

Research on MVB conformance test system

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Abstract. The design and implementation of the MVB conformance test system is of great significance in both professional theory and practical application. Conformance test for MVB, mainly to determine whether the MVB equipment IUT is consistent with the MVB protocol standard requirements in the TCN standard. The conformance test of MVB equipment IUT covers most of the contents of the RTP real-time protocol such as the physical layer, link layer, network layer, transport layer and application layer. This subject will analyse and study the consistency test of the MVB physical layer.

Keywords: MVB, Conformance test, TCN.

1 Introduction

With the widespread application of TCN networks in the field of domestic rail transit, many equipment manufacturers design and produce communication equipment in accordance with relevant standards. In order to achieve interoperability of equipment produced by different manufacturers, communication network equipment must be completely consistent with the standard requirements [1]. Conformance testing can ensure the consistency of a tested device with the requirements of the standard, and provides the necessary guarantee for interoperability between devices. Conformance testing can also verify which aspects of a device does not meet the requirements of the corresponding standard, which is helpful for the improvement of device design. In 2020, my country issued the GB/T28029 series of standards for TCN, in which GB/T28029.10-2020 [2] describes the MVB conformance test.

2 MVB (Multifunction Vehicle Bus)

TCN (Train Communication Network) train communication network as a kind of field bus applied to the special occasion of train control, is widely used in the field of rail transit. The TCN train communication network coordinates the work of various vehicles and equipment to ensure safe, stable and comfortable train operation. The generation and development of TCN is of great significance to the railway and urban rail transit communication network. During the operation of the train, there will be a lot of information about the working status

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of the on-board equipment, fault records and operation control. The TCN train communication network makes this information safe and fast. And efficient transmission and exchange between various on-board equipment. The TCN train communication network consists of two layers of buses, namely Wire Train Vehicle (WTB) and Multifunction Vehicle Bus (MVB). MVB is applied to the communication network of carriages or fixed formations, and is currently widely used in urban rail transit [3].

According to the provisions of the TCN standard, the MVB bus can use three different physical media and drive methods, namely, ESD (Electrical Short Distance Medium) without electrical isolation, and EMD (Electrical Middle-Distance Medium) with isolation, long-distance optical medium OGF (Optical Glass Fibre medium), the data transmission speed is 1.5Mbps. At present, EMD is widely used in the field of urban rail transit.

The data transmission in the MVB network adopts the form of unicast or broadcast, and the encoding form adopts Manchester encoding. The negative transition in the middle of the bit means "0", and the positive transition in the middle of the bit means "1". The message on the MVB bus consists of a master frame and a slave frame [4]. The structure of the message is shown in the figure below. The master frame is sent by the bus manager (BA) according to the cycle schedule. The master frame contains 9 bits of the start identifier identification code, 4 bits of F-code code indicating the type and size of the slave frame, 12 bits of the slave device address, and 8 CRC check. Bit, the end identifier is 1 bit. The slave frame contains 9 bits of the start identifier identification code, 16-256 bits of data field and an additional 8-bit check sequence for every 64 bits [5].

3 MVB conformance test

Conformance testing refers to the degree of compliance between the implementation of the test protocol and the protocol specification standards. It is a process that can determine whether a communication device complies with the technical requirements of the standard and demonstrates the performance required by the standard. The standards of communication protocols are usually very complicated, and it is difficult to conduct thorough tests in all aspects. Therefore, conformance testing does not provide thorough tests on every aspect of the standard. Since the conformance test is completed in a controlled environment, in fact, a device that has passed the conformance test cannot theoretically guarantee interoperability with any other device that has passed the conformance test. This is mainly because many other factors that affect the operation of the protocol, such as network load and timeout regulations, will affect the performance of the IUT and have an impact on interoperability. But in fact, the prospects for successful interconnection of devices that have passed the conformance test are indeed improved. The interoperability between devices that have passed the conformance test is relatively easy to achieve. Therefore, the conformance test is necessary for communication devices to achieve interoperability. Condition [6].

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According to IEC61375-3-2, the MVB physical layer conformance test includes resistance test, inductance test, measurement of insertion loss, measurement of signal waveform during transmission (heavy test circuit, light test circuit, idling test circuit and short test circuit), receiver behaviour test threshold 200mV and 500mV.

The resistance test is a pure resistance test for the termination resistance of the A line and B line of the MVB, where the IUT is powered off and the impedance should be 120 Ω range ± 10 %. Inductance testing is to measure the inductance of the device under test

when the IUT is powered off. The maximum permissible phase displacement is 0,087 rad in a frequency range between 0,5 and 2,0 BR. Measurement of insertion loss is to measure the insertion loss of the controller at different frequencies (0,5BR~2,0BR) when the IUT is powered off or in normal operation. The maximum allowable loss is required to be less than 0.15dB. The measurement of signal waveform during transmission is to check whether the output waveform under four circuit situations meets the standard IEC61375-3-2 requirements. The four circuit situations are shown in Figure 1 (Z_t is 120 Ω).

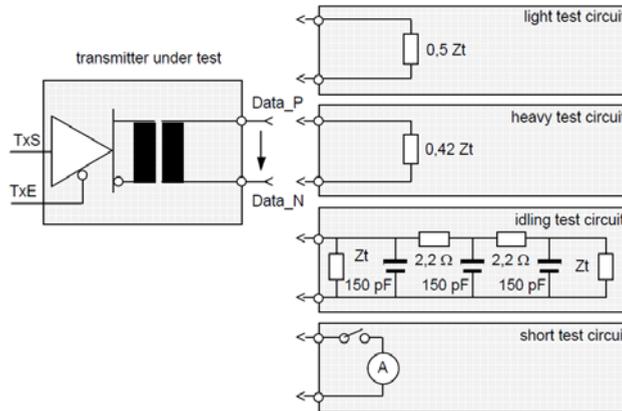


Fig. 1. EMD transmitter test circuits.

4 MVB conformance test system

The MVB conformance test system is composed of two layers, the first layer is to build the MVB network required for testing, and the second layer is the test instrument. The testing equipment adopts micro resistance tester, LCR tester, vector network analyser and oscilloscope. The structure diagram is shown in Figure 2.

First set up the MVB network required for testing. After completing the setup, connect to the test instrument to collect the test information, and then transmit it to the upper computer. The upper computer processes and analyses the data, compares it with the data required by the standard, and judges the data does it reach the requirement.

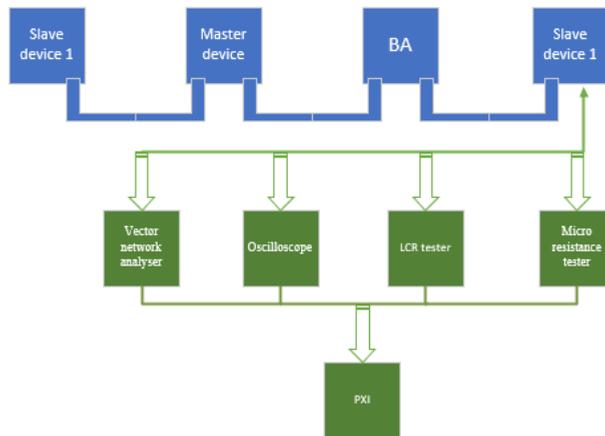


Fig. 2. MVB conformance test system.

5 MVB network for testing

The MVB network required for the test consists of three devices, a master device with BA function and two slave devices, as shown in Figure 3 and Figure 4.



Fig. 3. Slave device 2.

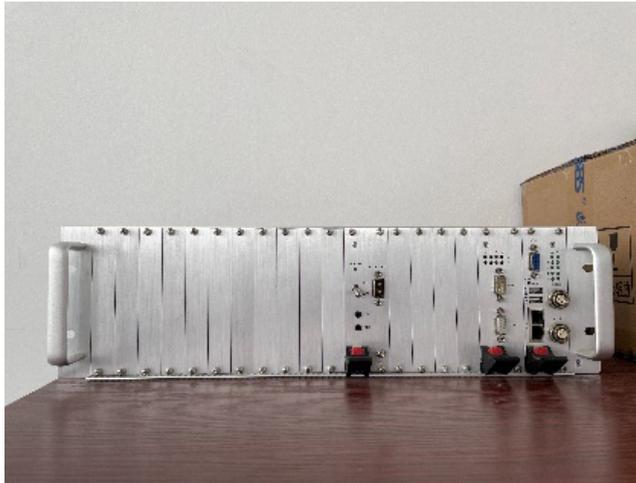


Fig. 4. Master device.

According to the test requirements and follow-up development needs, the ports of the three devices are configured as shown in Figure 5. The interface of related information displayed in slave device 1 is shown in Figure 6.

According to the period of sending and receiving data, a periodic schedule is established. The schedule is shown in Figure 7. The scheduling of period information is realized by referring to the single-processor real-time task scheduling algorithm. Use the least common multiple/greatest common divisor (LCM/HCF) method to determine the size of the MVB real-time schedule [8]. The synchronous RM scheduling algorithm is used to allocate the corresponding priority of each MVB period information to perform non-pre-emptive real-time scheduling, generate the corresponding scheduling table, and realize the communication between the devices. Figure 8 shows the interface for establishing communication between devices.

Slave device 1 is a control workstation with display function, which is responsible for displaying the network structure and realizing network port configuration functions in the MVB network. The interface design of this device is shown in Figure 9, which shows the basic information of the MVB network required for testing. MVB physical layer conformance test system will conduct test research based on this MVB network.

Address description	Device address	Port address		F-code	Port size/byte	Characteristic period/m s
		Hexadecimal	Decimal			
Port address from slave device 1 to master device	0x21	210	528	4	32	256
		211	529	4	32	256
		212	530	4	32	256
		213	531	4	32	256
Port address from slave device 2 to master device	0x3A	3A0	928	4	32	512
		3A1	928	4	32	512
		3A2	928	4	32	512
Port address from master device to slave device 1	0x11	201	513	4	32	256
		202	514	4	32	1024
		203	515	4	32	256
		204	516	4	32	256
		205	517	3	16	64
		206	518	4	32	64
Master device to all MVB devices	0x11	FF	255	3	16	64
Port address from master device to slave device 2	0x11	301	769	3	16	64
		302	770	4	32	64

Fig. 5. Network structure.

MVB conformance test system-MVB network			
RETURN		Network structure	
	Device address	Source port(Hexadecimal)	Sink port (Hexadecimal)
Master device	0x11	201、202、203、204、205、206、FF、301、302	210、211、212、213、3A0、3A1、3A2
Slave device 1	0x21	210、211、212、213	201、202、203、204、205、206
Slave device 2	0x3A	3A0、3A1、3A2	301、302
REFRESH			

Fig. 6. The interface of related information displayed in slave device 2.

Microcycle	Port address for sending data (hexadecimal)	Address description	F-code	Characteristic period/m s
1m s	FF	Master device to all VB devices	3	64
	302	Master device to slave device 2	4	64
1m s	301	Master device to slave device 2	3	64
	206	Master device to slave device 1	4	64
1m s	205	Master device to slave device 1	3	64
	201	Master device to slave device 1	4	256
1m s	203	Master device to slave device 1	4	256
	204	Master device to slave device 1	4	256
1m s	210	Slave device 1 to master device	4	256
	211	Slave device 1 to master device	4	256
1m s	212	Slave device 1 to master device	4	256
	213	Slave device 1 to master device	4	256
1m s	3A0	Slave device 2 to master device	4	512
	3A1	Slave device 2 to master device	4	512
1m s	3A2	Slave device 2 to master device	4	512
	202	Master device to slave device 1	4	1024

Fig. 7. Periodic schedule.

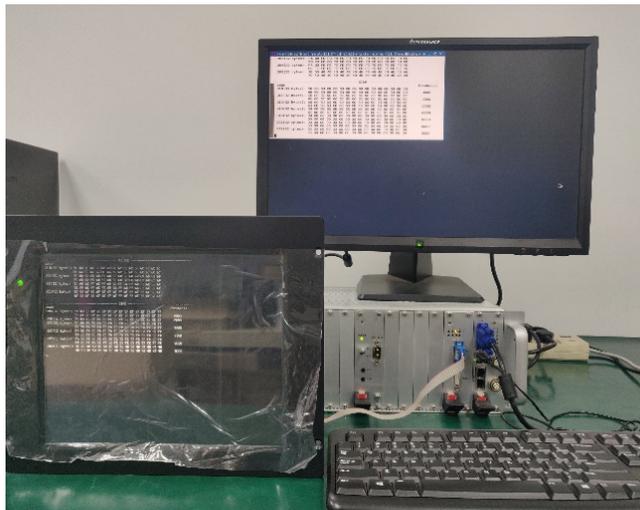


Fig. 8. The interface for establishing communication between devices.

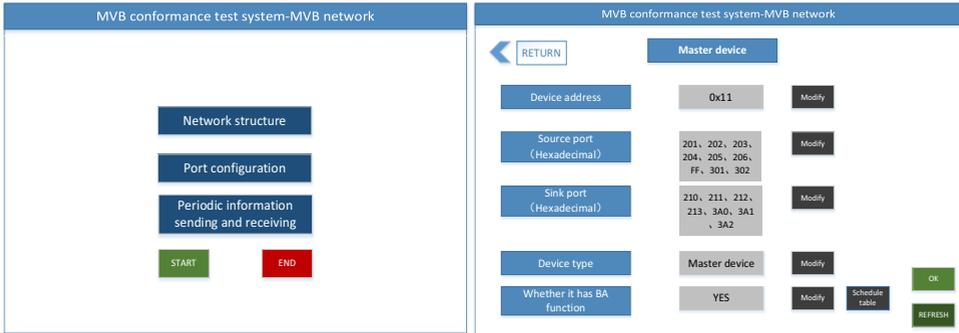


Fig. 9. The interface design of slave device 1.

6 Conclusion

As a train network widely used in urban rail transit, MVB plays a very important role in the safety, comfort and intelligence of urban rail transit. In order to ensure good interoperability and compatibility between train equipment produced by different countries and different manufacturers, conformance testing must be carried out. The formation of the MVB physical layer conformance test system is of great significance for subsequent conformance tests of RTP real-time protocols such as the MVB link layer, network layer, transport layer and application layer.

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