V6603H RS-485 Transceiver

Version: 0.2
Release Date: September 14, 2016

Specifications are subject to change without notice.

Revision History

Date	Version	Description
2016.02.05	0.1	Initial release
2016.09.14	0.2	• Added polarity detection and self-adaption • Updated power consumption in shutdown mode to 2μA

General Description

The V6603H is an RS-485 transceiver featuring half-duplex, low power consumption, low-slew-rate, polarity detection and self-adaption, and is completely compliant with the EIA/TIA-485 standard.

The V6603H integrates one driver and one receiver, both can be enabled independently. When both driver and receiver are disabled, the device will output the high impedance (Tri-State). The V6603H has high driving capability allowing up to 256 transmitters on the same communication bus. The low-slew-rate driver can reduce EMI and reflections caused by inappropriate terminal matching.

The V6603H can support the high-speed communication. The maximum communication speed is over 2 Mbps.

V6603H with built-in LDO can support the wide supply voltage input ranging from 3.3 V to 24 V. In the application of 3.3 V power supply, the input/output logic level is 3.3 V. In the application of 5-V power supply, the input/output logic level is 5 V. LDO can support the driving capability up to 60 mA.

The V6603H, with built-in pull-up and pull-down resistors, be of the 1.2 mA supply current under the no-load condition. In the shutdown mode, the power consumption is less than 2μA.

The V6603H is protected from faults due to shorted or open receiver input, over-temperature, over-current, and over-voltage protection. It features polarity detection and self-adaption which can eradicate connection failure due to mis-wiring.

Features

- Supply voltage range: 3.3 V ~ 24 V
- Half-duplex mode
- Maximum data rate: 2 Mbps @distance < 50 m, 1 Mbps @distance < 300 m
- High driving capability: Up to 256 transmitters on one bus
- Differential driver output: 1.3 V ≤ V_{OD} ≤ 5.0 V @54 Ω
- ESD protection: ±15 kV Human Body Model (HBM)
- Fail-safe receiver
- Over-temperature, over-current, and over-voltage protection
- Polarity detection and adaption, eradicating connection failure due to mis-wiring
- Low-slew-rate driver to minimize EMI and reduce reflections caused by inappropriate terminal matching
- Operation temperature: -40 °C ~ +85 °C
- Package: MSOP-10

Applications

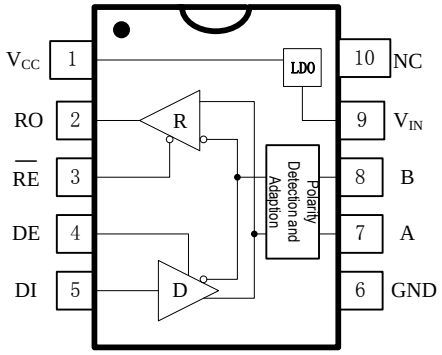
- Utility meters
- Industrial control

Table of Contents

Figure List

Table List

1. Pin Descriptions



No.	Pin	Description
1	V_{CC}	Positive supply input: 3.3V≤V_{CC}≤24V
2	RO	Receiver output. When $\overline{RE}$ is logic low, and (A-B)>-10mV, RO is logic high. When $\overline{RE}$ is logic low, and (A-B)<-50mV, RO is logic low.
3	$\overline{RE}$	Receiver output enable. When $\overline{RE}$ is logic low, RO is active. When $\overline{RE}$ is logic high, RO is in a high impedance state. When $\overline{RE}$ is logic high, and DE is logic low, the device enters low-power shutdown mode.
4	DE	Driver output enable. When DE is logic high, the driver output is enabled. When DE is logic low, the driver output is in a high impedance state. When $\overline{RE}$ is logic high, and DE is logic low, the device enters low-power shutdown mode.
5	DI	Driver input. When DE is logic high, logic low at DI enforces noninverting output low, and inverting output high. When DE is logic high, logic high at DI enforces noninverting output high, and inverting output low.
6	GND	Ground
7	A	Receiver positive input/Driver positive output Port A will be defined or redefined as noninverting or inverting according to the polarity detection.
8	B	Receiver negative input/Driver negative output Port B will be defined or redefined as noninverting or inverting according to the polarity detection.

No.	Pin	Description
9	V_{IN}	Positive supply input: $3.3V \le V_{IN} \le 24V$ V_{IN} should be connected to a 0.1-μF capacitor, and then connected to GND.
10	NC	NC

2. Truth Table

Table 2-1 Transmitting

Input			Output	
$\overline{RE}$	DE	DI	Inverting Output	Noninverting Output
Don't care	1	1	0	1
Don't care	1	0	1	0
0	0	Don't care	High impedance	High impedance
1	0	Don't care	Shutdown	

Table 2-2 Receiving

Input			Output
$\overline{RE}$	DE	A-B	RO
0	Don't care	>-10mV	1
0	Don't care	<-50mV	0
0	Don't care	Open/shorted	1
1	1	Don't care	High impedance
1	0	Don't care	Shutdown

In the table, **"1"** represents logic high, and **"0"** represents logic low.

Port A and B are defined or redefined as "driver inverting output" / "driver noninverting output", according to the polarity detection.

3. Specifications

All maximum/minimum specifications apply over the entire recommended operation range, unless otherwise noted. All typical specifications are at T_A=25°C, V_{CC}=10.0V unless otherwise noted.

All current into the device is positive, and all current out of the device is negative. All voltages are relative to the respective ground.

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Power						
Output Voltage	V_{CC}		3.3		24	V
No-load Regulation	$\Delta V_{OUT}/V_{OUT}$	7V≤V_{IN}≤20V		3		mV
Load Regulation	$\Delta V_{OUT}/V_{OUT}$	1mA≤I_{OUT}≤50mA		700		mV
Quiescent Current	I_Q			200		μA
Maximum Output Current	I_{PK}			60		mA
Minimum Input Voltage in No Load	$V_{IN,MIN}$			7		V
Temperature coefficient of Output Voltage	$\Delta V_{OUT}/\Delta T$	I_{OUT}=1mA		270		mV/℃
Driver						
Supply Voltage Range	V_{CC}		3.3		24	V
Driver Differential Outputs	V_{OD}	R_L=100Ω	2.0		V_{CC}	V
		R_L=54Ω	1.3	1.6	V_{CC}	
		No load			V_{CC}	
Change in Magnitude of Differential Output Voltage[1]	ΔV_{OD}	R_L=100Ω or 54Ω			0.2	V
Common-Mode Output Voltage	V_{OC}	R_L=100Ω or 54Ω		V_{CC}/2		V
Change in Magnitude of Common-Mode Output Voltage	ΔV_{OC}	R_L=100Ω or 54Ω			0.2	V
Input Threshold High	V_{IH}	DE, DI, $\overline{RE}$	3.0			V
Input Threshold Low	V_{IL}	DE, DI, $\overline{RE}$			0.8	V
Input Hysteresis	V_{HYS}	DE, DI, $\overline{RE}$		100		mV

[1] ΔV_{OD} denotes the change in magnitude of V_{OD}, and ΔV_{OC} denotes the change in magnitude of V_{OC}, when the DI input changes state.

Parameter	Symbol	Test Conditions		Min.	Typ.	Max.	Unit
Driver Short-Circuit Output Current[2]	I_{OSD}	$0 \le V_{OUT} \le +12V$			70		mA
		$-7V \le V_{OUT} \le V_{CC}$			-70		
Thermal-Shutdown Threshold	T_{TS}				150		°C
Thermal-Shutdown Hysteresis	T_{TSH}				30		°C
Receiver							
Receiver Differential Threshold Voltage	V_{TH}	$-7V \le V_{OUT} \le 12V$		-10		-50	mV
Receiver Input Hysteresis	ΔV_{TH}				20		mV
RO Threshold High	V_{OH}	I_O=-5mA		V_{CC}-0.7			V
RO Threshold Low	V_{OL}	I_O=5mA				0.5	V
Three-State Output Current at Receiver	I_{ORZ}	$0 \le V_O \le V_{CC}$				200	μA
Receiver Input Impedance	R_{IN}	$-7V \le V_{CM} \le 12V$		96			kΩ
Internal Pull-Up/Pull-Down Resistance	R_{BIAS}	$-7V \le V_{CM} \le 12V$			20		kΩ
Receiver Short-Circuit Output Current	I_{OSR}	$0 \le V_{RO} \le V_{CC}$			17	30	mA
ESD Protection							
A, B port ESD Protection		Human Body Model (HBM)			±15		KV
		Contact Discharge, IEC 61000-4-2			±15		KV
Supply Current							
Supply Current	I_{CC}	No load, $\overline{RE}$ =DE=V_{CC}	DI=V_{CC}		0.5	1	mA
			DI=0		0.9	1.25	mA
		No load, $\overline{RE}$ =DE=0	DI=0/V_{CC}		0.5	1	mA
Supply Current in Low-Power Shutdown Mode	I_{SHDN}	$\overline{RE}$=V_{CC}, DE=0				2	μA
Driver Switching Characteristics							

[2] The driver short-circuit output current denotes the peak current just prior to the foldback current limiting. The short-circuit foldback output current denotes the current hysteresis to allow a recovery from bus contention.

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Propagation Delay	t_{DPLH}	R_{DIFF}=54Ω, C_L=50pF			100	ns
	t_{DPHL}				100	ns
Driver Differential Output Rise or Fall Time					100	ns
Maximum Data Rate	F_{MAX}	Distance=50 m			2	Mbps
		Distance=302 m			1	Mbps
Receiver Switching Characteristics						
Propagation Delay	t_{RPLH}	$\|V_A-V_B\|\geq 2.0V$			80	ns
	t_{RPHL}	Rise or fall time is less than 15ns				ns
Receiver Input Rise or Fall Time	t_{RSKD}	$\|V_A-V_B\|\geq 2.0V$			80	ns
		Rise or fall time is less than 15ns				
Maximum Data Rate	F_{MAX}	Distance=50 m			2	Mbps
		Distance=302 m			1	Mbps
Temperature						
Operation Temperature	T_A		-40		+85	°C
Storage Temperature	T_S		-65		+150	°C
Lead Temperature (Soldering, 10s)				300		°C

4. Typical Operating Characteristics

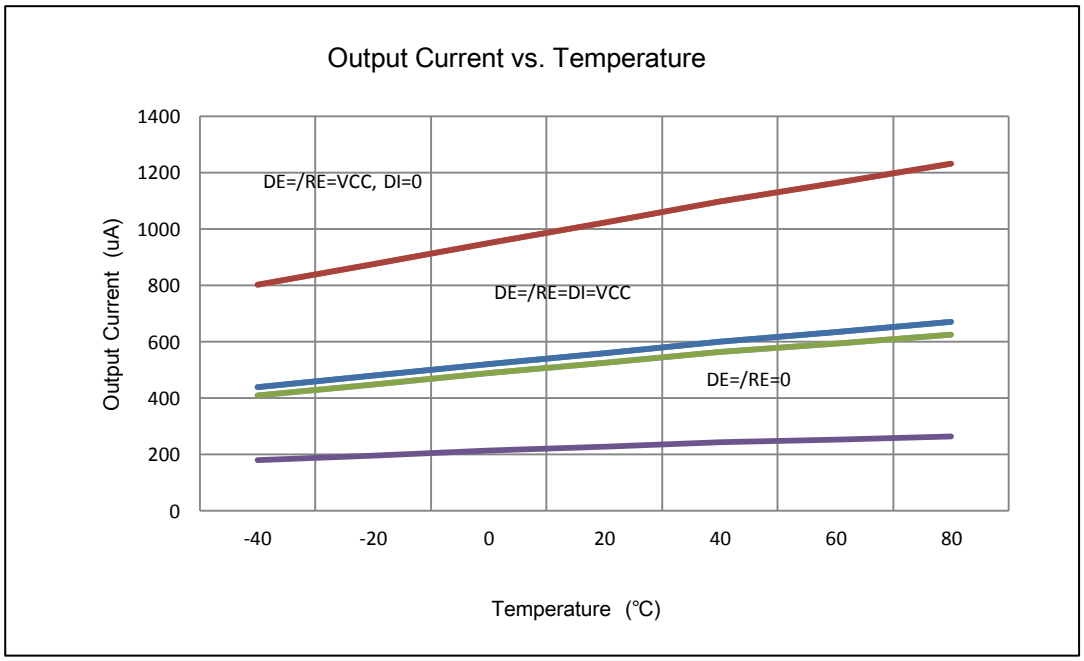


Figure 4-1 Output Current vs. Temperature

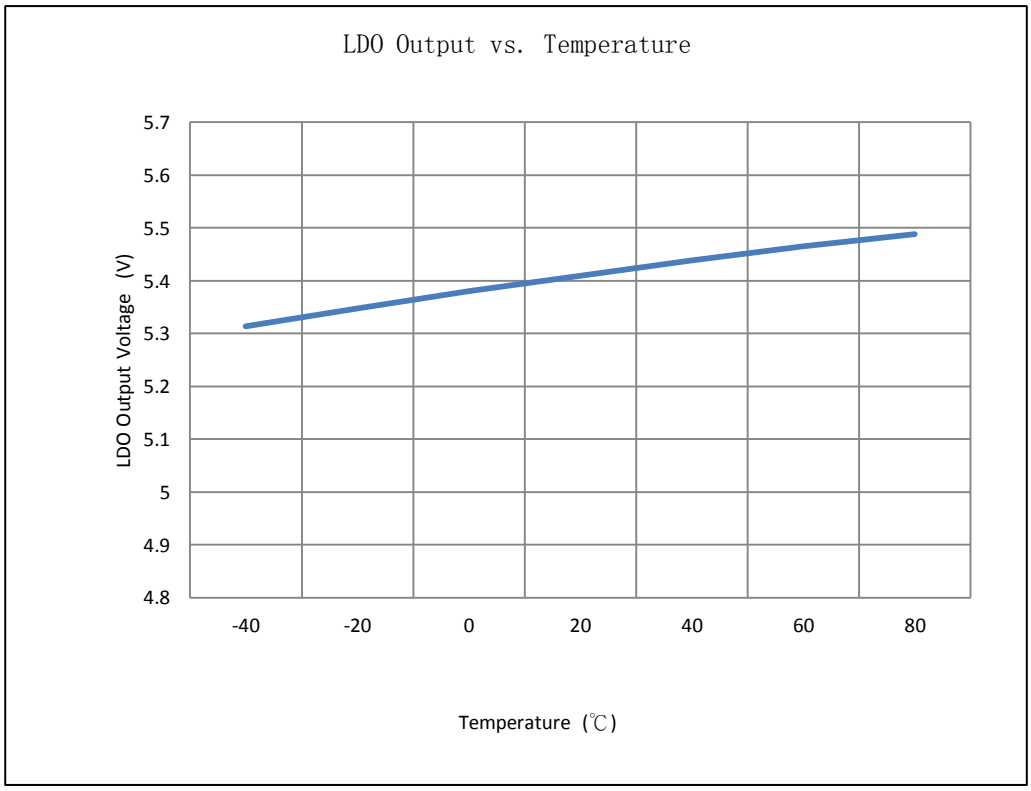


Figure 4-2 LDO Output Voltage vs. Temperature

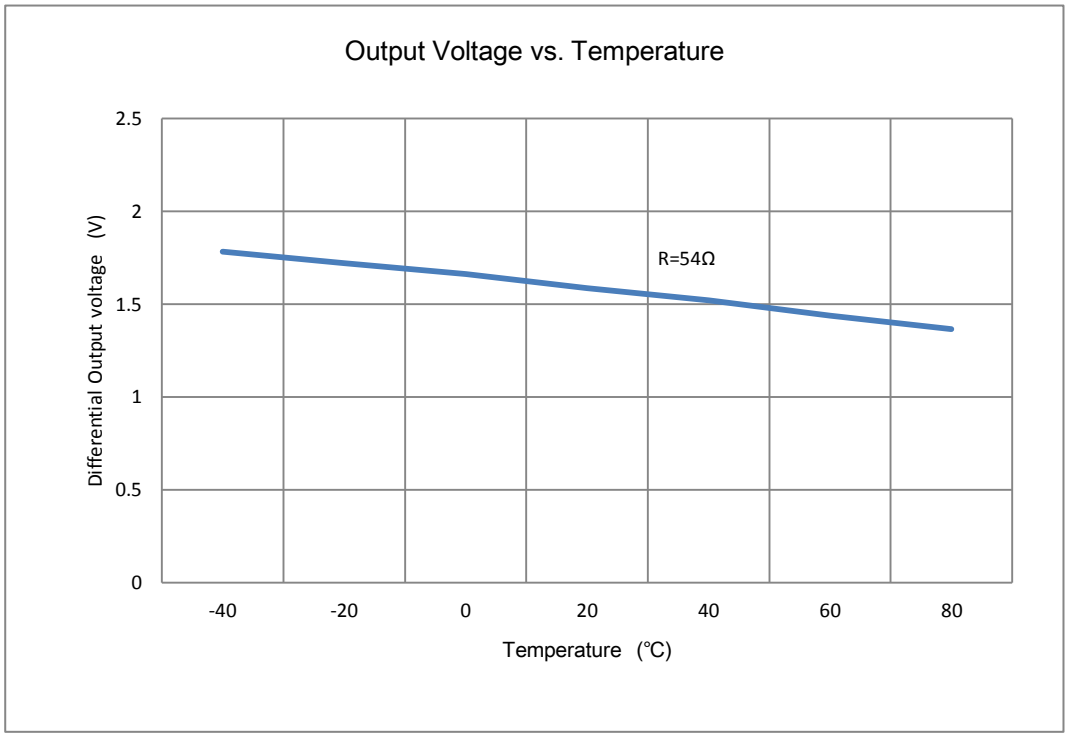


Figure 4-3 Driver Differential Output Voltage vs. Temperature

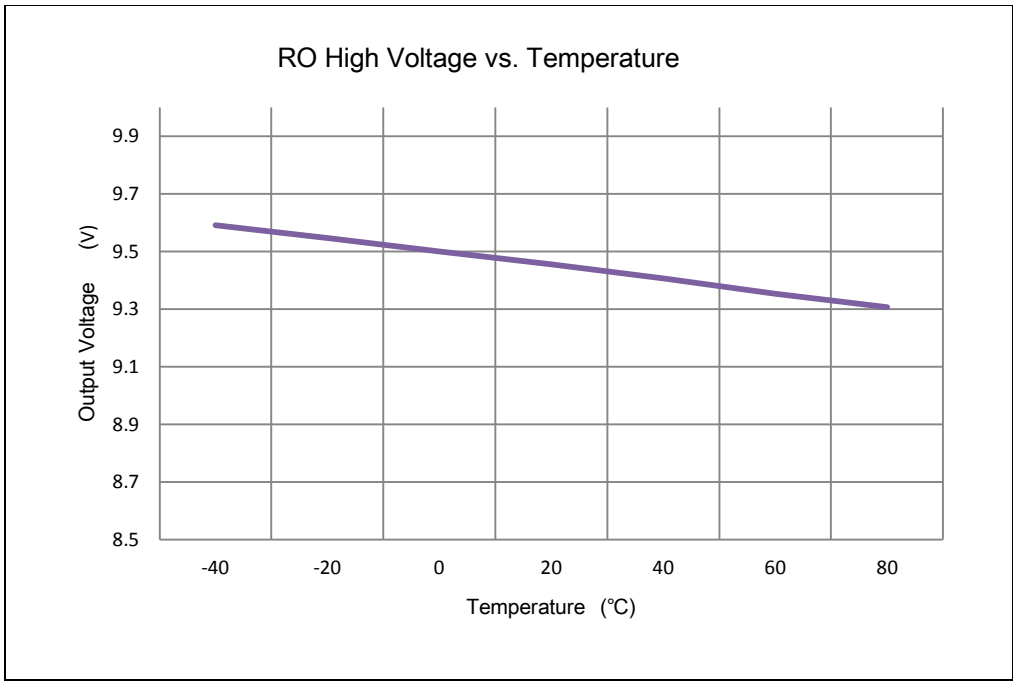


Figure 4-4 Receiver Output High Voltage vs. Temperature

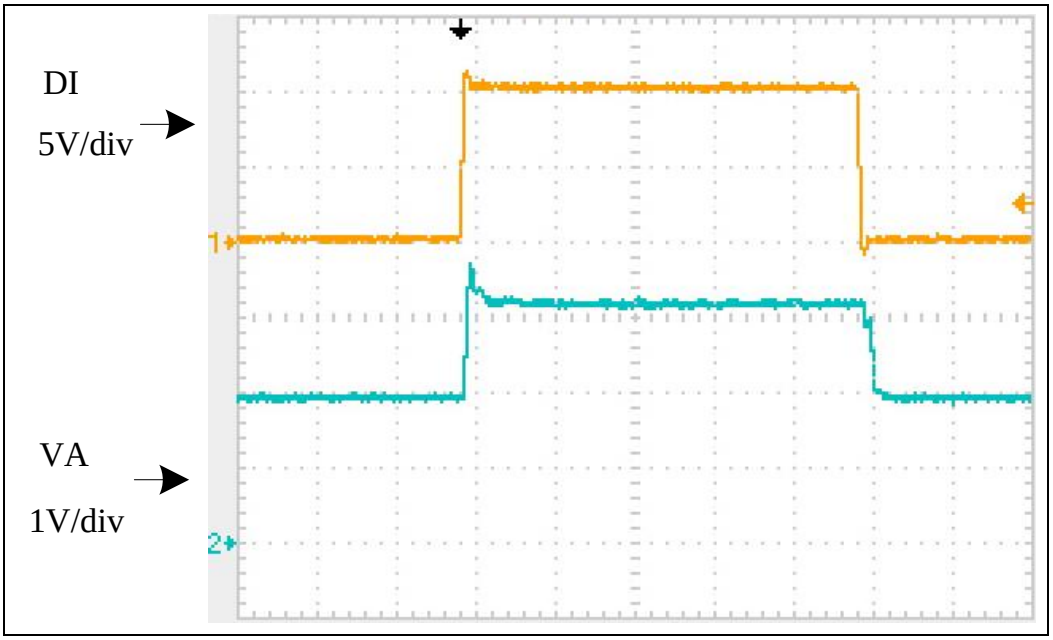


Figure 4-5 Driver Propagation Delay

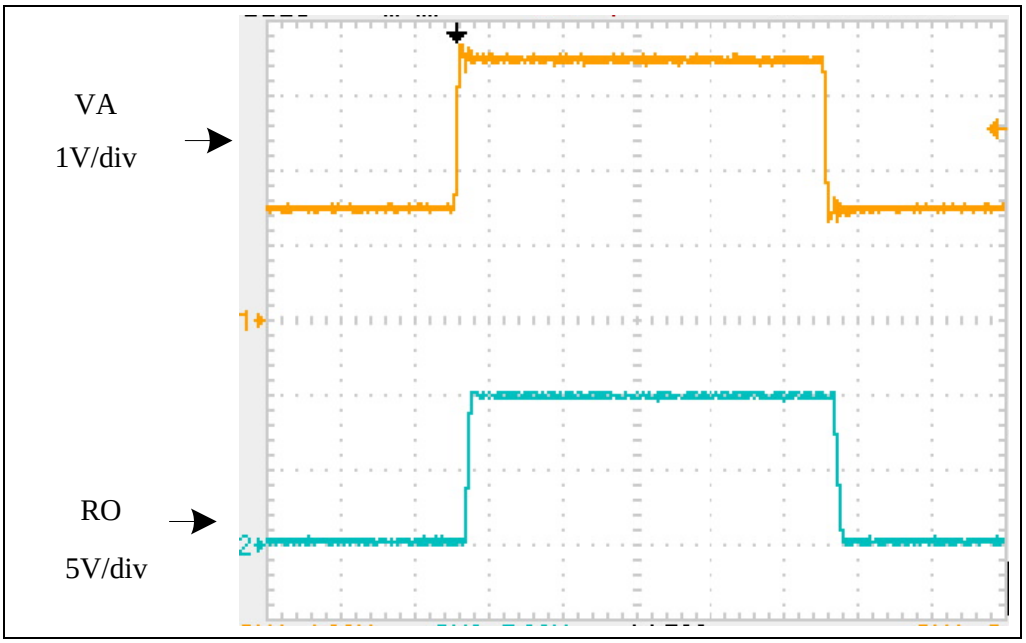


Figure 4-6 Receiver Propagation Delay

5. Test Circuits and Waveform

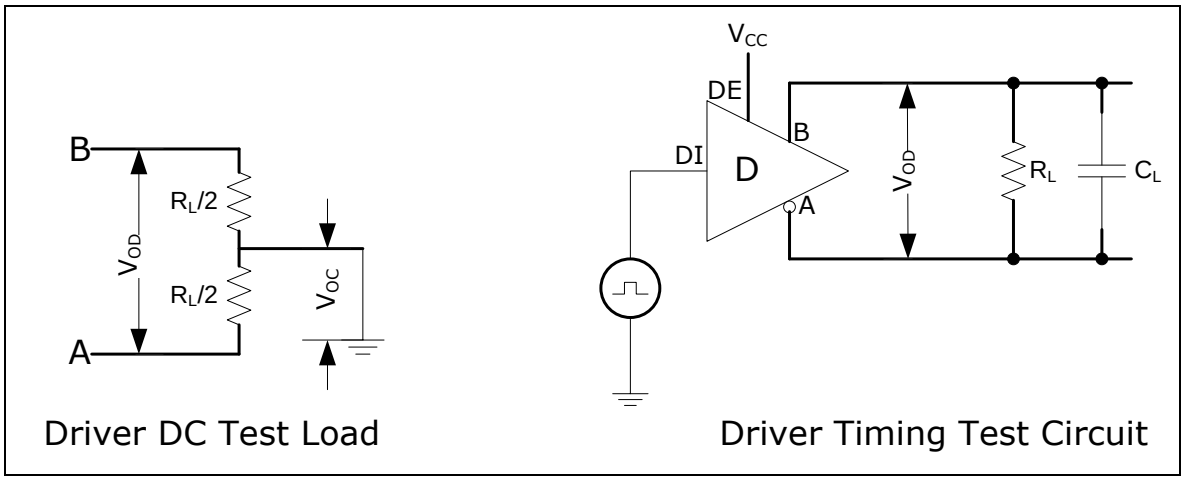


Figure 5-1 Driver Test Circuits

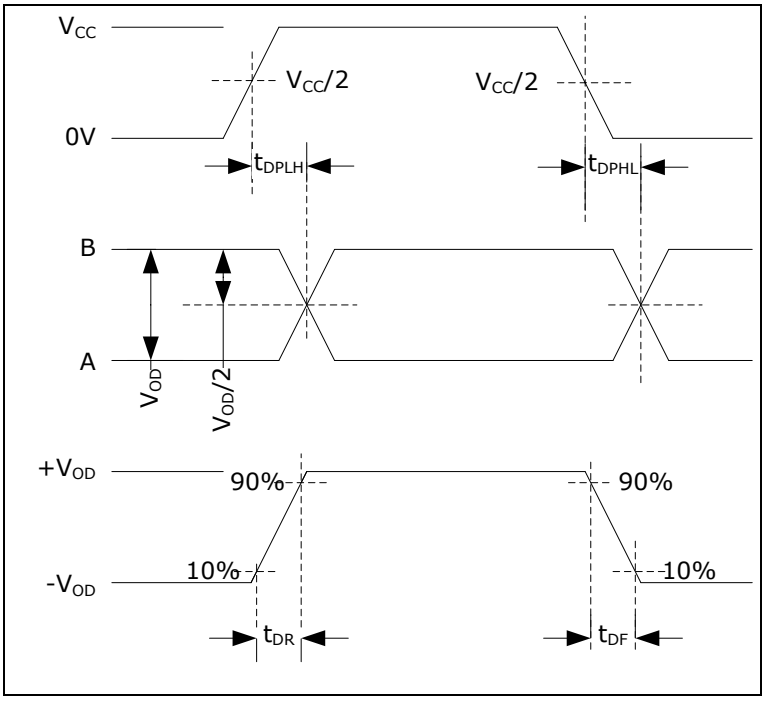


Figure 5-2 Driver Propagation Delay Waveform

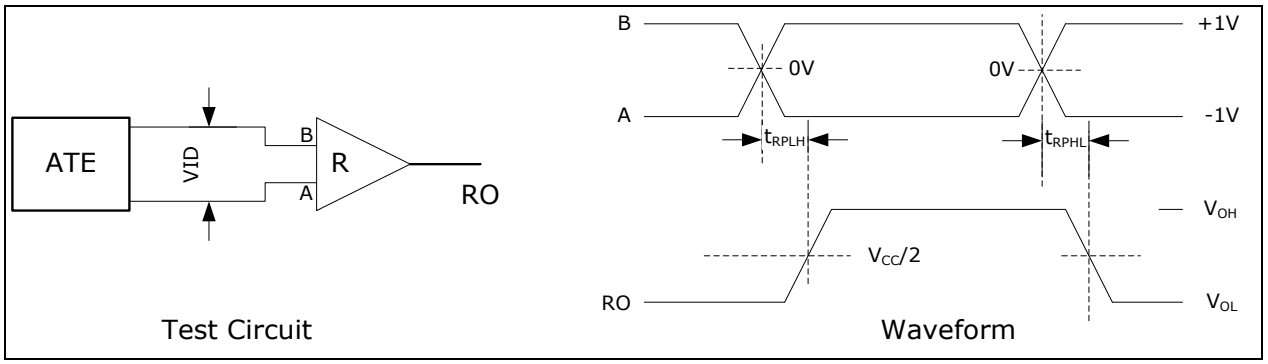


Figure 5-3 Receiver Propagation Delay Test Circuit and Waveform

6. Circuits Description

The V6603H is an RS-485 transceiver featuring half-duplex, low power consumption, low-slew-rate , polarity detection and self-adaption, and is completely compliant with the EIA/TIA-485 standard.

The V6603H integrates one driver and one receiver, both can be enabled independently. When both driver and receiver are disabled, the device will output the high impedance (Tri-State). The V6603H has high driving capability allowing up to 256 transmitters on the same communication bus. The low-slew-rate driver can reduce EMI and reflections caused by inappropriate terminal matching.

The V6603H can support the high-speed communication. The maximum communication speed is over 2 Mbps.

V6603H with built-in LDO can support the wide supply voltage input ranging from 3.3 V to 24 V. In the application of 3.3 V power supply, the input/output logic level is 3.3 V. In the application of 5-V power supply, the input/output logic level is 5 V. LDO can support the driving capability up to 60 mA.

The V6603H, with built-in pull-up and pull-down resistors, be of the 1.2 mA supply current under the no-load condition. In the shutdown mode, the power consumption is less than 2μA.

The V6603H is protected from faults due to shorted or open receiver input, over-temperature, over-current, and over-voltage protection. It features polarity detection and self-adaption which can eradicate connection failure due to mis-wiring.

6.1. Fail-Safe Protection

The V6603H has a fail-safe-protected receiver input. When the receiver input is shorted or open, or when all the drivers on the terminated cable are disabled, the device can guarantee the RO is logic high.

In the device, the receiver differential threshold voltage is -10mV and -50mV. If the differential input of the receiver (A-B) is higher than -10mV, RO will be logic high. If the differential input of the receiver (A-B) is lower than -50mV, RO will be logic low. If all the drivers on the terminated cable are disabled, the differential input of the receiver (A-B) will be pulled down to 0V, and RO will be logic high.

6.2. Over-Temperature Protection

The integrated thermal shutdown circuit in the V6603H can protect the device from the power dissipation caused by faults. When the temperature of the device exceeds +150°C, the device goes to thermal shut-down mode.

6.3. Output Protection

In the V6603H, the overvoltage protection is intended to protect the device from overvoltage.

The overvoltage protection circuit compares the output voltage of port A and port B all the time when both $\overline{RE}$ and DE are in the transmitting state ($\overline{RE}$=V_{CC}, 且 DE=V_{CC}). When V_A or V_B is less than GND, or V_A or V_B is higher than V_{CC}, the device is in the overvoltage mode.

6.4. Polarity Detection and Adaption

The embedded polarity detection and adaption circuit in the V6603H enables the device to detect, and define the polarity of both A and B ports continuously when the device works as a receiver.

There are internal pull-up and pull-down resistors in the V6603H, so, it is not necessary to connect resistors outside the device as done with traditional RS-485 transceivers. But, in an RS-485 network including the V6603H, it is recommended to connect a pull-up and a pull-down resistor outside the collector to define the polarity of the differential cable. The resistance should be no more than 15kΩ, usually 10kΩ.

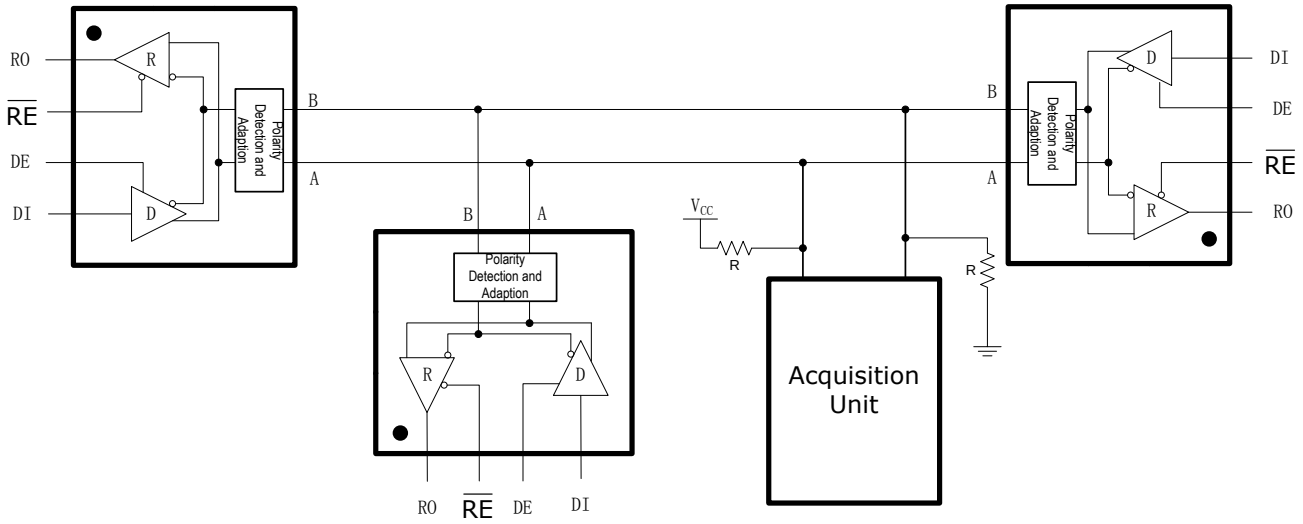


Figure 6.4-1 RS-485 Network Using V6603H

6.5. Up to 256 Transmitters on One Bus

With regard to a standard RS-485 transceiver, the receiver input impedance is 12kΩ (1-unit load), and the driver can drive up to 32-unit loads.

As for the V6603H, the receiver input impedance is higher than 1/8-unit loads (R1>96kΩ), which allows up to 256 transmitters on the bus. All drivers can be connected to one bus in any combination only if the total loads are no more than 32 units.

The receiver input resistor is paralleled to the internal pull-up and pull-down resistors, of which the total resistance is equal to the resistance of the receiver.

7. Outline Dimensions