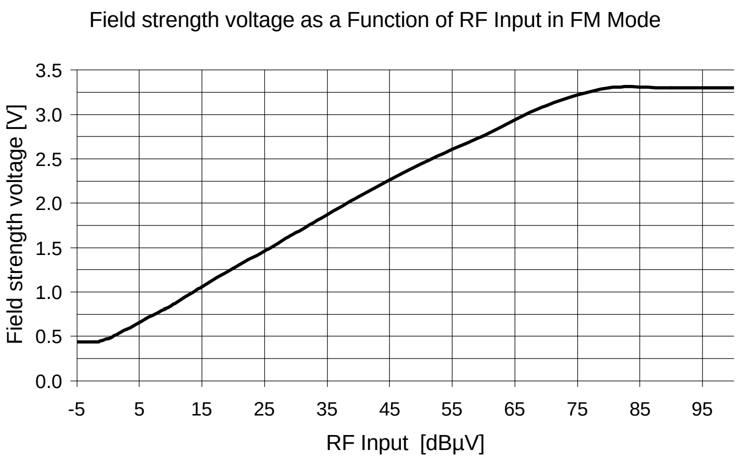


Figure 3 Field strength voltage as a Function of RF Input voltage in FM Mode

3. TUNER MEASUREMENT TEST CONDITIONS

All tuner data are measured under the following conditions unless otherwise noted:

- ambient temperature: + 25°C ± 3°C
- supply voltages: + 5V ± 0.1V
  + 8.5V ± 0.1V

3.1. AM MEASUREMENT TEST CONDITIONS

All tuner AM data are measured under the following conditions unless otherwise noted:

- Test frequencies: 530 kHz, 1000 kHz, and 1700 kHz
- RF Input level: 60 dBµV
- Modulation factor: 30%
- Audio frequency: 400 Hz
- AM Soft mute: On
- Wideband AGC: 150 mV

Figure 4 illustrates the AM test setup used.

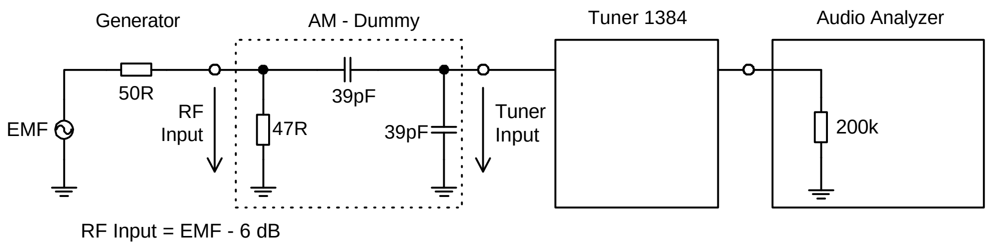


Figure 4 AM Test Setup

3.2. FM MEASUREMENT TEST CONDITIONS

All tuner FM data are measured under the following conditions unless otherwise noted:

- Test frequencies: 87.9 MHz, 97.3 MHz, and 107.9 MHz
- RF Input level: 60 dBµV
- Deviation: 22.5 kHz
- Audio frequency: 1 kHz
- Bandwidth mode: Dynamic
- Threshold extension: On
- Keyed AGC: On
- Wideband AGC: 12 mV

Figure 5 illustrates the FM test setup used.

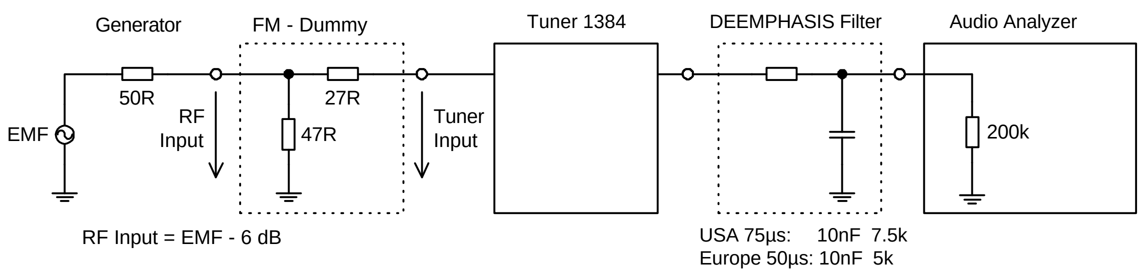


Figure 5 FM Test Setup

4. SERIAL INTERFACE

This section describes the serial interface communications to the tuner.

4.1. I²C BUS INTERFACE

Table 5 Bus Interface

I²C Bus Port	Pin
SDA	9
SCL	8

4.2. I²C BUS ADDRESS

Table 6 Bus Address

Component	Address
Tuner	C2
EEPROM	A8

5. I²C BUS PROTOCOL TUNER

No default settings at power-on reset.

5.1. CHIP ADDRESS

The data transfer has to be in this order. The LSB = 0 indicates a WRITE operation to the Tuner 1384. Bit 7 of each byte is considered the MSB and has to be transferred as the first of the byte.

Table 7 Chip Address

MSB							LSB
1	1	0	0	0	0	1	R/W

where:

R/W = 0 if write mode
1 if read mode

5.2. WRITE MODE

1. Send the Start condition.
2. Send the chip address and receive an ACK.
3. Send data byte 0 and receive an ACK.
4. Send data byte1 and receive an ACK.
5. Send data byte 2 and receive an ACK.
6. Send data byte 3 and receive an ACK.
7. Send data byte 4 and receive an ACK.
8. Send data byte 5 and receive an ACK.
9. Send data byte 6 and receive an ACK.
10. Send data byte 7 and receive an ACK.
11. Send the Stop condition.

The data become valid at the output of the internal latches with the acknowledge of each byte. A STOP condition after any byte can shorten transmission times.

When writing to the tuner by using the STOP condition before completion of the whole transfer:

- The remaining bytes will contain the old information
- If the transfer of a byte is not completed, this byte is lost and the previous information is available.

Table 8 Write Mode Data Bytes

DATA BYTE	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
0	AF	PLL14	PLL13	PLL12	PLL11	PLL10	PLL9	PLL8
1	PLL7	PLL6	PLL5	PLL4	PLL3	PLL2	PLL1	PLL0
2	MUTE	ANT6	ANT5	ANT4	ANT3	ANT2	ANT1	ANT0
3	IFMT	REF2	REF1	REF0	IFPR	BND2	BND1	AMFM
4	KAGC	AGC1	AGC0	AMSM/ FMBW	LODX	FLAG	BW1	BW0
5	LST4	LST3	LST2	LST1	LST0	LSL2	LSL1	LSL0
6	TE	CF6	CF5	CF4	CF3	CF2	CF1	CF0
7	FOF3	FOF2	FOF1	FOF0	FGN3	FGN2	FGN1	FGN0

For detail information see Table 9.

Table 9 Data Byte Detail

<table>
<tr><th>Byte Number</th><th>Bit Number</th><th>Description</th></tr>
<tr><td rowspan="2">0</td><td>0 to 6</td><td>Setting of the programmable counter of the synthesizer PLL</td></tr>
<tr><td>7</td><td>0 = No RDS update
1 = Start RDS update</td></tr>
<tr><td>1</td><td>0 to 7</td><td>Setting of the programmable counter of the synthesizer PLL</td></tr>
<tr><td rowspan="2">2</td><td>0 to 6</td><td>Setting of the antenna DAA</td></tr>
<tr><td>7</td><td>0 = FM MPX Output not muted
1 = FM MPX Output muted; load programmable divider for AM and FM</td></tr>
<tr><td rowspan="5">3</td><td>0</td><td>AM/FM switching
0 = FM mode
1 = AM mode</td></tr>
<tr><td>1 and 2</td><td>Frequency band selection
<table>
<tr><th>BND2</th><th>BND1</th><th>AMFM</th><th>Frequency Band</th><th>VCO Divider</th></tr>
<tr><td>0</td><td>0</td><td>0</td><td>FM Standard</td><td>2</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>AM SW Mono</td><td>10</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>FM Japan</td><td>3</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>AM SW Stereo</td><td>10</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>FM East</td><td>3</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>AM LW/MW Mono</td><td>20</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>FM Weather</td><td>1</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>AM LW/MW Stereo</td><td>20</td></tr>
</table></td></tr>
<tr><td>3</td><td>IF Counter prescaler ratio
0 = Prescaler is 40
1 = Prescaler is 10</td></tr>
<tr><td>4 to 6</td><td>Reference frequency for synthesizer
<table>
<tr><th>REF2</th><th>REF1</th><th>REF0</th><th>Reference Frequency</th></tr>
<tr><td>0</td><td>0</td><td>0</td><td>100 kHz</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>50 kHz</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>25 kHz</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>20 kHz</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>10 kHz</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>10 kHz</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>10 kHz</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>10 kHz</td></tr>
</table></td></tr>
<tr><td>7</td><td>IF Counter period
0 = 20 ms
1 = 2 ms</td></tr>
</table>

<table>
<tr><th>Byte Number</th><th>Bit Number</th><th>Description</th></tr>
<tr><td rowspan="6">4</td><td>0 and 1</td><td>IF2 Bandwidth setting
<table>
<tr><th>BW1</th><th>BW0</th><th>IF2 Bandwidth B_{-3dB}</th><th>Remarks</th></tr>
<tr><td>0</td><td>0</td><td>Dynamic: 25 kHz to 155 kHz</td><td></td></tr>
<tr><td>0</td><td>1</td><td>Wide: 130 kHz fixed</td><td>Speed up circuit for frequency offset detector active</td></tr>
<tr><td>1</td><td>0</td><td>Medium: 90 kHz fixed</td><td></td></tr>
<tr><td>1</td><td>1</td><td>Narrow: 61 kHz fixed</td><td></td></tr>
</table></td></tr>
<tr><td>2</td><td>Software-controlled flag
0 = Flag high
1 = Flag low</td></tr>
<tr><td>3</td><td>LO/DX Mode
0 = Distance mode
1 = Local mode</td></tr>
<tr><td>4</td><td><table>
<tr><th>Mode</th><th>Bit = 0</th><th>Bit = 1</th></tr>
<tr><td>AM</td><td>Soft mute off</td><td>Soft mute on</td></tr>
<tr><td>FM</td><td>FM mode, bandwidth selection via BW0 and BW1</td><td>Alignment mode</td></tr>
</table></td></tr>
<tr><td>5 and 6</td><td>Wideband AGC setting for AM and FM
<table>
<tr><th>AGC1</th><th>AGC2</th><th>Start Wideband AGC AM</th><th>Start Wideband AGC FM</th></tr>
<tr><td>0</td><td>0</td><td>150 mV</td><td>16 mV</td></tr>
<tr><td>0</td><td>1</td><td>275 mV</td><td>12 mV</td></tr>
<tr><td>1</td><td>0</td><td>400 mV</td><td>8 mV</td></tr>
<tr><td>1</td><td>1</td><td>525 mV</td><td>4 mV</td></tr>
</table></td></tr>
<tr><td>7</td><td>Keyed AGC for FM
0 = Keyed AGC off
1 = Keyed AGC on</td></tr>
<tr><td rowspan="2">5</td><td>0 to 2</td><td>Level slope setting of level DAA</td></tr>
<tr><td>3 to 7</td><td>Level starting point setting of level DAA</td></tr>
<tr><td rowspan="2">6</td><td>0 to 6</td><td>Setting of the IF2 center frequency</td></tr>
<tr><td>7</td><td>Threshold extension
0 = Threshold extension off
1 = Threshold extension on</td></tr>
<tr><td rowspan="2">7</td><td>0 to 3</td><td>IF Filter gain alignment</td></tr>
<tr><td>4 to 7</td><td>Frequency offset detector alignment</td></tr>
</table>

5.3. READ MODE

1. Send the Start condition.
2. Send the chip address and receive an ACK.
3. Read data byte 0 and send an ACK.
4. Send the Stop condition.

Table 10 Read Mode Data Byte Detail

BYTE NUMBER	BIT NUMBER	DESCRIPTION
0	0 to 7	Output of the IF counter result (see 5.3.1)

5.3.1. IF COUNTER RESULT

The IF Counter measures the first IF frequency in FM Mode and the second IF frequency in AM Mode. The result can be used as additional information about the signal quality. The measured frequency can be calculated from the readout value with the following formula.

$$f_{IF} = (\text{Readout} + \text{A}) * \text{Resolution} + \text{B}$$

Depending of the IF Counter Settings and Readout value different values for A, B and Resolution must be used. Table 11 lists this values.

Table 11 Values for IF frequency calculation

MODE	IF MEASURE TIME	IF PRESCALER	READOUT	A	RESOLUTION	B
FM	2 ms	10	218..255	-218	5 kHz	10065 kHz
			0..217	+37	5 kHz	10065 kHz
	2 ms	40	150..255	-150	20 kHz	8160 kHz
			0..149	+105	20 kHz	8160 kHz
	20 ms	10	0..4	+251	0.5 kHz	10636.5 kHz
			5..255	-6	0.5 kHz	10636.5 kHz
	20 ms	40	0..96	+159	2 kHz	10446 kHz
			97..255	-98	2 kHz	10446 kHz
AM	2 ms	10	0..3	+252	0.5 kHz	386.5 kHz
			4..255	-5	0.5 kHz	386.5 kHz
	20 ms	10	168..255	-168	0.05 kHz	443.65 kHz
			0..167	87	0.05 kHz	443.65 kHz

6. EEPROM CONTENT

When the radio is equipped with a 1384 tuner, alignment values for the tuner are written to an EEPROM (PCF8594C-2) mounted on the tuner module.

This section describes the uses of the 1384 tuner EEPROM. Because this EEPROM is shared by various software packages, the content of this EEPROM is standardized. This section lists the mapping of the EEPROM.

6.1. NONVOLATILE MEMORY DATA DESCRIPTION

Table 12 contains the bit sequence taken for bytes and Table 13 lists the tuner EEPROM subaddresses, their functions, and descriptions.

Table 12 Bit Sequence

MSB							LSB
7	6	5	4	3	2	1	0

Table 13 Layout of Tuner EEPROM

SUBADDRESS	FUNCTION	DESCRIPTION
00H to 09H	not used	
0AH	DAA Europe/USA, number of DAA alignments	• Bits 0 to 2 are the number of DAA alignments (3 to 7) • Bits 3 to 7 are not used
0BH	DAA Europe/USA, frequency offset at first alignment point	• The offset frequency is the number of steps above the lowest Europe FM band limit. (Step size is 100kHz) See 6.2
0CH	DAA Europe/USA, DAA value at alignment point 1	• Bits 0 to 6 are the DAA value, which has a range of 0 to127 • Bit 7 is not used
0DH and 0EH	DAA Europe/USA at alignment point 2	See 0BH and 0CH
0FH and 10H	DAA Europe/USA at alignment point 3	See 0BH and 0CH
11H and 12H	DAA Europe/USA at alignment point 4	See 0BH and 0CH
13H and 14H	DAA Europe/USA at alignment point 5	See 0BH and 0CH
15H and 16H	DAA Europe/USA at alignment point 6	See 0BH and 0CH
17H and 18H	DAA Europe/USA at alignment point 7	See 0BH and 0CH
19H	DAA Japan, number of DAA alignments	• Bits 0 to 2 are the number of DAA alignments (3 to 7) • Bits 3 to 7 are not used
1AH	DAA Japan, frequency offset at alignment point 1	The offset frequency is the number of steps above the lowest Japan FM band limit (step size is 100 kHz). See section 6.2 on page 16.
1BH	DAA Japan, DAA value at alignment point 1	• Bits 0 to 6 are the DAA value, which has a range of 0 to 127 • Bit 7 is not used
1CH and 1DH	DAA Japan at alignment point 2	See 1AH and 1BH
1EH and 1FH	DAA Japan at alignment point 3	See 1AH and 1BH
20H and 21H	DAA Japan at alignment point 4	See 1AH and 1BH

Subaddress	Function	Description
22H and 23H	DAA Japan at alignment point 5	See 1AH and 1BH
24H and 25H	DAA Japan at alignment point 6	See 1AH and 1BH
26H and 27H	DAA Japan at alignment point 7	See 1AH and 1BH
28H	DAA OIRT, number of DAA alignments	• Bits 0 to 2 are the number of DAA alignments (3 to 7) • Bits 3 to 7 are not used
29H	DAA OIRT, frequency offset at alignment point 1	The offset frequency is the number of steps above the lowest OIRT FM band limit (step size is 100 kHz)
2AH	DAA OIRT, DAA value at alignment point 1	• Bits 0 to 6 are the DAA value, which has a range of 0 to 127 • Bit 7 is not used
2BH and 2CH	DAA OIRT at alignment point 2	See 29H and 2AH
2DH and 2EH	DAA OIRT at alignment point 3	See 29H and 2AH
2FH and 30H	DAA OIRT at alignment point 4	See 29H and 2AH
31H and 32H	DAA OIRT at alignment point 5	See 29H and 2AH
33H and 34H	DAA OIRT at alignment point 6	See 29H and 2AH
35H and 36H	DAA OIRT at alignment point 7	See 29H and 2AH
37H	Weather band PLL offset	• Bits 0 and 1 are the weather band frequency correction Value : 0 frequency correction = +25 kHz 1 frequency correction = 0 kHz (no correction) 2 frequency correction = - 25 kHz (A frequency correction of +25 kHz is added in software to compensate for a frequency deviation of 25 kHz in hardware.) • Bits 2 to 7 are not used
38H	Antenna DAA value for the weather band	• Bits 0 to 6 are used for the DAA value (0 to 127). This value is valid for the whole weather band. • Bit 7 is not used
39H	Frequency value at which alignments were done for Europe/USA (see 43H, 4AH, 4EH, 51H)	The frequency is the number of steps above the lower Europe FM band limit (step size is 100 kHz)
3AH	Frequency value at which alignments were done for Japan (see 44H, 4BH, 4FH)	The frequency is the number of steps above the lower Japan FM band limit (step size is 100 kHz)
3BH	Frequency value at which alignments were done for OIRT (see 45H, 4CH, 50H)	The frequency is the number of steps above the lower OIRT FM band limit (step size is 100 kHz)
3CH	Frequency value at which alignments were done for WX (see 46H, 4DH)	The offset frequency above the lower WX band limit (see chapter 4)
3DH and 3EH	Frequency value at which the level curve is aligned for LW	• The upper byte is saved in 3DH • The lower byte is saved in 3EH
3FH and 40H	Frequency value at which the level curve is aligned for MW	• The upper byte is saved in 3FH • The lower byte is saved in 40H
41H and 42H	Frequency value at which the level curve is aligned for SW	• The upper byte is saved in 41H • The lower byte is saved in 42H
43H	FM Level start and level slope point value for Europe/USA	• Bits 0 to 2 are the level slope (0 to 7) • Bits 3 to 7 are the level start (0 to 31)

Subaddress	Function	Description
44H	FM Level start and level slope point value for Japan	• Bits 0 to 2 are the level slope (0 to 7) • Bits 3 to 7 are the level start (0 to 31)
45H	FM Level start and level slope point value for OIRT	• Bits 0 to 2 are the level slope (0 to 7) • Bits 3 to 7 are the level start (0 to 31)
46H	WX Level start and level slope point value	• Bits 0 to 2 are the level slope (0 to 7) • Bits 3 to 7 are the level start (0 to 31)
47H	LW Level start and level slope point value	• Bits 0 to 2 are the level slope (0 to 7) • Bits 3 to 7 are the level start (0 to 31)
48H	MW Level start and level slope point value	• Bits 0 to 2 are the level slope (0 to 7) • Bits 3 to 7 are the level start (0 to 31)
49H	SW Level start and level slope point value	• Bits 0 to 2 are the level slope (0 to 7) • Bits 3 to 7 are the level start (0 to 31)
4AH	FM Center frequency for Europe/USA	• Bits 0 to 6 are the center frequency • Bit 7 is not used
4BH	FM Center frequency for Japan	• Bits 0 to 6 are the center frequency • Bit 7 is not used
4CH	FM Center frequency for OIRT	• Bits 0 to 6 are the center frequency • Bit 7 is not used
4DH	Weather band center frequency	• Bits 0 to 6 are the center frequency • Bit 7 is not used
4EH	Frequency offset for Europe/USA	• Bits 0 to 3 are the frequency offset • Bits 4 to 7 are not used
4FH	Frequency offset for Japan	• Bits 0 to 3 are the frequency offset • Bits 4 to 7 are not used
50H	Frequency offset for OIRT	• Bits 0 to 3 are the frequency offset • Bits 4 to 7 are not used
51H	Filter gain (see 39H)	• Bits 0 to 3 are the filter gain (0 to15) • Bits 4 to 7 are not used

6.2. BAND LIMITS

Limitations:

Table 14 Low Limits

LOW LIMITS [KHZ]	FM	WX	MW	LW	SW
Europe	87500		522	144	5730
Japan	76000		520	5730	
Eastern Europe	64000		520	5730	
USA	87900	162400	520	5730	

Table 15 High Limits

HIGH LIMITS [KHZ]	FM	WX	MW	LW	SW
Europe	108000		1602	288	6295
Japan	91000		1720		6295
Eastern Europe	76000		1720		6295
USA	107900	162550	1720		6295

7. TUNER INITIALIZATION

Figure 6 illustrates the typical tuner initialization process.

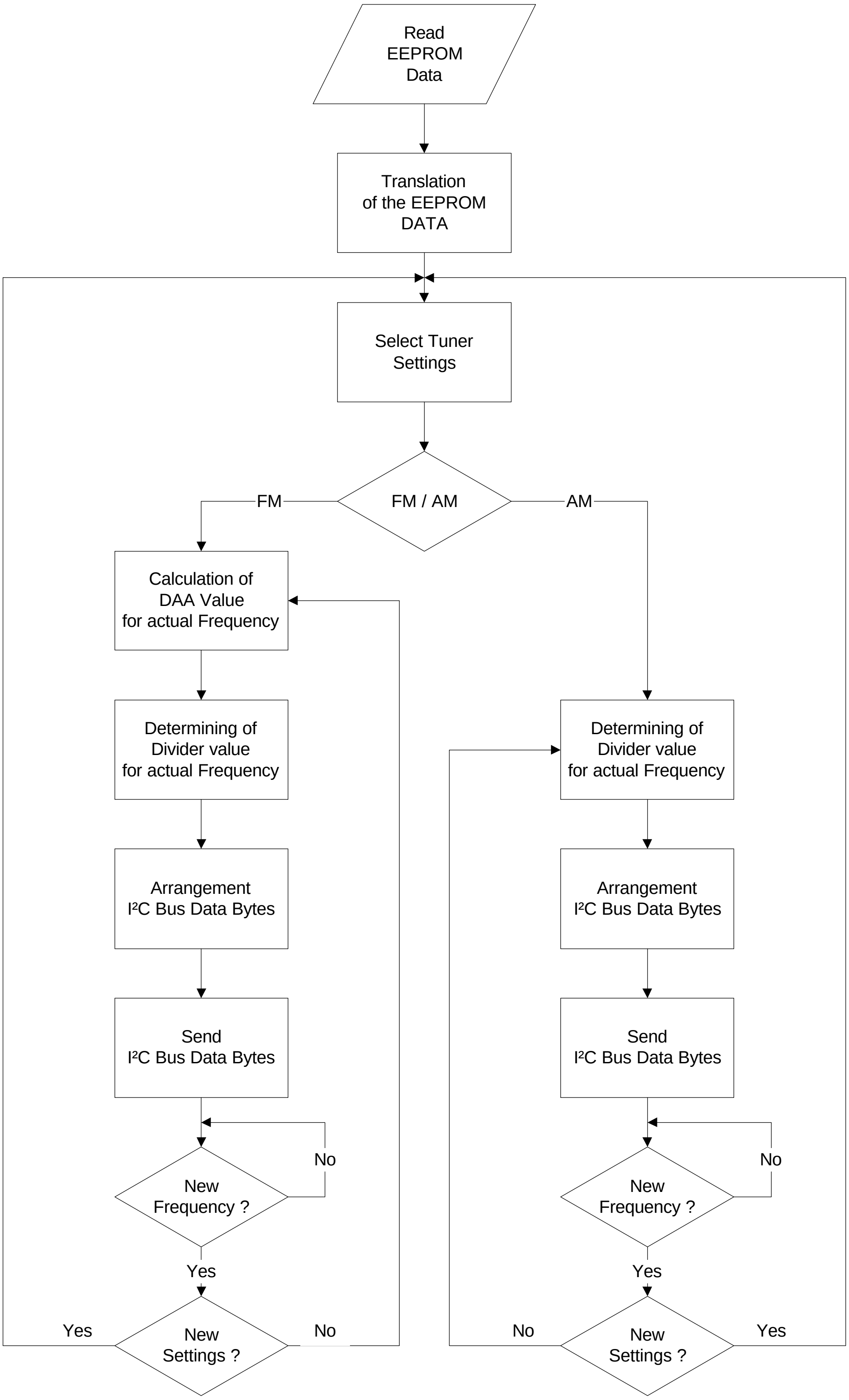


Figure 6 Tuner Initialization Process

7.1. RECOMMENDED SETTINGS FOR FM AND AM MODE

Table 16 lists the recommended setting in FM Mode for USA and Europe and Table 17 lists the recommended setting in AM Mode for USA and Europe.

Table 16 Recommended Settings for FM Mode

DATA BYTE	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
0	AF	PLL14	PLL13	PLL12	PLL11	PLL10	PLL9	PLL8
	0	X	X	X	X	X	X	X
1	PLL7	PLL6	PLL5	PLL4	PLL3	PLL2	PLL1	PLL0
	X	X	X	X	X	X	X	X
2	MUTE	ANT6	ANT5	ANT4	ANT3	ANT2	ANT1	ANT0
	X	X	X	X	X	X	X	X
3	IFMT	REF2	REF1	REF0	IFPR	BND2	BND1	AMFM
	1	0	0	0	1	0	0	0
4	KAGC	AGC1	AGC0	AMSM/ FMBW	LODX	FLAG	BW1	BW0
	1	0	1	0	0	0	0	0
5	LST4	LST3	LST2	LST1	LST0	LSL2	LSL1	LSL0
	X	X	X	X	X	X	X	X
6	TE	CF6	CF5	CF4	CF3	CF2	CF1	CF0
	1	X	X	X	X	X	X	X
7	FOF3	FOF2	FOF1	FOF0	FGN3	FGN2	FGN1	FGN0
	X	X	X	X	X	X	X	X

see chapter 7.6

Table 17 Recommended Settings for AM Mode

DATA BYTE	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
0	AF	PLL14	PLL13	PLL12	PLL11	PLL10	PLL9	PLL8
	0	X	X	X	X	X	X	X
1	PLL7	PLL6	PLL5	PLL4	PLL3	PLL2	PLL1	PLL0
	X	X	X	X	X	X	X	X
2	MUTE	ANT6	ANT5	ANT4	ANT3	ANT2	ANT1	ANT0
	X	0	0	0	0	0	0	0
3	IFMT	REF2	REF1	REF0	IFPR	BND2	BND1	AMFM
	1	0	0	1	1	1	0	1
4	KAGC	AGC1	AGC0	AMSM/ FMBW	LODX	FLAG	BW1	BW0
	0	0	0	1	0	0	0	0
5	LST4	LST3	LST2	LST1	LST0	LSL2	LSL1	LSL0
	X	X	X	X	X	X	X	X
6	TE	CF6	CF5	CF4	CF3	CF2	CF1	CF0
	0	0	0	0	0	0	0	0
7	FOF3	FOF2	FOF1	FOF0	FGN3	FGN2	FGN1	FGN0
	0	0	0	0	0	0	0	0

see chapter 7.6

7.2. EXAMPLE TRANSLATION OF THE EEPROM DATA

Table 18 Example Transformation of EEPROM Data

ADDRESS [HEX]	VALUE [HEX]	MEANING / ENCODING	
0A	07	Number of DAA alignments = 7	
0B	00	first alignment frequency	= value 100 kHz + lowest Europe band limit = 0 100 kHz +87500 kHz = 87.5 MH
0C	20	DAA value at first alignment frequency (87.5 MHz) = 32	
0D	22	second alignment frequency	= value 100 kHz + lowest Europe band limit = 34 100 kHz +87500 kHz = 90.9 MH
0E	23	DAA value at second alignment frequency (90.9 MHz) = 34	
0F	44	third alignment frequency	= value 100 kHz + lowest Europe band limit = 68 100 kHz +87500 kHz = 94.3 MH
10	28	DAA value at third alignment frequency (94.3 MHz) = 40	
11	66	fourth alignment frequency	= value 100 kHz + lowest Europe band limit = 102 100 kHz +87500 kHz = 97.7 MH
12	2D	DAA value at fourth alignment frequency (97.7 MHz) = 45	
13	89	fifth alignment frequency	= value 100 kHz + lowest Europe band limit = 137 100 kHz +87500 kHz = 101.2 MH
14	32	DAA value at fifth alignment frequency (101.2 MHz) = 50	
15	AB	sixth alignment frequency	= value 100 kHz + lowest Europe band limit = 171 100 kHz +87500 kHz = 104.6 MH
16	39	DAA value at sixth alignment frequency (104.6 MHz) = 57	
17	CD	seventh alignment frequency	= value 100 kHz + lowest Europe band limit = 205 100 kHz +87500 kHz = 108 MH
18	3F	DAA value at seventh alignment frequency (108 MHz) = 63	
19 to 27	XX	for Japan	Japan band not implemented in 1384 UFC
28 to 36	XX	for Eastern Europe	OIRT band not implemented in 1384 UFC
37 to 38	XX	for Weatherband	Weatherband not implemented in 1384 UFC
39	66	Frequency at which alignments Level Start, Level Slope, FM center frequency, Frequency offset and Filter Gain were done for Europe / USA.	= value 100 kHz + lowest Europe band limit = 102 100 kHz +87500 kHz = 97.7 MH
3A	XX	for Japan	Japan band not implemented in 1384 UFC
3B	XX	for Eastern Europe	OIRT band not implemented in 1384 UFC
3C	XX	for Weatherband	Weatherband not implemented in 1384 UFC
3D to 3E	XX	for LW	LW not implemented in 1384 UFC

Address [Hex]	Value [Hex]	Meaning / Encoding	
3F	03	Frequency at which the level curve is aligned for MW. The upper byte is saved in 3F. The lower byte is saved in 40.	= value 1 kHz = 909 1 kHz = 909 kHz
40	8D		
41 to 42	XX	for SW	SW not implemented in 1384 UFC
43	5C	FM Level Start and Level Slope for Europe and USA	Level Slope (Bit 0..2) = 100b = 4 Level Start (Bit 3..7) = 1011b = 11
44	XX	for Japan	Japan band not implemented in 1384 UFC
45	XX	for Eastern Europe	OIRT band not implemented in 1384 UFC
46	XX	for Weatherband	Weatherband not implemented in 1384 UFC
47	XX	for LW	LW not implemented in 1384 UFC
48	72	MW Level Start and Level Slope for Europe and USA	Level Slope (Bit 0..2) = 010b = 2 Level Start (Bit 3..7) = 1110b = 14
49	XX	for SW	SW not implemented in 1384 UFC
4A	40	FM center frequency for Europe / USA = 64	
4B	XX	for Japan	Japan band not implemented in 1384 UFC
4C	XX	for Eastern Europe	OIRT band not implemented in 1384 UFC
4D	XX	for Weatherband	Weatherband not implemented in 1384 UFC
4E	07	Frequency offset for Europe / USA = 7	
4F	XX	for Japan	Japan band not implemented in 1384 UFC
50	XX	for Eastern Europe	OIRT band not implemented in 1384 UFC
51	06	Filter Gain (Bit 0..3) = 6	

7.2.1. RESULTS OF TRANSFORMATION

For optimal performance in FM Mode the following parameter are necessary for initialization:

Table 19 Results FM

Parameter	Value
Filter Gain	6
Center Frequency	64
Frequency Offset	7
Level Start	11
Level Slope	4
DAA1 87.5 MHz	32
DAA2 90.9 MHz	35
DAA3 94.3 MHz	40
DAA4 97.7 MHz	45
DAA5 101.2 MHz	50
DAA6 104.6 MHz	57
DAA7 108.0 MHz	63

For optimal performance in AM Mode the following parameter are necessary for initialization:

Table 20 Results AM

PARAMETER	VALUE
MW Level Start	14
MW Level Slope	2

7.3. CALCULATION OF DAA VALUE FOR ACTUAL FREQUENCY

The DAA values number 1 to 7 are used for interpolation.

If actual frequency is one of the alignment frequencies

then DDA = DAA alignment Frequency

else Find two alignments points in the DAA array closest to the actual frequency.

Table 21 DAA Array

PARAMETER	VALUE
DAA1 1. alignment frequency	DAA1
DAA2 2. alignment frequency	DAA2
DAA3 3. alignment frequency	DAA3
DAA4 4. alignment frequency	DAA4
DAA5 5. alignment frequency	DAA5
DAA6 6. alignment frequency	DAA6
DAA7 7. alignment frequency	DAA7

Calculate slope *m*:

$$m = \frac{\text{DAA @ higher frequency - DAA @ lower frequency}}{\text{higher frequency - lower frequency}}$$

Calculate DAA:

$$\text{DAA} = round(\text{DAA @ higher freq.} + \text{acutal freq.} * \text{slope} - \text{higher freq.} * \text{slope})$$

7.3.1. EXAMPLE OF DAA CALCULATION

Actual frequency = 99.5 MHz
Actual frequency is unequal with alignment frequencies.
⇒ Find two alignment points in the DAA array (Table 22) closest to the actual frequency.

Table 22 Example DAA Array

PARAMETER	VALUE
DAA1 @ 87.5 MHz	32
DAA2 @ 90.9 MHz	35
DAA3 @ 94.3 MHz	40
DAA4 @ 97.7 MHz	45
DAA5 @ 101.2 MHz	50
DAA6 @ 104.6 MHz	57
DAA7 @ 108.0 MHz	63

⇒ DAA value for interpolation:

DAA lower frequency = DAA4 97.7 MHz
DAA higher frequency = DAA5 101.2 MHz

Calculation of the two-point slope *m*:

$$
\begin{aligned}
m &= \frac{\text{DAA @ higher frequency - DAA @ lower frequency}}{\text{higher frequency - lower frequency}} \\
&= \frac{\text{DAA5 @ 101.2 MHz - DAA4 @ 97.7 MHz}}{\text{102.2 MHz - 97.7 MHz}} \\
&= \frac{50 - 45}{101.2MHZ - 97.7MHz} \\
&= 1.429 \frac{1}{MHz}
\end{aligned}
$$

Calculation DAA value for actual frequency:

$$
\begin{aligned}
\text{DAA} &= round(\text{DAA @ higher freq.} + \text{acutal freq.} * \text{slope} - \text{higher freq.} * \text{slope}) \\
&= round(\text{DAA5 @ 101.2MHz} + \text{99.5 MHz} * \text{slope} - \text{101.2 MHz} * \text{slope}) \\
&= round\left(50 + \text{99.5MHz} * 1.429 \frac{1}{\text{MHz}} - \text{101.2MHz} * 1.429 \frac{1}{\text{MHZ}}\right) \\
&= round(47.57) \\
&= \underline{\underline{48}}
\end{aligned}
$$

7.4. DETERMINING DIVIDER BYTES

7.4.1. EXAMPLE AM MODE

Desired channel frequency: f_{CH} = 1000 kHz

Prescaler: p = 20

Chosen reference frequency: f_{REF} = 10 kHz

Programmable Counter N:

$$N = \frac{f_{CH} + f_{IF}}{f_{REF}} * p$$

$$= \frac{1MHz + 10.7MHz}{0.01MHz} * 20$$

$$= 23400 \equiv 5B68H$$

7.4.2. EXAMPLE FM MODE

Desired channel frequency: f_{CH} = 99.5 MHz

Prescaler: p = 2

Chosen reference frequency: f_{REF} = 100 kHz

Programmable Counter N

$$N = \frac{f_{CH} + f_{IF}}{f_{REF}} * p$$

$$= \frac{99.5MHz + 10.7MHz}{0.1MHz} * 2$$

$$= 2204 \equiv 89CH$$

7.5. EXAMPLE ARRANGEMENT OF I²C BUS DATA BYTES

Together with the results from 7.2.1, 7.3.1 and 7.4 the I²C bus data bytes can be arranged for FM Mode as shown in Table 23 and for AM Mode as shown in Table 24.

Table 23 Example I²C Bus Data for FM Mode

DATA BYTE	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0	VALUE [HEX]
0	AF	PLL14	PLL13	PLL12	PLL11	PLL10	PLL9	PLL8	08
	0	0	0	0	1	0	0	0	
1	PLL7	PLL6	PLL5	PLL4	PLL3	PLL2	PLL1	PLL0	9C
	1	0	0	1	1	1	0	0	
2	MUTE	ANT6	ANT5	ANT4	ANT3	ANT2	ANT1	ANT0	30
	0	0	1	1	0	0	0	0	
3	IFMT	REF2	REF1	REF0	IFPR	BND2	BND1	AMFM	88
	1	0	0	0	1	0	0	0	
4	KAGC	AGC1	AGC0	AMSM/	LODX	FLAG	BW1	BW0	A0
	1	0	1	0	0	0	0	0	
5	LST4	LST3	LST2	LST1	LST0	LSL2	LSL1	LSL0	5C
	0	1	0	1	1	1	0	0	
6	TE	CF6	CF5	CF4	CF3	CF2	CF1	CF0	C0
	1	1	0	0	0	0	0	0	
7	FOF3	FOF2	FOF1	FOF0	FGN3	FGN2	FGN1	FGN0	76
	0	1	1	1	0	1	1	0	

see chapter 7.6

Table 24 Example I²C Bus Data for AM Mode

DATA BYTE	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0	VALUE [HEX]
0	AF	PLL14	PLL13	PLL12	PLL11	PLL10	PLL9	PLL8	5B
	0	1	0	1	1	0	1	1	
1	PLL7	PLL6	PLL5	PLL4	PLL3	PLL2	PLL1	PLL0	68
	0	1	1	0	1	0	0	0	
2	MUTE	ANT6	ANT5	ANT4	ANT3	ANT2	ANT1	ANT0	00
	0	0	0	0	0	0	0	0	
3	IFMT	REF2	REF1	REF0	IFPR	BND2	BND1	AMFM	9D
	1	0	0	1	1	1	0	1	
4	KAGC	AGC1	AGC0	AMSM/	LODX	FLAG	BW1	BW0	10
	0	0	0	1	0	0	0	0	
5	LST4	LST3	LST2	LST1	LST0	LSL2	LSL1	LSL0	72
	0	1	1	1	0	0	1	0	
6	TE	CF6	CF5	CF4	CF3	CF2	CF1	CF0	00
	0	0	0	0	0	0	0	0	
7	FOF3	FOF2	FOF1	FOF0	FGN3	FGN2	FGN1	FGN0	00
	0	0	0	0	0	0	0	0	

see chapter 7.6

7.6. I²C BUS TRANSMISSION FOR CORRECT INITIALIZATION

For new frequency setting, in both AM and FM mode, the programmable divider is enabled by setting the mute bit (data byte 2 bit 7) to logic 1.

To select an FM frequency, **two** I²C bus transmissions are necessary. First data byte 2 bit 7 = 1 to enabled the programmable divider and second data byte 2 bit 7 = 0 to turn off mute of FM MPX output. The length of the second transmission can be 3 bytes to shorten transmission times.

7.6.1. EXAMPLE I²C BUS TRANSMISSION IN FM MODE

Table 25 Example I²C Bus Transmission

	ADDRESS	I²C DATA BYTE [HEX]
first transmission	C2	08 9C B0 88 A0 5C C0 76 STOP
second transmission	C2	08 9C 30 STOP

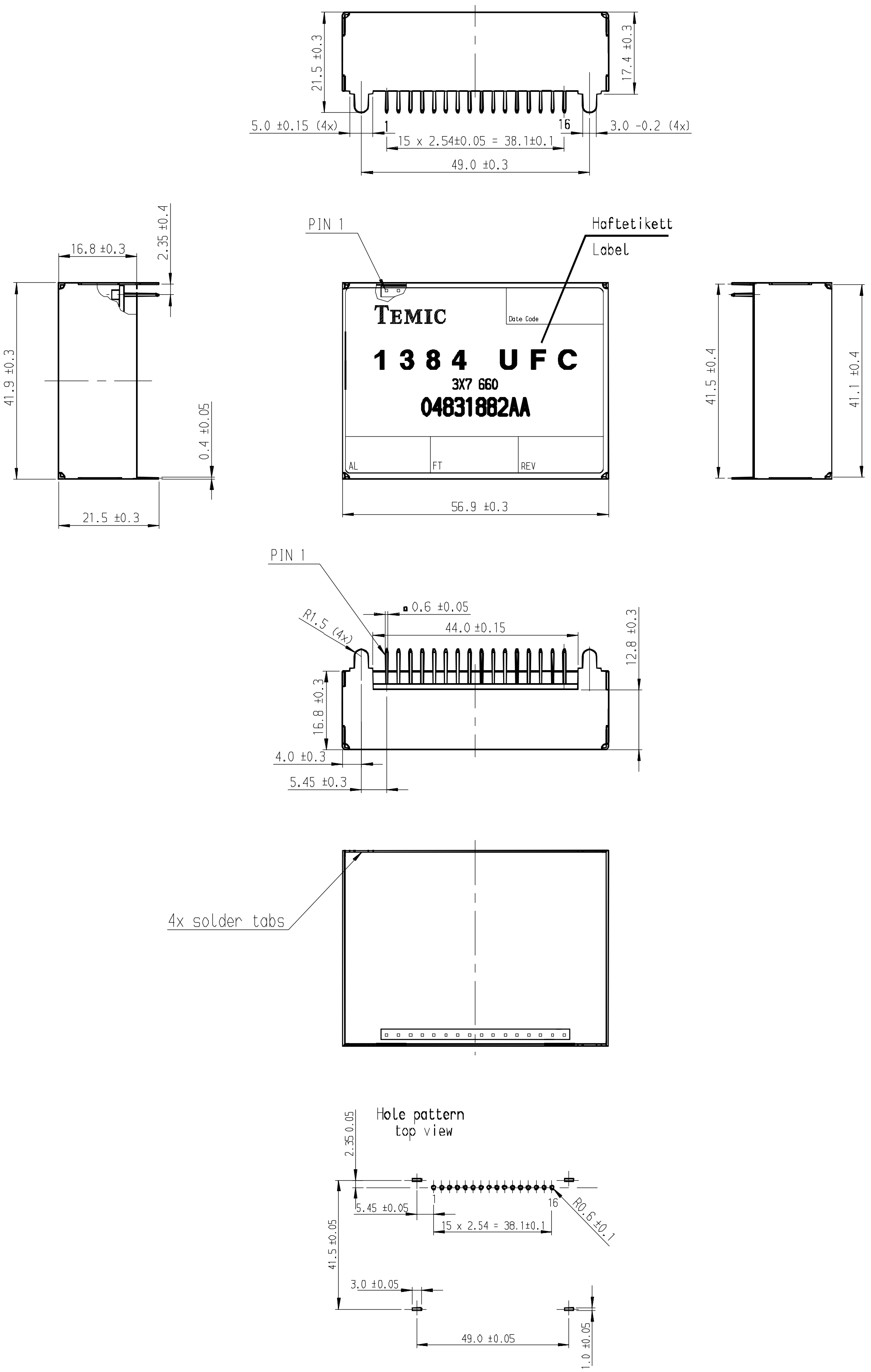
8. TERMINAL CONNECTIONS

Table 26 lists descriptions of terminal connections for the 1384 UFC Tuner.

Table 26 1384 UFC Tuner Terminal Connections

PIN	DESCRIPTION
1	Antenna input
2	RF Ground
3	Vcc 5V Supply voltage
4	Vcc 8.5V Supply voltage
5	Vcc Ground
6	Software flag output
7	Intermediate frequency BW flag output
8	SCL
9	SDA
10	Digital Ground
11	Field Strength (Level)
12	FM MPX Output
13	AM AF Output
14	RDS MPX Output
15	AF Hold
16	AF Sample

9. MECHANICAL DRAWING



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