

Adding CAN-FD Tx and Rx to an Existing mmWave Project

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ABSTRACT

This application note describes the steps required to integrate the usage of the CAN-FD interface on the mmWave devices.

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1 Initializing the Driver

The first step is to add code to include and initialize the CANFD driver. This driver is required for transmitting and receiving from the CANFD interface. The following is C code that initializes the CANFD driver. This tested code may be copied into the project.

```
#include <ti/drivers/canfd/canfd.h>
/*****
***** Global Definitions *****/
*****/
volatile uint32_t      gTxDoneFlag = 0, gRxDoneFlag = 0, gParityErrFlag = 0;
volatile uint32_t      gTxPkts = 0, gRxPkts = 0, gErrStatusInt = 0;
volatile uint32_t      iterationCount = 0U;
uint32_t              dataLength = 0U;
uint32_t              msgLstErrCnt = 0U;
uint32_t              gDisplayStats = 0;
uint8_t               rxData[64U];
uint32_t              txDataLength, rxDataLength;
CANFD_MCANFrameType   frameType = CANFD_MCANFrameType_FD;
static void MCANAppInitParams(CANFD_MCANInitParams* mcanCfgParams);
CANFD_Handle           canHandle;
CANFD_MsgObjHandle     txMsgObjHandle;
CANFD_MCANMsgObjCfgParams txMsgObjectParams;

/*****
***** CAN Driver Initialize Function *****/
*****/
void Can_Initialize(void)
{
    int32_t      errCode = 0;
    int32_t      retVal = 0;
    CANFD_MCANInitParams mcanCfgParams;
    CANFD_MCANBitTimingParams mcanBitTimingParams;
    CANFD_MCANMsgObjCfgParams rxMsgObjectParams;
    CANFD_MsgObjHandle rxMsgObjHandle;
    gTxDoneFlag = 0;
    gRxDoneFlag = 0;
    /* Setup the PINMUX to bring out the XWR16xx CAN pins */
    Pinmux_Set_OverrideCtrl(SOC_XWR16XX_PINE14_PADAE, PINMUX_OUTEN_RETAIN_HW_CTRL,
PINMUX_INPEN_RETAIN_HW_CTRL);
    Pinmux_Set_FuncSel(SOC_XWR16XX_PINE14_PADAE, SOC_XWR16XX_PINE14_PADAE_CANFD_TX);

    Pinmux_Set_OverrideCtrl(SOC_XWR16XX_PIND13_PADAD, PINMUX_OUTEN_RETAIN_HW_CTRL,
PINMUX_INPEN_RETAIN_HW_CTRL);
    Pinmux_Set_FuncSel(SOC_XWR16XX_PIND13_PADAD, SOC_XWR16XX_PIND13_PADAD_CANFD_RX);

    /* Configure the divide value for MCAN source clock */
    SOC_setPeripheralClock(gMmwMssMCB.socHandle, SOC_MODULE_MCAN, SOC_CLKSOURCE_VCLK, 4U, &errCode);
    /* Initialize peripheral memory */
    SOC_initPeripheralRam(gMmwMssMCB.socHandle, SOC_MODULE_MCAN, &errCode);
    MCANAppInitParams (&mcanCfgParams);
    /* Initialize the CANFD driver */
    canHandle = CANFD_init(&mcanCfgParams, &errCode);
    if (canHandle == NULL)
    {
        System_printf ("Error: CANFD Module Initialization failed [Error code %d]\n", errCode);
        return ;
    }
    /* Configuring 1Mbps and 5Mbps as nominal and data bit-rate respectively
    Prop seg: 8
    Ph seg 1: 6
    Ph Seg2 : 5
    Sync jump: 1
    BRP(Baud rate Prescaler): 2

    Nominal Bit rate = (40)/(((8+6+5)+1)*BRP) = 1Mhz
```

```

        Timing Params for Data Bit rate:
        Prop seg: 2
        Ph seg 1: 2
        Ph Seg2 : 3
        Sync jump: 1
        BRP(Baud rate Prescaler): 1
        Nominal Bit rate = (40)/(((2+2+3)+1)*BRP) = 5Mhz
    */
    mcanBitTimingParams.nomBrp      = 0x2U;
    mcanBitTimingParams.nomPropSeg  = 0x8U;
    mcanBitTimingParams.nomPseg1    = 0x6U;
    mcanBitTimingParams.nomPseg2    = 0x5U;
    mcanBitTimingParams.nomSjw      = 0x1U;

    mcanBitTimingParams.dataBrp      = 0x1U;
    mcanBitTimingParams.dataPropSeg  = 0x2U;
    mcanBitTimingParams.dataPseg1    = 0x2U;
    mcanBitTimingParams.dataPseg2    = 0x3U;
    mcanBitTimingParams.dataSjw      = 0x1U;

/* Configure the CAN driver */
    retVal = CANFD_configBitTime (canHandle, &mcanBitTimingParams, &errCode);
    if (retVal < 0)
    {
        System_printf ("Error: CANFD Module configure bit time failed [Error code %d]\n",
            errCode);
        return ;
    }
/* Setup the transmit message object */
    txMsgObjectParams.direction = CANFD_Direction_TX;
    txMsgObjectParams.msgIdType = CANFD_MCANXidType_29_BIT;
    txMsgObjectParams.msgIdentifier = 0xD1;
    txMsgObjHandle = CANFD_createMsgObject (canHandle, &txMsgObjectParams, &errCode);
    if (txMsgObjHandle == NULL)
    {
        System_printf ("Error: CANFD create Tx message object failed [Error code %d]\n",
            errCode);
        return ;
    }
/* Setup the receive message object */
    rxMsgObjectParams.direction = CANFD_Direction_RX;
    rxMsgObjectParams.msgIdType = CANFD_MCANXidType_29_BIT;
    rxMsgObjectParams.msgIdentifier = 0xD1;

    rxMsgObjHandle = CANFD_createMsgObject (canHandle, &rxMsgObjectParams, &errCode);
    if (rxMsgObjHandle == NULL)
    {
        System_printf ("Error: CANFD create Rx message object failed [Error code %d]\n",
            errCode);
        return ;
    }
}
}
}
/*****
***** CAN Parameters initialize Function *****/
*****/

static void MCANAppInitParams(CANFD_MCANInitParams* mcanCfgParams)
{
    /*Initialize MCAN Config Params*/
    memset (mcanCfgParams, sizeof (CANFD_MCANInitParams), 0);

    mcanCfgParams->fdMode      = 0x1U;
    mcanCfgParams->brsEnable    = 0x1U;
    mcanCfgParams->txpEnable    = 0x0U;
    mcanCfgParams->efbi         = 0x0U;
    mcanCfgParams->pxhddisable  = 0x0U;

```

```

mcanCfgParams->darEnable           = 0x1U;
mcanCfgParams->wkupReqEnable        = 0x1U;
mcanCfgParams->autoWkupEnable       = 0x1U;
mcanCfgParams->emulationEnable     = 0x0U;
mcanCfgParams->emulationFack       = 0x0U;
mcanCfgParams->clkStopFack         = 0x0U;
mcanCfgParams->wdcPreload           = 0x0U;
mcanCfgParams->tdcEnable            = 0x1U;
mcanCfgParams->tdcConfig.tdcf       = 0U;
mcanCfgParams->tdcConfig.tdco      = 8U;
mcanCfgParams->monEnable            = 0x0U;
mcanCfgParams->asmEnable            = 0x0U;
mcanCfgParams->tsPrescalar          = 0x0U;
mcanCfgParams->tsSelect             = 0x0U;
mcanCfgParams->timeoutSelect        = CANFD_MCANTimeOutSelect_CONT;
mcanCfgParams->timeoutPreload       = 0x0U;
mcanCfgParams->timeoutCntEnable     = 0x0U;
mcanCfgParams->filterConfig.rrfe    = 0x1U;
mcanCfgParams->filterConfig.rrfs    = 0x1U;
mcanCfgParams->filterConfig.anfe    = 0x1U;
mcanCfgParams->filterConfig.anfs    = 0x1U;
mcanCfgParams->msgRAMConfig.lss      = 127U;
mcanCfgParams->msgRAMConfig.lse     = 64U;
mcanCfgParams->msgRAMConfig.txBufNum = 32U;
mcanCfgParams->msgRAMConfig.txFIFOSize = 0U;
mcanCfgParams->msgRAMConfig.txBufMode = 0U;
mcanCfgParams->msgRAMConfig.txEventFIFOSize = 0U;
mcanCfgParams->msgRAMConfig.txEventFIFOWaterMark = 0U;
mcanCfgParams->msgRAMConfig.rxFIFO0size = 0U;
mcanCfgParams->msgRAMConfig.rxFIFO0OpMode = 0U;
mcanCfgParams->msgRAMConfig.rxFIFO0waterMark = 0U;
mcanCfgParams->msgRAMConfig.rxFIFO1size = 64U;
mcanCfgParams->msgRAMConfig.rxFIFO1waterMark = 64U;
mcanCfgParams->msgRAMConfig.rxFIFO1OpMode = 64U;
mcanCfgParams->eccConfig.enable      = 1;
mcanCfgParams->eccConfig.enableChk   = 1;
mcanCfgParams->eccConfig.enableRdModWr = 1;
mcanCfgParams->errInterruptEnable    = 1U;
mcanCfgParams->dataInterruptEnable   = 1U;
mcanCfgParams->appErrCallBack        = MCANAppErrStatusCallback;
mcanCfgParams->appDataCallBack       = MCANAppCallback;
}

```

2 Register Callbacks

2.1 Tx Complete and Rx Interrupt Callback

The application must implement a callback function to handle the transmit complete and receive interrupts.

```
static void MCANAppCallback(CANFD_MsgObjHandle handle, CANFD_Reason reason)
{
    int32_t          errCode, retVal;
    uint32_t          id;
    CANFD_MCANFrameType rxFrameType;
    CANFD_MCANXidType  rxIdType;

    if (reason == CANFD_Reason_TX_COMPLETION)
    {
        {
            gTxPkts++;
            gTxDoneFlag = 1;
            return;
        }
    }
    if (reason == CANFD_Reason_RX)
    {
        {
            /* Reset the receive buffer */
            memset(&rxData, 0, sizeof (rxData));
            dataLength = 0;

            retVal = CANFD_getData (handle, &id, &rxFrameType, &rxIdType, &rxDataLength,
&rxData[0], &errCode);
            if (retVal < 0)
            {
                System_printf ("Error: CAN receive data for iteration %d failed [Error
code %d]\n", iterationCount, errCode);
                return;
            }
            if (rxFrameType != frameType)
            {
                System_printf ("Error: CAN received incorrect frame type Sent %d Received
%d for iteration %d failed\n", frameType, rxFrameType, iterationCount);
                return;
            }
            /* Validate the data */
            gRxPkts++;
            gRxDoneFlag = 1;
            return;
        }
    }
    if (reason == CANFD_Reason_TX_CANCELED)
    {
        {
            gTxPkts++;
            gTxDoneFlag = 1;
            gRxDoneFlag = 1;
            return;
        }
    }
}
```

2.2 Error and Status Interrupt Callback

The application must implement a callback function to handle error and status interrupts.

```
static void MCANAppErrStatusCallback(CANFD_Handle handle, CANFD_Reason reason,
CANFD_ErrStatusResp* errStatusResp)
{
    /*Record the error count */
    gErrStatusInt++;
    return;
}
```

3 CAN-FD Transmit

The CANFD can work both in the FD mode and classic CAN mode, based on the frame type used during the transmission.

The following code can be used to transmit CAN data, based on the frame type defined during the initialization and the length message.

```
if(frameType == CANFD_MCANFrameType_FD)
{
    Task_sleep(1);
    while(len > 64U)
    {
        retVal = CANFD_transmitData (txMsgObjHandle, msg_id, CANFD_MCANFrameType_FD, 64U, &txmsg[index],
&errCode);
        index = index + 64U;
        len = len - 64U;
        Task_sleep(1);
    }
    retVal = CANFD_transmitData (txMsgObjHandle, msg_id, CANFD_MCANFrameType_FD, len, &txmsg[index],
&errCode);
}
else
{
    while(len > 8U)
    {
        retVal = CANFD_transmitData (txMsgObjHandle, msg_id,
CANFD_MCANFrameType_CLASSIC, 8U, &txmsg[index], &errCode);
        if (retVal < 0)
        {
            continue;
        }
        index = index + 8U;
        len = len - 8U;
    }
    retVal = CANFD_transmitData (txMsgObjHandle, msg_id, CANFD_MCANFrameType_CLASSIC,
len, &txmsg[index], &errCode);

    while(retVal < 0)
    {
        retVal = CANFD_transmitData (txMsgObjHandle, msg_id, CANFD_MCANFrameType_CLASSIC, len,
&txmsg[index], &errCode);
    }
}
```

4 Linking the CAN-FD Driver

The final step is to build the executable by linking with the CAN-FD drivers. If using a CCS project, the CAN-FD drivers can be added to the project's linker properties, as shown in [Figure 1](#).

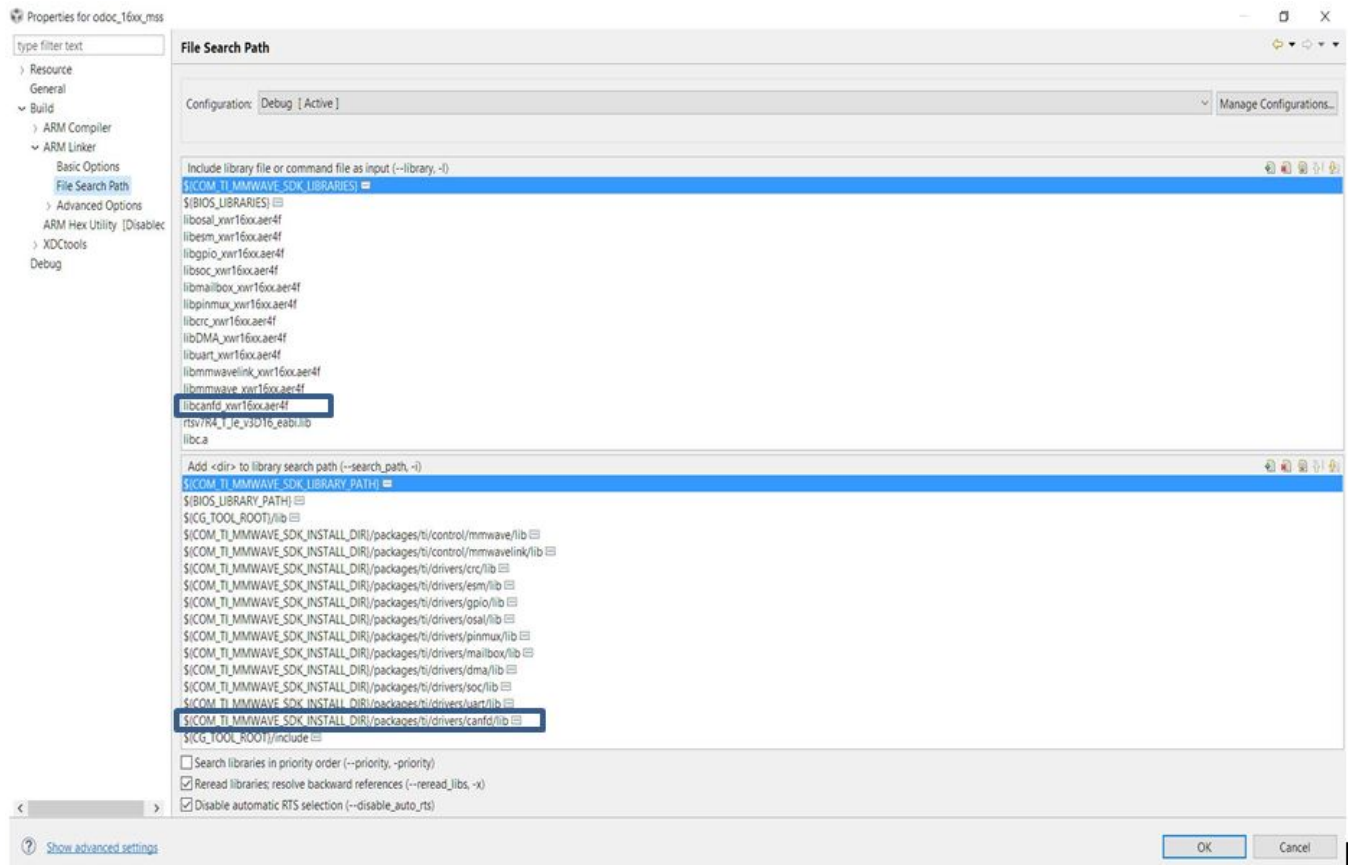


Figure 1. CCS Project Linker Properties

If using the makefile, perform the same procedure.

```
#####
# Additional libraries which are required to build the DEMO:
#####
MSS_MMW_DEMO_STD_LIBS = $(R4F_COMMON_STD_LIB) \
    -llibpinmux_$(MMWAVE_SDK_DEVICE_TYPE).$(R4F_LIB_EXT) \
    -llibdma_$(MMWAVE_SDK_DEVICE_TYPE).$(R4F_LIB_EXT) \
    -llibcrc_$(MMWAVE_SDK_DEVICE_TYPE).$(R4F_LIB_EXT) \
    -llibuart_$(MMWAVE_SDK_DEVICE_TYPE).$(R4F_LIB_EXT) \
    -llibgpio_$(MMWAVE_SDK_DEVICE_TYPE).$(R4F_LIB_EXT) \
    -llibmailbox_$(MMWAVE_SDK_DEVICE_TYPE).$(R4F_LIB_EXT) \
    -llibmmwavelink_$(MMWAVE_SDK_DEVICE_TYPE).$(R4F_LIB_EXT) \
    -llibmmwave_$(MMWAVE_SDK_DEVICE_TYPE).$(R4F_LIB_EXT) \
    -llibcli_$(MMWAVE_SDK_DEVICE_TYPE).$(R4F_LIB_EXT) \
    -llibcanfd_$(MMWAVE_SDK_DEVICE_TYPE).$(R4F_LIB_EXT)
MSS_MMW_DEMO_LOC_LIBS = $(R4F_COMMON_LOC_LIB) \
    -i$(MMWAVE_SDK_INSTALL_PATH)/ti/drivers/pinmux/lib \
    -i$(MMWAVE_SDK_INSTALL_PATH)/ti/drivers/uart/lib \
    -i$(MMWAVE_SDK_INSTALL_PATH)/ti/drivers/dma/lib \
    -i$(MMWAVE_SDK_INSTALL_PATH)/ti/drivers/crc/lib \
    -i$(MMWAVE_SDK_INSTALL_PATH)/ti/drivers/gpio/lib \
    -i$(MMWAVE_SDK_INSTALL_PATH)/ti/drivers/mailbox/lib \
    -i$(MMWAVE_SDK_INSTALL_PATH)/ti/control/mmwavelink/lib \
    -i$(MMWAVE_SDK_INSTALL_PATH)/ti/control/mmwave/lib \
    -i$(MMWAVE_SDK_INSTALL_PATH)/ti/utis/cli/lib \
    -i$(MMWAVE_SDK_INSTALL_PATH)/ti/drivers/canfd/lib
```

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