APU001 APPLICATION NOTE

CONFIGURING THE DW1000 FOR DATASHEET USE CASES

Version 1.2

This document is subject to change without notice

TABLE OF CONTENTS

LIST OF TABLES

1 OVERVIEW

The DW1000 Datasheet lists a number of power profiles showing use configurations and associated power consumption. These are numbered 1 to 16 and are reproduced in Table 1 below for clarity.

The purpose of this Application Note is to show how to configure the DW1000 to switch between these modes. It is assumed that the user is familiar with default configurations recommendations as given in the DW1000 User Manual [2], these details are not given in this document.

Table 1: Datasheet Operational Mode Descriptions

Mode	Data Rate	PRF (MHz)	Preamble (Symbols)	Data Length (Bytes)	Packet Duration (µs)	Typical Use Case (Refer to DW1000 user manual for further information)
Mode 1	110 kbps	16	1024	12	2084	RTLS, TDOA Scheme, Long Range, Low Density
Mode 2	6.8 Mbps	16	128	12	152	RTLS, TDOA Scheme, Short Range, High Density
Mode 3	110 kbps	16	1024	30	3487	RTLS, 2-way ranging scheme, Long Range, Low Density
Mode 4	6.8 Mbps	16	128	30	173	RTLS, 2-way ranging scheme, Short Range, High Density
Mode 5	6.8 Mbps	16	1024	1023	1339	Data transfer, Short Range, Long Payload
Mode 6	6.8 Mbps	16	128	127	287	Data transfer, Short Range, Short Payload
Mode 7	110 kbps	16	1024	1023	78099	Data transfer, Long Range, Long Payload
Mode 8	110 kbps	16	128	127	10730	Data transfer, Long Range, Short Payload
Mode 9	110 kbps	64	1024	12	2084	As Mode 1 using 64 MHz PRF
Mode 10	6.8 Mbps	64	128	12	152	As Mode 2 using 64 MHz PRF
Mode 11	110 kbps	64	1024	30	3487	As Mode 3 using 64 MHz PRF
Mode 12	6.8 Mbps	64	128	30	173	As Mode 4 using 64 MHz PRF
Mode 13	6.8 Mbps	64	1024	1023	1339	As Mode 5 using 64 MHz PRF
Mode 14	6.8 Mbps	64	128	127	287	As Mode 6 using 64 MHz PRF
Mode 15	110 kbps	64	1024	1023	78099	As Mode 7 using 64 MHz PRF
Mode 16	110 kbps	64	128	127	10730	As Mode 8 using 64 MHz PRF

2 MODES 1-16 CONFIGURATION FOR DW1000 DEVICE

2.1 Modes and DW1000 Profiles

The modes listed in the datasheet; 1-16, may be reduced to data rate, PRF and preamble lengths for the purposes of DW1000 configuration as the API and chip configuration will automatically handle the frame lengths. Note that frame lengths of greater than 127 bytes require a proprietary Decawave PHR encoding and are not standard IEEE802.15.4-2011 UWB frames; this needs to be set through the DW1000 API software depending on device configuration.

These reduced configuration modes are as follows:

Table 2: Reduced Configuration Modes

Modes	Data Rate	PRF	Preamble
1,3,7,8	110 kbps	16 MHz	1024
2,4,5,6	6.8 Mbps	16 MHz	128
9,11,15,16	110 kbps	64 MHz	1024
10,12,13,14	6.8 Mbps	64 MHz	128

2.2 DW1000 API Calls Required for Modes 1-16 Configuration

The DW1000 Device Driver Application Programming Interface (API) User Guide contains detailed information on device API calls which are not reproduced here.

For the purposes of this document, the API calls ***dwt_configure*** and ***dwt_writetxdata*** are required in order to place a pre-configured chip into any of the modes listed in Table 2.

2.2.1 dwt_configure

Please refer to [3].

The ***dwt_config_t*** structure associated with this API call stores the parameters necessary to configure the DW1000 for transmit and receive in

any of the modes 1-16. The relevant parameters and required settings are as follows: -

Table 3: dwt_configure_t struct parameter programming required for Mode 1-16 configuration

Parameters	Mode 1,3,7,8	Mode 2,4,5,6	Mode 9,11,15,16	Mode 10,12,13,14	Description
dataRate	DWT_BR_110K	DWT_BR_6M8	DWT_BR_110K	DWT_BR_6M8	Data rate; 110 kbps, 850kbps, 6.8 Mbps
Prf	DWT_PRF_16M	DWT_PRF_16M	DWT_PRF_64M	DWT_PRF_64M	Pulse Repetition Frequency; may be 16 MHz or 64 MHz
txPreambleLength	DWT_PLEN_1024	DWT_PLEN_128	DWT_PLEN_1024	DWT_PLEN_128	See User Manual for all possible configurations.
nsSFD	TRUE	FALSE	TRUE	FALSE	Use of non-standard SFD codes Boolean.
txCode	1-9	1-9	10-24	10-24	Transmit preamble code. Consult the DW1000 User Manual and the IEEE802.15.4-2011 standard for appropriate settings. Note that codes 1-9 are allowed for 16 MHz PRF, but that the standard restricts use of preamble codes by channel.
rxCode	1-9	1-9	10-24	10-24	Receive preamble code. Consult the DW1000 User Manual and the IEEE802.15.4-2011 standard for appropriate settings. Note that codes 1-9 are allowed for 16 MHz PRF, but that the standard restricts use of preamble codes by channel.
rxPAC	DWT_PAC64	DWT_PAC8	DWT_PAC64	DWT_PAC8	Preamble acquisition chunk size; 8 or 64
phrMode	DWT_PHRMODE_STD or DWT_PHRMODE_EXT	DWT_PHRMODE_STD or DWT_PHRMODE_EXT	DWT_PHRMODE_STD or DWT_PHRMODE_EXT	DWT_PHRMODE_STD or DWT_PHRMODE_EXT	DWT_PHRMODE_STD will denote standard PHR frames and DWT_PHRMODE_EXT will be required for systems using proprietary Decawave long frame PHR encoding.

2.2.2 dwt_writetxdata

Please refer to [3].

This function sets the frame length and programs the transmit buffer.

The relevant parameters and required settings are as follows: -

Table 4: dwt_writetxdata function parameter programming required for Mode 1-16 configuration

Parameters	All Modes	Description
txFrameLength	0x0C, 0x01E, 0x07F, 0x3FF	Set to the number of frame bytes including 2-byte CRC.
***txFrameBytes**	Transmit data	Pointer to the TX frame buffer
txBufferOffset	TX buffer offset	This specifies an offset in the DW1000's TX Buffer at which to start writing data.

3 REGISTER MAP REFERENCE

Register configurations for switching between modes 1-16 are given below for reference: -

Table 5: Register settings for each mode

Addr	Register Name	Sub Register	Field	Mode 1,3,7,8 Value	Mode 2,4,5,6 Value	Mode 9,11,15,16 Value	Mode 10,12,13,14 Value	Description
0x04	SYS_CFG		PHR_MODE	0x0 0x3 if frame length >127	0x0 0x3 if frame length >127	0x0 0x3 if frame length >127	0x0 0x3 if frame length >127	Required for extended frame length format
0x04	SYS_CFG		RXM110K	1	0	1	0	Set 110kbps mode
0x04	SYS_CFG		DIS_STXP	1	1	1	1	Disable smart power gating
0x08	TX_FCTRL		TFLEN	0x0C, 0x1E, 0x7F	0x0C, 0x1E, 0x7F	0x0C, 0x1E, 0x7F	0x0C, 0x1E, 0x7F	Frame Length (7 LSBs)
0x08	TX_FCTRL		TFLE	0x0, 0x7	0x0, 0x7	0x0, 0x7	0x0, 0x7	Extended frame length (3 MSBs), required for long frames
0x08	TX_FCTRL		TXBR	0x0	0x2	0x0	0x2	Tx bit rate
0x08	TX_FCTRL		TXPRF	0x1	0x1	0x2	0x2	Tx PRF
0x08	TX_FCTRL		TXPSR	0x2	0x1	0x2	0x1	Tx preamble symbol repetitions
0x08	TX_FCTRL		PE	0x0	0x1	0x0	0x1	Extended preamble length codes
0x09	TX_BUFFER			TX Data	TX Data	TX Data	TX Data	Tx data for transmit
0x1E	TX_POWER			0x75757575	0x75757575	0x67676767	0x67676767	Typical transmit power settings. The value given here is typical only, the actual programmed value will depend on device calibration. Please see the DW1000 datasheet and API document for further information.
0x1F	CHAN_CTRL		DWSFD	0x1	0x0	0x1	0x0	Decawave proprietary SFD. Use for 110 kbps and 850 kbps generally.
0x1F	CHAN_CTRL		TNSSFD	0x1	0x0	0x1	0x0	Transmit non-standard SFD

Addr	Register Name	Sub Register	Field	Mode 1,3,7,8 Value	Mode 2,4,5,6 Value	Mode 9,11,15,16 Value	Mode 10,12,13,14 Value	Description
0x1F	CHAN_CTRL		RNSSFD	0x1	0x0	0x1	0x0	Receive non-standard SFD
0x1F	CHAN_CTRL		TX_PCODE	0x01-0x09	0x01-0x09	0x0A-0x18	0x0A-0x18	Transmit preamble code. Consult the DW1000 User Manual and the IEEE802.15.4-2011 standard for appropriate settings. Note that codes 1-9 are allowed for 16 MHz PRF, but that the standard restricts use of preamble codes by channel.
0x1F	CHAN_CTRL		RX_PCODE	0x01-0x09	0x01-0x09	0x0A-0x18	0x0A-0x18	Receive preamble code. Consult the DW1000 User Manual and the IEEE802.15.4-2011 standard for appropriate settings. Note that codes 1-9 are allowed for 16 MHz PRF, but that the standard restricts use of preamble codes by channel.
0x23	AGC_CTRL	AGC_TUNE1	AGC_TUNE1	0x8870	0x8870	0x889B	0x889B	AGC tuning register 1
0x27	DRX_CONF	DRX_TUNE0b	DRX_DTUNE0b	0x16	0x01	0x16	0x01	Digital tuning register 0b
0x27	DRX_CONF	DRX_TUNE2	DRX_DTUNE2	0x371A011D	0x311A002D	0x373B0296	0x313B006B	Digital tuning register 2.
0x27	DRX_CONF	DRX_TUNE1a	DRX_TUNE1a	0x0087	0x0087	0x008D	0x008D	Digital tuning register 1a.
0x27	DRX_CONF	DRX_TUNE1b	DRX_TUNE1b	0x0064	0x0020	0x0064	0x0020	Digital tuning register 1b.

4 EXAMPLE CODE TO SET MODE 1

This section shows how to use the API function provided in Decawave's DW1000 driver software to configure the device for Mode 1 as described in Table 1.

In this mode the device is configured for 110 kbps rate, 16 MHz PRF and 1024 preamble length; in the example code the channel used is 2. An example use case is an RTLS TDoA Tag, with a 1 second blink rate.

```
int tdoa_tag_blink_test(void)
{
	//12 octets for Minimum IEEE ID blink
	typedef struct
	{
	    uint8 frameCtrl;             //  frame control bytes 00
	    uint8 seqNum;                //  sequence_number 01
	    uint8 tagID[ADDR_BYTE_SIZE]; //  02-09 64 bit addresses
	    uint8 fcs[2] ;               //  10-11  we allow space for the CRC as
	it is logically part of the message. However DW1000 TX calculates and adds
	these bytes.
	} iso_IEEE_EUI64_blink_msg ;

	iso_IEEE_EUI64_blink_msg msg ;

	dwt_config_t    configData ; //channel configuration data structure
	dwt_txconfig_t  configTx ; //tx spectrum configuration data structure
	uint8 pow;
	uint32 power;
	//before the device is reset the SPI frequency should be <=3 MHz
	//reset device
	dwt_softreset();

	//Firstly initialize the device and load the calibration data
	dwt_initialise(DWT_LOADTXCONFIG | DWT_LOADXTALTRIM) ;

	//configure channel parameters
	configData.chan = 2 ;
	configData.rxCode =  9 ;
	configData.txCode = 9 ;
	configData.prf = DWT_PRF_16M ;
	configData.dataRate = DWT_BR_110K ;
	configData.txPreambLength = DWT_PLEN_1024 ;
	configData.rxPAC = DWT_PAC8 ; // - this is not relevant for a TDoA Tag
	configData.nsSFD = 1 ;
	configData.smartPowerEn = 0; //not using smart power

	dwt_configure(&configData, DWT_LOADANTDLY | DWT_LOADXTALTRIM) ;

	configTx.PGdly = 0xc2; //PG delay value for Ch2

	//read the Tx power from the device
	power = dwt_readnvmtxpower(configData.prf - DWT_PRF_16M, configData.chan);
	//as not using smart power – only use the low byte
	pow = power & 0xFF ;

	configTX.power = (pow | (pow << 8) | (pow << 16) | (pow << 24));
	dwt_setsmarttxpower(0);
```

```
        //configure TX spectrum paramters
        dwt_configuretxrf(&configTx);

        //blink frames with IEEE EUI-64 tag ID
         nst->msg.frameCtrl = 0xC5 ;
         inst->msg.seqNum = inst->frame_sn++;

         dwt_writetxdata(12, (uint8 *)  (&msg), 0) ;   // write the frame data
         dwt_writetxfctrl(length, 0);
        //to start the first frame - set TXSTRT
        dwt_starttx(DWT_START_TX_IMMEDIATE);

        return DWT_SUCCESS ;
}
```

5 REFERENCES

5.1 Listing

Reference is made to the following documents in the course of this Application Note: -

Table 6: Table of References

Ref	Author	Version	Title
[1]	Decawave	Current	DW1000 Data Sheet
[2]	Decawave	Current	DW1000 User Manual
[3]	Decawave	Current	DW1000 Device Driver Application Programming Interface (API) User Guide.

6 DOCUMENT HISTORY

Table 7: Document History

Revision	Date	Description
1.0	31st March 2015	Initial release
1.1	31st December 2015	Scheduled update
1.2	1 August 2018	Logo Update

7 MAJOR CHANGES

Revision 1.0

Page	Change Description
All	Initial release

Revision 1.1

Page	Change Description
Front page	Update of version number to 1.1
All	Various typographical changes
All	Update of copyright date to 2015
7, 8	Update to column headings in Table 5

Revision 1.2

Page	Change Description
Front page	Update of version number to 1.2
All	Logo Update

8 FURTHER INFORMATION

Decawave develops semiconductors solutions, software, modules, reference designs - that enable real-time, ultra-accurate, ultra-reliable local area micro-location services. Decawave's technology enables an entirely new class of easy to implement, highly secure, intelligent location functionality and services for IoT and smart consumer products and applications.

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