eMarker Chip for USB Type-C Cables

Hynetek Semiconductor Co., Ltd.

HUSB332E

FEATURES

- USB Type-C 2.2 and PD 3.1 V1.8 compliant
  - USB-IF Certified. TID: 10226
  - Support SOP' communication
  - Integrated transceiver (BMC PHY)
  - Support both structured VDM version 1.0 and 2.x
- High integration
  - Embedded both side Ra resistors
  - Embedded both side VCONN diodes
- Different package options:
  - DFN1.6×1.6-4L
  - DFN2×2-6L
- Support 3 times Programming
- Integrated Over-temperature Protection
- 0.6 mA Ultra-Low Power Consumption
- Compatible with third party programming Tools
- Support 2.7 V ~ 5.75 V operation on VCONN1 and VCONN2 Pins
- 60 V high voltage tolerance on CC, VCONN1 and VCONN2 pins
- Support Thunderbolt 3, Thunderbolt 4 and USB4® Gen4 data communication
- CC Over-voltage Protection at BMC transmission function

APPLICATIONS

USB Type-C Cable ID

USB4® Passive Cable

GENERAL DESCRIPTION

HUSB332E is a USB Type-C eMarker for Cable ID applications. It is compliant with USB Type-C Specification Revision 2.2. It is also compliant to USB Power Delivery 3.1 and USB4® Specification.

Powered from VCONN1 or VCONN2, HUSB332E can determine to act as SOP'. The built-in OTP can be programmed through CC line.

The enhanced ±5 KV system ESD protection on the exposed pins can improve the system reliability significantly. The HUSB332E operates over a wide supply range of 2.7 V to 5.75 V. It is available in DFN2×2-6L and DFN1.6×1.6-4L packages. It is rated over the -40°C to +85°C temperature range.

TYPICAL APPLICATION CIRCUIT

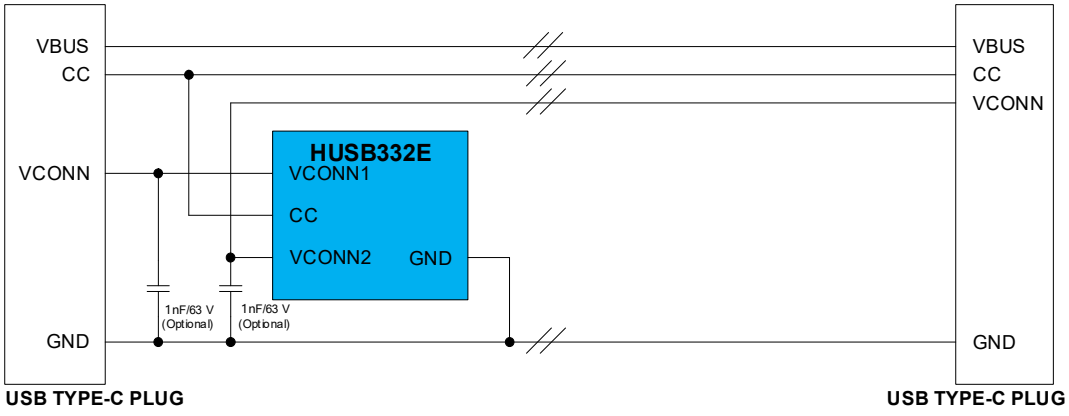

Figure 1. HUSB332E-XBUXX-DN04R Typical Application Circuit

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REVISION HISTORY

Version	Date	Descriptions
Rev.1.0	11/2023	Initial version
Rev.1.1	01/2024	Modify the Naming Convention of the HUSB332E in the Ordering Guide Modify the power consumption of HUSB332E in active mode Add Maximum Value for the Rising edge Threshold of Under-voltage Lockout

PIN CONFIGURATION AND FUNCTION DESCRIPTIONS

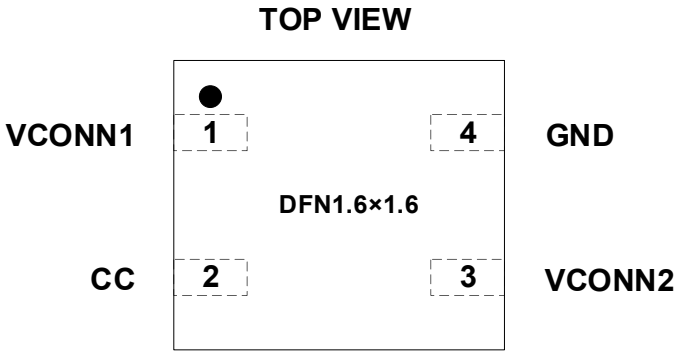


Figure 2 HUSB332E-XBXXX-DN04R Pin Assignment

Table 1. HUSB332E-XBXXX-DN04R 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. In debug mode, act as SCL of I^2C bus.
3	VCONN2	P	The input pin supplied from the other side VCONN. In debug mode, act as SDA of I^2C bus.
4	GND	A	Ground.

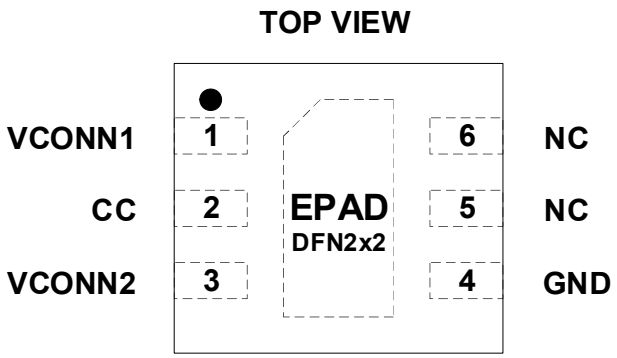


Figure 3. HUSB332E-XAXXX-DN06R Pin Assignment

Table 2. HUSB332E-XAXXX-DN06R 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. In debug mode, act as SCL of I^2C bus.
3	VCONN2	P	The input pin supplied from the other side VCONN. In debug mode, act as SDA of I^2C bus.
4	GND	A	Ground.
5	NC	D	NC
6	NC	D	NC

RECOMMENDED OPERATING CONDITIONS

Table 3. Recommended Operating Conditions

Parameter	Rating
VCONN1/2 Input Voltage	2.7 V to 5.75 V
Power Consumption – Full Operation	< 20 mW
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 4. 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		2.52	2.75	V
		Falling edge		2.42		V
Standby Current	$I_{DD\_STANDBY}$	V_{CONN1} or V_{CONN2} >V_{UVLO}, BMC is Idle		0.6		mA
Supply Current	I_{DD_BIST}	BIST mode, BMC is activated		1.7		mA
CC Over-voltage Protection Threshold	V_{OV}	Enabled to disable BMC transmission	6.3			V
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
Weakened Ra	R_{wa}			20		KΩ
CC Pin Impedance	Z_{OPEN}		1			MΩ
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 filter to limit broad-band noise ingression	$t_{RxFilter}$		100			ns
Receiver Input Impedance	z_{BmcRx}		1			MΩ

ABSOLUTE MAXIMUM RATINGS

Table 5. Absolute Maximum Ratings

Parameter	Rating
VCONN1, VCONN2 and CC to GND	−0.5 V to +60 V
Storage Temperature Range	−65°C to +150°C
Operating Temperature Range (Junction)	−40°C to +125°C
Soldering Conditions	JEDEC J-STD-020
Electrostatic Discharge (ESD)	
Human Body Model	±5000 V
Charged Device Model	±2000 V
Latch-Up	±200mA& MSV

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.

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 6. Thermal Resistance

Package Type	θ_{JA}	θ_{JC}	Unit
DFN1.6x1.6-4L	135	82	°C/W
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

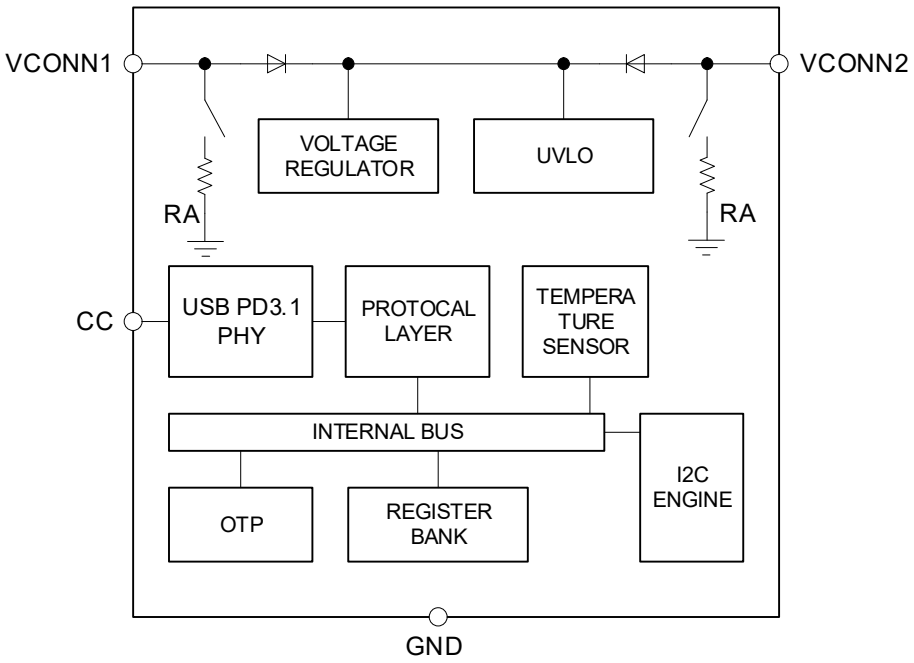


Figure 4. HUSB332E Functional Block Diagram

THEORY OF OPERATION

HUSB332E is an eMarker Chip. It is usually applied in a Type-C cable plug. HUSB332E employs two communication protocols, one is I²C communication protocol and another one is PD protocol. With both communication protocols, some customized info can be stored in the internal EPROM of HUSB332E. And these info can be ready by the external devices via USB PD protocol.

POWER CABLE TERMINATION

VCONN1 and VCONN2 cab be independent power input pin for HUSB332E. Anyone of both is powered up (VCONN1 or VCONN2 > VUVLO), HUSB332E is going to start up. When HUSB332E is not powered, VCONN1 and VCONN2 perform as a resistance characteristic. The equivalent resistance is Ra. While for CC pin, the impedance of CC should be higher than 1 MΩ when VCONN1 or VCONN2 is not powered.

HIGH VOLTAGE TOLERANCE

VCONN1, VCONN2 and CC pin are all of high voltage tolerance. They can be survived from a high voltage up to 60 V to withstand in some accidental faults, such as a short fault between CC pin and VBUS pin whose voltage could be up to 60 V.

PD MESSAGE INFOMATION

HUSB332E supports several extended messages for some customization info. 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. 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 1.7 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 HUSB332E 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 5.

Header No. of Data Objects = 4-7[1]	VDM Header	ID Header VDO	Cert Stat VDO	Product VDO	0..3[2] Product Type VDO(s)

Figure 5. Discover Identify Command Response

MANUFACTURER INFO

The Manufacturer_Info 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 MaxExtendedMsgLegacyLen.

HUSB332E does not support any Manufacturer String, if the received Get_Manufacturer_Info Message contains the info which HUSB332E does not support, HUSB332E responds Manufacturer Info with VID=0xFFFF, PID=0x0000, and filled the Manufacturer String field with a "Not Supported" string.

DISCOVER RESPONSE

HUSB332E supports Structured VDMs, therefore, the Discover Identity, Discover SVIDs, the Discover Modes, the Enter Mode and Exit Mode Commands are all supported by HUSB332E. HUSB332E does not initial any Structure VDMs. It can only respond a received Structure VDM REQ. Discover Identity is a MUST supported command for HUSB332E. For the other Structured VDMs, it is impacted by the modal operation field in the Discover Identity.

TYPICAL APPLICATION CIRCUITS

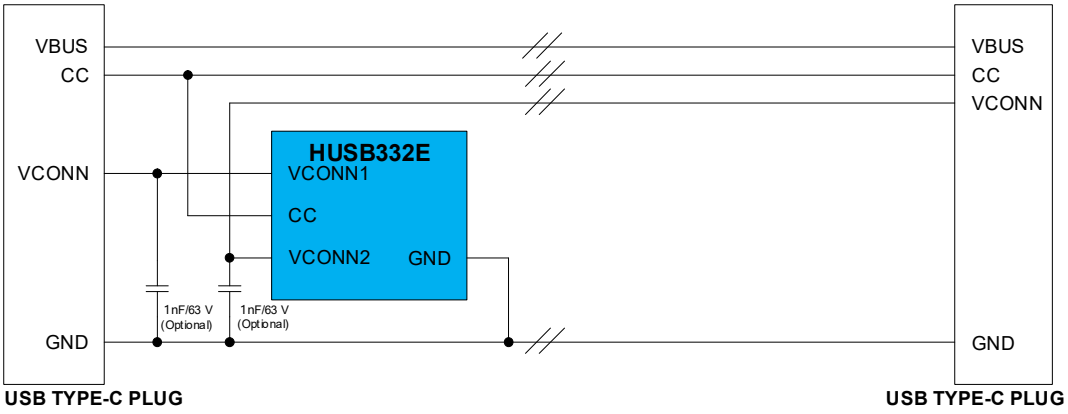


Figure 6. HUSB332E-XBUXX-DN04R Typical Application

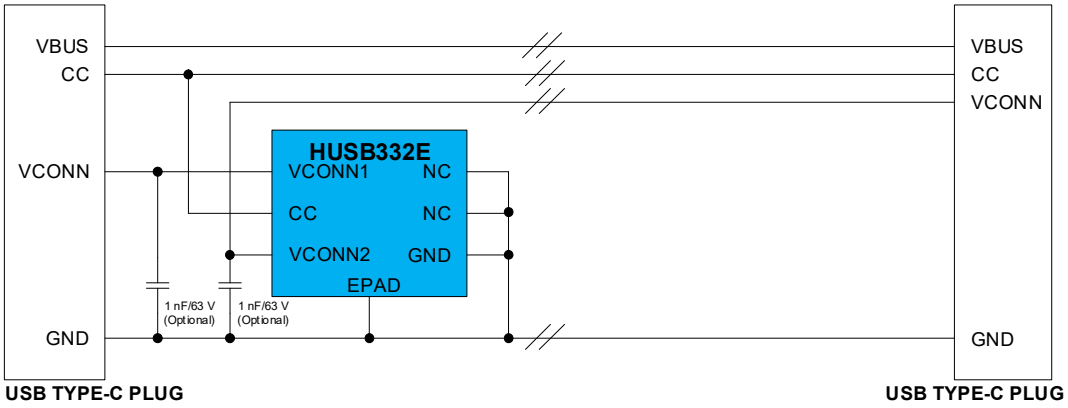


Figure 7. HUSB332E-XAUXX-DN06R Typical Application

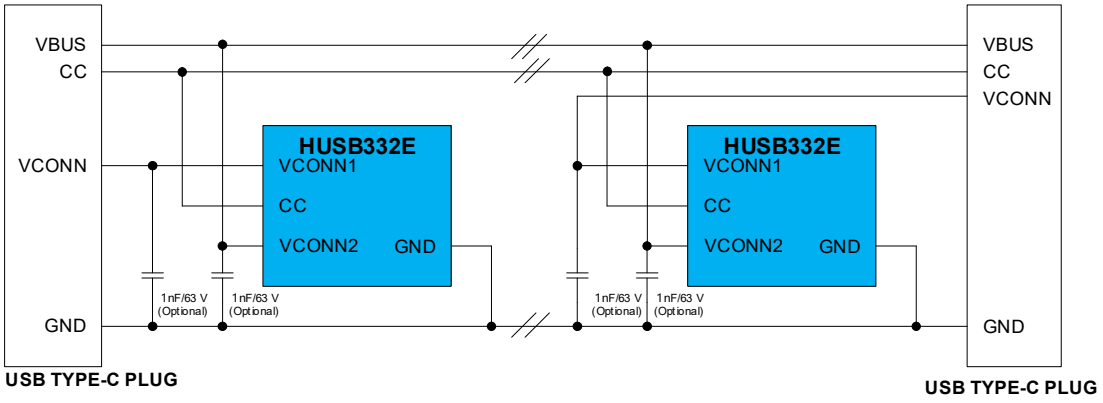


Figure 8. HUSB332E-XBTXX-DN04R Typical Application

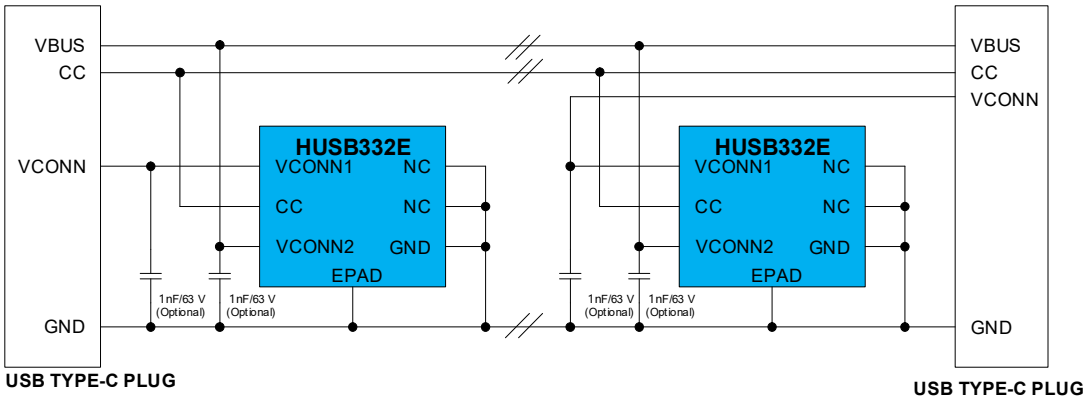
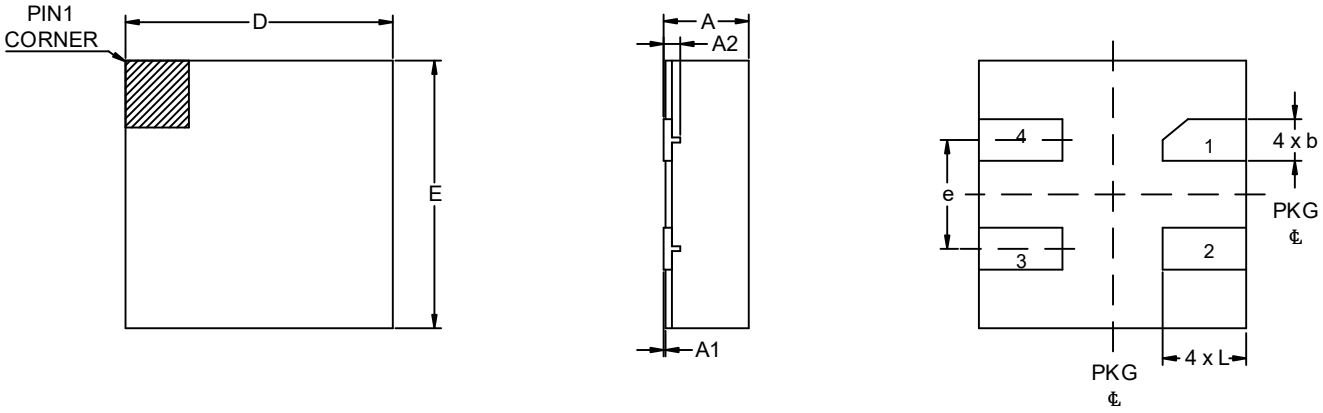


Figure 9. HUSB332E-XATXX-DN06R Typical Application

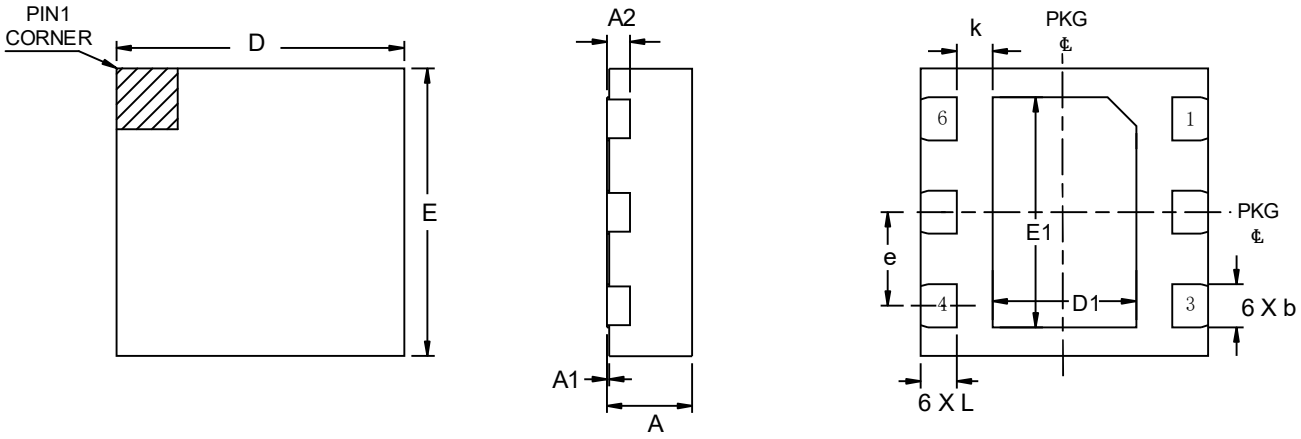
PACKAGE OUTLINE DIMENSIONS



TOP VIEW **SIDE VIEW**

SYMBOLS	DIMENSION IN MILLIMETERS		
	MIN	NOM	MAX
A	0.40	0.45	0.55
A1	0.00	0.02	0.05
A2		0.152 REF	
b	0.20	0.25	0.30
D		1.60 BSC	
E		1.60 BSC	
e		0.65 BSC	
L	0.45	0.50	0.55

Figure 10. DFN1.6×1.6-4L Package, 1.6 mm × 1.6 mm Body



TOP VIEW **SIDE VIEW** **BOTTOM VIEW**

SYMBOLS	DIMENSION IN MILLIMETERS		
	MIN	NOM	MAX
A	0.70	0.75	0.80
A1	0.00	0.02	0.05
A2		0.203 REF	
b	0.25	0.30	0.35
D		2.00 BSC	
E		2.00 BSC	
D1	0.63	1.00	1.10
E1	1.18	1.60	1.70
e		0.65 BSC	
L	0.20	0.25	0.35
k		0.15 MIN.	

Figure 11. DFN2×2-6L Package, 2 mm × 2 mm Body

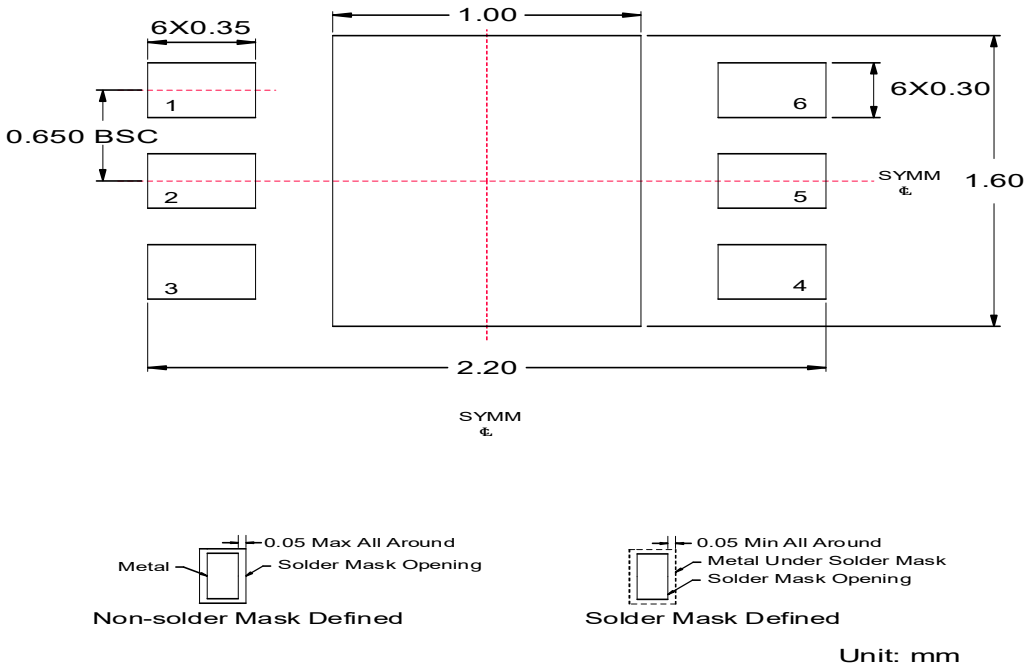


Figure 12 Recommended PCB Pad Layouts for DFN2×2-6L Package

PACKAGE TOP MARKING

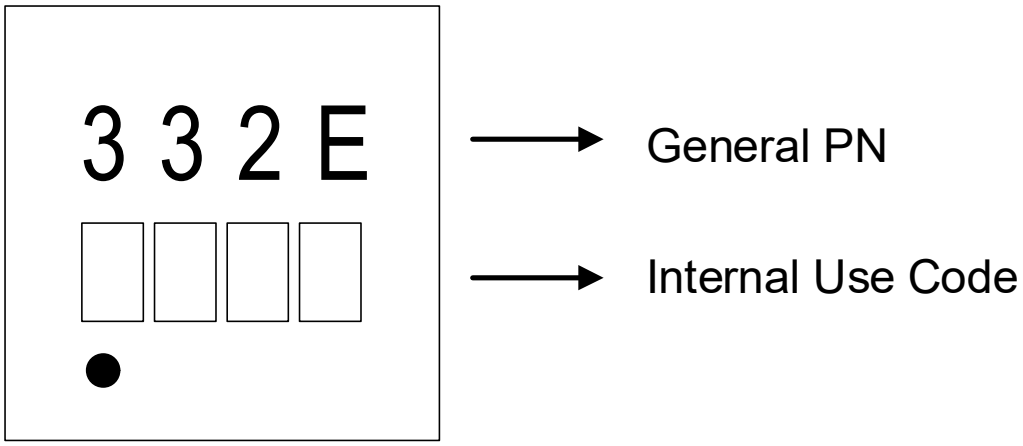


Figure 13. DFN1.6×1.6-4L& DFN2×2-6L Package Top Marking

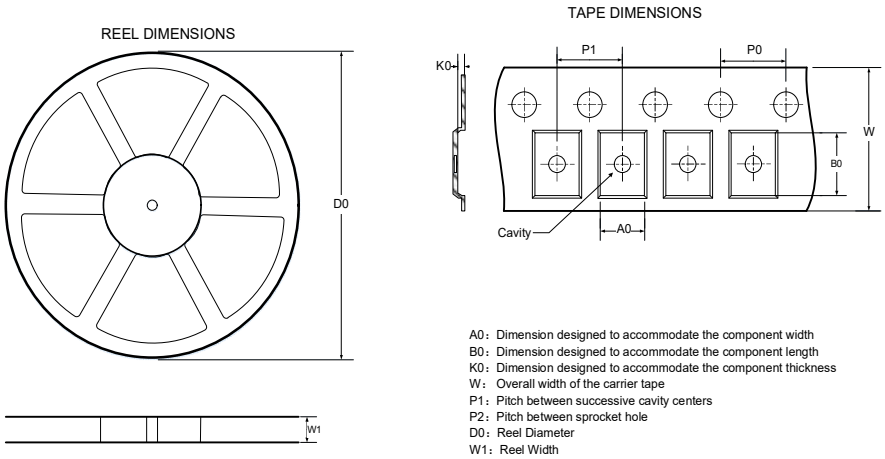
ORDERING GUIDE

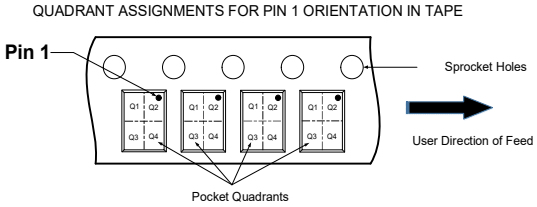
Order Model[a]	Description	Application	Package	Ta Range (°C)	Package Option
HUSB332E-XBU30-DN04R	PD3.1 EPR, USB2.0 supported, 2m cable	One eMarker Solution with VCONN Connected Through the Cable	DFN1.6×1.6-4L	−40 to +85	Tape & Reel, 4000
HUSB332E-XAU30-DN06R	PD3.1 EPR, USB2.0 supported, 2m cable	One eMarker Solution with VCONN Connected Through the Cable	DFN2×2-6L	−40 to +85	Tape & Reel, 4000
HUSB332E-XBT30-DN04R	PD3.1 EPR, OTP, USB2.0 supported, 2m cable	Two eMarkers Solution without VCONN Connected Through the Cable	DFN1.6×1.6-4L	−40 to +85	Tape & Reel, 4000
HUSB332E-XAT30-DN06R	PD3.1 EPR, OTP, USB2.0 supported, 2m cable	Two eMarkers Solution without VCONN Connected Through the Cable	DFN2×2-6L	−40 to +85	Tape & Reel, 4000

Note:

a. The models HUSB332E-XXUXX-DNXXR and HUSB332E-XXTXX-DNXXR cannot be used interchangeably.

TAPE AND REEL INFORMATION





DIMENSIONS AND PIN1 ORIENTATION

Device	Package Type	D0 (mm)	W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	P0 (mm)	W (mm)	Pin1 Quadrant	Quantity
HUSB332E-AAXXX-DN06R	DFN2X2-6L	178.00	9.50	2.30	2.30	1.10	4.00	4.00	8.00	Q2	4000
HUSB332E-ABXXX-DN04R	DFN1.6X1.6-4L	178.00	9.50	1.77	1.77	0.70	4.00	4.00	8.00	Q2	4000

All dimensions are nominal

Figure 12. Tape and Reel Information

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