TD_CAN Transceiver Modules' Application Guide 2022

MORNSUN®

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1. CAN bus basic knowledge

1.1 CAN basic characteristics

CAN is short for Controller Area Network. It's a kind of ISO International Standardized asynchronous Serial Communication Protocol. Compared with general communication bus, CAN bus data communication is with outstanding reliability, real-time and flexibility. CAN bus standard includes physical layer and data link layer. With the development of CAN, the design of application layer will also be taken into consideration.

(1) CANH and CANL are with low internal capacitance value: Cin≤20pF/1Mbps

(2) Differential internal capacitance value: Cdiff≤10pF/1Mbps

(3) CANH and CANL are with low internal resistance value: 5KΩ≤Rdiff≤50KΩ. The internal resistance of each node should keep as same as each other and their error should be controlled within 5%.

(4) Differential internal resistance value: 10KΩ≤Rdiff≤100KΩ. The internal resistance of each node should keep as same as each other and their error should be controlled within 5%.

(5) When configured two 120Ω termination resistors to 110 nodes (including master controller device and controlled setting), the drive can output at least 1.5V (the value of the terminal resistance is related to the parameters of the twisted pair used).

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1.2 CAN bus topology

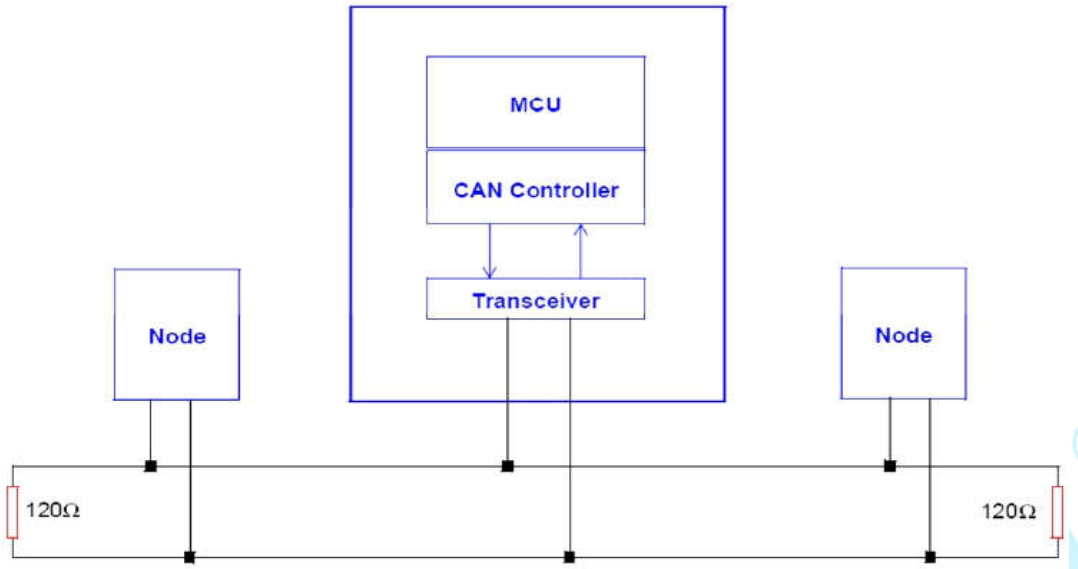

Fig.1 CAN bus network topology diagram

1.3 CAN bus transmission distance

In order to avoid cable radiation, line layout of the CAN bus network should be as close as possible to linear structure. It is necessary to connect a short stub cable to the trunk cable in practical application. As shown in Fig.2, in order to minimize standing wave, the spacing between nodes on the network should not be the same, and the length of the cable is equal as well. Please refer to parameters shown in Table 1.

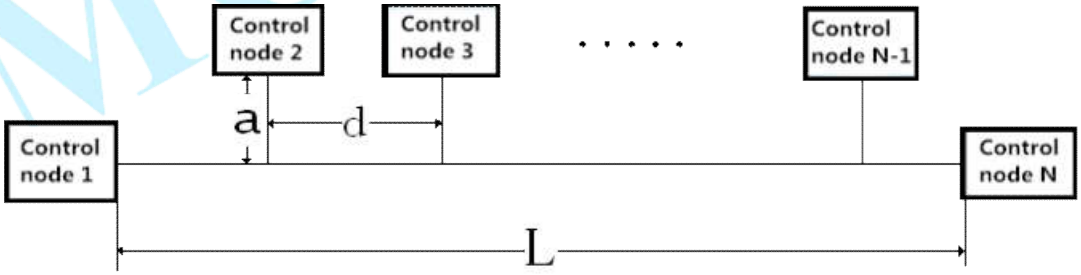

Fig.2 Wiring network layout (L: Bus length; a: Extension length; d: Node spacing)

Table.1 Network topology parameters

Parameters	Sign	Unit	Value			Condition
			Minimum value	Typical value	Maximum value	

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Bus length	L	m	0	/	40	1Mbit/s
Extension length	a	m	0	/	0.3	
Node spacing	d	m	0.1	/	40	

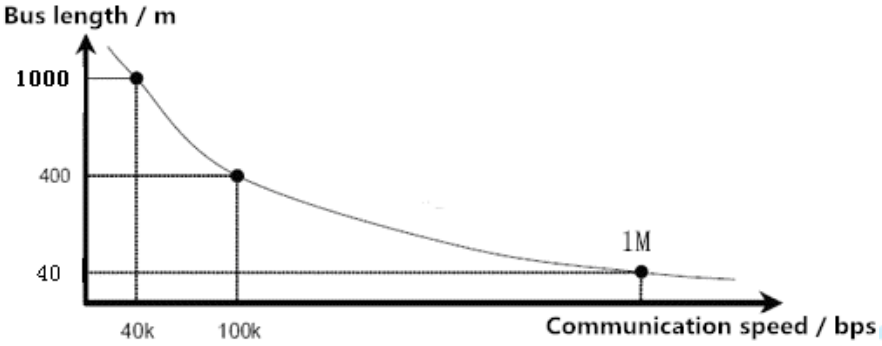

Fig.3 Transmission rate to bus length table

1.4 Number of nodes supported by CAN bus

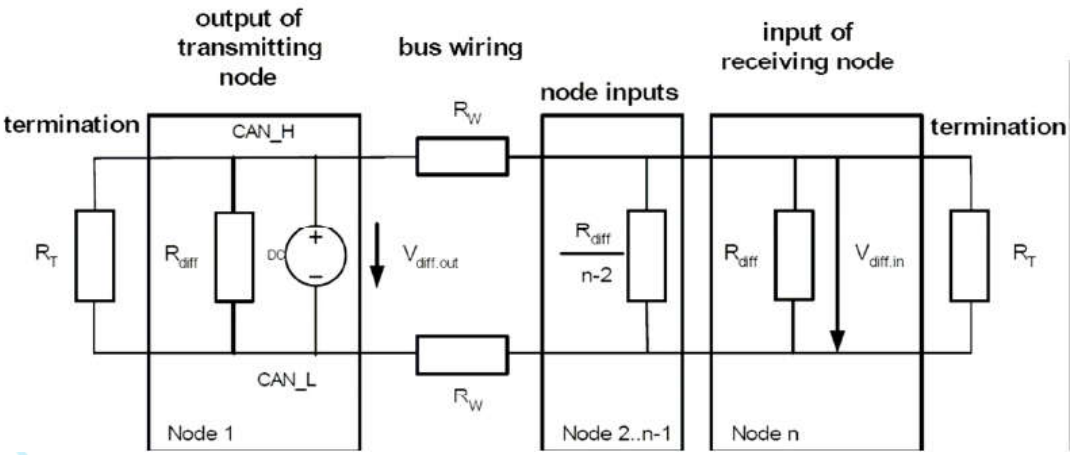

Fig.4 CAN bus equivalent impedance diagram

$$\frac{R_T.\min \times Rdiff.\min}{n_{\max} \times R_T.\min + 2Rdiff.\min} > R_L.\min$$

Rearrangde to nmax: $$n_{\max} < \mathrm{R}diff.\min \times (\frac{1}{R_L.\min} - \frac{2}{R_T.\min})$$

Transceiver	$R_{Diff.min}$ (kΩ)	$V_{CC.min}$ (V)	$R_{L.min}$ (Ω)	Number of Nodes ($R_{T.min}$=118 Ω)	Number of Nodes ($R_{T.min}$=130 Ω)
TJA1050	25	4.75	45	131	170
		4.9	39	217	256
PCA82C250	20	4.9	45	105	136

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1.5 Matching resistance of CAN bus terminal match resistance

According to ISO11898-2, CAN bus transmission medium must meet the specifications in Table 2 & 3.

Table.2 Transfer twisted pair parameters (shielded or unshielded)

Parameters	Sign	Units	Value			Condition
			Minimum value	Typical value	Maximum value	
Impedance	Z	Ω	95	120	140	Between CANH & CANL
Bus electrical resistivity	R	mΩ/m		70		
transport delay		ns/m		5		

Table.3 Recommended parameters for different transmission cables

Bus length	Cable		Terminal resistance	Maximum baud rate
	DC resistance	Cable sectional area		
0—40m	70mΩ/m	0.25mm2~0.34mm2 AWG23, AWG22	124Ω/1%	1Mbps at 40m
40m-300m	<60mΩ/m	0.34mm2~0.6mm2 AWG22, AWG20	127Ω/1% 2*)	>500Kbps at 100m
300m-600m	<40mΩ/m	0.5mm2~0.6mm2 AWG20	127Ω/1% 2*)	>100Kbps at 500m
600m-1km	<20mΩ/m	0.75mm2~0.8mm2 AWG18	127Ω/1% 2*)	>50Kbps at 1km

(1) Recommended values for cable AC parameters: 120Ω characteristic resistance, 5ns / m delay.

(2) In order to minimize the voltage attenuation caused by the DC resistance of the cable, matching a larger terminal resistance value would help to increase the bus length (e.g., use non-standard 150Ω ~ 300Ω whilst the reference value "118Ω <RL <130Ω" by ISO11898 standard).

1.6 Factors affecting communication quality in practical wiring

① The shorter the communication distance, the better the communication quality is. If communication distance is beyond 500 meters, it is recommended to add a repeater.

② The fewer the communication nodes, the better the communication quality is. If the number of

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nodes is more than 110, it is recommended to add a repeater.

③ The lower the communication baud rate, the better the communication quality is. In cases where application requirements are met, select the lower communication baud rate as much as possible. It is recommended to select between 10K-250Kbps.

④ The smaller the equivalent capacitance of the protection device between A and B ports, the less it affects communication. Thus, it is necessary to consider the equivalent capacitance when selecting protection device of ports (TVS tubes, varistors, etc.)

⑤ Branches of each communication node must be as short as possible to reduce the impact of signal reflection of the branches to the bus.

⑥ Appropriate terminal resistor can effectively reduce signal reflection. It is generally recommended to connect 120Ω resistors.

⑦ Using the shielded twisted-pair, connect all communication node reference ground through the shield and ground at one point. This will reduce interference, as well as improve communication quality.

2. Precautions for hardware interface design

2.1 Isolation design of CANH and CANL bus ports

CAN bus nodes are generally networked in daisy-chained or bus-topology. Once a failure occurs in the interface chip of a node, it may affect the quality of the entire network communication. Therefore CANH, CANL and bus should be isolated. When short circuit or power breakdown of CANH / CANL occurs on a node interface chip, potential barrier will form between the bus and the nodes, thereby reducing the impact on the bus.

2.2 Protection of CAN bus port

CAN bus communication is generally used in long distance transmission. Therefore the designer has to consider CANH/ CANL bus port lightning protection design. Common lightning protection design circuit is as shown in fig.5. Refer to the datasheet of TD_CAN series for the relevant parameters of the device. TD_CAN series module internal CANH / CANL line comes with built-in ESD protection function, so generally users no longer need external ESD

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protection devices.

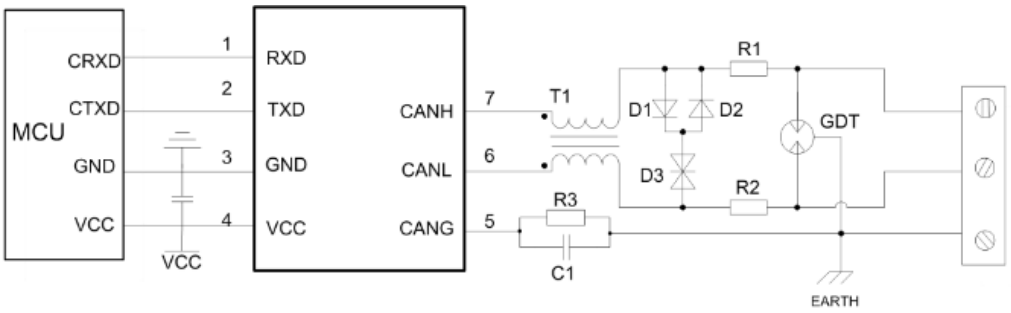

Fig.5 Port protection recommended circuit

2.3 Connection of bus reference ground

The CAN bus uses a differential mode to transmit the signal. It seems to no need a relative reference point to distinguish the signal and the system only needs to detect the potential difference between the two lines. But the designer should also consider the common-mode withstand voltage range of the CAN interface module. Only to meet this condition will the entire network work properly. When the common-mode voltage in the network line exceeds this range, it will affect the stability and reliability of communication, and even damage the interface. Using isolation technology can effectively solve the problem of common mode noise. So using TD_CAN isolated transceiver to build bus hardware port can isolate ground loops on each node on the bus and reduce the ground loop current between nodes, thereby reducing common mode interference. But for the serious interference and harsh electrical environment, it recommends designers to use shielded twisted pair. The bus reference ground of each communication node on the bus is connected through the shield to reduce common mode and radiation interference and to improve system reliability (as shown in fig.6).

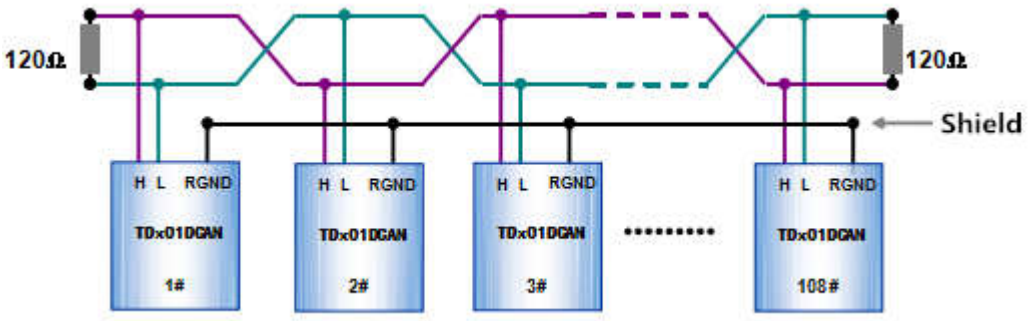

Fig.6 TD_CAN bus reference ground wiring diagram

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3. FAQs and solutions

Table.4 FAQs and solutions

Failure Phenomenon	Probable causes	Solutions
Unable to Communicate	H and L polarity reversed	Change H and L polarity
	inconsistent baud rate of each node	Adjust the baud rate of each node to be consistent
	incorrectly set CAN controller	Re-set the CAN controller to ensure the same parameters of the bus nodes in the design
	Wrong selection of the modules (e.g. 3Vdc input products and 5Vdc input products are incompatible)	elect the compatible module according to the power supply of the SCM (e.g. select TD3xx series if 3.3V power supply needed, select TD5xx series if 5V power supply needed)
	Unconformity baud rates of transmitter and receiver	Adjust and conform the baud rate of transmitter and transceiver
	CAN bus protection timeout	1) Increase the baud rate; 2) Use a transceiver module with lower speed
High error rate	inaccurate baud rate timer clock	Use a crystal oscillator with a suitable frequency (e.g. 16M)
	Unexpected high communication baud rate	Reduce communication baud rate
	non-matched terminal matching resistance	Select the appropriate terminal matching resistor
	Too large parasitic capacitor from peripheral devices	Use the devices with smaller parasitic capacitor
	Without CAN message modulation	Use a SCM with CAN controller
	Too many communication nodes	Add CAN repeater
	Communication distance too far	Add CAN repeater
	Short waiting time between the bus reception and transmission status	Increase the waiting time between two states
	Too strong external environment interference	Use a shielded transmission cable

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4. Recommendation of TD/TLA_CAN model selection

Table.5 Product selection

Channels	Features	Part No.	Vin (VDC)	Transmission rate(bps)	Nodes	Isolation (VDC)	note
Single	Universal	TD301DCAN	3.3	5K-1Mbps	110	3KV	DIP8
		TD501DCAN	5.0	5K-1Mbps	110	3KV	
		TDH301DCAN	3.3	5K-1Mbps	110	5kVAC	
		TDH501DCAN	5.0	5K-1Mbps	110	5kVAC	
		TD321DCAN	3.3	5K-1Mbps	110	3KV	Open-frame
		TD521DCAN	5.0	5K-1Mbps	110	3KV	
		TD321SCAN	3.3	5K-1Mbps	110	3KV	Open-frame SMD
		TD521SCAN	5.0	5K-1Mbps	110	3KV	
	Low consumption	TD301DCANH-W	3.3	40K-1Mbps	110	3KV	DIP8
		TD501DCANH-W	5.0	40K-1Mbps	110	3KV	
	Enhanced	TD301DCANH3	3.3	40K-1Mbps	110	2.5KV	DIP8
		TD501DCANH3	5.0	40K-1Mbps	110	2.5KV	
		TD321DCANH	3.3	40K-1Mbps	110	3KV	Open-frame
		TD521DCANH	5.0	40K-1Mbps	110	3KV	
		TD521SCANH	3.3	40K-1Mbps	110	3KV	Open-frame SMD
		TD521SCANH	5.0	40K-1Mbps	110	3KV	
		TD331SCANH	3.3	40k-1M	110	2.5KV	SMD12
		TD531SCANH	5	40k-1M	110	2.5KV	
	Surge protected	TD301DCANHE	3.3	20K-1Mbps	110	2.5KV	DIP8
		TD501DCANHE	5.0	20K-1Mbps	110	2.5KV	
	Compact size	TD301MCAN	3.3	40K-1Mbps	110	2.5KV	DIP8
		TD501MCAN	5.0	40K-1Mbps	110	2.5KV	
	IC	TD041SCANFD	3.3-5/5	40K-1Mbps	110	3750VAC	DFN16
		TD541SCANFD	5.0	40K-1Mbps	110	3000VDC	DFN20
		TDH541SCANFD	5.0	40K-1Mbps	110	5000VDC	DFN20
	IC Package	TDA51SCANHC	5.0	40K-1Mbps	110	5000Vrms	SOIC16
	CANFD	TD301MCANFD	3.3	40K-5Mbps	110	2.5KV	DIP8
		TD501MCANFD	5.0	40K-5Mbps	110	2.5KV	
		TD331SCANFD	3.3	40K-5Mbps	110	2.5KV	SMD12
		TD531SCANFD	5.0	40K-5Mbps	110	2.5KV	
		TD041SCANFD	3.3-5/5	40K-5Mbps	110	3750VAC	DFN16
		TD541SCANFD	5.0	40K-5Mbps	110	3000VDC	DFN20
		TDH541SCANFD	5.0	40K-5Mbps	110	5000VDC	DFN20

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	Automotive	CTD331SCANH	3.3	40k-1M	110	2.5KV	SMD12
		CTD531SCANH	5	40k-1M	110	2.5KV	
	Protocol Conversion	TD3USPCAN	3.3	5k-1M	110	3.0KV	DIP24
		TD5USPCAN	5	5k-1M	110	3.0KV	
	ACDC power supply integrated CAN bus	TLA03-03KCAN	115V AC /277V AC	5k-1M	110	4000VAC	3.3VDC output
		TLA05-03KCAN		5k-1M	110	4000VAC	5.0VDC output
		TLA12-03KCAN		5k-1M	110	4000VAC	12VDC output
Duplex	Two-port isolation	TD302DCAN	3.3	5K-1Mbps	110	2.5KV	DIP12
		TD502DCAN	5.0	5K-1Mbps	110	2.5KV	
	Two-port isolation; channel isolation	TD322DCAN	3.3	40K-1Mbps	110	3KV	
		TD522DCAN	5.0	40K-1Mbps	110	3KV	

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