TOSUN

TIO Series Product Family

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What Is the TIO Series Product Family?

TOSUN offers a wide range of product series, including the TC series, TP series, TE series, TLog series, TTS series, and TIO series. Among them, the TIO series products are general-purpose testing modules designed for automotive electronic systems. They can be used in scenarios such as hardware-in-the-loop (HIL) testing. These modules provide an efficient and flexible way to simulate and test various electronic control units (ECUs) in vehicles, helping engineers ensure system reliability and performance while accelerating development cycles and reducing costs. They are indispensable tools in the development of automotive electronic systems.

What Products Are Included in the TIO Series?

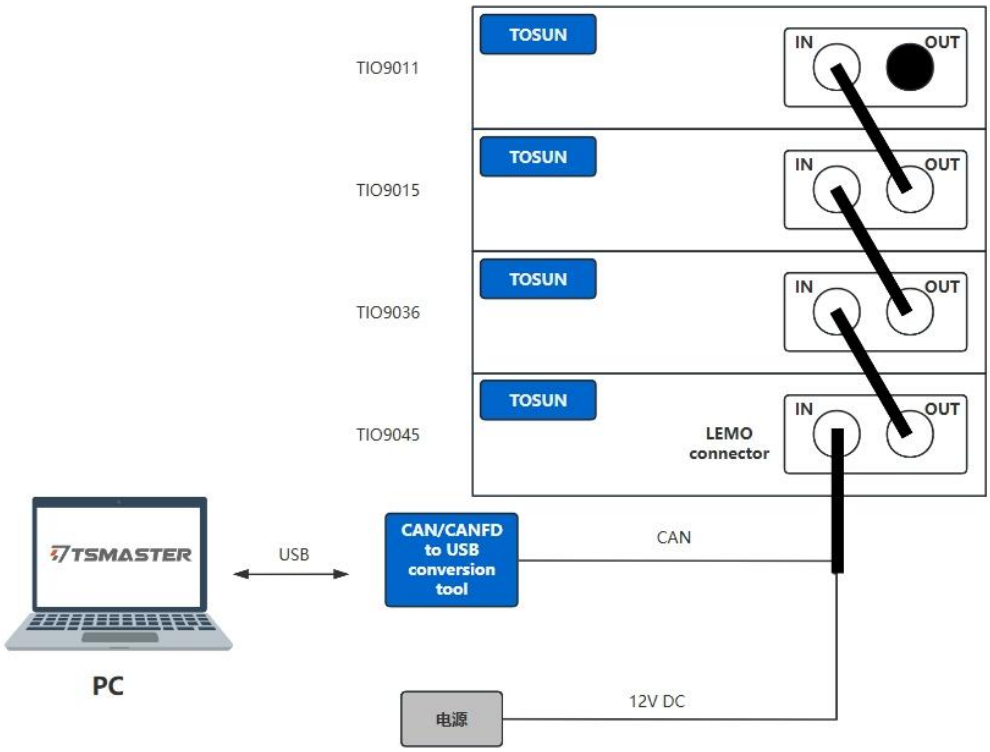
TIO9011	TIO9015	TIO9036	TIO9045

What Are Their Features?

- **Modular Design**: The TIO series devices feature a highly modular design, allowing users to quickly configure and expand the testing system by selecting the appropriate functional modules based on testing requirements.
- **Multifunctional Integration**: TIO series devices integrate functions such as relay control, resistance simulation, digital input/output, and analog input/output.
- **High-Precision Output/Acquisition**: TIO series devices provide high-precision signal processing, such as resistance simulation, voltage/current output and acquisition, and PWM signal output and acquisition.
- **Seamless Software Compatibility**: TIO series boards are highly compatible with TOSUN's TSMaster software, enabling seamless integration into some of TSMaster's automated test cases, simplifying the configuration process and lowering the learning curve.
- ...

How to Use TIO Series Products?

The TIO series devices adopt a highly modular design, allowing users to select the required modules and cascade them using LEMO connector cables. As shown in the figure below, after cascading multiple modules, connect the accessory TOSUN LEMO connector cable to the IN interface to power the devices and connect them to the CAN/CAN FD bus tool. The TIO series devices can then be controlled from the PC using TSMaster software.



Contents

1. About this User Manual

1.1 Disclaimer

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2. Product Overview




	TIO9011	TIO9015	TIO9036	TIO9045
Board Function	Digital input and output	Analog input and output	Resistance simulation	Relay on/off circuit
Number of Channels	12	8	6	18
Function Specification	PWM output: 0.03Hz~200kHz Duty cycle: 1%~99% PWM acquisition: 0.03Hz~200kHz Duty cycle: 1%~99%	Voltage output: 0~60V Voltage acquisition: -60~60V Current output: 0~25mA Current acquisition: 0~25mA	Resistance range: 1~4194303Ω	Channel overcurrent: 40V 1.8A
Operating Voltage	9~36V	9~36V	9~36V	9~36V
Power Consumption	5W (no external load)	5W (no external load)	10W	7W
Installation Method	Module splicing	Module splicing	Module splicing	Module splicing

3.TIO9011

3.1 Overview

TIO9011 is a digital input/output module with a total of 12 channels. All channels can operate independently for outputting high and low levels, collecting high and low levels, outputting PWM, and collecting PWM.

3.2 Specification

Number of channels: 12 channels (shared for input/output)

Operating voltage/static power consumption: 12V/1.1W

Relay type: Magnetic latching relay

Installation method: module splicing

3.3 Functional Data

PWM Output:

Parameter	Min	Max	Unit
PWM frequency	0.00003	200	kHz
PWM frequency accuracy			
➢ at PWM frequency ≤200kHz		0.300	%
➢ at PWM frequency ≤100kHz		0.150	%
➢ at PWM frequency ≤50kHz		0.075	%
➢ at PWM frequency ≤10kHz		0.020	%
➢ at PWM frequency ≤1kHz		0.003	%
PWM duty cycle range			
➢ at PWM frequency ≤200kHz	15	85	%
➢ at PWM frequency ≤100kHz	8	92	%
➢ at PWM frequency ≤50kHz	4	96	%
➢ at PWM frequency ≤10kHz	1	99	%
➢ at PWM frequency ≤1kHz	1	99	%
PWM duty cycle tolerance			
➢ at PWM frequency ≤200kHz		6.000	% abs
➢ at PWM frequency ≤100kHz		3.000	% abs
➢ at PWM frequency ≤50kHz		1.500	% abs
➢ at PWM frequency ≤10kHz		0.250	% abs
➢ at PWM frequency ≤1kHz		0.025	% abs

PWM Measurement:

Parameter	Min	Max	Unit
PWM frequency	0.00003	250	kHz
PWM frequency accuracy			
➢ at PWM frequency ≤250kHz		12.00	%
➢ at PWM frequency ≤100kHz		5.000	%
➢ at PWM frequency ≤50kHz		2.500	%
➢ at PWM frequency ≤10kHz		0.030	%
➢ at PWM frequency ≤1kHz		0.003	%
PWM duty cycle range			
➢ at PWM frequency ≤250kHz	10	90	%
➢ at PWM frequency ≤100kHz	4	96	%
➢ at PWM frequency ≤50kHz	2	98	%
➢ at PWM frequency ≤10kHz	7	93	%
➢ at PWM frequency ≤1kHz	1	99	%
PWM duty cycle tolerance			
➢ at PWM frequency ≤250kHz		12.50	% abs
➢ at PWM frequency ≤100kHz		5.000	% abs
➢ at PWM frequency ≤50kHz		2.500	% abs
➢ at PWM frequency ≤10kHz		0.500	% abs
➢ at PWM frequency ≤1kHz		0.050	% abs

* The above parameters were measured under the following conditions: 12V power supply, using the module's built-in internal VBAT (5V) and VREF (1.8V), with the channel mode set to push-pull output. The rise and fall times of the digital signal are approximately 300ns.

Drive Capability:

The digital signal output supports push-pull, low-side drive (NMOS open-drain), and high-side drive (PMOS open-drain):

- Push+Pull (push-pull mode): Can output both low and high levels, providing strong driving capability.
- Push (high-side drive): Can output high levels. Low levels require a pull-down.
- Pull (low-side drive): Can output low levels. High levels require a pull-up.

Only in Push mode and Push+Pull modes, the internal high level reference voltage (VCC_5V) or an externally connected high level reference voltage (VBAT) will be used. The threshold voltage (VREF) and high level voltage (VBAT) can be set through an external reference voltage.

	Single-channel current output capability	Maximum output current per channel when all 12 channels are simultaneously outputting	Single-channel input/output voltage range
External High Level Reference Voltage	250mA	100mA	0-60V

When using an external VBat, as the VBat voltage increases, the heat generated by the TIO9011 module under load will also increase significantly. To prevent excessive temperature from damaging the hardware, a safe temperature of around 60°C is recommended. Under a 10W load, the recommended VBat voltage and frequency for a single channel of the TIO9011 module are as follows:

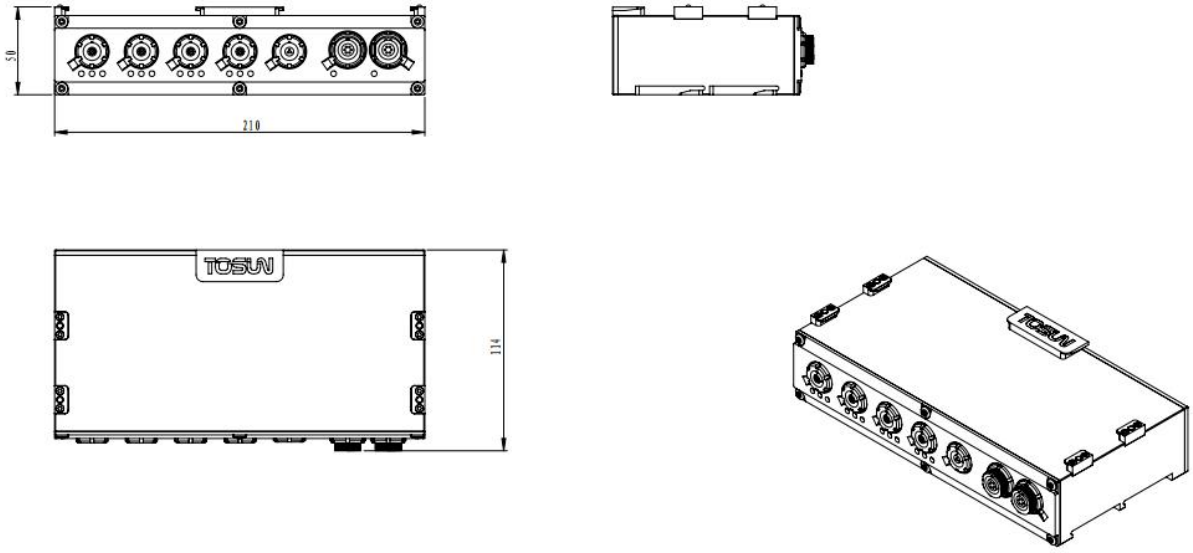
VBat Supply Voltage (V)	Maximum Allowed Frequency (Hz)	Duty Cycle (%)	Pull-Down Resistor (Ω)	Pull-Down Resistor Power (W)	VBat Current (A)	VBat Power Consumption (W)
12	200K	50	600	10	0.486	5.832
24	50K	50	600	10	0.423	10.152

36	30K	50	600	10	0.517	18.612
48	15K	50	600	10	0.586	28.128
60	10K	50	600	10	0.684	41.04

3.4 Electrical Data

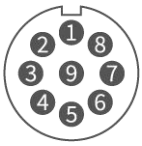
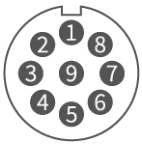
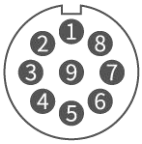
Parameter		Test Condition	Minimum Value	Typical Value	Maximum Value	Unit
Operating Voltage	DC power supply	All channel high level output (no external load)	9	12.0	36	V
Operating Current	DC power supply	All channel high level output (no external load)	--	0.29	--	A
Power Consumption	DC power supply	All channel high level output (no external load)	--	3.5	--	W
CAN Interface	Bus pin voltage resistance	CANH、CAHL	-58	--	58	V
	Isolation withstand voltage	Leakage current less than 1mA	2500	--	--	VDC
EMC Compatibility	ESD	IEC61000-4-2 standard	Contact discharge: 8 Air discharge: 15	--	--	kV

3.5 Mechanical Data

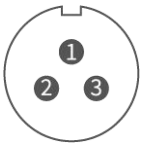


3.6 Hardware Interface

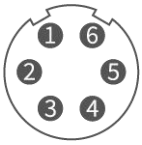
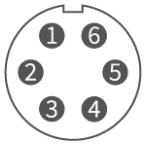
➢ 9Pin-LEMO connector interface:

	PIN	Definition	PIN	Definition
 DI/DO 1-3	Pin 1	DI/DO 2	Pin 2	DI/DO 1
	Pin 3	GND	Pin 7	GND
	Pin 8	DI/DO 3	Pin 9	GND
 DI/DO 4-6	Pin 1	DI/DO 5	Pin 2	DI/DO 4
	Pin 3	GND	Pin 7	GND
	Pin 8	DI/DO 6	Pin 9	GND
 DI/DO 7-9	Pin 1	DI/DO 8	Pin 2	DI/DO 7
	Pin 3	GND	Pin 7	GND
	Pin 8	DI/DO 9	Pin 9	GND
 DI/DO 10-12	Pin 1	DI/DO 11	Pin 2	DI/DO 10
	Pin 3	GND	Pin 7	GND
	Pin 8	DI/DO 12	Pin 9	GND

➢ 3Pin-LEMO connector interface:

	PIN	Definition	PIN	Definition
 V_Bat&V_Ref	Pin 1	GND	Pin 2	V_Bat
	Pin 3	V_Ref		

➢ 6Pin-LEMO connector interface:

	PIN	Definition		PIN	Definition
	Pin 1	VIN		Pin 1	VIN
	Pin 2	GND		Pin 2	GND
	Pin 3	Cfg1		Pin 3	Cfg1

OUT	Pin 4	Cfg2	IN	Pin 4	Cfg2
	Pin 5	CAN_L		Pin 5	CAN_L
	Pin 6	CAN_H		Pin 6	CAN_H

3.7 LED

Description of indicator:

Indicator	**Definition**
Status	Indicator for status
Power	Indicator for power
DI/DO 1~12	Indicator for DIDO channel

Description of LED color:

Color	**Description**
Status Green Blinking	ID negotiation is in progress.
Status Green	ID negotiation is completed.
Power Green	The device powers on normally.
DI/DO Green	The DIDO channels are in working status.

3.8 Scope of Delivery

✓ Main device: TIO9011

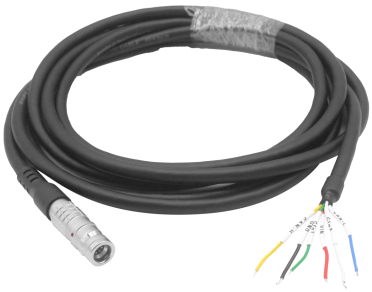
✓ TIO9011 LEMO interface connectors*4

✓ TIO series general OUT-IN cascade harness

3.9 Optional Accessories

✓ TIO9011 LEMO interface connector harness

✓ TIO series general IN harness



✓ TIO series general LEMO connector (with terminal resistor)

4. TIO9015

4.1 Overview

TIO9015 is an analog output/input module with a total of 8 independent input/output channels. Each channel supports voltage output, voltage acquisition, current output, and current acquisition functions. When operating in voltage mode, it also supports the function of feedback output voltage. The voltage output supports high voltage output from 0 to 60V, and the voltage acquisition supports a wide voltage range of -60V to +60V or 0 to +60V.

4.2 Specification

Number of channels: 8 channels (shared for input/output)

Operating voltage/static power consumption: 12V/4W

Relay type: magnetic latching relay

Installation method: module splicing

4.3 Specification

Voltage Output:

Number of Channels	8 channels
Output Range	0V~+60V
DAC Resolution	16bit
Accuracy	Transient accuracy: ±(0.1%+5mV) Average accuracy: ±(0.1%+5mV) When outputting 0V, there may be a voltage of up to 300mV depending on the channel.
Output Current	20mA@4 channels 10mA@8 channels

Voltage Acquisition:

Number of Channels	8 channels
Measurement Range	-60V~+60V, 0V~+60V
Sampling Rate	250kHz
Reporting Rate	1kHz (active reporting) 4kHz (polling)
ADC Resolution	20bit
Accuracy	0~60V acquisition mode: Transient accuracy: ±(0.1%+20mV) Average accuracy: ±(0.1%+5mV) -60~60V acquisition mode: Transient accuracy: ±25mV Average accuracy: ±5mV
Input Impedance	300KΩ

Current Output:

Number of Channels	8 channels
Output Range	0mA~25mA
DAC Resolution	16bit
Accuracy	Transient accuracy: ±(0.1%+5uA) Average accuracy: ±(0.1%+5uA)

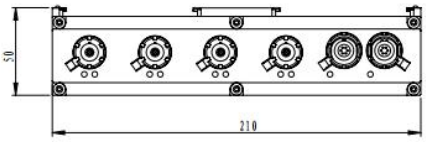
Current Acquisition:

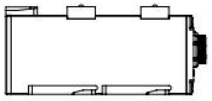
Number of Channels	8 channels
Measurement Range	0mA~25mA
Sampling Rate	250kHz
Reporting Rate	1kHz (active reporting) 4kHz (polling)
ADC Resolution	20bit
Accuracy	Transient accuracy: ±(1%+250uA) Average accuracy: ±(1%+10uA)

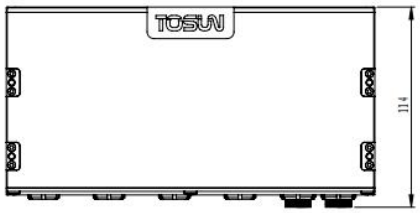
4.4 Electrical Data

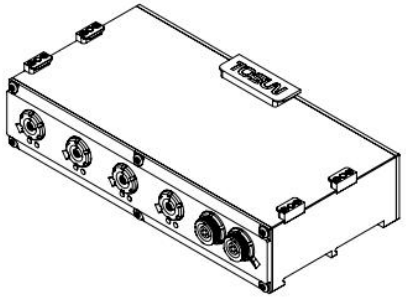
Parameter		Test Condition	Minimum Value	Typical Value	Maximum Value	Unit
Operating Voltage	DC power supply	All channel feedback mode for outputting 60V voltage	9	12.0	36	V
Operating Current	DC power supply	All channel feedback mode for outputting 60V voltage	--	0.38	--	A
Power Consumption	DC power supply	All channel feedback mode for outputting 60V voltage	--	4.6	--	W
CAN Interface	Bus pin voltage resistance	CANH、CAHL	-58	--	58	V
	Isolation withstand voltage	Leakage current less than 1mA	2500	--	--	VDC
EMC Compatibility	ESD	IEC61000-4-2 standard	Contact discharge: 8 Air discharge: 15	--	--	kV

4.5 Mechanical Data



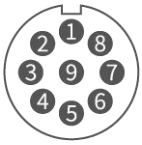
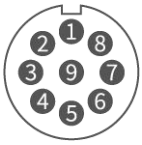
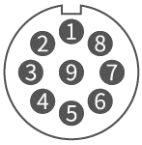
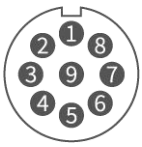




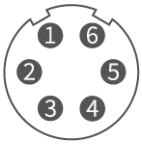
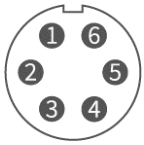


4.6 Hardware Interface

➢ 9Pin-LEMO connector interface:

	PIN	Definition	PIN	Definition
 AI/AO 1-2	Pin 1	AIAO 1-	Pin 2	AIAO 1+
	Pin 4	GND	Pin 5	AIAO 2-
	Pin 6	AIAO 2+	Pin 8	GND
 AI/AO 3-4	Pin 1	AIAO 3-	Pin 2	AIAO 3+
	Pin 4	GND	Pin 5	AIAO 4-
	Pin 6	AIAO 4+	Pin 8	GND
 AI/AO 5-6	Pin 1	AIAO 5-	Pin 2	AIAO 5+
	Pin 4	GND	Pin 5	AIAO 6-
	Pin 6	AIAO 6+	Pin 8	GND
 AI/AO 7-8	Pin 1	AIAO 7-	Pin 2	AIAO 7+
	Pin 4	GND	Pin 5	AIAO 8-
	Pin 6	AIAO 8+	Pin 8	GND

- 6Pin-LEMO connector interface:

	PIN	Definition		PIN	Definition
 OUT	Pin 1	VIN	 IN	Pin 1	VIN
	Pin 2	GND		Pin 2	GND
	Pin 3	Cfg1		Pin 3	Cfg1
	Pin 4	Cfg2		Pin 4	Cfg2
	Pin 5	CAN_L		Pin 5	CAN_L
	Pin 6	CAN_H		Pin 6	CAN_H

4.7 LED

Description of indicator:

Indicator	Definition
Status	Indicator for status
Power	Indicator for power
AI/AO 1~8	Indicator for AIAO channel

Description of LED color:

Color	Description
Status Green Blinking	ID negotiation is in progress.
Status Green	ID negotiation is completed.
Power Green	The device powers on normally.
AI/AO Green	The AIAO channels are in working status.

4.8 Scope of Delivery

✓ Main device: TIO9015

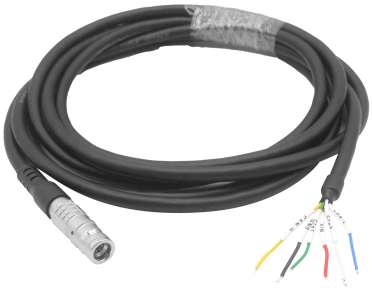
✓ TIO9015 LEMO interface connectors*4

✓ TIO series general OUT-IN cascade harness

4.9 Optional Accessories

✓ TIO9015 LEMO interface connector harness

✓ TIO series general IN harness



✓ TIO series general LEMO connector (with terminal resistor)

5. TIO9036

5.1 Overview

TIO9036 is a resistance module with a total of 6 independent channels. Each channel can output resistance from 1 to 4194303Ω. In cases where the resolution or range is insufficient, the channels can also be used in parallel or series. The resistance module can be utilized in various signal systems and can simulate functions such as thermistors or resistive sensors.

5.2 Specification

Number of channels: 6 channels

Operating voltage/static power consumption: 12V/2W

Relay type: magnetic latching relay

Installation method: module splicing

5.3 Functional Data

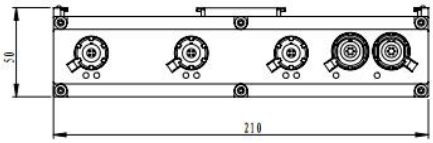
Output Resistance Range	1Ω~4194303Ω
Step Value	1Ω
Resistance Accuracy	1Ω~500Ω, accuracy ±0.5Ω 500Ω~4194303Ω, accuracy ±0.1%
Resistance Power	1/4W

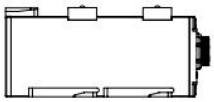
Note: When setting resistance values on the TIO9036, commands must be spaced at least 50ms apart.

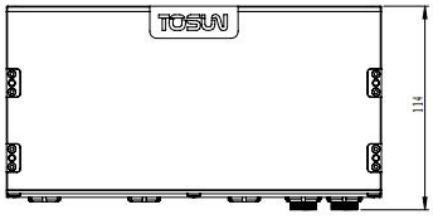
5.4 Electrical Data

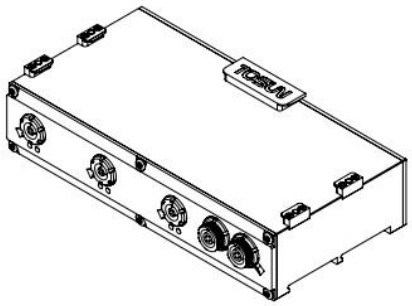
Parameter		Test Condition	Minimum Value	Typical Value	Maximum Value	Unit
Operating Voltage	DC power supply	Output resistance value	9	12.0	36	V
Operating Current	DC power supply	Output resistance value	--	0.83	--	A
Power Consumption	DC power supply	Output resistance value	--	10	--	W
CAN Interface	Bus pin voltage resistance	CANH、CAHL	-58	--	58	V
	Isolation withstand voltage	Leakage current less than 1mA	2500	--	--	VDC
EMC Compatibility	ESD	IEC61000-4-2 standard	Contact discharge: 8 Air discharge: 15	--	--	kV

5.5 Mechanical Data



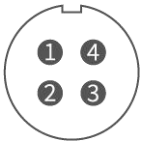
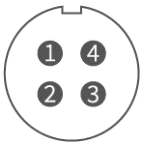
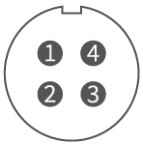




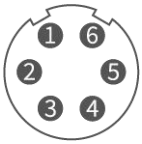
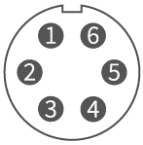


5.6 Hardware Interface

➢ 4Pin-LEMO connector interface:

	PIN	Definition	PIN	Definition
 Res 1/2	Pin 1	Res 1A	Pin 2	Res 2A
	Pin 3	Res 2B	Pin 4	Res 1B
 Res 3/4	Pin 1	Res 3A	Pin 2	Res 4A
	Pin 3	Res 4B	Pin 4	Res 3B
 Res 5/6	Pin 1	Res 5A	Pin 2	Res 6A
	Pin 3	Res 6B	Pin 4	Res 5B

➢ 6Pin-LEMO connector interface:

	PIN	Definition		PIN	Definition
 OUT	Pin 1	VIN	 IN	Pin 1	VIN
	Pin 2	GND		Pin 2	GND
	Pin 3	Cfg1		Pin 3	Cfg1
	Pin 4	Cfg2		Pin 4	Cfg2
	Pin 5	CAN_L		Pin 5	CAN_L

	Pin 6	CAN_H		Pin 6	CAN_H

5.7 LED

Description of indicator:

Indicator	**Definition**
Status	Indicator for status
Power	Indicator for power
Res1~6	Indicator for channel

Description of LED color:

Color	**Description**
Status Green Blinking	ID negotiation is in progress.
Status Green	ID negotiation is completed.
Power Green	The device powers on normally.
Res Green	The Res channel is in working status.

5.8 Scope of Delivery

✓ Main device: TIO9036

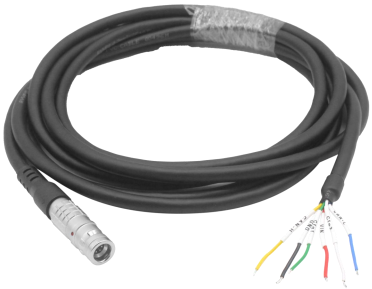
✓ TIO9036 LEMO interface connectors*3

✓ TIO series general OUT-IN cascade harness

5.9 Optional Accessories

✓ TIO9036 LEMO interface connector harness (this harness introduces approximately 0.5Ω of line resistance)

✓ TIO series general IN harness



✓ TIO series general LEMO connector (with terminal resistor)

6. TIO9045

6.1 Overview

TIO9045 is a general-purpose relay module with 18 channels. Each channel is controlled by one relay, and each relay has three terminals (CH/NO/NC).

6.2 Specification

Number of channels: 18 channels

Operating voltage/static power consumption: 12V/0.5W

Relay type: power relay

Installation method: module splicing

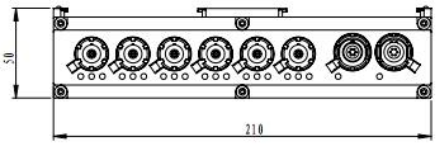
6.3 Functional Data

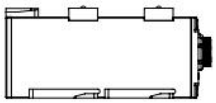
Channel Overcurrent Capacity	DC 40V 1.8A

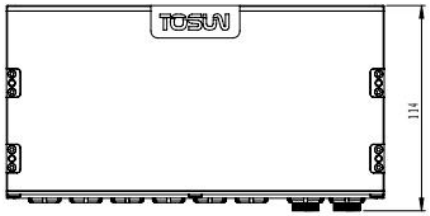
6.4 Electrical Data

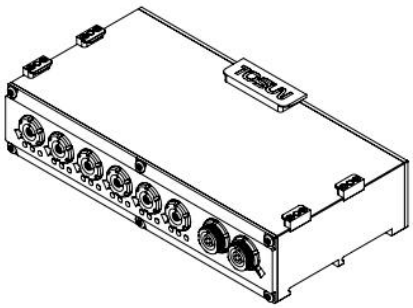
Parameter		Test Condition	Minimum Value	Typical Value	Maximum Value	Unit
Operating Voltage	DC power supply	Relay in conducting state	9	12	32	V
Operating Current	DC power supply	Relay in conducting state	--	0.63	--	A
Power Consumption	DC power supply	Relay in conducting state	--	7.6	--	W
CAN Interface	Bus pin voltage resistance	CANH、CAHL	-58	--	58	V
	Isolation withstand voltage	Leakage current less than 1mA	2500	--	--	VDC
EMC Compatibility	ESD	IEC61000-4-2 standard	Contact discharge: 8 Air discharge: 15	--	--	kV

6.5 Mechanical Data



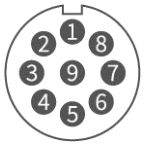
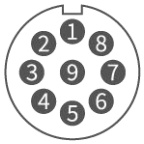
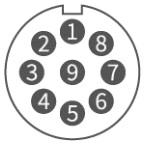


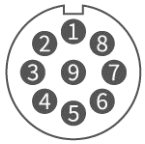




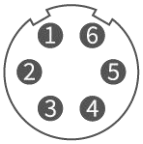
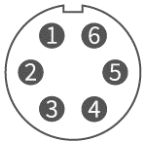
6.6 Hardware Interface

➢ 9Pin-LEMO connector interface:

	PIN	Definition	PIN	Definition	PIN	Definition
 Relay 1-3	Pin 1	NO 1	Pin 2	COM 1	Pin 3	COM 2
	Pin 4	NC 3	Pin 5	NO 3	Pin 6	COM 3
	Pin 7	NC 2	Pin 8	NC 1	Pin 9	NO 2
 Relay 4-6	Pin 1	NO 4	Pin 2	COM 4	Pin 3	COM 5
	Pin 4	NC 6	Pin 5	NO 6	Pin 6	COM 6
	Pin 7	NC 5	Pin 8	NC 4	Pin 9	NO 5
 Relay 7-9	Pin 1	NO 7	Pin 2	COM 7	Pin 3	COM 8
	Pin 4	NC 9	Pin 5	NO 9	Pin 6	COM 9
	Pin 7	NC 8	Pin 8	NC 7	Pin 9	NO 8
 Relay 10-12	Pin 1	NO 10	Pin 2	COM 10	Pin 3	COM 11
	Pin 4	NC 12	Pin 5	NO 12	Pin 6	COM 12
	Pin 7	NC 11	Pin 8	NC 10	Pin 9	NO 11
 Relay 13-15	Pin 1	NO 13	Pin 2	COM 13	Pin 3	COM 14
	Pin 4	NC 15	Pin 5	NO 15	Pin 6	COM 15
	Pin 7	NC 14	Pin 8	NC 13	Pin 9	NO 14

 Relay 16-18	Pin 1	NO 16	Pin 2	COM 16	Pin 3	COM 17
	Pin 4	NC 18	Pin 5	NO 18	Pin 6	COM 18
	Pin 7	NC 17	Pin 8	NC 16	Pin 9	NO 17

➢ 6Pin-LEMO connector interface:

	PIN	Definition		PIN	Definition
 OUT	Pin 1	VIN	 IN	Pin 1	VIN
	Pin 2	GND		Pin 2	GND
	Pin 3	Cfg1		Pin 3	Cfg1
	Pin 4	Cfg2		Pin 4	Cfg2
	Pin 5	CAN_L		Pin 5	CAN_L
	Pin 6	CAN_H		Pin 6	CAN_H

6.7 LED

Description of indicator:

Indicator	Definition
Status	Indicator for status
Power	Indicator for power
Relay1~18	Indicator for channel

Description of LED color:

Color	Description
Status Green Blinking	ID negotiation is in progress.
Status Green	ID negotiation is completed.
Power Green	The device powers on normally.
Relay Green	The Relay channel is in working status.

6.8 Scope of Delivery

✓ Main device: TIO9045

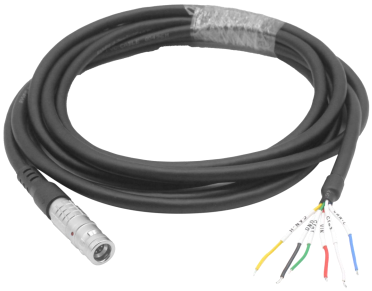
✓ TIO9045 LEMO interface connectors*6

✓ TIO series general OUT-IN cascade harness

6.9 Optional Accessories

✓ TIO9045 LEMO interface connector harness

✓ TIO series general IN harness



✓ TIO series general LEMO connector (with terminal resistor)

7. Quick Start

7.1 Software Overview

TSMaster is a powerful and comprehensive tool that can connect, configure, and control all TOSUN hardware tools and devices, enabling functions such as automotive bus embedded code generation, monitoring, simulation, development, UDS diagnostics, CCP/XCP calibration, ECU flashing, I/O control, test measurement, and so on.

TSMaster supports Matlab Simulink co-simulation and CarSim dynamic model ECU algorithm simulation testing (soft real-time HIL). It provides users with a series of convenient functions and editors, allowing them to directly execute ECU code within TSMaster and supports C script and Python script editing. At the same time, TSMaster also offers a mini-program function, enabling users to customize the simulation test panel, test process, test logic, and even the entire test system, and automatically generate reports. The code written by users based on TSMaster is hardware-independent, and can be easily shared, referenced, and used on different hardware platforms.

TSMaster supports multiple commonly used bus tool brands, including Vector, Kvaser, PEAK, IXXAT, as well as mainstream instruments in the market (such as oscilloscopes, waveform generators, and digital multimeters) and boards (such as AI, DI, DO, etc.). Its design concept is to perfectly integrate with the test system to achieve joint simulation and testing of multiple hardware and multiple channels. This enables TSMaster to meet the PV/DV test verification needs for various automotive electronic components and assemblies, as well as the inspection

requirements for the production line.

7.2 Software Installation

TSMaster software download link:

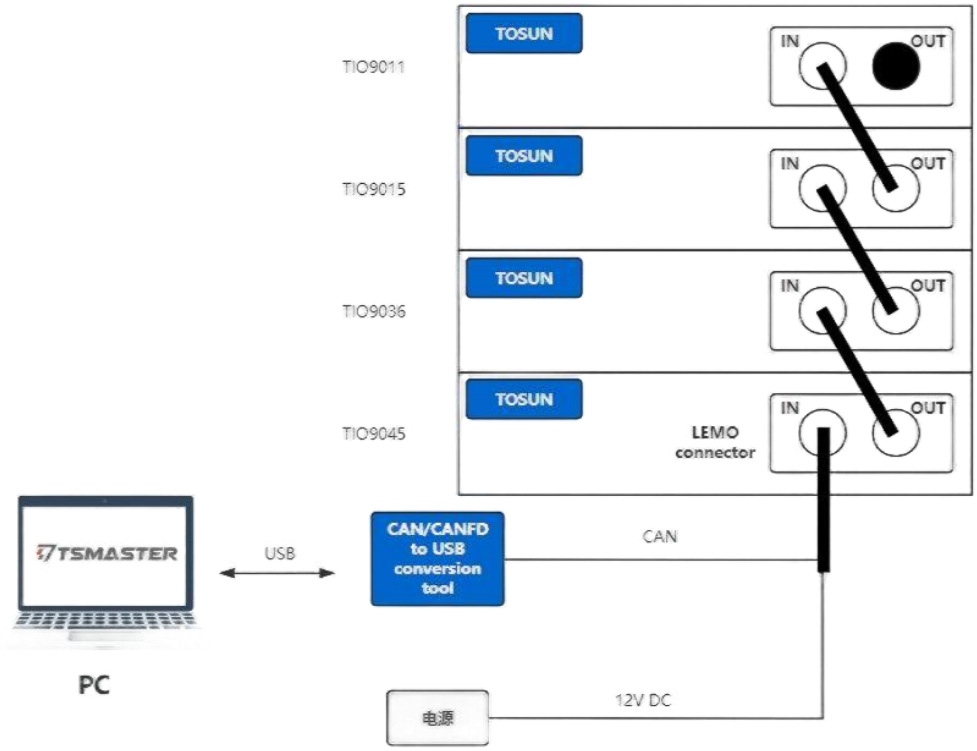
https://www.tosunai.com/downloads/

If the link is not accessible, you can contact the corresponding sales personnel or visit the official TOSUN website to obtain the software. Meanwhile, you can scan the QR code to follow the TOSUN official account to get the download link.

After the installation，you can see the following software on the PC.

7.3 Device Usage

The TIO series devices feature a highly modular design, allowing users to select the required modules and cascade them using LEMO connector harnesses. As shown in the figure below, multiple modules can be cascaded and connected to the IN interface for power supply using TOSUN's matching LEMO connector harness. By connecting the CAN/CAN FD bus tool, the TIO series devices can be controlled via the TSMaster software on a PC.



Users operate the device by loading the TIO module database in TSMaster.

Before that, it's important to understand that the TIO modules are controlled through CAN messages. The control message IDs for TIO modules follow a unified set of rules:

The message type uses an extended data frame, and the ID structure is:

0xXX0NYYYZZ

XX: (message type encoding)

00	Request type, i.e., the message sent to the TIO module
08	Response type, i.e., messages replied by the TIO module after receiving control messages
18	Active report type, the message reported in real-time by the TIO module when the TIO module is in normal operating status

0N: (module number, i.e., the position of the module within the integrated system after splicing)

00	The module is located at position 1 in the integrated system
01	The module is located at position 2 in the integrated system
02	The module is located at position 3 in the integrated system
03	The module is located at position 4 in the integrated system
...	And so on...
0F	The module is located at position 16 in the integrated system

YY: (module type)

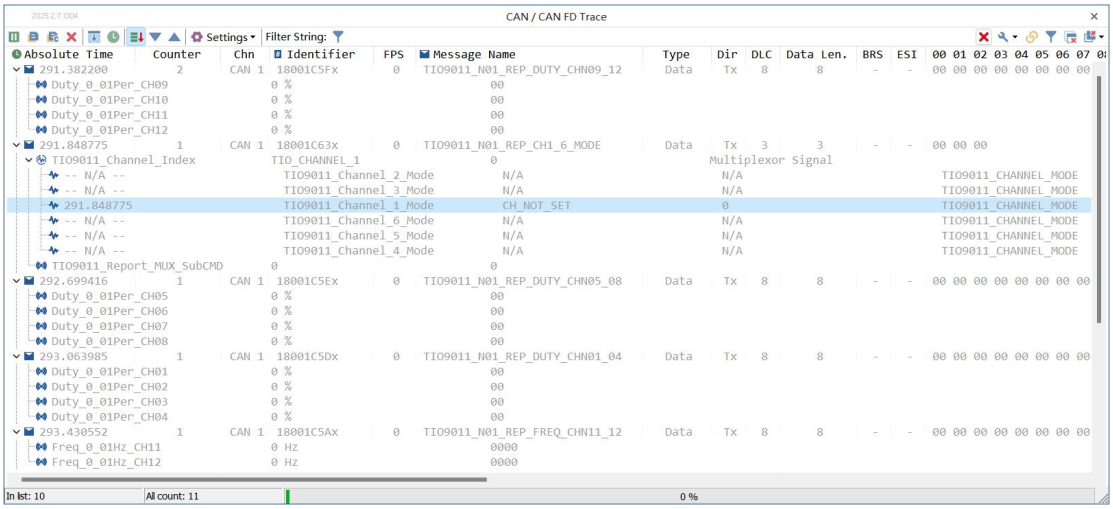
1C/1D	TIO9011 module
1E	TIO9015 module
20	TIO9036 module
21	TIO9045 module

ZZ: (command type)

TIO9015	26	Set output analog value
	04	Set message cycle
	27	Get output analog value
	25	Get input analog value
	61	Set/get channel mode, board card self-calibration
TIO9036	61	Set channel mode
	04	Set message cycle
	29	Get output resistance value
	28	Set output resistance value
TIO9045	04	Set message cycle
	0E	Get relay status
	0D	Set relay status
TIO9011	(18)04	Set message cycle
	(18)07	Get collected level

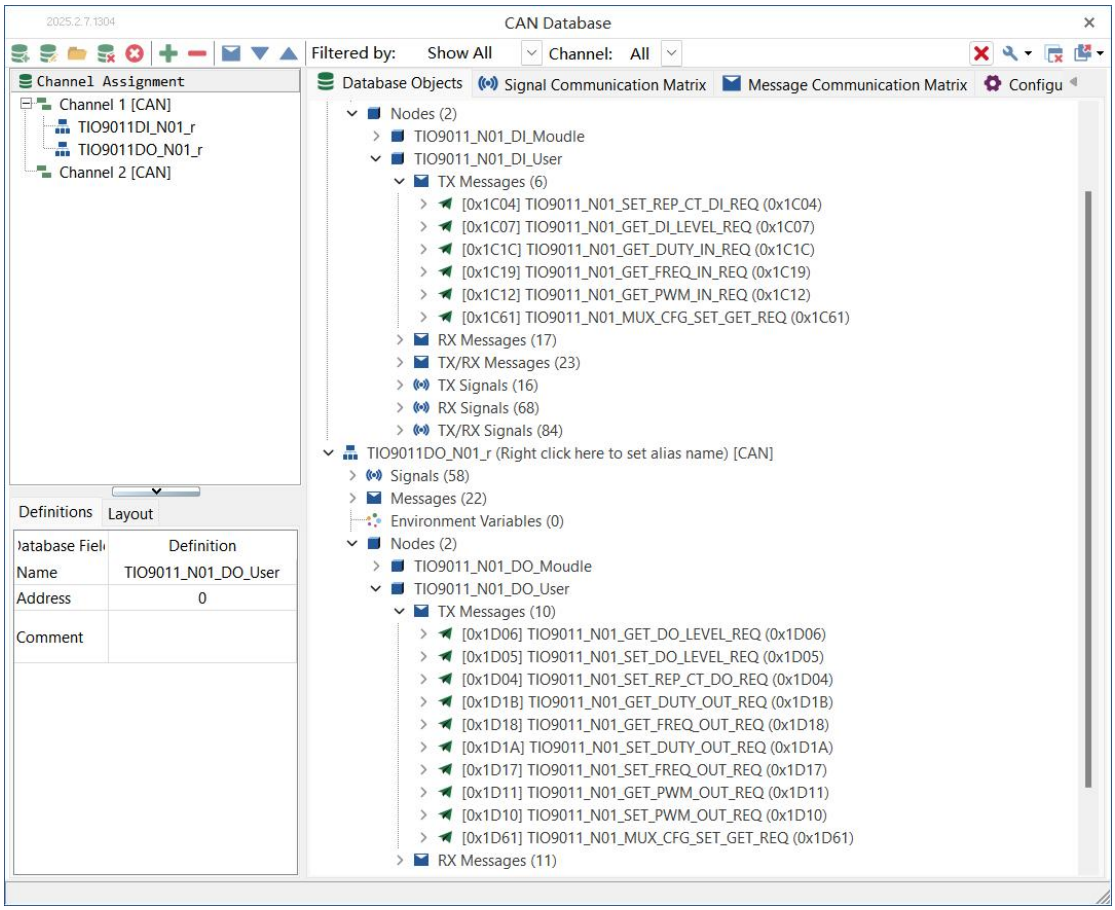
	(18)1C	Get collected PWM duty cycle
	(18)19	Get collected PWM frequency
	(18)12	Get collected PWM frequency and duty cycle
	(18)61	Set modes for channels 1 to 6
	(19)06	Get output level
	(19)05	Set output level
	(19)04	Set message cycle
	(19)1B	Get output PWM duty cycle
	(19)18	Get output PWM frequency
	(19)1A	Set output PWM duty cycle
	(19)17	Set output PWM frequency
	(19)11	Get output PWM frequency and duty cycle
	(19)10	Set output PWM frequency and duty cycle
	(19)61	Set modes for channels 7 to 12

After loading the database, users can directly send all the above messages to control the TIO module and also perform signal analysis on the messages reported by the TIO modules. Taking TIO9011 as an example, after loading the database in TSMaster, in the CAN message information window, the signal values of the messages reported by TIO9011 will be automatically parsed, as shown below:



At the same time, users can view all control messages for TIO9011 in the CAN database. By selecting and sending a message, users can control the board card to execute the corresponding

function.



Message	Description
TIO9011_N01_SET_REP_CT_DI_REQ	Set message cycle
TIO9011_N01_GET_DI_LEVEL_REQ	Get level
TIO9011_N01_GET_DUTY_IN_REQ	Get PWM duty cycle
TIO9011_N01_GET_FREQ_IN_REQ	Get PWM frequency
TIO9011_N01_GET_PWM_IN_REQ	Get PWM frequency and duty cycle
TIO9011_N01_MUX_CFG_SET_GET_REQ	Set mode for channels 1-6
TIO9011_N01_GET_DO_LEVEL_REQ	Get output voltage level
TIO9011_N01_SET_DO_LEVEL_REQ	Set output voltage level
TIO9011_N01_SET_REP_CT_DO_REQ	Set message cycle
TIO9011_N01_GET_DUTY_OUT_REQ	Get output PWM duty cycle
TIO9011_N01_GET_FREQ_OUT_REQ	Get output PWM frequency

TIO9011_N01_SET_DUTY_OUT_REQ	Set output PWM duty cycle
TIO9011_N01_SET_FREQ_OUT_REQ	Set output PWM frequency
TIO9011_N01_GET_PWM_OUT_REQ	Get output PWM frequency and duty cycle
TIO9011_N01_SET_PWM_OUT_REQ	Set output PWM frequency and duty cycle
TIO9011_N01_MUX_CFG_SET_GET_REQ	Set mode for channels 7-12

8. Inspection and Maintenance

The main electrical components of TIO series products are semiconductor components. Although the equipment has a long service life, they may also accelerate aging and significantly reduce their service life under an incorrect environment. Therefore, during the use of the equipment, periodic inspection should be carried out to ensure that the use environment maintains the required conditions.

It is recommended to conduct inspections at least once every 6 months to 1 year. Under improper environmental, more frequent inspections should be conducted. As shown in the table below, if you encounter problems during maintenance, please read the following content to find the possible causes of the problem. If the problem still cannot be solved, please contact Shanghai TOSUN Technology Ltd.

Item	Inspection	Standard	Action
Power Supply	Inspect for voltage fluctuations at the power supply end	Power supply port +12V DC	Use a voltage meter to check the power input end. Take necessary actions to keep the voltage fluctuations within the acceptable range.
Surrounding Environment	Check the ambient temperature of the surrounding environment. (Including the internal temperature of enclosed environments)	-40℃~+80℃	Use a thermometer to check the temperature and ensure that the ambient temperature within in the acceptable range.
	Check the ambient	The relative	Use a hygrometer to check

	humidity. (Including the internal humidity of enclosed environments)	humidity must be within the range of 10% to 90%	the humidity and ensure that the ambient humidity within the acceptable range.
	Check for the accumulation of dust, powder, salt, and metal shavings	No accumulation	Clean and protect the equipment.
	Check for any contact with water, oil, or chemical sprays on the equipment	No contact	Clean and protect the equipment if necessary.
	Check for the presence of corrosive or flammable gases in the equipment area	No presence	Inspect by the smell, or using a sensor.
	Check for levels of vibration and shock	Vibration and shock are within the acceptable range	Install padding or other shock-absorbing devices if necessary.
	Check for noise sources near the equipment	No significant noise source	Isolate the equipment from noise sources or protect the equipment.
Wiring Installation	Check the crimped connectors in the external wiring	Ensure enough space between the connectors	Visually inspect and adjust if necessary.
	Check for damage in the external wiring	No damage	Visually inspect and replace the wiring if necessary.

TOSUN

Engineer Everything !

Software

Support CAN(FD)/LIN/FlexRay/SOME/IP and DoIP

UDS diagnostics/ECU flashing/CCP/XCP calibration

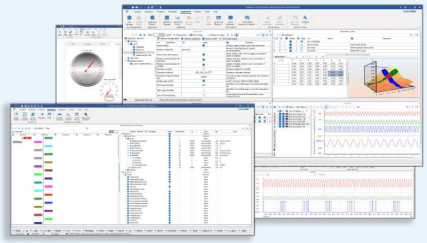
Embedded code generation/Application builder

Encrypted release/Logging and bus replay

Graphical programming/Residual bus simulation

C and Python scripting

Bus monitoring/Transmiting/Automated testing



TSMASTER

Hardware

1/2/4/8/12-channel CAN FD/CAN to USB/PCIe device

1/2/6-channel LIN to USB/PCIe device

Multi channel FlexRay/CAN FD to USB/PCIe device

Multi channel automotive Ethernet/CAN FD to USB/PCIe device

Automotive Ethernet media conversion device (T1 to Tx)

Multi-channel CAN FD/Ethernet/LIN datalogger

TTS test systems

-CAN FD/CAN/FlexRay/LIN communication boards

-Relay and fault injection boards

-Resistors for sensor simulation

-Digital I/O, Analog I/O boards available

CAN CAN FD lin FlexRay OPEN ALLIANCE

Solutions

- Bus Conformance
- Network Automation Testing System
- Charging Testing System
- EMB Calibration Testing Equipment
- Information Security Solutions
- Steer-by-Wire Chassis Testing Solutions
- EOL Testing Equipment
- Motor Performance
- Durability Testing Solutions
- FCT

About TOSUN

The core product, TSMaster, is a comprehensive tool for automotive R&D, testing, production, and after-sales. It integrates essential functions with hardware support to streamline processes and ensure precision, making it ideal for automotive professionals.

International Organization

ASAM CiA

Quality Assurance

ISO9001:2015

CE Certification

CE

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