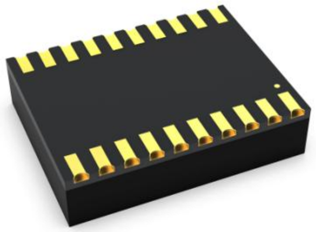
TD(H)541S485S-FT
DFN package isolated RS485 Transceiver

Features

- Ultra-small, ultra-thin, chip scale DFN package
- Compliant with TIA/EIA-485-A standard
- Integrated isolated 5V power
- I/O power supply range supports 3.3V and 5V microprocessors(Specific application refer to " Recommendations ②")
- High isolation to 5000VDC (TD541S485S-FT 3000VDC)
- Bus-Pin ESD protection up to 15kV(HBM)
- Baud rate up to 20Mbps
- >25kV/us CMTI
- Low communication delay
- Full-duplex
- 1/8 unit load, up to 256 nodes on a bus
- Bus fail-safe
- Bus driver short circuit protection
- Industrial operating ambient temperature range: -40℃ to +105℃
- Meet AEC-Q100 standards
- Moisture Sensitivity Level (MSL) 3

Package



Applications

- Industrial Automation
- Building Automation
- Smart Electricity Meter
- Remote Signal Interaction, Transmission

Functional Description

TD(H)541S485S-FT is a full-duplex enhanced transceiver designed for RS–485 data bus networks, which is fully compliant with TIA/EIA-485-A standard and is suitable for data transmission of up to 20 Mbps. Their logic side supports 3.3V and 5V logic level conversion. Receivers have an exceptionally high input impedance, which places only 1/8 of the standard load on a shared bus and up to 256 transceivers.

The reliability design of A, B, Z, Y pin is emphasized, including driver output over current protection and enhanced ESD design. The ESD protection level of A, B, Z, Y pin can be up to 15kV (Human Body Model).

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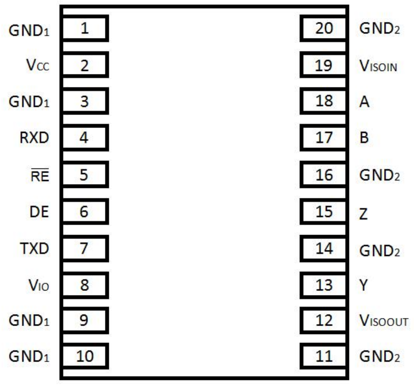
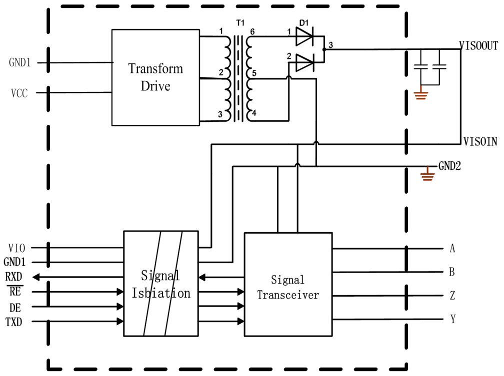
Contents

Pin Connection



Note: All GND1 pins are internally connected.
All GND2 pins are internally connected.

Internal Block



Function Table

Letter	Description
H	High-Level
L	Low-Level
X	Unrelated
Z	High Impedance

Table 1. Driver Function table

TXD	DE	Output	
		Y	Z
H	H	H	L
L	H	L	H
X	L	Z	Z
OPEN	H	H	L

Table 2. Receiver Function table

Difference input $V_{ID} = (V_A – V_B)$	$\overline{RE}$	RXD
–0.01 V ≤ V_{ID}	L	H
–0.2 V < V_{ID} < –0.01 V	L	Uncertainty
V_{ID} ≤ –0.2 V	L	L
X	H	H
Open circuit	L	H
Short circuit	L	H

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Pin Descriptions

Pin Number	Pin Name	Pin Functions
1	GND_1	Ground (Logic side).
2	V_{CC}	Power supply. By using 1uF ceramic capacitance ground(GND1).
3	GND_1	Ground (Logic side).
4	RXD	Receiver output pin.
5	$\overline{RE}$	Receiver enable input. When $\overline{RE}$ is low, if (A − B) ≥ −10 mV, then RXD = high. if (A − B) ≤ −200 mV, then RXD = low.
6	DE	Driver enable input. When DE is high, outputs are enabled. When DE is low, outputs are high impedance. Drive DE low and $\overline{RE}$ high to enter shutdown mode.
7	TXD	Driver input pin.
8	V_{IO}	Power supply of Logic side. By using 0.1uF ceramic capacitance ground(GND1).
9	GND_1	Ground(Logic side).
10	GND_1	Ground(Logic side).
11	GND_2	Ground (Bus Side).
12	V_{ISOOUT}	Insulation power output. By using 1uF Ceramic capacitance ground(GND2, pin11). The pin needs to be connected to pin19 in application.
13	Y	Driver Noninverting Output.
14	GND_2	Ground (Bus Side).
15	Z	Driver inverting Output.
16	GND_2	Ground (Bus Side).
17	B	Receiver Inverting Input.
18	A	Receiver Noninverting Input.
19	V_{ISOIN}	Insulation power input. By using 0.1uF ceramic capacitance ground(GND2, pin20). The pin needs to be connected to pin12 in application.
20	GND_2	Ground (Bus Side).

Absolute Maximum Ratings

General test conditions: Free-air, normal operating temperature range (Unless otherwise specified).

Parameters	Unit
Supply voltage (V_{CC}, V_{IO})	-0.3V to +6V
A, B, Z, Y Bus voltage	-8V to+13V
Digital Input Voltage (DE, $\overline{RE}$, TXD, RXD)	-0.3V to+6V
Operating Temperature Range	−40°C to +105°C
Storage Temperature Range	−50°C to +125°C
Reflow Soldering Temperature	Peak temp. ≤250℃, maximum duration ≤60s at 217℃. Please also refer to IPC/JEDEC J-STD-020D. 3.

Important: Exposure to absolute maximum rated conditions for an extended period may severely affect the device reliability, and stress levels exceeding the “Absolute Maximum Ratings” may result in permanent damage.

Recommended Operating Conditions

Symbol	Recommended Operating Conditions		Min.	Typ.	Max.	Unit
V_{CC}	Supply voltage		4.5	5	5.5	V
V_{IO}	Supply voltage		3.0	5	5.5	
V_I	Voltage at any bus terminal (differential or common mode)		-7		12	
V_{IH}	High-level input voltage(TXD, DE, $\overline{RE}$)		2.375		V_{IO}	
V_{IL}	Low-level input voltage(TXD, DE, $\overline{RE}$)		0		0.8	
I_{OS}	Output current	Driver	-60		60	mA
		Receiver	-8		8	
R_{IN}	Differential output load resistance		54	60		Ω
T_A	Operating temperature range		-40		105	℃
-	Signaling rate				20	Mbps

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Electrical Characteristics

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
Driver						
$\lvert V_{OD}\rvert$	Differential driver output	No load	3.0			V
		R_L = 54Ω, Figure 7	1.5	2.0		V
		R_L = 100Ω, Figure 7	2.0			
ΔV_{OD}	$\Delta\lvert V_{OD}\rvert$ for complementary output states	R_L = 54Ω, Figure 7			±0.2	V
V_{OC}	Common-Mode output voltage	Figure 6	1		3	V
$\Delta V_{OC(SS)}$	$\Delta\lvert V_{OC}\rvert$ for complementary output states	Figure 6	-0.1		0.1	V
I_{OS}	Output short-circuit current	-7V ≤ V_{OUT} ≤ 12V		±110	±250	mA
Receiver						
$V_{IT(+)}$	Positive differential input threshold voltage	−7 V ≤ V_{CM} ≤ +12 V			–10	mV
$V_{IT(-)}$	Negative differential input threshold voltage	−7 V ≤ V_{CM} ≤ +12 V	–200			mV
V_{hys}	Hysteresis voltage ($V_{IT+} – V_{IT–}$)	−7 V ≤ V_{CM} ≤ +12 V		20		mV
R_{ID}	Differential input resistance(A, B)	−7 V ≤ V_{CM} ≤ +12 V	96			kΩ
I_I	Input current (A, B)	DE=0, $\overline{RE}$ =0, V_{CC}=0 or 5V V_{OUT} = 12V		190	250	uA
		V_{OUT} = -7V	-200	-110		uA
V_{OH}	RXD output high voltage	I_{OUT} = 20 μA, $V_A − V_B$ = 0.2 V	V_{IO} − 0.1			V
		I_{OUT} = 4 mA, $V_A − V_B$ = 0.2 V	V_{IO} − 0.4	V_{IO} − 0.2		V
V_{OL}	RXD output low voltage	I_{OUT} = −20 μA, $V_A − V_B$ = −0.2 V			0.1	V
		I_{OUT} = −4 mA, $V_A − V_B$ = −0.2 V			0.4	V
Power supply and safeguard characteristic						
I_{CC}	Supply current	DE = $\overline{RE}$ = 0V		15	30	mA
I_{CC}	Working current	Between Y, Z 100Ω load		60	100	mA
		Between Y, Z 54Ω load		75	120	mA
ESD	HBM	A, B, Z, Y to GND			±15	kV
		Other pin			±2	kV
	Contact	A, B, Z, Y to GND			±4	kV
EFT	IEC61000-4-4	A, B, Z, Y and GND			±2	kV
SURGE	IEC61000-4-5	A, B, Z, Y and GND(Common Mode)			±2	kV
VI-O	Insulate voltage	TD541S485S-FT			3000	VDC
		TDH541S485S-FT			5000	VDC
	Insulate impedance		1			GΩ
	Insulate capacitance			3		pF
CMTI	Common mode transient immunity	TXD = V_{CC} or 0 V, V_{CM} = 1 kV, transient magnitude = 800 V	25			kV/us

Transmission Characteristics

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
-	Maximum data rate	Duty 40% ~ 60%			20	Mbps
T_{PHL}, T_{PLH}	Driver propagation delay	R_L = 54Ω, C_L = 50pF, Figure 8		25	90	ns
$\lvert T_{PHL}$-$T_{PLH}\rvert$	Driver skew ($\lvert T_{PHL}$ - $T_{PLH}\rvert$)				15	ns
T_R, T_F	Driver rise/fall time				60	ns
T_{PHL}, T_{PLH}	Receiver propagation delay	C_L = 15pF Figure 9		60	150	ns
$\lvert T_{PHL}$-$T_{PLH}\rvert$	Receiver skew ($\lvert T_{PLH}$ - $T_{PHL}\rvert$)			10	20	ns
T_R, T_F	Receiver rise/fall time	C_L = 15pF Figure 9		25		ns

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Physical Specifications

Parameters	Value	Unit
Weight	0.9(Typ.)	g

Typical Performance Curves

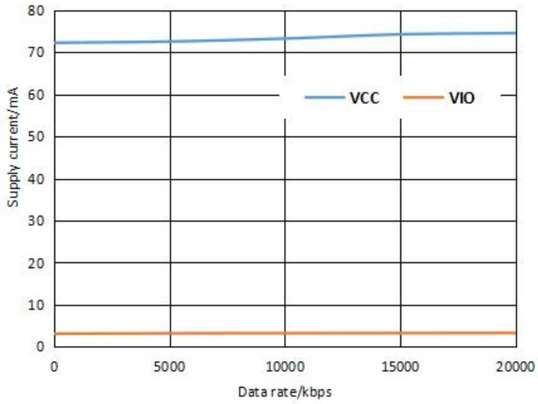

Figure 1. Supply current vs. Data rate

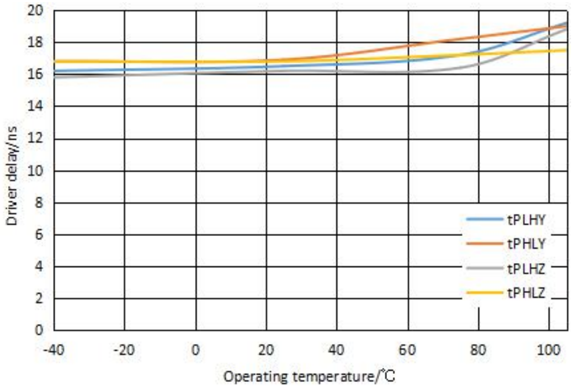

Figure 2. Driver delay vs. Operating temperature

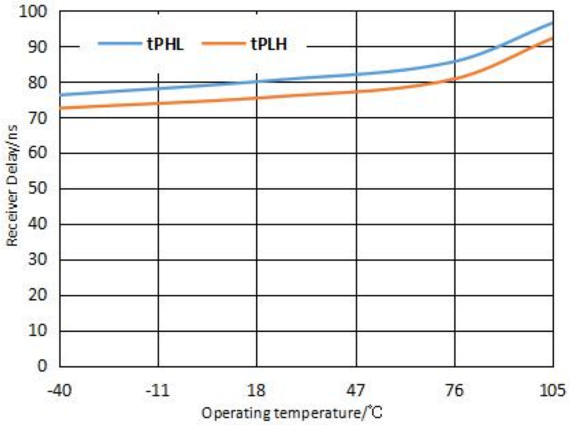

Figure 3. Receiver delay vs. Operating temperature

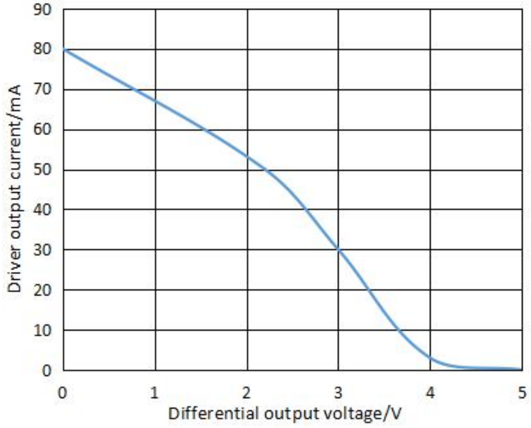

Figure 4. Driver output current vs. Differential output voltage

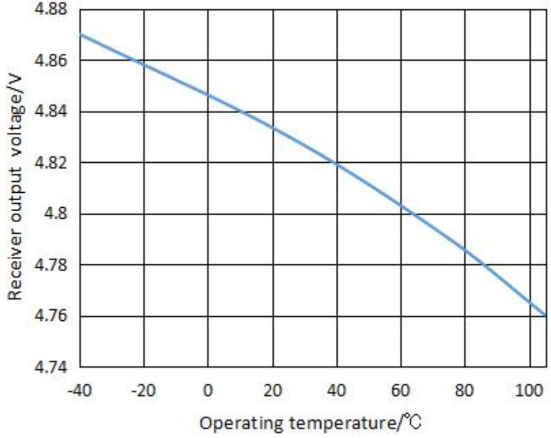

Figure 5. Receiver output high voltage vs. Operating temperature

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Test Circuits

Note: The load capacitance of the test conditions includes the parasitic capacitance of the test probe and the test fixture (no special instructions). The rising and falling edges of the test signal are less than 6ns, the frequency is 100kHz, and the duty cycle is 50%. Impedance matching Zo = 54Ω (no special instructions).

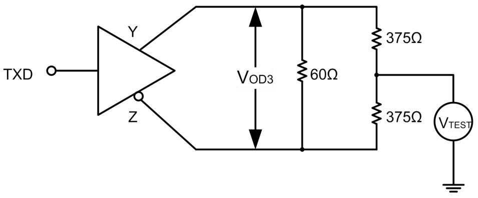

Fig 6. Common Mode Output Test Circuit

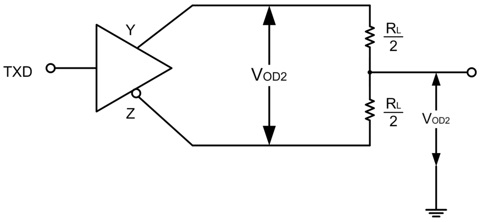

Fig 7. Differential output test circuit

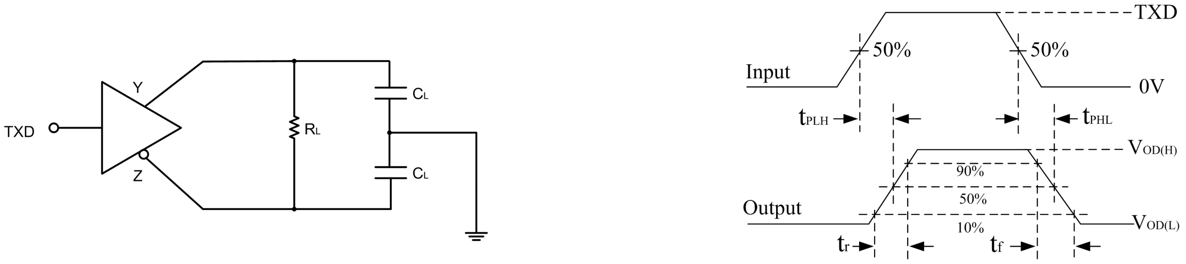

Fig 8. Send Delay Test Circuit

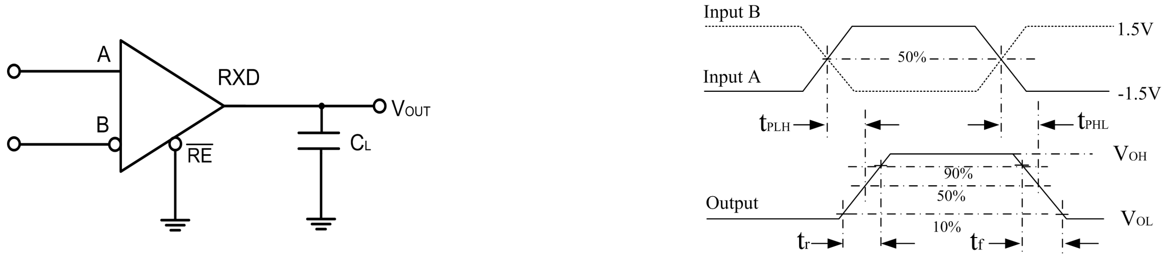

Fig 9. Receive delay test circuit

Detailed Description

TD(H)541S485S-FT is a full-duplex enhanced RS485 isolated transceiver with isolated power supply. In addition to an isolated power supply, each transceiver contains a drive and a receiver. The transceiver has a standby bus failure protection function to ensure that the receiver output is high when the receiver input is open, short, or when the bus is idle. TD(H)541S485S-FT adopts 5VDC power supply. The whole machine can monitor the overall working state of the module and limit the output high current, so as to prevent the bus overload or short circuit from causing non-recoverable damage to the transceiver.

Receiver input filter: TD(H)541S485S-FT receiver integrated high performance input filter, the filter can greatly enhance the receiver's noise suppression ability to high speed differential signal. Therefore, the transmission delay of the receiver is also caused by this reason.

Bus failure protection: In general, when -200mV < A - B < -10mV, the bus receiver will be in an uncertainty state.This phenomenon occurs when the bus is idle. Bus failure protection ensures that the receiver outputs a high level when the receiver input is open, short, or when the bus access port matches the resistance. TD(H)541S485S-FT receiver threshold voltage is relatively accurate, and the threshold voltage to the reference ground has a margin of at least 10mV, which can ensure that even if the bus differential voltage is 0V, the receiver output level is high, and meets the requirements of EIA/TIA-485 standard ±200mV.

The bus load capacity (256 point): standard RS485 receiver input impedance is defined as 12 kΩ (unit load). A standard RS485 driver can drive at least 32 load units. TD(H)541S485S-FT bus receiver designed by 1/8 unit load, the input impedance is greater than 96 kΩ. As a result, the bus allows access to more transceivers (up to 256). TD(H)541S485S-FT can also be mixed with the standard RS485 transceiver with 32 unit loads (cumulative receiver load cannot exceed 32 units).

Low power SHUTDOWN mode: When high level is input and low power is input, the transceiver enters SHUTDOWN mode. When the transceiver enters off mode, its overall standby power consumption decreases, DE can be short-connected and controlled by the same I/O. If the high level is input and the holding time of DE low level is less than 50ns, the transceiver cannot enter the off mode. If the holding time can be maintained at least 600ns, the transceiver will reliably enter the off mode.

Drive output protection: TD(H)541S485S-FT internal integrated drive short circuit (or overcurrent) protection module. In case of bus error or driver short circuit, the module can limit the output current of the driver within a certain limit.

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Application Circuit

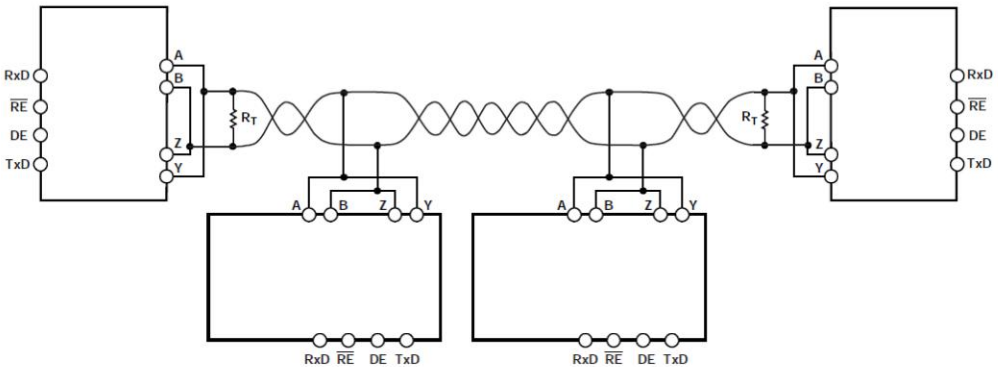

Fig 10. Typical Application Circuit (Half-Duplex Network Topology)

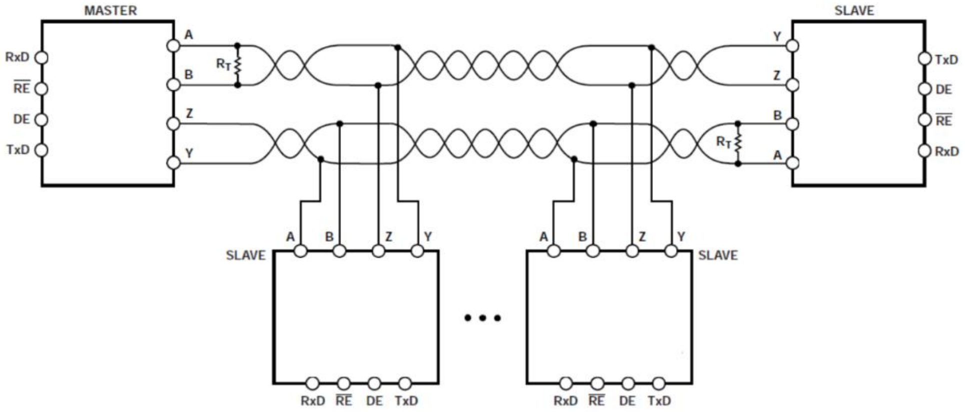

Fig 11. Typical Application Circuit (Full-Duplex Network Topology)

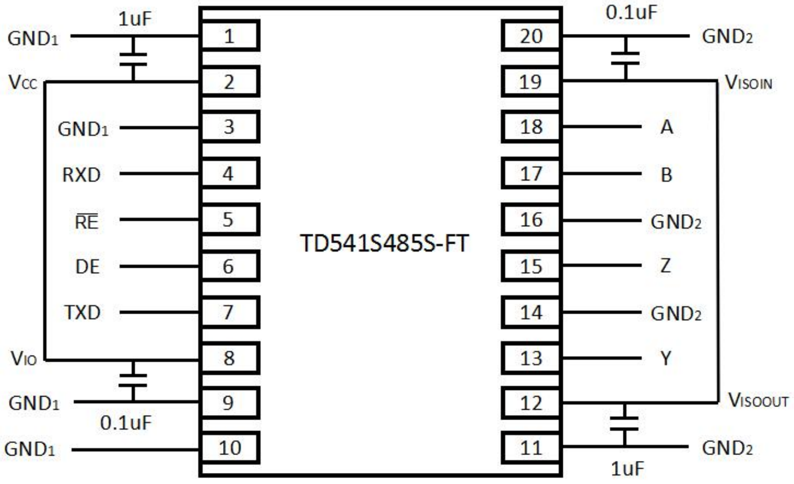

Fig 12. Typical Application of PCB layout

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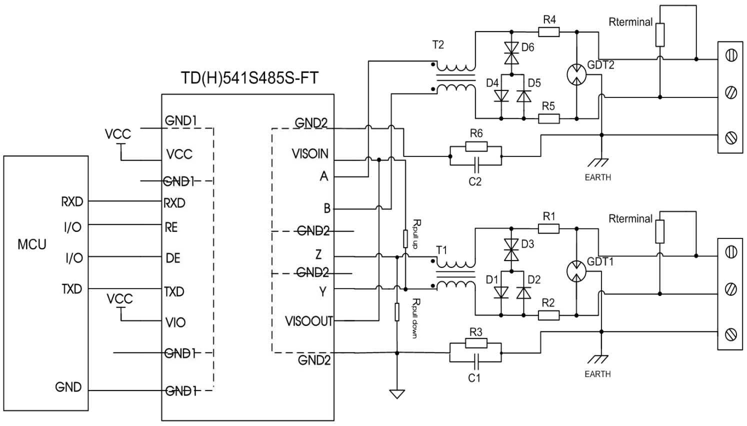


Figure13. Port Protection Recommended Circuit

Recommended components and values:

Component	Recommended part, value	Component	Recommended part, value
R3,R6	1MΩ	R1,R2,R4,R5	2.7Ω/2W
C1,C2	1nF, 2kV	D1,D2,D4,D5	1N4007
T1,T2	ACM2520-301-2P	D3,D6	SMBJ8.5CA
GDT1,GDT2	B3D090L	$R_{terminal}$	120Ω

As the modules internal A / B / Z / Y lines come with its own ESD protection, which generally satisfy most application environments without the need for additional ESD protection devices. For harsh and noisy application environments such as motors, high voltage/current switches, lightning and similar however, we recommended that the user protects the module’s A / B / Z / Y lines with additional measures and external components such as TVS tube, common mode inductors, Gas discharge tube, shielded twisted pair of wires with the same single network Earth point. Figure 13 shows our recommended circuit diagram for such type of applications with components and values given in the table above. This recommendation is for reference only and may have to be adapted accordingly with appropriate component values in order to match the actual situation and application.

Note: Select the $R_{terminal}$ according to the actual application.

Recommendations

① Power isolation V_{ISOOUT} need through a series of capacitors connected to the output pin V_{ISOIN}, in addition to the mentioned in article 5 of the pull up and down function, the power supply is not recommended for other purposes, otherwise it may cause the bus voltage did not meet the requirements of communication, causes the communication failure.

② V_{IO} pin decide the output level of RXD pin. Normally, V_{IO} pin need to connected to the V_{cc} pin to support 5V microprocessors. V_{IO} pin need to disconnect to the V_{cc} pin and need a 3.3V power supply separately to support 3.3V microprocessors if necessary.

③ TXD contains a 10kΩ pull up resistor, DE and $\overline{RE}$ contains a 10kΩ pull down resistor each.

④ DE, $\overline{RE}$, TXD pin is always not allow to set to open drain output state connect the controller, otherwise it will lead to uncertain consequences.

⑤ To maintain bus idle stability, we need at least one node will pull up Y to V_{ISOIN} and drop down Z to GND2 on the bus. Overall network at the same time pull up and drop down resistors of the parallel value must around 380Ω to 420Ω(0.2W)

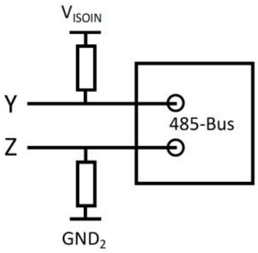


Figure14. Typical connection of pull-up and pull-down resistors

⑥ Hot-swap is not supported.

⑦ If the external input of TXD is insufficient, the pull-up resistor should be added according to the situation.

⑧ Refer to *IPC 7093* for the welding process design of this product. For detailed operation guidance, please refer to *Hot Air Gun Welding Operation Instruction for DFN Package Product* or *Welding Operation Instruction for DFN Package Product*.

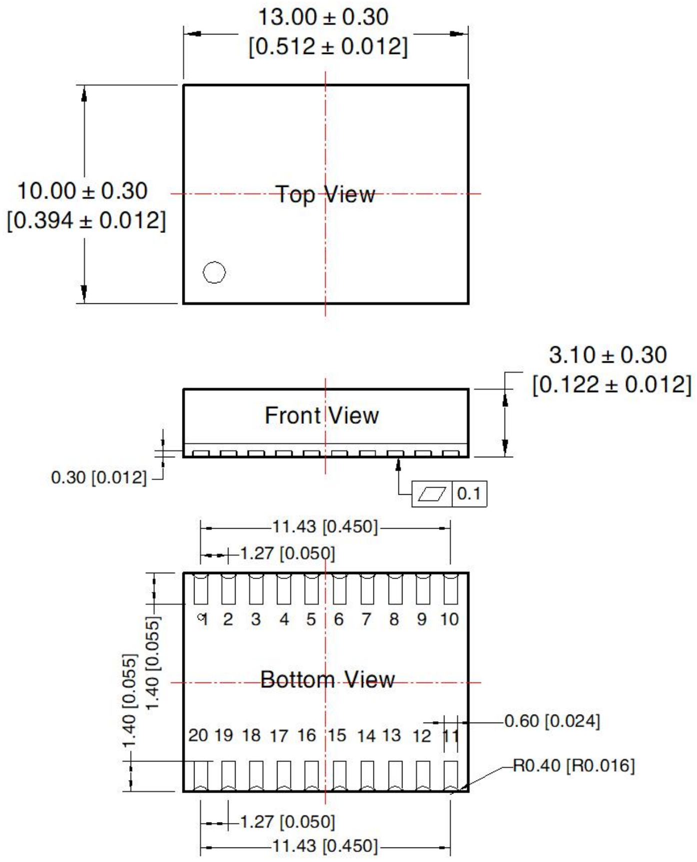
After-sales Service

1. Factory inspection and quality control are strictly enforced before shipping any product; please contact your local representative or our technical support if you experience any abnormal operation or possible failure of the module;
2. The products have a 3-year warranty period, from the date of shipment. The product will be repaired or exchanged free of charge within the warranty period for any quality problem that occurs under normal use.

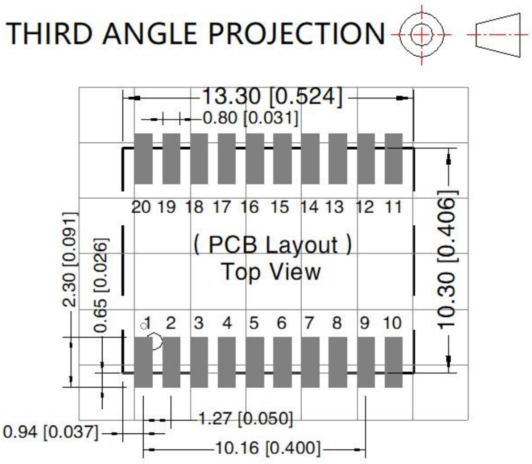
Ordering Information

Part number	Package	Number of pins	Product marking	Tape & Reel
TD541S485S-FT	DFN	20	TD541S485S-FT	1k/REEL
TDH541S485S-FT	DFN	20	TDH541S485S-FT	1k/REEL

Package Information



Note:
Unit: mm[inch]
Pin diameter tolerances: ± 0.10[± 0.004]



Note: Grid 2.54*2.54mm

Pin–Out			
Pin	Mark	Pin	Mark
1	GND1	11	GND2
2	VCC	12	VISOOUT
3	GND1	13	Y
4	RXD	14	GND2
5	RE	15	Z
6	DE	16	GND2
7	TXD	17	B
8	VIO	18	A
9	GND1	19	VISOIN
10	GND1	20	GND2

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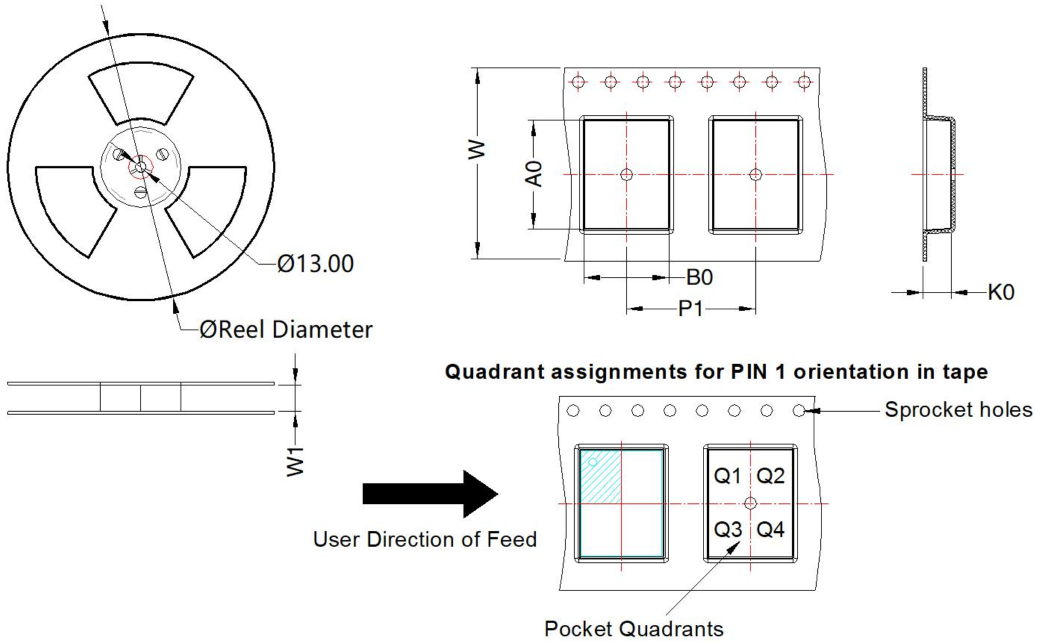
Tape & Reel Information



Quadrant assignments for PIN 1 orientation in tape

Device	Package Type	Pin	MPQ	Reel Diameter (mm)	Reel Width W1(mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TD(H)541S485H	DFN 10x13	16	1000	330.0	24.4	13.52	10.52	3.5	16.0	24.0	Q1
TD(H)541S485S-F											
TD(H)541SCANH		20									
TD(H)541SCANFD											
TD(H)541S485S-FT											

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