



Protocol Analyzer SD Introduction

The whole name of the SD is Secure Digital, which is a kind of standard interface for the Memory Card. The SD has been developed by the Panasonic, Matsushita and Toshiba together in Aug.1999, which is widely applied in the different portable devices, such as Digital Camera, PDA, NB Walkman and MP3 Walkman. The technology of the SD Card is based on the MMC(Multi Media Card) Format, but the SD Card owns the higher transmission rate. The size of the common SD Card is 32mm x 24mm x 2.1mm, the thickness is about 1.4mm and the volume is rather small;

The transmission rate of the SD Card is updated constantly, which takes the 150KB/s of the CD-ROM as one time to be calculated. Specifically, the transmission rate of the SD Card is higher than that of the CD-ROM.

Multiples	Transmission Rate (MB/s)	SD CLASS	Multiples	Transmission Rate (MB/s)	SD CLASS
6x	0.9	n/a	100x	15.0	6
10x	1.5	n/a	133x	20.0	6
13x	2.0	2	150x	22.5	6
26x	4.0	4	200x	30.0	6
32x	4.8	4	266x	40.0	6
40x	6.0	6	300x	45.0	6
66x	10.0	6	-	-	-

Table 1: The Multiples and Transmission Rate Table of SD Card

The Matsushita, Toshiba and San Disk has established the SD Card Association in 2000. And the SD Card Association provides its members with many SD Interface Specifications, such as SD card, mini SD card, micro SD card, SDHC card, mini SDHC card and micro SDHC card. Please visit the website (<http://www.sdcard.org>) to learn the detailed information.



SDIO & SDHC

SDIO is a kind of interface, which is based on the SD Slot Format. The NB or the PDA can connect with different peripheral devices according to the SDIO, such as Wireless Network Card, Bluetooth Controller, Video Device and GPS Receiver. The importance of the SD Interface on the market is enhanced according to the suchlike supports. In order to meet the requirement of the high capacity, the SD Card Association has also issued the SDHC (Secure Digital High Capacity), which is the extension of the SD Format. The highest capacity of the SDHC can be 32GB, which uses the FAT32 File Format; but in contrast, the highest capacity is only 2GB if the SD uses the FAT16 Foramt.

The SDHC and SD are the same, but they have the different CLASSES. In the SDHC, the CLASS 2 can transmit 2MB Data per second, the CLASS 4 can transmit 4MB Data per second and the CLASS 6 can 6MB Data per second.

The Appearance and Pins of the SD Card

The SD has nine Pins in general, there are the Power, Control Signal, Clock Signal and 4-byte Data Bus on the connecting finger of the Card. There is a Write Protection Switch on the right side of the Card, which can be used to protect the data of the Write Card from erasing accidentally. The Print Circuit in the SD Card includes the NAND Flash Memory, SD Controller and aided components. In the 9-Pin Connecting Finger on the SD Card, the functions of the PIN1~PIN7 are the same with that of the PINs on the MMC Card. Generally, the SD Card can receive the Swap action for about 10000 times. The internal NAND Flash Memory of the SD Card can read/write from 20,000 times to 30,000 times repeatedly and the Drop with 3 meters.

Pin	Name
1	ÖææH
2	ÔT Ö
3	XÙÙ
4	VDD
5	Clock
6	VSS
7	Data0
8	Data1
9	Data2



Table 2: Name of SD Card Pin



The Features and Advantages of SD Card

- Targeted for portable and stationary applications
- Memory capacity:
Standard Capacity SD Memory Card: Up to and including 2 GB
High Capacity SD Memory Card: More than 2GB (This version of specification limits capacity up to and including 32GB)
- Voltage range:
High Voltage SD Memory Card – Operating voltage range: 2.7-3.6 V
Dual Voltage SD Memory Card – Operating voltage range: Low Voltage Range (T.B.D) and 2.7-3.6 V
- Designed for read-only and read/write cards.
- Default mode: Variable clock rate 0 - 25 MHz, up to 12.5 MB/sec interface speed (using 4 parallel data lines)
- High-Speed mode: Variable clock rate 0 - 50 MHz, up to 25 MB/sec interface speed (using 4 parallel data lines)
- Switch function command supports High-Speed, eCommerce, and future functions
- Correction of memory field errors
- Card removal during read operation will never harm the content
- Content Protection Mechanism - Complies with highest security of SDMI standard.
- Password Protection of cards (CMD42 - LOCK_UNLOCK)
- Write Protect feature using mechanical switch
- Built-in write protection features (permanent and temporary)
- Card Detection (Insertion/Removal)
- Application specific commands
- Comfortable erase mechanism

The SD Card not only has the light volume and the convenient use, but also has a strongest feature, that is the “Secrecy”.

The SD Card has developed a Three-layer Format Specification (continuously developing) at present, the three layers are described as below:

Physical Layer: Describe the SD Card of the re-write type and the Read-only type with Non-volatility.

File System Layer: Use the ISO 9232 Standard.

Application Layer: It has the characteristics to be used for the contents in different states, such as Audio-SD AUDIO, Picture-SD PICTURE, Voice-SD VOICE and Video-SD VIDEO.

There is the Secrecy function in every layer, the SD adopts the Recordable Media Content Protection Technology which is developed by the IBM, Intel, Matsushita and Toshiba together. And the SD – AUDIO conforms to the portable device rule which is issued by the Launch Secure Digital Music Alliance.



Protocol Analyzer SD Decoding Introduction

The HOST controls the transmission control which is from the HOST to SD Card. The Command which is transmitted by the HOST can be divided into two types, namely, Broadcast Command Mode and Address Command Mode (Point to Point Transfer).

Broadcast Command Mode:

It is suitable for all the kinds of the SD Card, and it will ask to respond in some Commands.

Address Command Mode (Point to Point Transfer):

When the Address Command is transmitted to the appointed Card Device, it will ask the Card Device which will receive the Command to transmit the corresponding Response.

When the Protocol Analyzer SD is doing the transmission, it can be divided into two Transmission Operation Modes, which are the Card identification mode and the Data transfer mode.

Card identification mode:

When the HOST enters the Card identification mode, it will reset the device and start to search whether the new Card Device is installed in the Protocol Analyzer, and the searched process won't be stop until it accepts the SEND_RCA Command (CMD3) . When the Card Device enters this Mode, it will be reset .

Data transfer mode:

When the Card Device enters the Data transfer mode, the first received Command is RCA; when the HOST enters the Data transfer mode, it will judge the states of all the Card Devices in the Protocol Analyzer firstly.

Card Device State	Operation Mode
Inactive State	Inactive
Idle State	Card identification mode
Ready State	
Identification State	
Stand-by State	Data transfer mode
Transfer State	
Sending data State	
Receive data State	
Programming State	
Disconnect State	

Table 3: Comparison between Operation Mode and Card Device State

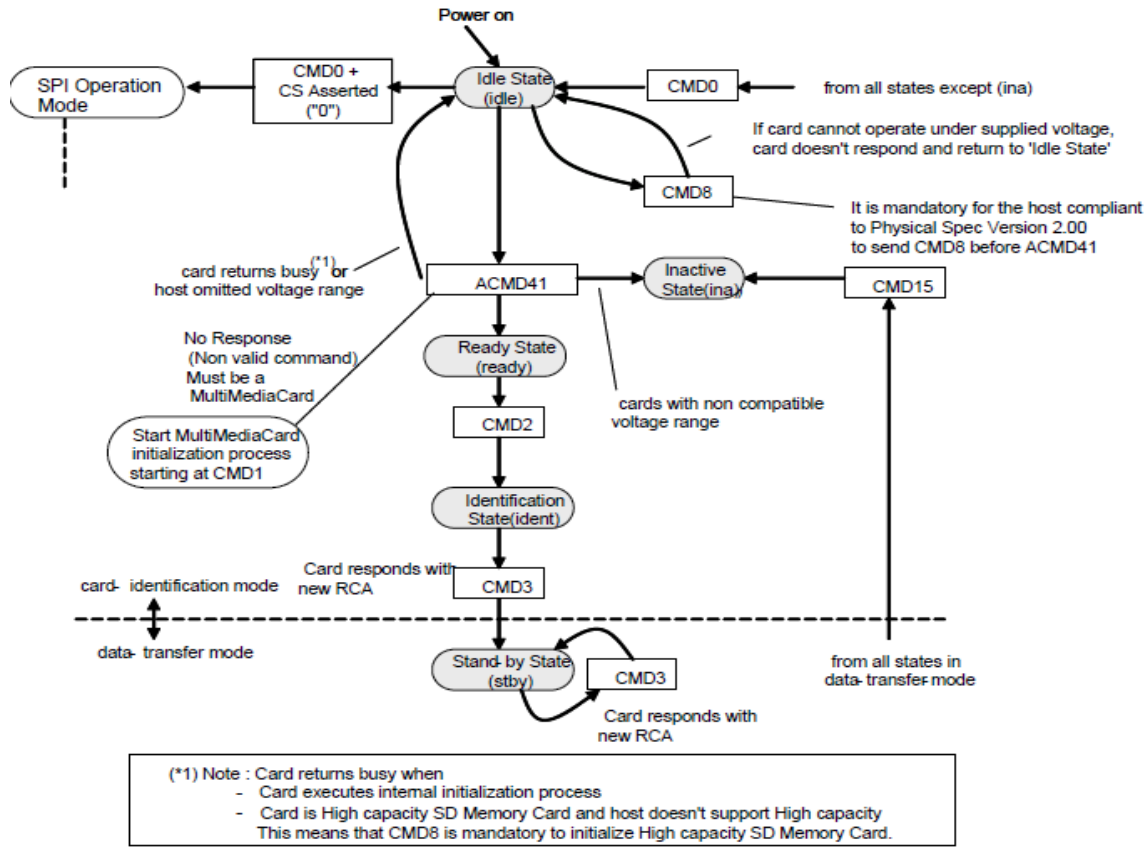


Figure 1: SD Memory Card State Diagram

When the Protocol Analyzer SD starts transmitting, it will transmit the Command to inform the Address to be received by Data. The different Commands represent the different Functions, please refer to the attachment 1 to learn the detailed information of the Command: Command Table and Register Description of the Protocol Analyzer SD.



SD Card Actual Measurement

The Protocol Analyzer SD2.0/SDIO which is developed by ZeroPlus Technology can help engineers to measure the signal's packet of the SD2.0/SDIO. Connecting the test cable of the Logic Analyzer to the test board can start to measure, see the Figure 2:

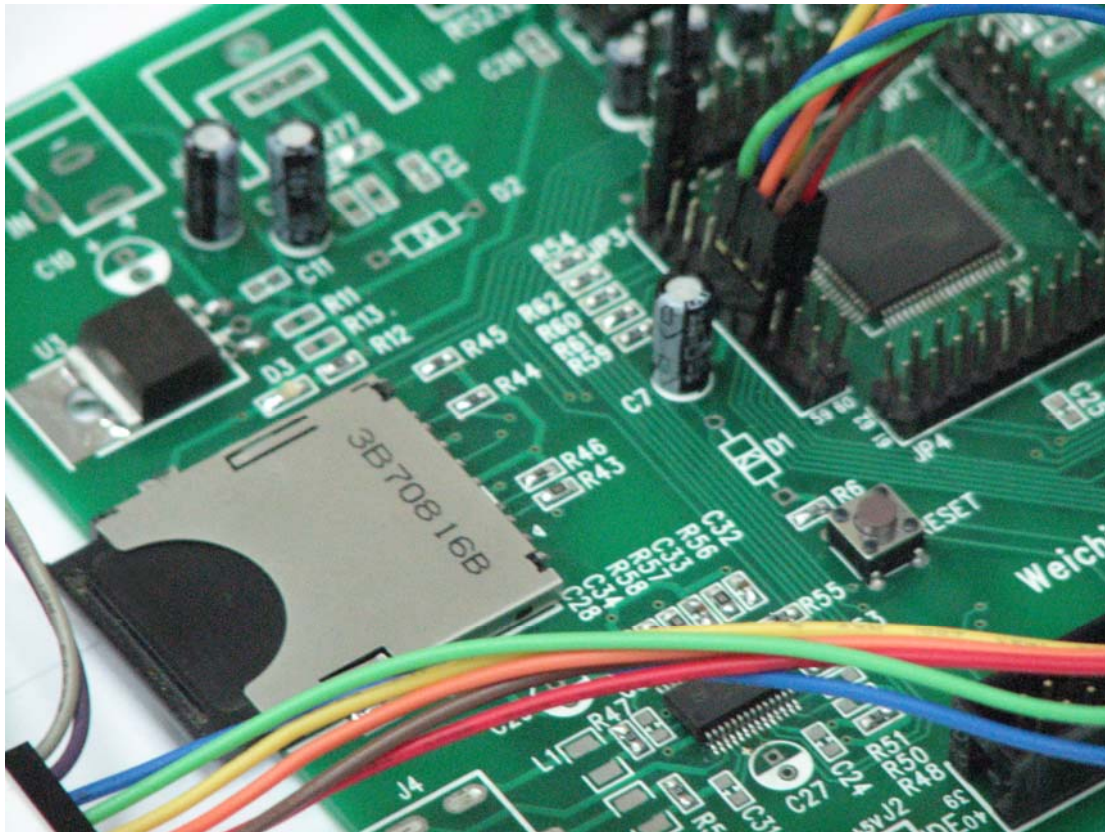
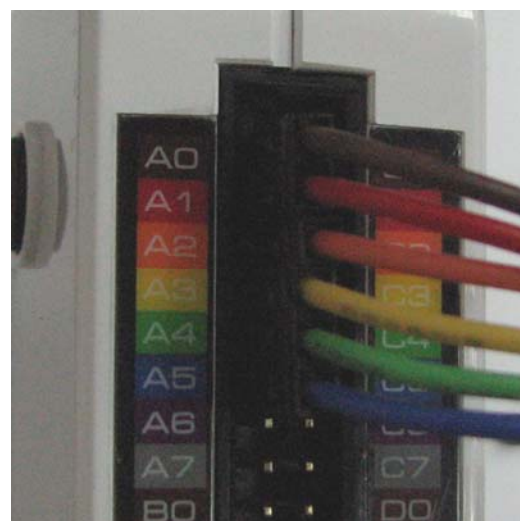


Figure 2: Connection between ZeroPlus Logic Analyzer and Test Board

According to the Table 2, Name of SD Card Pin, connect the Command, Clock, Data0, Data1, Data2 and Data3 with the A0, A1, A2, A3, A4 and A5 of the Logic Analyzer respectively in sequence.

Logic Analyzer Channel	SD Card Pin
A0	Pin 2 (Command)
A1	Pin 5 (Clock)
A4	Pin 7 (Data0)
A5	Pin 8 (Data1)
A6	Pin 9 (Data2)
A7	Pin 1 (Data3)





After connecting the test board well, open the Logic Analyzer Software to start analyzing (Please visit the website of ZeroPlus Technology to learn the details of the Software Analysis Operation Mode.). When completing the analysis, the result can be displayed in the below Figure 3 and Figure 4.

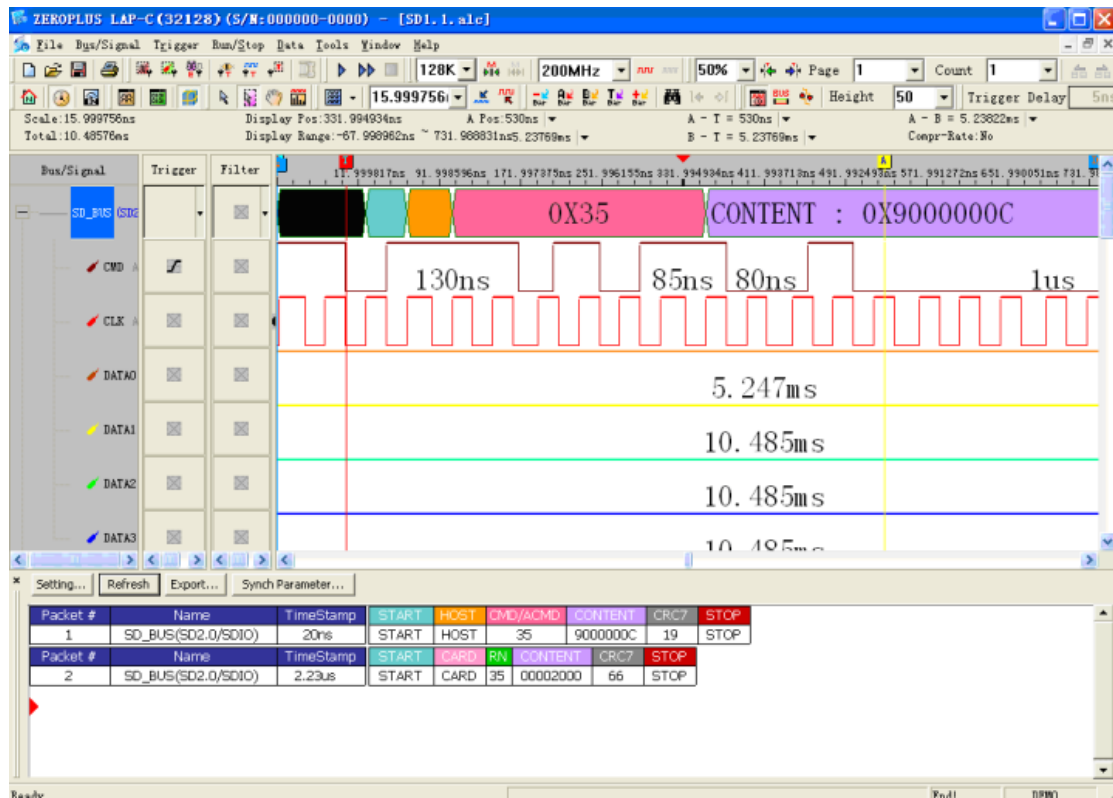


Figure 3: Use the ZeroPlus Protocol Analyzer SD2.0/SDIO to analyze the SD CMD

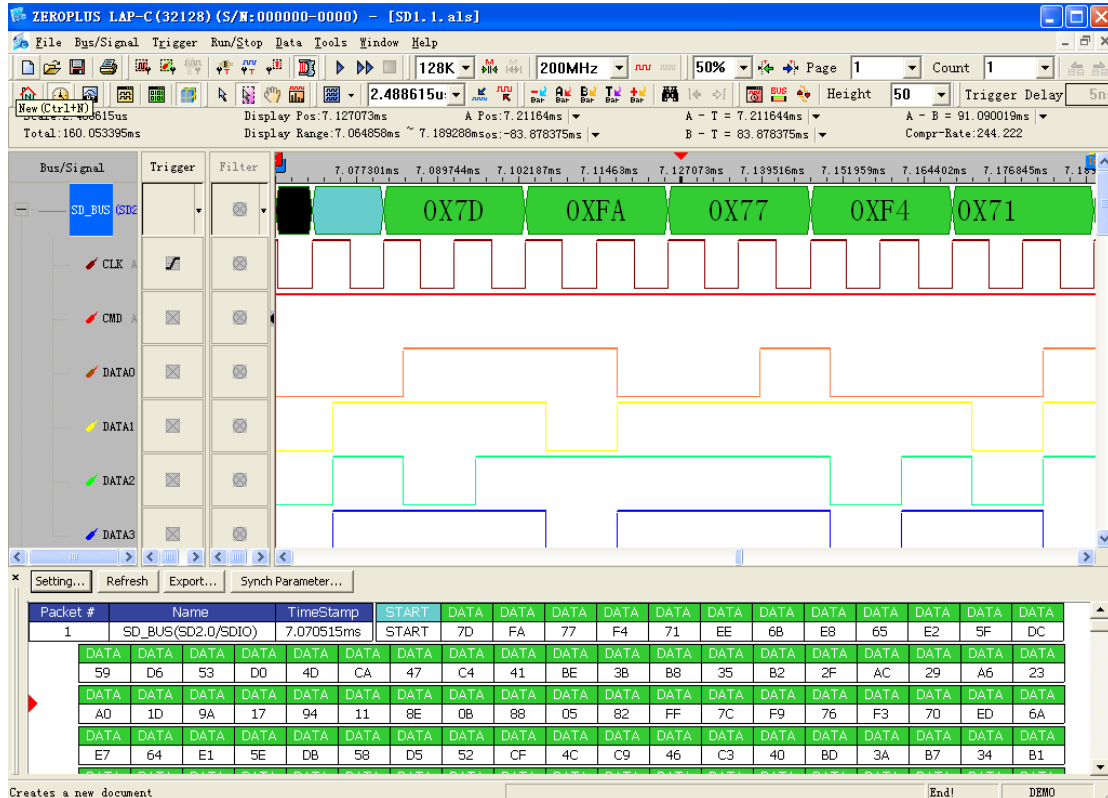


Figure 4: Use the ZeroPlus Protocol Analyzer SD2.0/SDIO to analyze the SD DATA

The ZeroPlus Technology Protocol Analyzer SD2.0/SDIO Decoding Module not only can support to analyze the Command and Data of the Protocol Analyzer SD, but also can support to analyze the SDIO. Users only need to do setting in the Setup dialog box of the Protocol Analyzer, see the Figure 5 as below about the relative setup:

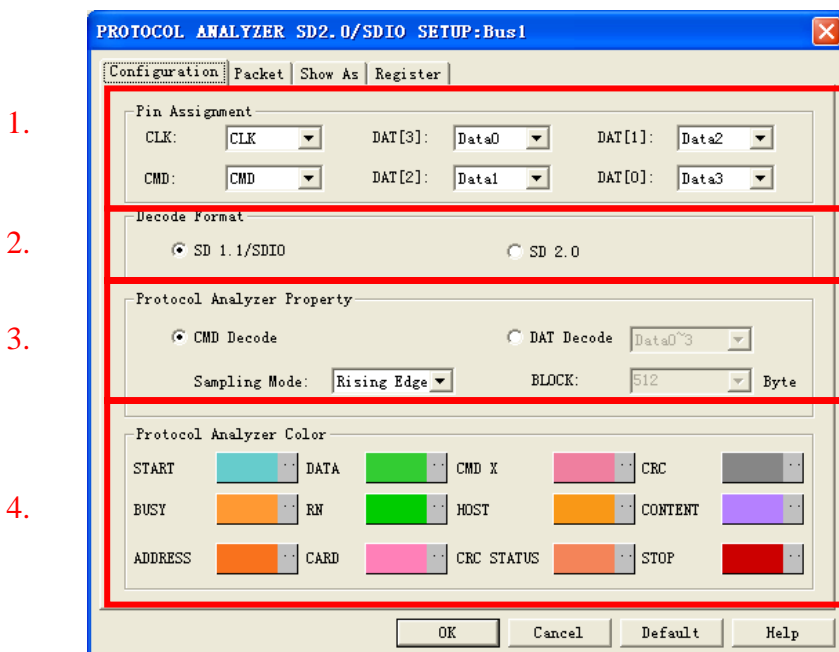


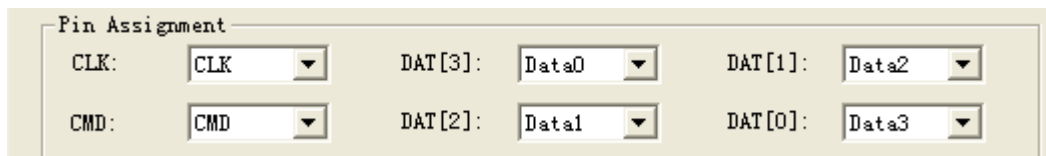
Figure 5: ZeroPlus Technology Protocol Analyzer SD2.0/SDIO Setup Dialog Box



Protocol Analyzer SD2.0/SDIO Setup Dialog Box Introduction

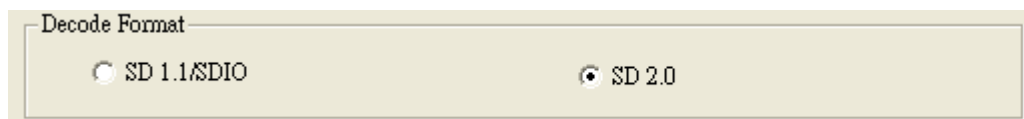
1. Pin Assignment:

It can be used to set the channels which are connected with the Logic Analyzer when analyzing the Protocol Analyzer SD2.0/SDIO.



2. Decode Format:

Users can set the Decode Format as the SD1.1/SDIO or the SD2.0 for the Protocol Analyzer.



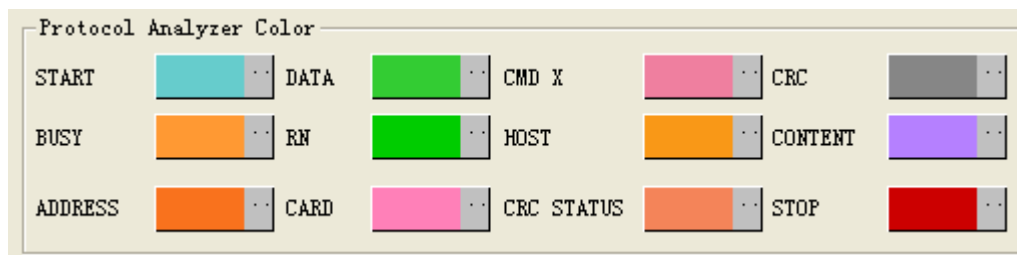
3. Protocol Analyzer Property:

Set **CMD Decode** or **DAT Decode**, **Sampling Mode** and **BLOCK** Length



4. Protocol Analyzer Color:

Users can vary the color of the items.



If users need to analyze the states of the COMMAND and DATA at the same time, they can set two groups of Protocol Analyzer Decoding with the help of the ZeroPlus Logic Analyzer Software; one is used to analyze the status of the SD_Command and the other is used to analyze the status of the SD_Data.



Setup Steps:

1. Select the signals in the Bus/Signal Column firstly and right click the highlighted signals, then click the “Channels Setup” item in the drop-down menu.
2. Open the **Channels Setup** dialog box, then select the A0, A1, A4, A5, A6 and A7 of the two Buses respectively. After the setting is completed, see the Figure 6 and Figure 7:

Users can set the Channel Name in here.

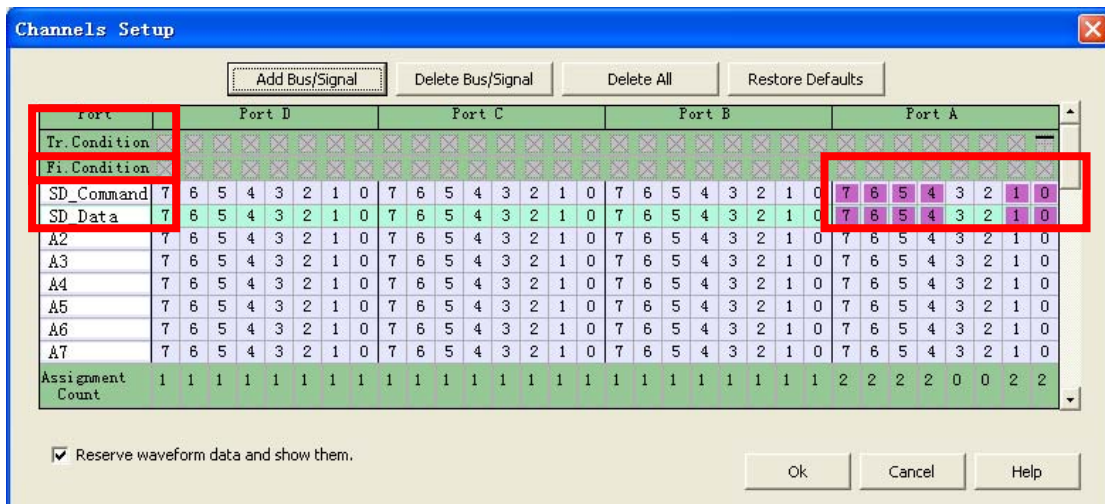


Figure 6: Channels Setup Dialog Box

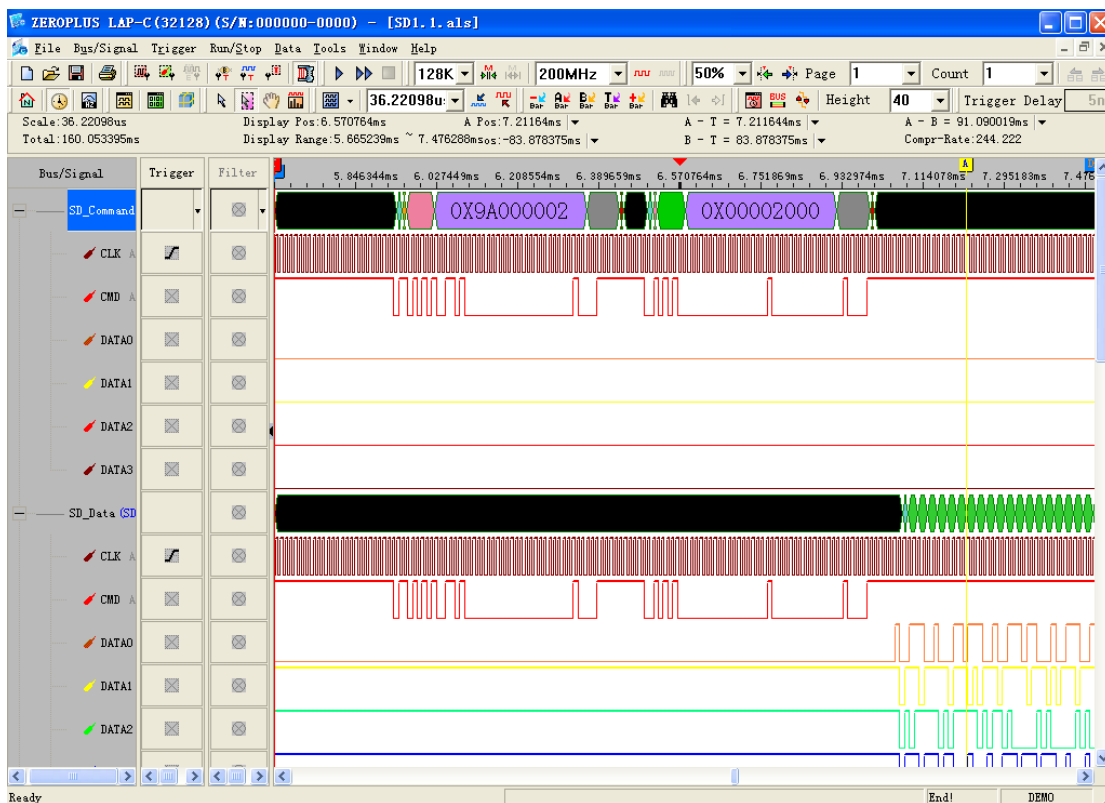


Figure 7: The result of analyzing the Command and Data at the same time



Conclusion

The Application of the SD Card is very wide, we can find its application in the Mobile Phones, Audio, Digital Camera and so forth. That's to say, it is a kind of hot Memory Card Interface, which does provide so much convenience for the Consumer Electronics Product. However, A few Product R&D Companies pay attention to such trend, they have issued many products constantly. But as the R&D Companies design the products, they also need the suitable instruments to meet the requirements of the market.

ZeroPlus Technology Logic Analyzer can support more than fifty Protocol Analyzers at present. When the R&D engineers analyze the signal of the Protocol Analyzer, they can short the time of the Development Project according to the function of the Software Automatic Decoding and make product appear on the market earlier. When they face the different Digital Signals, they don't need to use the oscillograph to analyze the signal by way of manual decoding. If you want to know more detailed information, please visit the website of ZeroPlus Technology, www.zeroplus.com.tw.

Reference:

SD Specifications Simplified_Physical_Layer_Spec from
<http://www.sdcard.org/developers/tech/sdcard/>

<<PC hardware interfaces a developer's reference>> Chen Liguang (Translator) Michael Gook (Original Author) , published by FLAG PUBLISHING.