Gowin USB Type-C PD Protocol Hardware and Software Design

Reference Manual

IPUG544-1.0E,3/18/2019

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Revision History

Date	Version	Description
3/18/2019	1.0E	Initial version published.

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1 About This Guide

1.1 Purpose

Gowin USB type-C PD protocol hardware and software design reference manual mainly describes the architecture, communication flow, software and hardware design flow and method based on Gowin platform, user interface and reference design. It is mainly used to help users quickly understand the features, characteristics, and usage of Gowin USB type-C PD.

1.2 Supported Products

The information presented in this guide applies to the following products:

1. GW2A series FPGA products
2. GW2AR series FPGA products

1.3 Related Documents

The latest user guides are available on our Website. Refer to the related documents at www.gowinsemi.com

1. GW2A series FPGA Products Data Sheetl
2. GW2AR series FPGA Products Data Sheet
3. Gowin YunYuan Software User Guide

1.4 Terminology and Abbreviations

The terminology and abbreviations used in this manual are as shown in the Table 1-1 below. .

Table 1-1 Abbreviations and Terminologies

Terminology and Abbreviations	Meaning
USB	Universal Serial Bus
PD	Power Delivery
BMC	Bi-Phase Mark Coding
SOP	Start Of Packet
CRC	Cyclic Redundancy Check

1.5 Support and Feedback

Gowin Semiconductor provides customers with comprehensive technical support. If you have any questions, comments, or suggestions, please feel free to contact us directly by the following ways.

Website: www.gowinsemi.com

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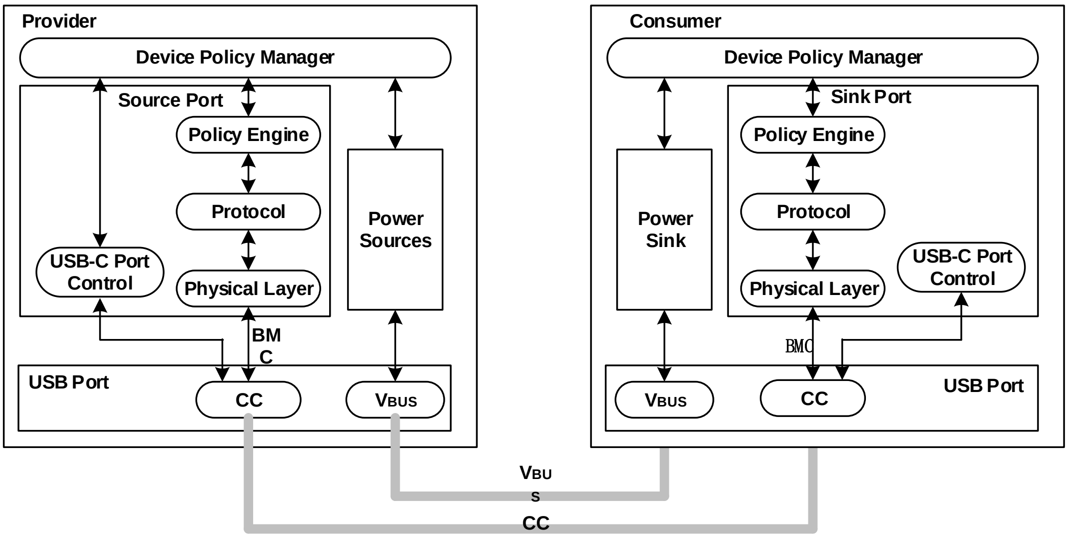
2USB Type-C PD Protocol

2.1 USB Type-C PD Protocol Architecture

USB Type -C Power Deliveryprotocol architecture is shown in the Figure 2-1.

Figure 2-1 USB Type-C PD Protocol Architecture



USB Type -C Power Deliveryprotocol architecture is divided into:

- Provider Transmitter
- Consumer Receiver

Provider and Consumer consist of the following:

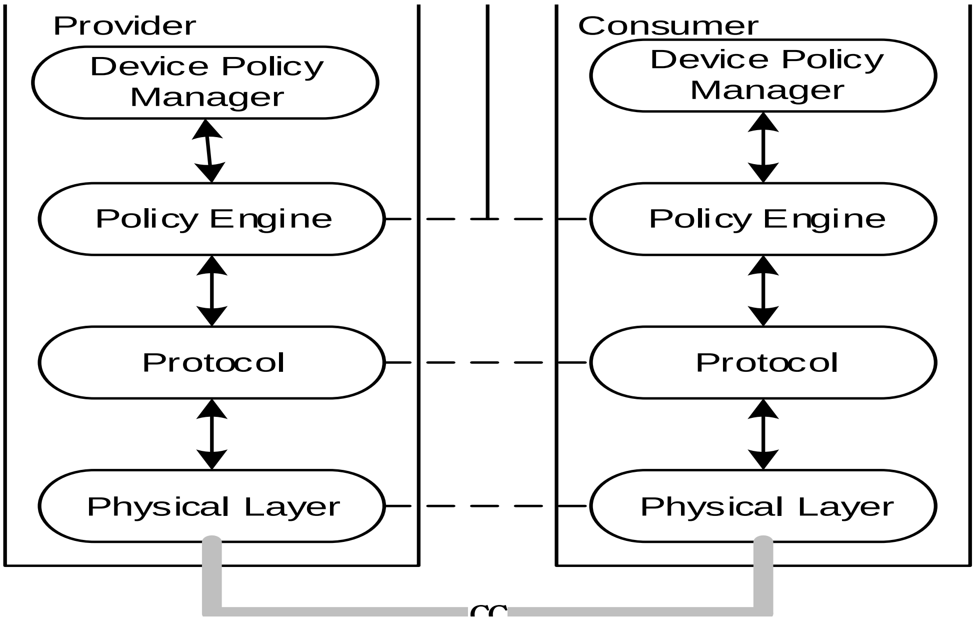
- Device Policy Manager
- Policy Engine
- Protocol Layer
- Physical Layer

Provider and Consumer communicate data through CC port and are powered through V_{BUS} port.

2.2 USB Type-C PD Protocol Communication Flow

Type -C Power Deliveryprotocol data communication flow is shown in the Figure 2-2.

Figure 2-2 USB Type-C PD Protocol Data Communication Flow



After the Consumer receiver plugs in the USB type-c device, the Provider transmitter completes the following flow:

- Detect whether the Consumer receiver has a USB type-c device plugged in.
- Detect the insertion direction of USB type-c interface front and back
- Detect initialized power supply and establish data communication relationship
- Detect V_{BUS} port current
- USB Type-C PD Protocol Communication

2.3 USB Type-C PD Protocol

2.3.1 Policy Engine

Policy Engine layer building is shown in the Table 2-1.

Table 2-1 Message Sequence

Message Sequence
Power Negotiation
Reclaiming Power with GotoMin Message
Soft Reset
Hard Reset
Power Role Swap
Fast Role Swap
Data Role Swap
Vconn Swap
Additional Capabilities, Status and Information
Security

Message Sequence
Firmware Update
Structured VDM
Built in Self-Test (BIST)

2.3.2 Protocol Layer

Protocol layer includes three message types:

- Control Message
- Data Message
- Extended Message

Control Message

The types of message included in Control Message are shown in the Table 2-2.

Table 2-2 Control Message Type

Bits	Message Type
00001	GoodCRC
00010	GotoMin
00011	Accept
00100	Reject
00101	Ping
00110	PS_RDY
00111	Get_Source_Cap
01000	Get_Sink_Cap
01001	DR_Swap
01010	PR_Swap
01011	VCONN_Swap
01100	Wait
01101	Soft_Reset
10000	Not_Supported
10001	Get_Source_Cap_Extended
10010	Get_Status
10011	FP_Swap
10100	Get_PPS_Status
10101	Get_Country_Codes

Data Message

The types of message included in Data Message are shown in the Table 2-3.

Table 2-3 Data Message Type

Bits	Type
00001	Source_Capabilities
00010	Request
00011	BIST
00100	Sink_Capabilities
00101	Battery_Status
00110	Alert
00111	Get_Country_Info
01111	Vendor_Defined

Extended Message

The types of message included in Extended Message are shown in the Table 2-4.

Table 2-4 Extended Message Type

Bits	Type
00001	Source_Capabilities_Extended
00010	Status
00011	Get_Battery_Cap
00100	Get_Battery_Status
00101	Battery_Capabilities
00110	Get_Manufacturer_Info
00111	Manufacturer_Info
01000	Security_Request
01001	Security_Response
01010	Firmware_Update_Request
01011	Fimrware_Update_Response
01100	PPS_Status
01101	Country_Info
01110	Country_Codes

2.3.3 Physical Layer

Message packet format of Physical Layer is shown in the Figure 2-3.

Figure 2-3 Message Packet

Preamble (training for receive)	SOP*(Start of Packet)	Message Header	Byte 0...n	CRC	EOP(End of Packet)

Physical Layer packet includes:

- Preamble
- SOP*, Start of Packet
- Message Header
- Message Data Information
- CRC Check
- EOP, End of Packet

SOP

The types included in SOP are shown in the Table 2-5.

Table 2-5 SOP Type

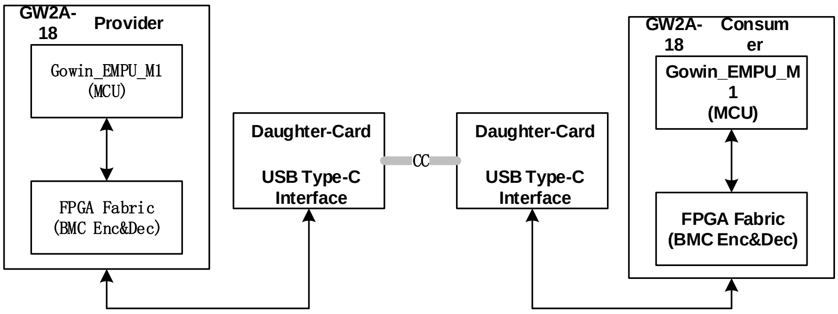
Type	K-code number	K-code
SOP	1	Sync-1
	2	Sync-1
	3	Sync-1
	4	Sync-2
SOP'	1	Sync-1
	2	Sync-1
	3	Sync-3
	4	Sync-3
SOP''	1	Sync-1
	2	Sync-3
	3	Sync-1
	4	Sync-3
SOP''_Debug	1	Sync-1
	2	RST-2
	3	Sync-3
	4	Sync-2
SOP'_Debug	1	Sync-1
	2	RST-2
	3	RST-2
	4	Sync-3
Cable Reset	1	RST-1
	2	Sync-1
	3	RST-1
	4	Sync-3
Hard Reset	1	RST-1
	2	RST-1
	3	RST-1
	4	RST-2

3Gowin USB Type-C PD Protocol Design Flow

3.1 Hardware Design Platform

Gowin USB Type-C PD protocol hardware design platform is shown in the Figure 3-1.

Figure 3-1 Gowin USB Type-C PD Protocol Hardware Design Platform



Gowin USB Type-C PD protocol hardware design platform is divided into:

- Provider Transmitter
- Consumer Receiver

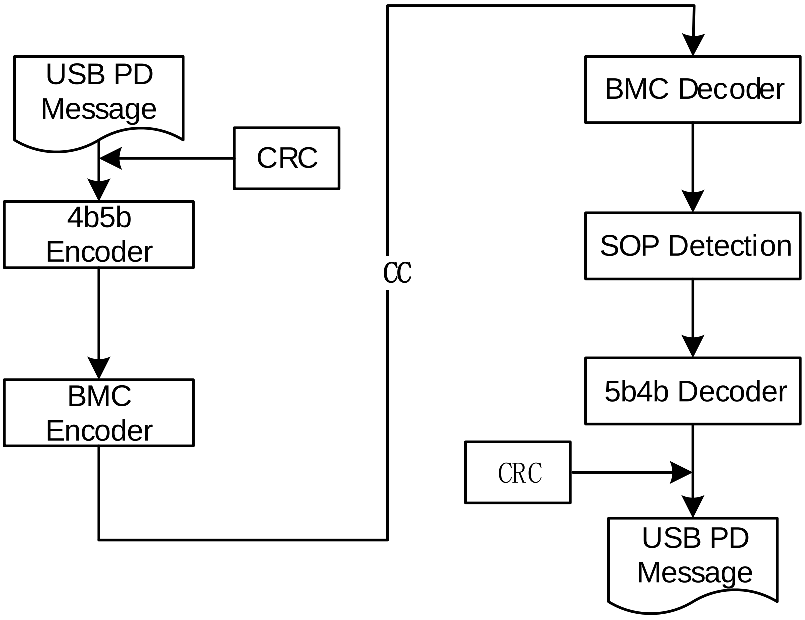
Provider and Consumer respectively consist of the following:

- GW2A-18 Development Board
  - Gowin_EMPU_M1，MCU Soft Core
  - FPGA Fabric，BMC Encoding and Decoding
- Daughter Card
  - USB Type-C Interface and Interface Circuit

3.2 Software Design Flow

Gowin USB Type-C PD protocol software design flow is shown in the Figure 3-2.

Figure 3-2 Gowin USB Type-C PD Protocol Software Design Flow



Gowin USB Type-C PD protocol software design flow includes:

- Generate USB Type-C PD Message
- Provider Transmitter CRC Check
- 4b5b Encoding
- BMC Encoding
- BMC Decoding
- SOP Detection
- 5b4b Decoding
- Consumer Receiver CRC Check
- Parse USB Type-C PD Message

4Gowin USB Type-C PD Protocol Design Implementation

Gowin USB Type-C PD protocol design implementation includes:

- Gowin USB Type-C PD Protocol Hardware Design
- Gowin USB Type-C PD Protocol Software Design

4.1 Hardware Design

Gowin USB Type-C PD protocol hardware design implementation includes:

- Gowin_EMPU_M1，MCU Soft Core Hardware Design
- BMC Codec Hardware Design

Gowin USB type-C PD protocol design release provides Gowin USB Type-C PD protocol hardware design implementation.

4.2 Software Design

Gowin USB Type-C PD protocol software design implementation includes:

- Generate USB Type-C PD Message
- Provider Transmitter CRC Check
- 4b5b Encoding
- BMC Encoding
- BMC Decoding
- SOP Detection
- 5b4b Decoding
- Consumer Receiver CRC Check
- Parse USB Type-C PD Message

Gowin USB type-C PD protocol design release provides Gowin USB Type-C PD protocol software design implementation.

5User Interface

5.1 Provider User Interface

Provider user interface is shown in Table 5-1.

Table 5-1 Provider User Function Interface

Function	Description
type_c_power_negotiation_flow	Power Negotiation Provider is as transmitter and Consumer is as recevier
type_c_vdm_Consumer_flow	Structured VDM Provider is as transmitter and Consumer is as recevier
type_c_vdm_cable_flow	Structured VDM Provider is as transmitter and cable is as recevier
type_c_reclaim_power_flow	Reclaiming Power with GotoMin Message Provider is as transmitter and Consumer is as recevier
type_c_src_soft_reset_flow	Soft Reset Provider is as transmitter and Consumer is as recevier
type_c_src_hard_reset_flow	Hard Reset Provider is as transmitter and Consumer is as recevier
type_c_src_power_role_swap_flow	Power Role Swap Provider is as transmitter and Consumer is as recevier
type_c_src_data_role_swap_flow	Data Role Swap Provider is as transmitter and Consumer is as recevier
type_c_src_vconn_swap_flow	Vconn Swap Provider is as transmitter and Consumer is as recevier
type_c_src_alert_flow	Alert Provider is as transmitter and Consumer

Function	Description
	is as recevier
type_c_snk_capa_flow	Sink Capabilities Provider is as transmitter and Consumer is as recevier
type_c_src_battery_capa_flow	Battery Capabilities Provider is as transmitter and Consumer is as recevier
type_c_src_battery_status_flow	Battery Status Provider is as transmitter and Consumer is as recevier
type_c_src_manufacturer_info_flow	Manufacturer Information Provider is as transmitter and Consumer is as recevier
type_c_cable_plug_manufacturer_info_flow	Manufacturer Information Provider is as transmitter and cable is as recevier
type_c_src_country_code_flow	Country Codes Provider is as transmitter and Consumer is as recevier
type_c_cable_plug_country_code_flow	Country Codes Provider is as transmitter and cable is as recevier
type_c_src_country_info_flow	Country Information Provider is as transmitter and Consumer is as recevier
type_c_cable_plug_country_info_flow	Country Information Provider is as transmitter and cable is as recevier
type_c_src_security_flow	Security Provider is as transmitter and Consumer is as recevier
type_c_cable_plug_security_flow	Security Provider is as transmitter and cable is as recevier
type_c_src_fw_up_flow	Firmware Update Provider is as transmitter and Consumer is as recevier
type_c_cable_plug_fw_up_flow	Firmware Update Provider is as transmitter and cable is as recevier
type_c_Provider_respond_to_Consumer	Provider responds to Consumer's message Provider is as responder and Consumer is as receiver
cc_port_rx_GPIO_Config	Configs RX CC-Port' GPIO
ADC2_Config	Configs ADC2
cc_port_power_on_detection	Detects CC-Port voltage value

5.2 Consumer User Interface

Consumer user interface is shown in the Table 5-2.

Table 5-2 Consumer User Function Interface

Function	Description
type_c_snk_soft_reset_flow	Soft Reset Consumer is as transmitter and Provider is as recevier
type_c_snk_hard_reset_flow	Hard Reset Consumer is as transmitter and Provider is as recevier
type_c_snk_power_role_swap_flow	Power Role Swap Consumer is as transmitter and Provider is as recevier
type_c_fast_role_swap_flow	Fast Power Role Swap Consumer is as transmitter and Provider is as recevier
type_c_snk_data_role_swap_flow	Data Role Swap Consumer is as transmitter and Provider is as recevier
type_c_snk_vconn_swap_flow	Vconn Swap Consumer is as transmitter and Provider is as recevier
type_c_snk_alert_flow	Alert Consumer is as transmitter and Providert is as recevier
type_c_src_capa_flow	Source Capabilities Consumer is as transmitter and Providert is as recevier
type_c_src_capa_ext_flow	Source Capabilities Extended Consumer is as transmitter and Providert is as recevier
type_c_snk_battery_capa_flow	Battery Capabilities Consumer is as transmitter and Provider is as recevier
type_c_snk_battery_status_flow	Battery Status Consumer is as transmitter and Provider is as recevier
type_c_snk_manufacturer_info_flow	Manufacturer Information Consumer is as transmitter and Provider is as recevier
type_c_snk_country_code_flow	Country Codes Consumer is as transmitter and Provider is as recevier
type_c_snk_country_info_flow	Country Information Consumer is as transmitter and Provider is as recevier
type_c_snk_security_flow	Security

Function	Description
	Consumer is as transmitter and Provider is as recevier
type_c_snk_fw_up_flow	Firmware Update Consumer is as transmitter and Provider is as recevier
type_c_Consumer_respond_to_Provider	Consumer responds to Provider's message Consumer is as responder and Provider is as receiver
cc_port_rx_GPIO_Config	Configs RX CC-Port GPIO

6Reference Design

Gowin USB type-c PD protocol design release provides Provider and Consumer hardware reference design and software reference design.

Please refer to the Gowin_EMPU_M1 reference manual for hardware design and software design compilation, debugging, and download methods.

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