增加通讯距离 修改输出功率方法

- 如果开发板是带功放的核心板，启动功放修改输出功率方法如下：

加功放时需要在文件 hal_board_cfg.h 中修改下面的宏，去掉 x HAL_PA_LNA 前面的 x 即可打开功放，默认时没有启用功放的，下面是讲解功放功作原理。

```
#define HAL_PA_LNA              //去掉 x HAL_PA_LNA 前面的 x
```

- 2.5.1a 不带功放修改输出功率增加通讯距离方法如下：

要改变输出功率在文件 mac_pib.c 中，根据加的功放改变下面红色的字就行了，

```
/* PIB default values */
static CODE const macPib_t macPibDefaults =
{
    ..............
  /* Proprietary */
#if defined (HAL_PA_LNA)
  19,                                   /* phyTransmitPower for CC2591 */
#elif defined (HAL_PA_LNA_CC2590)
  11,                                   /* phyTransmitPower for CC2590 */
#else
  3,                                    /* phyTransmitPower without frontend */
#endif
    ..............
};
```

如果是旧版本请按照以前手册上的方法修改哦

先分析一下 cc2591 在 zstack 中的设置，RFX2401C 控制也是差不多的

一、cc2591 在 zstack 中的设置

CC2530 和 CC2591 的连接图，最好按照下面的连接，这是 zstack 的默认连接端口，这样修改的代码最少，如果你完全弄明白了 PA,EN 的意思，你可以修改到其他端口。

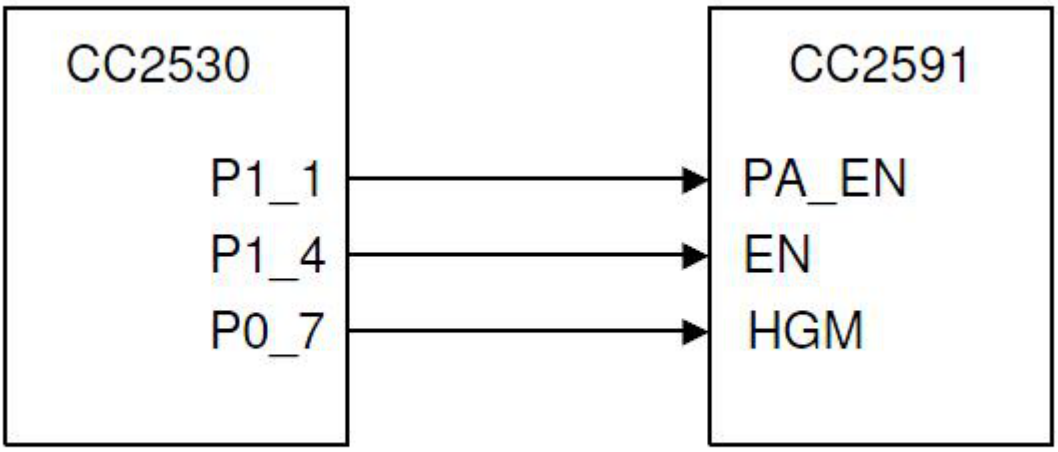


Figure 1. CC2530-CC2591 Interconnect

PAEN	EN	RXTX	HGM	Mode of Operation
0	0	NC	X	Power Down
0	1	NC	0	RX LGM
0	1	NC	1	RX HGM
1	0	NC	X	TX
1	1	NC	X	Not allowed

Table 8.1 Control Logic for Connecting the CC2591 to a CC2530 Device

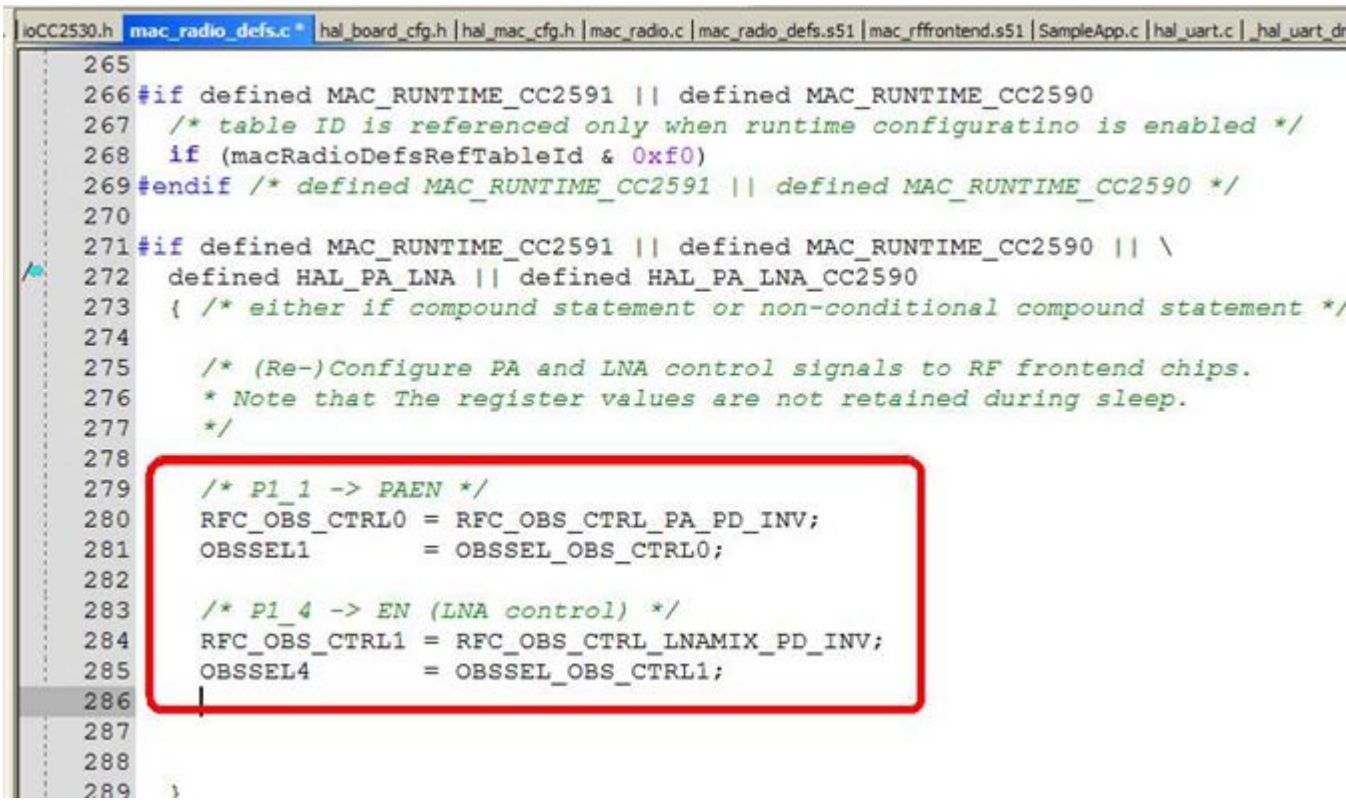
1.开启 PA 的宏定义，将 HAL_PA_LNA 前面小写的 x 删除，如下图。

```
60 #include "hal_defs.h"
61 #include "hal_types.h"
62
63 /* ------------------------------------------------------------------------------------------------
64  *                                          CC2590/CC2591 support
65  *
66  *                           Define HAL_PA_LNA_CC2590 if CC2530+CC2590EM is used
67  *                           Define HAL_PA_LNA if CC2530+CC2591EM is used
68  *                           Note that only one of them can be defined
69  * ------------------------------------------------------------------------------------------------
70  */
71 #define HAL_PA_LNA
72 #define XHAL_PA_LNA_CC2590
73
74
75 /* ------------------------------------------------------------------------------------------------
76  *                                          Board Indentifier
77  *
78  *      Define the Board Identifier to HAL_BOARD_CC2530EB_REV13 for SmartRF05 EB 1.3 boa
79  * ------------------------------------------------------------------------------------------------
80  */
81
82 #if !defined (HAL_BOARD_CC2530EB_REV17) && !defined (HAL_BOARD_CC2530EB_REV13)
83   #define HAL_BOARD_CC2530EB_REV13
```

看看各个端口的配置，P0.7

```
288
289 #define MAC_RADIO_SRC_MATCH_INIT_EXTPENDEN()          st( SRCEXTPENDEN0 = 0;
290                                                           SRCEXTPENDEN1 = 0;
291                                                           SRCEXTPENDEN2 = 0;
292 #define MAC_RADIO_SRC_MATCH_INIT_SHORTPENDEN()        st( SRCSHORTPENDEN0 = 0
293                                                           SRCSHORTPENDEN1 = 0
294                                                           SRCSHORTPENDEN2 = 0
295
296 #define MAC_RADIO_SRC_MATCH_TABLE_WRITE(offset, p, len)    macMemWriteRam( (ma
297 #define MAC_RADIO_SRC_MATCH_TABLE_READ(offset, p, len)     macMemReadRam( SRC_
298
299
300 /* ----------- PA/LNA control ---------- */
301 #define HAL_PA_LNA_RX_HGM()                           st( P0_7 = 1; )
302 #define HAL_PA_LNA_RX_LGM()                           st( P0_7 = 0; )
303
304
305 /* ------------------------------------------------------------------------------------------------
306  *                                          Common Radio Externs
307  * ------------------------------------------------------------------------------------------------
```

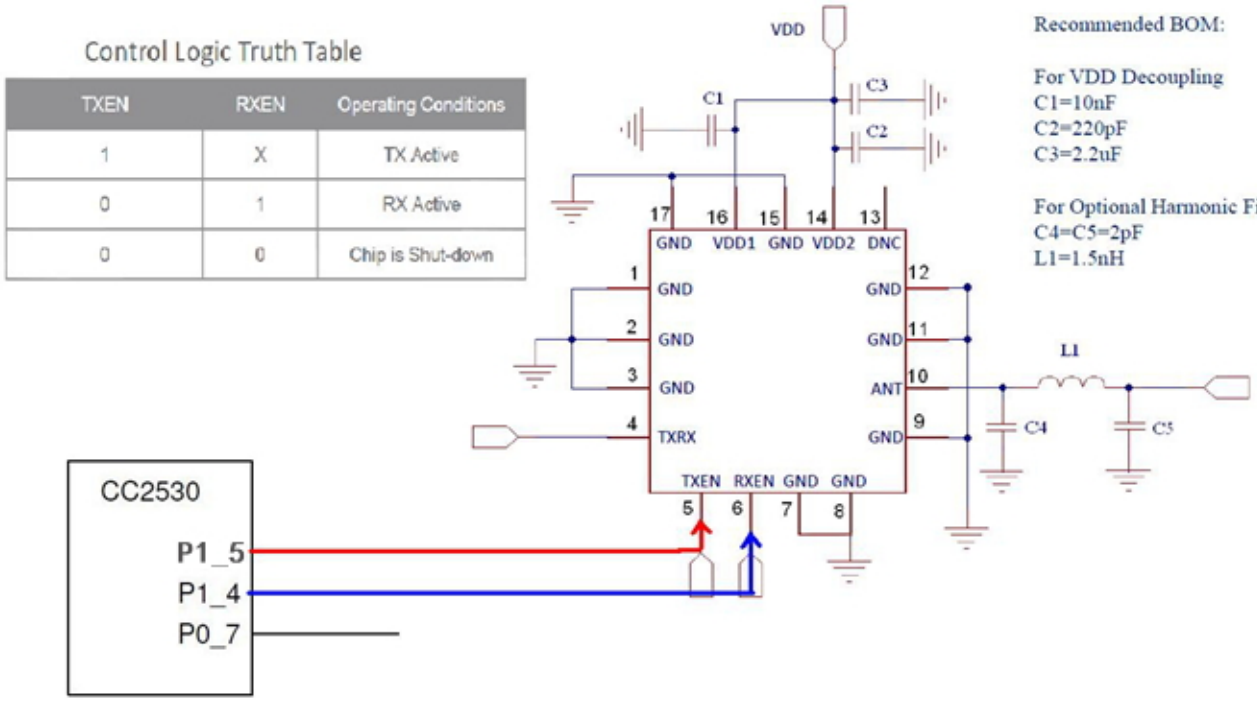
P1.1 P1.4 配置



到这里 CC2591 的配置，就完成了，如果你其他方面没有问题，CC2591 就可以正常工作了，主要是 zstack 已经将我们把工作做好了。

二．RFX2401C 在 zstack 中的设置

先　　看　　原　　理　　图　　连　　接



RFX2401C 只需要 2 个控制 IO 就可以了，这里使用 P1.4 和 P1.5，控制时序参照上图中的逻辑表即可。

从上图可以看出，只要 RXEN 保持高电平，TXEN 决定发送和接收，所以要设置 P1.4=1;控制 P1.5 就行了，P0.7 可以作为自由的 IO 来使用了，如果你的 RFX2401C 不是上面的连接端口，请根据自己板子情况自行设定。

打开 mac_radio_defs.c 找到 288 行 macRadioTurnOnPower 函数，修改红色字体就行。

```
MAC_INTERNAL_API void macRadioTurnOnPower(void)
{
  /* Enable RF error trap */
  MAC_MCU_RFERR_ENABLE_INTERRUPT();

#if defined MAC_RUNTIME_CC2591 || defined MAC_RUNTIME_CC2590
  /* table ID is referenced only when runtime configuratino is enabled
*/
  if (macRadioDefsRefTableId & 0xf0)
```

```
#endif /* defined MAC_RUNTIME_CC2591 || defined MAC_RUNTIME_CC2590 */

#if defined MAC_RUNTIME_CC2591 || defined MAC_RUNTIME_CC2590 || \
  defined HAL_PA_LNA || defined HAL_PA_LNA_CC2590
  { /* either if compound statement or non-conditional compound statement
*/

    /* (Re-)Configure PA and LNA control signals to RF frontend chips.
    * Note that The register values are not retained during sleep.
    */

    /* P1_5 -> PAEN */
    RFC_OBS_CTRL0 = RFC_OBS_CTRL_PA_PD_INV;
    OBSSEL5       = OBSSEL_OBS_CTRL0;       //P1_5 TXEN

    /* P1_4 -> EN (LNA control) */
    //RFC_OBS_CTRL1 = RFC_OBS_CTRL_LNAMIX_PD_INV;
    //OBSSEL4       = OBSSEL_OBS_CTRL1;
    P1SEL &= ~0X10;
     P1DIR |= 0X10;
     P1_4 = 1;          //P1_4 RXEN   andy pa

    /* For any RX, change CCA settings for CC2591 compression workaround.
     * This will override LNA control if CC2591_COMPRESSION_WORKAROUND
     * flag is defined.
     */
    COMPRESSION_WORKAROUND_ON();
  }
#endif /* defined MAC_RUNTIME_CC2591 || ... || defined HAL_PA_LNA_CC2590
*/

  if (macChipVersion <= REV_B)
  {
    /* radio initializations for disappearing RAM; PG1.0 and before only
*/
    MAC_RADIO_SET_PAN_ID(macPib.panId);
    MAC_RADIO_SET_SHORT_ADDR(macPib.shortAddress);
    MAC_RADIO_SET_IEEE_ADDR(macPib.extendedAddress.addr.extAddr);
  }

  /* Turn on frame filtering */
  MAC_RADIO_TURN_ON_RX_FRAME_FILTERING();
}
```

三．增加通讯距离 修改输出功率方法

加功放时需要在文件 hal_board_cfg.h 中定义下面的宏，两者只能一个有效

```
#define HAL_PA_LNA              // 去掉 x HAL_PA_LNA 前面的 x
#define xHAL_PA_LNA_CC2590 //功放为 0xCC2590
```

要改变输出功率在文件 mac_pib.c 中，根据加的功放改变下面红色的字就行了，

```
/* PIB default values */
static CODE const macPib_t macPibDefaults =
{
  54,                                   /* ackWaitDuration */
  FALSE,                                 /* associationPermit */
  TRUE,                                  /* autoRequest */
  FALSE,                                 /* battLifeExt */
  6,                                    /* battLifeExtPeriods */

  NULL,                                  /* *pMacBeaconPayload */
  0,                                    /* beaconPayloadLength */
  MAC_BO_NON_BEACON,                          /* beaconOrder */
  0,                                    /* beaconTxTime */
  0,                                    /* bsn */

  {0, SADDR_MODE_EXT},                       /* coordExtendedAddress */
  MAC_SHORT_ADDR_NONE,                        /* coordShortAddress */
  0,                                    /* dsn */
  FALSE,                                 /* gtsPermit */
  4,                                    /* maxCsmaBackoffs */

  3,                                    /* minBe */
  0xFFFF,                               /* panId */
  FALSE,                                 /* promiscuousMode */
  FALSE,                                 /* rxOnWhenIdle */
  MAC_SHORT_ADDR_NONE,                        /* shortAddress */

  MAC_SO_NONE,                           /* superframeOrder */
  0x01F4,                               /* transactionPersistenceTime */
  FALSE,                                 /* assocciatedPanCoord */
  5,                                    /* maxBe */
  1220,                                 /* maxFrameTotalWaitTime */

  3,                                    /* maxFrameRetries */
  32,                                   /* ResponseWaitTime */
  0,                                    /* syncSymbolOffset */
  TRUE,                                  /* timeStampSupported */
```

```
  FALSE,                                    /* securityEnabled */

  /* Proprietary */
#if defined (HAL_PA_LNA)
  19,                                       /* phyTransmitPower for CC2591 */
#elif defined (HAL_PA_LNA_CC2590)
  11,                                       /* phyTransmitPower for CC2590 */
#else
  3,                                        /* phyTransmitPower without frontend */
#endif
  MAC_CHAN_11,                                 /* logicalChannel */
  {0, SADDR_MODE_EXT},                         /* extendedAddress */
  1,                                        /* altBe */
  MAC_BO_NON_BEACON,                           /* deviceBeaconOrder */
};
```

19 就对应下面的 19dbm，要不同的功率按下面的值修改即可；

```
/*****************************cc2591*************************************/
#if defined HAL_PA_LNA || defined MAC_RUNTIME_CC2591
const uint8 CODE macRadioDefsTxPwrCC2591[] =
{
  20,   /* tramsmit power level of the first entry */
  (uint8)(int8)10, /* transmit power level of the last entry */
  /*   20 dBm */     0xE5,     /* characterized as 20 dBm in datasheet */
  /*   19 dBm */     0xD5,     /* characterized as 19 dBm in datasheet */
  /*   18 dBm */     0xC5,     /* characterized as 18 dBm in datasheet */
  /*   17 dBm */     0xB5,     /* characterized as 17 dBm in datasheet */
  /*   16 dBm */     0xA5,     /* characterized as 16 dBm in datasheet */
  /*   15 dBm */     0xA5,
  /*   14 dBm */     0x95,     /* characterized as 14.5 dBm in datasheet */
  /*   13 dBm */     0x85,     /* characterized as 13 dBm in datasheet */
  /*   12 dBm */     0x85,
  /*   11 dBm */     0x75,     /* characterized as 11.5 dBm in datasheet */
  /*   10 dBm */     0x65      /* characterized as 10 dBm in datasheet */
};
#endif

/*****************************cc2590*************************************/
/* Placeholder for CC2590 */
#if defined HAL_PA_LNA_CC2590 || defined MAC_RUNTIME_CC2590
const uint8 CODE macRadioDefsTxPwrCC2590[] =
{
  11,   /* tramsmit power level of the first entry */
  (uint8)(int8)-12, /* transmit power level of the last entry */
```

```
  /* Note that the characterization is preliminary */
  /* 11 dBm */    0xF5,    /* characterized as 11.8 dBm */
  /* 10 dBm */    0xE5,    /* characterized as 10.6 dBm */
  /*  9 dBm */    0xD5,    /* characterized as 9.5 dBm */
  /*  8 dBm */    0xC5,    /* characterized as 8.5 dBm */
  /*  7 dBm */    0xB5,    /* characterized as 7.6 dBm */
  /*  6 dBm */    0xA5,    /* characterized as 6.4 dBm */
  /*  5 dBm */    0xA5,    /* characterized as 6.4 dBm */
  /*  4 dBm */    0x95,    /* characterized as 4.7 dBm */
  /*  3 dBm */    0x85,    /* characterized as 3.5 dBm */
  /*  2 dBm */    0x75,    /* characterized as 2.0 dBm */
  /*  1 dBm */    0x75,    /* characterized as 2.0 dBm */
  /*  0 dBm */    0x65,    /* characterized as 0.3 dBm */
  /* -1 dBm */    0x65,    /* characterized as 0.3 dBm */
  /* -2 dBm */    0x55,    /* characterized as -1.7 dBm */
  /* -3 dBm */    0x55,    /* characterized as -1.7 dBm */
  /* -4 dBm */    0x45,    /* characterized as -3.9 dBm */
  /* -5 dBm */    0x45,    /* characterized as -3.9 dBm */
  /* -6 dBm */    0x45,    /* characterized as -3.9 dBm */
  /* -7 dBm */    0x35,    /* characterized as -6.3 dBm*/
  /* -8 dBm */    0x25,    /* characterized as -7.8 dBm */
  /* -9 dBm */    0x25,    /* characterized as -7.8 dBm */
  /* -10 dBm */   0x15,    /* characterized as -9.8 dBm */
  /* -11 dBm */   0x15,    /* characterized as -9.8 dBm */
  /* -12 dBm */   0x05,    /* characterized as -11.8 dBm */
};
#endif

/*************************没加功放*************************************/
#if defined MAC_RUNTIME_CC2591 || defined MAC_RUNTIME_CC2590 || \
  (!defined HAL_PA_LNA && !defined HAL_PA_LNA_CC2590)

#ifdef HAL_MCU_CC2533
const uint8 CODE macRadioDefsTxPwrBare[] =
{
  4,   /* tramsmit power level of the first entry */
  (uint8)(int8)-21, /* transmit power level of the last entry */
  /*   4 dBm */    0xEC,    /* characterized as   4.5 dBm in datasheet */
  /*   3 dBm */    0xDC,    /* characterized as   3     dBm in datasheet */
  /*   2 dBm */    0xDC,
  /*   1 dBm */    0xCC,    /* characterized as   1.7 dBm in datasheet */
  /*   0 dBm */    0xBC,    /* characterized as   0.3 dBm in datasheet */
  /*  -1 dBm */    0xAC,    /* characterized as -1     dBm in datasheet */
  /*  -2 dBm */    0xAC,
```

```
  /*   -3 dBm */     0x9C,     /* characterized as -2.8 dBm in datasheet */
  /*   -4 dBm */     0x9C,
  /*   -5 dBm */     0x8C,     /* characterized as -4.1 dBm in datasheet */
  /*   -6 dBm */     0x7C,     /* characterized as -5.9 dBm in datasheet */
  /*   -7 dBm */     0x7C,
  /*   -8 dBm */     0x6C,     /* characterized as -7.7 dBm in datasheet */
  /*   -9 dBm */     0x6C,
  /* -10 dBm */      0x5C,     /* characterized as -9.9 dBm in datasheet */
  /* -11 dBm */      0x5C,
  /* -12 dBm */      0x5C,     /* characterized as -9.9 dBm in datasheet */
  /* -13 dBm */      0x4C,     /* characterized as -12.8 dBm in datasheet */
  /* -14 dBm */      0x4C,
  /* -15 dBm */      0x3C,     /* characterized as -14.9 dBm in datasheet */
  /* -16 dBm */      0x3C,
  /* -17 dBm */      0x2C,     /* characterized as -16.6 dBm in datasheet */
  /* -18 dBm */      0x2C,
  /* -19 dBm */      0x1C,     /* characterized as -18.7 dBm in datasheet */
  /* -20 dBm */      0x1C,     /* characterized as -18.7 dBm in datasheet */
  /* -21 dBm */      0x0C
};
#else /* HAL_MCU_CC2533 */
const uint8 CODE macRadioDefsTxPwrBare[] =
{
  3,   /* tramsmit power level of the first entry */
  (uint8)(int8)-22, /* transmit power level of the last entry */
  /*    3 dBm */     0xF5,     /* characterized as    4.5 dBm in datasheet */
  /*    2 dBm */     0xE5,     /* characterized as    2.5 dBm in datasheet */
  /*    1 dBm */     0xD5,     /* characterized as    1     dBm in datasheet */
  /*    0 dBm */     0xD5,     /* characterized as    1     dBm in datasheet */
  /*   -1 dBm */     0xC5,     /* characterized as -0.5 dBm in datasheet */
  /*   -2 dBm */     0xB5,     /* characterized as -1.5 dBm in datasheet */
  /*   -3 dBm */     0xA5,     /* characterized as -3     dBm in datasheet */
  /*   -4 dBm */     0x95,     /* characterized as -4     dBm in datasheet */
  /*   -5 dBm */     0x95,
  /*   -6 dBm */     0x85,     /* characterized as -6     dBm in datasheet */
  /*   -7 dBm */     0x85,
  /*   -8 dBm */     0x75,     /* characterized as -8     dBm in datasheet */
  /*   -9 dBm */     0x75,
  /* -10 dBm */      0x65,     /* characterized as -10    dBm in datasheet */
  /* -11 dBm */      0x65,
  /* -12 dBm */      0x55,     /* characterized as -12    dBm in datasheet */
  /* -13 dBm */      0x55,
  /* -14 dBm */      0x45,     /* characterized as -14    dBm in datasheet */
  /* -15 dBm */      0x45,
```

```
  /* -16 dBm */     0x35,     /* characterized as -16    dBm in datasheet */
  /* -17 dBm */     0x35,
  /* -18 dBm */     0x25,     /* characterized as -18    dBm in datasheet */
  /* -19 dBm */     0x25,
  /* -20 dBm */     0x15,     /* characterized as -20    dBm in datasheet */
  /* -21 dBm */     0x15,
  /* -22 dBm */     0x05       /* characterized as -22    dBm in datasheet */
};
#endif /* HAL_MCU_CC2533 */
#endif /* defined MAC_RUNTIME_CC2591 || defined MAC_RUNTIME_CC2590 ||
                (!defined HAL_PA_LNA && !defined HAL_PA_LNA_CC2590) */
```

下面是设置mactxpower，但实际上zstack没定义HAL_MAC_USE_REGISTER_POWER_VALUES，因而只编译蓝色部分；

```
#ifndef HAL_MAC_USE_REGISTER_POWER_VALUES
/* ------------------------------------------ */

MAC_INTERNAL_API void macRadioSetTxPower(uint8 txPower)
{
  halIntState_t  s;
#if defined MAC_RUNTIME_CC2591 || defined MAC_RUNTIME_CC2590
  const uint8 CODE *pTable = macRadioDefsTxPwrTables[macRadioDefsRefTableId >> 4];
#elif defined HAL_PA_LNA || defined HAL_PA_LNA_CC2590
  const uint8 CODE *pTable = macRadioDefsTxPwrTables[0];
#else
  const uint8 CODE *pTable = macRadioDefsTxPwrBare;
#endif

  /* if the selected dBm is out of range, use the closest available */
  if ((int8)txPower > (int8)pTable[MAC_RADIO_DEFS_TBL_TXPWR_FIRST_ENTRY])
  {
    /* greater than base value -- out of table range */
    txPower = pTable[MAC_RADIO_DEFS_TBL_TXPWR_FIRST_ENTRY];
  }
  else if ((int8)txPower < (int8)pTable[MAC_RADIO_DEFS_TBL_TXPWR_LAST_ENTRY])
  {
    /* smaller than the lowest power level -- out of table range */
    txPower = pTable[MAC_RADIO_DEFS_TBL_TXPWR_LAST_ENTRY];
  }

  /*
   *  Set the global variable reqTxPower.  This variable is referenced
```

```
     *    by the function macRadioUpdateTxPower() to write the radio register.
     *
     *    A lookup table is used to translate the power level to the register
     *    value.
     */
    HAL_ENTER_CRITICAL_SECTION(s);
    /* When calculating index to the power register value table,
     * either txPower (of uint8 type) has to be explicitly type-casted to int8
     * or the subtraction expression has to be type-casted to uint8 to work
     * with the integral promotions.
     * The latter is more code size efficient and hence the latter is used.
     */
    {
      uint8 index = pTable[MAC_RADIO_DEFS_TBL_TXPWR_FIRST_ENTRY] - txPower
        + MAC_RADIO_DEFS_TBL_TXPWR_ENTRIES;
      reqTxPower = pTable[index];
    }
    HAL_EXIT_CRITICAL_SECTION(s);

    /* update the radio power setting */
    macRadioUpdateTxPower();
}

#else
/* ------------------------------------------ */

MAC_INTERNAL_API void macRadioSetTxPower(uint8 txPower)
{
    halIntState_t    s;

    /* same as above but with no lookup table, use raw register value */
    HAL_ENTER_CRITICAL_SECTION(s);
    reqTxPower = txPower;
    HAL_EXIT_CRITICAL_SECTION(s);

    /* update the radio power setting */
    macRadioUpdateTxPower();
}

#endif
```

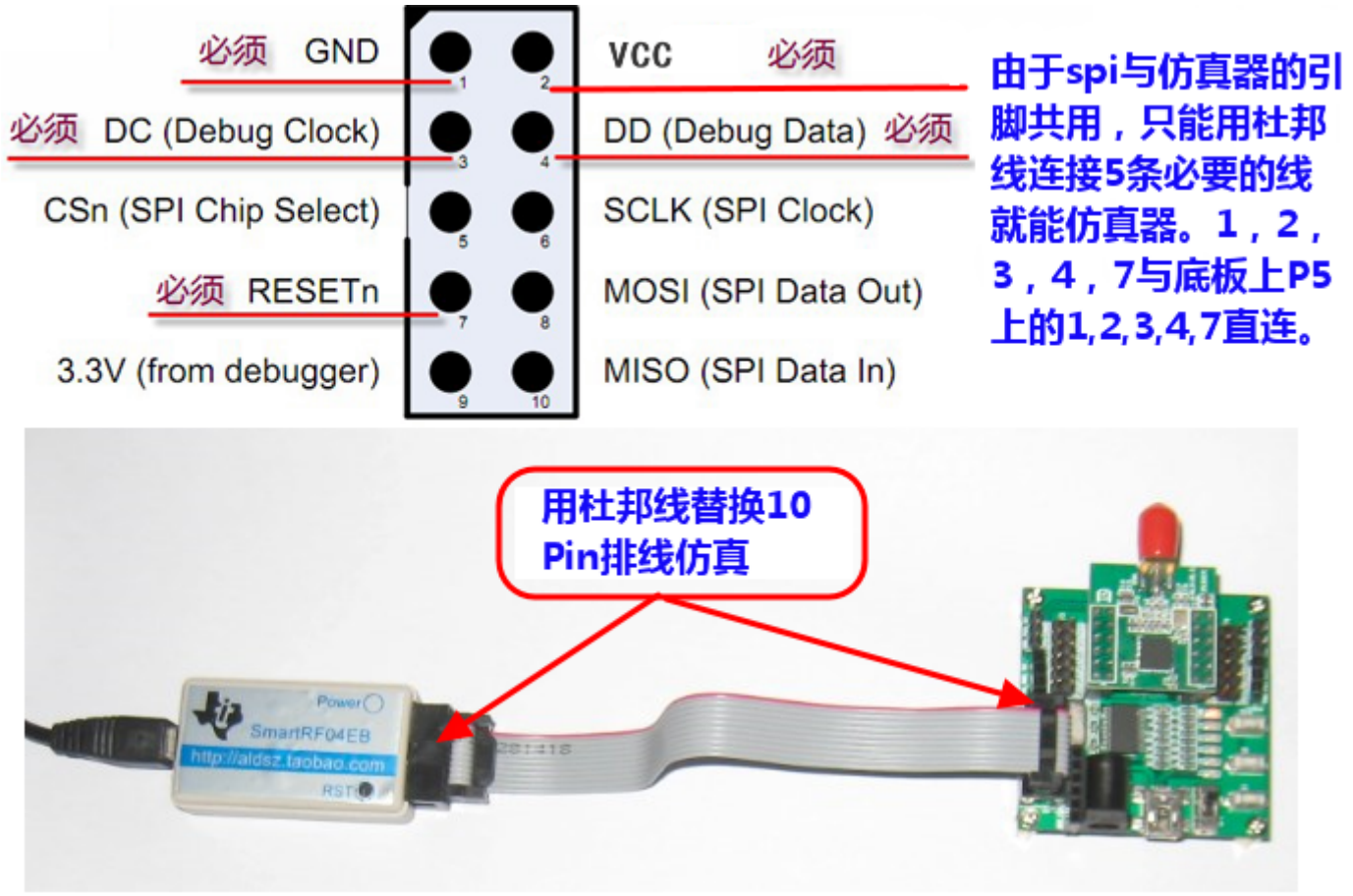
在 mac_pib.c 文件中的 MAC_MlmeSetReq 函数里设置

```
case MAC_PHY_TRANSMIT_POWER_SIGNED:
  /* Set the transmit power */
  macRadioSetTxPower(macPib.phyTransmitPower);
  break;
```

上面这段代码调用函数 macRadioSetTxPower 来设置 txpower；macPib.phyTransmitPower 为 mac 层的 pib 值；就是最开始的红色的 19,11,0 等值；

在函数 macRadioSetTxPower 中通过调用 macRadioUpdateTxPower();函数把值更新到相应的寄存器中；

四.调试程序和运行开发板程序



如果只是下载程序可以直接用 10Pin 线连接都行,如果想打断点跟踪调试连网异常，这时就要用杜邦线连接，因为带功放将 P1.4 和 P1.5 被 SPI 占用了，所以最好用杜邦线连接。如果有多余的 10Pin 线剪开 SPI 的 4 条线也行。不过经测试基本上不影响调试，万一出现异常时知道怎么回事就行。

移植方法：

我们已经将”11.按键无线控制台灯和 LED 灯-2530PA”移植好了，大家可以以此为模板，把其它实验的源文件添加进行进行编译测试。如“EB2530\第 5 章 zigbee 协议栈应用与组网”里面相应的实验目录下的 SampleApp\Source 下面的文件复制到“2530PA\11. 按键无线控制台灯和 LED 灯-2530PA\Projects\zstack\Samples\SampleApp\Source”，有些传感器需要在工程中添加源文件才行哦，更具体的请参考相关实验的文档。

由于不需要 P0_7来控制 PA 的接收增益，所以，在使用 PA 定义后，如果需要使用此 IO 脚。则在

```
#define HAL_BOARD_INIT()                                              \
{                                                                     \
  uint16 i;                                                           \
                                                                      \
  SLEEPCMD &= ~OSC_PD;                      /* turn on 16MHz RC and 32MHz XOSC */             \
  while (!(SLEEPSTA & XOSC_STB));           /* wait for 32MHz XOSC stable */                  \
  asm("NOP");                               /* chip bug workaround */                         \
  for (i=0; i<504; i++) asm("NOP");         /* Require 63us delay for all revs */             \
  CLKCONCMD = (CLKCONCMD_32MHZ | OSC_32KHZ); /* Select 32MHz XOSC and the source for 32K clock */ \
  while (CLKCONSTA != (CLKCONCMD_32MHZ | OSC_32KHZ)); /* Wait for the change to be effective */  \
  SLEEPCMD |= OSC_PD;                       /* turn off 16MHz RC */                           \
                                                                      \
  /* Turn on cache prefetch mode */                                   \
  PREFETCH_ENABLE();                                                  \
                                                                      \
  /* set direction for GPIO outputs  */                               \
  LED1_DDR |= LED1_BV;                                                \
                                                                      \
  /* Set PA/LNA HGM control P0_7 */                                   \
  P0DIR |= BV(7);                                                     \
                                                                      \
  /* configure tristates */                                           \
  P0INP |= PUSH2_BV;                                                  \
                                                                      \
  /* setup RF frontend if necessary */                                \
  HAL_BOARD_RF_FRONTEND_SETUP();                                      \
}
```

删除蓝色的2行内容，并且在

mac_radio_defs.h 文件中

```
#define HAL_PA_LNA_RX_HGM()                         st( P0_7 = 1; )
#define HAL_PA_LNA_RX_LGM()                         st( P0_7 = 0; )
```

部分修改为

```
#define HAL_PA_LNA_RX_HGM()
#define HAL_PA_LNA_RX_LGM()
```

这样，在无线发送和接收的 P0_7　就不会影响到了。