

# Register Map for the OpenHT

Wojciech Kaczmariski, SP5WWP  
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## 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	SSB	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

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

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

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

Bits [8:6] – **RESERVED**

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

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

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

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

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

Bit [15] – **SSB**

<b>SSB</b>	<b>Value</b>	<b>Description</b>
	<u>0x0</u>	USB (default)
	0x1	LSB

**1.2 Control register 2**

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
<b>0x0001</b>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<b>STATE</b>	
<b>0x0000</b>	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] – **STATE** – set the FPGA to one of the operating modes

STATE	Value	Description
	0x0	idle (default)
	0x1	<i>TX</i>
	0x2	<i>RX</i>
	0x3	reserved

Bits [7:2] – **CTCSS\_TX** – set the transmitter's CTCSS frequency (in hertz)

CTCSS_TX	Value	Description
	0x00	none (default)
	0x01	67.0
	0x02	69.3
	...	...
	0x3F	254.1

Bits [15:8] – reserved.

### 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
<b>0x0003</b>	<div> <div>MSB</div> <div>16-bit signed integer</div> <div>LSB</div> </div>															
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
<b>0x0004</b>	<div> <div>MSB</div> <div>16-bit signed integer</div> <div>LSB</div> </div>															
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
<b>0x0005</b>	<div> <div>MSB</div> <div>16-bit signed integer</div> <div>LSB</div> </div>															
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
<b>0x0006</b>	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:

$$D(x) = p_1 x + p_2 \operatorname{sgn}(x) x^2 + p_3 x^3$$

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
<b>0x0007</b>	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
<b>0x0008</b>	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 Modulators

### 2.1 Frequency modulator

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
<b>0x0009</b>	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

Instantaneous frequency control word, signed.

### 2.2 Amplitude modulator

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
<b>0x000A</b>	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

Instantaneous amplitude control word, unsigned.

### 2.3 SSB modulator

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
<b>0x000B</b>	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

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## 2.4 Reserved 1

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0x000C	RESERVED															
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

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## 3 Status registers

### 3.1 Status register 1

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0x000D	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”.

### 3.2 Status register 2

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0x000E	-	-	-	-	-	-	-	-	-	-	-	-	-	-	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, 64, 152 MHz clocks)

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

Bit [1] – **PLL1** – Phase locked loop lock flag (7.2 MHz sample rate generator master clock)

PLL1	Value	Description
	0x0	PLL unlocked (default)
	0x1	PLL locked

Bits [15:2] – reserved.

## 4 Demodulators

### 4.1 Frequency demodulator register

	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

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## 4.2 Amplitude demodulator register

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
<b>0x0010</b>	<div> <div>MSB</div> <div>16-bit unsigned integer</div> <div>LSB</div> </div>															
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

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## 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
<b>0x0011</b>	<div> <div>MSB</div> <div>16-bit signed integer</div> <div>LSB</div> </div>															
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
<b>0x0012</b>	<div> <div>MSB</div> <div>16-bit signed integer</div> <div>LSB</div> </div>															
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

Read/write register

Read-only register

Address	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	Page(s)
0x0000	SSB	MOD			IO0_SRC			RESERVED			PD	DEM0D			BAND		tbf
0x0001	-	-	-	-	-	-	-	-	CTCSS_TX						STATE		tbf
0x0002	MSB							16-bit signed integer							LSB		tbf
0x0003	MSB							16-bit signed integer							LSB		tbf
0x0004	MSB							16-bit signed integer							LSB		tbf
0x0005	MSB							16-bit signed integer							LSB		tbf
0x0006	MSB							16-bit signed integer							LSB		tbf
0x0007	MSB							16-bit signed integer							LSB		tbf
0x0008	MSB							16-bit signed integer							LSB		tbf
0x0009	MSB							16-bit signed integer							LSB		tbf
0x000A	MSB							16-bit unsigned integer							LSB		tbf
0x000B	MSB							16-bit signed integer							LSB		tbf
0x000C	RESERVED																tbf
0x000D	REV																tbf
0x000E	-	-	-	-	-	-	-	-	-	-	-	-	-	-	PLL1	PLL0	tbf
0x000F	MSB							16-bit signed integer							LSB		tbf
0x0010	MSB							16-bit unsigned integer							LSB		tbf

*Register map for the OpenHT*

0x0011	MSB	16-bit signed integer	LSB	<i>tb<sub>f</sub></i>
0x0012	MSB	16-bit signed integer	LSB	<i>tb<sub>f</sub></i>