IBD185

ST STM32F103VBT6
GPIO MiniPCIe Daughter Card

USER GUIDE

Version 1.0

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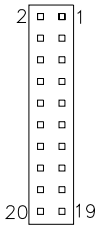
IBD185 Connectors Pin Definition

J1, J2 for I2C

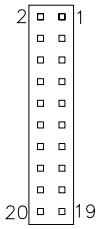
Pin #	Signal Name
1	SCL
2	SDA
3	GND

J3 Supports 16-in GPIO



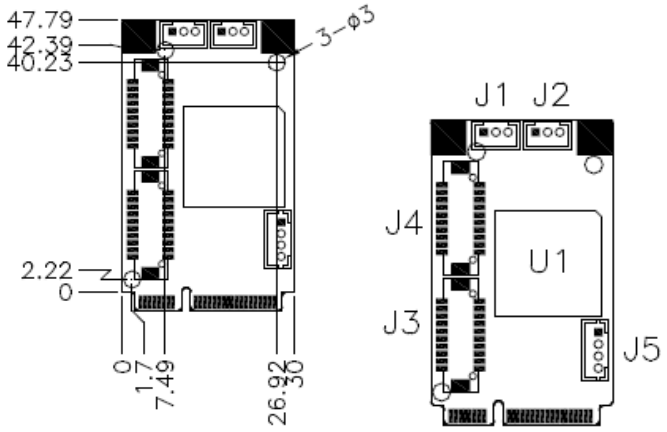
Signal Name	Pin #	Pin #	Signal Name
3.3V	2	1	3.3V
DIN8	4	3	DIN0
DIN9	6	5	DIN1
DIN10	8	7	DIN2
DIN11	10	9	DIN3
DIN12	12	11	DIN4
DIN13	14	13	DIN5
DIN14	16	15	DIN6
DIN15	18	17	DIN7
Ground	20	19	Ground

J4 Supports 16-out GPIO



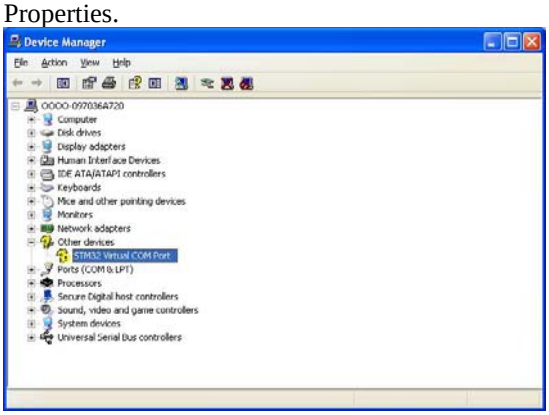
Signal Name	Pin #	Pin #	Signal Name
3.3V	2	1	3.3V
OUTPUT24	4	3	OUTPUT16
OUTPUT25	6	5	OUTPUT17
OUTPUT26	8	7	OUTPUT18
OUTPUT27	10	9	OUTPUT19
OUTPUT28	12	11	OUTPUT20
OUTPUT29	14	13	OUTPUT21
OUTPUT30	16	15	OUTPUT22
OUTPUT31	18	17	OUTPUT23
Ground	20	19	Ground

IBD185 Mechanical Drawing

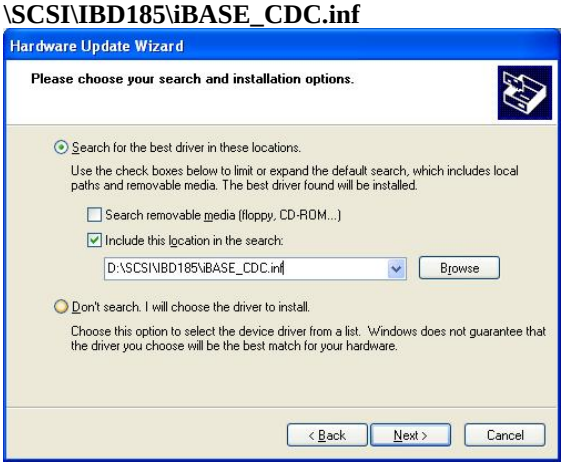


IBD185 Driver Installation

1. In the Windows OS, go to the Computer Management screen. In the 'Other devices' as shown, right click the "STM32 Virtual COM Port" Properties.

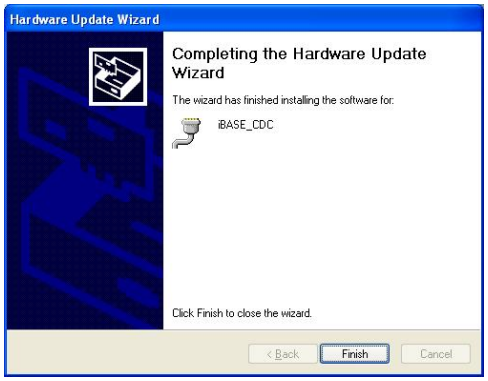


2. In the STM32 Virtual COM Port Properties screen, click ***Update Driver***.
3. In the Hardware Update Wizard screen, select "No, not this time" and click ***Next*** to continue.
4. Select "Install from a list or specific location (Advanced), and click ***Next*** to continue.
5. To choose the "search" and "installation" options, click the checkbox of "Include this location in the search", and click ***Browse*** to find the driver's path in the CD provided or enter the path directly - **\SCSI\IBD185\iBASE_CDC.inf**

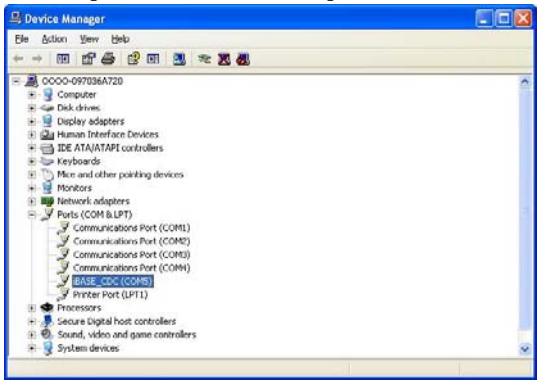


6. Click ***Continue Anyway***.

7. Click ***Finish*** to close the wizard.



8. There are a total of two serial ports. Therefore, the Hardware Update Wizard procedure has to be repeated for the rest of the serial ports



IBD185 MCU Protocol Specification

1 Software Requirements

1.1 Description

MCU provides the following functionality:

1.1.1 GPIO configuration

Software can configure the functionality of GPIO pins on MCU.
MCU provides commands to configure the pin function as digital input or digital output.

1.1.2 GPIO status

Software can control the output pin and get the status of input pin on MCU.
MCU provides commands to control the output of pin which is configured as an output pin or to read back the status of pin which is configured as input pin.

1.1.3 I2C Bus interface

Software can perform I2C bus operation on MCU.
MCU provides command interface to control the I2C bus master on it.

1.2 Protocol

1.2.1 Signal transmission format

Bandwidth
Baud rate: 115200 bps.

Data Format
Parity: No Parity
1 start bit
8 data bits
1 stop bit

1.2.2 Packet Format

Header	Size	Command	Data	CRC
2 bytes	1 byte	1 byte	0 – 64 bytes	2 bytes

Header
bytes indicate start of the packet.

Size
specifies number of bytes for data field.

CRC
verifies data integrity for header, size, command and data bytes.

Command
identifies action, which is required to be performed on the data.

1.2.3 CRC

Protocol uses 16-bit CCITT CRC to verify data integrity.
P(x) = X16+X12+X5+1.

```
unsigned calc_crc(unsigned char *data, unsigned n, unsigned start)
 {
   unsigned I, k, q, c, crcval;
   crcval=start;
   for (I=0; I<n; I++)
   {
       c=data(I) & 0xFF;
       q=(crcval^c) & 0x0F;
       crcval=(crcval>>4)^(q*0x1081);
       q=(crcval^(c>>4)) & 0x0F;
       crcval=(crcval>>4)^(q*0x1081);
   }
   return crcval;
 }
```

1.2.4 Communications flow

Communication between PC and MCU utilizes Master-Slave model, where PC is a master, and MCU is a slave.
Master sends requests to the slave, and slave has to reply to them. Slave acts like a passive device and cannot send any requests to the master.

1.3 Command and Reply Codes

1.3.1 Summary

Code	Value	Description
GET_FIRMWARE_VERSION	0x80	Get MCU Firmware Version
GET_GPIO_CONFIG	0x8A	Get GPIO configuration
SET_GPIO_CONFIG	0x8B	Set GPIO configuration
GET_GPIO_STATUS	0x8C	Get GPIO Status
SET_GPIO_STATUS	0x8D	Set GPIO Status
I2C_API_COMMAND	0x8E	I2C Bus Interface Command

<Note>The command 0xF0 ~ 0xFF is the reserved command for instruction controller.

1.3.2 Get Mcu Firmware Version

Read version number of the MCU firmware

Request

Header	Size	Command	Data	CRC
0xFF 0xEE	0x00	GET_FIRMWARE_VERSION	None	

Reply

Header	Size	Command	Data	CRC
0xFF 0xEE	Size of Version structure	GET_FIRMWARE_VERSION	Version structure	

Version Structure

Field	Type	Description
Major version	byte	Major version number
Minor version	byte	Minor version number
Build	byte	Build number

1.3.3 Get GPIO Configuration

Read the GPIO pin configuration of the MCU

Request

Header	Size	Command	Data	CRC
0xFF 0xEE	0x00	GET_GPIO_CONFIG	GPIO Pin Index	

The “GPIO Pin Index” of GPIO pin is count from 0.

Reply

Header	Size	Command	Data	CRC
0xFF 0xEE	Size of GpioPinCfg structure	GET_GPIO_CONFIG	GpioPinCfg structure	

Device reply a packet without “Data” field (“Size” is 0, none “Data”) means fail. If the request performed successfully, device will reply a packet with specific data structure.
The format is listed below:

GpioPinCfg Structure

Field	Type	Description
Pin Index	byte	Pin Index 0x00 – 1st pin index 0x01 – 2nd pin index …… 0xFF – All of the pins
Pin Config	Array of byte	Pin Configuration 0x00 – as a digital input pin 0x01 – as a digital output pin The length of “Pin Config” is depends on the number of “Pin Index”. If the specific index is 0xFF means all of the pins.

Host can retrieve configurations of all GPIO pins by sending a request packet with designating the field “Pin Index” in “GpioPinCfg” as 0xFF. Device will reply a packet with all GPIO pins configurations in sequential bytes array. The “Pin Config[]” bytes array are in order of the GPIO pin index.

1.3.4 Set GPIO Configuration

Set up the GPIO pin configuration of the MCU

Request

Header	Size	Command	Data	CRC
0xFF 0xEE	0x00	SET_GPIO_CONFIG	GPIO Pin Index	

The “GPIO Pin Index” of GPIO pin is count from 0.

Reply

Header	Size	Command	Data	CRC
0xFF 0xEE	Size of GpioPinCfg structure	SET_GPIO_CONFIG	GpioPinCfg structure	

Device reply a packet without “Data” field (“Size” is 0, none “Data”) means fail. If the request performed successfully, device will reply a packet with specific data structure.
The format is listed below:

GpioPinCfg Structure

Field	Type	Description
Pin Index	byte	Pin Index 0x00 – 1st pin index 0x01 – 2nd pin index ..... 0xFF – All of the pins
Pin Config	Array of byte	Pin Configuration 0x00 – as a digital input pin 0x01 – as a digital output pin

Host can set configurations of all GPIO pins by sending a request packet with designating the field “Pin Index” in “GpioPinCfg” as 0xFF.
Device will reply a packet with all GPIO pins configurations in sequential bytes array. The “Pin Config[]” bytes array are in order of the GPIO pin index.

1.3.5 Get GPIO Status

Read the GPIO pin group status of the MCU

The status of a GPIO pin is represented by a byte of bitmap that groups 8 pins status in one register. This status bitmap is only valid for output pins. Therefore the retrieved status bitmap should be masked with the pin configurations of this group.

Request

Header	Size	Command	Data	CRC
0xFF 0xEE	0x00	GET_GPIO_STATUS	GPIO Group Index	

The "GPIO Group Index" is count from 0 and can be calculated simply by a formula: GPIO Group Index = (GPIO Pin Index/8)

Reply

Header	Size	Command	Data	CRC
0xFF 0xEE	Size of GpioGrpStatus structure	GET_GPIO_STATUS	GpioGrpStatus structure	

Device reply a packet without "Data" field ("Size" is 0, none "Data") means fail. If the request performed successfully, device will reply a packet with specific data structure. The format is listed below:

GpioGrpStatus Structure

Field	Type	Description
Group Index	byte	Group Index 0x00 – 1st group index 0x01 – 2nd group index ..... 0xFF – All of the groups
Group Status	Array of byte	Status bitmap of grouped pins bit 0 .. bit 7 for each of the pin signal and the bitmapping define is listed below : 0[bit] – signal level Low (logic 0) 1[bit] – signal level High (logic 1)

Host can retrieve status of all GPIO pins by sending a request packet with designating the field "Group Index" in "GpioGrpStatus" as 0xFF. Device will reply a packet with all GPIO pins status in sequential bytes array. The "Group Status[]" bytes array are in order of the GPIO group index. Besides, the bit sequence in a "Group Status" byte is mapping to the order of pin index in the same GPIO group.

1.3.6 Set GPIO Status

Set up the GPIO pin group status of the MCU

The status of a GPIO pin is represented by a byte of bitmap that groups 8 pins status in one register. This status bitmap is only valid for output pins. Please make the settings of status bitmap according to the pin configurations of this group.

Request

Header	Size	Command	Data	CRC
0xFF 0xEE	Size of GpioGrpStatus structure	SET_GPIO_STATUS	GPIO Group Index	

The "GPIO Group Index" is count from 0 and can be calculated simply by a formula: GPIO Group Index = (GPIO Pin Index/8)

Reply

Header	Size	Command	Data	CRC
0xFF 0xEE	Size of GpioGrpStatus structure	SET_GPIO_STATUS	GpioGrpStatus structure	

Device reply a packet without "Data" field ("Size" is 0, none "Data") means fail. If the request performed successfully, device will reply a packet with specific data structure. The format is listed below:

GpioGrpStatus Structure

Field	Type	Description
Group Index	byte	Group Index 0x00 – 1st group index 0x01 – 2nd group index ..... 0xFF – All of the groups
Group Status	Array of byte	Status bitmap of grouped pins bit 0 .. bit 7 for each of the pin signal and the bitmapping define is listed below : 0[bit] – signal level Low (logic 0) 1[bit] – signal level High (logic 1)

Host can set status of all GPIO output pins by sending a request packet with designating the field "Group Index" in "GpioGrpStatus" as 0xFF. Device will reply a packet with all GPIO pins status in sequential bytes array. The "Group Status[]" bytes array are in order of the GPIO group index. Besides, the bit sequence in a "Group Status" byte is mapping to the order of pin index in the same GPIO group.

1.3.7 I2C Bus Interface Sub Command Set

This command set is a subset of the IB protocol command.
It provides an interface for HOST to control the I2C bus master on DEVICE side.

The sub command set is constructed by a specific command ID (I2C_API_COMMAND) in “Command” field of packet, and the payloads are embedded in “Data” field.

Header	Size	Command	Data	CRC
2 bytes	1 byte	1 byte	0 – 64 bytes	2 bytes

Sub Command Set

Sub Command Length	Sub Command Code	Sub Command Data
1 byte	1 byte	0 – 32 bytes

The supported command of I2C bus interface command set list below:

Code	Symbol	Description
0x01	I2CAPI_BUS_INIT	Initial the specific I2C bus master
0x02	---	reserved
0x03	I2CAPI_BUS_ENABLE	Enable/Disable the specific I2C bus
0x04	I2CAPI_DEV_STATUS	Detect the slave status on the specific I2C bus.
0x05	I2CAPI_DEV_READ	Perform I2C device read operation
0x06	I2CAPI_DEV_WRITE	Perform I2C device write operation
0x07	I2CAPI_BUS_RESET	Reset the specific I2C bus
0x08	---	reserved

Here is a simple illustration of the interface functions in pseudo code.

```
I2C_Bus_Init(BusID,Speed);

I2C_Bus_Enable(BusID,Enabled);

I2C_Device_Detect(BusID,SlvAddr);

I2C_Device_Read(BusID,SlvAddr,CmdLen,CmdCode[8],Flag,DatLen,
DatBuff[32]);

I2C_Device_Write(BusID,SlvAddr,CmdLen,CmdCode[8],Flag,DatLen,
DatBuff[32]);

I2C_Bus_Reset(BusID,Flag);
```

I2C Bus Initialize

Initialize the I2C bus master on MCU.
Start up an I2C bus with specific Bus ID and Speed.
The Bus ID can be 1 or 2.
Bus ID is 1 means the I2C1 on MCU, and so on.
The Speed can be 0, 1, 2.
Speed=0 means de-initialize the I2C Bus.
Speed=1 means initialize the specific I2C Bus in 400Kbps.
Speed=2 means initialize the specific I2C Bus in 100Kbps (default).

Sub Command Request

Sub Command Length	Sub Command Code	Sub Command Data
size of the I2cApiBusInit structure	I2CAPI_BUS_INIT	I2cApiBusInit structure

Sub Command Reply

Sub Command Length	Sub Command Code	Sub Command Data
size of the I2cApiBusInit structure +1	I2CAPI_BUS_INIT	I2cApiBusInit structure followed by one byte I2cApiResult

The reply packet contains the parameters that device received and followed by one byte of result.
I2cApiResult = 0 means the execution result is fail.

I2cApiBusInit Structure

Field	Type	Description
Bus ID	byte	Designate which I2C bus on MCU 1 – 1st I2C bus master 2 – 2nd I2C bus master
Bus Speed	byte	I2C bus speed selection 0: De-Initialize the specific I2C bus 1: 400Kbps 2: 100Kbps (default)

I2C Bus Enable

Enable/Disable the specific I2C bus master on MCU.

Sub Command Request

Sub Command Length	Sub Command Code	Sub Command Data
size of the I2cApiBusEnabled structure	I2CAPI_BUS_ENABLE	I2cApiBusEnabled structure

Sub Command Reply

Sub Command Length	Sub Command Code	Sub Command Data
size of the I2cApiBusEnabled structure +1	I2CAPI_BUS_ENABLE	I2cApiBusEnabled structure followed by one byte I2cApiResult

The reply packet contains the parameters that device received and followed by one byte of result.
I2cApiResult = 0 means the execution result is fail.

I2cApiBusEnabled Structure

Field	Type	Description
Bus ID	byte	Designate which I2C bus on MCU 1 – 1st I2C bus master 2 – 2nd I2C bus master
Bus Enabled	byte	I2C bus enabled 0: Disable 1: Enable

I2C Device Status

Try to detect the slave device status on the specific I2C bus.

The slave address should be left shift one bit to skip the position of the LSB (R/$\overline{W}$ bit).

For Example:
Stuff the slave address with 0xA0 to designate the slave device which 7 bits slave address is 0x50.

Sub Command Request

Sub Command Length	Sub Command Code	Sub Command Data
size of the I2cApiDevStatus_T structure	I2CAPI_DEV_STATUS	I2cApiDevStatus_T structure

I2cApiDevStatus_T Structure

Field	Type	Description
Bus ID	byte	Designate which I2C bus on MCU 1 – 1st I2C bus master 2 – 2nd I2C bus master
Slv Addr	byte	7bits I2C slave address

Sub Command Reply

Sub Command Length	Sub Command Code	Sub Command Data
size of the I2cApiDevStatus_R structure+1	I2CAPI_DEV_STATUS	I2cApiDevStatus_R structure followed by one byte I2cApiResult

The reply packet contains the I2cApiBusStatus_R structure and followed by one byte of result.
I2cApiResult = 0 means the execution result is fail.

I2cApiDevStatus_R Structure

Field	Type	Description
Bus ID	byte	Designate which I2C bus on MCU 1 – 1st I2C bus master 2 – 2nd I2C bus master
Slv Addr	byte	I2C slave address
Slv Status	byte	Status of the specific slave address 0:Not ready (Busy/Fail) 1:Ready

I2C Device Read/Write

The two interfaces are providing generic command format for I2C bus read/write operation.

The generic command format of an I2C operation can be shown below:

BudID	SlvAdd	CmdLen	CmdCode	Flag	DatLen	DatBuff
Bud ID 1:I2C1 2:I2C2	(7bits SADD <<1)	Length of CmdCode	Command code	0:Normal 1:Block	Length of DatBuff	Data bytes

Limitation:
The max length of command code limits in 8 bytes.
The max length of data byte limits in 32 bytes.

The generic command can be varied to several types of I2C read/write operations. Such as Byte Write/Byte Read, Word Write/Word Read, Sequential Write/Sequential Read, and Block Write/Block Read.

Stuff the command interface with proper arguments to perform different kinds of I2C read/write depends on your needs.

Please refer to the user's manual of your I2C slave device to transmit the I2C command in correct format.

I2C Device Read

Perform an I2C bus read operation.

Sub Command Request

Sub Command Length	Sub Command Code	Sub Command Data
size of the I2cApiDevRead_T structure	I2CAPI_DEV_READ	I2cApiDevRead_T structure

I2cApiDevRead_T Structure

Field	Type	Description
Bus ID	byte	Designate which I2C bus on MCU 1 – 1st I2C bus master 2 – 2nd I2C bus master
Slv Addr	byte	I2C slave address
Cmd Len	byte	Length of the following command code
Cmd Code	Array of byte	command code
Flag	byte	operation flag 0x00: Normal operation 0x01: Block operation
Dat Len	byte	Number of the data bytes you want to read.

Sub Command Reply

Sub Command Length	Sub Command Code	Sub Command Data
size of the I2cApiDevRead_R structure	I2CAPI_DEV_READ	I2cApiDevRead_R structure It contains the read back data.

The reply packet contains the I2cApiDevRead_R structure.

The I2cApiDevRead_R structure returns the device received significant arguments and followed by one byte result.
If the read operation has performed successfully, the result would be equal to the value of “Dat Len” and the retrieved sequential reading data bytes should concatenated to the result byte in the rear of packet, otherwise the read operation has error, the returned packet would be without reading data bytes.

I2cApiDevRead_R Structure

Field	Type	Description
Bus ID	byte	Designate which I2C bus on MCU 1 – 1st I2C bus master 2 – 2nd I2C bus master
Slv Addr	byte	I2C slave address
Cmd Len	byte	Length of the command code
Flag	byte	operation flag 0x00: Normal operation 0x01: Block operation
Dat Len	byte	Length of the data byte
Result	byte	Operation result Result >=0 and Result <=32 : Done Result >32 : Error The read operation is Success if the “Result” is equal to the number of bytes you want to read.
Dat Buff	Array of byte	Data bytes The data bytes to read in sequence.

I2C Device Write

Perform an I2C bus write operation.

Sub Command Request

Sub Command Length	Sub Command Code	Sub Command Data
size of the I2cApiDevWrite_T structure	I2CAPI_DEV_WRITE	I2cApiDevWrite_T structure

I2cApiDevWrite_T Structure

Field	Type	Description
Bus ID	byte	Designate which I2C bus on MCU 1 – 1st I2C bus master 2 – 2nd I2C bus master
Slv Addr	byte	I2C slave address
Cmd Len	byte	Length of the following command code
Cmd Code	Array of byte	command code
Flag	byte	operation flag 0x00: Normal operation 0x01: Block operation
Dat Len	byte	Number of the data bytes you want to write.
Dat Buff	Array of byte	Data bytes The data bytes to write in sequence.

Sub Command Reply

Sub Command Length	Sub Command Code	Sub Command Data
size of the I2cApiDevWrite_R structure	I2CAPI_DEV_WRITE	I2cApiDevWrite_R structure

The reply packet contains the I2cApiDevWrite_R structure.

The I2cApiDevWrite_R structure returns the device received significant arguments and followed by one byte result.

I2cApiDevWrite_R Structure

Field	Type	Description
Bus ID	byte	Designate which I2C bus on MCU 1 – 1st I2C bus master 2 – 2nd I2C bus master
Slv Addr	byte	I2C slave address
Cmd Len	byte	Length of the command code
Flag	byte	operation flag 0x00: Normal operation 0x01: Block operation
Dat Len	byte	Length of the data byte
Result	byte	Operation result Result >=0 and Result <=32 : Done Result >32 : Error The read operation is Success if the “Result” is equal to the number of bytes you want to write.

I2C Bus Reset

Reset the specific I2C bus master on MCU.

Sub Command Request

Sub Command Length	Sub Command Code	Sub Command Data
size of the I2cApiBusReset structure	I2CAPI_BUS_RESET	I2cApiBusReset structure

Sub Command Reply

Sub Command Length	Sub Command Code	Sub Command Data
size of the I2cApiBusReset structure +1	I2CAPI_BUS_RESET	I2cApiBusReset structure followed by one byte I2cApiResult

The reply packet contains the parameters that device received and followed by one byte of result.
I2cApiResult = 0 means the execution result is fail.

I2cApiBusReset Structure

Field	Type	Description
Bus ID	byte	Designate which I2C bus on MCU 1 – 1st I2C bus master 2 – 2nd I2C bus master
Flag	byte	Flag for reset I2C bus 0: Re-Config I2C bus (default) 1: Reset I2C bus (reserved)

APPENDIX

A protocol instruction example for I2C read/write operation:
The I2C device (24C02 EEPROM) is connected to the I2C1 Bus on MCU.
(7bits SlaveAddress: 0x50, 8 bytes per page)

Page Write from address 0x00 on 24C02

REQUEST PACKET:

Header	Size	Command
0xFF, 0xEE	16	0x8E

Data					CRC
					0x8E, 0x61
Sub Cmd Len	Sub Cmd Code	Sub Cmd Data			
14	0x06	BudID	SlvAdd	CmdLen	CmdCode
		0x01 (I2C1)	0xA0 (0x50 << 1)	1	0x00 (writing from 0x00)
		Flag	DatLen	DatBuff	
		0x00	8	0x00,0x01,0x02,0x03, 0x04,0x05,0x06,0x07	

REPLY PACKET:

Header	Size	Command
0xFF, 0xEE	8	0x8E

Data					CRC
					0x7E, 0x38
Sub Cmd Len	Sub Cmd Code	Sub Cmd Data			
6	0x06	BudID	SlvAdd	CmdLen	
		0x01 (I2C1)	0xA0 (0x50 << 1)	1	
		Flag	DatLen	Result	
		0x00	8	8 (Result==DatLen means success)	

Read 8 bytes from address 0x00 on 24C02

REQUEST PACKET:

Header	Size	Command
0xFF, 0xEE	8	0x8E

Data					CRC
					0xD0, 0x5E
Sub Cmd Len	Sub Cmd Code	Sub Cmd Data			
6	0x05	BudID	SlvAdd	CmdLen	CmdCode
		0x01 (I2C1)	0xA0 (0x50 << 1)	1	0x00 (reading from 0x00)
		Flag	DatLen		
		0	8		

REPLY PACKET:

Header	Size	Command
0xFF, 0xEE	16	0x8E

Data						CRC
						0xD9, 0xD0
Sub Cmd Len	Sub Cmd Code	Sub Cmd Data				
14	0x05	BudID	SlvAdd	CmdLen		
		0x01 (I2C1)	0xA0 (0x50 << 1)	1		
		Flag	DatLen	Result	DatBuff	
		0	8	8 (Result == DatLen means success)	0x00,0x01, 0x02,0x03, 0x04,0x05, 0x06,0x07	