Register map for the OpenHT

Wojciech Kaczmarski, SP5WWP

M17 Project, March 2023

1 Control registers

1.1 Control register 1

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0x0000	-	MOD			IO0_SRC			RESERVED			PD	DEMOD			BAND	
0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW

Bits [1:0] – **BAND** – select operating band by using one of the DDR receivers

BAND	Value	Description
	0x0	Sub-GHz (default)
	0x1	2.4 GHz
	0x2	invalid
	0x3	invalid

Bits [4:2] – **DEMOD** – select the demodulator

DEMOD	Value	Description
	<u>0x0</u>	FM (default)
	0x1	AM
	0x2	SSB
	0x3 to 0x7	reserved

Bit [5] – **PD** – Phase dithering for the FM transmitter submodule

PD	Value	Description
	<u>0x0</u>	phase dithering disabled (default)
	0x1	phase dithering enabled

Bits [8:6] – **RESERVED**

RESERVED	Value	Description
	<u>0x0</u>	-
	0x1 to 0x7	-

Bit [11:9] – **IO0_SRC** – IO0 signal source mux

IO0_SRC	Value	Description
	<u>0x0</u>	Logic low (default)
	0x1	DRDY signal
	0x2 to 0x7	reserved

Bits [14:12] – **MOD** – select modulation

MOD	Value	Description
	<u>0x0</u>	FM (default)
	0x1	AM
	0x2	SSB
	0x3 to 0x7	invalid

Bit [15] – reserved.

1.2 Control register 2

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0x0001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW

Reserved for future use.

1.3 I branch offset null

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0x0002	MSB							16-bit signed integer								LSB
0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW

Signed 16-bit value to be added to the I branch after applying predistortion.

1.4   Q branch offset null

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0x0003	MSB							16-bit signed integer								LSB
0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW

Signed 16-bit value to be added to the Q branch after applying predistortion.

1.5   I branch linear gain

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0x0004	MSB							16-bit signed integer								LSB
0x4000	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW

Signed, fixed-point, 16-bit gain value to be applied to the I branch. 0x4000 corresponds to +1.0 (default value).

1.6   Q branch linear gain

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0x0005	MSB							16-bit signed integer								LSB
0x4000	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW

Signed, fixed-point, 16-bit gain value to be applied to the Q branch. 0x4000 corresponds to +1.0 (default value).

1.7 Digital predistortion register 1

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0x0006	MSB							16-bit signed integer								LSB
0x4000	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW

Polynomial coefficient p_1 value of the formula below:

$$D(x) = p_1 x + p_2 \, sgn(x) x^2 + p_3 x^3$$

Signed, fixed-point value, where 0x4000 equals positive unity, "+1.0" (default value). This applies to all 3 registers holding the predistortion coefficients. To disable the predistortion, set p_1 to 0x4000 (+1.0) and both p_2 and p_3 to 0x0000 (0.0).

1.8 Digital predistortion register 2

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0x0007	MSB							16-bit signed integer								LSB
0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW

Polynomial coefficient p_2 value. See *1.5* for details. Default value is 0x0000 (zero).

1.9 Digital predistortion register 3

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0x0008	MSB							16-bit signed integer								LSB
0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW

Polynomial coefficient p_3 value. See *1.5* for details. Default value is 0x0000 (zero).

2   Status registers

2.1   Status register 1

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0x0009								REV								
0x4854	0	1	0	0	1	0	0	0	0	1	0	1	0	1	0	0
	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

Readback only register. This is mostly for fun or to check if the SPI comms are OK. Can be used to store revision number. The default **REV** value decodes to "HT".

2.2   Status register 2

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0x000A	-	-	-	-	-	-	-	-	-	-	-	-	-	PLL2	PLL1	PLL0
0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

Values in this register are reset to 0x0000 at start-up and get updated in realtime.

Bit [0] – **PLL0** – Phase locked loop lock flag, 38 MHz branch

PLL0	Value	Description
	0x0	PLL unlocked (default)
	0x1	PLL locked

Bit [1] – **PLL1** – Phase locked loop lock flag, 64 MHz branch

PLL1	Value	Description
	<u>0x0</u>	PLL unlocked (default)
	0x1	PLL locked

Bit [2] – **PLL2** – Phase locked loop lock flag, 152 MHz branch

PLL2	Value	Description
	<u>0x0</u>	PLL unlocked (default)
	0x1	PLL locked

Bits [15:3] – reserved.

3   Demodulators

3.1   *Frequency demodulator register*

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0x000B	MSB							16-bit signed integer								LSB
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

--

3.2 Amplitude demodulator register

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0x000C	MSB							16-bit unsigned integer								LSB
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

--

4 Modulators

4.1 Frequency modulator

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0x000D	MSB							16-bit signed integer								LSB
0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW

Instantenous frequency control word, signed.

4.2 Amplitude modulator

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0x000E	MSB							16-bit unsigned integer								LSB
0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW	RW

Instantenous amplitude control word, unsigned.

5   Debug, raw readback

5.1   I branch sample

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0x000F	MSB							16-bit signed integer								LSB
0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

Raw *I* branch sample, 16-bit, left justified, signed. Bits [2:0] are always zero.

5.2   Q branch sample

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0x0010	MSB							16-bit signed integer								LSB
0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

Raw *Q* branch sample, 16-bit, left justified, signed. Bits [2:0] are always zero.

6   Registers summary

Address	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	Page(s)
0x0000	-	MOD			IO0_SRC			RESERVED			PD	DEMOD			BAND		*1, 2, 3*
0x0001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*3*
0x0002	MSB	16-bit signed integer														LSB	*3*
0x0003	MSB	16-bit signed integer														LSB	*4*
0x0004	MSB	16-bit signed integer														LSB	*4*
0x0005	MSB	16-bit signed integer														LSB	*4*
0x0006	MSB	16-bit signed integer														LSB	*5*
0x0007	MSB	16-bit signed integer														LSB	*5*
0x0008	MSB	16-bit signed integer														LSB	*5*
0x0009	REV																*6*
0x000A	-	-	-	-	-	-	-	-	-	-	-	-	-	PLL2	PLL1	PLL0	*6, 7*
0x000B	MSB	16-bit signed integer														LSB	*7*
0x000C	MSB	16-bit unsigned integer														LSB	*8*
0x000D	MSB	16-bit signed integer														LSB	*8*
0x000E	MSB	16-bit unsigned integer														LSB	*8*
0x000F	MSB	16-bit signed integer														LSB	*9*
0x0010	MSB	16-bit signed integer														LSB	*9*