MPX-2515 User's Guide

MPX-2515 CAN 2.0B USB card features USB 2.0 full speed to CAN 2.0B bus interface in Mini-PCIe form factor. This MPX-2515 User's Guide describes how to use MPX-2515 card.

Contents

1 Technical Guide

1.1 Introduction

The MPX-2515 CAN 2.0B USB card is a USB 2.0 compliant device, which implements Controller Area Network (CAN) version 2.0B interface. This card is made in Mini-PCIe form factor so that this module is able to insert into motherboards that provide Mini-PCIe slot, like most Commell motherboards do. In addition, users are able to connect this card to an USB Type A receptacle that most PC has by using the OALUSB-H4-1 optional cable. MPX-2515 CAN 2.0B USB card provides the following features.

1.1.1 Features

- USB 2.0 Full Speed compliant
- Controller Area Network (CAN) version 2.0B
- Implement ISO-11898 Standard Physical Layer
- Supports 1 Mb/s operation (recommend 125 Kbps)
- Default to 125 Kbps
- On board 120 Ohm line terminator (enabled/disabled by jumper)
- 0 to 8 byte length in the data field
- Standard and extended data and remote frames
- Two receive buffers with prioritized message storage
- Six 29-bit filters
- Two 29-bit masks
- Data byte filtering on the first two data bytes
- One-shot mode ensures message transmission is attempted only one time
- Typical 5 mA active current
- Typical 1 uA standby current (sleep mode)
- Externally-controlled slope for reduced RFI emissions
- Detection of ground fault (permanent Dominant) on TXD input
- Power-on Reset and voltage brown-out protection
- Protection against high-voltage transients
- Automatic thermal shutdown protection
- Up to 112 nodes can be connected
- High-noise immunity due to differential bus implementation
- IEC 61000-4-2 (ESD) ± 15kV (air/contact) protection
- IEC 61000-4-4 (EFT) 50A (5/50ns) protection
- Produced in Mini-PCIe card form factor (easily locked on motherboard)

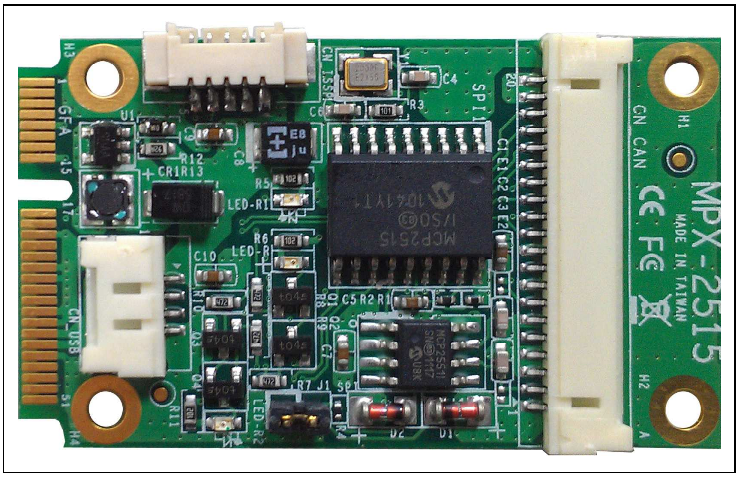


Figure 1 MPX-2515 CAN 2.0B USB Card

1.1.2 Supported Operating Systems

The following operating systems are supported by MPX-2515:

- Microsoft Windows XP 32-/64-bit versions
- Microsoft Windows Vista 32-/64-bit versions
- Microsoft Windows 7 32-/64-bit versions

1.2 MPX-2515 Block Diagram

The MPX-2515 CAN 2.0B USB card is composed of a System on Chip, a stand-alone CAN controller, and a high-speed CAN transceiver.

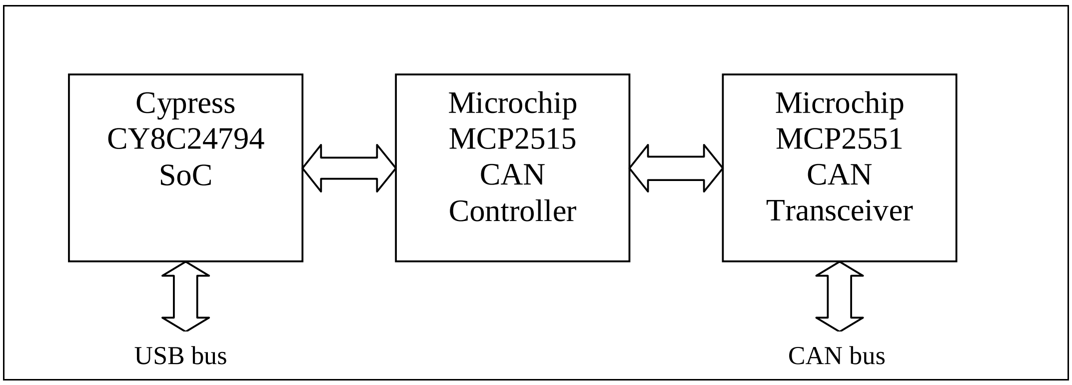


Figure 2 MPX-2515 Block Diagram

The above figure shows the components diagram of the MPX-2515 CAN 2.0B USB card. The Cypress CY24794 controller implemented a USB device that interacts with a USB host to perform requests and return responses. A Microchip MCP2515 CAN controller is connecting to CY24794 via SPI and other signals. Another Microchip MCP2551 CAN Transceiver is interfacing to the CAN bus to send and receive CAN messages.

1.3 CY8C24794 Programmable System-on-Chip

We uses Cypress CY8C24794 PSoC Programmable System-on-Chip as the general purpose controller for MPX-2515 card. A firmware has implement for CY8C24794 to support full speed USB, SPI master, timers, and others for MPX-2515 functionalities. The full speed USB interface is used to communicate with a USB host to perform request packets and return response packets. The SPI master interface however is used to communicate to the MCP2515 CAN bus controller for CAN activities. Please refer to the CY8C24x94 PSoC Programmable System-on-Chip Technical Reference Manual for detail information.

The following figure shows the block diagram of CY8C24794.

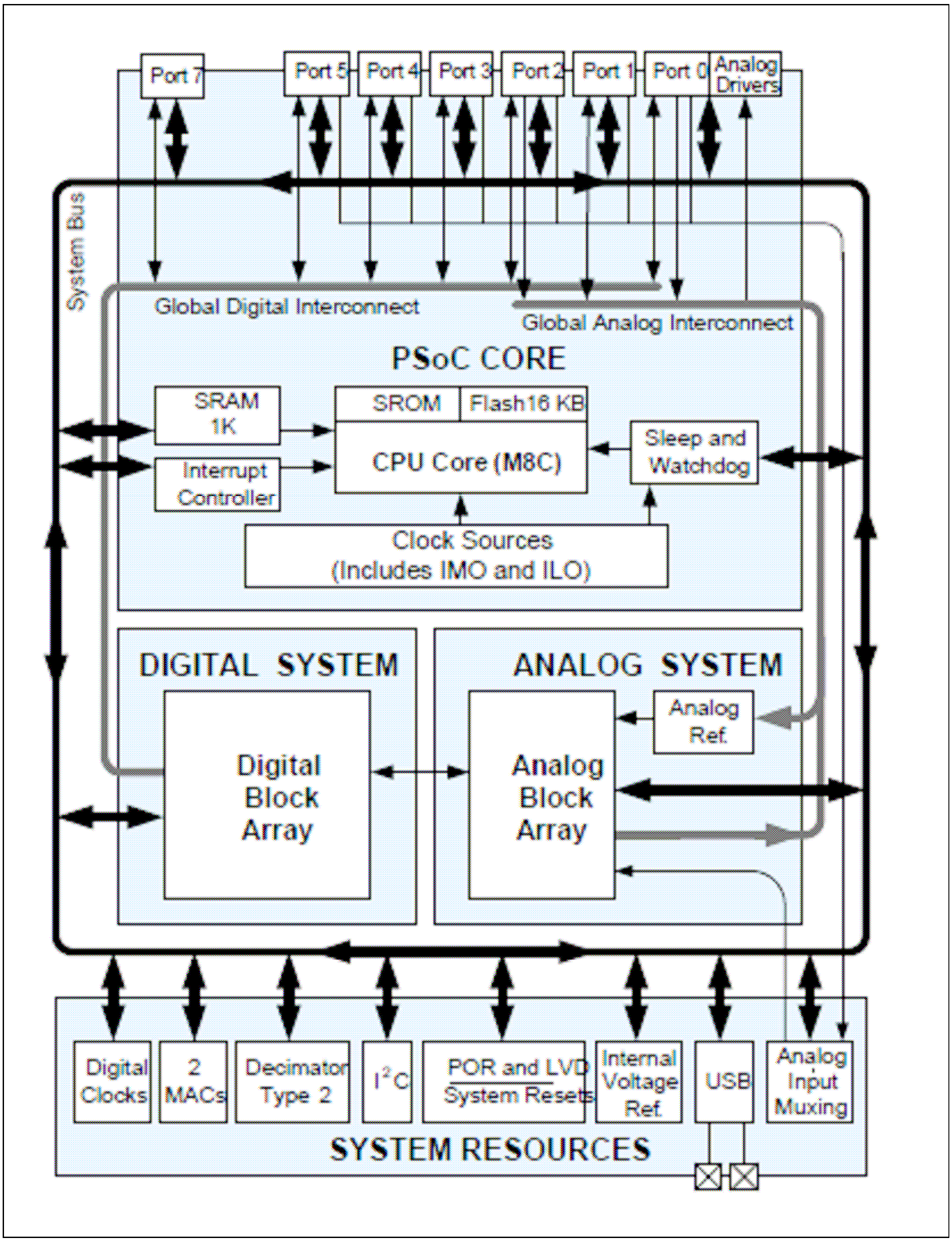


Figure 3 CY8C24794 Block Diagram

1.4 MCP2515 Stand-Alone CAN Controller With SPI Interface

Microchip Technology's MCP2515 is a stand-alone Controller Area Network (CAN) controller that implements the CAN specification, version 2.0B. It is capable of transmitting and receiving both standard and extended data and remote frames. The MCP2515 has two acceptance masks and six acceptance filters that are used to filter out unwanted messages. Thereby reducing the host MCUs overhead. The MCP2515 interfaces with CY8C24794 microcontroller via an industry standard Serial Peripheral Interface (SPI).

The following figure shows the block diagram of MCP2515

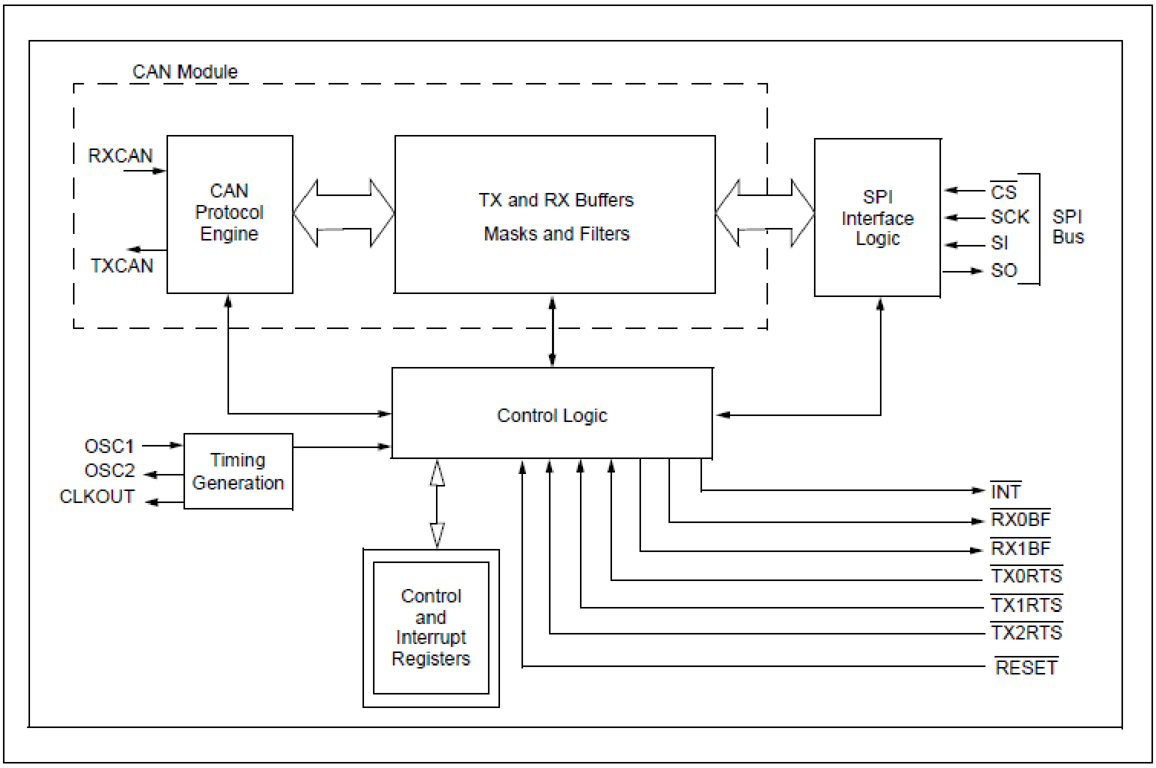


Figure 4 MCP2515 Block Diagram

The MCP2515 has three transmit and two receive buffers, two acceptance masks (one for each receive buffer) and a total of six acceptance filters. The following figure shows the MCP2515 buffers and protocol engine block diagram. Please refer to MCP2515 data sheet for detail information.

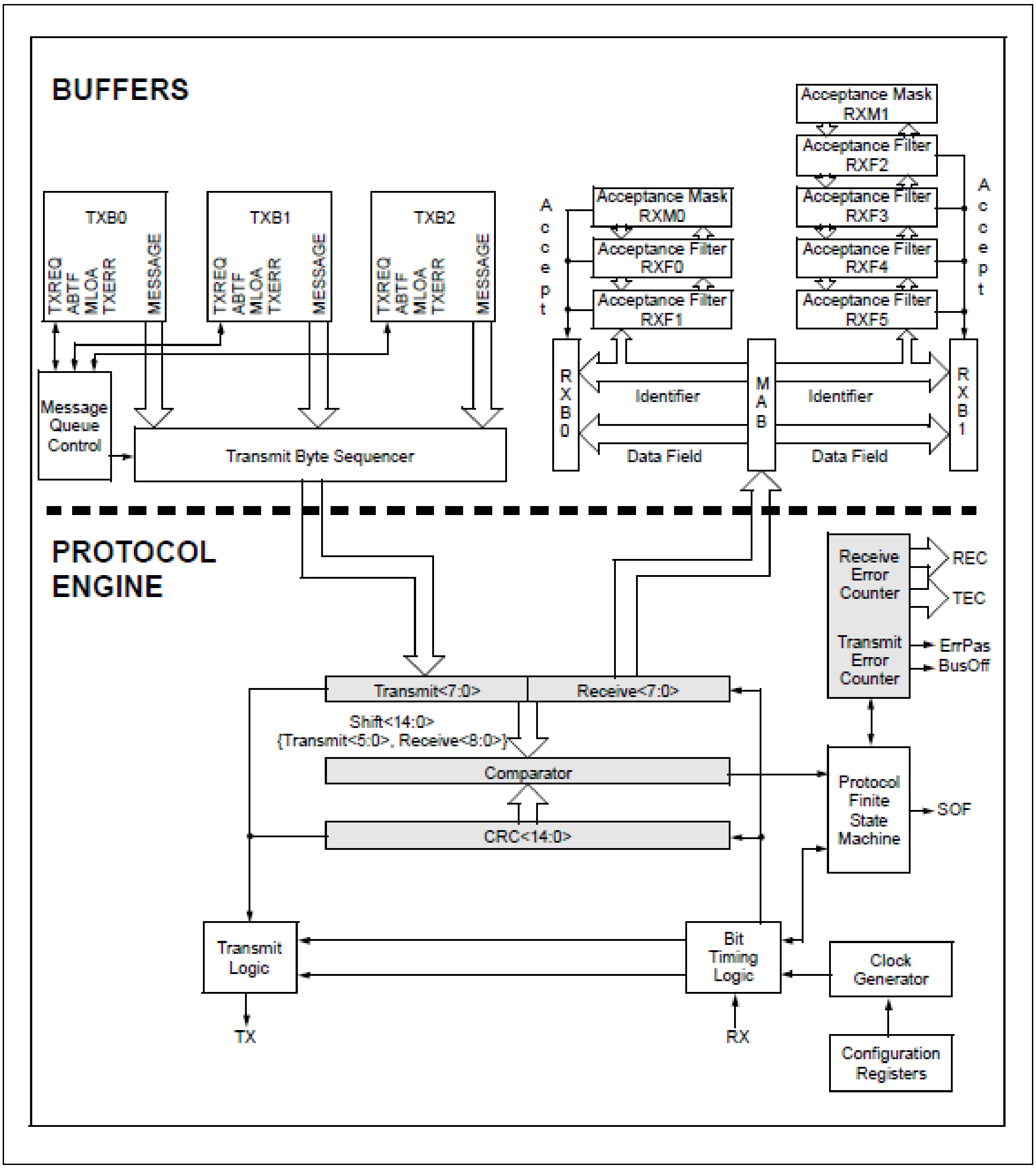


Figure 5 MCP2515 Buffers and Protocol Engine Blcok Diagram

The following table shows the MCP2515 Controller Register Map. Please refer to the MCP2515 data sheet for detail information.

Lower Address Bits	Higher-Order Address Bits							
	0000 xxxx	0001 xxxx	0010 xxxx	0011 xxxx	0100 xxxx	0101 xxxx	0110 xxxx	0111 xxxx
0000	RXF0SIDH	RXF3SIDH	RXM0SIDH	TXB0CTRL	TXB1CTRL	TXB2CTRL	RXB0CTRL	RXB1CTRL
0001	RXF0SIDL	RXF3SIDL	RXM0SIDL	TXB0SIDH	TXB1SIDH	TXB2SIDH	RXB0SIDH	RXB1SIDH
0010	RXF0EID8	RXF3EID8	RXM0EID8	TXB0SIDL	TXB1SIDL	TXB2SIDL	RXB0SIDL	RXB1SIDL
0011	RXF0EID0	RXF3EID0	RXM0EID0	TXB0EID8	TXB1EID8	TXB2EID8	RXB0EID8	RXB1EID8
0100	RXF1SIDH	RXF4SIDH	RXM1SIDH	TXB0EID0	TXB1EID0	TXB2EID0	RXB0EID0	RXB1EID0
0101	RXF1SIDL	RXF4SIDL	RXM1SIDL	TXB0DLC	TXB1DLC	TXB2DLC	RXB0DLC	RXB1DLC
0110	RXF1EID8	RXF4EID8	RXM1EID8	TXB0D0	TXB1D0	TXB2D0	RXB0D0	RXB1D0
0111	RXF1EID0	RXF4EID0	RXM1EID0	TXB0D1	TXB1D1	TXB2D1	RXB0D1	RXB1D1
1000	RXF2SIDH	RXF5SIDH	CNF3	TXB0D2	TXB1D2	TXB2D2	RXB0D2	RXB1D2
1001	RXF2SIDL	RXF5SIDL	CNF2	TXB0D3	TXB1D3	TXB2D3	RXB0D3	RXB1D3
1010	RXF2EID8	RXF5EID8	CNF1	TXB0D4	TXB1D4	TXB2D4	RXB0D4	RXB1D4
1011	RXF2EID0	RXF5EID0	CANINTE	TXB0D5	TXB1D5	TXB2D5	RXB0D5	RXB1D5
1100	BFPCTRL	TEC	CANINTF	TXB0D6	TXB1D6	TXB2D6	RXB0D6	RXB1D6
1101	TXRTSCTRL	REC	EFLG	TXB0D7	TXB1D7	TXB2D7	RXB0D7	RXB1D7
1110	CANSTAT	CANSTAT	CANSTAT	CANSTAT	CANSTAT	CANSTAT	CANSTAT	CANSTAT
1111	CANCTRL	CANCTRL	CANCTRL	CANCTRL	CANCTRL	CANCTRL	CANCTRL	CANCTRL

Note: Shaded register locations indicate that these allow the user to manipulate individual bits using the Bit Modify command.

Figure 6 MCP2515 Controller Register Map

The following table shows the MCP2515 Control Register Summary. Please refer to the MCP2515 data sheet for detail information.

Register Name	Address (Hex)	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	POR/RST Value
BFPCTRL	0C	—	—	B1BFS	B0BFS	B1BFE	B0BFE	B1BFM	B0BFM	--00 0000
TXRTSCTRL	0D	—	—	B2RTS	B1RTS	B0RTS	B2RTSM	B1RTSM	B0RTSM	--xx x000
CANSTAT	xE	OPMOD2	OPMOD1	OPMOD0	—	ICOD2	ICOD1	ICOD0	—	100- 000-
CANCTRL	xF	REQOP2	REQOP1	REQOP0	ABAT	OSM	CLKEN	CLKPRE1	CLKPRE0	1110 0111
TEC	1C	Transmit Error Counter (TEC)								0000 0000
REC	1D	Receive Error Counter (REC)								0000 0000
CNF3	28	SOF	WAKFIL	—	—	—	PHSEG22	PHSEG21	PHSEG20	00-- -000
CNF2	29	BTLMODE	SAM	PHSEG12	PHSEG11	PHSEG10	PRSEG2	PRSEG1	PRSEG0	0000 0000
CNF1	2A	SJW1	SJW0	BRP5	BRP4	BRP3	BRP2	BRP1	BRP0	0000 0000
CANINTE	2B	MERRE	WAKIE	ERRIE	TX2IE	TX1IE	TX0IE	RX1IE	RX0IE	0000 0000
CANINTF	2C	MERRF	WAKIF	ERRIF	TX2IF	TX1IF	TX0IF	RX1IF	RX0IF	0000 0000
EFLG	2D	RX1OVR	RX0OVR	TXBO	TXEP	RXEP	TXWAR	RXWAR	EWARN	0000 0000
TXB0CTRL	30	—	ABTF	MLOA	TXERR	TXREQ	—	TXP1	TXP0	-000 0-00
TXB1CTRL	40	—	ABTF	MLOA	TXERR	TXREQ	—	TXP1	TXP0	-000 0-00
TXB2CTRL	50	—	ABTF	MLOA	TXERR	TXREQ	—	TXP1	TXP0	-000 0-00
RXB0CTRL	60	—	RXM1	RXM0	—	RXRTR	BUKT	BUKT	FILHIT0	-00- 0000
RXB1CTRL	70	—	RSM1	RXM0	—	RXRTR	FILHIT2	FILHIT1	FILHIT0	-00- 0000

Figure 7 MCP2515 Control Register Summary

1.5 MCP2551 High-Speed CAN Transceiver

The MCP2551 is a high-speed CAN, fault-tolerant device that serves as the interface between a CAN protocol controller and the physical bus. The MCP2551 device provides differential transmit and receive capability for the CAN protocol controller, and is fully compatible with the ISO-11898 standard, including 24V requirements. It will operate at speeds of up to 1 Mb/s.

The following figure shows the MCP2551 block diagram. Please refer to the MCP2551 data sheet for detail information.

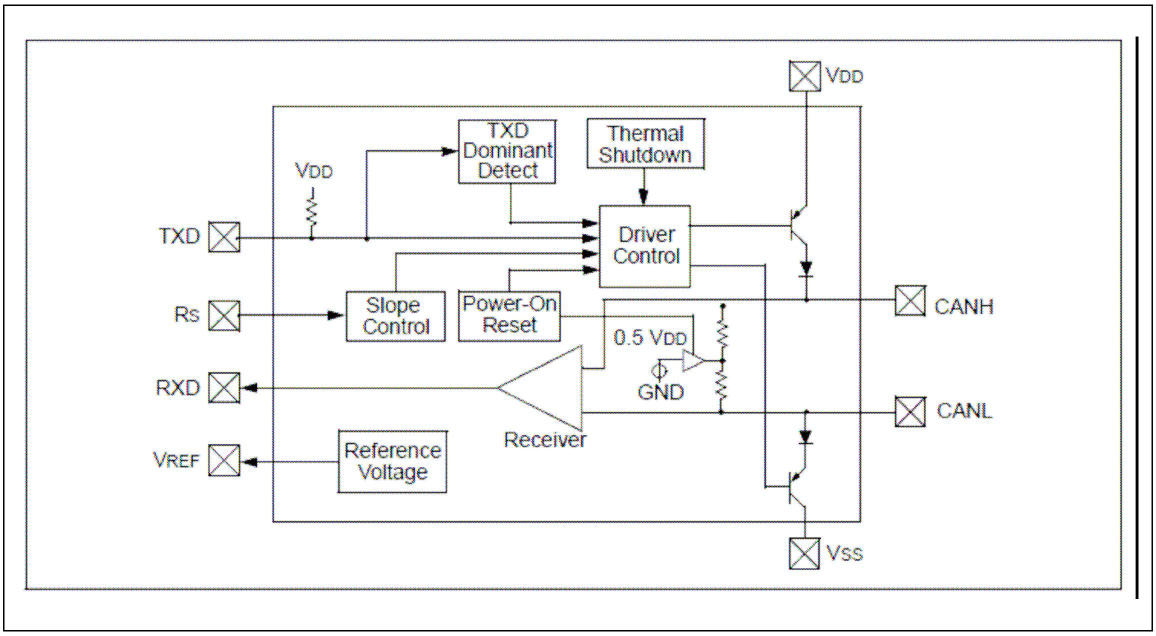


Figure 8 MCP2551 Block Diagram

1.6 MPX-2515 ISO OSI Model

1.6.1 Introduction

This section defines the MPX-2515 card in the ISO OSI reference model. The following figure shows this model.

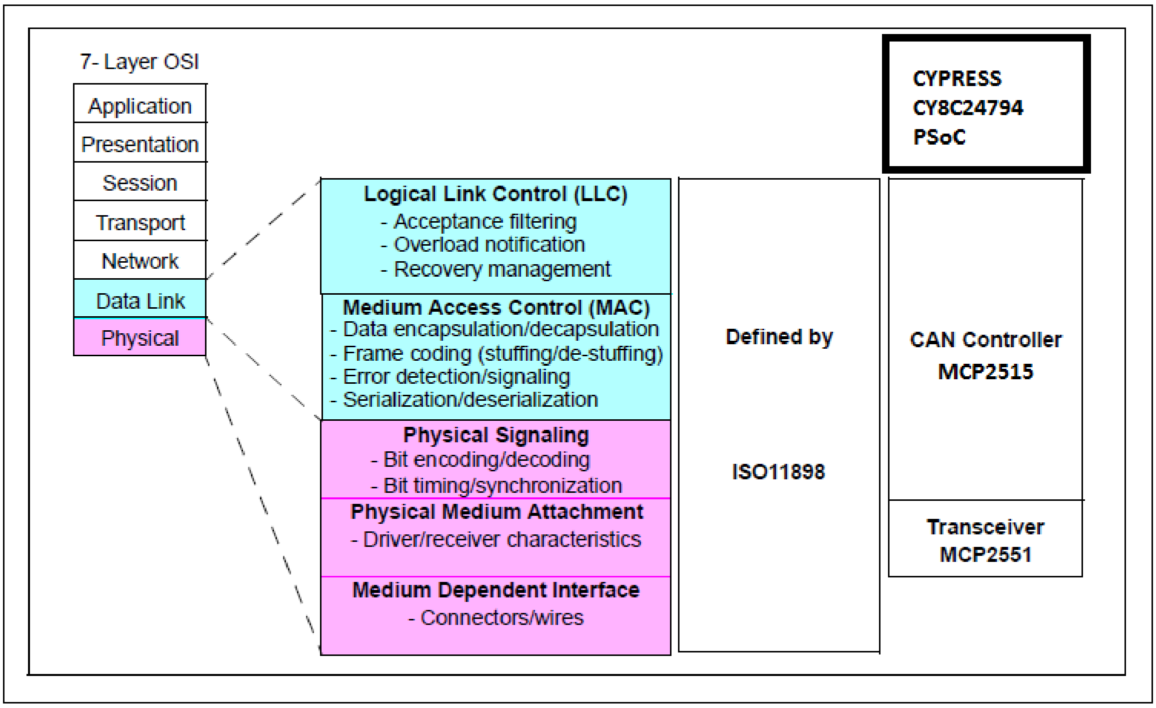


Figure 9 MPX-2515 ISO/OSI Reference Model

The Controller Area Network (CAN) protocol defines the Data Link Layer and part of the Physical Layer in the OSI model. Therefore, all the undefined layers can be defined by the system designer, or can be implemented using existing non-proprietary High Layer Protocols (HLPs) and physical layers.

Data Link Layer The Data Link Layer is defined by the CAN specification. This Data Link Layer is divided into Logical Link Control (LLC) Layer and Medium Access Control Layer (MAC). The Logical Link Control (LLC) manages the overload control and notification, message filtering and recovery management functions. the Medium Access Control (MAC) performs the data encapsulation/decapsulation, error detection and control, bit stuffing/destuffing and the serialization and deserialization functions.

Physical Layer The Physical Medium Attachment (PMA) and Medium Dependent Interface (MDI) are the two sub-layers of the physical layer which are not defined by CAN. However, the Physical Signaling (PS) sub-layer of the physical layer is defined by the CAN specification. The system designer can choose any driver/receiver and transport medium as long as the PS requirements are met.

The International Standards Organization (ISO) has defined a standard which incorporates the CAN specification as well as the physical layer. The standard, ISO-11898, was originally created for high-speed in-vehicle communication using CAN. ISO-11898 specifies the physical layer to ensure compatibility between CAN transceivers.

1.6.2 ISO11898-1 Physical Signaling

The bit encoding/decoding and synchronization shall meet the requirements defined in ISO-11898-1 and it is recommended to follow the definitions as given in the Recommended bit timing settings table. The according bus length estimations are therefore shown in the table follows it.

Bit rate	Nominal bit time t_b	Valid range for location of sample point	Recommended location of sample point
1 Mbit/s	1 µs	75% to 90%	87,5%
800 kbit/s	1,25 µs	75% to 90%	87,5%
500 kbit/s	2 µs	85% to 90%	87,5%
250 kbit/s	4 µs	85% to 90%	87,5%
125 kbit/s	8 µs	85% to 90%	87,5%
50 kbit/s	20 µs	85% to 90%	87,5%
20 kbit/s	50 µs	85% to 90%	87,5%
10 kbit/s	100 µs	85% to 90%	87,5%

Table 1 Recommended bit timing settings

The following table shows the according bus length estimations.

Bit rate	Bus length[1]
1 Mbit/s	25 m
800 kbit/s	50 m
500 kbit/s	100 m
250 kbit/s	250 m
125 kbit/s	500 m
50 kbit/s	1.000 m
20 kbit/s	2.500 m
10 kbit/s	5.000 m

Table 2 Estimated bus lengths

1.7 MPX-2515 Card vs. ISO-11898-2

1.7.1 ISO-11898-2 Overview

ISO-11898-2 is the international standard for high-speed CAN communications in road vehicles. ISO-11898-2 specifies the PMA and MDA sub-layers of the ISO/OSI Physical Layer.

The following figure shows a representation of a common CAN node/bus as described by ISO-11898.

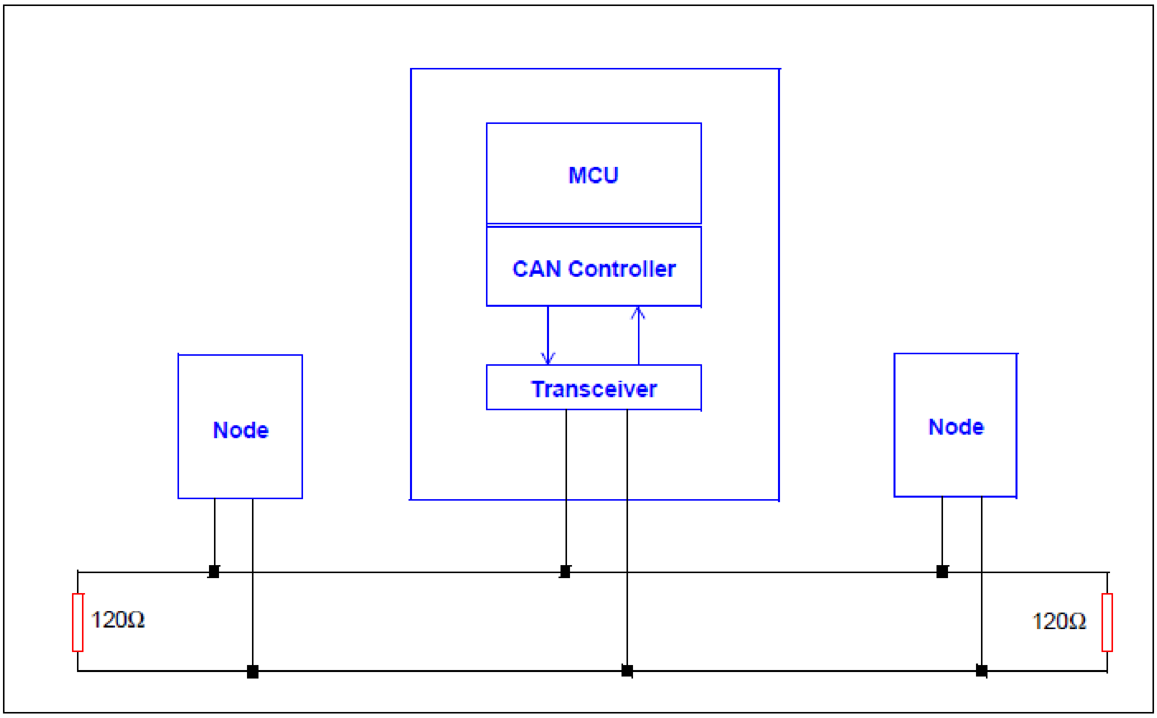


Figure 10 CAN Node on Bus

1.7.2 Bus Levels

CAN specifies two logical states: recessive and dominant. ISO-11898 defines a differential voltage to represent recessive and dominant states (or bits), as shown in the following figure.

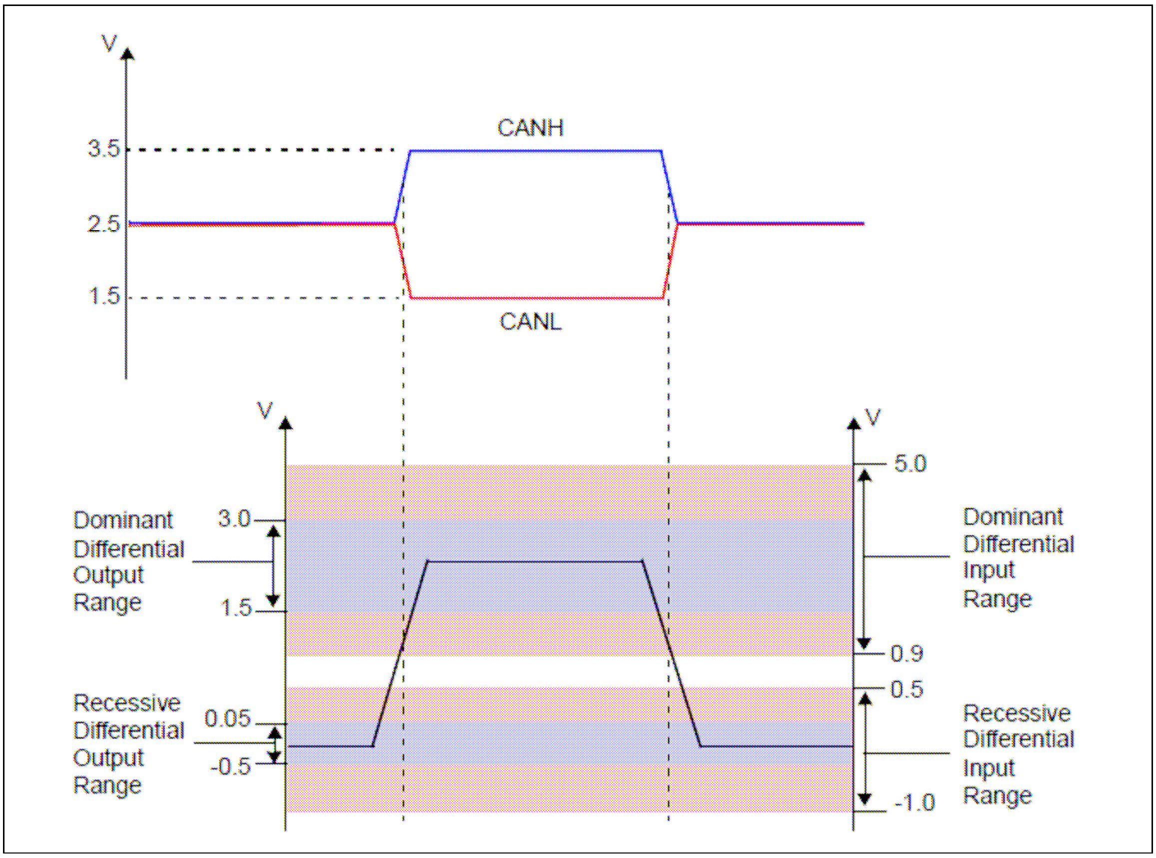


Figure 11 CAN Differential Bus

Recessive State

In the recessive state (i.e., logic '1' on the MCP2551 TXD input), the differential voltage on CANH and CANL is less than the minimum threshold (< 0.5V receiver input or < 1.5V transmitter output).

Dominant State

In the dominant state (i.e., logic '0' on the MCP2551 TXD input), the differential voltage on CANH and CANL is greater than the minimum threshold. A dominant bit overdrives a recessive bit on the bus to achieve nondestructive bitwise arbitration.

1.7.3 Comparison

The ISO-11898-2 specification requires that a compliant or compatible transceiver must meet a number of electrical specifications. The following table shows the major

ISO-11898-2 electrical requirements vs. Microchip MCP2551 specification (and of course MPX-2515 card).

Parameter	ISO-11898-4		MCP2551		Unit	Comments
	min	max	min	max		
DC Voltage on CANH and CANL	-3	+32	-40	+40	V	Exceeds ISO-11898
Transient voltage on CANH and CANL	-150	+100	-250	+250	V	Exceeds ISO-11898
Common Mode Bus Voltage	-2.0	+7.0	-12	+12	V	Exceeds ISO-11898
Recessive Output Bus Voltage	+2.0	+3.0	+2.0	+3.0	V	Meets ISO-11898
Recessive Differential Output Voltage	-500	+50	-500	+50	mV	Meets ISO-11898
Differential Internal Resistance	10	100	20	100	kΩ	Meets ISO-11898
Common Mode Input Resistance	5.0	50	5.0	50	kΩ	Meets ISO-11898
Differential Dominant Output Voltage	+1.5	+3.0	+1.5	+3.0	V	Meets ISO-11898
Dominant Output Voltage (CANH)	+2.75	+4.50	+2.75	+4.50	V	Meets ISO-11898
Dominant Output Voltage (CANL)	+0.50	+2.25	+0.50	+2.25	V	Meets ISO-11898
Permanent Dominant Detection (Driver)	Not Required		1.25	—	ms	
Power-On Reset and Brown-Out Detection	Not Required		Yes		–	

Table 3 MPX-2515 (MCP2551) vs. ISO-11898-2

1.8 MPX-2515 I/O Interfaces

This section defines all input/output ports for MPX-2515 CAN 2.0B USB card. It includes ports for connection and jumper for control.

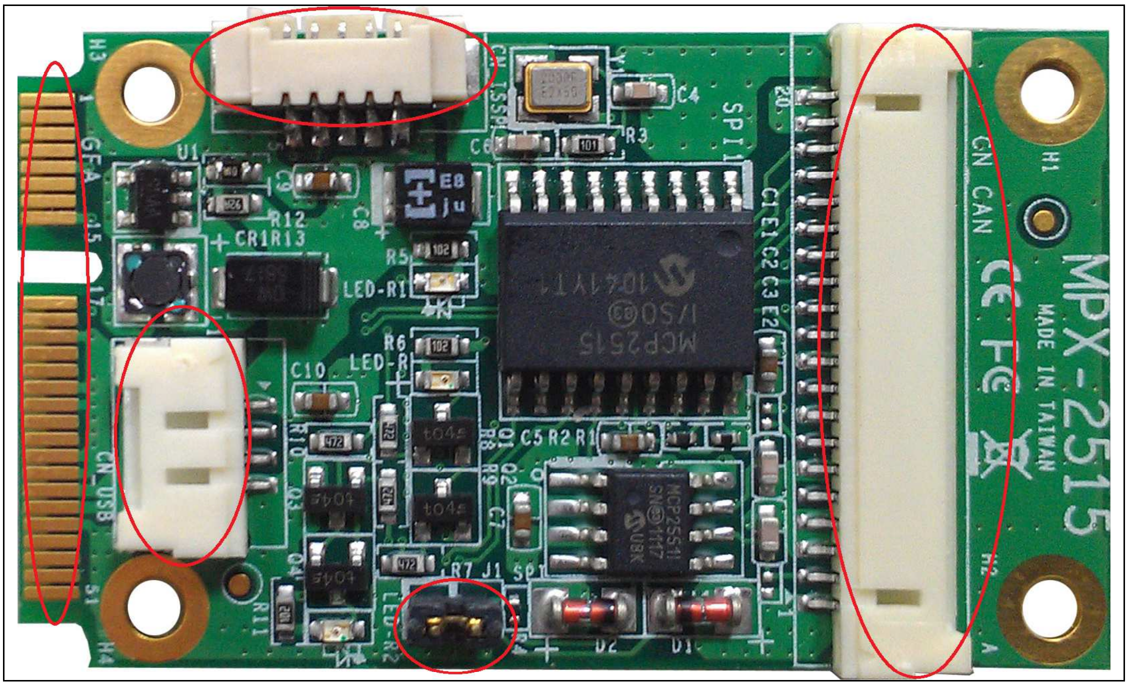


Figure 12 I/O Ports and Jumper

- **Mini card golden finger -** The USB signals of this industrial standard mini-PCIe interface are used to connect to a USB host.
- **CN_USB connector -** The connector for connecting to a USB host by cable. Please refer to its corresponding section for detail information.
- **J1 -** The Line Termination jumper.
- **CN_CAN connector -** The connector for connecting to the CAN bus.
- **CN_ISSP connector -** The connector for firmware uploading.

1.8.1 Mini Card Golden Finger

The MPX-2515 CAN 2.0B USB card implements only the USB D+ and USB D-, ground, and 3.3V voltage supply of the mini card golden finger. Users can use this mini card golden finger to connect to a USB host of the motherboard.

The following figure shows the location of golden finger of MPX-2515 card.

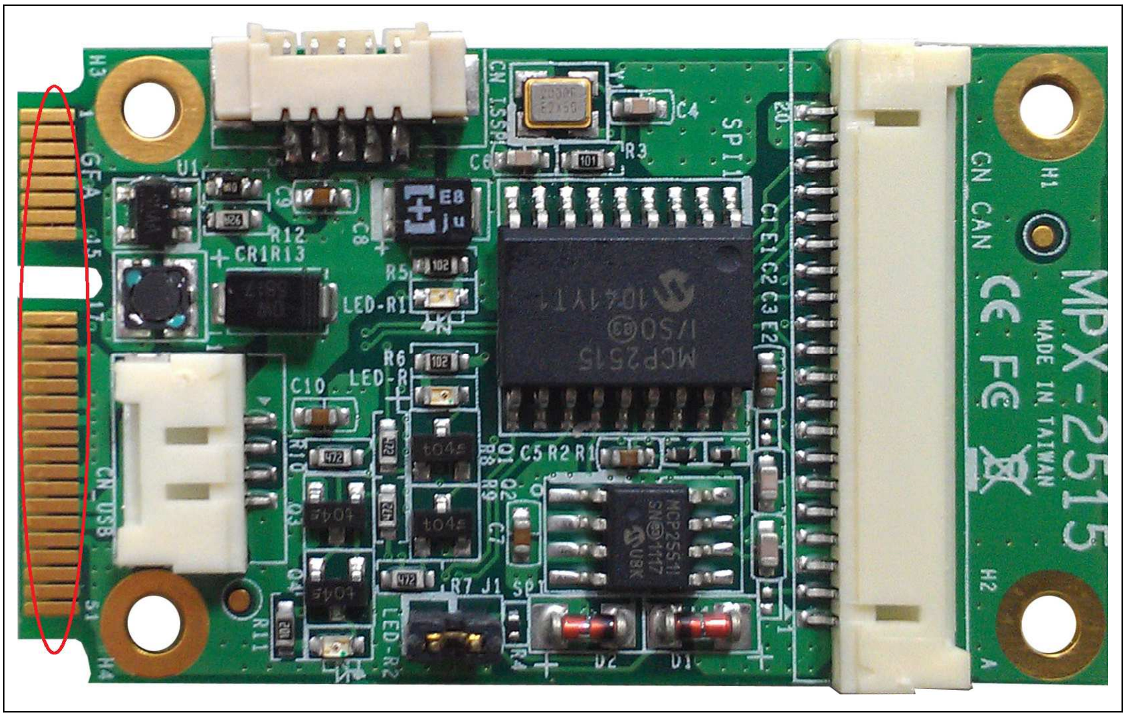


Figure 13 MPX-2515 Golden Finger

The following figure shows the I/O pins definitions of MPX-2515 CAN 2.0B USB card.

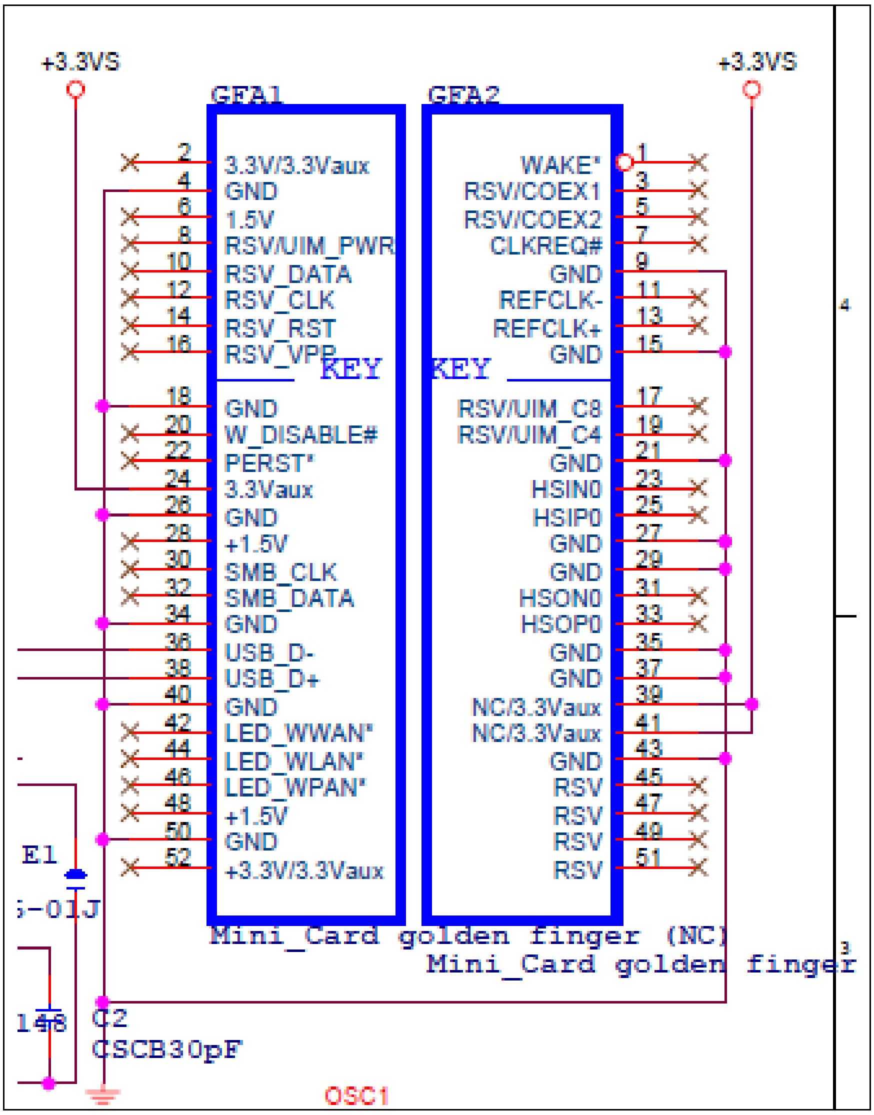


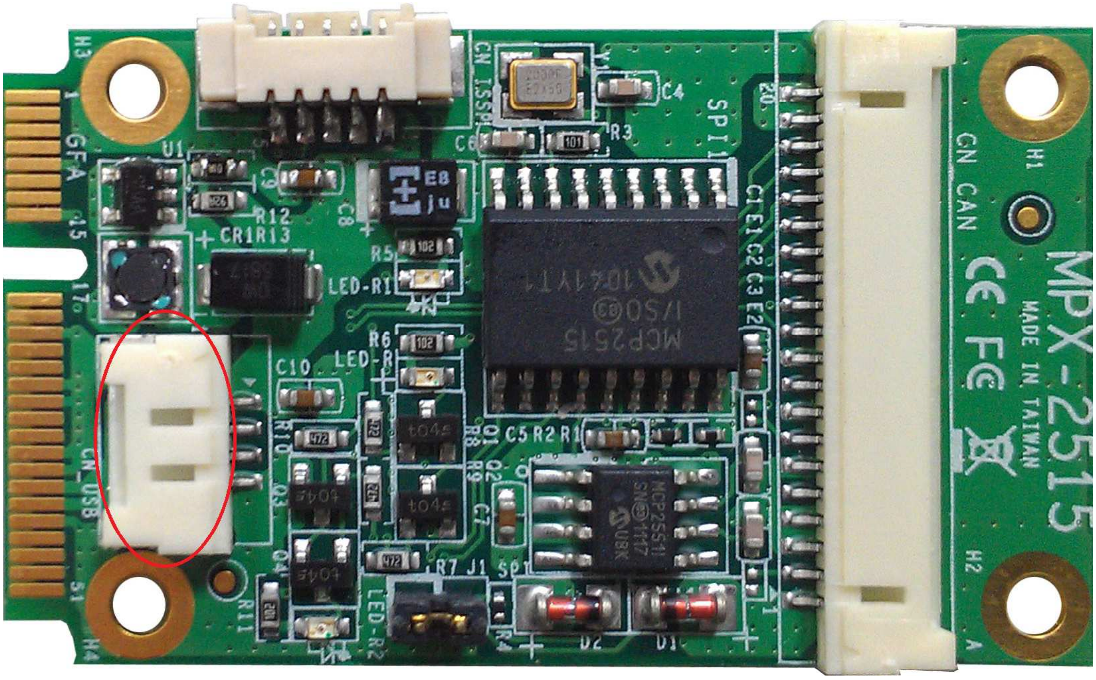
Figure 14 Golden Finger Pins Definitions

1.8.2 CN_USB Connector

This connector is provided to as an alternate to connect the MPX-2515 CAN 2.0B USB card to a USB host. Users can connect OALUSB-H4-1 cable from this connector to a USB Type A receptacle to connect to a USB host.

The following figures shows/defines the pins definitions.

Figure 15 MPX-2515 OALUSB Connector



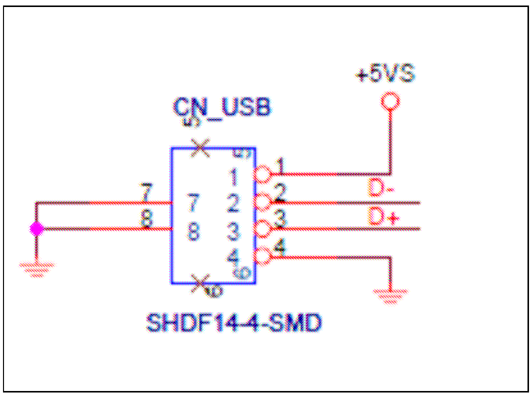


Figure 16 CN_USB Pins Definitions

Please refer to the OALUSB-H4-1 section for the cable information.

1.8.3 Jumper for Line Termination

Users apply this line termination jumper to enable 120 Ohm line termination if the MPX-2515 CAN 2.0B USB card is connecting to a CAN bus at the end side. Users need to apply this 120 Ohm line terminator in order to increase the signaling quality on the bus.

The jumper is enabled by default. Remove the connector if your node is not at the end side of the bus.

J1 Status	120 Ohm Line Termination
Close	Enabled
Open	Disabled

Table 4 J1 Line Termination

The following figure shows the location of the jumper.

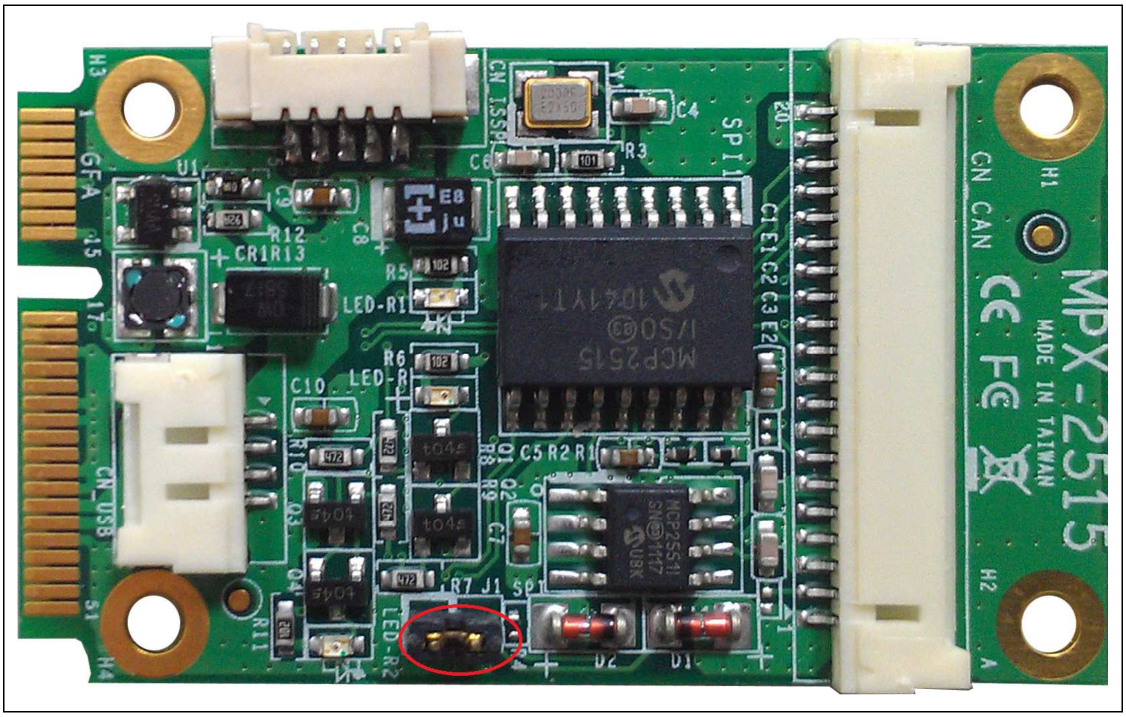


Figure 17 MPX-2515 Line Termination Jumper

1.8.4 CN_CAN Connector

CN_CAN connector provides signals for CAN bus. The OAL-2515 cable connects this port to the CAN bus via D-SUB9 connector, which compliant to the industrial standard.

The following figures show/define the pins definitions of CN_CAN connector.

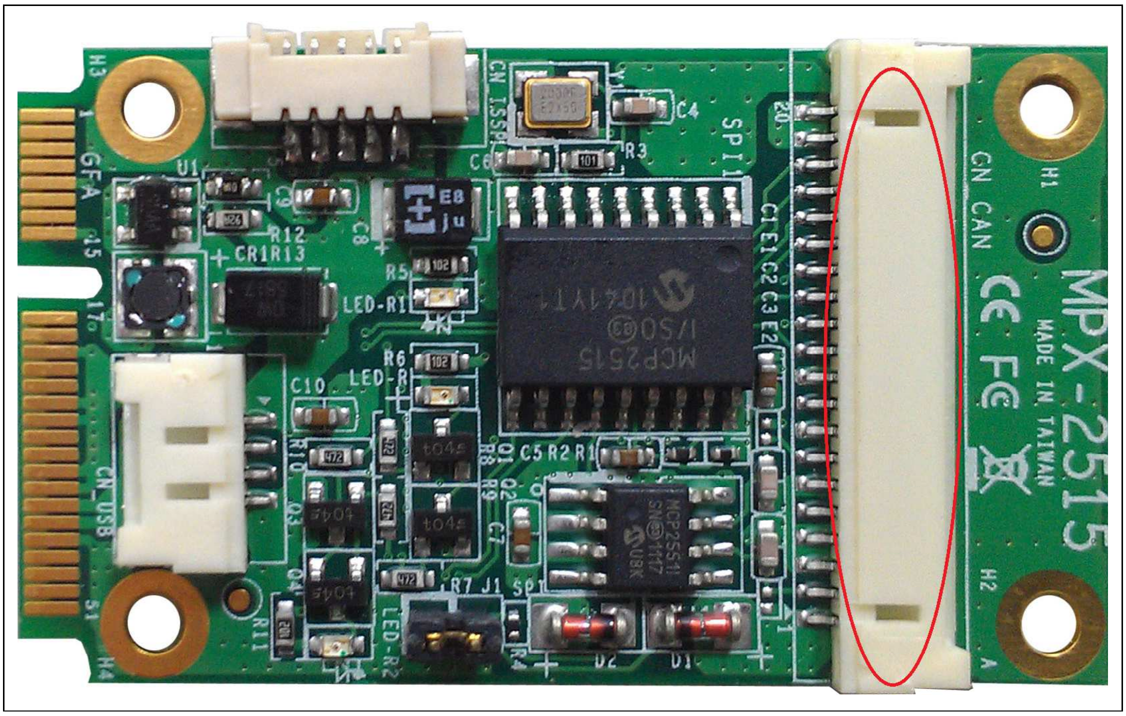


Figure 18 MPX-2515 CN_CAN Connector

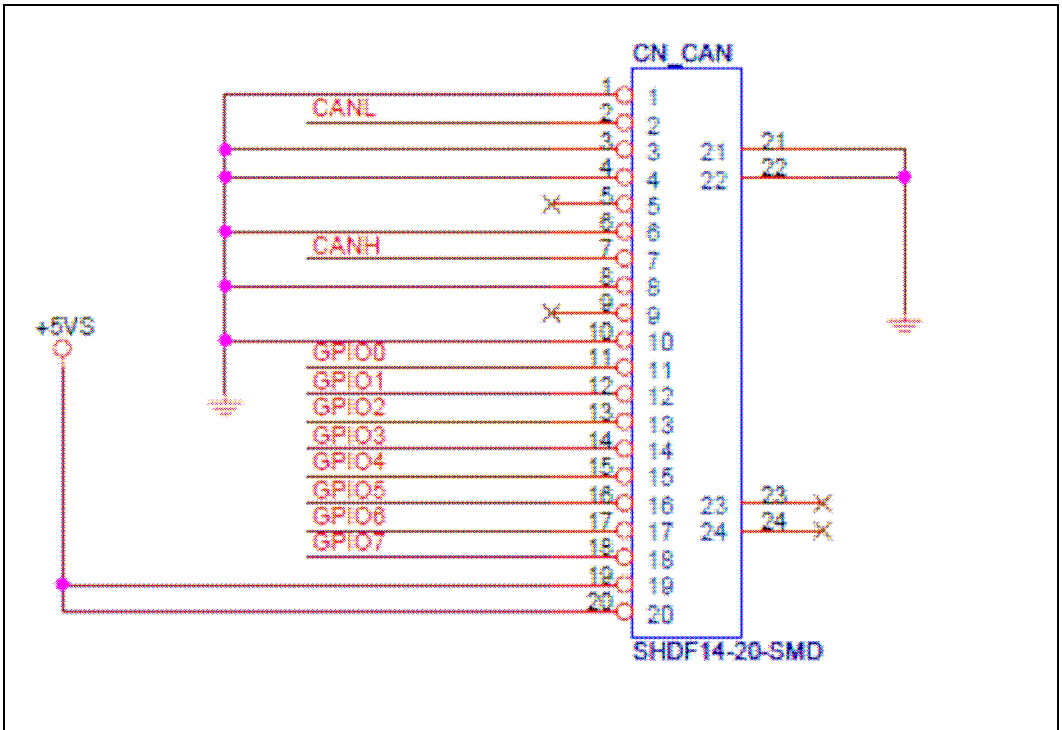


Figure 19 CN_CAN Pins Definitions

Please refer to the OAL-2515 Cable section for cable information.

1.8.5 CN_ISSP Connector

CN_ISSP connector is used to upload MPX-2515 firmware. MPX-2515 users are normally not using this connector.

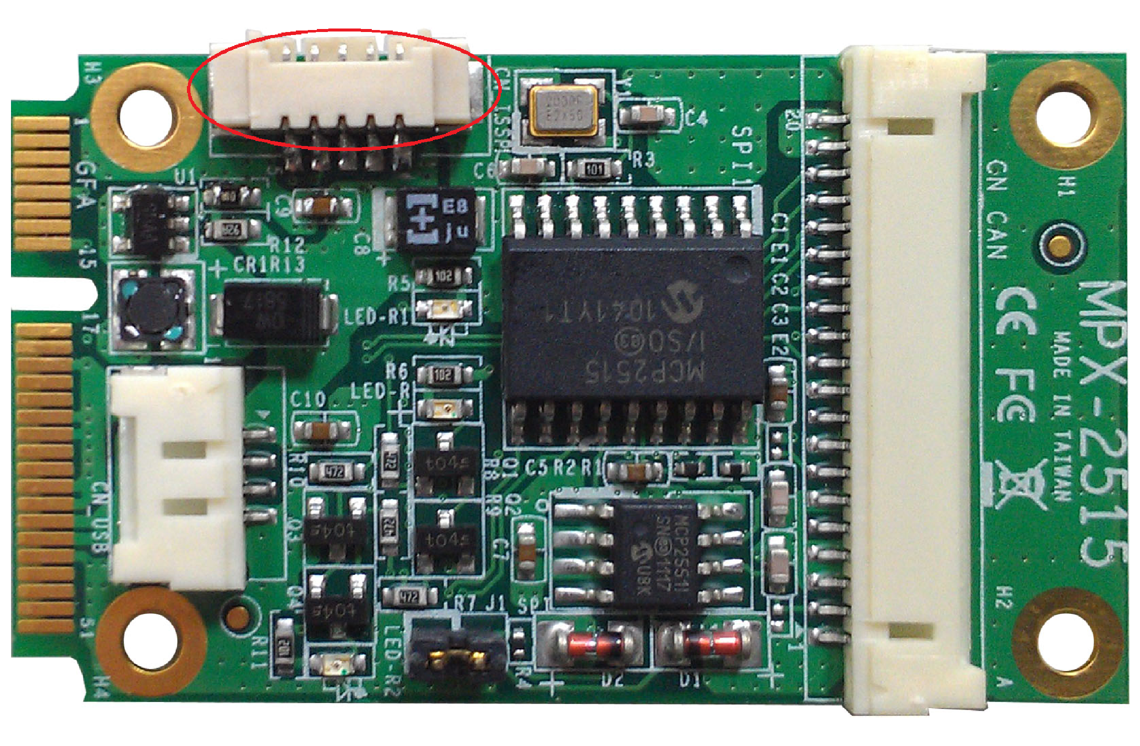


Figure 20 CN_ISSP Connector

1.9 MPX-2515 Card Properties

This section describes all other properties that are not listed above.

1.9.1 USB Properties

This sub-section defines MPX-2515 card USB properties, which include device identifier, device attribute, and endpoints.

- **Vendor ID** = 0xCECE
- **Product ID** = 0x2515
- **USB Device Instance Id:** USB\VID_CECE&PID_2515\1234567, for example.

- **Device String:** "MPX1515 USB-CAN20B Card" is the string shown in the Microsoft Windows platforms.
- **USB Serial Number:** This is a seven digits number, which starts with digit number 1. It looks like 1001234. Every MPX-2515 card has its unique serial number. This serial number can be retrieved by USB default command. Please refer to the example in the SDK chapter.
- **Endpoint 0**: USB default endpoint. USB vendor specific command is implemented in this endpoint.
- **Endpoint 1**: MPX-2515 card implements BULK IN transfer at this endpoint. Application issues a BULK IN transfer to return a response packet from the MPX-2515 card.
- **Endpoint 2:** MPX-2515 card implements BULK OUT transfer at this endpoint. Application then issues a BULK OUT transfer toward this endpoint to ask MPX-2515 firmware to carry out a request packet.
- **Endpoint 3:** INTERRUPT IN transfer. MPX-2515 keep its status in an eight bytes packet so that the application can keep informed by issuing an INTERRUPT IN transfer over this endpoint. Please refer to the CCP chapter for details.
- **Endpoint 4:** BULK IN transfer. Application issues BULK IN transfer over this endpoint to receive all MPX-2515 received CAN messages in a bulk. Please refer to the CCP chapter for details.

The following figure shows the General Properties of the MPX-2515 successfully installed on a Windows system.

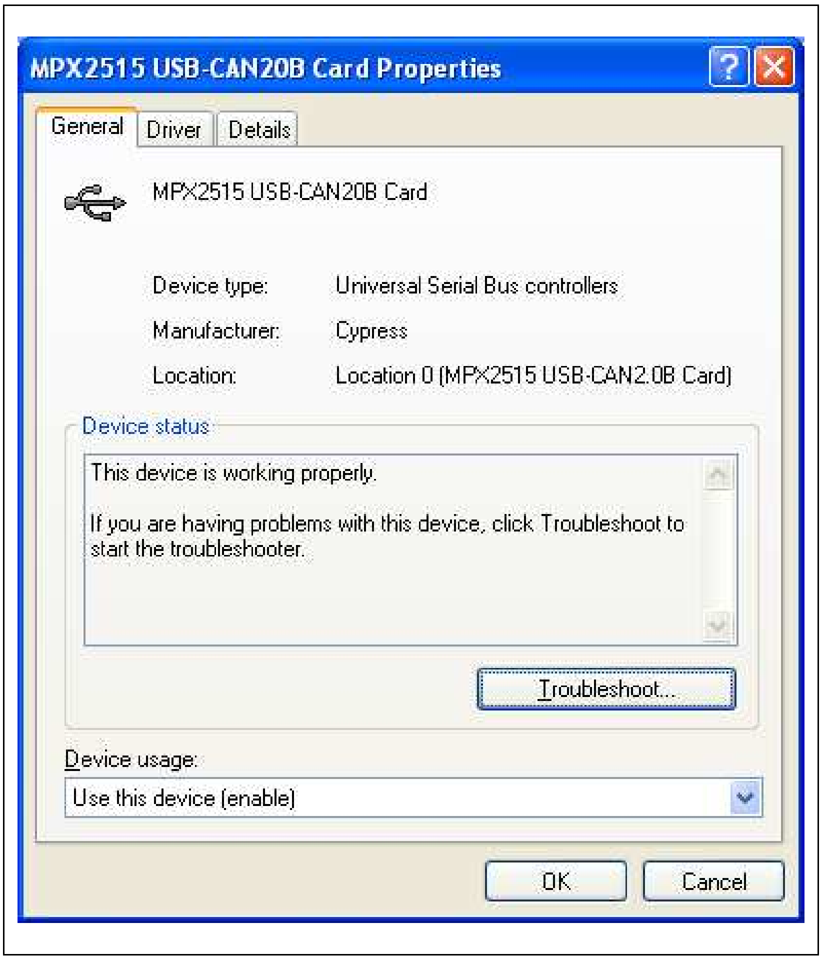


Figure 21 General Properties of MPX-2515

The following figure shows the Device Instance ID of the MPX-2515 on a Windows system.

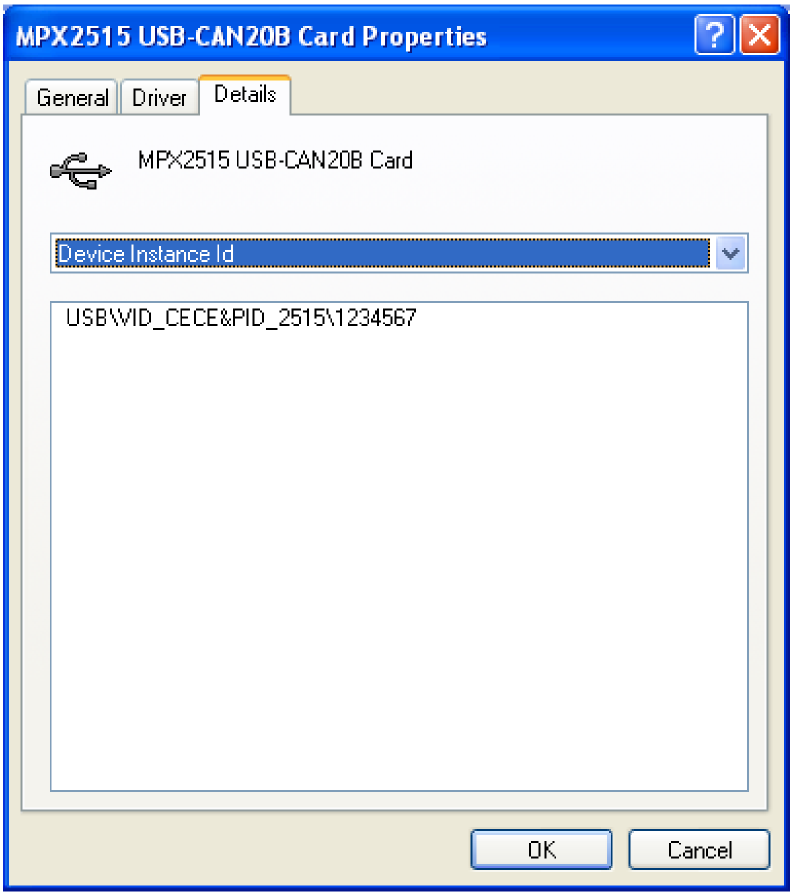


Figure 22 Device Instance ID of MPX-2515

1.9.2 LED Indicators

The following table defines the LED indicators that are used in the MPX-2515 card. Please be noted that these LED indicators can be turned off by the software. CCP provides a command that the application can issue to command MPX-2515 card to either turn on or turn off these LED indicators. Please refer to the CCP section for the format of this command.

POSITION	COLOR	DESCRIPTION
Q2	Red	CAN bus errors
Q3	Green	System timer blinking
Q5	Yellow	CAN bus received/transmit activities

Table 5 MPX-2515 LED Indicators

1.10 OAL-2515 Cable

OAL-2515 cable is used to connect the MPX-2515 CAN 2.0B USB card to the CAN bus. This cable has D-SUB9 standard connector for CAN bus. The OAL-2515 cable is compliant to CiA 303 CANopen Recommendation Par1 Cabling and connector pin assignment.

The following figure shows the drawing of OAL-2515 cable. Please refer to the GSE1205001.pdf (comes in the product CD) for detail information.

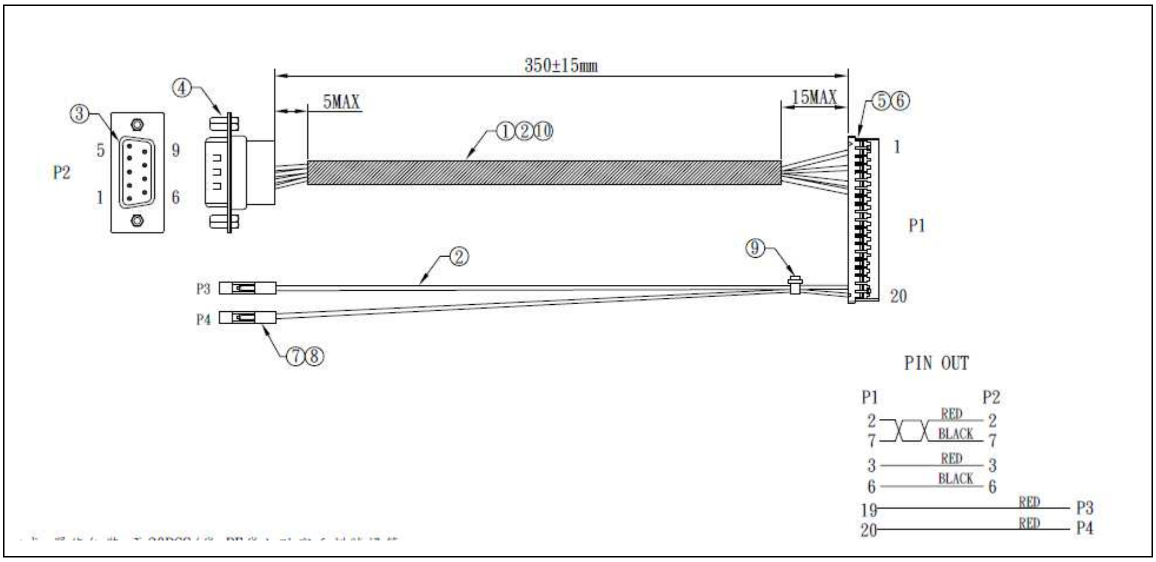


Figure 23 OAL-2515 Drawing

The 9-pin D-SUB male connector is used to connect to a CAN bus network. The following figure shows the 9-pin D-SUB male connector pin outs.

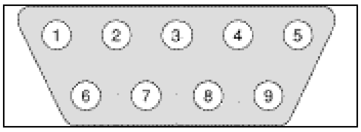


Figure 24 D-SUB Male 9-Pin Connector

The following table defines the pin outs of the 9-pin D-SUB connector for CAN bus.

PIN	NAME	DESCRIPTION
1	N/C	No Connect
2	CAN_L	CAN LOW
3	CAN GND	CAN Ground
4	N/C	No connect
5	N/C	Optional CAN_SHIELD
6	CAN GND	Optional CAN Ground

7	CAN_H	CAN HIGH
8	N/C	No Connect
9	N/C	No Connect

Table 6 OAL-2515 D-SUB9 Male Pin Outs

1.11 OALUSB-H4-1 Cable

The OALUSB-H4-1 cable is used to connect the MPX-2515 CAN 2.0B USB card to a USB host Type A receptacle. The following figure shows its drawing.

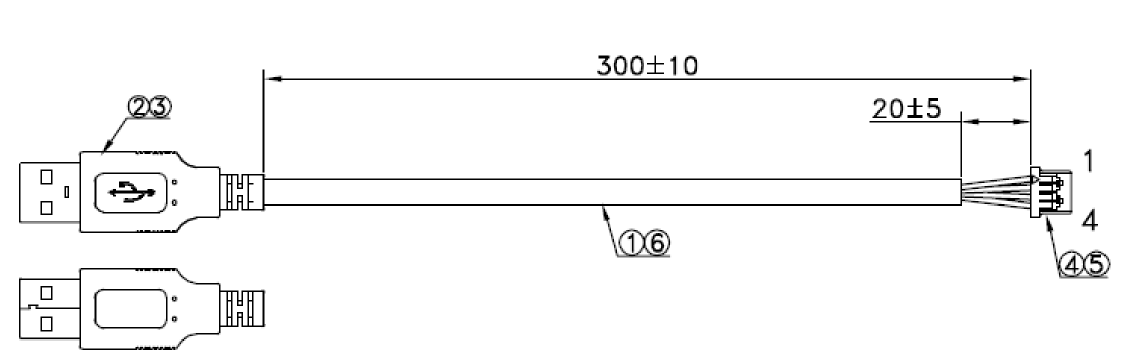


Figure 25 OALUSB-H4-1 Drawing

1.12 OALUSB-H4 Cable

The OALUSB-H4 cable is used to connect the MPX-2515 CAN 2.0B USB card to a USB host pin header on the motherboard. The following figure shows its drawing.

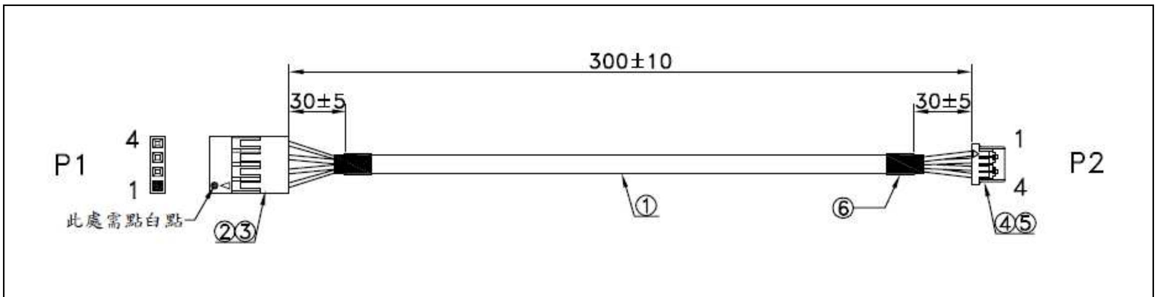


Figure 26 Cable OALUSB-H4 Drawing

Please be noted that the P1 end connects to a USB host pin header on a motherboard while P2 end connects to the CN_USB connector of MPX-2515 card.

1.13 How to Connect

1.13.1 Connect to USB Host via Mini-PCIe Slot

One of the two ways to connect to a USB host is inserting the MPX-2515 card into a Mini-PCIe slot.

You simply insert the MPX-2515 card golden finger portion into an industrial standard Mini-PCIe slot makes this MPX-2515 card connecting to a USB host.

The following figure shows of how to insert MPX-2515 card into a Mini-PCIe slot so that it connects to a USB host.

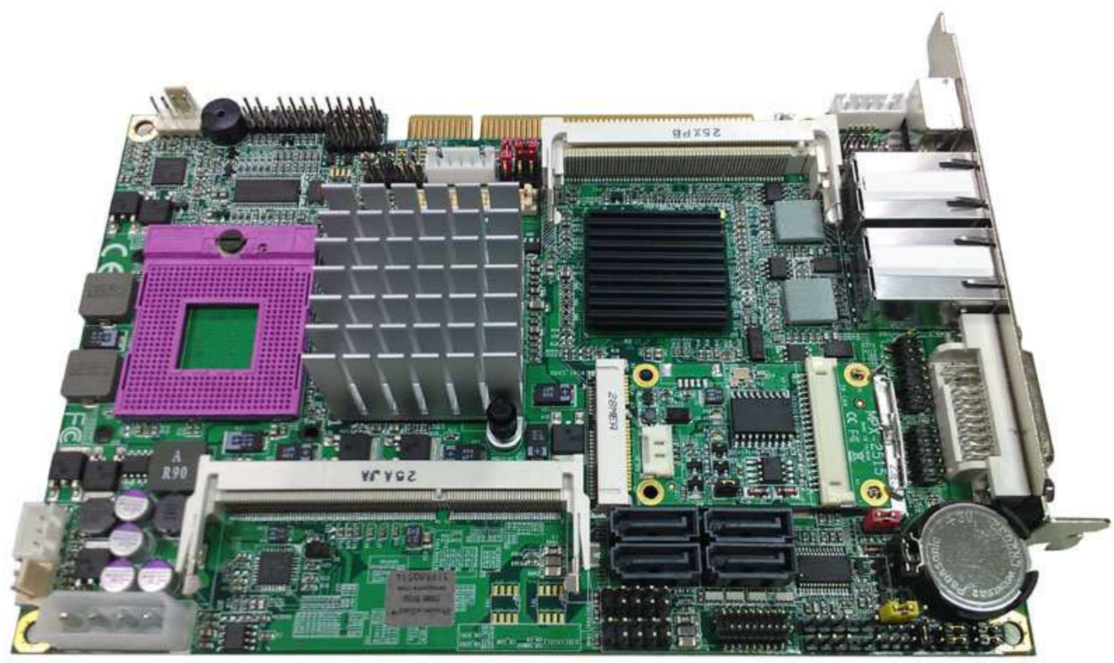


Figure 27 MPX-2515 Card Inserted Into a Mini-PCIe Slot

1.13.2 Connect to USB Host via Cable

You can connect the MPX-2515 card to a USB host by using OALUSB-H4-1 or OALUSB-H4 cable alternatively if a Mini-PCIe slot is not available or you prefer to connect to a USB Host Type A receptacle or your motherboard (like most Commell motherboards) that has USB Host pin header.

Simply connect OALUSB-H4-1 cable to CN_USB connector of MPX-2515 card and the other Type A plug is used to connect to a USB Type A receptacle.

The following figures shows how you use OALUSB-H4-1 cable to connect MPX-2515 card to a PC USB host.

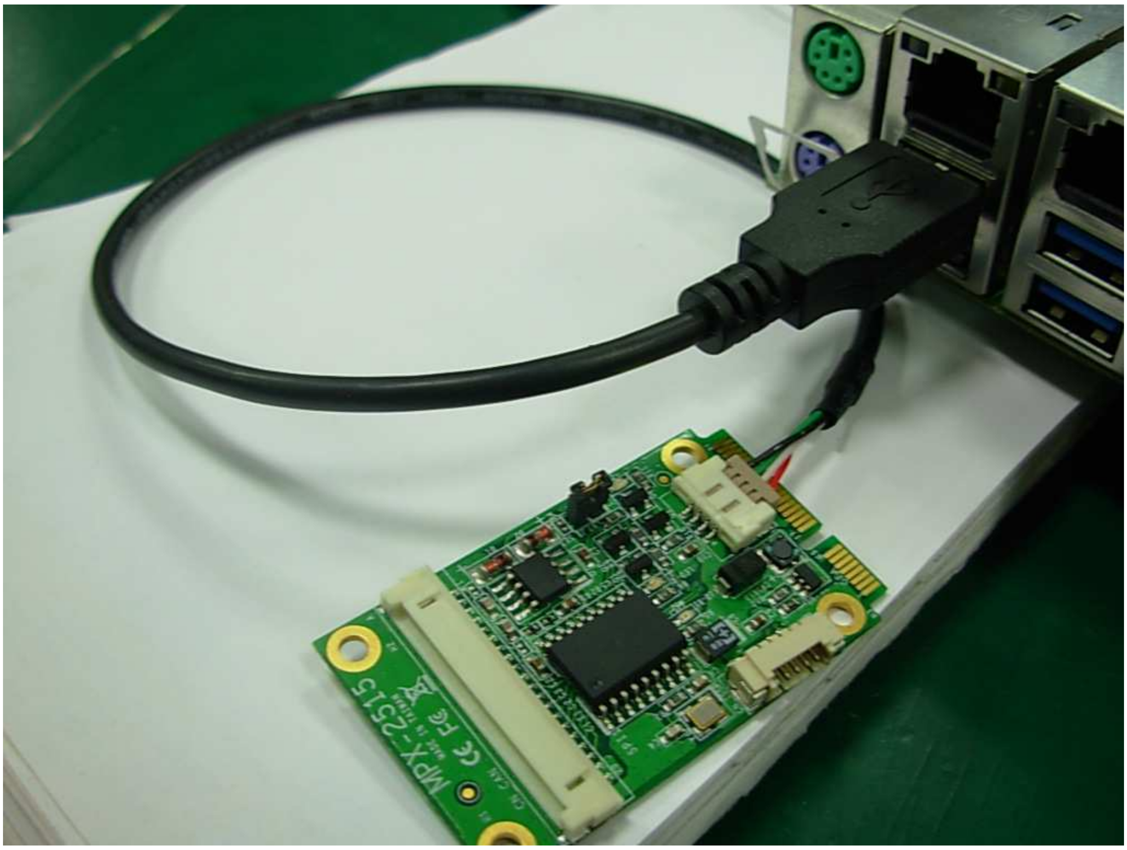


Figure 28 Connect to a USB Host Type A Receptacle

The following figure shows how to use the OALUSB-H4 cable to connect MPX-2515 card to a USB host pin header on a motherboard.

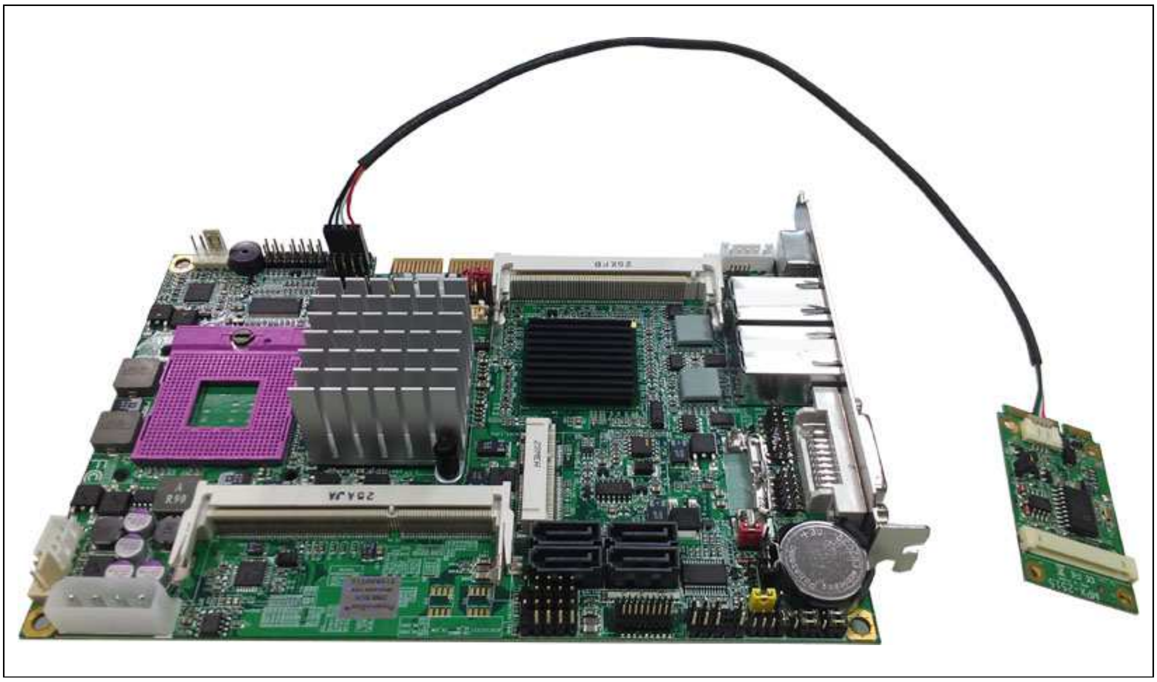


Figure 29 Usage of OALUSB-H4 Cable

1.13.3 Connect to CAN Bus

The following figure shows an example of the CAN bus node connection.

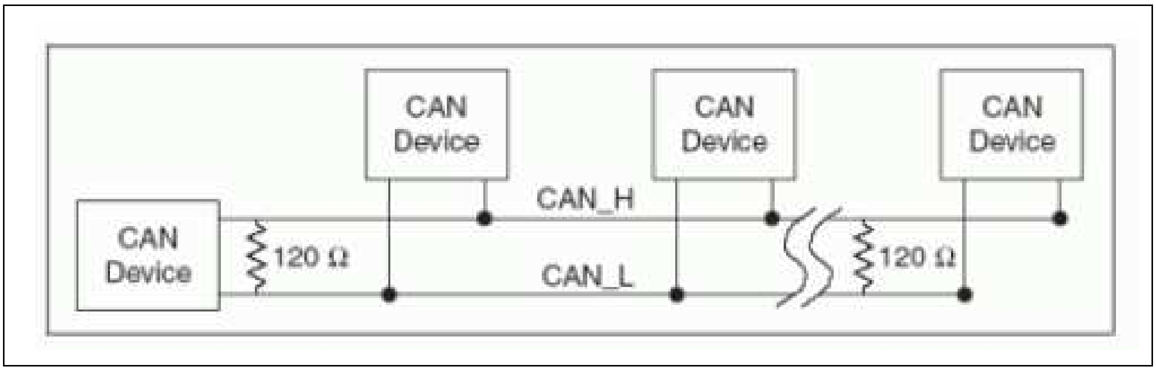


Figure 30 High-Speed CAN Networking

OAL-2515 cable is the cable that connects MPX-2515 card to the CAN bus. OAL-2515 one ends with a 9-pin D-SUB connector for connecting to the CAN bus networking.

Figure 31 MPX-2515 Card Connects to CAN bus

Line Termination

It's important that you need to enable the Line Termination provided on the MPX-2515 card if you are happening to connect the MPX-2515 card to the end of a CAN bus networking. Users enable/disable the line termination by closing/opening the Line Termination Jumper on the MPX-2515 card.

Line Termination

For high-speed CAN, both ends of the pair of signal wires (CAN_H and CAN_L) must be terminated. The termination resistors on a cable should match the nominal impedance of the cable. ISO 11989 requires a cable with a nominal impedance of 120 Ohm. MPX-2515 card provides 120 Ohm resistor for termination. Users enable/disable 120 Ohm line termination by closing/opening the jumper.

2 Device Drivers

This chapter describes how to install the corresponding drivers for your target operating system.

2.1 Device Drivers for Windows

The following figure shows the MPX-2515 card device drivers file organization for different Microsoft Windows systems.

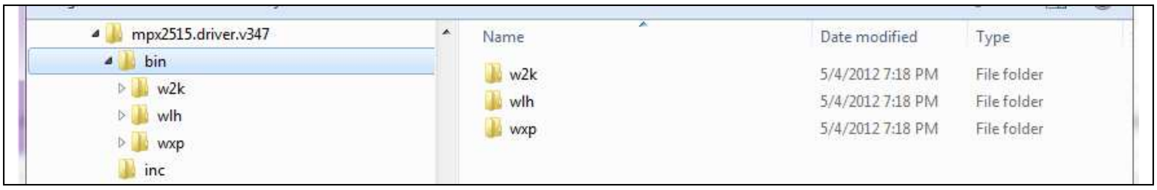


Figure 32 Device Drivers Organization

The following figure shows the Device Driver Properties after the MPX-2515 card has successfully installed.

Figure 33 MPX-2515 Card Device Driver Properties

2.1.1 Windows 2000

The following figure shows the MPX-2515 card device driver for Windows 2000. File path is .\mpx2515.driver.v347\bin\w2k\x86.

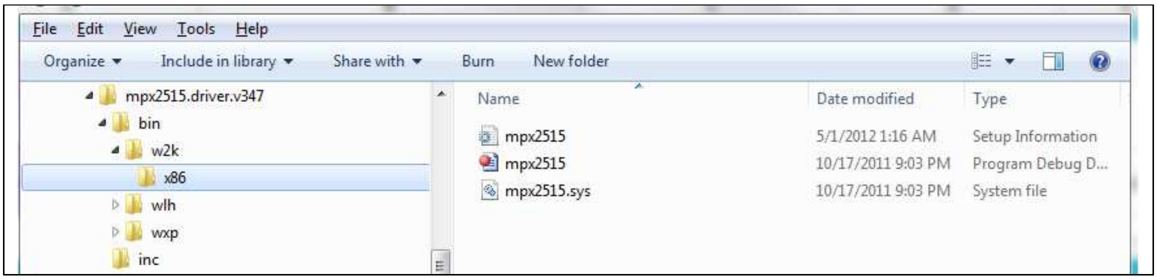


Figure 34 Device Driver for Windows 2000

2.1.2 Windows XP (32-bit) Device Driver

The following figure shows the MPX-2515 card device driver for Windows XP 32-bit version. File path is .\mpx2515.driver.v347\bin\wxp\x86.

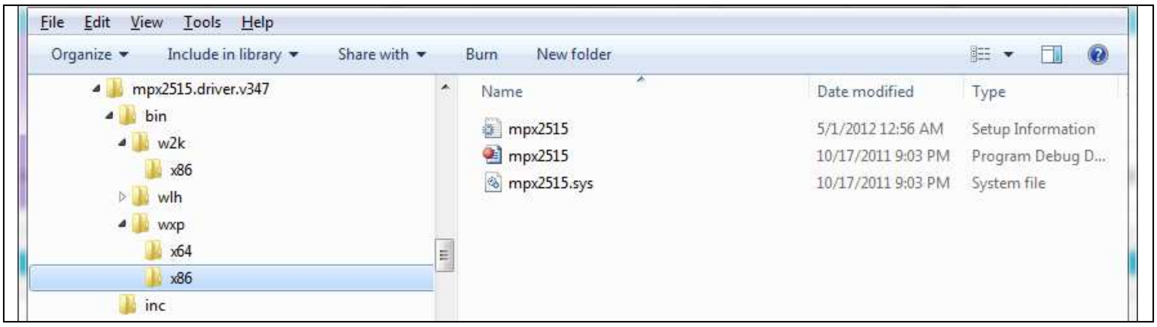


Figure 35 Windows XP 32-bit Device Driver

2.1.3 Windows XP (64-bit) Device Driver

The following figure shows the MPX-2515 card device driver for Windows XP 664-bit version. File path is .\mpx2515.driver.v347\bin\wxp\x64.

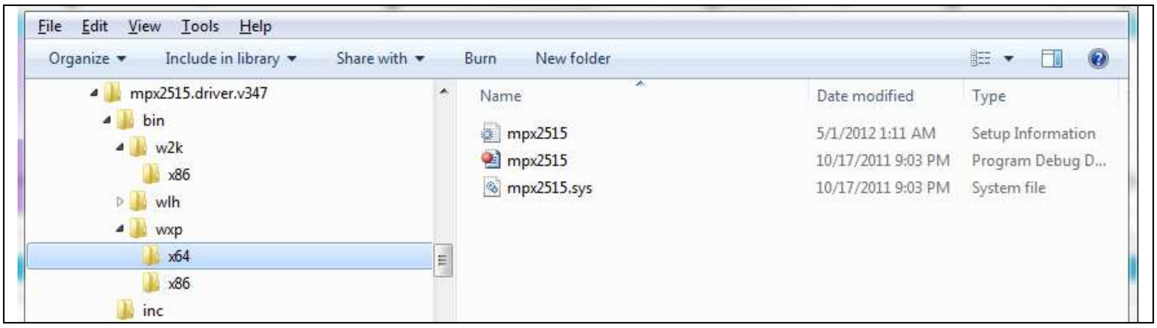


Figure 36 Windows XP 64-bit Device Driver

2.1.4 Windows Vista (32-bit) and Windows 7 (32-bit) Device Driver

The following figure shows the MPX-2515 card device driver for Windows Vista and Windows 7 32-bit version. File path is .\mpx2515.driver.v347\bin\wlh\x86.

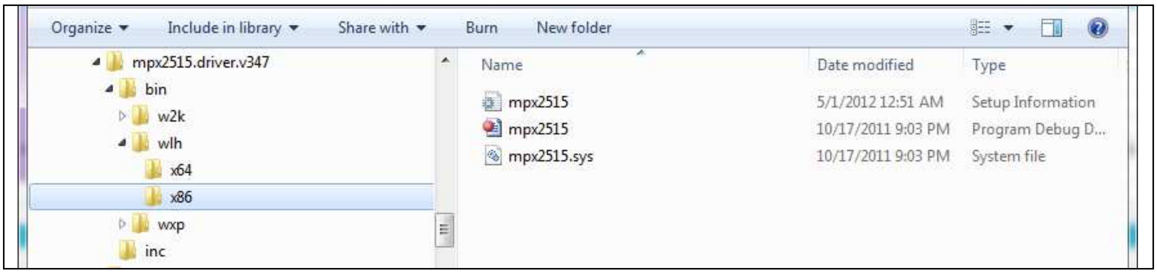


Figure 37 Windows Vista and Windows 7 Device Driver (32-bit)

2.1.5 Windows Vista (64-bit) and Windows 7 (64-bit) Device Driver

The following figure shows the MPX-2515 card device driver for Windows Vista and Windows 7 64-bit version. File path is .\mpx2515.driver.v347\bin\wlh\x64.

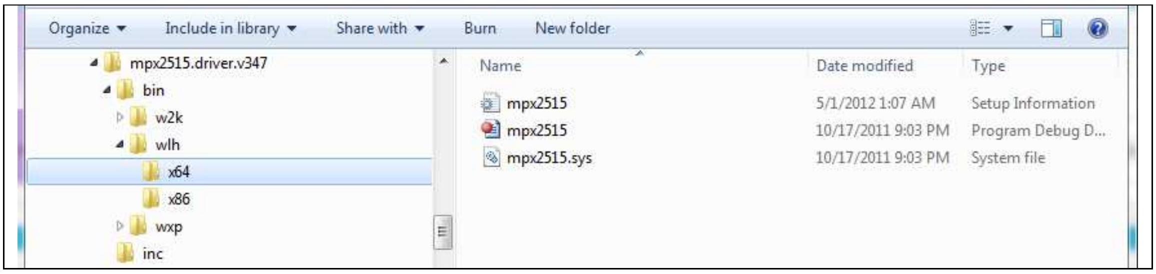


Figure 38 Windows Vista and Windows 7 Device Driver (64-bit)

2.2 How to Install Device Driver

This section describes the procedure to install the MPX-2515 card device driver for your target Microsoft Windows platform.

Have your product CD ready to be accessed by your Windows. Connect the MPX-2515 card through USB via one of the three methods mentioned in the previous sections and following the device driver setup instructions. The following screen shots will give you a detail ideal of the device driver setup procedure.

3 Firmware Update

3.1 Introduction

The MPX-2515 implements a bootloader that can reprogram the CY8C24794 device over the USB interface. The bootloading information can be sent through Cypress USB Bootloader Host interface

The USB bootloader supports a fully functional device reprogramming ability with built in error detection and an industry standard communication interface.

This chapter describes the steps of updating the firmware for MPX-2515 card via Cypress bootloader feature.

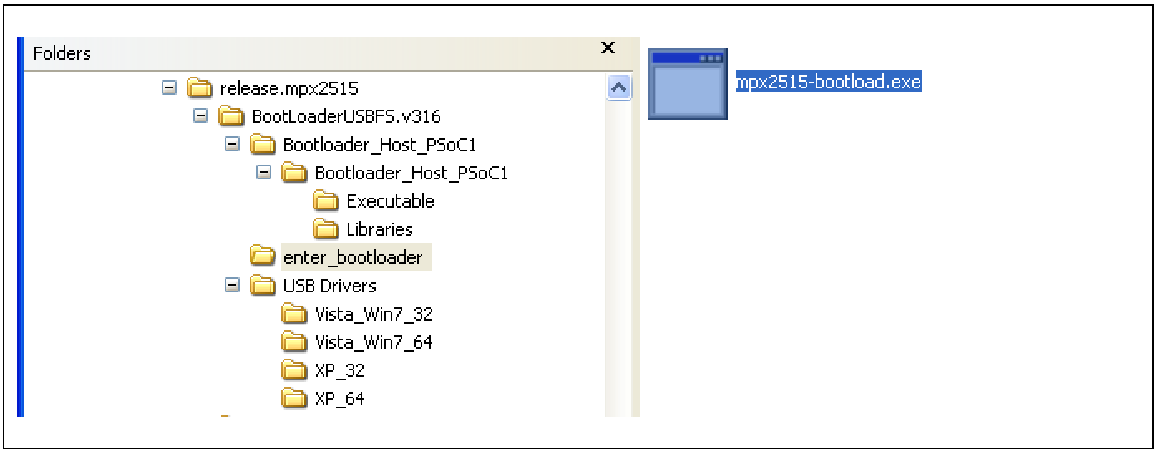
- Have bootloader device drivers ready. bootloader device drivers are different with MPX-2515 device drivers. Bootloader device drivers are come with the production CD. This procedure runs only at the first time firmware update.
- Enter bootloader mode. Please refer to 3.2 for detail description.
- Install bootloader device driver. Only in the first time update.
- Execute bootloader host application. Please refer to 3.4 for detail information. This completes the update procedure.

3.2 Enter Boot Loader

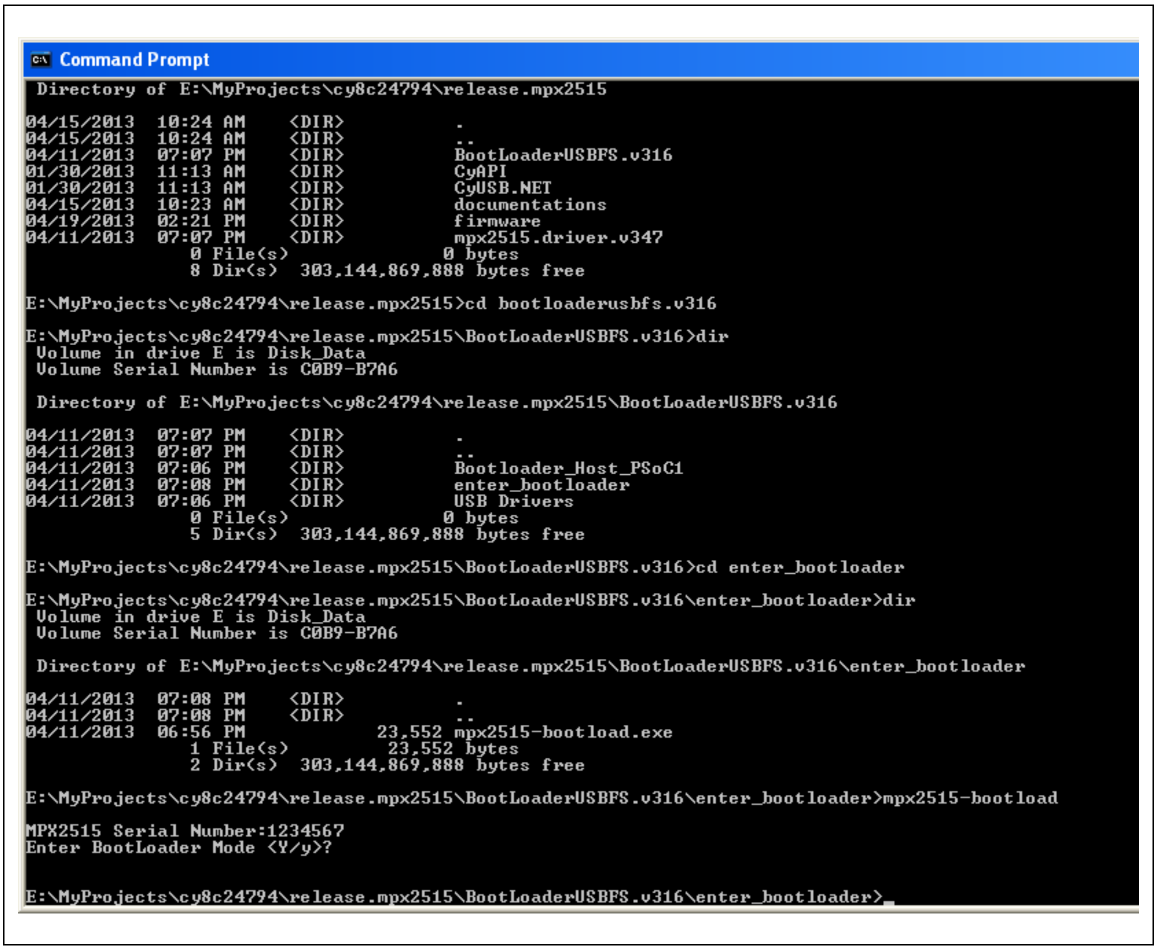
The MPX-2515 firmware needs to be in the bootloader mode in order to take bootloader commands from the PC USB host application.

Commell provides a DOS utility to put MPX-2515 firmware into bootloader mode. Please have the MPX-2515 card well connecting to the PC USB host platform before proceeding the update process.

The following figure shows where the enter bootloader DOS utility locates in the production CD.

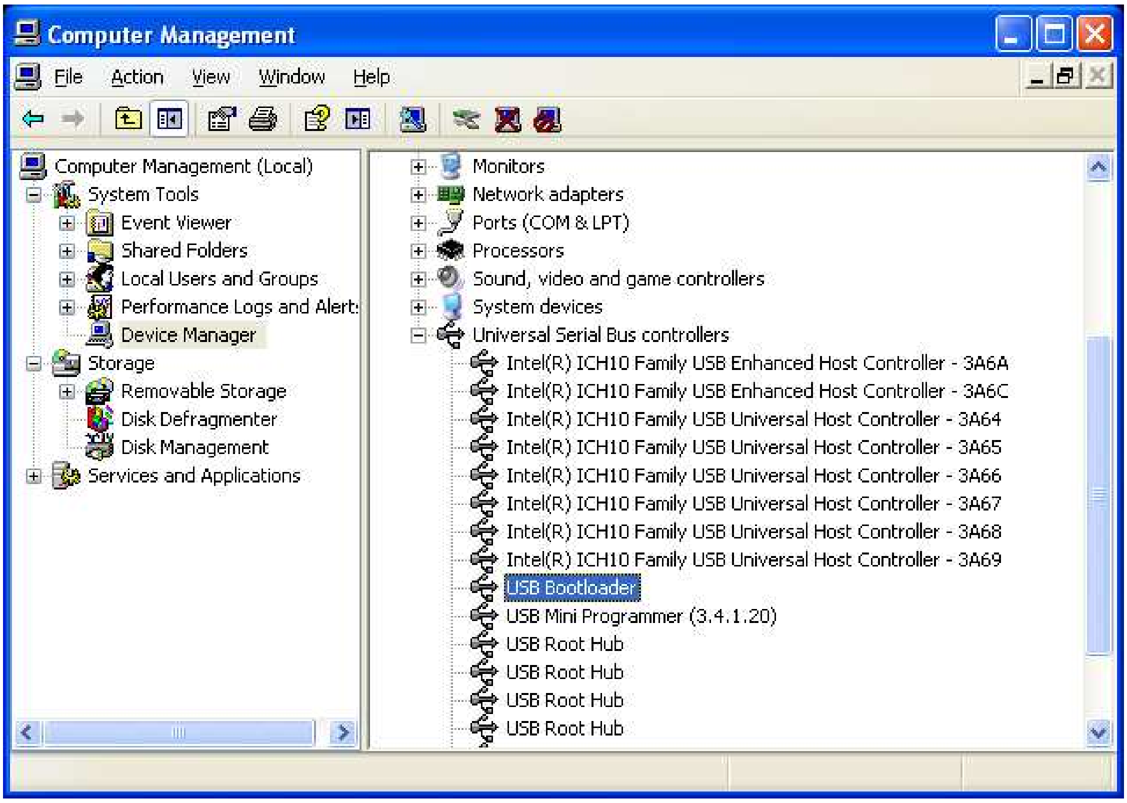


The following figure shows how this mpx2515-bootload.exe is running.




```
 Directory of E:\MyProjects\cy8c24794\release.mpx2515

04/15/2013  10:24 AM    <DIR>          .
04/15/2013  10:24 AM    <DIR>          ..
04/11/2013  07:07 PM    <DIR>          BootLoaderUSBFS.v316
01/30/2013  11:13 AM    <DIR>          CyAPI
01/30/2013  11:13 AM    <DIR>          CyUSB.NET
04/15/2013  10:23 AM    <DIR>          documentations
04/19/2013  02:21 PM    <DIR>          firmware
04/11/2013  07:07 PM    <DIR>          mpx2515.driver.v347
               0 File(s)              0 bytes
               8 Dir(s)  303,144,869,888 bytes free

E:\MyProjects\cy8c24794\release.mpx2515>cd bootloaderusbfs.v316

E:\MyProjects\cy8c24794\release.mpx2515\BootLoaderUSBFS.v316>dir
 Volume in drive E is Disk_Data
 Volume Serial Number is C0B9-B7A6

 Directory of E:\MyProjects\cy8c24794\release.mpx2515\BootLoaderUSBFS.v316

04/11/2013  07:07 PM    <DIR>          .
04/11/2013  07:07 PM    <DIR>          ..
04/11/2013  07:06 PM    <DIR>          Bootloader_Host_PSoC1
04/11/2013  07:08 PM    <DIR>          enter_bootloader
04/11/2013  07:06 PM    <DIR>          USB Drivers
               0 File(s)              0 bytes
               5 Dir(s)  303,144,869,888 bytes free

E:\MyProjects\cy8c24794\release.mpx2515\BootLoaderUSBFS.v316>cd enter_bootloader

E:\MyProjects\cy8c24794\release.mpx2515\BootLoaderUSBFS.v316\enter_bootloader>dir
 Volume in drive E is Disk_Data
 Volume Serial Number is C0B9-B7A6

 Directory of E:\MyProjects\cy8c24794\release.mpx2515\BootLoaderUSBFS.v316\enter_bootloader

04/11/2013  07:08 PM    <DIR>          .
04/11/2013  07:08 PM    <DIR>          ..
04/11/2013  06:56 PM            23,552 mpx2515-bootload.exe
               1 File(s)         23,552 bytes
               2 Dir(s)  303,144,869,888 bytes free

E:\MyProjects\cy8c24794\release.mpx2515\BootLoaderUSBFS.v316\enter_bootloader>mpx2515-bootload

MPX2515 Serial Number:1234567
Enter BootLoader Mode (Y/y)?

E:\MyProjects\cy8c24794\release.mpx2515\BootLoaderUSBFS.v316\enter_bootloader>_
```

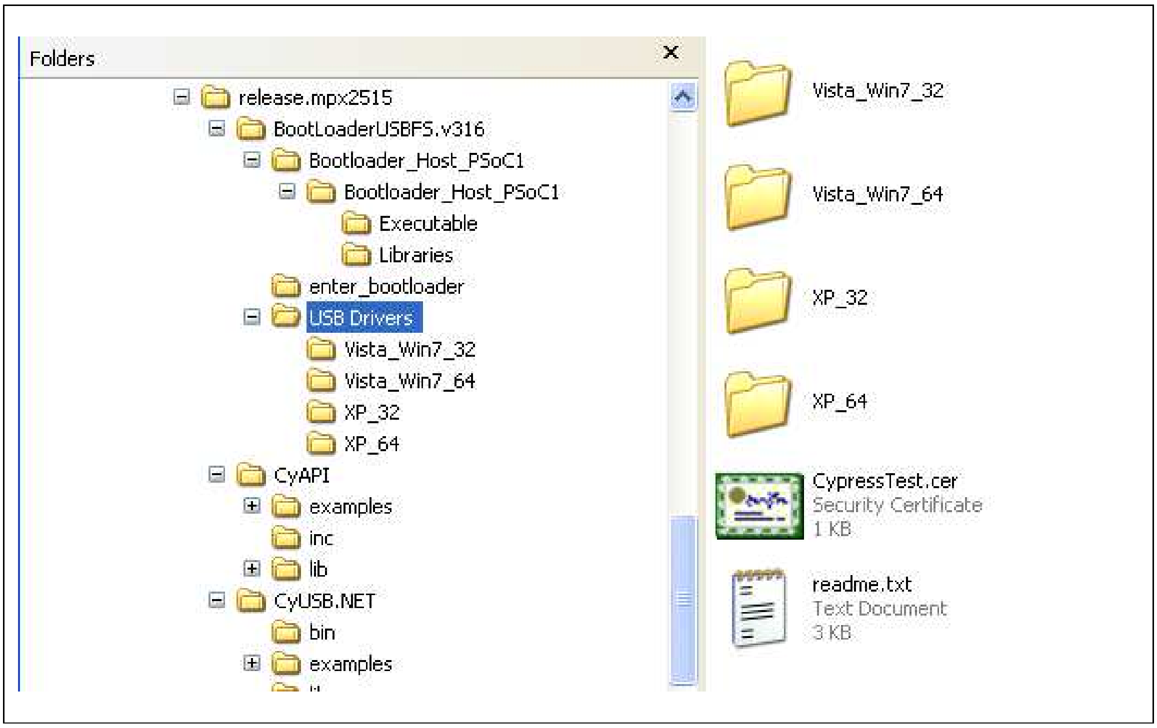
You check whether the MPX-2515 is in bootloader mode or not via checking the "USB Bootloader" device in USB category of the Device Manager. The following figure shows the MPX-2515 has been changed to the "USB Bootloader" mode.



3.3 Install Boot Loader Device Driver

You will be prompted by the Windows if the MPX-2515 card is entering the bootloader mode in the first time.

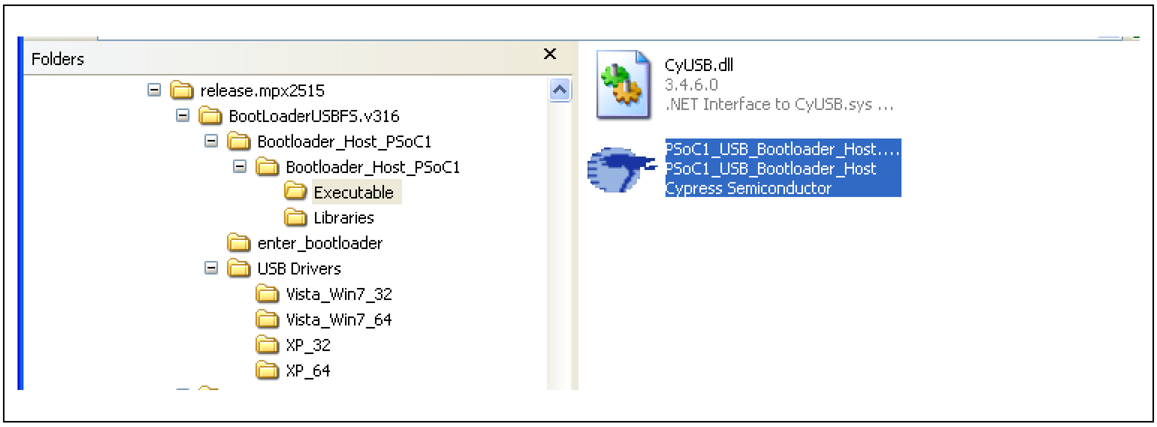
The following figure shows all possible USB Bootloader mode device drivers for Microsoft Windows Systems. Please pick up the one that meets your installing operating system.



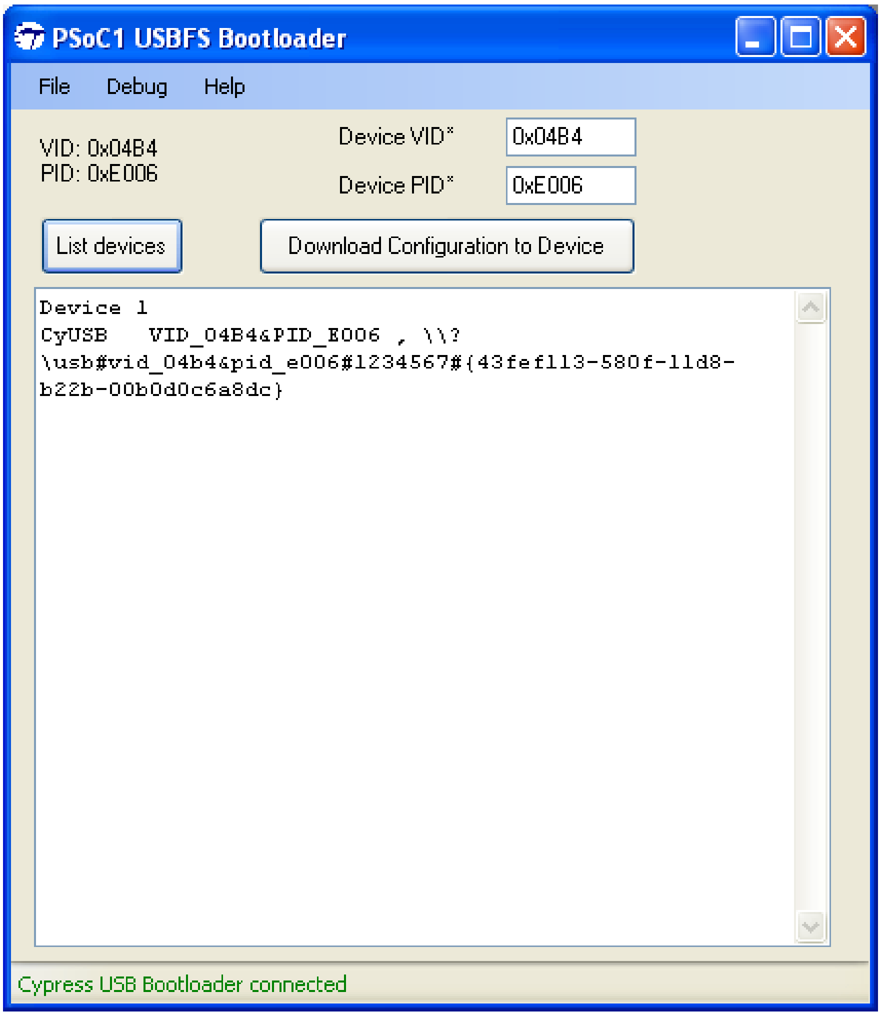
Please follows the Device Driver Installation Wizard to install a appropriate device driver from the provided USB Bootloader device drivers folders.

3.4 Boot Loader Host Application

The MPX-2515 firmware now is ready to be updated. Launch the Cypress Bootloader host application. The following figure shows where is this bootloader host application.

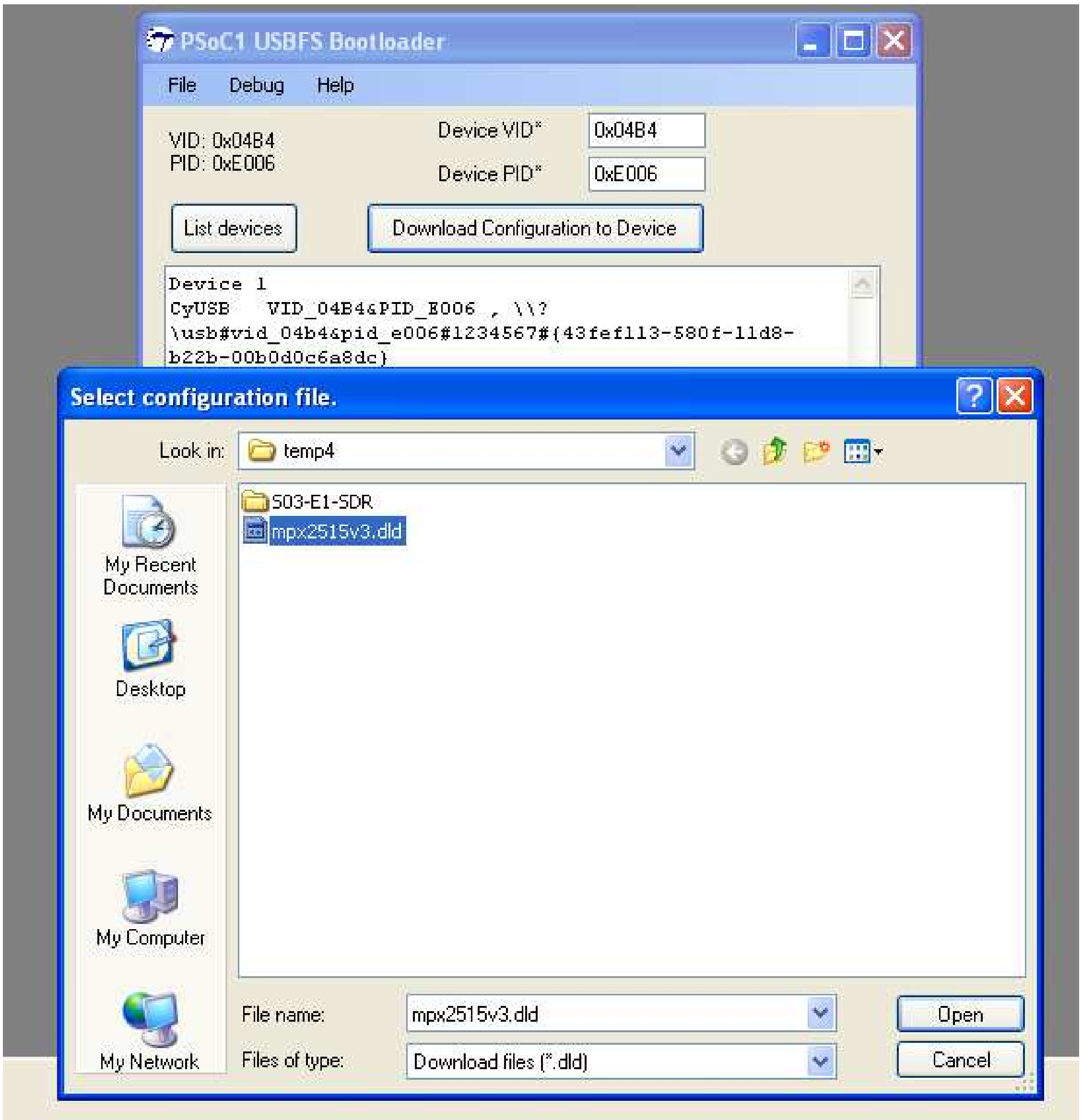


The following figure shows how the PSoC1_USB_Bootloader_Host_Application is running.



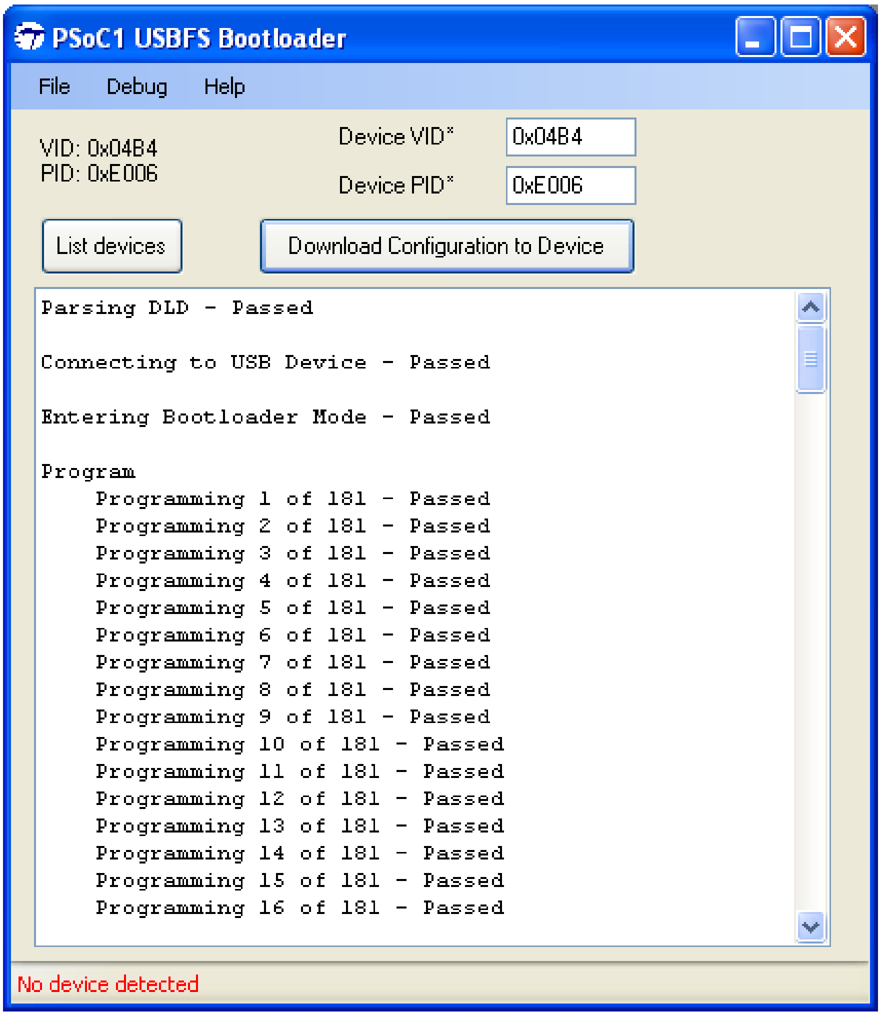
List devices ---> This program lists devices that are in bootloader mode by clicking the "List devices" button.

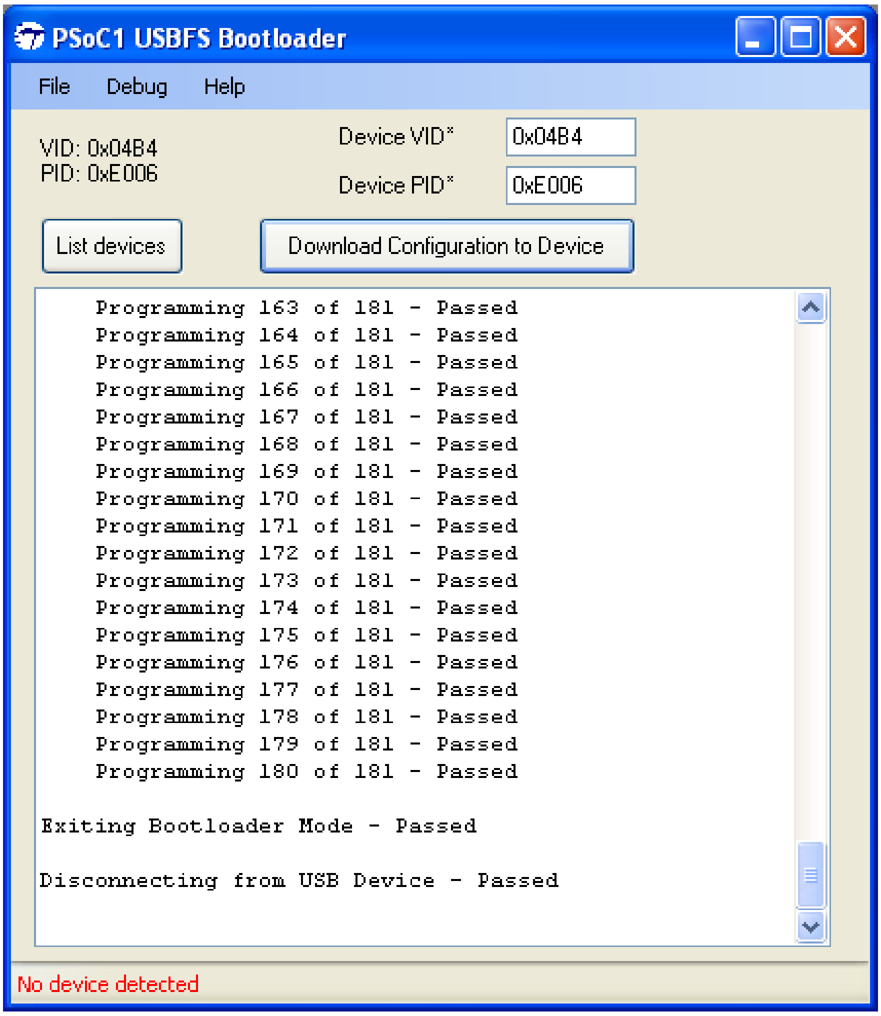
Download Configuration to device ---> Click on this button to choose the new configuration file to reprogram the MPX-2515 firmware. The following file dialog shows after this button has been clicked.



Choose the .DLD file that released from Commell to proceed the new firmware updating process.

The following figures show the updating messages during the update process.


PSoC1 USBFS Bootloader
File Debug Help
VID: 0x04B4
PID: 0xE006
Device VID* 0x04B4
Device PID* 0xE006
List devices
Download Configuration to Device
Parsing DLD - Passed
Connecting to USB Device - Passed
Entering Bootloader Mode - Passed
Program
Programming 1 of 181 - Passed
Programming 2 of 181 - Passed
Programming 3 of 181 - Passed
Programming 4 of 181 - Passed
Programming 5 of 181 - Passed
Programming 6 of 181 - Passed
Programming 7 of 181 - Passed
Programming 8 of 181 - Passed
Programming 9 of 181 - Passed
Programming 10 of 181 - Passed
Programming 11 of 181 - Passed
Programming 12 of 181 - Passed
Programming 13 of 181 - Passed
Programming 14 of 181 - Passed
Programming 15 of 181 - Passed
Programming 16 of 181 - Passed
No device detected



You are now completed the MPX-2515 firmware update process.

3.5 In Case Failed

Here is the steps to following if the firmware update process is failed.

- Keep the Cypress Bootloader Host Application running still.
- Disconnect the MPX-2515 card from the USB receptacle.
- Re-insert the MPX-2515 card into the same USB receptacle.

- Repeat the update procedures.

4 Reference

[1] CY8C24x94 PSoC Programmable System-on-Chip Technical Reference Manual (TRM). Cypress Document No. 001-14463 Rev. *E.

[2] MCP2515 Stand-Alone CAN Controller With SPI Interface DS21801F, Microchip.

[3] MCP2551 High-Speed CAN Transceiver DS21667F, 2010 Microchip.

[4] Microsoft Visual Studio 2010 Help, Microsoft.

[5] CiA 301 CANopen application layer and communication profile version 4.2.0, 21 February 2011, CAN in Automation.

[6] CiA 103 Intrinsically safe capable physical layer version 1.0.0, February 2010, CAN in Automation.

[7] CiA 303 CANopen Recommendation Part 1 Cabling and connector pin assignment Version 1.8.0, 27 April 2012, CAN in Automation.

[8] A CAN Physical Layer Discussion, AN228, DS00228A, 2002 Microchip.

MPX-2515 Programmer’s Guide

Commell MPX-2515 CAN 2.0B USB card features USB 2.0 to CAN 2.0B bus interface in Mini-PCIe form factor. This MPX-2515 Programmer's Guide provides the Commell CAN Protocol (CCANP), which is the protocol used in between the USB host side and the firmware of the MPX-2515 card. Command packets and response packets are defined and carried through the CCANP. Microsoft Windows programmers use the CCP to request the MPX-2515 firmware to execute the commands defined in the CCANP.

Contents

1 Commell CAN Protocol

1.1 Introduction

This chapter defines the Commell CAN Protocol (CCANP), which is used to carry CAN bus request packets from the USB host side to the USB device side (MPX-2515). After the MPX-2515 firmware executed the request packet, the USB host side application then retrieves the corresponding response packet from the MPX-2515 firmware.

The MPX-2515 firmware implements four endpoints to facilitate the CCANP and therefore the host applications.

- Endpoint 1 - The endpoint 1 implements the Bulk In transfers. The USB host applications read endpoint 1 to return response packets.

- Endpoint 2 - The endpoint 2 implements the Bulk Out transfers. The USB host applications write request packets to this endpoint in order for the MPX-2515 firmware to carry on the requested command.

- Endpoint 3 - Endpoint 3 implements the Interrupt In transfer. The USB host applications can hence read the interrupt in packet at anytime in order to realize some important status of the MPX-2515 firmware.

- Endpoint 4 - In order to speed up the process on the received CAN messages, an endpoint 4 was implemented to allow the USB host applications to read the Firmware Message Buffer (FMB) at anytime. The MPX-2515 firmware updates this buffer very often. The USB host applications determine the received messages by checking the timestamp and other information incorporated in the header of the FMB.

The following figure shows the transaction types and operation sequences of CCANP.

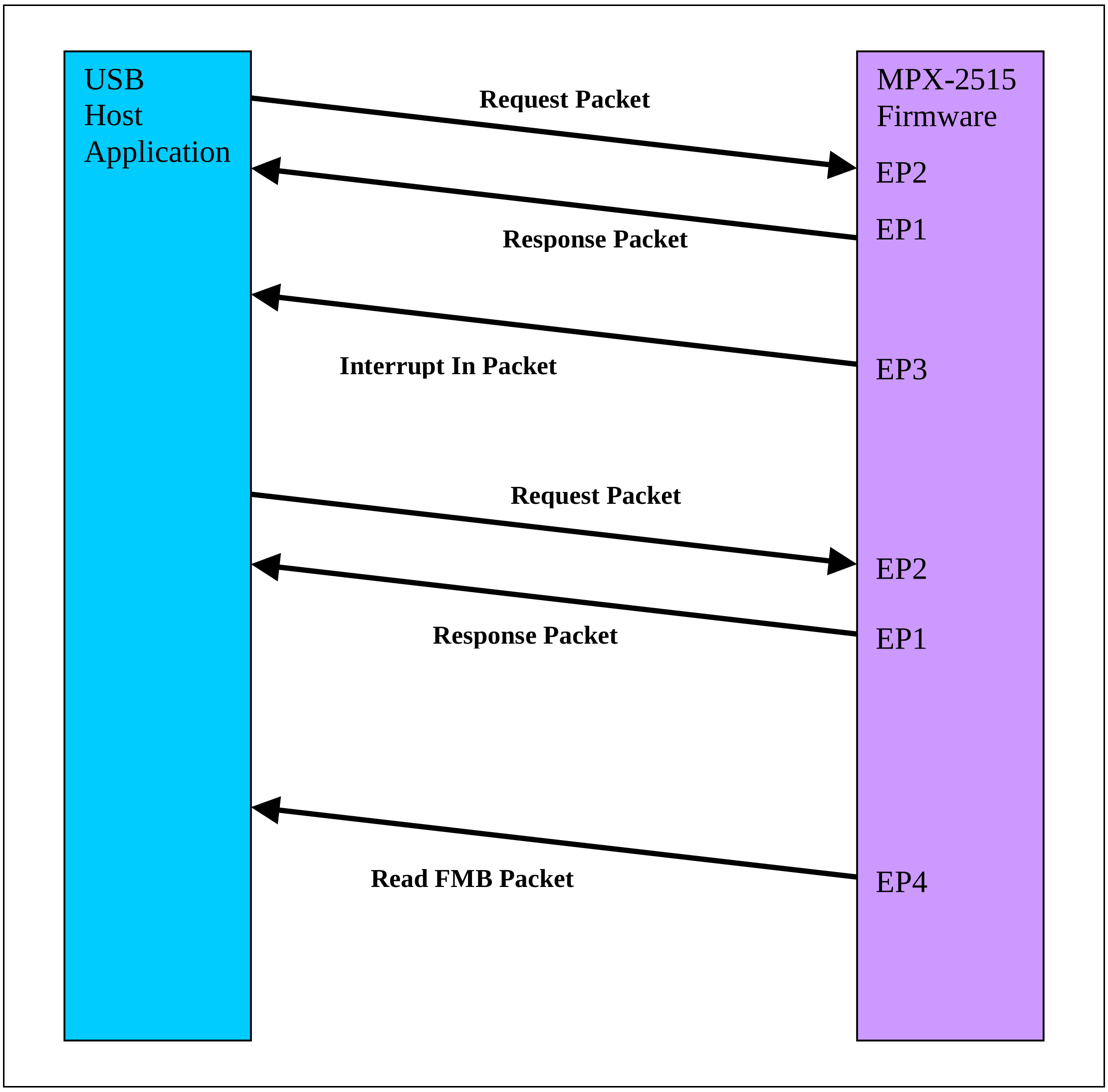


Figure 1 CCANP Transactions and Operation Sequences

A response packet is corresponding to a request packet. And hence USB host applications usually first issue a CCANP Request Packet to the MPX-2515 card via a BULK OUT (at endpoint 2) transfer and then issue a CCP Response Packet to the MPX-2515 card via a BULK IN (at endpoint 1) transfer. The application should always check the Status Code filed in the response packet in order to determine the final status of the corresponding request carried out in the connected CAN bus.

1.2 Interrupt In Packet

The MPX-2515 card provides status packet that the USB host can read out in order to realize the status of the MPX-2515 controller as well as the connecting CAN bus activities.

This status packet can be obtained via issuing an INTERRUPT IN transfer over the endpoint 3 of the MPX-2515 card. This status packet contains eight bytes per packet. This section defines each byte of the status packet.

Please be noted that interrupt in transfers can be issued at anytime. MPX-2515 applications are encouraged to retrieve the status packets often in order to check out the status that the application has concerned.

The following table defines the format of the Status Packet. MPX-2515 application programmers can also refer to the Microchip MCP2515 data sheet for more information.

OFFSET	BYTE	NAME
0	1	READ STATUS INSTRUCTION (return byte) **Bit 7 CANNTF.TX2IF** **Bit 6 TXB2CNTRL.TXREQ** **Bit 5 CANINTF.TX1IF** **Bit 4 TXB1CNTRL.TXREQ** **Bit 3 CANINTF.TX0IF** **Bit 2 TXB0CNTRL.TXREQ** **Bit 1 CANINTFL.RX1IF** **Bit 0 CANINTF.RX0IF**
1	1	RX STATUS INSTRUCTION (return byte): **Bit 7:6 Receive Message** 00: No RX message 01: Message in RXB0 10: Message in RXB1 11: Messages in both buffers **Bit 5 Don't Care** **Bit 4:3 Message Type Received** 00: Standard data frame 01: Standard remote frame 10: Extended data frame 11: Extended remote frame **Bit 2:1:0 Filter Match** 000: RXF0 001: RXF1 010: RXF2 011: RXF3 100: RXF4 101: RXF5 110: RXF0 (rollover to RXB1) 111: RXF1 (rollover to RXB1)
2	1	EFLG - ERROR FLAG **Bit 7 RX1OVR:** Receive Buffer 1 overflow flag bit. **Bit 6 RX0OVR:** Receive Buffer 0 overflow flag bit. **Bit 5 TXBO:** Bus-Off Error flag bit

		Bit 4 TXEP: Transmit Error-Passive flag bit. **Bit 3 RXEP:** Receive Error-Passive flag bit. **Bit 2 TXWAR:** Transmit Error Warning flag bit. **Bit 1 RXWAR:** Receive Error Warning flag bit. **Bit 0 EWARN:** Error Warning flag bit.
3	1	Firmware Message Buffer (FMB) status: **Bit 7:6:5:4:3 Buffer 2 Overwritten Number** This number increases by value of one if a CAN message has arrived and has overwritten at Buffer 2 storage prior to the previous stored has read back by the USB host. **Bit 2 Buffer 2 Indicator** 0 / 1: empty / occupied **Bit 1 Buffer 1 Indicator** 0 / 1: empty / occupied **Bit 0 Buffer 0 Indicator** 0 / 1: empty / occupied
4	1	Reserved.
5	1	Reserved.
6	1	Reserved.
7	1	Reserved.

Table 1 Status Packet Format

1.3 Request Packet vs. Response Packet

This section defines the format of Request Packet as well as the format of Response Packet. At this moment, both Request Packets and Response Packets are limited to 64 bytes per packet.

The Request Packet is used to send command to the CY8C24794 micro controller in the MPX-2515 CAN USB Card to carry out over the connecting CAN bus. A Request Packet is sent to endpoint 2 of the MPX-2515 card through a BULK OUT transfer.

While, the Response Packet is used to retrieve the result of an executed command from the CY8C24794 micro controller. A Response Packet is returned from endpoint 1 of the MPX-2515 card through a BULK IN transfer.

The following table defines the Request Packet used in CCA-P.

OFFSET	NAME	DESCRIPTION
0	HEADER_MSB	0X55
1	HEADER_LSB	0XAA
2	VERSION	0X01
3	SIZEOF_DATA	The number of bytes residing in the DATA field.

4	COMMAND	The command category code.
5	ERROR	0X00
6	DATA_0 or COMMAND_0	Byte 0 of the data field or command_0 byte.
7	DATA_1 or COMMAND_1	Byte 1 of the data filed or command_1 byte.
8	DATA_2 or COMMAND_2	Byte 2 of the data field or command_2 byte.
9	DATA_3 or COMMAND_3	Byte 3 of the data field or command_3 byte.
10 to N	DATA	The DATA field; up to 53 bytes.
N+1	CHECKSUM	2's complement checksum of all fields except this checksum field.

Table 2 CCANP Request Packet Format

The following table defines the format of CCAP Response Packet.

OFFSET	NAME	DESCRIPTION
0	HEADER_MSB	0X66
1	HEADER_LSB	0XBB
2	VERSION	0X01
3	SIZEOF_DATA	The number of bytes residing in the DATA field.
4	COMMAND	The corresponding command category code.
5	ERROR	The error code.
6 to N	DATA	The DATA field; up to 57 bytes.
N+1	CHECKSUM	2's complement checksum of all fields except this checksum field.

Table 3 CCANP Response Packet Format

1.4 Defined Constants

This section defines constants used in MPX-2515 programming. Please be noted that all these constants are defined in C programming language style.

```
/* COMMAND: Service code */
#define CCP_CAN_SYSTEM_SERVICE  0X20
#define CCP_CAN_RX_MASKS_FILTERS  0X22
#define CCP_CAN_TX  0X23
#define CCP_CAN_BIT_MODIFY  0X25
#define CCP_CAN_READ_FMB  0X26

/* DATA_0: sub-command code */
#define CAN_GET_INFO  0X01
#define CAN_GET_TICKCOUNT  0X02
```

```
#define CAN_SET_LED_SWITCH  0X03
#define CAN_SET_TRANSFER_RATE  0X04
#define CAN_RESET_INSTRUCT  0X85

#define MCP_RX_MASK_0  0X20
#define MCP_RX_MASK_1  0X24
#define MCP_RX_FILTER_0  0X00
#define MCP_RX_FILTER_1  0X04
#define MCP_RX_FILTER_2  0X08
#define MCP_RX_FILTER_3  0X10
#define MCP_RX_FILTER_4  0X14
#define MCP_RX_FILTER_5  0X18

#define MCP_LOAD_TXB0SIDH  0X40
#define MCP_LOAD_TXB0D0  0X41
#define MCP_LOAD_TXB1SIDH  0X42
#define MCP_LOAD_TXB1D0  0X43
#define MCP_LOAD_TXB2SIDH  0X44
#define MCP_LOAD_TXB2D0  0X45
#define MCP_ABORT_TXB0  0X38
#define MCP_ABORT_TXB1  0X48
#define MCP_ABORT_TXB2  0X58

/* MCP2515 Register Address */
#define RXM0SIDH  0X20
#define RXM1SIDH  0X24
#define RXF0SIDH  0X00
#define RXF1SIDH  0X04
#define RXF2SIDH  0X08
#define RXF3SIDH  0X10
#define RXF4SIDH  0X14
#define RXF5SIDH  0X18

/* Others */
#define EP1  1 /* Endpoint 1 */
#define EP2  2 /* Endpoint 2 */
#define EP3  3 /* Endpoint 3 */
#define EP4  4 /* Endpoint 4 */
```

1.5 CCP_CAN_SYSTEM_SERVICE

The CCP_CAN_SYSTEM_SERVICE uses 0X20 as its command category service code. This service however contains several sub-services, which are identified by the Sub-Command Codes that is starting at the first byte of the DATA field. This section defines this service.

1.5.1 CAN_GET_INFO

The CAN_GET_INFO command returns the USB vendor ID, product ID, and the firmware version of the targeted MPX-2515 card.

```
#define CCP_CAN_SYSTEM_SERVICE  0X20 /* command category code */
#define CAN_GET_INFO  0X01  /* sub-command code */
#define EP2  2 /* Endpoint 2 */
#define EP3  3 /* Endpoint 3 */
```

OFFSET	BULK OUT (EP2)	BULK IN (EP1)
SIZEOF_DATA	0X01	0X07
COMMAND	0X20	0X20
ERROR	0X00	Error code
DATA_0	0X01	Number of bytes return (0X06)
DATA_1	CHECKSUM	VID_MSB (0XCE)
DATA_2		VID_LSB (0XCE)
DATA_3		PID_MSB (0X25)
DATA_4		PID_LSB (0X15)
DATA_5		Firmware version major
DATA_6		Firmware version minor
DATA_7		CHECKSUM

Table 4 CAN_GET_INFO Format

1.5.2 CAN_GET_TICKCOUNT

The CAN_GET_TICKCOUNT command retrieves the MPX-2515 system tick count since the system get started. Please be noted that each tick count is 100 micro seconds inside MPX-2515 system.

```
/* Each tickcount is 100 micro-second */
#define CCP_CAN_SYSTEM_SERVICE  0X20 /* command category code */
#define CAN_GET_TICKCOUNT  0X02  /* sub-command code */
#define EP2  2 /* Endpoint 2 */
#define EP3  3 /* Endpoint 3 */
```

OFFSET	BULK OUT (EP2)	BULK IN (EP1)
SIZEOF_DATA	0X01	0X06
COMMAND	0X20	0X20
ERROR	0X00	Error code
DATA_0	0X02	Number of bytes return (0X05)
DATA_1	CHECKSUM	[Timestamp + 3]: LSB
DATA_2		[Timestamp + 2]
DATA_3		[Timestamp + 1]
DATA_4		[Timestamp + 0]: MSB
DATA_5		CHECKSUM

Table 5 CAN_GET_TICKCOUNT Format

1.5.3 CAN_SET_LED_SWITCH

The CAN_SET_LED_SWITCH command turns the main LED switch on or off. Every individual LED indicator will be in the off state if application sets the main LED switch to the OFF state via this command. Please be noted that the main LED switch is default to ON state each time the MPX-2515 card be powered on.

```
#define CCP_CAN_SYSTEM_SERVICE  0X20 /* COMMAND: service code */
#define CAN_SET_LED_SWITCH  0X03  /* DATA_0: sub-command code */
#define LED_SWITCH_OFF  0X00  /* @ DATA_1 */
#define LED_SWITCH_ON  0X01  /* @ DATA_1 */
#define EP2  2 /* Endpoint 2 */
#define EP3  3 /* Endpoint 3 */
```

OFFSET	BULK OUT (EP2)	BULK IN (EP1)
SIZEOF_DATA	0X02	0X01
COMMAND	0X20	0X20
ERROR	0X00	Error code
DATA_0	0X03	Number of byte written (0X01)
DATA_1	0X00 / 0X01	Checksum
DATA_2	Checksum	
DATA_3		
DATA_4		
DATA_5		

1.5.4 CAN_SET_TRANSFER_RATE

The CAN_SET_TRANSFER_RATE command sets the MCP2515 bit transfer rate on the connecting CAN bus.

MPX-2515 defaults to 125 Kbps transfer rate each time it boots up. Application issues this command to change to its desired CAN bus transfer rate. There are four transfer rates that the application can set via this command. Applications need to program all relevant MCP2515 registers if other transfer rate is desired.

```
#define CCP_CAN_SYSTEM_SERVICE  0X20 /* COMMAND: service code */
#define CAN_SET_TRANSFER_RATE  0X04  /* DATA_0: sub-command code */
#define CAN_1000K_BPS  0X00  /* @DATA_1 */
#define CAN_500K_BPS  0X01  /* @DATA_1 */
#define CAN_250K_BPS  0X03  /* @DATA_1 */
#define CAN_125K_BPS  0X07  /* @DATA_1 */
#define EP2  2 /* Endpoint 2 */
#define EP3  3 /* Endpoint 3 */
```

OFFSET	BULK OUT (EP2)	BULK IN (EP1)
SIZEOF_DATA	0X02	0X01
COMMAND	0X20	0X20

ERROR	0X00	Error code
DATA_0	0X04	Number of byte written (0X01)
DATA_1	Desired rate.	Checksum
DATA_2	Checksum	
DATA_3		
DATA_4		
DATA_5		

1.5.5 CAN_RESET_INSTRUCT

The CAN_RESET_INSTRUCT implements MCP2515 Reset Instruction. The Reset instruction can be used to re-initialize the internal registers of the MCP2515 and set Configuration mode. This command provides the same functionality, via the SPI interface, as the RESET# pin.

```
#define CCP_CAN_SYSTEM_SERVICE  0X20 /* COMMAND: command code */
#define MCP2515_RESET_INSTRUCT  0X85  /* DATA_0: sub-command code
*/
#define EP2  2 /* Endpoint 2 */
#define EP3  3 /* Endpoint 3 */
```

OFFSET	BULK OUT (EP2)	BULK IN (EP1)
SIZEOF_DATA	0X01	0X00
COMMAND	0X20	0X20
ERROR	0X00	Error code
DATA_0	0X85	CHECKSUM
DATA_1	CHECKSUM	
DATA_2		
DATA_3		
DATA_4		
DATA_5		

Table 6 CAN_RESET_INSTRUCT Format

1.5.6 CAN_READ_INSTRUCT

The CAN_READ_INSTRUCT implements MCP2515 Read Instruction. The Read instruction is started by lowering the CS# pin. The Read instruction is then sent to the MCP2515 followed by the 8-bit address (A7 through A0). Next, the data stored in the register at the selected address will be shifted out on the SO pin.

The internal address pointer is automatically incremented to the next address once each byte of data is shifted out. Therefore, it is possible to read the next consecutive register address by continuing to provide clock pulses. Any number of consecutive register locations can be read sequentially using this method. The read operation is terminated by raising the CS# pin. The following figure shows the MCP2515 Read instruction.

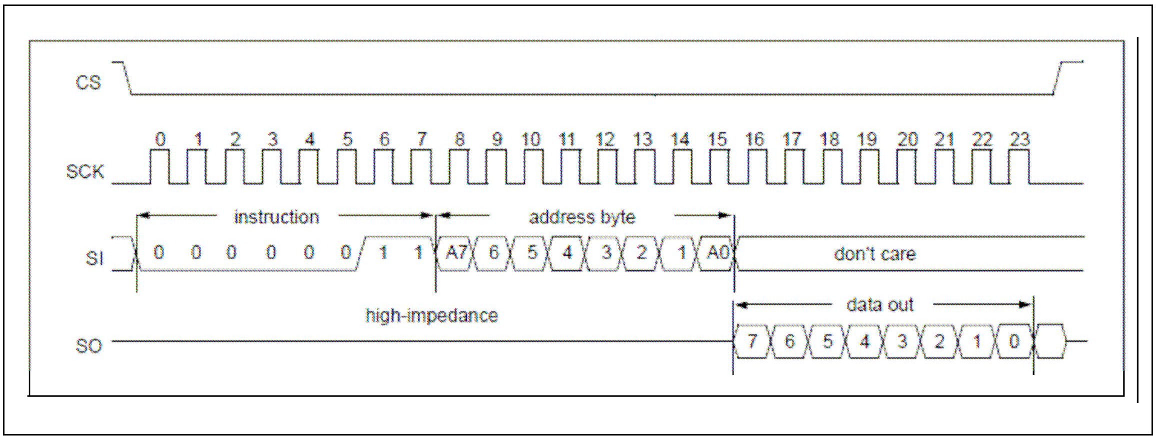


Figure 2 MCP2515 Read Instruction

```
#define CCP_CAN_SYSTEM_SERVICE  0X20 /* COMMAND: command code */
#define CAN_READ_INSTRUCT  0X86  /* DATA_0: sub-command code */
#define EP2  2 /* Endpoint 2 */
#define EP3  3 /* Endpoint 3 */
```

OFFSET	**BULK OUT (EP2)**	**BULK IN (EP1)**
SIZEOF_DATA	0X04	Number of bytes returned
COMMAND	0X20	Byte_0 (return byte 0)
ERROR	0X00	Byte_1 (return byte 1)
DATA_0	0X86	Byte_2 (return byte 2)
DATA_1	Number of bytes to read	...
DATA_2	0X03 (constant)	...
DATA_3	Starting register address	...
DATA_4	Checksum	...
...		
DATA_n		Checksum

1.5.7 CAN_WRITE_INSTRUCT

The CAN_WRITE_INSTRUCT implements MCP2515 Write Instruction. The Write instruction is started by lowering the CS# pin. The Write instruction is then sent to the MCP2515 followed by the address and at least one byte of data.

It is possible to write to sequential registers by continuing to clock in data bytes, as long as CS# is held low. Data will actually be written to the register on the rising edge of the SCK line for the D0 bit. If the CS# line is brought high before eight bits are loaded, the write will be aborted for that data byte and previous bytes in the command will have been written. The following figure shows the timing diagram of the byte write sequence.

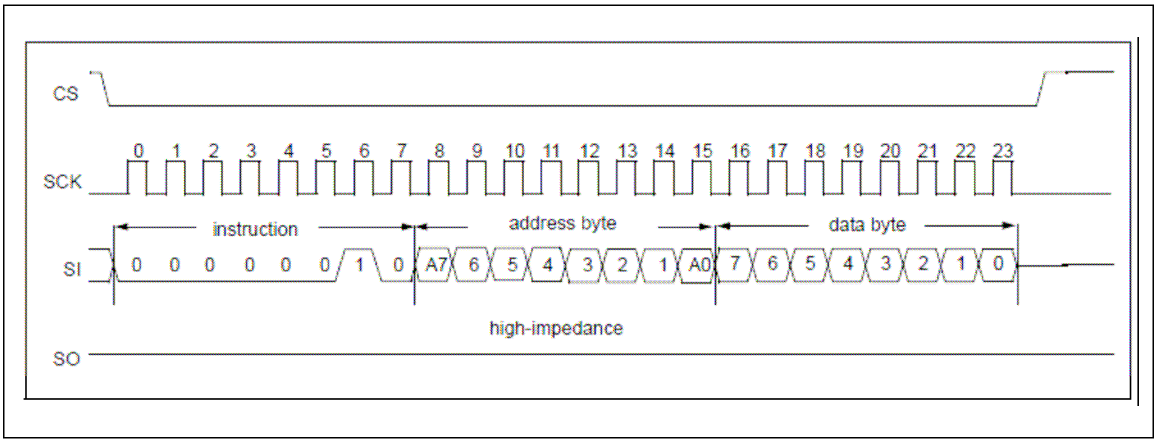


Figure 3 MCP2515 Write Instruction

```
#define CCP_CAN_SYSTEM_SERVICE  0X20 /* COMMAND: command code */
#define CAN_WRITE_INSTRUCT  0X88  /* DATA_0: sub-command code */
#define EP2  2 /* Endpoint 2 */
#define EP3  3 /* Endpoint 3 */
```

OFFSET	**BULK OUT (EP2)**	**BULK IN (EP1)**
SIZEOF_DATA	??	0X01
COMMAND	0X20	0X20
ERROR	0X00	Error code
DATA_0	0X88	Number of bytes written
DATA_1	Number of bytes to write	Checksum
DATA_2	0X02 (constant)	
DATA_3	Starting register address	
DATA_4	Byte_0	
DATA_5	Byte_1	
DATA_6	Byte_2	
...	...	
...	...	
DATA_N	Checksum	

1.6 CCP_CAN_READ_FMB Service

1.6.1 Introduction to Message Reception

The MCP2515 includes two full receive buffers with multiple acceptance filters for each. There is also a separate Message Assembly Buffer (MAB) that acts as a third receive buffer.

Of the three receive buffers, the MAB is always committed to receiving the next message from the bus. The MAB assembles all messages received. These messages will be transferred to the RXBn buffers only if the acceptance filter criteria is met.

The remaining two receive buffers, called RXB0 and RXB1, can receive a complete message from the protocol engine via the MAB. The MCU can access one buffer, while the other buffer is available for message reception, or for holding a previously received message.

The entire content of the MAB is moved into the receive buffer once a message is accepted. This means, that regardless of the type of identifier (standard or extended) and the number of data bytes received, the entire receive buffer is overwritten with the MAB contents. Therefore, the contents of all registers in the buffer must be assumed to have been modified when any message is received.

RXB0, the higher priority buffer, has one mask and two message acceptance filters associated with it. The receive message is applied to the mask and filters for RXB0 first.

RXB1 is the lower priority buffer, with one mask and four acceptance filters associated with it.

In addition to the message being applied to the RXB0 mask and filters first, the lower number of acceptance filters makes the match on RXB0 more restrictive and implies a higher priority for that buffer.

When a message is received, bits <3:0> of the RXBnCTRL register will indicate the acceptance filter number that enabled reception and whether the received message is a remote transfer request.

1.6.2 Firmware Messages Buffer (FMB)

In order to reduce the message overwritten possibility, the MPX-2515 firmware has reserved a 64-byte buffer in the memory to store acceptance messages that have received in the MCP2515 message buffer. This Firmware Messages Buffer (FMB) can hold up to three CAN messages associated with some selected MCP2515 registers values at the time the message is received. Applications is then able to analyze the situation of controller and the bus by checking these registers values.

The following figure shows the relationship between FMB of CY8C24794 and RXBn of MCP2515.

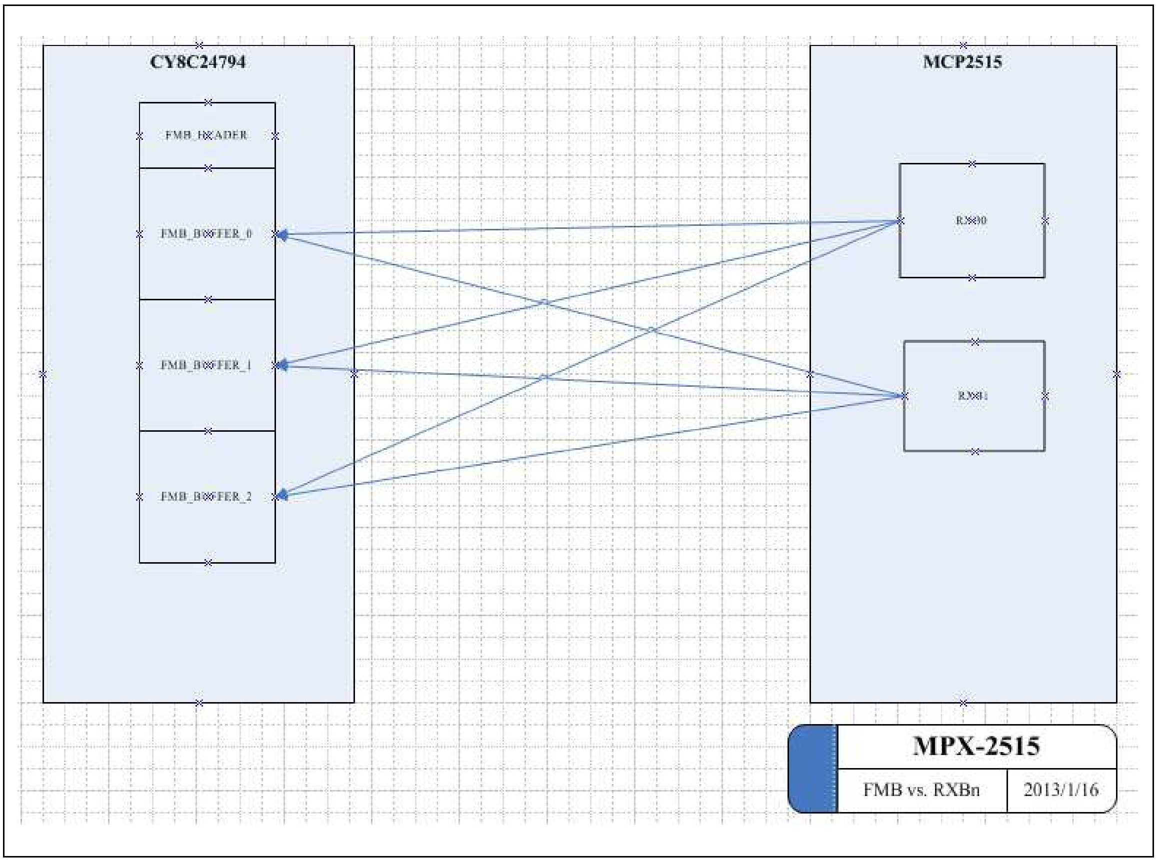


Figure 4 FMB vs. RXBn

1.6.3 CCP_CAN_RED_FMB

The CCP_CAN_READ_FMB service return 64-byte Firmware Message Buffer (FMB). Application issue a BULK IN transfer over the endpoint 4 to proceed this service. Neither CCP Request Packet format nor CCP Response Packet format applies to this service.

The whole Firmware Message Buffer (FMB) can be retrieved via BULK IN transfers over the endpoint 4 from the USB host. The first byte of each message contains ether 0X60 or 0X70, which denotes that this message is copied from RXB0 buffer or RXB1 buffer. The second byte is the associated RXBnCTRL register value. Applications can check this byte for more message received information. The third byte is EFLG at the receiving time. Then, comes a four bytes timestamp in 100 us time unit. Standard ID or Extended ID is followed. RXBnDLC byte has RTR bit indicating whether a Remote Transmit Request. RXBnDLC also contains Data Length Code (DLC) bits that tell valid bytes in this message. All message bytes are then followed.

Please be noted that CCP provides a way that application can check the status of this FMB. Application issues an INTERRUPT IN transaction over endpoint 3 to retrieve an eight bytes Status Packet, which contains FMB status byte at the offset 3 (zero-based packet). Please refer to the INTERRUPT IN section for detail definitions.

Below is the suggestion of control flow.

1. Issue INTERRUPT IN transaction over endpoint 3.
2. Check FMB Status byte (at offset 3)
3. Issue BULK IN on endpoint 4 to retrieve 64-byte FMB
4. Process message(s)
5. Go back to Step 1.

The following table defines the format of Firmware Messages Buffer. Please refer to the MCP2515 data sheet for detail definition of MCP2515 registers values in the FMB.

OFFSET	NAME	DESCRIPTION
0	RXB_HEADER_MSB	The value of 0X5A
1	RXB_HEADER_LSB	The value of 0X6B
2	RXB_NEXT	Next available buffer (0, 1, 2)
Buffer 0 Start		
3	RXB0 / RXB1	0X60 / 0X70
4	RXBnCTRL	See below notes.
5	EFLG	See below notes.
6	Timestamp + 3	Timestamp LSB
7	Timestamp + 2	
8	Timestamp + 1	
9	Timestamp + 0	Timestamp MSB
10	RXBnSIDH	
11	RXBnSIDL	
12	RXBnEID8	
13	RXBnEID0	
14	RXBnDLC	
15	RXBnD0	
16	RXBnD1	
17	RXBnD2	
18	RXBnD3	

19	RXBnD4	
20	RXBnD5	
21	RXBnD6	
22	RXBnD7	
Buffer 1 Start		
23	RXB0 / RXB1	0X60 / 0X70
24	RXBnCTRL	
25	EFLG	
26	Timestamp + 3	LSB
27	Timestamp + 2	
28	Timestamp + 1	
29	Timestamp + 0	MSB
30	RXBnSIDH	
31	RXBnSIDL	
32	RXBnEID8	
33	RXBnEID0	
34	RXBnDLC	
35	RXBnD0	
36	RXBnD1	
37	RXBnD2	
38	RXBnD3	
39	RXBnD4	
40	RXBnD5	
41	RXBnD6	
42	RXBnD7	
Buffer 2 Start		
43	RXB0 / RXB1	0X60 / 0X70
44	RXBnCTRL	
45	EFLG	
46	Timestamp + 3	LSB
47	Timestamp + 2	
48	Timestamp + 1	
49	Timestamp + 0	MSB
50	RXBnSIDH	
51	RXBnSIDL	
52	RXBnEID8	
53	RXBnEID0	
54	RXBnDLC	
55	RXBnD0	
56	RXBnD1	
57	RXBnD2	
58	RXBnD3	
59	RXBnD4	
60	RXBnD5	
61	RXBnD6	

62	RXBnD7	
2's Complement Checksum		
63	Checksum	

Table 7 Firmware Message Buffer (FMB) format

Notes:

- RXB0 / RXB1: 0X60 if the message is from RXB0. 0X70 if the message is from RXB1.
- n value: 0 if the message is from RXB0; 1 if the message if from RXB1.
- RXBnCTRL: Contains the RXBnCTRL register value of MCP2515.
- EFLG: The value of EFLG register of MCP2515.
- Timestamp: Four bytes unsigned integer value. in 100 us unit.
- RXBnSIDH, RXBnSIDL, RXBnEID8, RXBnEID0, RXBnDLC, RXBnD0, RXBnD1, RXBnD2, RXBnD3, RXBnD4, RXBnD5, RXBnD6, and RXBnD7 are values from MCP2515 corresponding registers.

1.7 CCP_CAN_RX_MASKS_FILTERS Service

1.7.1 Introduction to Message Acceptance Filters and Masks

The CCP_CAN_RX_MASKS_FILTERS uses 0X22 as its command category code. This service provides ways to configure the masks and filters registers of the MCP2515 CAN bus controller.

The MCP2515 includes two full receive buffers (RxB0 and RxB1) with multiple acceptance filters for each. There is also a separate Message Assembly Buffer (MAB) that acts as a third receive buffer.

The MAB is always committed to receiving the next message from the bus. The MAB assembles all messages received. These messages will be transferred to the RxBn buffers only if the acceptance filter criteria is met.

The message acceptance filters and masks are used to determine if a message in the message assembly buffer should be loaded into either of the receive buffers. Once a valid message has been received into the MAB, the identifier fields of the message are compared to the filter values. If there is a match, that message will be loaded into the appropriate receive buffer.

FILTER MATCHING

The filter masks are used to determine which bits in the identifier are examined with the filters. A truth table is shown below that indicates how each bit in the identifier is compared to the masks and filters to determine if the message should be loaded into a receive buffer. The mask essentially determines which bits to apply the acceptance filters to. If any mask bit is set to a zero, that bit will automatically be accepted, regardless of the filter bit.

Mask Bit n	Filter Bit n	Message Identifier bit	Accept or Reject bit n
0	x	x	Accept
1	0	0	Accept
1	0	1	Reject
1	1	0	Reject
1	1	1	Accept

Note: x = don't care

Table 8 Filter / Mask Truth Table

The following figure shows the receiver buffer block diagram. Please refer to the MCP2515 data sheet for detail information.

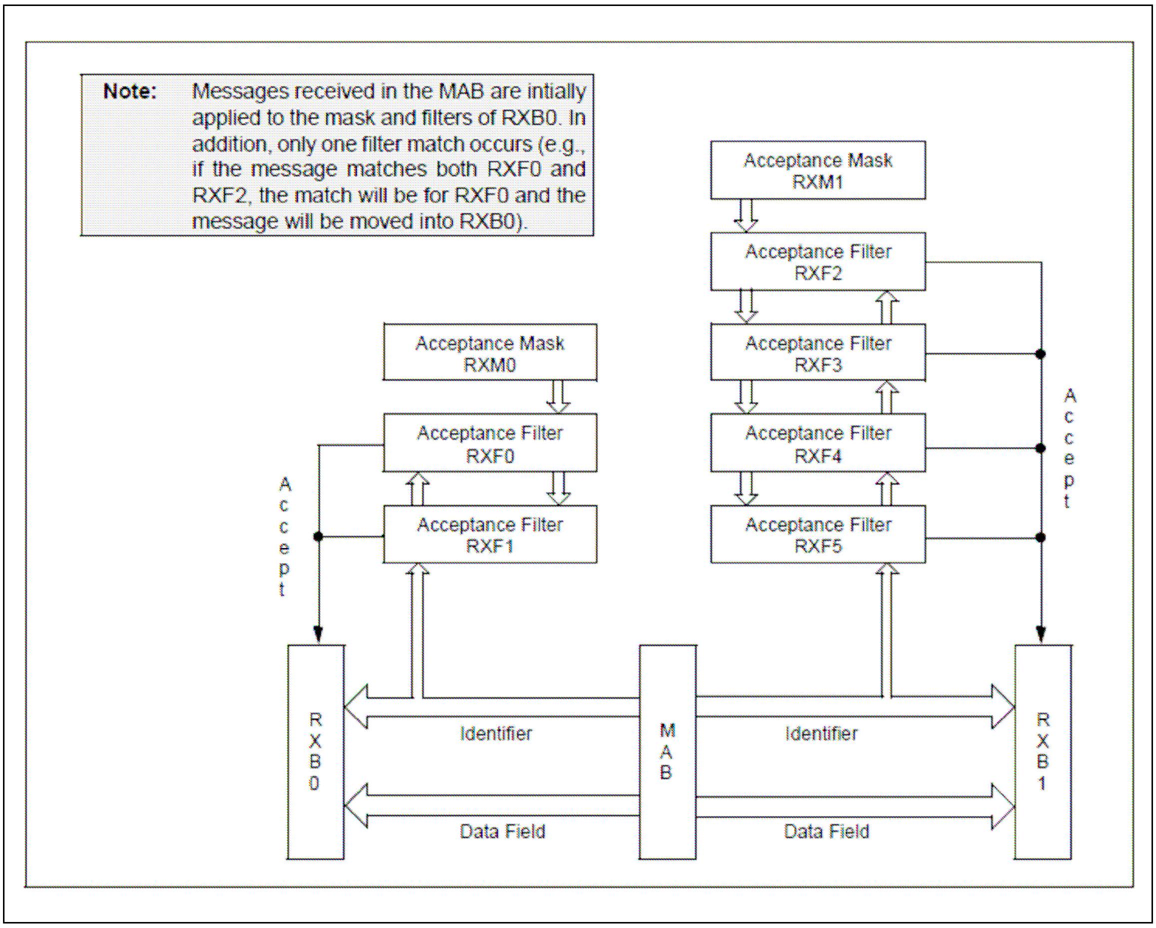


Figure 5 MCP2515 Receive Buffer Block Diagram

As shown in the above receive buffers block diagram, acceptance filters RXF0 and RXF1 (and filter mask RXM0 are associated with RXB0. Filters RXF2, RXF3, RXF4, RXF5 and mask RXM1 are associated with RXB1.

The following figure shows how the masks and filters apply to CAN frames.

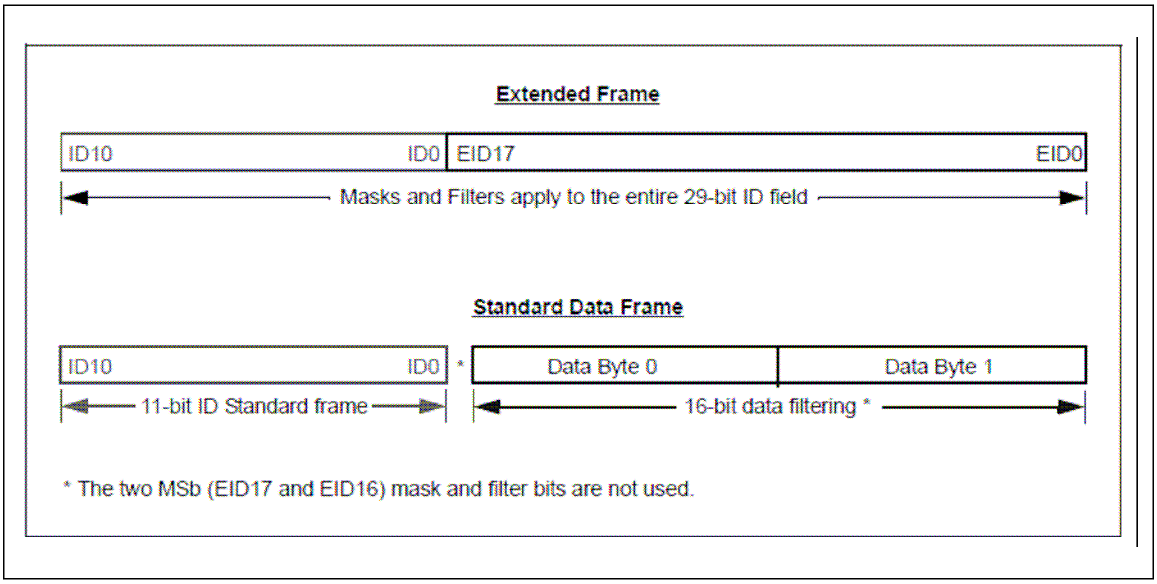


Figure 6 Masks and Filters Apply to CAN Frames

FILHIT BITS

Filter matches on received messages can be determined by the FILHIT bits in the associated RXBnCTRL register. RXB0CTRL.FILHIT0 for buffer 0 and RXB1CTR.FILHIT<2:0> for buffer 1.

The three FILHIT<2:0> bits for receive buffer 1 (RXB1) are coded as follows:

- 101 = Acceptance filter 5 (RXF5)
- 100 = Acceptance filter 4 (RXF4)
- 011 = Acceptance filter 3 (RXF3)
- 010 = Acceptance filter 2 (RXF2)
- 001 = Acceptance filter 1 (RXF1)
- 000 = Acceptance filter 0 (RXF0)

Note: 000 and 001 can only occur if the BUKT bit in RXB0CTRL is set, allowing RXB0 message to roll over into RXB1.

RXB0CTRL contains two copies of the BUKT bit and the FILHIT<0> bit.

The coding of the BUKT bit enables these three bits to be used similarly to the RXB1CTRL.FILHIT bits and to distinguish a hit on filter RXF0 and RXF1 in either RXB0 or after a roll over into RXB1.

- 111 = Acceptance Filter 1 (RXB1)
- 110 = Acceptance Filter 0 (RXB1)
- 001 = Acceptance Filter 1 (RXB0)
- 000 = Acceptance Filter 0 (RXB0)

Please refer to the MCP2515 data sheet for detail information.

1.7.2 MCP_RX_MASK_0

The MCP_RX_MASK_0 request is defined as the sub-command code 0X20 of CCP_CMND_CAN_RX_MASKS_FILTERS service.

```
#define CCP_CAN_RX_MASKS_FILTERS  0X22
#define MCP_RX_MASK_0  0X20
#define EP2  2 /* Endpoint 2 */
#define EP3  3 /* Endpoint 3 */
```

OFFSET	BULK OUT (EP2)	BULK IN (EP1)
SIZEOF_DATA	0X06	0X01
COMMAND	0X22	0X22
ERROR	0X00	Error code
DATA_0	0X20	Number of bytes written
DATA_1	0X04: Number of bytes to write.	checksum
DATA_2	RXM0SIDH	
DATA_3	RXM0SIDL	
DATA_4	RXM0EID8	
DATA_5	RXM0EID0	
DATA_6	checksum	
DATA_7		

1.7.3 MCP_RX_MASK_1

The MCP_RX_MASK_1 request is defined as the sub-command code 0X24 of CCP_CMND_CAN_RX_MASKS_FILTERS service.

```
#define CCP_CAN_RX_MASKS_FILTERS  0X22
#define MCP_RX_MASK_1  0X24
#define EP2  2 /* Endpoint 2 */
#define EP3  3 /* Endpoint 3 */
```

OFFSET	BULK OUT (EP2)	BULK IN (EP1)
SIZEOF_DATA	0X06	0X01
COMMAND	0X22	0X22
ERROR	0X00	Error code
DATA_0	0X24	Number of bytes written
DATA_1	0X04: Number of bytes to write.	checksum

DATA_2	RXM1SIDH	
DATA_3	RXM1SIDL	
DATA_4	RXM1EID8	
DATA_5	RXM1EID0	
DATA_6	checksum	
DATA_7		

1.7.4 MCP_RX_FILTER_0

The MCP_RX_FILTER_0 request is defined as the sub-command code 0X00 of CCP_CMND_CAN_RX_MASKS_FILTERS service.

```
#define CCP_CAN_RX_MASKS_FILTERS  0X22
#define MCP_RX_FILTER_0  0X00
#define EP2  2 /* Endpoint 2 */
#define EP3  3 /* Endpoint 3 */
```

OFFSET	BULK OUT (EP2)	BULK IN (EP1)
SIZEOF_DATA	0X06	0X01
COMMAND	0X22	0X22
ERROR	0X00	Error code
DATA_0	0X00	Number of bytes written
DATA_1	0X04: Number of bytes to write.	checksum
DATA_2	RXF0SIDH	
DATA_3	RXF0SIDL	
DATA_4	RXF0EID8	
DATA_5	RXF0EID0	
DATA_6	checksum	
DATA_7		

1.7.5 MCP_RX_FILTER_1

The MCP_RX_FILTER_1 request is defined as the sub-command code 0X04 of CCP_CMND_CAN_RX_MASKS_FILTERS service.

```
#define CCP_CAN_RX_MASKS_FILTERS  0X22
#define MCP_RX_FILTER_1  0X04
#define EP2  2 /* Endpoint 2 */
#define EP3  3 /* Endpoint 3 */
```

OFFSET	BULK OUT (EP2)	BULK IN (EP1)
SIZEOF_DATA	0X06	0X01
COMMAND	0X22	0X22

ERROR	0X00	Error code
DATA_0	0X04	Number of bytes written
DATA_1	0X04: Number of bytes to write.	checksum
DATA_2	RXF1SIDH	
DATA_3	RXF1SIDL	
DATA_4	RXF1EID8	
DATA_5	RXF1EID0	
DATA_6	checksum	
DATA_7		

1.7.6 MCP_RX_FILTER_2

The MCP_RX_FILTER_2 request is defined as the sub-command code 0X08 of CCP_CMND_CAN_RX_MASKS_FILTERS service.

```
#define CCP_CAN_RX_MASKS_FILTERS  0X22
#define MCP_RX_FILTER_2  0X08
#define EP2  2 /* Endpoint 2 */
#define EP3  3 /* Endpoint 3 */
```

OFFSET	**BULK OUT (EP2)**	**BULK IN (EP1)**
SIZEOF_DATA	0X06	0X01
COMMAND	0X22	0X22
ERROR	0X00	Error code
DATA_0	0X08	Number of bytes written
DATA_1	0X04: Number of bytes to write.	checksum
DATA_2	RXF2SIDH	
DATA_3	RXF2SIDL	
DATA_4	RXF2EID8	
DATA_5	RXF2EID0	
DATA_6	checksum	
DATA_7		

1.7.7 MCP_RX_FILTER_3

The MCP_RX_FILTER_3 request is defined as the sub-command code 0X10 of CCP_CMND_CAN_RX_MASKS_FILTERS service.

```
#define CCP_CAN_RX_MASKS_FILTERS  0X22
#define MCP_RX_FILTER_3  0X10
#define EP2  2 /* Endpoint 2 */
#define EP3  3 /* Endpoint 3 */
```

OFFSET	BULK OUT (EP2)	BULK IN (EP1)
SIZEOF_DATA	0X06	0X01
COMMAND	0X22	0X22
ERROR	0X00	Error code
DATA_0	0X10	Number of bytes written
DATA_1	0X04: Number of bytes to write.	checksum
DATA_2	RXF3SIDH	
DATA_3	RXF3SIDL	
DATA_4	RXF3EID8	
DATA_5	RXF3EID0	
DATA_6	checksum	
DATA_7		

1.7.8 MCP_RX_FILTER_4

The MCP_RX_FILTER_4 request is defined as the sub-command code 0X14 of CCP_CMND_CAN_RX_MASKS_FILTERS service.

```
#define CCP_CAN_RX_MASKS_FILTERS  0X22
#define MCP_RX_FILTER_4  0X14
#define EP2  2 /* Endpoint 2 */
#define EP3  3 /* Endpoint 3 */
```

OFFSET	BULK OUT (EP2)	BULK IN (EP1)
SIZEOF_DATA	0X06	0X01
COMMAND	0X22	0X22
ERROR	0X00	Error code
DATA_0	0X14	Number of bytes written
DATA_1	0X04: Number of bytes to write.	checksum
DATA_2	RXF4SIDH	
DATA_3	RXF4SIDL	
DATA_4	RXF4EID8	
DATA_5	RXF4EID0	
DATA_6	checksum	
DATA_7		

1.7.9 MCP_RX_FILTER_5

The MCP_RX_FILTER_5 request is defined as the sub-command code 0X18 of CCP_CMND_CAN_RX_MASKS_FILTERS service.

```
#define CCP_CAN_RX_MASKS_FILTERS  0X22
#define MCP_RX_FILTER_5  0X18
#define EP2  2 /* Endpoint 2 */
#define EP3  3 /* Endpoint 3 */
```

OFFSET	BULK OUT (EP2)	BULK IN (EP1)
SIZEOF_DATA	0X06	0X01
COMMAND	0X22	0X22
ERROR	0X00	Error code
DATA_0	0X18	Number of bytes written
DATA_1	0X04: Number of bytes to write.	checksum
DATA_2	RXF5SIDH	
DATA_3	RXF5SIDL	
DATA_4	RXF5EID8	
DATA_5	RXF5EID0	
DATA_6	checksum	
DATA_7		

1.8 CCP_CAN_TX Service

1.8.1 Introduction to Message Transmission

TRANSMIT BUFFERS

The MCP2515 implements three transmit buffers. Each of these buffers occupies 14 bytes of SRAM and are mapped into the device memory map.

The first byte, TXBnCTRL, is a control register associated with the message buffer. The information is this register determines the conditions under which the message will be transmitted and indicates the status of the message transmission.

Five bytes are used to hold the standard and extended identifiers, as well as other message arbitration information.

The last eight bytes are for the eight possible data bytes of the message to be transmitted.

At a minimum, the TXBnSIDH, TXBnSIDL and TXBnDLC registers must be loaded. If data bytes are present in the message, the TXBnDm registers must also be loaded. If the message is to use extended identifiers, the TXBnEIDm registers must aso be loaded and the TXBnSIDL.EXIDE bit set.

TRANSMIT PRIORITY

Transmit priority is a prioritization within the MCP2515 of the pending transmittable messages. This is independent from, and not necessarily related to, any prioritization implicit in the message arbitration scheme built into the CAN protocol.

There are four levels of transmit priority. If TXBnCTRL.TXP<1:0> for a particular message buffer is set to 11, that buffer has the highest possible priority. If TXBnCTRL.TXP<1:0> for a particular buffer is 00, that buffer has the lowest possible priority.

ABORTING TRANSMISSION

The MCU can request to abort a message in a specific message buffer by clearing the associated TXBnCTRL.TXREQ bit.

In addition, all pending messages can be requested to be aborted by setting the CANCTRL.ABAT bit. This bit must be reset (typically after the TXREQ bits have been verified to be cleared) to continue transmitting messages.

Messages that were transmitting when the abort was requested will continue to transmit. If the message does not successfully complete transmission (i.e., lost arbitration or was interrupted by an error frame), it will then be aborted.

1.8.2 MCP_LOAD_TXB0SIDH

The MCP_LOAD_TXB0SIDH command loads the bytes in the Request Packet to the associated MCP2515 registers in order to complete the corresponding message transmission on the CAN bus.

```
#define CCP_CAN_TX_SERVICE  0X23 /* command category code */
#define MCP_LOAD_TXB0SIDH  0X40  /* sub-command code */
#define EP2  2 /* Endpoint 2 */
#define EP3  3 /* Endpoint 3 */
```

OFFSET	BULK OUT (EP2)	BULK IN (EP1)
SIZEOF_DATA	0X14	0X05
COMMAND	0X23	0X23
ERROR	0X00	Error code
DATA_0	0X40	Number of bytes return (0X04)
DATA_1	Overwrite flag	EFLG before transmitting
DATA_2	Reserved	TXB0CTRL before transmitting
DATA_3	0X30	EFLG after transmitted
DATA_4	Value to load to TXB0CTRL	TXB0CTRL after transmitted

DATA_5	0X31	checksum
DATA_6	0X0D	
DATA_7	TXB0SIDH	
DATA_8	TXB0SIDL	
DATA_9	TXB0EID8	
DATA_10	TXB0EID0	
DATA_11	TXB0DLC	
DATA_12	TXB0D0	
DATA_13	TXB0D1	
DATA_14	TXB0D2	
DATA_15	TXB0D3	
DATA_16	TXB0D4	
DATA_17	TXB0D5	
DATA_18	TXB0D6	
DATA_19	TXB0D7	
DATA_20	checksum	

1.8.3 MCP_LOAD_TXB0D0

The MCP_LOAD_TXB0D0 command loads the bytes in the Request Packet to the associated MCP2515 registers in order to complete the corresponding message transmission on the CAN bus.

```
#define CCP_CAN_TX_SERVICE  0X23 /* command category code */
#define MCP_LOAD_TXB0D0  0X41  /* sub-command code */
#define EP2  2 /* Endpoint 2 */
#define EP3  3 /* Endpoint 3 */
```

OFFSET	BULK OUT (EP2)	BULK IN (EP1)
SIZEOF_DATA	0X14	0X05
COMMAND	0X23	0X23
ERROR	0X00	Error code
DATA_0	0X41	Number of bytes return (0X04)
DATA_1	Overwrite flag	EFLG before transmitting
DATA_2	Reserved	TXB0CTRL before transmitting
DATA_3	0X30	EFLG after transmitted
DATA_4	Value to load to TXB0CTRL	TXB0CTRL after transmitted
DATA_5	0X36	checksum
DATA_6	0X09	
DATA_7	Reserved	
DATA_8	Reserved	
DATA_9	Reserved	

DATA_10	Reserved	
DATA_11	TXB0DLC	
DATA_12	TXB0D0	
DATA_13	TXB0D1	
DATA_14	TXB0D2	
DATA_15	TXB0D3	
DATA_16	TXB0D4	
DATA_17	TXB0D5	
DATA_18	TXB0D6	
DATA_19	TXB0D7	
DATA_20	checksum	

1.8.4 MCP_LOAD_TXB1SIDH

The MCP_LOAD_TXB1SIDH command loads the bytes in the Request Packet to the associated MCP2515 registers in order to complete the corresponding message transmission on the CAN bus.

```
#define CCP_CAN_TX_SERVICE  0X23 /* command category code */
#define MCP_LOAD_TXB1SIDH  0X42  /* sub-command code */
#define EP2  2 /* Endpoint 2 */
#define EP3  3 /* Endpoint 3 */
```

OFFSET	BULK OUT (EP2)	BULK IN (EP1)
SIZEOF_DATA	0X14	0X05
COMMAND	0X23	0X23
ERROR	0X00	Error code
DATA_0	0X42	Number of bytes return (0X04)
DATA_1	Overwrite flag	EFLG before transmitting
DATA_2	Reserved	TXB1CTRL before transmitting
DATA_3	0X40	EFLG after transmitted
DATA_4	Value to load to TXB1CTRL	TXB1CTRL after transmitted
DATA_5	0X41	checksum
DATA_6	0X0D	
DATA_7	TXB1SIDH	
DATA_8	TXB1SIDL	
DATA_9	TXB1EID8	
DATA_10	TXB1EID0	
DATA_11	TXB1DLC	
DATA_12	TXB1D0	
DATA_13	TXB1D1	
DATA_14	TXB1D2	

DATA_15	TXB1D3	
DATA_16	TXB1D4	
DATA_17	TXB1D5	
DATA_18	TXB1D6	
DATA_19	TXB1D7	
DATA_20	checksum	

1.8.5 MCP_LOAD_TXB1D0

The MCP_LOAD_TXB0SIDH command loads the bytes in the Request Packet to the associated MCP2515 registers in order to complete the corresponding message transmission on the CAN bus.

```
#define CCP_CAN_TX_SERVICE  0X23 /* command category code */
#define MCP_LOAD_TXB1D0  0X43  /* sub-command code */
#define EP2  2 /* Endpoint 2 */
#define EP3  3 /* Endpoint 3 */
```

OFFSET	BULK OUT (EP2)	BULK IN (EP1)
SIZEOF_DATA	0X14	0X05
COMMAND	0X23	0X23
ERROR	0X00	Error code
DATA_0	0X43	Number of bytes return (0X04)
DATA_1	Overwrite flag	EFLG before transmitting
DATA_2	Reserved	TXB1CTRL before transmitting
DATA_3	0X40	EFLG after transmitted
DATA_4	Value to load to TXB0CTRL	TXB1CTRL after transmitted
DATA_5	0X46	checksum
DATA_6	0X09	
DATA_7	Reserved	
DATA_8	Reserved	
DATA_9	Reserved	
DATA_10	Reserved	
DATA_11	TXB1DLC	
DATA_12	TXB1D0	
DATA_13	TXB1D1	
DATA_14	TXB1D2	
DATA_15	TXB1D3	
DATA_16	TXB1D4	
DATA_17	TXB1D5	
DATA_18	TXB1D6	
DATA_19	TXB1D7	

DATA_20	checksum	

1.8.6 MCP_LOAD_TXB2SIDH

The MCP_LOAD_TXB2SIDH command loads the bytes in the Request Packet to the associated MCP2515 registers in order to complete the corresponding message transmission on the CAN bus.

```
#define CCP_CAN_TX_SERVICE  0X23 /* command category code */
#define MCP_LOAD_TXB2SIDH  0X44  /* sub-command code */
#define EP2  2 /* Endpoint 2 */
#define EP3  3 /* Endpoint 3 */
```

OFFSET	BULK OUT (EP2)	BULK IN (EP1)
SIZEOF_DATA	0X14	0X05
COMMAND	0X23	0X23
ERROR	0X00	Error code
DATA_0	0X44	Number of bytes return (0X04)
DATA_1	Overwrite flag	EFLG before transmitting
DATA_2	Reserved	TXB2CTRL before transmitting
DATA_3	0X50	EFLG after transmitted
DATA_4	Value to load to TXB0CTRL	TXB2CTRL after transmitted
DATA_5	0X51	checksum
DATA_6	0X0D	
DATA_7	TXB2SIDH	
DATA_8	TXB2SIDL	
DATA_9	TXB2EID8	
DATA_10	TXB2EID0	
DATA_11	TXB2DLC	
DATA_12	TXB2D0	
DATA_13	TXB2D1	
DATA_14	TXB2D2	
DATA_15	TXB2D3	
DATA_16	TXB2D4	
DATA_17	TXB2D5	
DATA_18	TXB2D6	
DATA_19	TXB2D7	
DATA_20	checksum	

1.8.7 MCP_LOAD_TXB2D0

The MCP_LOAD_TXB2D0 command loads the bytes in the Request Packet to the associated MCP2515 registers in order to complete the corresponding message transmission on the CAN bus.

```
#define CCP_CAN_TX_SERVICE  0X23 /* command category code */
#define MCP_LOAD_TXB2d0  0X45  /* sub-command code */
#define EP2  2 /* Endpoint 2 */
#define EP3  3 /* Endpoint 3 */
```

OFFSET	BULK OUT (EP2)	BULK IN (EP1)
SIZEOF_DATA	0X14	0X05
COMMAND	0X23	0X23
ERROR	0X00	Error code
DATA_0	0X45	Number of bytes return (0X04)
DATA_1	Overwrite flag	EFLG before transmitting
DATA_2	Reserved	TXB2CTRL before transmitting
DATA_3	0X50	EFLG after transmitted
DATA_4	Value to load to TXB0CTRL	TXB2CTRL after transmitted
DATA_5	0X56	checksum
DATA_6	0X09	
DATA_7	Reserved	
DATA_8	Reserved	
DATA_9	Reserved	
DATA_10	Reserved	
DATA_11	TXB2DLC	
DATA_12	TXB2D0	
DATA_13	TXB2D1	
DATA_14	TXB2D2	
DATA_15	TXB2D3	
DATA_16	TXB2D4	
DATA_17	TXB2D5	
DATA_18	TXB2D6	
DATA_19	TXB2D7	
DATA_20	checksum	

1.8.8 MCP_ABORT_TXB0

The MCP_ABORT_TXB0 command set the TXREQ.ABTF to abort the corresponding message. Please refer to the ABORT TRANSMISSION paragraph and the MCP2515 data sheet for transmission abort limitations.

```
#define CCP_CAN_TX_SERVICE  0X23 /* command category code */
#define MCP_ABORT_TXB0  0X38  /* sub-command code */
#define EP2  2 /* Endpoint 2 */
#define EP3  3 /* Endpoint 3 */
```

OFFSET	BULK OUT (EP2)	BULK IN (EP1)
SIZEOF_DATA	0X04	0X01
COMMAND	0X23	0X23
ERROR	0X00	Error code
DATA_0	0X38	Abort status code
DATA_1	Reserved	checksum
DATA_2	0X30	
DATA_3	0X08	
DATA_4	checksum	
DATA_5		

1.8.9 MCP_ABORT_TXB1

The MCP_ABORT_TXB1 command set the TXREQ.ABTF to abort the corresponding message. Please refer to the ABORT TRANSMISSION paragraph and the MCP2515 data sheet for transmission abort limitations.

```
#define CCP_CAN_TX_SERVICE  0X23 /* command category code */
#define MCP_ABORT_TXB1  0X48  /* sub-command code */
#define EP2  2 /* Endpoint 2 */
#define EP3  3 /* Endpoint 3 */
```

OFFSET	BULK OUT (EP2)	BULK IN (EP1)
SIZEOF_DATA	0X04	0X01
COMMAND	0X23	0X23
ERROR	0X00	Error code
DATA_0	0X48	Abort status code
DATA_1	Reserved	checksum
DATA_2	0X40	
DATA_3	0X08	
DATA_4	checksum	
DATA_5		

1.8.10 MCP_ABORT_TXB2

The MCP_ABORT_TXB2 command set the TXREQ.ABTF to abort the corresponding message. Please refer to the ABORT TRANSMISSION paragraph and the MCP2515 data sheet for transmission abort limitations.

```
#define CCP_CAN_TX_SERVICE  0X23 /* command category code */
```

```
#define MCP_ABORT_TXB2  0X58  /* sub-command code */
#define EP2  2 /* Endpoint 2 */
#define EP3  3 /* Endpoint 3 */
```

OFFSET	BULK OUT (EP2)	BULK IN (EP1)
SIZEOF_DATA	0X04	0X01
COMMAND	0X23	0X23
ERROR	0X00	Error code
DATA_0	0X58	Abort status code
DATA_1	Reserved	checksum
DATA_2	0X50	
DATA_3	0X08	
DATA_4	checksum	
DATA_5		

1.9 CCP_CAN_BIT_MODIFY Service

1.9.1 Introduction to Bit Modify

The Bit Modify instruction provides a means for setting or clearing individual bits in specific status and control registers. This command is not for all registers. Please refer to the MCP2515 data sheet to determine which registers allow the use of this command.

Note:

Executing the Bit Modify command on registers that are not bit-modifiable will force the mask to FFh. This will allow byte writes to the registers, not bit modify.

The following figure shows the Bit Modify operations.

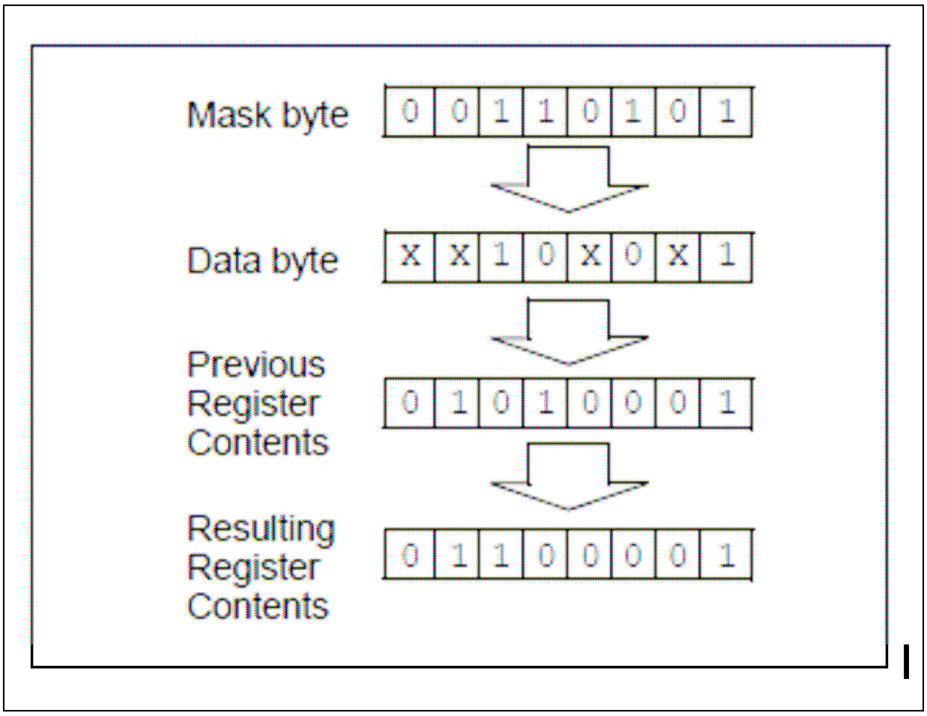


Figure 7 Bit Modify Instruction

The part is selected by lowering the CS# pin and the Bit Modify command byte is then sent to the MCP2515. The command is followed by the address of the register, the mask byte and finally the data byte.

The mask byte determines which bits in the register will be allowed to change. A '1' in the mask byte will allow a bit in the register to change, while a '0' will not.

The data byte determines what value the modified bits in the register will be changed to. A '1' in the data byte will set the bit and a '0' will clear a bit, provided that the mask for that bit is set to a '1'.

1.9.2 CAN_BIT_MODIFY Command

The CAN_BIT_MODIFY command is provided to implement the MCP2515 Bit Modify Instruction.

The following figure defines the MCP2515 Bit Modify Instruction. Please refer to the MCP2515 data sheet for detail information.

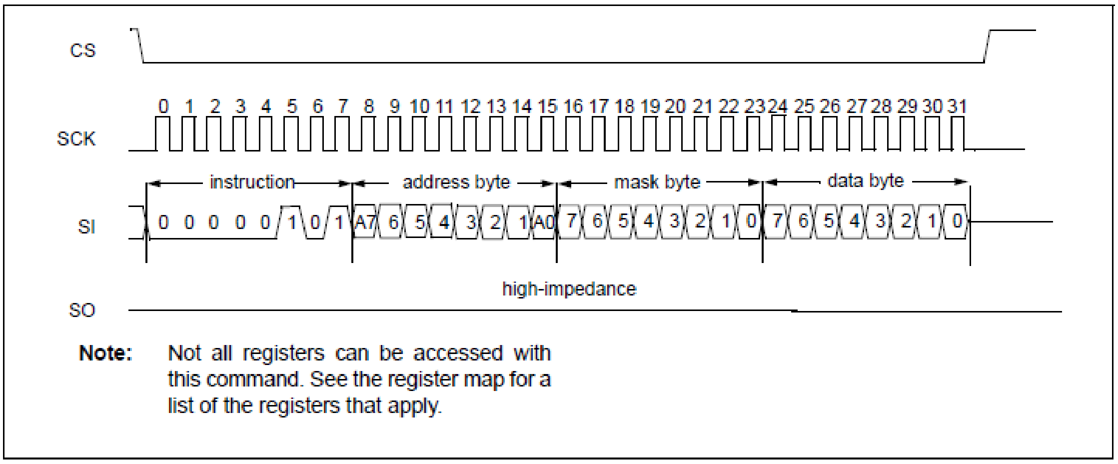


Figure 8 MCP2515 Bit Modify Instruction

The following registers can be modified by the Bit Modify Instruction. Please refer to the MCP2515 data sheet for detail information.

- **BFPCTRL (0X0C):** RXnBF Pin Control and Status Register
- **TXRTSCTRL (0X0D):** TXnRTS Pin Control and Status Register
- **CANCTRL (0X0F):** CAN Control Register
- **CNF3 (0X28):** Configuration 3 Register
- **CNF2(0X29):** Configuration 2 Register
- **CNF1(0X2A):** Configuration 1 Register
- **CANINTE (0X2B):** Interrupt Enable Register
- **CANINTF (0X2C):** Interrupt Flag Register
- **EFLG (0X2D):** Error Flag Register
- **TXB0CTRL (0X30):** Transmit Buffer 0 Control Register
- **TXB1CTRL (0X40):** Transmit Buffer 1 Control Register
- **TXB2CTRL (0X50):** Transmit Buffer 2 Control Register
- **RXB0CTRL (0X60):** Receive Buffer 0 Control Register
- **RXB1CTRL (0X70):** Receive Buffer 1 Control Register

```
/* command category code */
#define CCP_CAN_BIT_MODIFY_SERVICE  0X26

#define EP2  2 /* Endpoint 2 */
```

OFFSET	BULK OUT (EP2)	BULK IN (EP1)
SIZEOF_DATA	0X03	N/A
COMMAND	0X26	
ERROR	0X00	
DATA_0	Bit Modifiable register	

DATA_1	Bit Modify mask	
DATA_2	Bit Modify value	
DATA_3	Checksum	
DATA_4		
DATA_5		
DATA_6		
DATA_7		

NOTE. There is no BULK IN transfer on this command at endpoint 3.
Applications shouldn't issue a BULK IN transfer by using the 0X26 command code.

2 Reference

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[5] CiA 301 CANopen application layer and communication profile version 4.2.0, 21 February 2011, CAN in Automation.

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[7] CiA 303 CANopen Recommendation Part 1 Cabling and connector pin assignment Version 1.8.0, 27 April 2012, CAN in Automation.

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