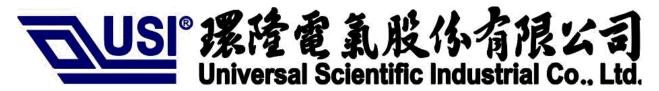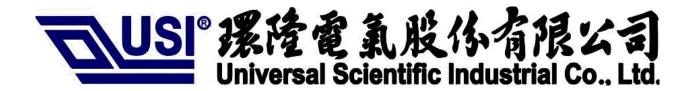# WM-SG-SM-42 Application Note
For Region US915

Version: 1.1

Contents

1. The US915 configuration in device

1. Preamble Format

Modulation	Sync word	Preamble Length
LORA	0x34	8 symbols
GFSK	0xC194C1	5 bytes

2. Default Channels

Uplink with 125KHz Band Width:
64 channels numbered 0 to 63 utilizing LoRa 125 kHz BW varying from DR0 to DR3, using coding rate 4/5, starting at 902.3 MHz and incrementing linearly by 200 kHz to 914.9 MHz

Uplink with 500KHz Band Width:
8 channels numbered 64 to 71 utilizing LoRa 500 kHz BW at DR4 starting at 903.0 MHz and incrementing linearly by 1.6 MHz to 914.2 MHz.

Downlink with 500KHz Band Width:
8 channels numbered 0 to 7 utilizing LoRa 500 kHz BW at DR8 to DR13, starting at 923.3 MHz and incrementing linearly by 600 kHz to 927.5 MHz

3. Data Rate and Output Power Encoding

Data Rate	Configuration	Bit Rate
DR0	LoRa: SF10 / 125KHz	980
DR1	LoRa: SF9 / 125KHz	1760
DR2	LoRa: SF8 / 125KHz	3125
DR3	LoRa: SF7 / 125KHz	5470
DR4	LoRa: SF8 / 500KHz	12500
DR5..DR7	RFU	

DR8	Lora: SF12 / 500KHz	980
DR9	Lora: SF11 / 500KHz	1760
DR10	Lora: SF10 / 500KHz	3900
DR11	Lora: SF9 / 500KHz	7000
DR12	Lora: SF8 / 500KHz	12500
DR13	Lora: SF7 / 500KHz	21900
DR14..DR15	RFU	

4. Power Table

TxPower	Configuration
0	30 dBm
1	28 dBm
2	26 dBm
3	24 dBm
4	22 dBm
5	20 dBm
6	18 dBm
7	16 dBm
8	14 dBm
9	12 dBm
10	10 dBm
11 ~ 15	RFU

5. LinkAdrReq Command

The US915 United-State LoRaWAN only supports a maximum of 16 channels. When ChMaskCntl field is 0 the chMask field individually enables/disables each of the 16 channels.

ChMaxCntl	ChMask applies to
0	Channels 0 to 15
1	Channels 16 to 31
2	Channels 32 to 47
3	Channels 48 to 63

4	Channels 64 to 71
5	RFU
6	All 125KHz ON ChMask applies to channels 64 to 71
7	All 125KHz OFF ChMask applies to channels 64 to 71

6. Maximum Payload size

The maximum MACPayload size length (M) is given by the following table. It is derived from limitation of the PHY layer depending on the effective modulation rate used taking into account a possible repeater encapsulation layer. The maximum application payload length in the absence of the optional FOpt control field (N) is also given for information only. The value of N might be smaller if the FOpt field is not empty:

Data Rate	M	N
DR0	19	11
DR1	61	53
DR2	133	125
DR3	250	242
DR4	250	242
DR5..DR7	Not defined	
DR8	41	33
DR9	117	109
DR10	230	222
DR11	230	222
DR12	230	222
DR13	230	222
DR14..DR15	Not defined	

If the end-device will never operate with a repeater then the maximum application payload length in the absence of the optional FOpt control field should be:

Data Rate	M	N
DR0	19	11
DR1	61	53
DR2	133	125
DR3	250	242

DR4	250	242
DR5..DR7	Not defined	
DR8	61	53
DR9	137	129
DR10	250	242
DR11	250	242
DR12	250	242
DR13	250	242
DR14..DR15	Not defined	

7. Receive Window

    The RX1 receive channel can be determined as follows:

        RX1 Channel Number = Transmit Channel Number

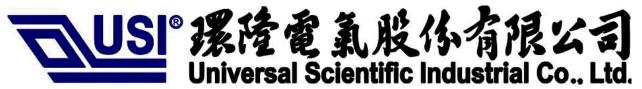   The RX1 window data rate depends on the transmit data rate as following table:

RX1DROffset (Code value)	0	1	2	3
DR0	DR10	DR9	DR8	DR8
DR1	DR11	DR10	DR9	DR9
DR2	DR12	DR11	DR10	DR10
DR3	DR13	DR12	DR11	DR11
DR4	DR13	DR13	DR12	DR12

    The RX2 receive window uses a fixed frequency and data rate. The default parameters are: **923.3 MHz / DR8 (SF12/500KHz).**

8. Default Setting
    The following parameters are default values in device for the AS923-Thailand band.

ITEM	Value
RECEIVE_DELAY1	1s
RECEIVE_DELAY2	2s
JOIN_ACCEPT_DELAY1	5s
JOIN_ACCEPT_DELAY2	6s

2. AT Command Example for US915

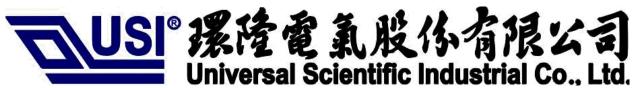1) Configuration command sequence for US915

```
# AT+WDCT=0              /*  factory reset */
# ATZ                    /* reset module */
# AT+DC=0                /* disable duty cycle (optinal) */
# AT+ADDR=<dev_addr>     /* set lora device address */
# AT+APPEUI=<app_eui>    /* set application eui */
# AT+NSK=<nsk>           /* set NSK (for ABP) */
# AT+ASK=<ask>           /* set ASK (for ABP) */
# AT+AK=<ak>             /* set AK (for OTAA) */
# AT+WDCT                /* save changes to eeprom */
# ATZ                    /* reset module */
# AT+BAND=1              /* switch to Japan BAND */
# AT+WDCT                /* save changes to eeprom */
# ATZ                    /* reset module */
# AT+DR=0                /* (or AT+DR=2) set TX/RX1 data rate depends on the working DR shown
                              on the application data traffic on TTN */
# AT+RX2DR=8             /* change RX2 data rate to DR0 */
# AT+WDCT                /* save changes to eeprom */
# ATZ                    /* reset module */
```

2) Disable unused channel for TTN frequency plan

```
/* remove all channels except for downlink ch9..15 and all uplink channels.*/
# AT+CHMSK=00fe000000000000ff
# AT+WDCT
# ATZ
```

3) Join command sequence for OTAA

```
# AT+JOIN=1       /* join GW with OTAA protocol */
+JoinAccepted     /* wait until this event happended */
# AT+SEND=7 00000000000000fa0000000000000005 0   /* send 1st packet to gateway */
                                          /*  7: port number,  last 0: no ask needed  */
                                          /* 00000000000000fa0000000000000005 : payload */
# AT+SEND=7 00000000000000fa0000000000000005 0   /* send 2nd packet to gateway */
```

/* 7: port number, last 0: no ask needed */
/* 00000000000000fa0000000000000005 : payload */

4) Join command sequence for ABP

\# AT+JOIN=0   /* join GW with ABP protocol */
\# AT+SEND=7 00000000000000fa0 000000000000005 0   /* send 1st packet to gateway */
/* 7: port number, last 0: no ask needed */
/* 00000000000000fa0000000000000005 : payload */
\# AT+SEND=7 00000000000000fa0 000000000000005 0   /* send 2nd packet to gateway */
/* 7: port number, last 0: no ask needed */
/* 00000000000000fa0000000000000005 : payload */