Electronic Marker for USB Type-C Passive Cable

1. Features

- **Passed USB-IF PD3.1 certification. TID number: 7106**
- Support USB Type-C 2.1 and USB PD3.1
  - ➢ **Support SOP' communication**
  - ➢ **Adaptive engine of BMC receiver**
  - ➢ **Embedded PHY**
  - ➢ **Support Get_Manufacturer_Info**
  - ➢ **Support EPR Mode Capable**
- High level of integration
  - ➢ **Integrated ISO diodes**
  - ➢ **Integrated Ra and support Ra remove**
- Extremely low BOM cost
  - ➢ **Low BOM cost**
- Flexible customization
  - ➢ **In-cable programming through CC**
- Extremely low power consumption
- Power supply: 2.7V ~ 5.5V
- VCONN and VCC range -0.3V ~ 28V
- Package: DFN-6L 2mm x 2mm

2. Typical Applications

- Passive USB Type-C cables such as full -featured C-to-C cables
- USB Type-C EPR Mode Capable cables

3. Description

IP2133 is an electronic marker for USB Type-C passive cables with extremely low BOM cost, which makes the cable connectors compact. IP2133 supports structured VDM Discovery Identity Command directed to SOP', which provides a method to determine the characteristics of cables, e.g., current-carrying capability, performance and vendor identification. Being compliant to PD3.1 V2.0, IP2133 supports extended message Get_Manufacture_Info by returning a Manufacture_Info message containing manufacturer info data block (MIDB). IP2133 Support in-cable programmed through CC PIN.
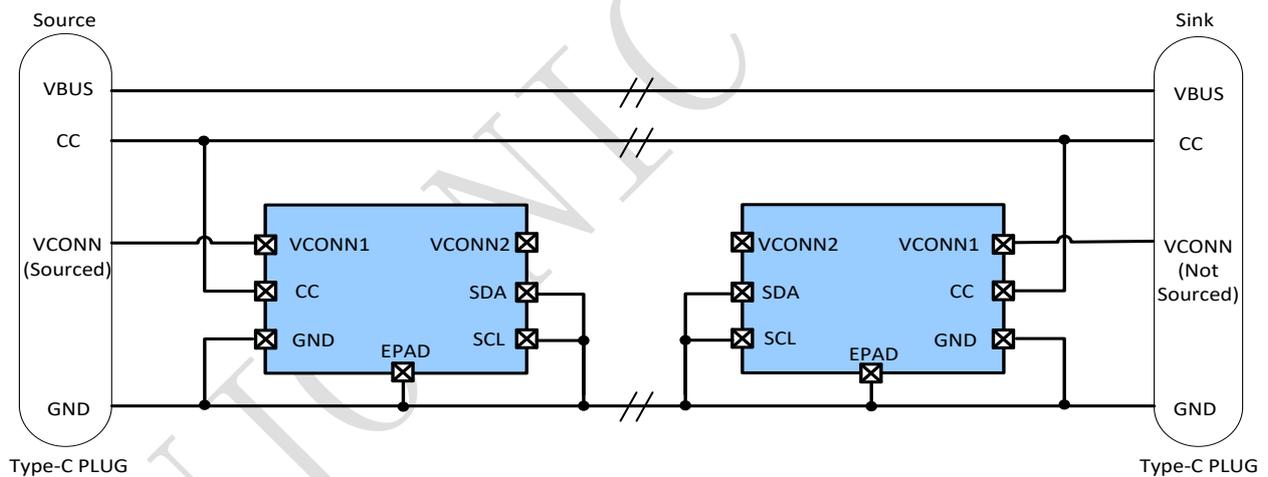
IP2133 integrate patented adaptive engine of BMC receiver for robust communication with BMC transmitters.
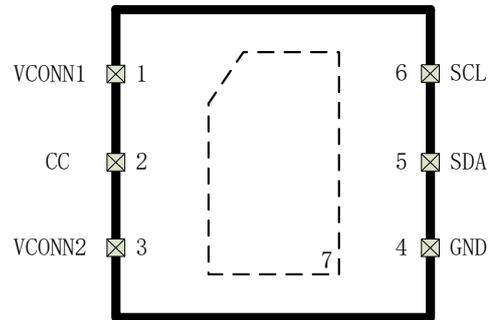
4. Typical Application Schematic

Passive Cable : Electronically Marked Cable with VCONN connected through the cable
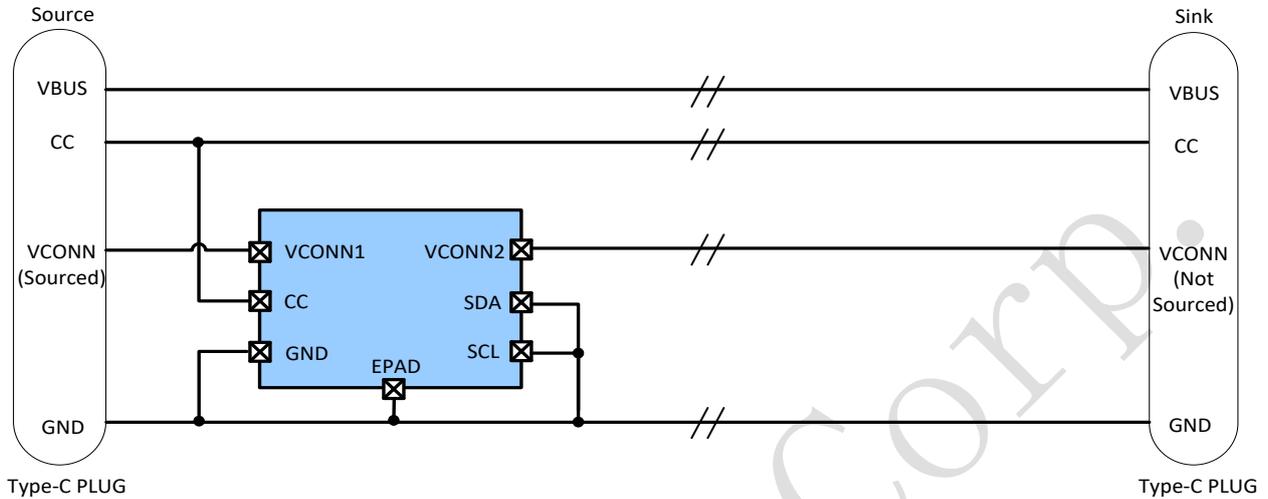
Passive Cable : Electronically Marked Cable with SOP' at both ends(with VCONN not connected through the cable)

5. PIN Description

Pin name	Pin number	Pin description
VCONN1	1	Power supply
CC	2	USB Type-C configuration channel
VCONN2	3	Power supply
GND	4	Ground
SDA	5	I2C data
SCL	6	I2C clock
EPAD	7	Exposed Pad

6. IP Series Products List

IC Part No.	Features	Package
IP2133	USB2.0/USB3.2,Gen1/Gen2,cable	DFN-6L
IP2133_EPR	USB2.0/USB3.2,Gen1/Gen2,EPR Mode Capable cable	DFN-6L

7. Block diagram
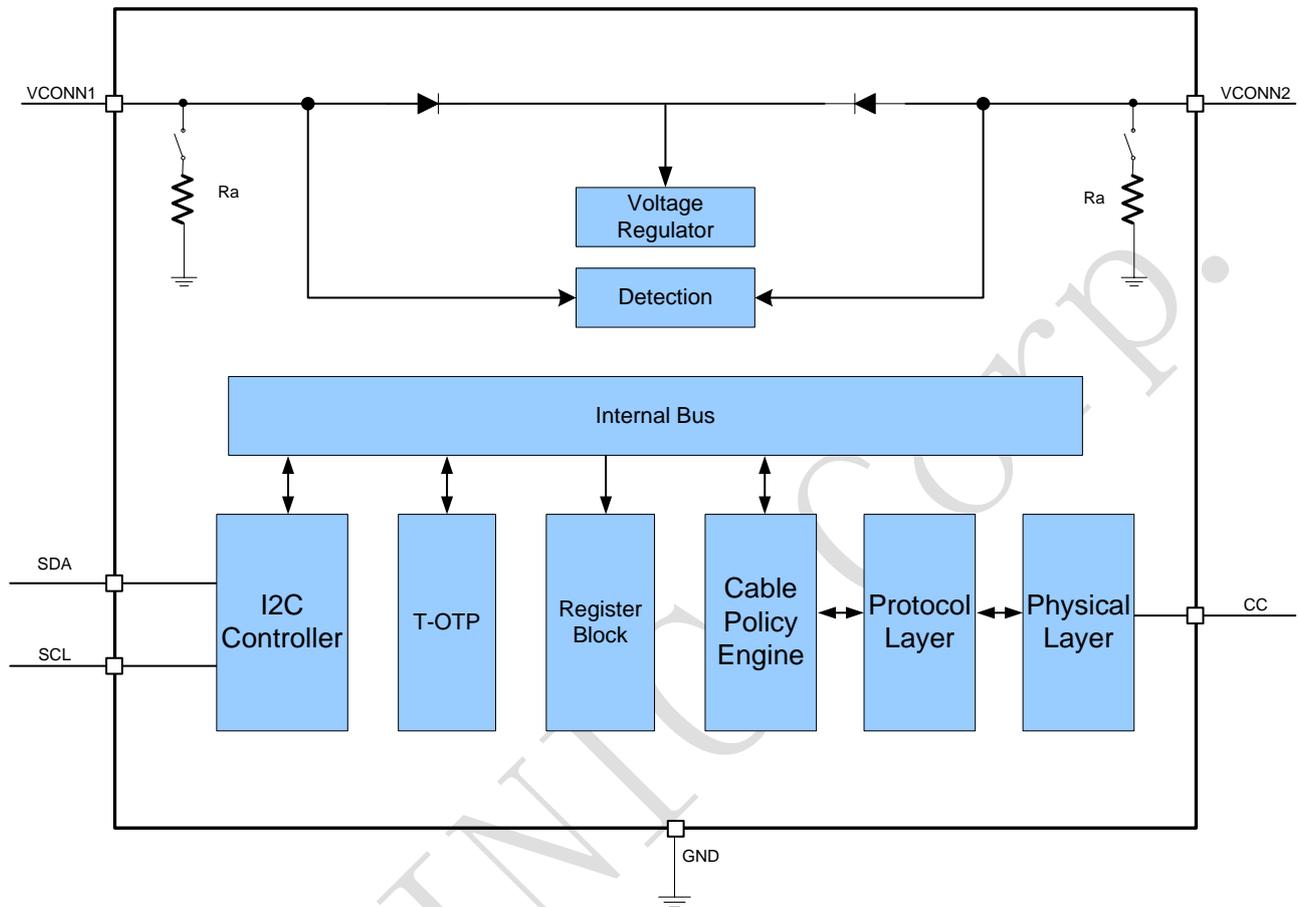
8. Absolute Maximum Ratings

Parameters	Symbol	Value	Unit
VCONN1 Input Voltage Range	VCONN1	-0.3 ~ 28	**V**
VCONN2 Input Voltage Range	VCONN2	-0.3 ~ 28	**V**
CC Input Voltage Range	VCC	-0.3 ~ 28	**V**
SDA Input Voltage Range	SDA	-0.3 ~ 7	**V**
SCL Input Voltage Range	SCL	-0.3 ~ 7	**V**
Junction Temperature Range	T_J	-40 ~ 150	**℃**
Storage Temperature Range	Tstg	-60 ~ 150	**℃**
Lead Temperature (Soldering, 10sec.)	Ts	260	**℃**
Package Thermal Resistance	T_A	-40~120	**℃**
Package Thermal Resistance	θ_{JA}	90	**℃/W**

Human Body Model VCONN1,VCONN2 and CC Pin	ESD	8	**KV**

*Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to Absolute Maximum Rated conditions for extended periods may affect device reliability.

*Voltages are referenced to GND unless otherwise noted.

9. Recommended Operating Conditions

Parameters	Symbol	Min.	Typ.	Max.	Unit
VCONN1 Input Voltage Range	VCONN1	2.7	5	5.75	**V**
VCONN2 Input Voltage Range	VCONN2	2.7	5	5.75	**V**
CC Input Voltage Range	CC			5.5	**V**
SDA Input Voltage Range	SDA			4	**V**
SCL Input Voltage Range	SCL			4	**V**
Ambient Temperature	T_A	- 40		105	**℃**

*Devices' performance cannot be guaranteed when working beyond those Recommended Operating Conditions.

10. Electrical Characteristics

Unless otherwise specified, T_A=25℃, 4.5V ≤ VCONN1/2 ≤ 5.5V

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Input Voltage	VCONN1/2	Supplied directly	2.75	5	5.75	**V**
Input UVLO Threshold	UVLO	Supplied directly		2.4		**V**
Quiescent Current	I_Q	No load, VCONN1/2=5V	0.3	1	1.6	**mA**
Current at transmitting	I_{TX}	VCONN1/2=5V	0.4	1.75	3	**mA**
Current at receiving	I_{RX}	VCONN1/2=5V	0.4	1.1	1.6	**mA**
Cable termination	Ra		0.8	1	1.2	**KΩ**
Weaken termination	Rweak		10	17	22	**KΩ**
Bit Rate	$f_{BitRate}$		270	300	330	**K**
OVP on CC, upper threshold	$V_{OVP\_CC\_up}$		5	5.8	7.5	**V**

OVP on CC, hysteresis	$V_{OVP\_CC\_hys}$		0.1	0.2	0.7	**V**
OVP on VCONN1/2, upper threshold	$V_{OVP\_VCONN\_up}$		6	7	8	**V**
OVP on VCONN1/2, hysteresis	$V_{OVP\_VCONN\_hys}$		0.1	0.2	0.7	**V**

11. Function Description

SOP' communication

SOP' Communication is recognized by electronics in one Cable Plug，IP2133 supports SOP' communication. When no Contract or an Implicit Contract is in place (e.g., after a Power Role Swap or Fast Role Swap), only the Source port that is supplying VCONN is allowed to send packets to a Cable Plug (SOP') and is allowed to respond to packets from the Cable Plug (SOP') with a GoodCRC in order to discover the Cable Plug's characteristics. The communication process is shown in the figure below:
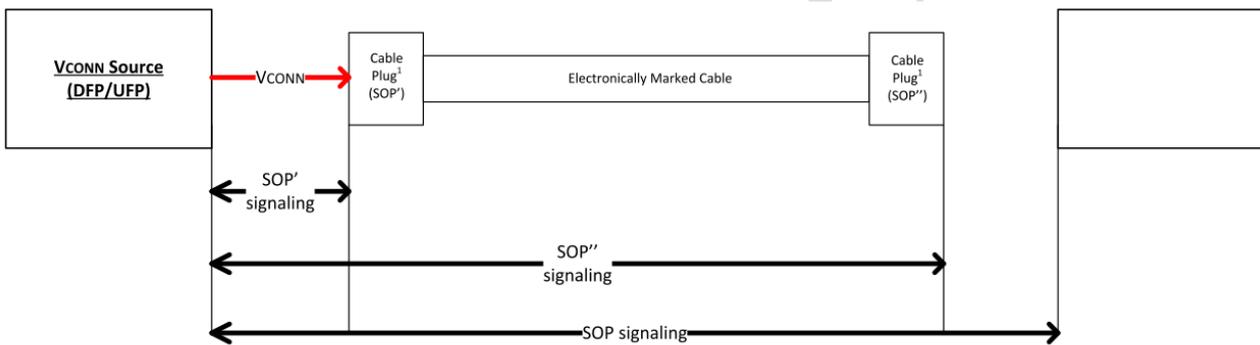
PD Protocol and Message Supported

IP2133 will detect and respond to the received packets with below three ordered sets, Hard Reset, Cable Reset and SOP'. Their ordered sets are defined in the following table.

K-code Number	K-Code in code table		
	Hard Reset	Cable Reset	SOP'
1	RST-1	RST-1	Sync-1
2	RST-1	Sync-1	Sync-1
3	RST-1	RST-1	Sync-3
4	RST-2	Sync-3	Sync-3

> **Hard Reset and Cable Reset**

IP2133 will monitor for Hard Reset and Cable Reset signaling and reset when either of them is detected. IP2133 will perform the equivalent of a power cycle and return its power-up state.

➢ Control Message

This chip will respond to the following control messages required for passive USB Type-C cable. Any messages except those in the table will be ignored by no action after returning the GoodCRC message.

MessageHeader[4:0]	Message Type	Description
Transmitted Message		
0 0001	GoodCRC	Be sent to acknowledge that the previous message was correctly received (i.e. had a good CRC)
0 0011	Accept	Be sent to indicate that it has completed its Soft Reset.
Received Message		
0 0001	GoodCRC	The sent message has been correctly received
0 1101	Soft_Reset	Reset MessageIDCounter before sending the Accept Message response
Others	N/A	Ignored

➢ Data Message

This chip will respond to the following data messages required for passive USB Type-C cable. Any messages except those in the table will be ignored.

MessageHeader[4:0]	Message Type	Description
Transmitted Message/NA		
Received Message		
0 0011	BIST	Including BIST Carrier Mode and BIST Test Data
0 1111	Vendor_Defined	See below section
Others	N/A	Ignored

➢ Discover Identity

Discover Identity command is used to identify the VCONN Source power cable plug,The command format is as follows：

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)

✧ ID Header

The ID Header VDO contains information corresponding to the Power Delivery Product. The fields in the ID

Header VDO Shall be as defined in Table.

Bit(s)	Description
B31	USB Communications Capable as USB Host: • **Shall** be set to one if the product is capable of enumerating USB Devices. • **Shall** be set to zero otherwise
B30	USB Communications Capable as a USB Device: • **Shall** be set to one if the product is capable of being enumerated as a USB Device. • **Shall** be set to zero otherwise
B29...27	Product Type (UFP): • 000b – Undefined • 001b – PDUSB Hub • 010b – PDUSB Peripheral • 011b – PSD • 100b – **Reserved, Shall Not** be used. • 101b – Alternate Mode Adapter (AMA) • 110b – VCONN-Powered USB Device (VPD) • 111b – **Reserved, Shall Not** be used. Product Type (Cable Plug): • 000b – Undefined • 001b...010b – **Reserved, Shall Not** be used. • 011b – Passive Cable • 100b – Active Cable • 101b...111b – **Reserved, Shall Not** be used.
B26	Modal Operation Supported: • **Shall** be set to one if the product supports Modal Operation. • **Shall** be set to zero otherwise
B25...23	Product Type (DFP): • 000b – Undefined • 001b – PDUSB Hub • 010b – PDUSB Host • 011b – Power Brick • 100b - Alternate Mode Controller (AMC) • 101b...111b – **Reserved, Shall Not** be used.
B22...16	**Reserved. Shall** be set to zero.
B15...0	16-bit unsigned integer. USB Vendor ID

✧ Cert Stat VDO

The Cert Stat VDO Shall contain the XID assigned by USB-IF to the product before certification in binary format. The fields in the Cert Stat VDO Shall be as defined in Table:

Bit(s)	Description	Reference
B31...0	32-bit unsigned integer, XID	Assigned by USB-IF

✧ Product VDO

The Product VDO contains identity information relating to the product. The fields in the Product VDO Shall be as defined in Table.

| Bit(s)	Description	Reference
B31...16	16-bit unsigned integer. USB Product ID	*[USB 2.0]/[USB 3.2]*
B15...0	16-bit unsigned integer. bcdDevice	*[USB 2.0]/[USB 3.2]*

✧ Passive Cable VDO

A Passive Cable has a USB Plug on each end at least one of which is a Cable Plug supporting SOP' Communication. A Passive Cable Shall Not incorporate data bus signal conditioning circuits and hence has no concept of Super Speed Directionality. A Passive Cable Shall include a VBUS wire and Shall only respond to SOP' Communication. Passive Cables Shall support the Structured VDM Discover Identity Command and Shall return the Passive Cable VDO in a Discover Identity Command ACK as shown in Table .

Bit(s)	Field	Description
B31...28	HW Version	0000b...1111b assigned by the VID owner
B27...24	Firmware Version	0000b...1111b assigned by the VID owner
B23...21	VDO Version	Version Number of the VDO (not this specification Version): • Version 1.0 = 000b Values 001b...111b are *Reserved* and *Shall Not* be used
B20	*Reserved*	*Shall* be set to zero.
B19...18	USB Type-C plug to USB Type-C/Captive	00b = *Reserved*, *Shall Not* be used 01b = *Reserved*, *Shall Not* be used 10b = USB Type-C 11b = Captive
B17	EPR Mode Capable	0b – Cable is not EPR Mode Capable 1b = Cable is EPR Mode Capable
B16...13	Cable Latency	0000b – *Reserved*, *Shall Not* be used. 0001b – <10ns (~1m) 0010b – 10ns to 20ns (~2m) 0011b – 20ns to 30ns (~3m) 0100b – 30ns to 40ns (~4m) 0101b – 40ns to 50ns (~5m) 0110b – 50ns to 60ns (~6m) 0111b – 60ns to 70ns (~7m) 1000b – > 70ns (>~7m) 1001b ....1111b *Reserved*, *Shall Not* be used. Includes latency of electronics in Active Cable
B12...11	Cable Termination Type	00b = V$_{CONN}$ not required. Cable Plugs that only support *Discover Identity* Commands *Shall* set these bits to 00b. 01b = V$_{CONN}$ required 10b...11b = *Reserved*, *Shall Not* be used
B10...9	Maximum V$_{BUS}$ Voltage[2]	Maximum Cable V$_{BUS}$ Voltage: 00b – 20V 01b – 30V[1] (*Deprecated*) 10b – 40V[1] (*Deprecated*) 11b – 50V
B8...7	*Reserved*	*Shall* be set to zero.
B6...5	V$_{BUS}$ Current Handling Capability	00b = *Reserved*, *Shall Not* be used. 01b = 3A 10b = 5A 11b = *Reserved*, *Shall Not* be used.
B4...3	*Reserved*	*Shall* be set to zero.
B2...0	USB Highest Speed	000b = [USB 2.0] only, no SuperSpeed support 001b = [USB 3.2] Gen1 010b = [USB 3.2]/[USB4] Gen2 011b = [USB4] Gen3 100b...111b = *Reserved*, *Shall Not* be used

[1] Values no longer allowed. When present the field *Shall* be interpreted as if it was 00b.
[2] EPR Sinks with a captive cable *Shall* report 50V.

12. Typical Application Schematic

> ## USB2.0 Cable Application Schematic

IP2133 Support USB Type-C 2.1 protocol,It also supports low BOM cost. No capacitor is needed between VBUS and GND.It can save PCB Layout space.
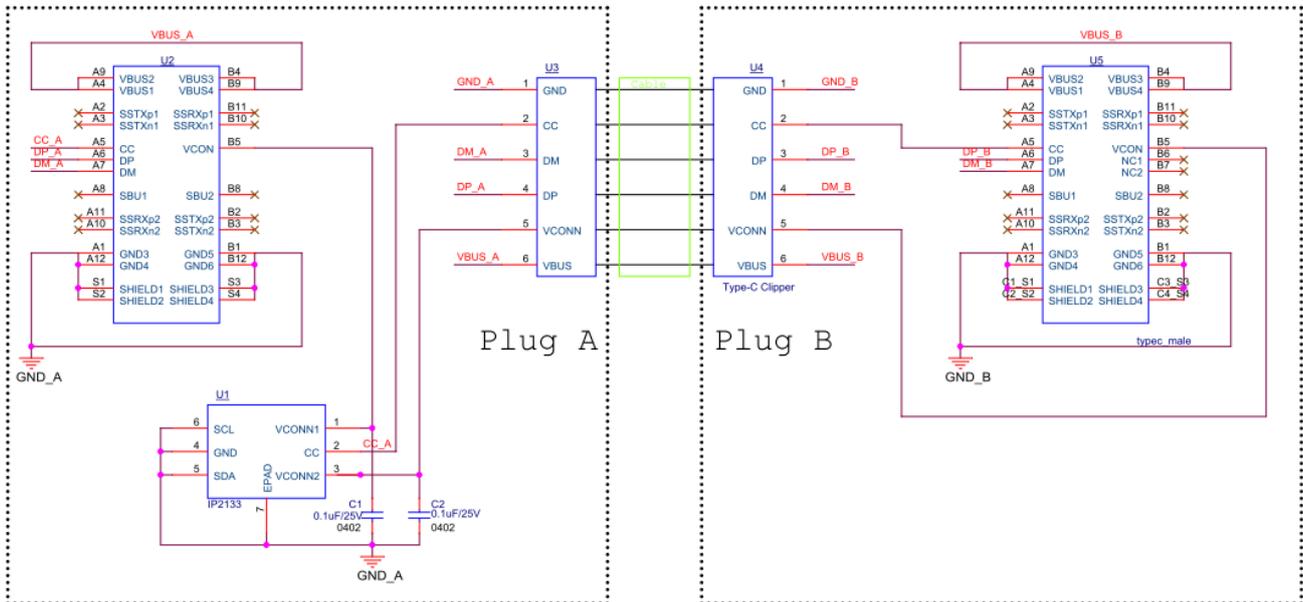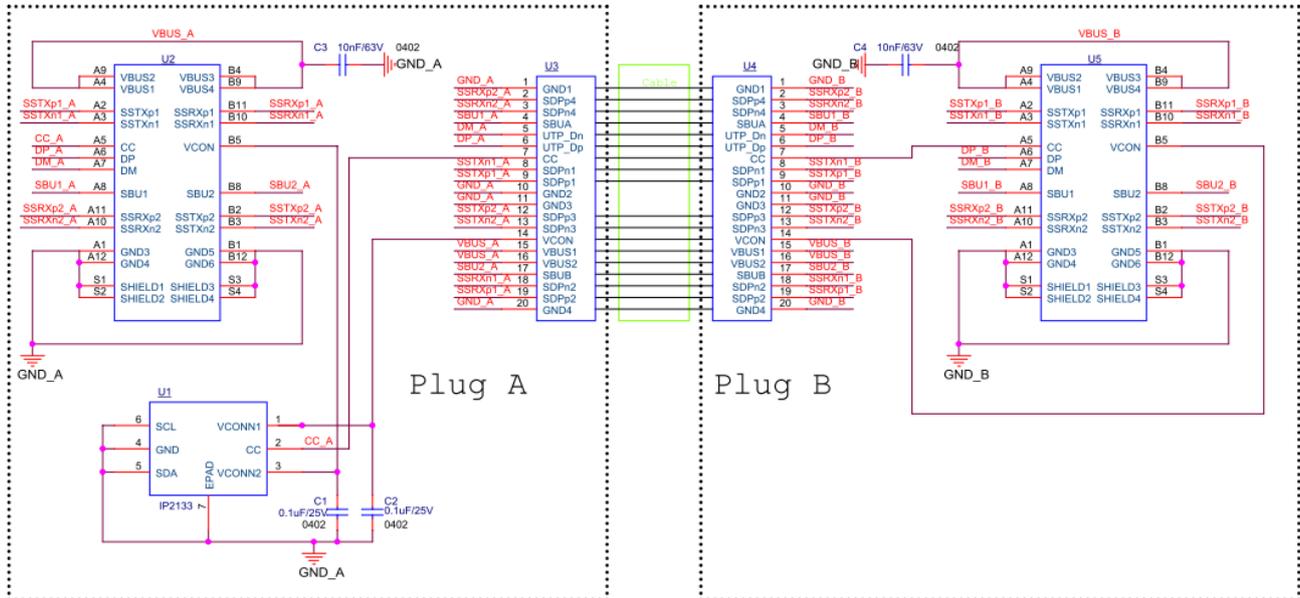

USB 2.0 Cable BOM list

| Part NO.	Name	Part description	Unit	Quantity	Location	Remark
1	IC	DFN-6L E-Maker,IP2133	PCS	1	U1	
2	USB Type-C Plug	N/A	PCS	2	U2,U5	
3	MLCC	0402 100nF,25V,X5R	PCS	2	C1，C2	

➢ USB3.2 Cable Application Schematic

When IP2133 is used as a USB 3.2 cable, a 10nF capacitor needs to be connected between VBUS and GND, and the capacitor withstand voltage is above 63V.


USB 3.1 cable BOM list

Part NO.	Name	Part description	Unit	NO.	Location	Remark
1	IC	DFN-6LE-Maker,IP2133	PCS	1	U1	
2	MLCC	0402 100nF,25V,X5R	PCS	2	C1，C2	
3	MLCC	0402 10nF,63V,X5R	PCS	2	C3，C4	
4	USB Type-C Plug	N/A	PCS	2	U2,U5	

13. Package outline dimensions
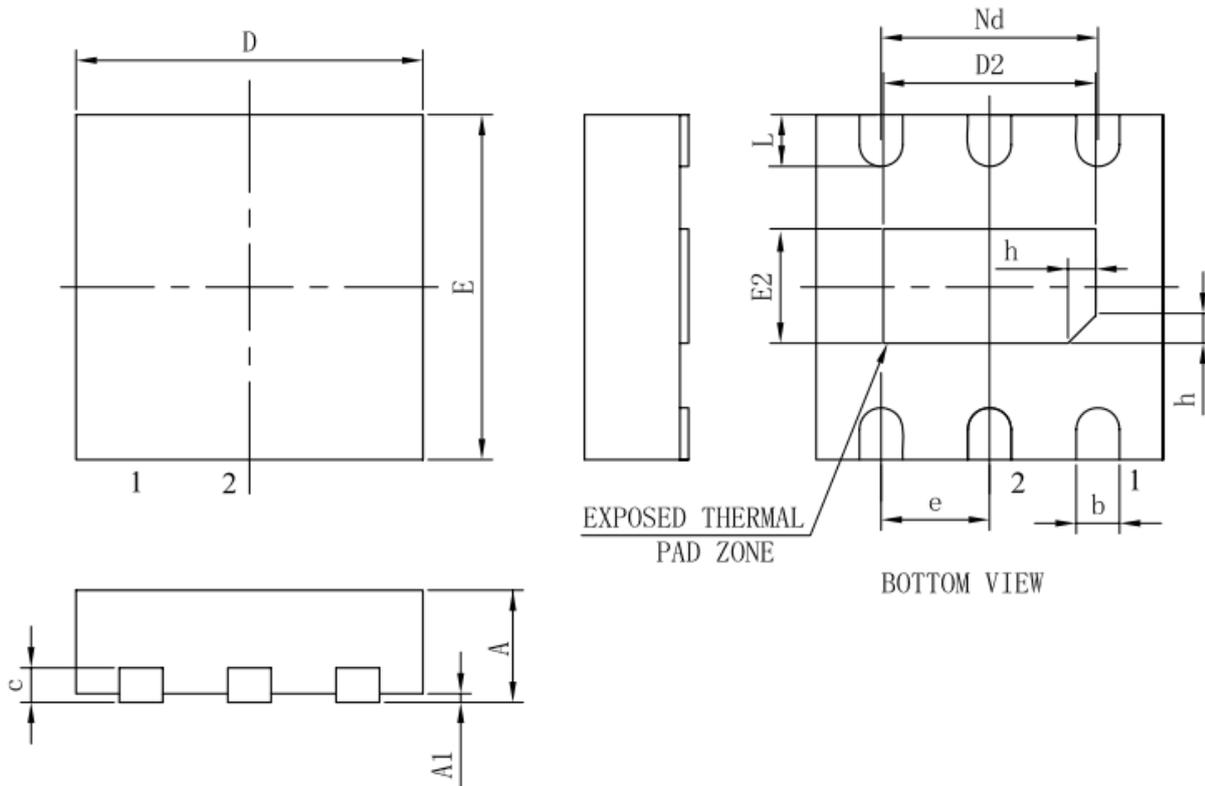
SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	0.70	0.75	0.80
A1	—	0.02	0.05
b	0.25	0.30	0.35
c	0.18	0.20	0.25
D	1.95	2.00	2.05
D2	1.00	1.23	1.45
e	0.65BSC		
Nd	1.30BSC		
E	1.95	2.00	2.05
E2	0.50	0.68	0.85
L	0.25	0.30	0.40
h	0.10	0.15	0.20
载体尺寸（mil)	63*43		

14. Layout Pad Reference
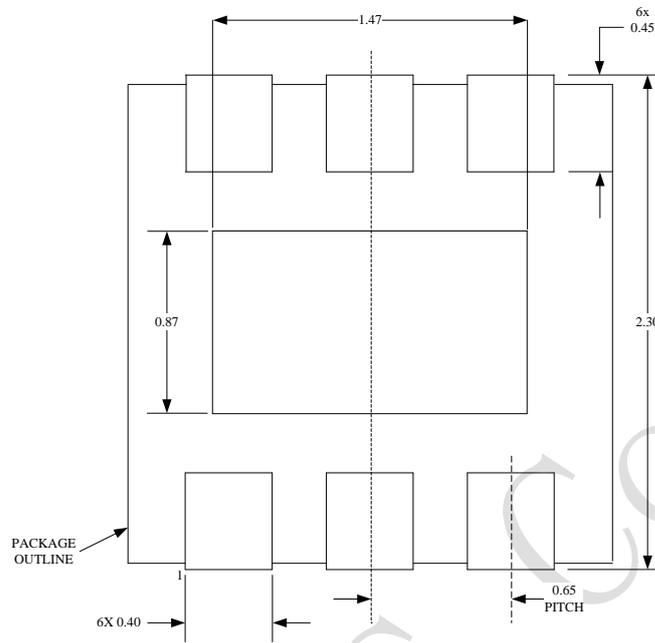
LAND PATTERN EXAMPLE
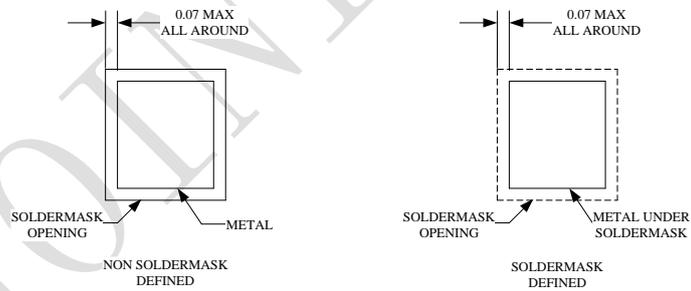
SOLEDR MASK DETAILS

15. Tape Information

| Name	W	Ao	Bo	A1	B1	Ko	K1	E	F	P	Po	P2	Po10	Do	D1	T	
DATA (Unit:mm)	8 +0.10 -0.10	3.26 +0.10 -0.10	3.3 +0.10 -0.10			1.4 +0.10 -0.10		1.75 +0.10 -0.10	3.5 +0.05 -0.05	4 +0.10 -0.10	4 +0.10 -0.10	2 +0.05 -0.05	40 +0.20 -0.20	1.55 +0.10 -0.00	1.05 +0.05 -0.05	0.2 +0.02 -0.02	
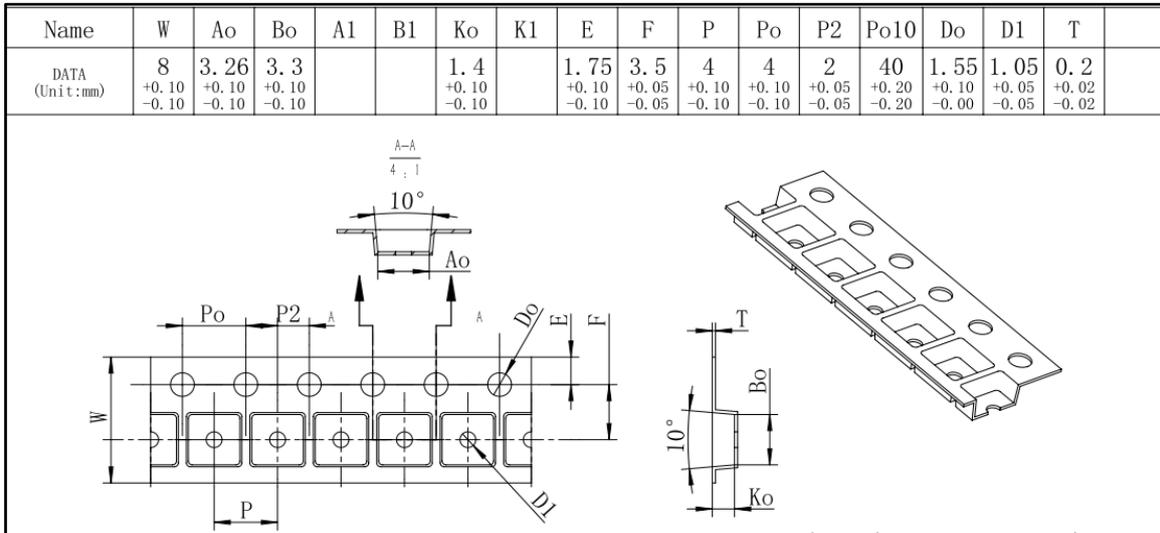
16. Marking Specification
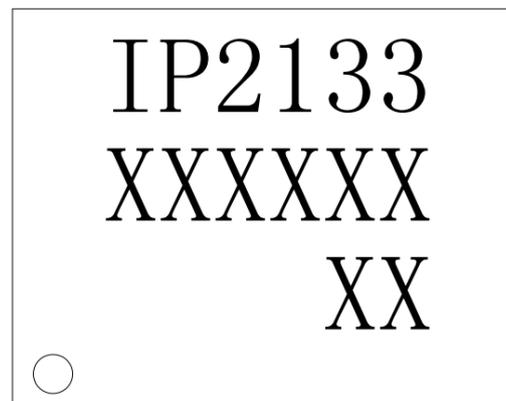
说明：
1、2133 ——产品型号IP2133
2、XXXXXX ——生产批号
3、XX ——版本号与封装厂代码
4、 ○ ——Pin 1脚位置标识

17.Solder Instruction

It is recommended to use high temperature(250℃ Max) reflow soldering as below.
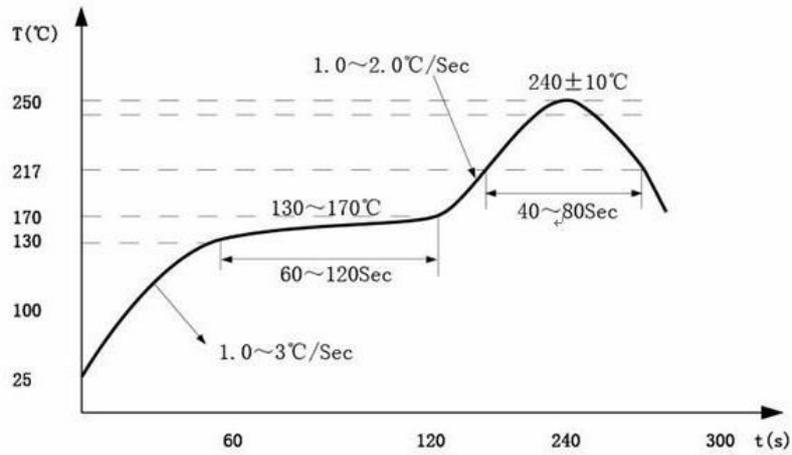
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