Oscilloscope CAN XL Protocol Introduction and Decoding Test

SIGLENT TECHNOLOGIES CO.,LTD

Copyright and Statement

Trademark Information

SIGLENT is a registered trademark of SIGLENT TECHNOLOGY CO., LTD.

Statement

· Our products are protected by approved and pending patents of the People's Republic of China

· Our company reserves the right to change specifications and prices

· The information provided in this manual supersedes all previously published materials

· The contents of this manual may not be copied, excerpted, or translated in any form or by any means without the consent of our company

Product Certification

SIGLENT certifies that this product complies with China's national product standards and industry product standards, and further certifies that this product complies with the relevant standards of other members of international standards organizations.

Contact Us

Service Hotline: 400-878-0807

E-mail: support@siglent.com

Website: https://www.siglent.com

1 Introduction

As data communication in automotive and industrial applications grows, the traditional CAN protocol can no longer meet the higher data rate requirements. The traditional CAN protocol has limitations in data rate and bus load capacity, making it difficult to meet high-bandwidth and high-real-time application scenarios. To address this, CAN XL (Controller Area Network eXtended Large), the third-generation CAN protocol, emerges. CAN XL achieves a data transmission rate of up to 20 Mbit/s at the physical layer, and the single frame data length is extended to a 2048 byte data field, significantly improving communication efficiency. Mapping Ethernet frames to CAN XL frames and integrating them into the Ethernet environment can adapt to higher data transmission rates and more complex application scenarios.

2 CAN XL protocol

Since its introduction in 1986, the CAN protocol has been widely used in the automotive industry, and has gradually evolved into three generations of protocols: CAN 2.0, CAN FD and CAN XL. According to the ISO OSI layer model, CAN applications usually cover the physical layer, data link layer and application layer. Figure 1 shows the typical architecture of the bottom layer of the CAN protocol. The PMA layer converts the logical signal into the physical level CAN_H and CAN_L signals, and passes them to the PMD sublayer through the MDI interface. The PMD sublayer completes the actual driving and receiving on the physical medium.

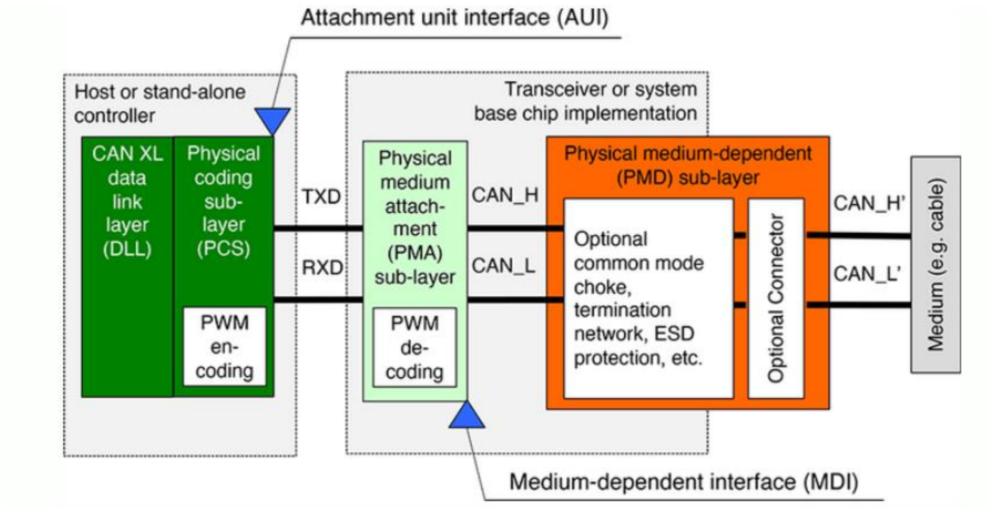


Figure 1 CAN Protocol Underlying Implementation

Different from CAN/CAN FD, the CAN XL protocol adds PWM encoding/decoding in the PCS and PMA sublayers, switches the bus driving mode of the PMA sublayer from explicit/implicit and level 0/evel1, achieves an increase in the data segment rate, and is compatible with the NRZ encoding of traditional CAN protocol. It is the core technology for physically realizing high-speed data transmission and dynamic mode switching.

2.1 CAN XL Operating Mode

The CAN frame consists of three main phases, including the Arbitration Phase, the Data Phase, and the Arbitration Phase. Each phase contains different fields to implement bus arbitration, data transmission, and error checking. The CAN controller is used at the protocol layer to convert messages into CAN frames that comply with the CAN specification, and sends them in the form of binary code streams to implement the CAN bus protocol bottom layer and data link layer, defining communication rules and rate limits. The CAN transceiver is used to convert logic levels into differential levels, which are applied to the physical layer of the CAN bus. Different transceivers determine the actual transmission capacity of the physical signal.

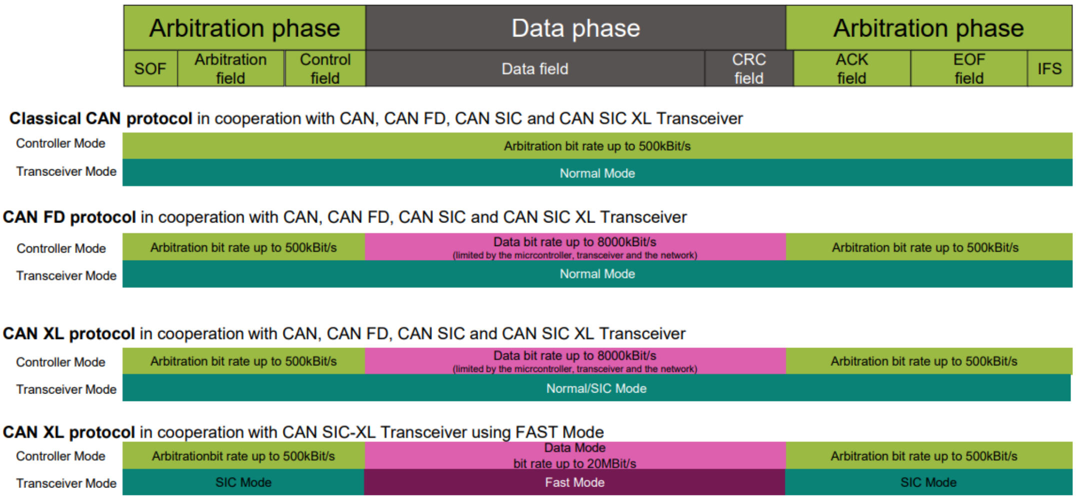


Figure 2 Comparison of CAN/CAN FD/CAN XL signal rates and transmission modes

Specifically, the CAN signal data rate in the arbitration phase is allowed to reach 500kbit/s in controller mode, while the data segment rate in the CAN FD protocol signal is as high as 8Mbit/s, and the CAN SIC-XL fast mode transceiver in the CAN XL protocol signal achieves a data rate of 20Mbit/s.

The transceiver operating mode of CAN and CAN FD signals is normal, and the driving level is dominant level and recessive level. The standard operating mode of CAN XL signals is SIC mode, and the driving level is also dominant level and recessive level, which is used in arbitration phase and data phase. The SIC XL controller can switch the transceiver to Fast mode in the data phase, at which time Level_0/Level_1 is used as the driving level, and the output will be an alternating differential signal, which effectively reduces reflections and signal distortion.

2.1.1 CAN XL frame structure

The following introduces the main components of the CAN XL frame. In the arbitration phase,includes Priority ID, XL, and ADS. Priority ID is 11 bits in total, which is a bus arbitration priority identifier used to process priority; XL contains multiple bits, and the invisible level identifies the CAN XL frame to distinguish CAN/CAN FD; ADS moves from the arbitration phase to the data phase, which contains 4 fixed bits, and enters the fast stage after the ADH bit.

The data phase contains the control field, the data field, and the CRC field. SDT is an 8-bit protocol type

identifier, indicating the data segment encapsulation type; SEC is 1 bit, indicating whether it is encrypted data; DLC is 11 bits, defining the data segment length; SBC is 3 bits, which is a dynamic fill bit count; PCRC is 13 bits, used to verify the integrity of the arbitration phase and control phase data; VCID is 8 bits, a virtual CAN channel identifier, similar to VLAN in Ethernet; AF is 32 bits, used for addressing fields; Data bytes has 1~2048 bytes, and the transmission rate is 10M or higher; FCRC is 32 bits, used for data verification.
In the arbitration phase, it includes the response field and the end field. DAS is converted from data phase to arbitration phase, which contains 4 fixed bits; ACK has 6 bits, the dominant the dominant level indicates confirmation of receipt of the data frame; EOF has 7 bits, which indicates the end of the frame. The figure below clearly shows the field structure of each part of the CANXL frame.

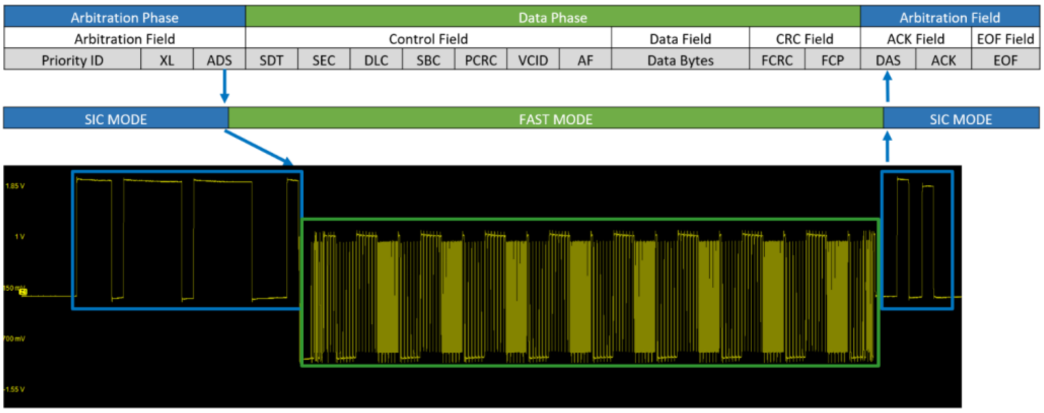


Figure 3 CAN XL frame structure

Oscilloscope measurement

SIGLENT SDS7000A oscilloscope decoding analysis function applies software algorithms to extract serial data information from the physical layer waveform, quickly test and decode signals, and display information frames. Let's use the oscilloscope to decode CAN XL.
Click Decode in the analysis, and you can select the decoding type as CAN, CAN FD or CAN XL in the bus protocol, and select CAN XL. You can select the source in the protocol signal, means the source will be decoded. The source can be selected as C1, C2 or MATH. For example, C1 is the original CAN_H signal, and C2 is the CAN_L signal. Then open MATH and set the function to F1, select C1-C2 to represent the signal after differential processing.

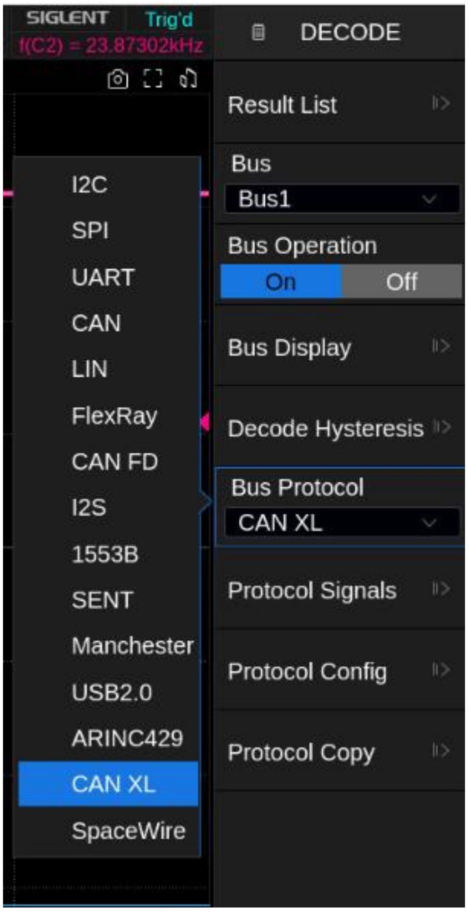


Figure 4 Entering CAN XL decoding

Decoding the Fast Data Signals of CAN XL.

As shown in Figure 5, the signal tested and decoded at this time is the Fast signal of source 1. Enter the protocol signal interface, set the SIC threshold to 1.12V; the Fast threshold to -540mV, and the threshold level needs to be set within the vertical level range of the SIC and Fast signals respectively.

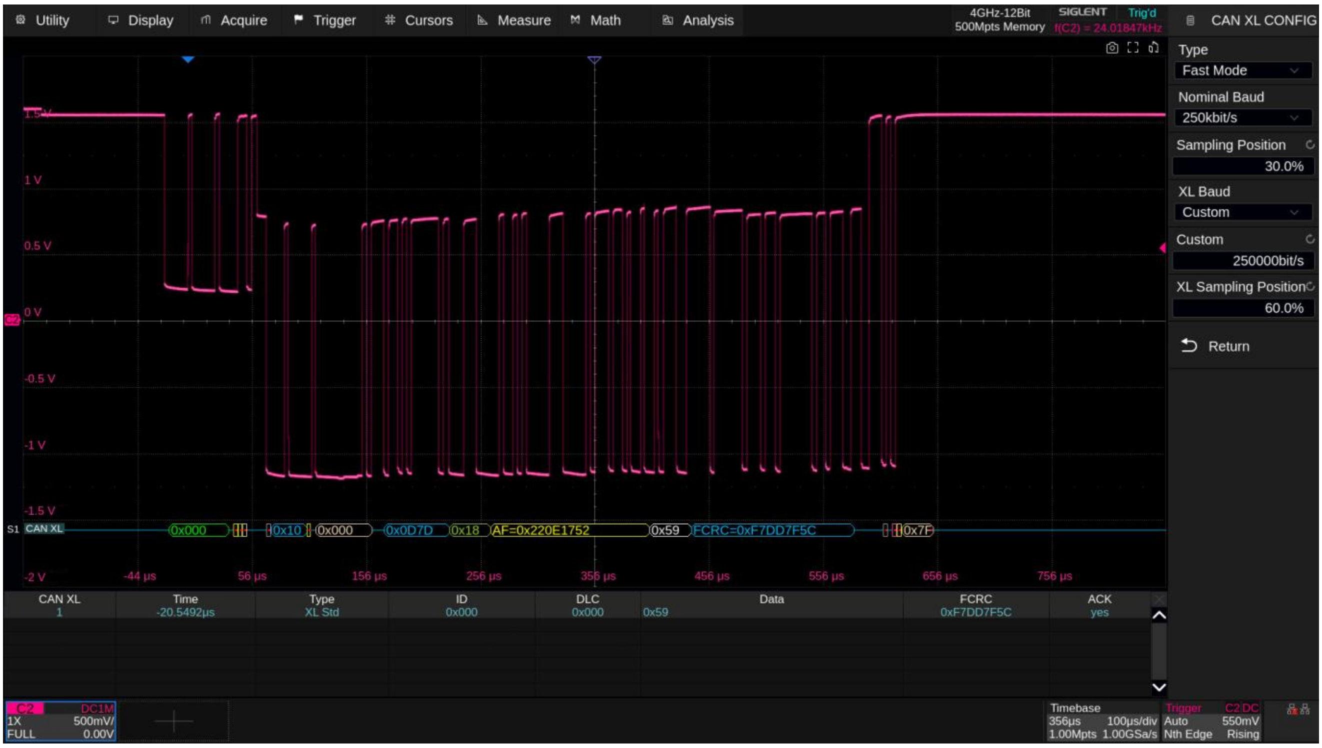


Figure 5 Protocol signal settings for CAN XL Fast mode

Enter the protocol configuration interface, select the type as Fast mode, set the standard baud rate to 250kbit/s, and set the XL standard baud rate to a custom 250kbit/s. The baud rate is determined by the characteristics of the signal itself. The sampling position represents the percentage of the current sampling point position in the total bit in a bit. Set the sampling position to the default.

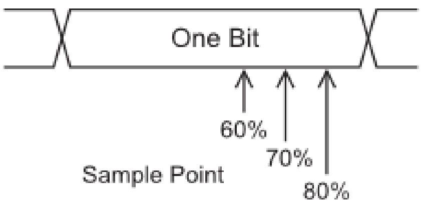


Figure 6 Sampling position diagram

After the configuration is completed, the signal will be successfully decoded, and bus 1 will be displayed in the decoding list. The decoding result of the signal can be seen at the bottom of the screen in Figure 7, including ID, DLC, SDT, PCRD, VCID, AF, data, FCRC and other information.

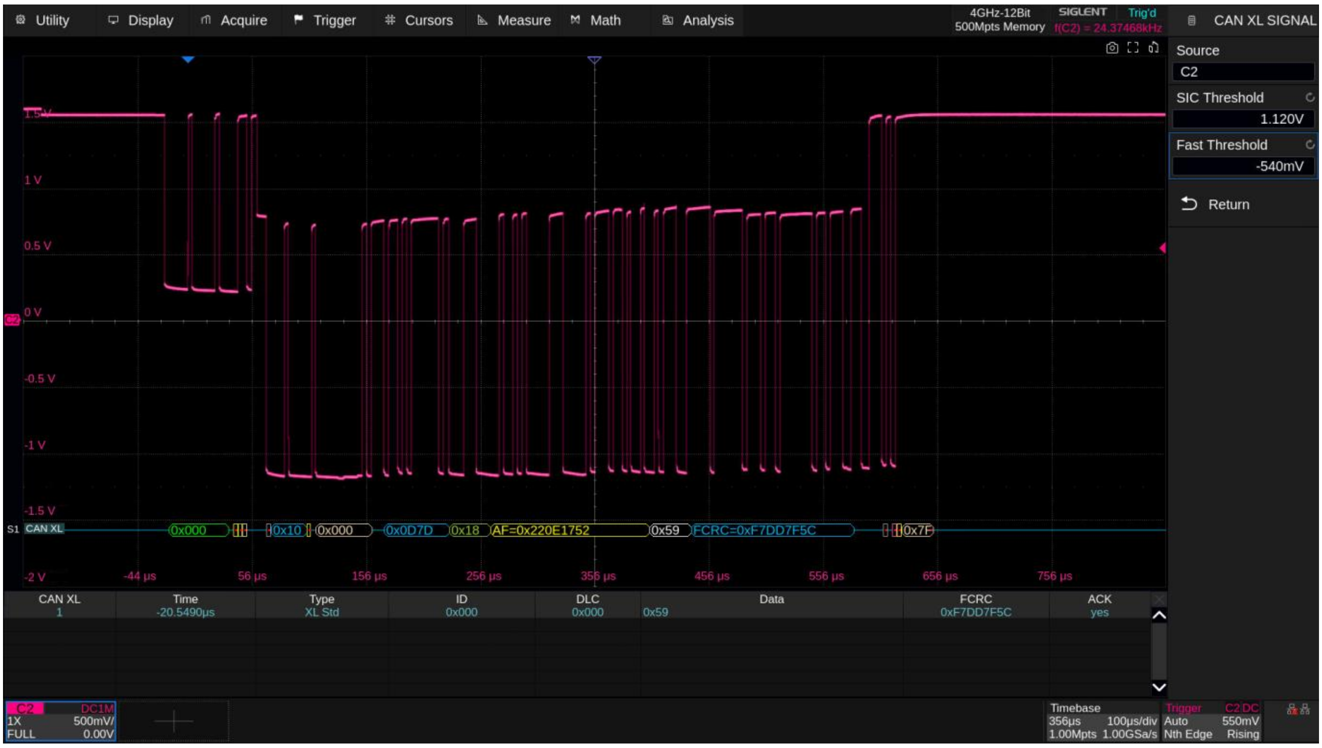
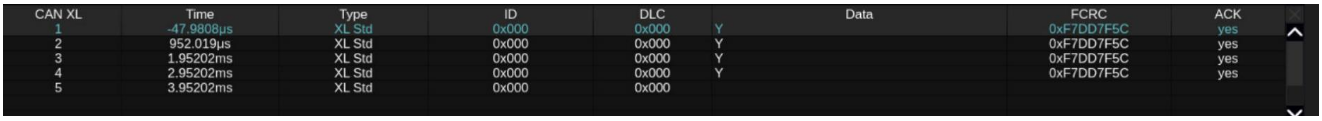


Figure 7　CAN XL Fast Mode Protocol singal Settings



CAN XL	Time	Type	ID	DLC		Data	FCRC	ACK
1	-47.9808µs	XL Std	0x000	0x000	Y		0xF7DD7F5C	yes
2	952.019µs	XL Std	0x000	0x000	Y		0xF7DD7F5C	yes
3	1.95202ms	XL Std	0x000	0x000	Y		0xF7DD7F5C	yes
4	2.95202ms	XL Std	0x000	0x000	Y		0xF7DD7F5C	yes
5	3.95202ms	XL Std	0x000	0x000				

Figure 8　Decoding multiple frames of CANXL list display

If one screen decodes multiple waveform frames, opening the list display of bus 1 will display the results of multi frame decoding.

Decoding the SIC part of the CAN XL signal

Similarly, input a SIC signal to the oscilloscope. In the protocol signal, set the signal source to C1. Set the SIC threshold within the vertical level range. This waveform does not have the Fast part, so the Fast threshold does not need to be set.

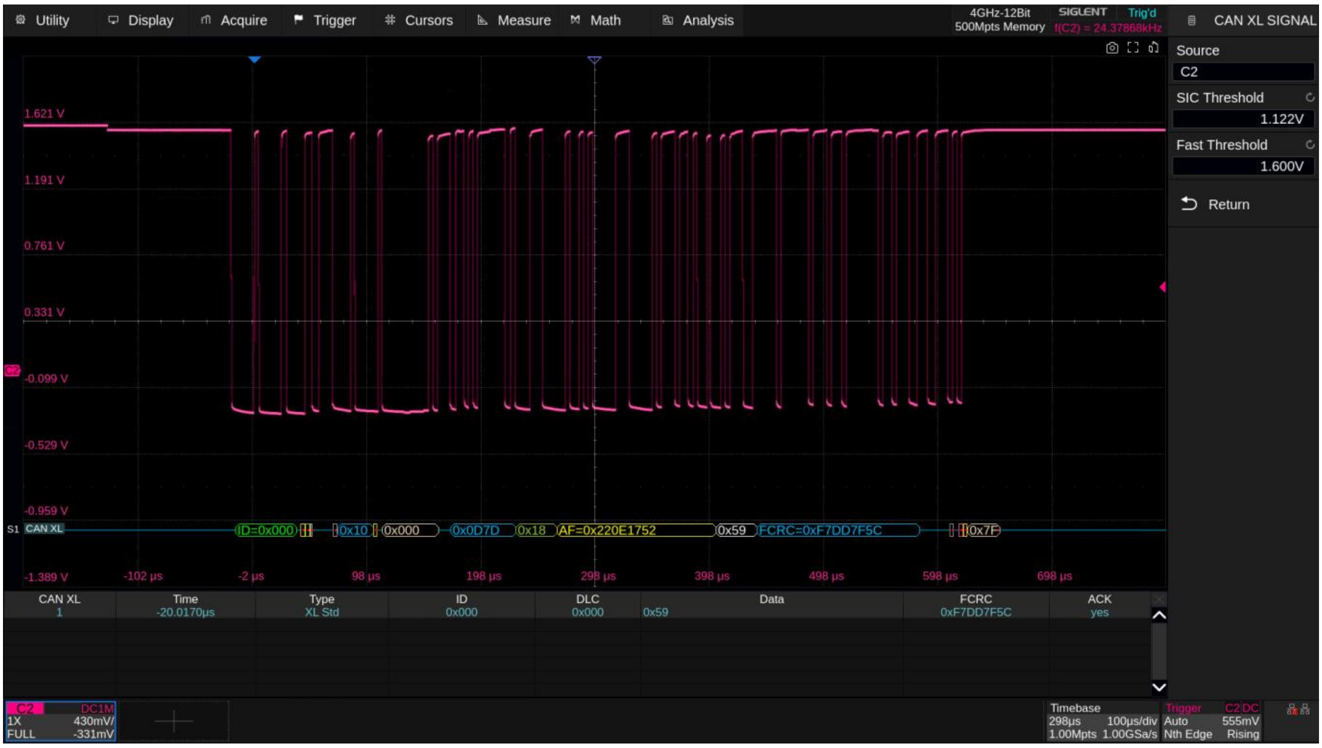


Figure 9 CAN XL SIC Mode Protocol Signal Setting

Enter the protocol configuration, select the type as SIC mode, configure the baud rate according to the specific waveform type. Set the standard baud rate to 250kbit/s, XL to the custom 250kbit/s, and set the sampling position to default. As shown in the figure 10 below, the decoding results are displayed on the screen below.

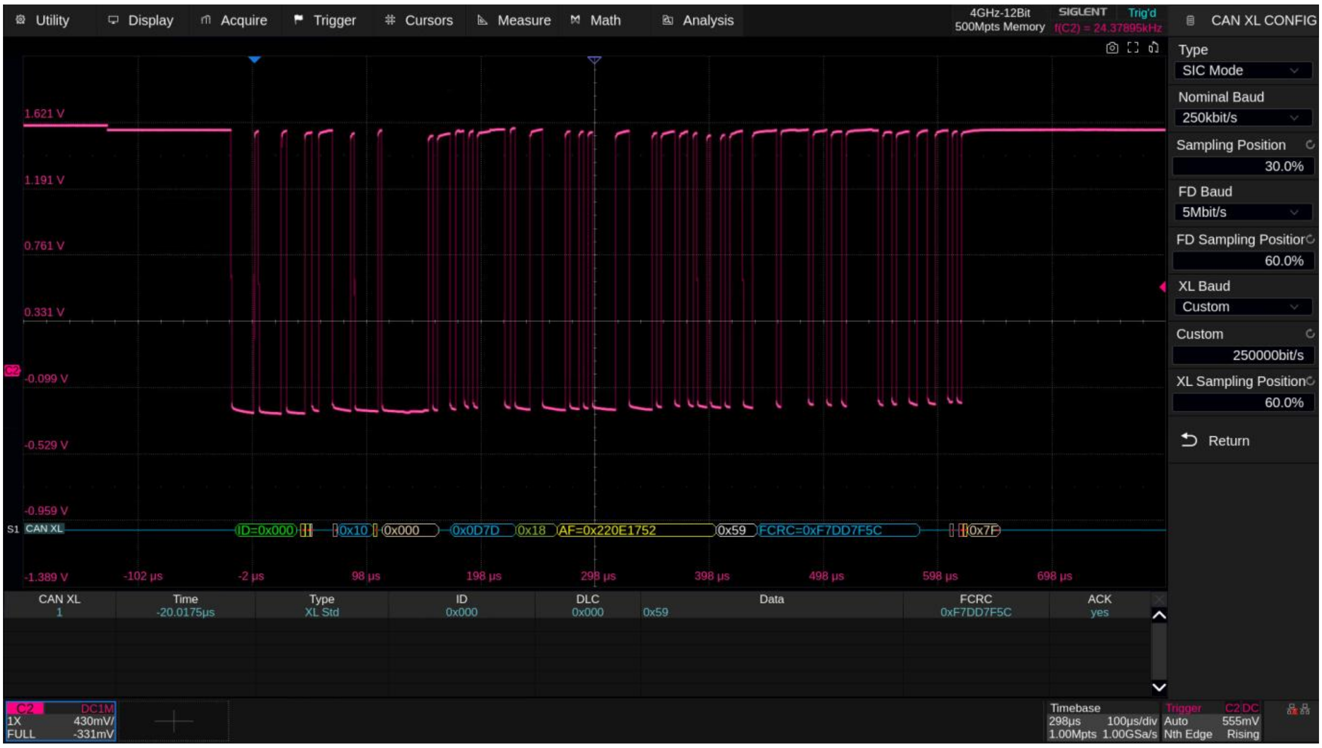


Figure 10 CAN XL SIC Mode Protocol Configuration Settings

4 summary

CAN XL is the latest generation of CAN technology. Its SIC/FAST dual-mode separation technology achieves high-speed and stable transmission in the data stage, meeting the needs of modern automotive electronics and industrial automation for high speed and high capacity data transmission. At the same time, for the testing of CAN XL signals, SDS7000A can fully sample the waveform details of high-speed signals at a sampling rate of 20GSa/s, and the decoding function clearly displays the signal frame, helping engineers to accurately locate problems, debug systems and optimize network performance. It is a key tool for CAN XL network development and maintenance.

About SIGLENT

SIGLENT is an international high-tech company, concentrating on R&D, sales, production and services of electronic test & measurement instruments.

SIGLENT first began developing digital oscilloscopes independently in 2002. After more than a decade of continuous development, SIGLENT has extended its product line to include digital oscilloscopes, isolated handheld oscilloscopes, function/arbitrary waveform generators, RF/MW signal generators, spectrum analyzers, vector network analyzers, digital multimeters, DC power supplies, electronic loads and other general purpose test instrumentation. Since its first oscilloscope was launched in 2005, SIGLENT has become the fastest growing manufacturer of digital oscilloscopes. We firmly believe that today SIGLENT is the best value in electronic test & measurement.

Headquarters:

- SIGLENT Technologies Co., Ltd
- Add: Bldg No.4 & No.5, Antongda Industrial Zone, 3rd Liuxian Road, Bao'an District, Shenzhen, 518101, China
- Tel: + 86 755 3688 7876
- Fax: + 86 755 3359 1582
- Email: sales@siglent.com
- Website: int.siglent.com

North America:

- SIGLENT Technologies America, Inc
- 6557 Cochran Rd Solon, Ohio 44139
- Tel: 440-398-5800
- Toll Free: 877-515-5551
- Fax: 440-399-1211
- Email: info@siglentna.com
- Website: www.siglentna.com

Europe:

- SIGLENT Technologies Germany GmbH

Follow us on
Facebook: SiglentTech