

Additional Resources	None
----------------------	------

1. Introduction

This document is written to provide guidance of how the RSSI and Carrier Sense (CS) features of the AIS baseband processor can be used. The following sections are written to reflect the order to which a software designer may approach their design.

1.	Introduction	1
2.	History	1
3.	CS-TDMA and RSSI	2
4.	Calculating the Look-up Table Cross Reference Values	2
5.	Look-up Table Updating	3
6.	Method of measuring RSSI and CS	4
a.	RSSI Measurement Process	6
b.	CS Tx Activation Process	6
7.	C-BUS Reference	6

Where necessary additional explanation is provided, however good understanding of the latest CMX7032-FI1 datasheet and user manual is required. By default the look-up tables are populated with values derived by experimentation (SA605 - High performance low power mixer FM IF System IC by NXP (formally Phillips)).

2. History

Version	Changes	Date
1.0	New Issue	18-6-09

3. CS-TDMA and RSSI

The CMX7042 FI1.x is designed to be used in all AIS Class B transponders, including those that support CS-TDMA. In such applications Carrier Sensing is a useful aid in determining slot occupancy. CS-TDMA is not used for slot synchronisation.

The threshold value used for CS is determined by calculation from the RSSI measurements made by the RSSI function over the previous 60 seconds of slot reception.

4. Calculating the Look-up Table Cross Reference Values

The look-up table ranges from 0 to 127 equating to nominal voltages 10% to 90% AV_{DD}. Each of the 0 to 127 values corresponds to a specific RF power level. To match RF power level to corresponding table value can be performed by:

- Experimentation
 - By measuring values at RSSI pin for a specific applied RF Power level
- Using RSSI vs. RF Plots
 - By reading off corresponding RSSI Voltages vs. Input RF Power level

Whichever method is used, the values should be scaled and anti-logged.

For Example:

Index	Value at CMX70x2 RSSI Input pin (V)	Calculation (AV _{DD} = 3.3) See 1 note below
0	0	0
1	0.026	$(1/127) \times AV_{DD}$
58	1.507	$(58/127) \times AV_{DD}$
127	3.3	$(127/127) \times AV_{DD}$

The look-up table is shown as the following.

Index	Value (Dec)	Value (Hex)	Value at CMX70x2 RSSI Input pin (V)
0	-	-	0
1	-	-	0.026
58	-	-	1.507
127	-	-	3.3

Note 1

The CMX7032 FI-1.x states that the AuxADC input range is 10% to 90% of AV_{DD}. In practice however the range is likely to be greater than this (<10% to >90%), so either set of values could be used. As discussed the RSSI values read back will be proportional to input voltage in both cases and so will be accurate enough for CS-TDMA.

The engineer must now work out what values to insert in Value Column above that correspond to a specific RF power applied at the input to the RF IC. This can be by experimentation using datasheet plots. Additional calculation is required at this stage to compensate for the naturally logarithmic behaviour of the RSSI pin on the RF IC.

For example:

Table index 58 = 1.507V

By evaluation of the RF device it was shown that an RF input level of -92.3dBm results in a voltage of 1.507V (closest value) at the CMX70x2 RSSI pin.

Evaluated values may be slightly different to datasheet plots due to component tolerances, component matching etc.

The value must now be anti-logged to produce the linear equivalent.

$$\text{Linear Value} = 10^{(-92.3/20)} = 2.43e-5$$

Therefore look-up table index 58 = $2.43e-5 \times \text{Scaling Factor}$

To calculate the scaling it is easiest to take the largest expected RF signal input and adjust it to the maximum possible value in the look-up table (i.e., 32767).

For Example:

AIS has a typical maximum RF signal of interest at -70dBm , so

$$\text{Linear Value} = 10^{(-70/20)} = 3.16e-4$$

$$\text{Scaling Factor} = 32767/3.16e-4 = 1031618\ 352$$

$$\text{Therefore look-up table index 58} = 2.43e-5 \times 1031618\ 352 = 2518 = \$09D6$$

This exercise is repeated for every entry in the look-up table. This process is most conveniently performed using a spreadsheet. Their values can then be loaded into the look-up table.

The CMX70x2 Gain and Accumulation calculations are performed in Q15 format. Where b15 = sign bit

Therefore a range of -1 to $+1$ is possible, therefore

1 = \$7FFF
 0.5 = \$3FFF
 0.25 = \$1FFF
 0.125 = \$0FFF
 0.0625 = \$07FF
 0.03125 = \$03FF
 0.0000305 = \$0001
 -1.0 = \$8000

Note. The above calculation is a generic calculation and does not represent the values shown in the current CMX70x2 datasheet.

5. Look-up Table Updating

Now that each of the 128 x 16 bit look up table values have been calculated the RSSI look-up table may be set-up.

\$C8 In configuration Mode - [b15..DATA..b8][b4..Config..b0]

```
.
.
$A7 TxDataWord 1 Load      // LookUpXref Index1
$A8 TxDataWord 2 Load      // LookUpXref Index2
$B6 TxDataWord 3 Load      // LookUpXref Index3
$B7 TxDataWord 4 Load      // LookUpXref Index4
DataWordResetN_Tx         // Reset Data Buffer and load first 4 words (100b)
Test Status Register ($C6) Data Task Complete Flag, b10 // If set continue
Loop:
$A7 TxDataWord 1 Load      // LookUpXref IndexN+1
$A8 TxDataWord 2 Load      // LookUpXref IndexN+2
```

```

$B6 TxDataWord 3 Load      // LookUpXref IndexN+3
$B7 TxDataWord 4 Load      // LookUpXref IndexN+4
DataWordWriteN_Tx          // Write 4 words to data register (100b)
Test Status Register ($C6) Data Task Complete Flag, b10 // If set continue
Go to Loop:                 //Until 128 Words have been written (N = 31)
then:
RSSI_Lookup                 //Issue task to write all 128 Words to the
Look-up Table
:
:

```

6. Method of measuring RSSI and CS

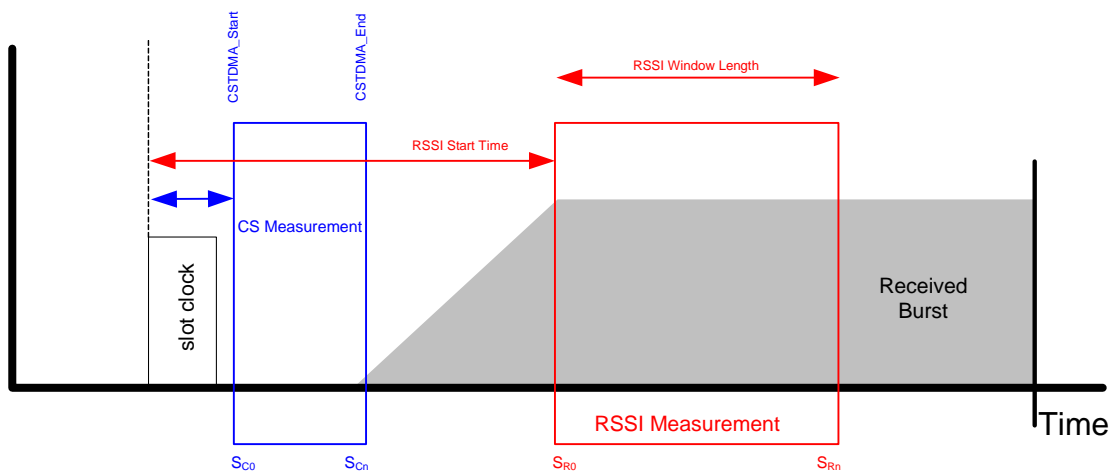


Figure 1 Illustration of CS and RSSI timing and use in an individual slot.

The related standard does not define a specific method of measuring background noise, but does provide a framework for a suitable host driven algorithm. The following description is one suggested method of how a host may effectively derive a threshold for the CS function. To determine the CS threshold the background noise should be measured. The RSSI function is used for this purpose.

An RSSI measurement is taken for a period of time (RSSI Window Length – 20ms suggested) in the middle of each received slot. The measurement result for a slot is the average of the samples taken. See Note 2 below.

4 seconds of slot measurements are taken, the lowest measurement recorded and stored.

This process is repeated every 4s for a total period of 60 seconds (4 x 15). The lowest value taken is the measured background noise level.

This 60 seconds period is a rolling window, so the background noise figure will be updated every 4s.

10dB is added to the measured background noise figure and this is used as the CS detect threshold. This threshold may be updated every 4s.

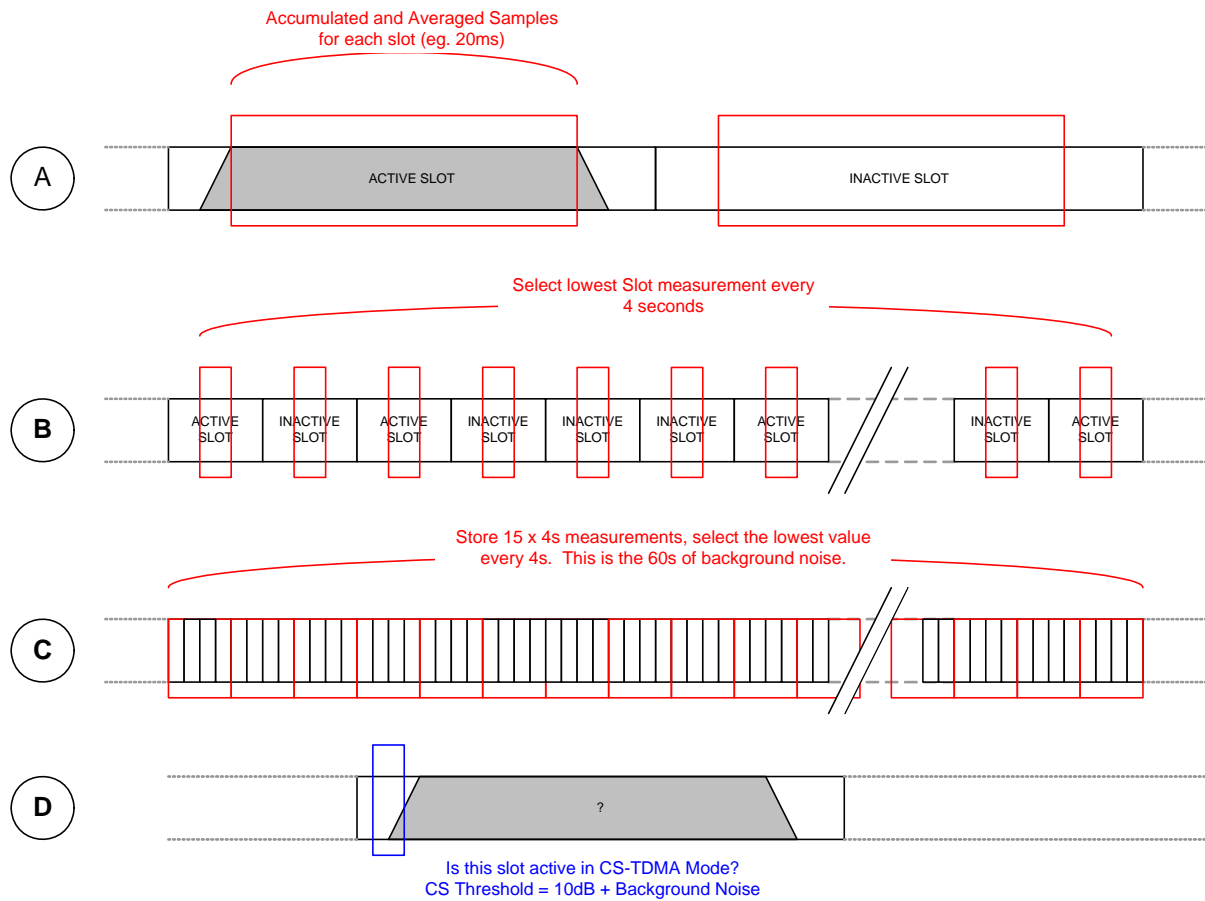


Figure 2 Illustration of CS and RSSI timing across multiple slots.

Note 2

RSSI Window Length and RSSI and RSSI Start Time are defined in 24kHz ticks. Default settings for both parameters is 27 and 60 respectively; higher values are possible for both but considered unnecessary in AIS applications.

Note that $(\text{RSSI Window Length} \times 2) + \text{RSSI Start Time} \ll \text{Slot Length}$

a. Internal RSSI Measurement Process

Values are sampled at 48k samples/sec.

Samples are scaled to 0 to 127 levels (S_{Rn}).

Samples are then cross referenced to the look-up table and are scaled (S_{Rn}) X_{ref}

Apply the RSSI_gain value (R_g)

And the summed values are made available in \$BA and \$BB CBus Registers

$$\text{\$BA or \$BB C-BUS Register Value} = \sum_{R0}^{Rn} R_g.(S_{Rn})X_{ref}$$

b. Internal CS Tx Activation Process

Values are sampled at 48k samples/sec.

Samples are scaled to 0 to 127 levels (S_{Cn}).

Samples are then cross referenced to the look-up table and are scaled (S_{Cn}) X_{ref}

Apply the CSTDMA_gain value (C_g)

If the measured CS value is greater than the CS-Threshold value then Tx will be aborted.

$$\text{\$C2 C-Bus Register Value} < \sum_{C0}^{Cn} C_g.(S_{Cn})X_{ref}$$

7. C-BUS References

CS-Threshold Reg - \$C2		// CS-TDMA threshold data value (Q15 Format).
Command Reg - \$C8	- Config Task b4..0	
		// 00101b - RSSI_window 2 Sets RSSI window timing (Word 1) and length (Word 2).
		// 00110b - RSSI_gain, Sets RSSI gain factor
		// 00111b - CSTDMA_gain, Sets CSTDMA gain factor
Mode Reg - \$C1	- b4..3	// CS Enable & CS Channel Select
	- b14..12	// 100b RSSI1 Input & 101b RSSI2 Input
Status2 Reg - \$C5	- b11..8	// 0101b - Tx aborted – carrier sensed (CSTDMA)
RSSI1 Reg - \$BA		// RSSI data from Rx1
RSSI2 Reg - \$BB		// RSSI data from Rx2

CML does not assume any responsibility for the use of any algorithms, methods or circuitry described. No IPR or circuit patent licenses are implied. CML reserves the right at any time without notice to change the said algorithms, methods and circuitry and this product specification. CML has a policy of testing every product shipped using calibrated test equipment to ensure compliance with this product specification. Specific testing of all circuit parameters is not necessarily performed.

 CML Microcircuits (UK) Ltd <small>COMMUNICATION SEMICONDUCTORS</small>	 CML Microcircuits (USA) Inc. <small>COMMUNICATION SEMICONDUCTORS</small>	 CML Microcircuits (Singapore) Pte Ltd <small>COMMUNICATION SEMICONDUCTORS</small> Singapore China	
Tel: +44 (0)1621 875500 Fax: +44 (0)1621 875600 Sales: sales@cmlmicro.com Tech Support: techsupport@cmlmicro.com	Tel: +1 336 744 5050 800 638 5577 Fax: +1 336 744 5054 Sales: us.sales@cmlmicro.com Tech Support: us.techsupport@cmlmicro.com	Tel: +65 67450426 Fax: +65 67452917 Sales: sg.sales@cmlmicro.com Tech Support: sg.techsupport@cmlmicro.com	Tel: +86 21 6317 4107 +86 21 6317 8916 Fax: +86 21 6317 0243 Sales: cn.sales@cmlmicro.com.cn Tech Support: sg.techsupport@cmlmicro.com
- www.cmlmicro.com -			