USB Signal Action and Measurement Practice (II)
- USB-OTG Measurement Case -

Preface

We have introduced USB structure, action process and data transaction communication protocol in Part I, in this part we will make an actual measurement with OTG application, which is very popular in mobile devices. You would find through that measurement solutions of Zeroplus is very helpful.

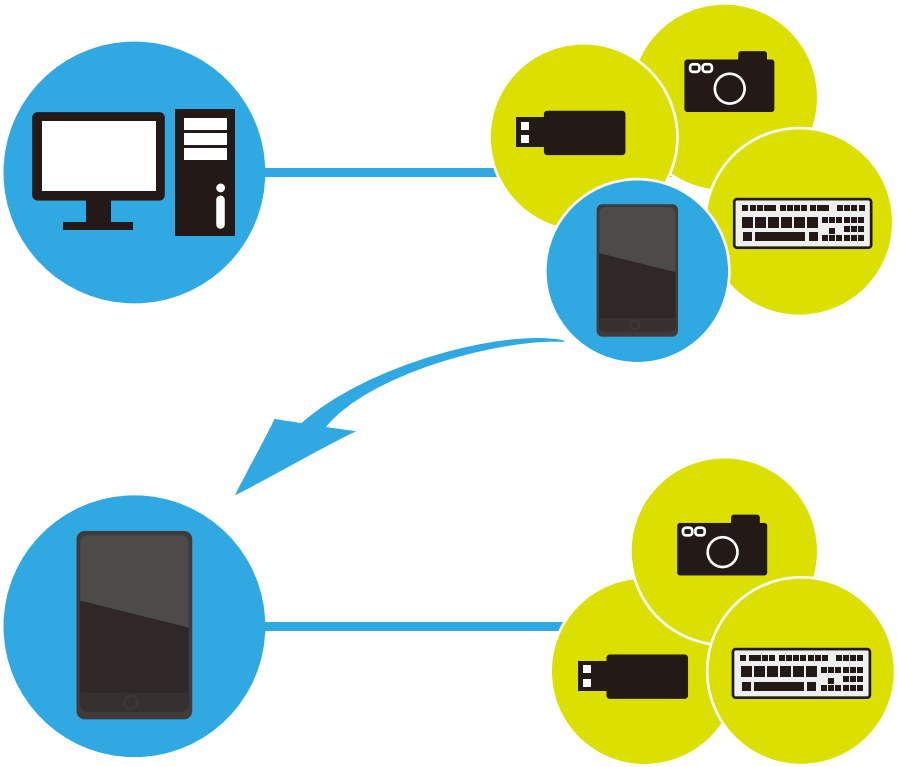
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What is OTG?

OTG, On The Go, is released by USB-IF(Universal Serial Bus Implementers Forums) association to replenish the content of USB 2.0. A standard USB structure must have a master and a slave. As a general rule, PC is the master and USB device is the slave. In this kind of structure, the USB device only can passively return data to USB host or wait its instructions.

USB OTG has changed this structure. See Fig. 1, it adopts dual-role device (DRD for short) and has another peer-to-peer pipe; so the USB device is not limited to be the slave any more, it could also be the host giving instructions. Currently OTG structure is widely used in new smart phones and tablet PCs. Many phones have already supports normal USB periphery devices, such as HID devices (USB mouse, keyboard, gamepad), USB hub, flash drive, card reader, 2.5" mobile HD; they even can control the digital camera or read its data. Since USB could be used for charging, in USB host mode mobile device could charge other periphery devices through OTG structure, USB application area is expanded.



▲ Fig. 1: diagram of standard USB and OTG structure

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New USB-OTG Port Mode

In USB 2.0 specification, USB port is divided into A type and B type, but later it releases Mini-A/B type and Micro A/B type to be smaller and used in mobile devices. From Fig. 2 we can see there is one more ID Pin in Mini and Micro types of port. In OTG structure, this ID Pin determines the device is master or slave. If the device is master, the pin would connect GND, or it would not be connected. See Fig. 3 for its mode of connection.

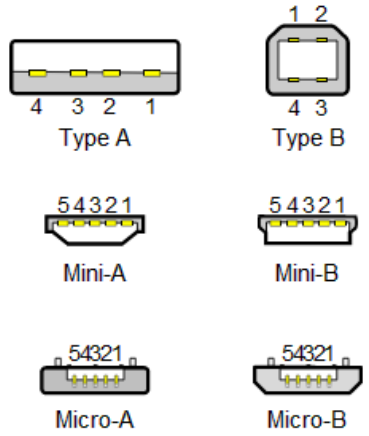


Photo by: Darx, Damian Yerrick, et al

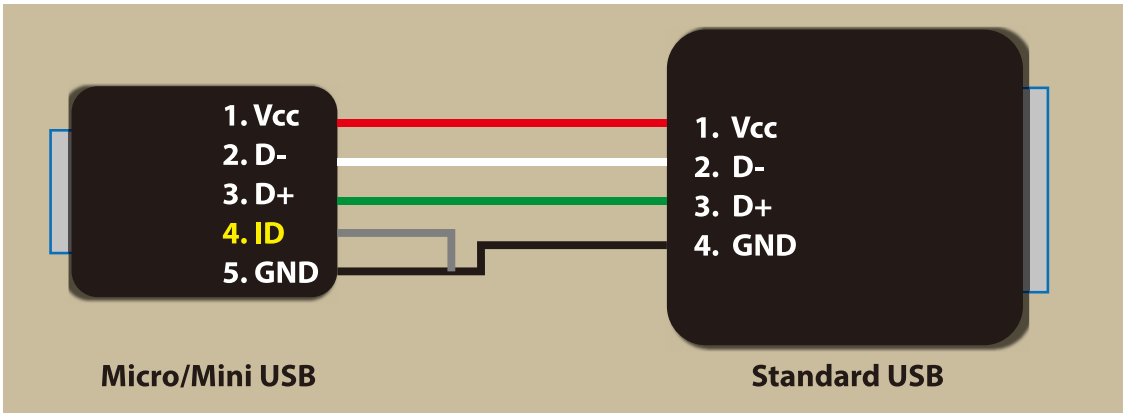
Micro/Mini USB

Pin	Function
1	V-Bus (5V)
2	D-
3	D+
4	ID
5	GND

Standard USB

Pin	Function
1	V-Bus (5V)
2	D-
3	D+
4	GND

▲ Fig. 2: difference between Standard, Mini and Micro types



▲ Fig. 3: mode of connection for USB-OTG Host

In mobile devices supporting OTG, USB OTG Chip would check whether the ID Pin is connected with GND or not to judge the device is master or slave. Since the ID Pin is connected in production of USB cable, we shall buy specific cable that supporting OTG master to make the device be the master, so as to control other USB devices.

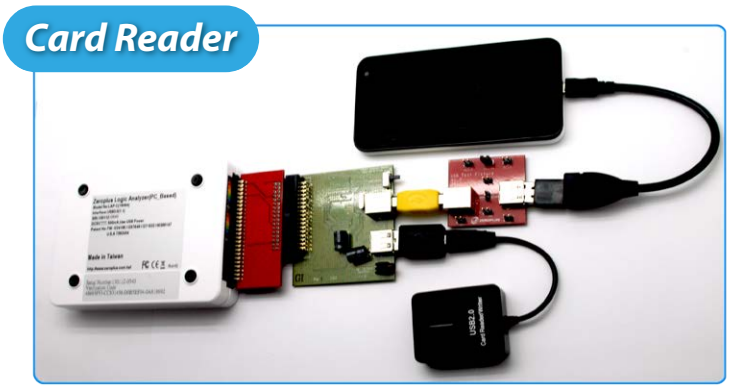


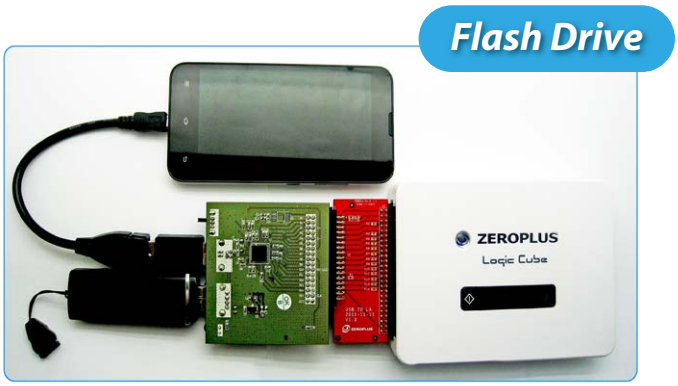
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Actual Measurement with USB 2.0 Capture Board

USB 2.0 Capture Board, developed by Zeroplus Technology, can analyze software and hardware. It supports decoding of USB 2.0 (high speed), USB 1.1 (full speed) and USB 1.0 (low speed). Engineers could use it to measure and analyze USB signals of different speed to improve their working efficiency.









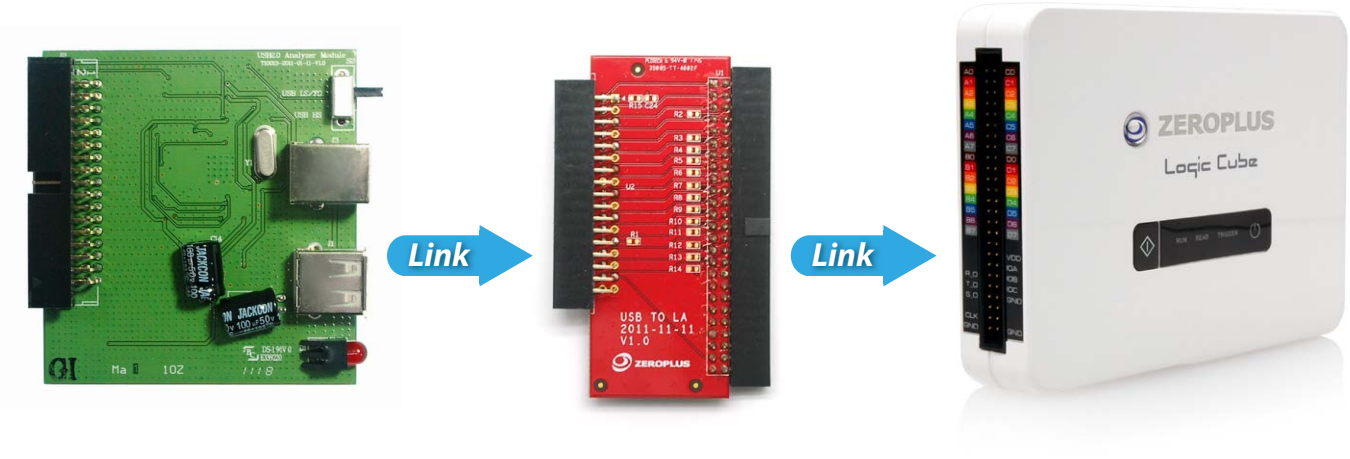
▲ **Fig. 4: USB-OTG measurement by Logic Analyzer of Zeroplus**

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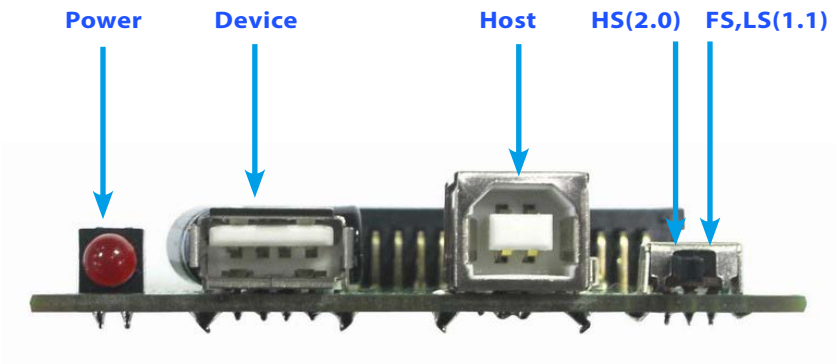
How to use Logic Analyzer and USB 2.0 Capture Board

USB signal only includes D+ and D-. During measuring, the USB 2.0 Capture Board would convert the serial signal to parallel signal, and then transfer it to the Logic Analyzer. For easy using, only a connecting plate is needed to connect USB 2.0 Capture Board and Logic Analyzer (Fig. 5). On one side of USB 2.0 Capture Board there are switch of USB2.0 and USB1.1/1.0, standard USB Host Port (B type) and Device Port (A type), so users could quickly switch and measure USB port (Fig. 6).

Note: If the device is mobile, an exclusive cable of OTG Master shall be bought for the Host port.



▲ Fig. 5: USB 2.0 Capture Board & Logic Analyzer connection



▲ Fig. 6: Host and Device ports on the I/O side of USB 2.0 Capture Board

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How to Set the Software and Channel ?

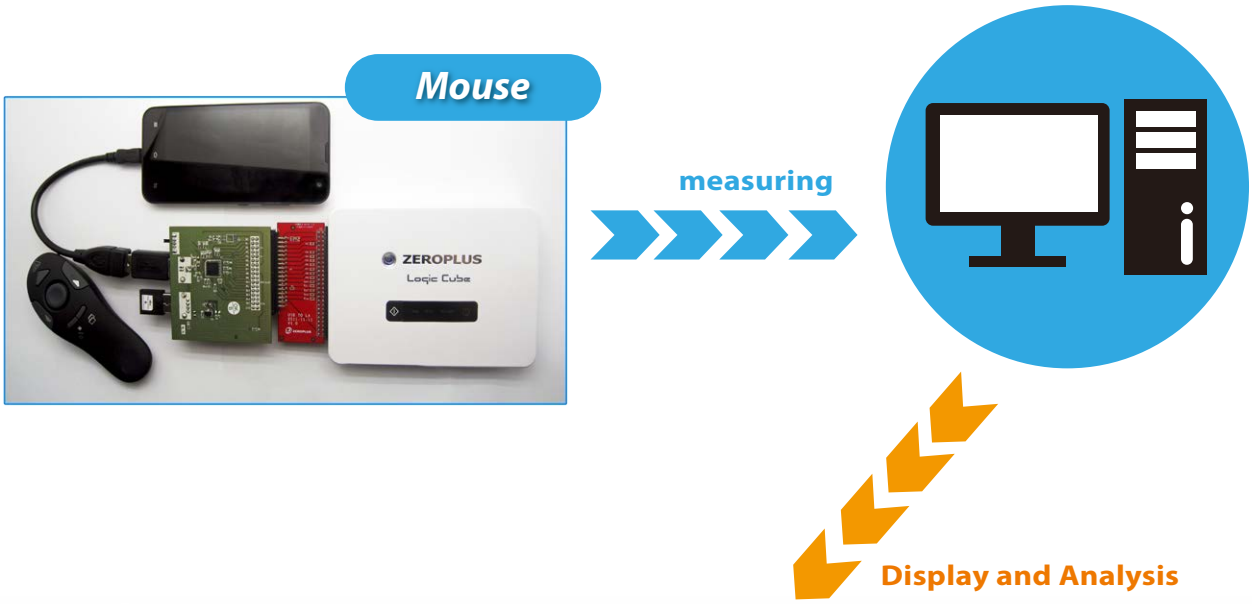
Since the pin quantity of USB2.0 Capture Board is limited, so the used channel quantity of software is also limited. See Tab. 3 for every channel's function. Channels A0-B7 and C3 are used for decoding USB2.0 high speed signal, C0 and C1 are for USB1.1/1.0 signal. For software setting, please refer to our official website.

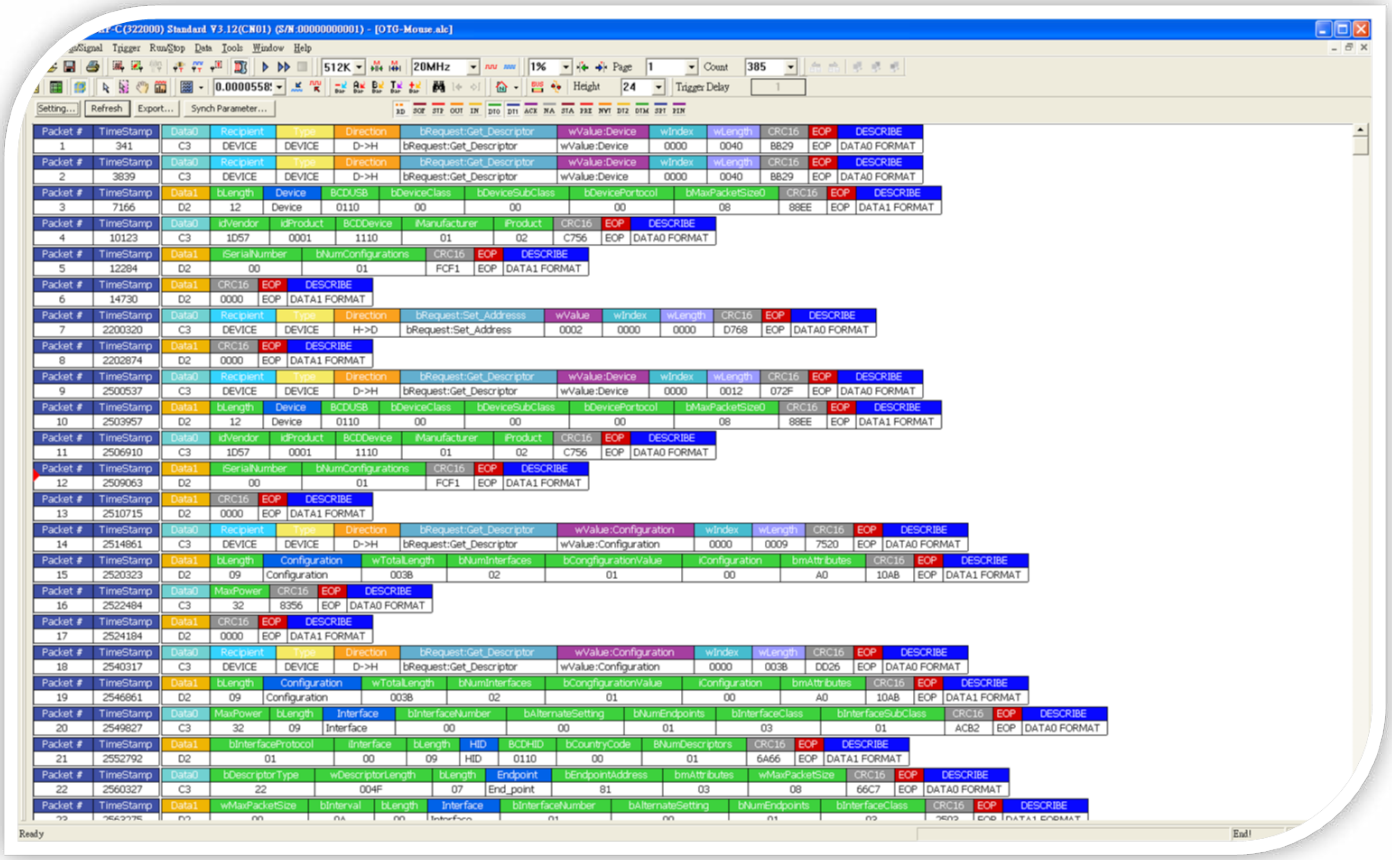
Pin Comparison Table			
Pin	**LA Channel**	**Pin**	**LA Channel**
DB 0	A0	DB11	B3
DB 1	A1	DB12	B4
DB 2	A2	DB13	B5
DB 3	A3	DB14	B6
DB 4	A4	DB15	B7
DB 5	A5	CLK	CLK
DB 6	A6	D+	C0
DB 7	A7	D-	C1
DB 8	B0	RX-Valid	C3
DB 9	B1	GND	GND
DB 10	B2	GND	GND

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Example—Smart Phone Connecting HID Device (OTG Measurement)

Below image shows the process of analyzing the USB2.0 signal of smart phone connecting with mouse and showing it in the PC. USB decoding bus designed by Zeroplus Technology could decode the USB packets directly, that would help engineers debugging and checking much quickly.





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Summary

From personal PC's standard configuration to main communication interface of devices, USB technology develops very fast in a short time. Manufactures now expand their R&D area to mobile devices from computer periphery. No need to say there is a great business opportunity. To help engineers quickly understand USB signal structure and process, Zeroplus Technology has particularly designed USB2.0 Capture Board, which, used with Logic Analyzer of Zeroplus, could analyze signals of USB1.0, USB1.1 and USB2.0. In recent years mobile devices become more and more popular, measurement on smart devices largely increases, so a solution for USB-OTG measurement is urgently needed. This article is intended to share this kind of solution with engineers, we hope it is useful for those who still don't understand USB signals.

Besides, Zeroplus Technology owns over a hundred decoding buses, which could analyze lots of kinds of signal, such as I2C, SPI, etc., and also designs signal convert versions in correspondence with various signals for easy measurement. Zeroplus' professional technology and service are your best choice.

For more product information, please go to ZEROPLUS website



▲ Logic Analyzer LAP-C Series



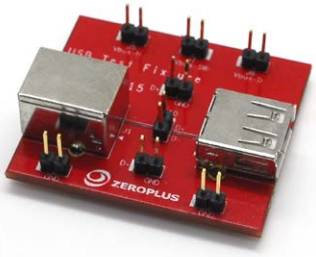
▲ USB 2.0 Capture Board

Note: USB 2.0 Capture Board can only be used for models with 32 channels, and only for C Series.

- USB 2.0 Capture Board Introduction
- USB2.0 Decoding software

ZEROPLUS provides a lot of USB measurement data, please go to " Technical Support "

- USB 2.0 Signal Analysis Skills
- Debugging USB1.1 Buses in Embedded System Designs



▲ USB Test Fixture(B TO A)

Roger Tsai
Instrument Department/ FAE

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