eMarker Chip for USB Type-C Cables

Hynetek Semiconductor Co., Ltd.

HUSB332C

FEATURES

- USB Type-C 2.1 and USB PD 3.1 Compliant
  - Support SOP' Communication
  - Integrated Transceiver (BMC PHY)
  - Support Both Structured VDM Version 1.0 and 2.0
- High Integration
  - Embedded Both Side Ra Resistors
  - Embedded Both Side VCONN Diodes
- Different Package Options:
  - DFN2×2-6L
- Support 4 Times Programming
- Compatible with CC Wire Programming Tools
- Support 2.7 V ~ 5.75 V operation on VCONN1 and VCONN2 Pins
- 35 V High Voltage Tolerance on CC, VCONN1 and VCONN2 Pins
- Support Thunderbolt 3 and Thunderbolt 4 Data Communication
- Encryption Commands Supported for Vendor Identification
- Integrated Over-temperature Protection
- 0.6 mA Ultra-Low Power Consumption
- IEC61000-4-2 Class 3A contact discharge ESD on CC, VCONN1 and VCONN2 pins
- Class 3A HBM ESD Rating for all pins

APPLICATIONS

USB Type-C Cable ID

USB4™ Passive Cable

GENERAL DESCRIPTION

HUSB332C is a USB Type-C eMarker for Cable ID applications. It is compliant with USB Type-C Specification Revision 2.1. It is also compliant to USB Power Delivery 3.1 and USB4™ Specification.

Powered from VCONN1 or VCONN2, HUSB332C can determine to act as SOP'. The built-in OTP can be programmed through CC line or I²C bus so that it will be flexible for in-system programming.

The enhanced system ESD protection on the exposed pins can improve the system reliability significantly. The HUSB332C operates over a wide supply range of 2.7 V to 5.75 V. It is available in DFN2×2-6L package. It is rated over the -40°C to +85°C temperature range.

TYPICAL APPLICATION CIRCUIT

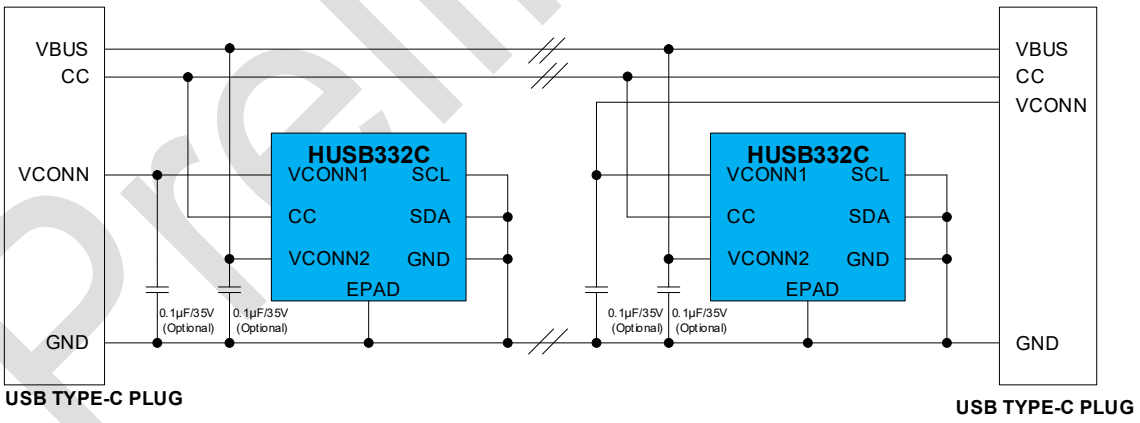

Figure 1. Typical Application Circuit

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REVISION HISTORY

Version	Date	Descriptions
Rev. 0.1	08/2022	Initial version
Rev. 0.2	10/2022	Modify the value of ESD

PIN CONFIGURATION AND FUNCTION DESCRIPTIONS

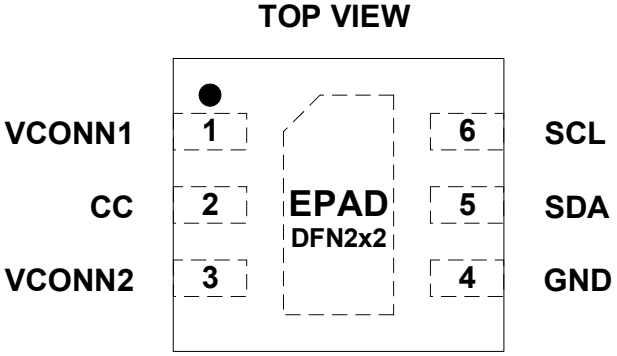


Figure 2. HUSB332C_U40DA Pin Assignment

Table 1. HUSB332C_XXXDA Pin Function Descriptions

Pin No.	Pin Name	Type	Description
1	VCONN1	P	The input pin supplied from VCONN.
2	CC	D	USB Type-C CC line input and output.
3	VCONN2	P	The input pin supplied from the other side VCONN.
4	GND	A	Ground.
5	SDA	D	This pin is only used for debug. Please connect it to ground.
6	SCL	D	This pin is only used for debug. Please connect it to ground.

RECOMMENDED OPERATING CONDITIONS

Table 2.

Parameter	Rating
VCONN1 Input Voltage	2.7 V to 5.75 V
VCONN2 Input Voltage	2.7 V to 5.75 V
Operating Temperature Range (Junction)	−40°C to +125°C
Ambient Temperature Range	−40°C to 85°C

SPECIFICATIONS

V_{CONN1} or V_{CONN2} = 5 V and T_A = 25°C for typical specifications, unless otherwise noted.

Table 3. Electrical Specification

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
GENERAL PARAMETERS						
VCONN1/VCONN2 Voltage	V_{CONN}		2.7	5	5.75	V
Under-voltage Lockout	V_{UVLO}	Rising edge		2.6		V
		Falling edge		2.35		V
Standby Current	$I_{DD\_STANDBY}$	V_{CONN1} or V_{CONN2} >V_{CONN}, BMC is Idle		0.6		mA
Supply Current	I_{DD_BIST}	BIST mode, BMC is activated		2.6		mA
Over-temperature Protection Threshold	T_{OT_DEF}	Default trimmed	80	90	100	°C
Operating Ambient Temperature	T_A		-40		85	°C
BMC COMMON PARAMETERS						
Bit Rate	$f_{BitRate}$		270	300	330	kbps
BMC TX PARAMETERS						
Maximum Difference between the Bit-rate during the Part of the Packet Following the Preamble and the Reference Bit-rate.	$p_{BitRate}$				0.25	%
Time to Cease Driving the Line after the End of the Last bit of the Frame.	$t_{EndDriveBMC}$				23	µs
Fall Time	t_{Fall}	From 90% to 10% amplitude	300			ns
Time to Cease Driving the Line after the Final High-to-Low Transition.	$t_{HoldLowBMC}$		1			µs
Time from the End of Last Bit of a Frame until the Start of the First bit of the Next Preamble.	$t_{InterFrameGap}$		25			µs
Rise Time	t_{Rise}	From 10% to 90% amplitude	300			ns
Time Before the Start of the First Bit of the Preamble when the Transmitter shall Start Driving the Line.	$t_{StartDrive}$		-1		1	µs
Voltage Swing	v_{Swing}		1.05	1.125	1.2	V
Transmit Low Voltage			-75		75	mV
Transmitter Output Impedance	z_{Driver}		33	54	75	Ω
BMC RX PARAMETERS						
Power Cable Termination	R_a	V_{CONN1} and V_{CONN2}<V_{UVLO}	800		1200	Ω
Time Window for Detecting Bus Non-idle	$t_{TransitionWindow}$		12		20	µs
Number to Count to Detect Bus Non-idle	n_{Count}		3			
Time Constant of a Single Pole	$t_{RxFilter}$		100			ns

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Filter to Limit Broad-band Noise Ingression						
Receiver Input Impedance	Z_{BmcRx}		1			MΩ

ABSOLUTE MAXIMUM RATINGS

Table 4. Absolute Maximum Ratings[a]

Parameter	Rating
VCONN1, VCONN2 and CC to GND	−0.5 V to +35 V
Storage Temperature Range	−65°C to +150°C
Operating Temperature Range (Junction)	−40°C to +125°C
Soldering Conditions	JEDEC J-STD-020 (T_P: 260°C)
Electrostatic Discharge (ESD)	
Human Body Model (CC, VCONN1, VCONN2)	±4000 V
Human Body Model (SCL, SDA)	±4000 V
Charged Device Model	±2000 V
IEC61000-4-2 (CC, VCONN1, VCONN2)[b]	±4000 V

Note:

a. Stresses at or above those listed under Absolute Maximum Ratings may cause permanent damage to the product. This is a stress rating only; functional operation of the product at these or any other conditions above those indicated in the operational section of this specification is not implied. Operation beyond the maximum operating conditions for extended periods may affect product reliability.

b. The HUSB332C was assembled in the cable, and all pins are not connected with a capacitor.

THERMAL RESISTANCE

Thermal performance is directly linked to printed circuit board (PCB) design and operating environment. Close attention to PCB thermal design is required.

θ_{JA} is the natural convection junction to ambient thermal resistance measured in a one cubic foot sealed enclosure.

θ_{JC} is the junction to case thermal resistance.

Table 5. Thermal Resistance

Package Type	θ_{JA}	θ_{JC}	Unit
DFN2x2-6L	102.4	74.5	°C/W

ESD CAUTION

Electrostatic Discharge Sensitive Device.

Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

FUNCTIONAL BLOCK DIAGRAM

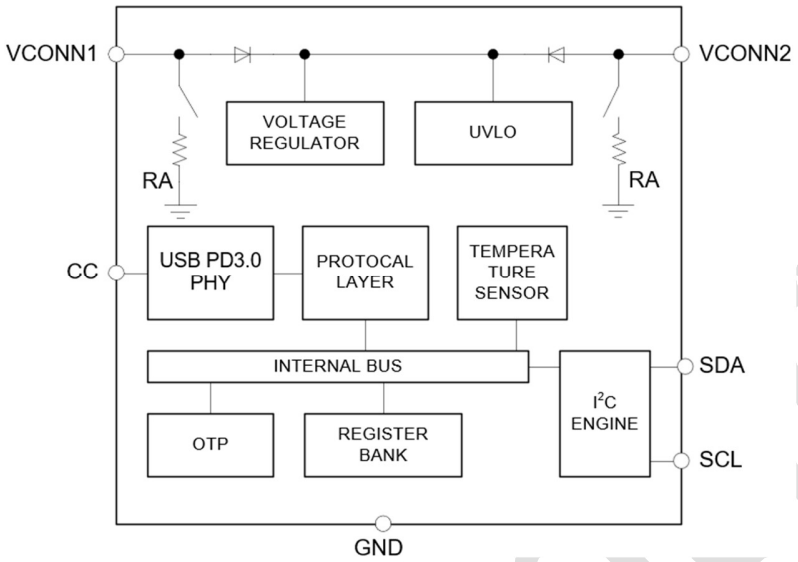


Figure 3. HUSB332C Functional Block Diagram

THEORY OF OPERATION

The HUSB332C is a USB eMarker Chip. It is usually applied in a USB Type-C cable plug. The HUSB332C employs two communication protocols, one is I²C communication protocol and the other is USB PD protocol. With both communication protocols, some customized information can be stored in the internal EPROM of the HUSB332C. And this information can be ready by the external devices via USB PD protocol.

POWER CABLE TERMINATION

VCONN1 and VCONN2 pins are independent power input pin for the HUSB332C. When it is powered up (V_{CONN1} or V_{CONN2}>V_{UVLO}), the HUSB332C starts up. If (V_{CONN1} or V_{CONN2} < V_{UVLO}), the pins (VCONN1 and VCONN2) perform as a resistance characteristic. The equivalent resistance is Ra.

HIGH VOLTAGE TOLERANCE

The VCONN1, VCONN2 and CC pins are all high voltage tolerance. They can be survived from a high voltage of up to 35 V to withstand in some accidental faults, such as a short fault between CC pin and VBUS pin whose voltage could be up to 35 V.

PD MESSAGE INFORMATION

The HUSB332C supports several extended messages for some customization information. It is able to respond the correct message once there is an inquiry message received.

DISCOVER IDENTITY

The Discover Identity Command is provided to enable an Initiator (DFP) to identify its Port Partner and for an Initiator (VCONN Source) to identify the Responder (Cable Plug). The Discovery Identity Command is also used to determine whether a Cable Plug is PD-Capable by looking for a GoodCRC Message Response.

The Discover Identity Command shall be used to determine whether a given Cable Plug is PD Capable. In this case a Discover Identity Command request sent to SOP' shall not cause a Soft Reset if a GoodCRC Message response is not returned since this can indicate a non-PD Capable cable. Note that a Cable Plug will not be ready for PD Communication until 50 ms after VCONN has been applied. During Cable Plug discovery, when there is an Explicit Contract, Discover Identity Commands are sent at a rate defined by the DiscoverIdentityTimer up to a maximum of nDiscoverIdentityCount times. See USB Power Delivery Specification Revision 3.1, Version 1.0 for details.

A PD-Capable Cable Plug shall return a Discover Identity Command ACK in response to a Discover Identity Command request sent to SOP'.

The Number of Data Objects field in the Message Header in the Discover Identity Command request shall be set to 1 since the Discover Identity Command request shall not contain any VDOs.

The Discover Identity Command ACK sent back by the HUSB332C shall contain an ID Header VDO, a Cert Stat VDO, a Product VDO and the Product Type VDOs defined by the Product Type as shown in Figure 4.

Figure 4. Discover Identify Command Response

MANUFACTURER INFORMATION

The Manufacturer Information Message Shall be sent in response to a Get_Manufacturer_Info Message. The Manufacturer_Info Message contains the USB VID and the Vendor's PID to identify the device and the device's manufacturer byte array in a variable length Data Block of up to 26 bytes.

The Manufacturer_Info Message format is shown in Figure 5.

Figure 5. Manufacturer Information Message

For the MIDB, it consists of VID, PID and Manufacture String. They can be sent with a pre-determined offset.

Offset	Field	Description
0	VID	Vendor ID (assigned by the USB-IF)
2	PID	Product ID (assigned by the manufacturer)
4	Manufacturer String	Vendor defined null terminated string of 0…21 characters. If the Manufacturer Info Target field or Manufacturer Info Ref field in the ***Get_Manufacturer_Info*** Message is unrecognized the field Shall return a null terminated ascii text string "Not Supported".

Figure 6. Manufacturer Information MIDB

The VID, PID information can be programmed. Please be noted that, if the received Get_Manufacturer_Info Message contains the information which the HUSB332C does not support, such as the Manufacturer Information Target field in the Get_Manufacturer_Info Message equals Battery (01b) and the Manufacturer Information Ref field is Invalid, the HUSB332C responds Manufacturer Information with VID=0xFFFF, PID=0x0000.

Offset	Field	Description
0	***Manufacturer Info Target***	0: Port/Cable Plug 1: Battery 255…2: ***Reserved***, ***Shall Not*** be used.
1	***Manufacturer Info Ref***	If ***Manufacturer Info Target*** subfield is Battery (01b) the ***Manufacturer Info Ref*** field Shall contain the Battery number reference which is the number of the Battery indexed from zero: • Values 0…3 represent the Fixed Batteries. • Values 4…7 represent the Hot Swappable Batteries. Otherwise, this field is ***Reserved*** and ***Shall*** be set to zero.

Figure 7. Get_Manufacturer_Info MIDB

The HUSB332C does not support any Manufacturer String. A "Not Supported" string is filled in this field.

DISCOVER RESPONSE

The HUSB332C supports Structured VDMs. Therefore, the Discover Identity, Discover SVIDs, the Discover Modes, the Enter Mode and Exit Mode Commands are all supported by the HUSB332C. The HUSB332C does not initial any Structure VDMs. It can only respond a received Structure VDM REQ. Discover Identity is a MUST supported command for the HUSB332C. For the other Structured VDMs, it is impacted by the modal operation field in the Discover Identity.

TYPICAL APPLICATION CIRCUITS

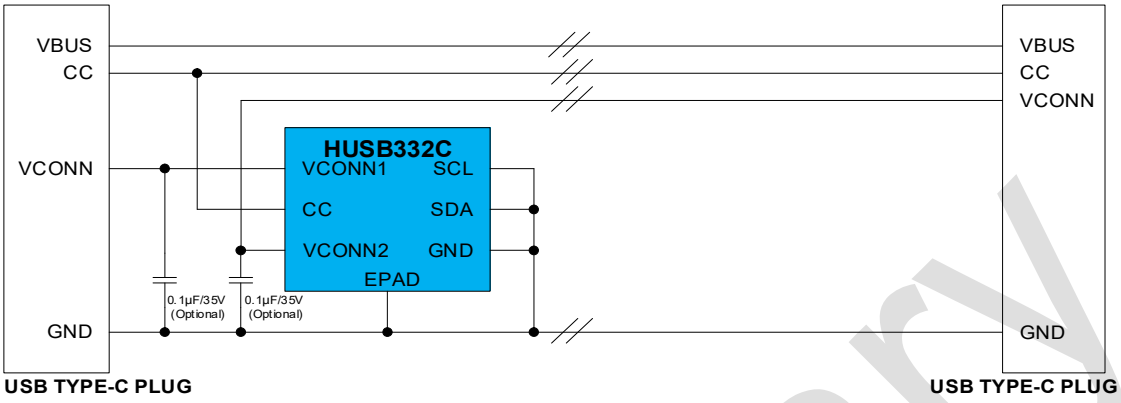


Figure 8. One eMarker Solution with VCONN Connected Through the Cable

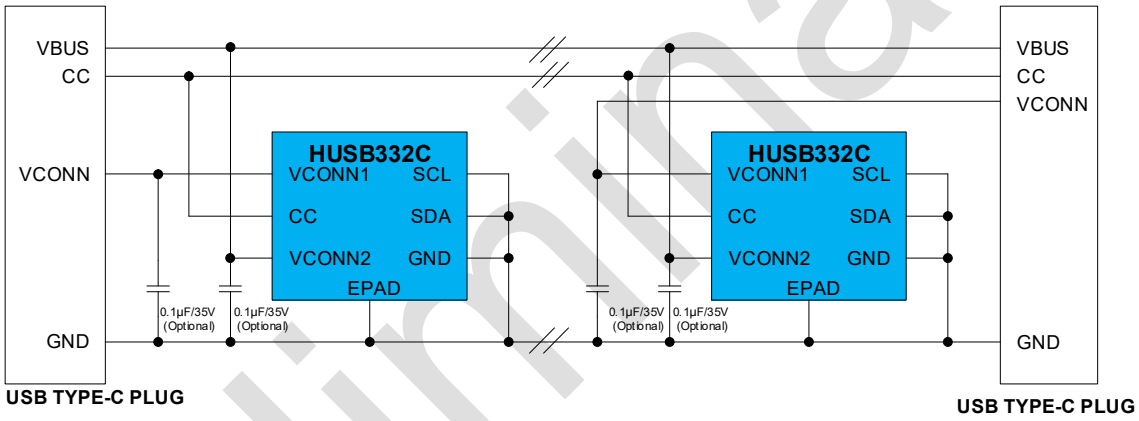
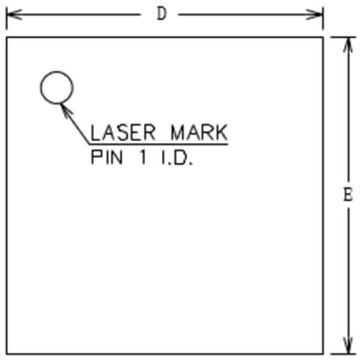
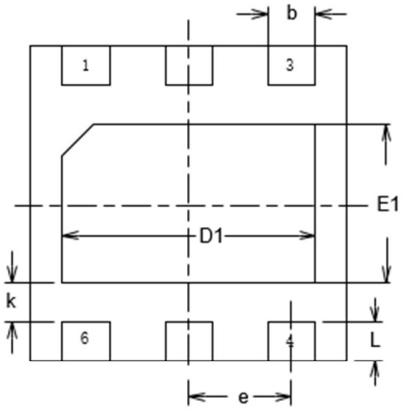
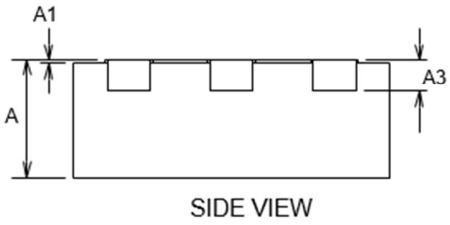


Figure 9. Two eMarkers Solution without VCONN Connected Through the Cable

PACKAGE OUTLINE DIMENSIONS







Symbol	Millimeter	
	Min.	Max.
A	0.7	0.8
A1	0	0.05
A3	0.18	0.25
D	1.9	2.1
E	1.9	2.1
D1	1.18	1.7
E1	0.63	1.1
k	0.15MIN	
b	0.25	0.35
e	0.65TYP	
L	0.2	0.35

Figure 10. DFN2×2-6L Package, 2 mm × 2 mm Body

ORDERING GUIDE

Order Model	Description	Application	Package	Ta Range	Package Option
HUSB332C_U40DA	Default USB4 Gen 3, ERP Mode Capable, 1m cable	Two eMarkers Solution without VCONN Connected Through the Cable	DFN2×2-6L	−40°C to +85°C	Tape & Reel, 4000

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