IQRF CDC

CDC implementation in IQRF USB devices

Technical guide

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CDC class

Unlike the Custom class, the CDC class provides a simpler serial bus via USB interface. A device equipped with the firmware supporting CDC creates a virtual serial port enabling to communicate with PC or another equipment (supporting USB) via the USB interface like through a standard COM port.

Prior to CDC usage, the IQRF USB CDC driver must be installed. It is available to download from www.iqrf.org/cdc within the WinUSB and MPUSB drivers installators. For all current IQRF USB devices, the WinUSB should be selected. CDC driver is also installed within the IQRF IDE development environment installation. This driver uses VID / PID by MICRORISC when used with IQRF devices.

IQRF kits working with IQRF IDE use the Custom class but can be switched to/from the CDC class by the IQRF IDE (if the kit is equipped with the CDC option).

TIP

For testing a communication in CDC mode various SW terminals operating with PC serial ports are available. Select a terminal enabling to issue direct byte commands and data. Recommended terminal: Docklight, www.docklight.de. There is a project containing all supported commands for this terminal available at www.iqrf.org/218. It is necessary just to select the COM port used.

Unsuitable terminals: Windows Hyperterminal, Tera Term, …

This document describes CDC implementation in IQRF USB devices.

Communication

Communication is based on *commands* sent from PC and USB device responds with *answers*. Additionally, USB device can send asynchronous *messages* as well.

Format

Every command begins with the ">" character. Every answer and asynchronous message begins with the "<" character. It allows easy orientation in directions if a PC terminal is used. Every packet is terminated with the `CR` character (`CR LF` is also accepted).

Command:

`>[body][CR]`

Answer:

`<[body][CR]`

Message:

`<[body][CR]`

        `[body]` – Body of the command
        `[CR]`   – Carriage Return (value `0x0D`)

General error

In case of syntax error or not supported command general error message is issued.

Answer:

`<ERR[CR]`

Communication test

Command:

`>[CR]`

Answer:

`<OK[CR]`

Commands

Some older IQRF USB devices support no CDC at all or only a subset of commands described in this guide. See Table_1 below for supported devices with respect to the firmware inside.

Reset USB Device

5 s after receiving of this command the USB device is reset. This delay allows to disconnect USB communication on PC side in time.

Command:
```
>R[CR]
```

Answer:
```
<R:OK[CR]
```

Reset TR Module

TR module inside the USB device is reset.

Command:
```
>RT[CR]
```

Answer:
```
<RT:OK[CR]
```

Get USB Device Info

Returns USB device identification.

Command:
```
>I[CR]
```

Answer:
```
<I:[type]#[version]#[id][CR]
```
    [type]   – Device type (in text format)
    [version] – Firmware version (in text format)
    [id]   – Serial number (in text format)

Example:
```
>I[CR]
<I:GW-USB-03#02.01#03010000[CR]
```
    [type]   – GW-USB-03
    [version] – 2.01
    [id]   – 0x03010000

Get TR Module Info

Returns identification of TR module inside the USB device.

Command:

>IT[CR]

Answer:

<IT:[module_info][CR]

> [module_info] – Description see *IQRF OS Reference guide* (function moduleInfo).
> - For IQRF OS v4.02D or lower: 8 B Module Info (LSB first) and 8 B dummy data is returned.
> - For IQRF OS v4.03D or higher: 8 B Module Info (LSB first), 8 B dummy data and 16 B IBK (Individual Bonding Key) is returned.

The TR module in CK-USB-04A is allowed to be plugged / unplugged into / from the SIM connector while powered off only (e.g. while the SW2 pushbutton is held). If TR is plugged in without the CK-USB-04A reset, the *IT* answer is not valid for CK-USB-04A with FW lower than v1.11.

For CK-USB-04A with FW v1.11 or higher the answer takes about 300 ms.
For GW-USB-06 with FW v1.06 or higher the answer takes about 2 s if the device is not in programming mode.

Connectivity Indication

USB device issues an acoustical or optical indication.

Command:

>B[CR]

Answer:

<B:OK[CR]

Get Status

Returns information about current status.

Command:

>S[CR]

Answer:

<S:[spi_status][CR]

> [spi_status] - Value according to the table in *IQRF SPI User's guide* (chapter *SPI status*)

Send Data

Sends data to TR module inside the USB device.

Command:

`>DS[dlen]:[data][CR]`

>> `[dlen]` – Data length (number of bytes in the `[data]` field), in hexadecimal
>>> – Range 1 to 41
>>> – Range 1 to 64 (GW-USB-05 and CK-USB-04A)
>> `[data]` – Actual data for TR module
>>> – Number of bytes must correspond to `[dlen]`

Answers:

`<DS:OK[CR]`

>> Data successfully sent to TR module

`<DS:ERR[CR]`

>> – Communication failure (checksum error)
>> – `[dlen]` out of range
>> – Data length mismatch (number of bytes in `[data]` does not correspond to `[dlen]`)

`<DS:BUSY[CR]`

>> – SPI bus is busy, communication is just running
>> – TR module is not in communication mode

Example:

`>DS[0x05]:Hello[CR]`
`<DS:OK[CR]`

Receive Data

Asynchronous message sent by the USB device after data receipt from TR module.

Messages:

`<DR[dlen]:[data][CR]`

>> `[dlen]`
>>> – Data length (number of bytes in the `[data]` field), in hexadecimal
>>> – Range 1 to 41
>>> – Range 1 to 64 (GW-USB-05)
>> `[data]` Actual data from TR module

`<DR:ERR[CR]`

>> Communication failure (checksum error)

Example:

`<DR[0x05]:Hello[CR]`

Switch to USB Custom Class

USB class is switched to Custom and the device is reset 5 s after this command is issued. This delay allows to cancel USB communication on PC side. Refer to user's manual of given USB device how to return to CDC.

Command:

`>U[CR]`

Answer:

`<U:OK[CR]`

Switch to USB CDC – UART

USB device is switched to CDC – UART transparent mode and the device is reset 5 s after this command is issued. This delay allows to cancel USB communication on PC side. Refer to user's manual of given USB device how to return back.

Command:

`>UU[CR]`

Answer:

`<UU:OK[CR]`

Switch to USB CDC - SPI

USB device is switched to CDC – SPI transparent mode and the device is reset 5 s after this command is issued. This delay allows to cancel USB communication on PC side. Refer to user's manual of given USB device how to return back.

Command:

`>US[CR]`

Answer:

`<US:OK[CR]`

Upload commands

Enter programming mode

Enter programming mode of TR module inside the USB device.

Command:

`>PE[CR]`

Answers:

`<PE:OK[CR]`
> TR module is in programming mode.

`<PE:ERR1[CR]`
> TR module is not in programming mode.

Terminate programming mode

Terminate programming mode of the TR module inside the USB device.

Command:

`>PT[CR]`

Answer:

`<PT:OK[CR]`
> TR module programming mode is terminated.

`<PT:ERR1[CR]`
> – Communication failure
> – TR module is still in programming mode

Upload / download TR memory

Command *PM* allows to upload/download data to/from TR module inside the USB device.
General format of *PM* command is:

```
>PM[target][addr_L][addr_H][data][CR]
```
          [target]   Specifies upload/download operation and the target memory
          [addr_L]   Specifies low address of tagret memory
          [addr_H]   Specifies high address of tagret memory
          [data]   Data to be uploaded

Format of [target]:
bit7: Operation: 1 - Upload, 0 - Download
bit6, bit5, bit4: Reserved for future use, should be cleared
bit3, bit2, bit1, bit0: Specifies TR module memory to upload / download

Answers:

```
<PM:OK[CR]
```
          Data successfully sent to TR module, TR module is in programming mode, next data can be sent.

```
<PM:ERR2[CR]
```
          Incorrect [target] memory

```
<PM:ERR3[CR]
```
          Incorrect [data] length

```
<PM:ERR4[CR]
```
          Incorrect [addr_L][addr_H] address

```
<PM:ERR5[CR]
```
          Specified [target] memory is write only.

```
<PM:ERR6[CR]
```
          Communication failure, upload/download error

```
<PM:ERR7[CR]
```
          Operation is not supported by TR module (e.g. TRs with 0S 3.xx does not support *Access key* and *User key*)

```
<PC:BUSY[CR]
```
          – SPI bus is busy, communication is running.
          – TR module is not in programming mode.

When uploading the memories from a `.HEX` file, the addresses must be properly interpreted with respect to mapping of individual memory types into a single virtual space. E.g., the CC5X compiler generates virtual addresses from physical addresses in EEEPROM by adding the offset 0x0200. See table *Virtual and physical addresses* below. For the HEX format description, refer to *CC5X C compiler User's guide* (included in IQRF IDE) or *IQRF DPA Framework Technical guide*, chapter *Custom DPA Handler Code at .hex File*.

Caution: All addresses in `.HEX` files generated by CC5X compiler are multiplied by two.

Therefore, when handling with memories according to all the commands described below, all addresses read from a `.HEX` file must be divided by two first.

All addresses mentioned below mean the resulting addresses (thus divided by two already).

Individual memory types (see below) can be uploaded in any order, with the only exception: if the `.IQRF` file as well as the *Access password* and/or *User key* are to be uploaded, the `.IQRF` file must be uploaded sooner.

Tip: Upload the *Access password* and *User key* as the last one(s).

Virtual and physical addresses

Virtual address (in .HEX)	Flash					EEPROM Physical address	EEEPROM Physical address
	Physical address	Standard	Extended	Configuration	OS		
0000	0000				0000		
.	.				.		
0200							0000
.							
0400							
.							
09FF							07FF
0A00							0800
.	.						
					2BFF		
.	.	2C00					
.	.	.					
.	.	37BF					
.	.		37C0				
.	.		.				
.	.		37DF				
.	.			37E0			
.	.			-"-	.		
.	.			39FF			
.	.	3A00					
.	.	.					
3FFF	3FFF	3FFF					
4000							3E00
.							
41FF							3FFF
4200	Unused						
.							
EFFF							
F000						00	
.						.	
F0FF						FF	

OS: Accessible via Special upload from .IQRF file only

EEEPROM: Addressable by #pragma (0000–07FF); Not addressable by #pragma (0800–3FFF)

Upload TR configuration

Upload / download configuration to / from TR module inside the USB device.

Upload command:

```
>PM[target][data][CR]
```

[target 0x80]	Specifies TR configuration upload
[data[0]]	XOR of all configuration bytes with initial value 0x5F
[data[1]-data[31]]	Configuration (31 B). See *IQRF DPA Framework Technical guide*, chapter *HWP configuration* .

Answers:

See chapter Upload/download TR module memory

Download command:

```
>PM[target][CR]
```

[target 0x00]	Specifies TR configuration download

Answer:

```
<PM[data][CR]
```

[data[0]]	XOR of all configuration bytes with initial value 0x5F
[data[1]-data[31]]	Configuration (31 B)

Upload TR RFPGM configuration

Upload / download RFPGM configuration to / from the TR module inside the USB device.

Upload Command:

```
>PM[target][data][CR]
```

[target 0x81]	Specifies TR RFPGM configuration upload
[data]	RFPGM configuration – 1 B. See IQRF OS Ref. guide, function setupRFPGM().

Answers

See chapter Upload/download TR module memory.

Download command:

```
>PM[target][CR]
```

[target 0x01]	Specifies TR RFPGM configuration download

Answer:

```
<PM[data][CR]
```

[data]	RFPGM configuration – 1 B. See IQRF OS Ref. guide, funxtion setupRFPGM().

Upload TR RF band configuration

Upload/download RF band configuration to/from the TR module inside the USB device.

Upload Command:

```
>PM[target][data][CR]
```
      `[target 0x82]`   Specifies TR RF band configuration upload
      `[data`   RF band configuration
              `0x00`   868 MHz
              `0x01`   916 MHz
              `0x02]`   433 MHz

Answers

See chapter Upload/download TR module memory.

Download command:

```
>PM[target][CR]
```
      `[target 0x02]`   Specifies TR RF band configuration download

Answer:

```
<PM[data][CR]
```
      `[data]`   RF band configuration – 1 B

Upload TR Access password

Upload Access password to the TR module inside the USB device. Access password is write-only, can not be downloaded.

Upload command:

```
>PM[target][data][CR]
```
      `[target 0x83]`   Specifies TR Access password upload
      `[data]`   Access password – 16 B

Answers:

See chapter *Upload/download TR module memory.*

Upload TR User key

Upload User key to TR module inside the USB device. User key is write-only, can not be downloaded.

Upload command:

```
>PM[target][data][CR]
```
      `[target 0x84]`   Specifies TR User key upload
      `[data]`   User key – 16 B

Answers:

See chapter Upload/download TR module memory.

Upload TR Flash program memory

Upload / download Flash memory of TR module inside the USB device.

Upload command:

```
>PM[target][addr_L][addr_H][data][CR]
```
[target 0x85]	Specifies TR Flash memory upload
[addr_L]	Low address
[addr_H]	High address
[data]	Data to be uploaded – 32 B (16 instructions) in little endian order

Conditions:

[addr_L][addr_H]	Address should be modulo 16 and should point to: – Application memory: Area 0x3A00 − 0x3FFF (1536 machine instructions) – Extended Flash memory: Area 0x2C00 − 0x37BF (3008 machine instructions) See table *Virtual and physical addresses* above.

Answers:

See chapter Upload / download TR module memory.

Download command:

```
>PM[target][addr_L][addr_H][CR]
```
[target 0x05]	Specifies TR Flash download
[addr_L]	Low address
[addr_H]	High address

Conditions:

[addr_L][addr_H]	Address should be modulo 32 and should point to: – Application memory: Area 0x3A00 − 0x3FFF (1536 machine instructions) – Extended Flash memory: Area 0x2C00 − 0x37BF (3008 machine instructions) See table *Virtual and physical addresses* above.

Answer:

```
<PM[xor data][CR]
```
[xor data]	Device returns 32 B: instr.low8[addr] XOR instr.high8[addr] instr.low8[addr+1] XOR instr.high8[addr+1] · · · instr.low8[addr+31] XOR instr.high8[addr+31]

Upload TR internal EEPROM memory

Upload / download internal EEPROM of TR module inside the USB device.

Upload command:

```
>PM[target][addr_L][addr_H][data][CR]
```
[target 0x86]	Specifies TR internal EEPROM upload
[addr_L]	Low address
[addr_H]	High address
[data]	Data to be uploaded, 1-32 bytes

Conditions:

[addr_L][addr_H]	Address should point to area $0x0000 - 0x00BF$. The sum of address and data length should be $< 0x00C0$.

Answers:

See chapter Upload / download TR module memory.

Download command:

```
>PM[target][addr_L][addr_H][CR]
```
[target 0x06]	Specifies TR internal EEPROM download
[addr_L]	Low address
[addr_H]	High address

Conditions:

[addr_L][addr_H]	Address should point to area $0x0000 - 0x00A0$.

Answer:

```
<PM[data][CR]
```
[data]	Internal EEPROM content – 32 B

Upload TR external EEPROM memory

Upload / download external EEPROM of TR module inside the USB device.

Command:

```
>PM[target][addr_L][addr_H][data][CR]
```
  [target 0x87]   Specifies TR external EEPROM upload
  [addr_L]   Low address
  [addr_H]   High address
  [data]   Data to be uploaded – 32 B

Conditions:

[addr_L][addr_H]   Address should be modulo 32 and point to area 0x0000 − 0x3FE0

Answers:

See chapter Upload / download TR module memory.

Download command:

```
>PM[target][addr_L][addr_H][CR]
```
  [target 0x07]   Specifies TR external EEPROM download
  [addr_L]   Low address
  [addr_H]   High address

Conditions:

[addr_L][addr_H]   Address should point to area 0x0000 − 0x3FE0

Answer:

```
<PM[data][CR]
```
  [data]   External EEPROM content – 32 B

Special upload

Upload data from .IQRF file to the TR module inside the USB device.

Command:

```
>PM[target][data][CR]
```
  [0x88]   Specifies special upload
  [data]   Data to be uploaded

Conditions:

[data]   Should contain 1 line of an *.iqrf file

Answers:

See chapter Upload / download TR module memory.

CDC commands overview

Function			Command	Target	Blocks
Communication test			*Blank*		
Reset USB Device			R		
Reset TR Module			RT		
Get USB Device Info			I		
Get TR Module Info			IT		
Connectivity Indication			B		
Get Status			S		
Send Data			DS		Up to 41 or 64 B
Receive Data			DR		Up to 41 or 64 B
Switch to USB Custom Class			U		
Switch to USB CDC – UART			UU		
Switch to USB CDC - SPI			US		
Enter programming mode			PE		
Terminate programming mode			PT		
Upload	**Flash**	**Write application**	PM	85	16 words
		Verify application		05	32 B
	Plug-in	**Write**		88	1 line
	Configuration	**Write OS – RF band**		82	1 B
		Read OS – RF band		02	1 B
		Write OS – RFPGM		81	1 B
		Read OS – RFPGM		01	1 B
		Write HWP		80	32 B
		Read HWP		00	32 B
		Write Security – Access password		83	16 B
		Write Security – User key		84	16 B
	EE	**Write**		86	Up to 32 B
		Read		06	32 B
	EEE	**Write**		87	32 B
		Read		07	32 B

Supported devices

	Command / Message	CK-USB-04	CK-USB-04A	GW-USB-03	GW-USB-03A	GW-USB-04	GW-USB-05	GW-USB-06	GW-USB-07
R	Reset USB device	–	1.01	2.03	1.00	1.20	1.03	1.00	1.00
RT	Reset TR module	–	1.01	2.03	1.00	1.20	1.03	1.00	1.00
I	Get USB Device Info	–	1.01	2.03	1.00	1.20	1.03	1.00	1.00
IT	Get TR Module Info	–	1.01	2.03	1.00	1.20	1.03	1.00	1.00
B	Connectivity Indication	–	1.01	2.03	1.00	1.20	1.03	1.00	1.00
S	Get Status	–	1.01	2.03	1.00	1.20	1.03	1.00	1.00
DS	Send Data	–	1.01	2.03	1.00	1.20	1.03	1.00	1.00
DR	Received Data	–	1.01	2.03	1.00	1.20	1.03	1.00	1.00
U	Switch to USB Custom Class	–	1.01	2.03	1.00	1.20	1.03	1.00	1.00
UU	Switch to USB CDC – UART	–	1.10	–	–	–	1.07	1.04	1.00
US	Switch to USB CDC - SPI	–	1.10	–	–	–	1.07	1.04	1.00
PE	Enter programming mode	–	–	–	–	–	–	1.07 *	1.00
PT	Terminate programming mode	–	–	–	–	–	–	1.07 *	1.00
PM	Upload / download TR memory	–	–	–	–	–	–	1.07 *	1.00

* Commands PE, PT and PM are available also for GW-USB-06 with FW v1.06 but with IQRF OS v4.00D only.

Table 1 – Commands supported by individual IQRF USB devices with respect to FW inside.

Document history

- 181018   Updated for IQRF OS v4.03D (IBK included in *Get TR Module info*). References to the HEX format description added into chapter *Upload / download TR memory*.
- 180319   Upload revised and extended. Tables *Virtual and physical addresses* and *CDC commands overview* added.
- 171018   Chapter *Upload / download TR memory* extended (the last paragraph and a *Tip* added).
- 170810   TR transceiver upload in IQRF CDC USB mode added.
- 150806   Extended for GW-USB-06. Chapters *CDC class* and *Get TR Module Info* revised.
- 150119   Extended for CDC SPI and CDC UART modes.
- 140129   CK-USB-04A support added.
  Document file renamed from MNCDC_130121 to User_Guide_CDC_140129.
- 130121   GW-USB-05 support added.
- 121008   First chapter extended. Bugs in *Switch to USB Custom Class* and *Reset USB Device* fixed.
- 110526   *Switch to USB Custom Class* command added.
- 110318   First release.

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