



The Key Technology of Measuring the AC97 Digital Audio

AC97 Introduction:

The AC97 (Audio Code 97) is one of Audio Interface which is widely used in the PC system. It was developed by YAMAHA and Innovation Technology and completed by Intel Architecture Labs in 1997. It also applied in the Intel i810 Chip in 1999.

Development History of the AC97:

AC97 V1.x compliant indicates fixed 48K sampling rate operation (non-extended feature set).

AC97 V2.1 compliant indicates extended audio feature set (optional variable rate, multichannel, etc.).

AC97 V2.2 compliant indicates extended audio, enhanced riser audio support, and optional S/PDIF.

AC97 V2.3 compliant indicates extended configuration information and optional jack sensing support.

The AC97 V2.3 has become the mainstream at present, and the below are the characteristics of the AC97:

1. 16bit Stereo Left/ Right and DAC Output.
2. 16bit Mono/Stereo SRC and the Left/ Right Channel Input of ADC.
3. Multi-level Analog Mixed-input and the LINE_OUT and AUX_OUT Output.
4. Support the Power Supply Management.
5. Support Multi-channel Clock (8.0, 11.025, 16.0, 22.05, 32.0, 44.1 and 48KHz).
6. Support S/PDIF Output.
7. Modem ADC/DAC and the GPIO.
8. Enhance 3D Stereo Audio.
9. Tone controllable.

The function of the AC97 is very powerful, and it is not complex in the application of the circuit design. Only 5 signal lines for Data Transmission and Control, which are RESET, SYNC, BIT_CLK, SDATA_OUT and SDATA_IN; the five signal lines are collectively called as AC-Link. The AC97 has other signal channels except the AC-Link, such as the Digital Signal I/O and the Analog Signal I/O, and so on. Please refer to the AC97 V2.3 IC Pin List.



Name	Description
AC-Link Signal	
RESET	Reset chip signal.
SYNC	Sampling ; synchronous clock.
BIT_CLK	Frequency ; 24MHz Bit Input .
SDATA_OUT	Serial data output.
SDATA_IN	Serial fata input.
Digital Signal I/O	
S/PDIF_OUT	S/PDIF Output.
GPIO0	General Input/ Output.
GPIO1	General Input/ Output.
Analog Signal I/O	
AUX_IN_L	Left Channel Input.
AUX_IN_R	Right Channel Input.
MIC1	MIC1 Channel Input.
MIC2	MIC2 Channel Input.
CD-L	CD Left Channel Input.
CD-R	CD Right Channel Input.
CD-GND	CD Input Ground connecting
MIC1-R	MIC1 Right Channel Input.
MIC1-L	MIC1 Left Channel Input.
LINE_IN_L	LINE Left Channel Input.
LINE_IN_R	LINE Right Channel Input.
MONO_OUT	MONO Output.
LINE_OUT_L	LINE Left Channel Output.
LINE_OUT_R	LINE Right Channel Output.
AUX_OUT_L	AUX Output.
AUX_OUT_R	AUX Output.
AUX_OUT_C	AUX Output.
LFE	Low Frequency Output.
VIDEO_L	VIDEO Left Channel Output.
VIDEO_R	VIDEO Right Channel Output.

Table 1: AC97 V2.3 IC Pin List



The Measurement and Analysis of the AC97

There are many Audio Cards that can support AC97 in the market. Furthermore ,many new functions were added to AC97, it means some part of IC pins are different from the original AC97 pins definition and specification. Therefore , it is necessary to find the AC-Link Signal Pins first then start analyzing signals . We take a measurement of Realtek's ALC5611. It is a AC97 Audio CODEC + Touch Panel Controller which is pushed out by Realtek. Firstly,. Secondly, connect the pins (RESET#, BIT_CLK, SYNC, SDATA_IN and SDATA_OUT) of the AC-Link Signal of the ALC5611 to ZeroPlus Logic Analyzer (See *Figure 1*).

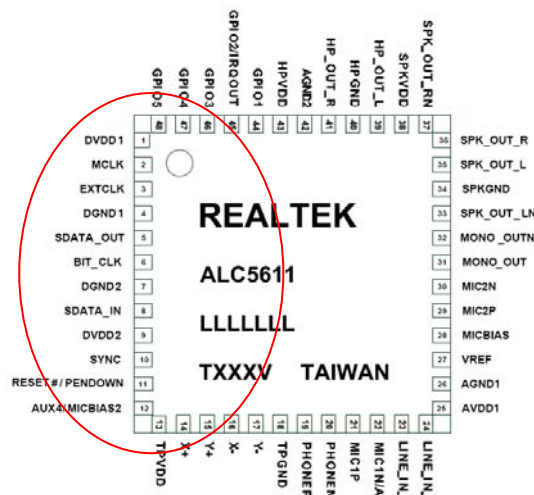


Figure1: ALC 5611 Pin Diagram (From Realtek ALC5611 DataSheet1.1)

Refer to *Figure1*, ALC 5611 Pin Diagram: connect the RESET# (Pin 11) to the A3 of Logic Analyzer; connect the BIT_CLK (Pin 6) to the A1 of Logic Analyzer; connect the SYNC (Pin 10) to the A0 of Logic Analyzer; connect the SDATA_IN/ SDATA_OUT (Pin8/ Pin5) to the A2 of Logic Analyzer. The SDATA_IN and SDATA_OUT of Protocol Analyzer AC97 Analysis Module of ZeroPlus Logic Analyzer are alternative. If users want to analyze the SDATA_IN and SDATA_OUT at the same time, they need to set two groups of Protocol Analyzer AC97 Analysis Module.

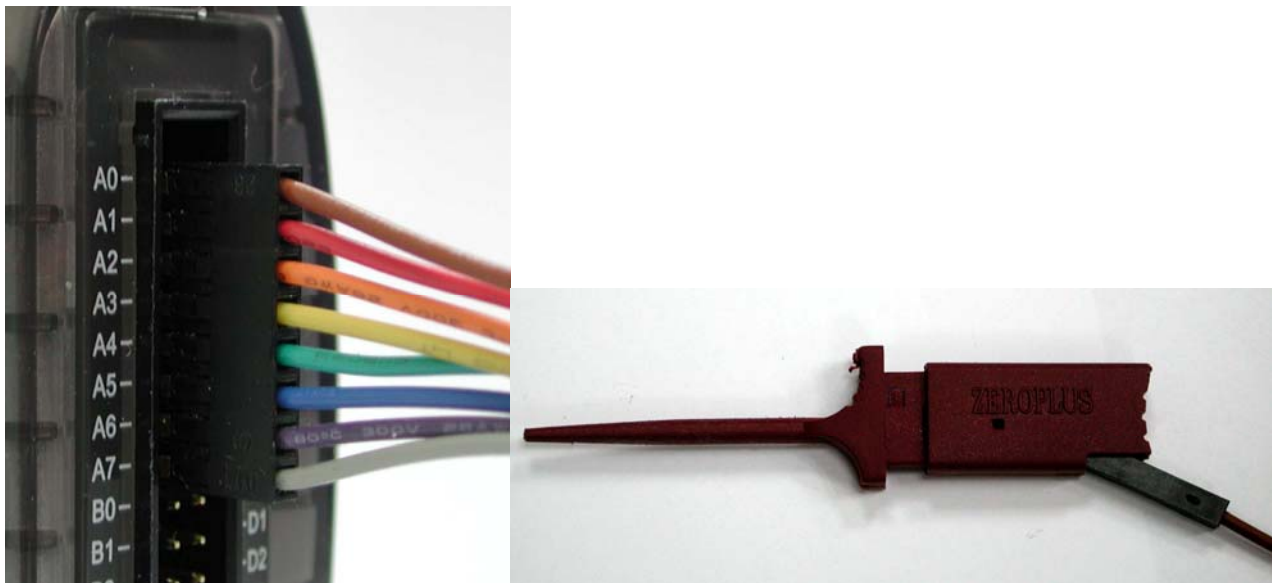
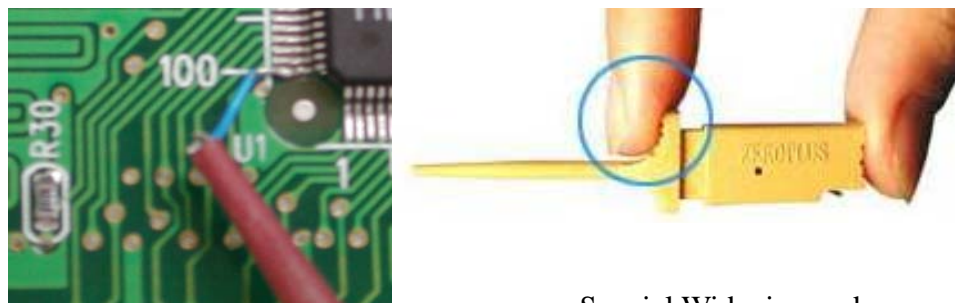


Figure 2: ZeroPlus Logic Analyzer and Probe

When using the ZeroPlus Logic Analyzer to measure the signal, if there has on Pin on the test point of the tested board, users can draw out the test point by connecting with the cable, then use the attached test probe to connect with the tested board.



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Figure 3: The Probe of ZeroPlus Logic Analyzer

Tip: The test lines and test probes of ZeroPlus Logic Analyzer are distinguished by eight different colors (brown, red, orange, yellow, green, blue, purple and gray). And they are ranged by matching with the color code of the resistor from low to high, which is convenient for users to distinguish.www.zeroplus.com.tw



After completing connecting with the tested board, open the Software of Logic Analyzer of ZeroPlus Technology to start analyzing signals (To know the detailed operation of the Software, please refer to the Software Instruction or visit our website:www.zeroplus.com.tw).

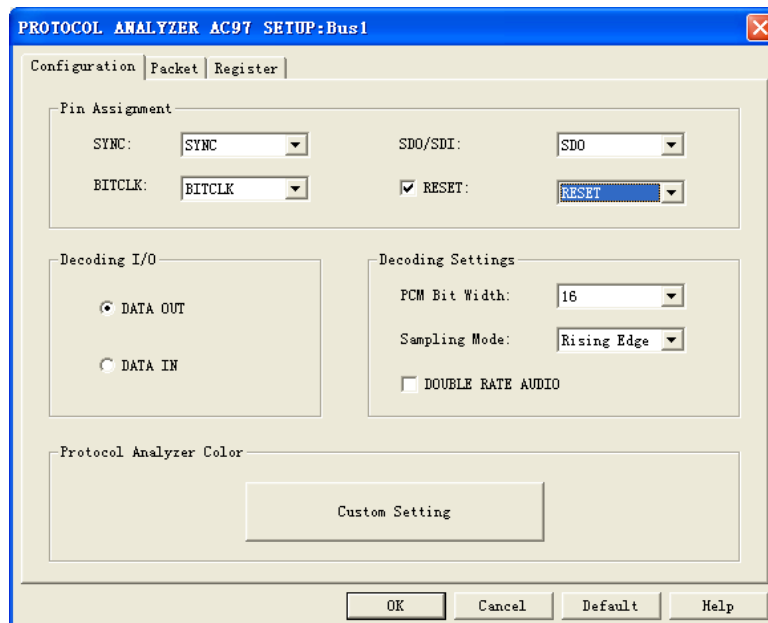


Figure 3: The Configuration Interface of Protocol Analyzer AC97 Analysis Module of ZeroPlus Technology

Set the Protocol Analyzer AC97 Analysis Module according to the AC97 Signal Format, and clicking OK.

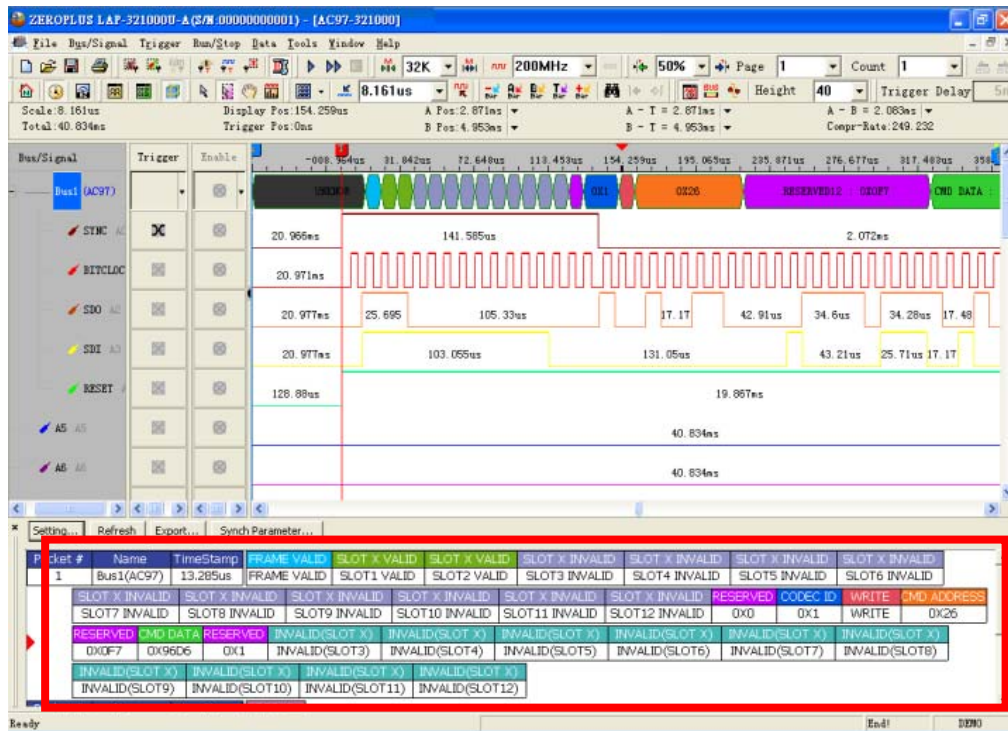
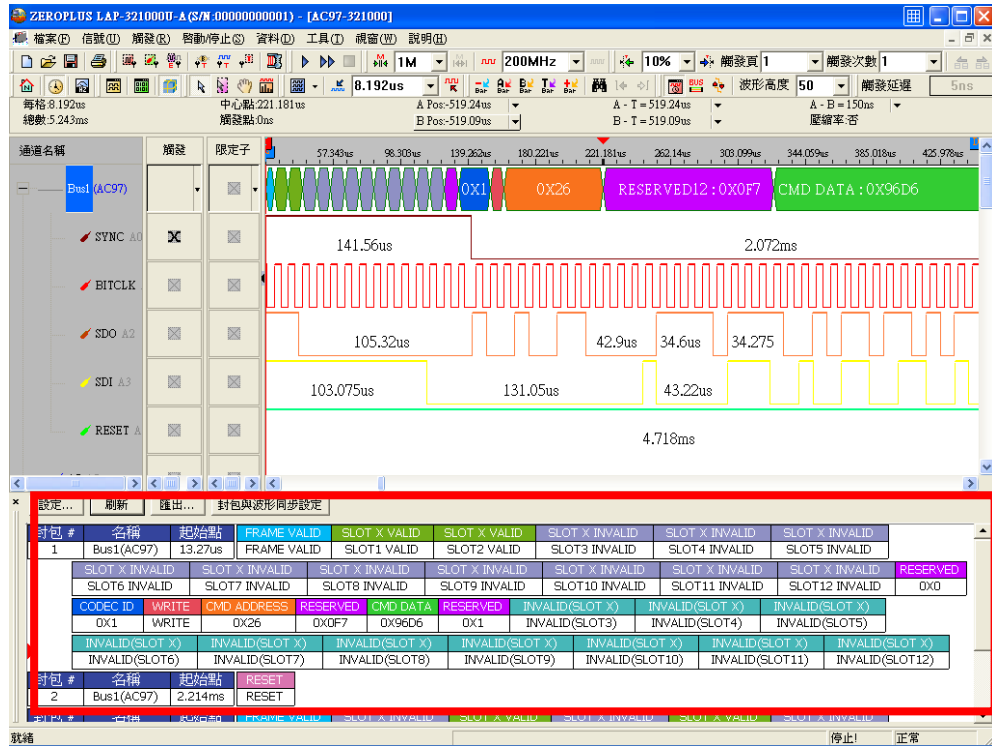



Figure 4: AC97 Decoding Image



Tip: When using the Protocol Analyzer to analyze the signal, users can click the  to display the packet list which will show the packet of the Protocol Analyzer with the column mode at the bottom of the software window (Refer to the marked area of the Figure 4).

Decoding: Instructions of AC97 Protocol:

SYNC: connecte to AC97 SYNC Signal.

BITCLK: connect to AC97 BIT_CLK Signal.

Remark: The SYNC and BIT_CLK are used to display the position of the packet segment of AC97.

SDO/SDI: Connect to AC97 SDATA_IN or SDATA_OUT. Two groups of Protocol Analyzer AC97

If users want to analyze SDATA_IN and SDATA_OUT at the same time , just set 2 buses .

RESET: Connect to AC97 RESET# Signal.

DOUBLE RATE AUDIO: It can do the PCM_R, PCM_L and PCM_C analysis

Data Introduction of the Digital Input/ Output of the AC-LINK:

There are 13 Data Slots for the AC-LINK for the Data Input/ Data Output, which are used to specify the Data Format for the Input/ Output. The Data Slots are different according to the difference of the Input and Output, which are described as the below tables (Refer to *Table 2* and *Table 3*).




Slot	Name	Function
0	SDATA_OUT_TAG	Protocol of the AC97 Codec is effective.
1	CMD_ADDR	Command of AC97 Communication
2	CMD_DATA	Data of Communication.
3	PCM_L_FRONT	PCM L FRONT 16, 18, 20bit Data
4	PCM_R_FRONT	PCM R FRONT 16, 18, 20bit Data
5	LINE_1_DAC	Modem Line 1 Data Input
6	PCM_L / Double rate audio	PCM L 16, 18, 20bit Data Output/ Control the Double Rate Audio to 88.2KHz or 96KHz
7	PCM_R / Double rate audio	PCM R 16, 18, 20bit Data Output/ Control the Double Rate Audio to 88.2KHz or 96KHz
8	PCM_C / Double rate audio	PCM C 16, 18, 20bit Data Output/ Control the Double Rate Audio to 88.2KHz or 96KHz
9	PCM_S / Double rate audio	PCM S 16, 18, 20bit Data Output/ Control the Double Rate Audio to 88.2KHz or 96KHz.
10	Modem Line DAC / Double rate audio / SPDIF OUT	16 bit Modem Line Data Output/ Control the Double Rate Audio to 88.2KHz or 96KHz/ SPDIF Output
11	Modem Handset DAC / Double rate audio/ SPDIF OUT	16bit Modem Handset Data Output/ Control the Double Rate Audio to 88.2KHz or 96KHz/ SPDIF Output
12	Modem IO CTRL / Double rate audio	Modem IO CTRL/ Control the Double Rate Audio to 88.2KHz or 96KHz

Table 2: AC-LINK Data Output Slot



Slot	Name	Function
0	SDATA_OUT_TAG	AC97 Codec Option Protocol.
1	CMD ADDR	AC97 Codec Command Status.
2	CMD DATA	AC97 Codec Data Status.
3	PCM L Record	16, 18 and 20bit are inputted by the PCM L Data.
4	PCM R Record	16, 18 and 20bit are inputted by the PCM R Data.
5	LINE 1 ADC	16bit Modem Line1 Data Input
6	Dedicated Microphone ADC	16, 18 and 20bit PCM Data are inputted by the Fiber Data.
7	Reserved	Reserved
8	Reserved	Reserved
9	Reserved	Reserved
10	Modem ADC	16bit Modem Handset Data Output.
11	Modem handset Input ADC	Modem Handset ADC Input Data.
12	Modem IO status	Modem Input Status.

Table 3: AC-LINK Data Input Slot

Zeroplus Logic Analyzer can analysis the Protocol Analyzer Module to decode different serial signals. For example that AC-LINK Signals are serial signals, so the RAM Size will be very important when using the Logic Analyzer. Thus , Zeroplus Technology provides the patent technology of Compression to deal with the problem; it can increase the allowed time length of present RAM Size according to the special compression algorithms. Users only need to press the  on the software window to activate the Compression function. The Figure 5 and Figure 6 are the time display for the “Before Compression” and “After Compression”.

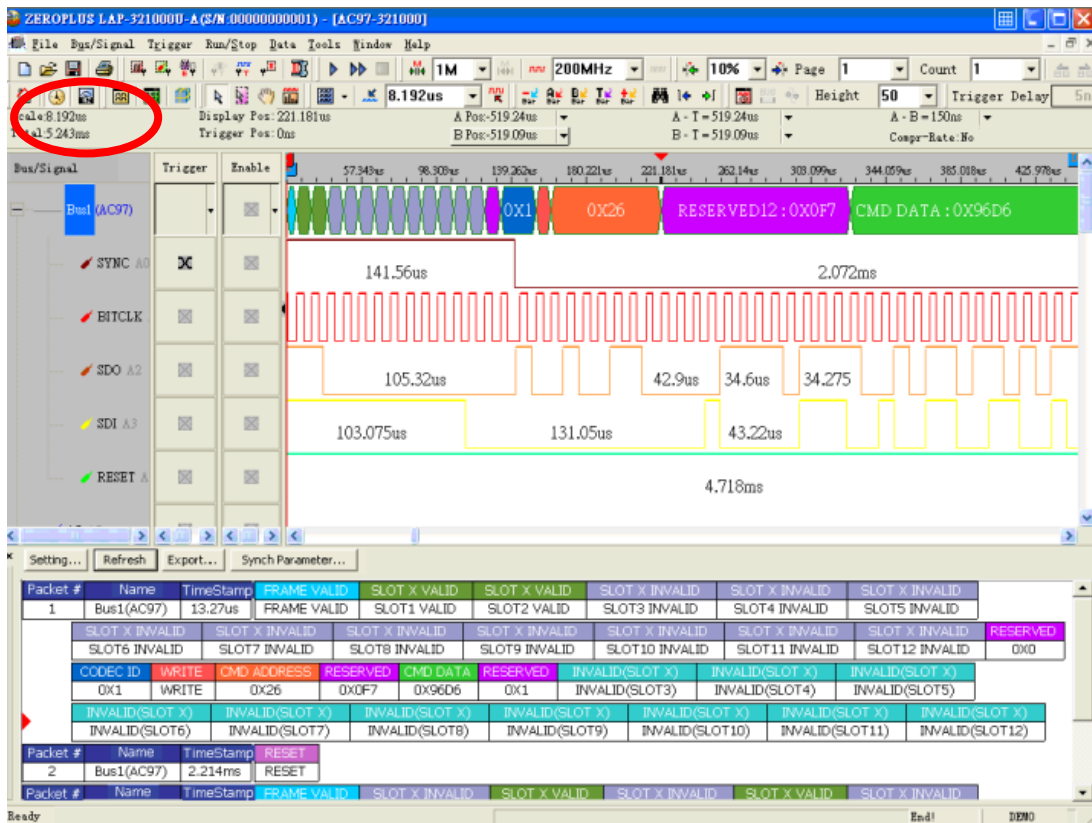
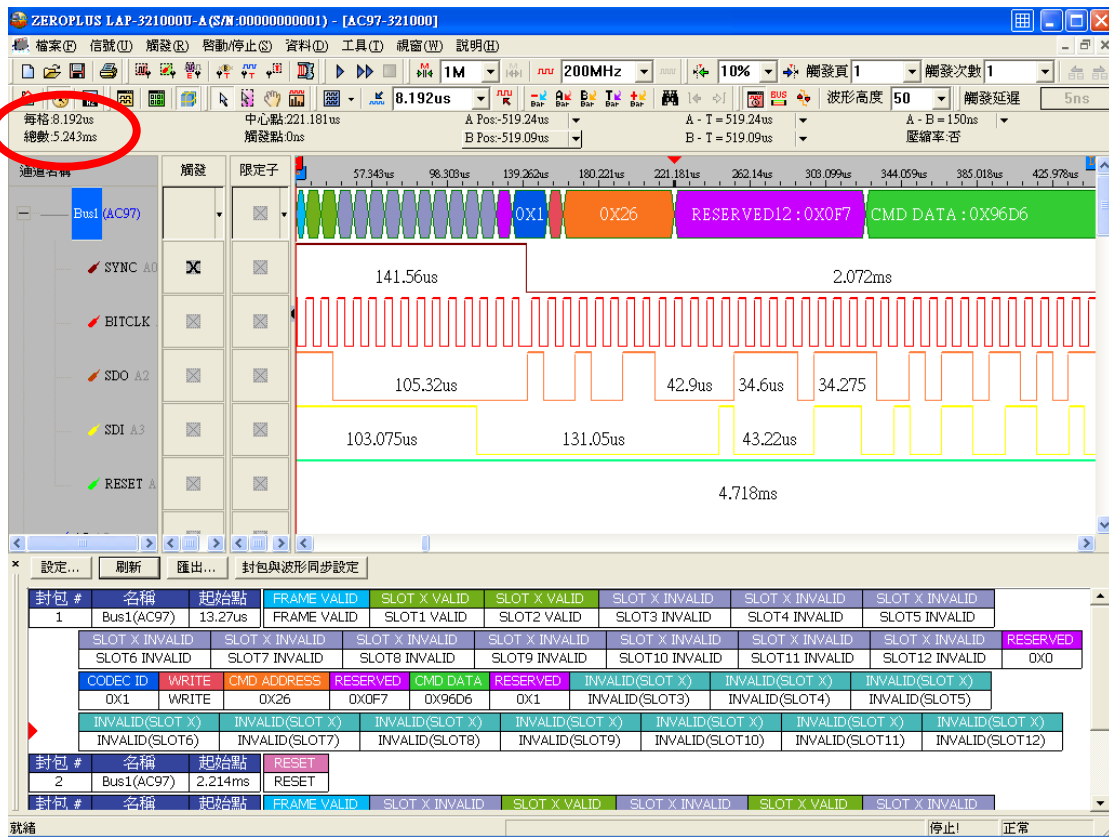


Figure 5: Waveform before Activating the Compression (The total time length is 5.243ms)

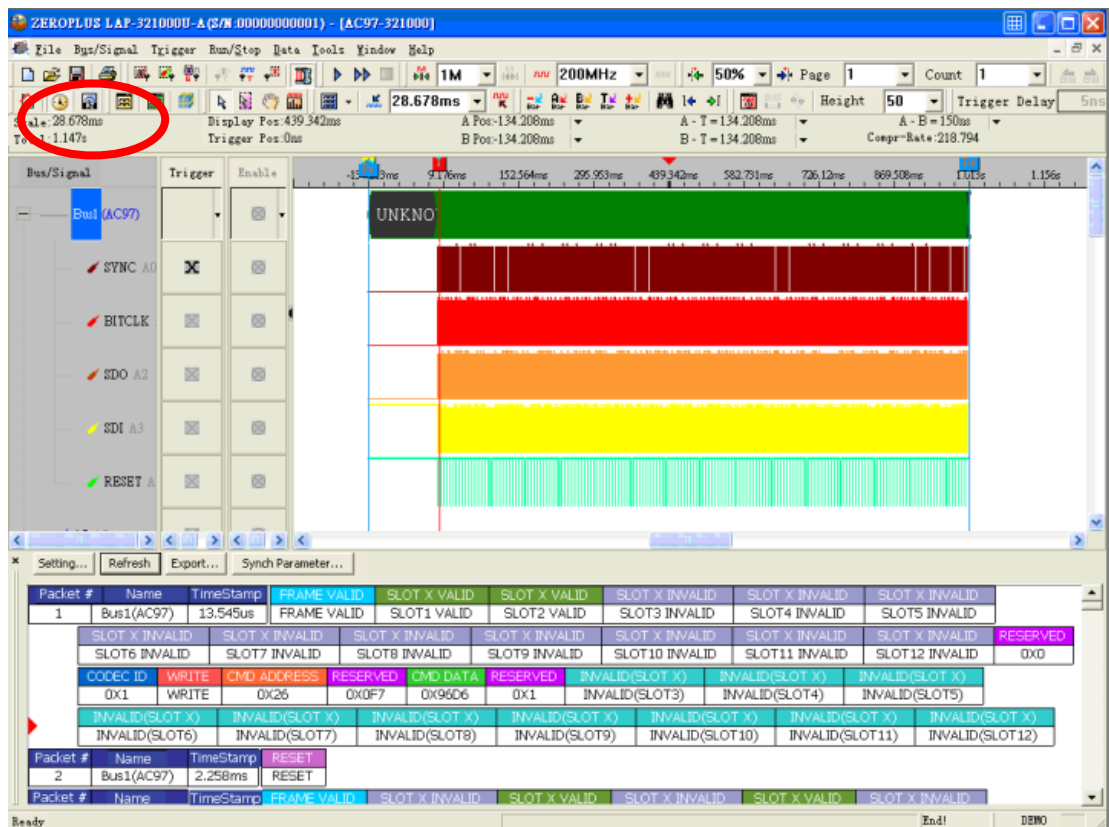
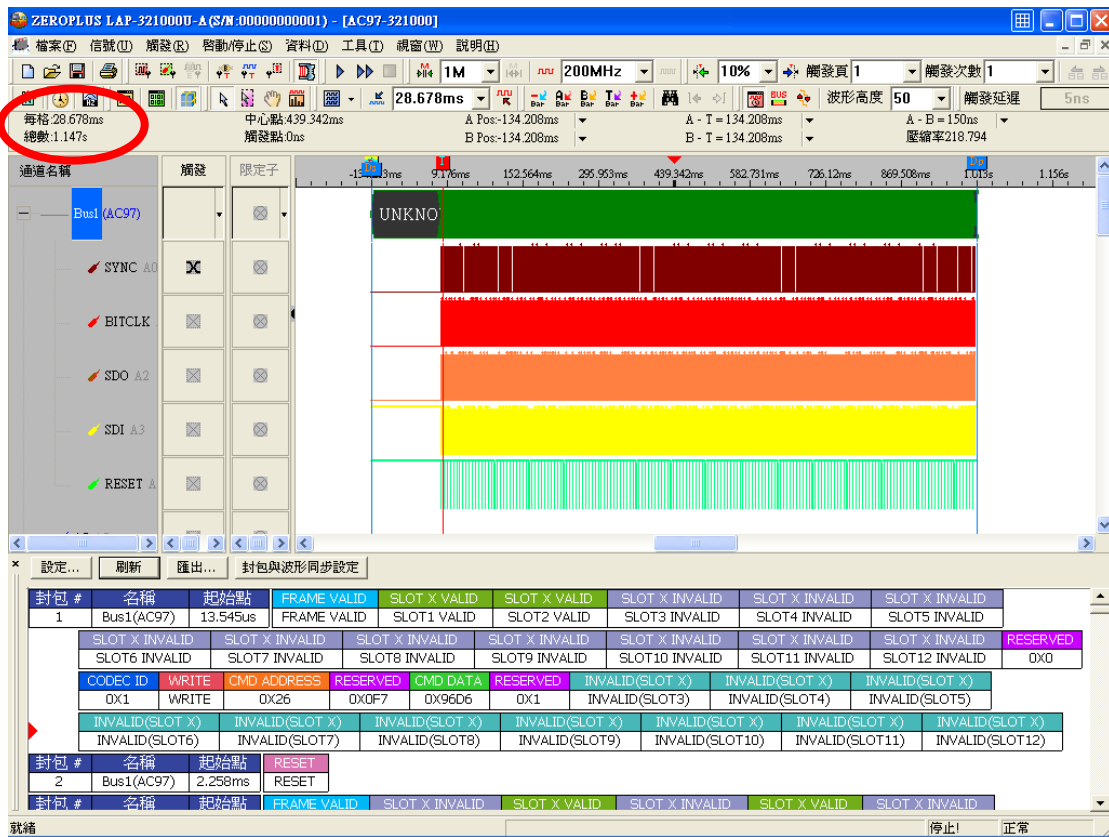


Figure 5: Waveform after Activating the Compression (The total time length is 1.147s)



According to the comparison between Figure 5 and Figure 6, it is clear to see that the stored time length of the waveform is greatly improved after using the Compression function.



Conclusion:

Today, Digital Signal and Protocols are widely use in different electronic products and technical area. From mobile phone, PC, multimedia,automotive to RF and so on, all the use trends are testing the analysis ability of engineers who have to deal with the Digital Signal for developing or testing and debugging. It is very hard to analyze the Digital Signal when engineers only use the oscilloscope. However, matching with ZEROPLUS Logic Analyzer can improve the efficiency of development greatly. ZeroPlus Logic Analyzer has launched over 55 Protocol Analyzer Modules and Patent Technologies for different technical areas. For more detailed introduction about ZeroPlus Logic Analyzer, please visit our website: www.zeroplus.com.tw.

Reference:

AC97_R23.PDF from www.intel.com

ALC5611_DATASHEET_1.1.PDF from www.realtek.com.tw

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