V660X RS-485 Transceiver

Version: **1.0**
Release Date: **July 9, 2018**

Specifications are subject to change without notice.

Revision History

Date	Version	Description
2018-07-09	V1.0	• New update

General Description

The V660X are series of RS-485 transceivers featuring half-duplex, low power consumption and high ESD protection. It is completely compliant with the EIA/TIA-485 standard.

The V660X integrates one driver and one receiver. The V660X has high driving capability allowing up to 256 transceivers on the same communication bus.

V6602 and V6602H incorporate low-slew-rate driver which can reduce EMI and reflections caused by inappropriate terminal matching. It can realize the error-free data transmission up to 500 Kbps.

The V6603 and V6603H can support the high-speed communication. The maximum communication speed is up to 2 Mbps.

V6602H and V6603H with built-in LDO can support the wide supply voltage input up to 24V. The output of LDO is 5.0V and can support the driving capability up to 100 mA.

The V660X series have less than 0.6-mA supply current under the no-load condition. In the shutdown mode, the power consumption is less than 6μA.

The V660X series are protected from faults due to shorted or open receiver input, and integrates over-temperature, over-current, over-voltage protection, and real-time polarity detection and adaption.

Features

- Supply voltage range: 3.3V/5.0V(V6602, V6603); 3.3V/5V/7V~24V(V6602H, V6603H)
- Built-in LDO: 3.3V @ 3.3V input；5V@5V input, 5V@7V~24V input (V6602H, V6603H)
- Half-duplex mode
- Low-slew-rate error-free data transmission: <500 Kbps (V6602, V6602H)
- high-speed communication: 2 Mbps @distance<50m, 1 Mbps @distance<300m(V6603, V6603H)
- High driving capability: Up to 256 transceivers on one bus
- Differential driver output: $1.5V \le V_{OD} \le V_{CC}$@54Ω
- Input common voltage range: -7V ~ +12V
- ESD protection: ±15kV Human Body Model (HBM)
- Fail-safe receiver
- Over-temperature, over-current, and over-voltage protection
- Supporting real-time polarity detection and adaption
- Operation temperature: -40°C ~+85°C
- Package: SOP-8

Applications

- Utility meters
- Industrial control

Table of Contents

Figure List

Table List

1. Pin Descriptions

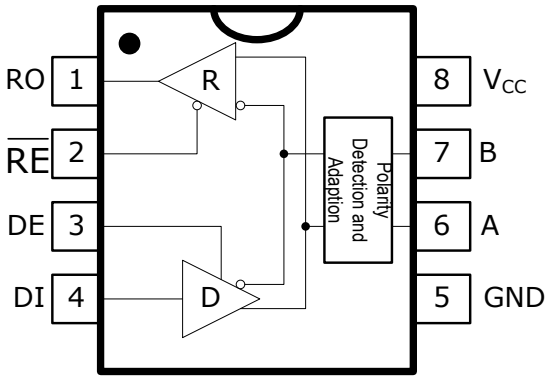


Figure 1-1 V6602/V6603 pin location

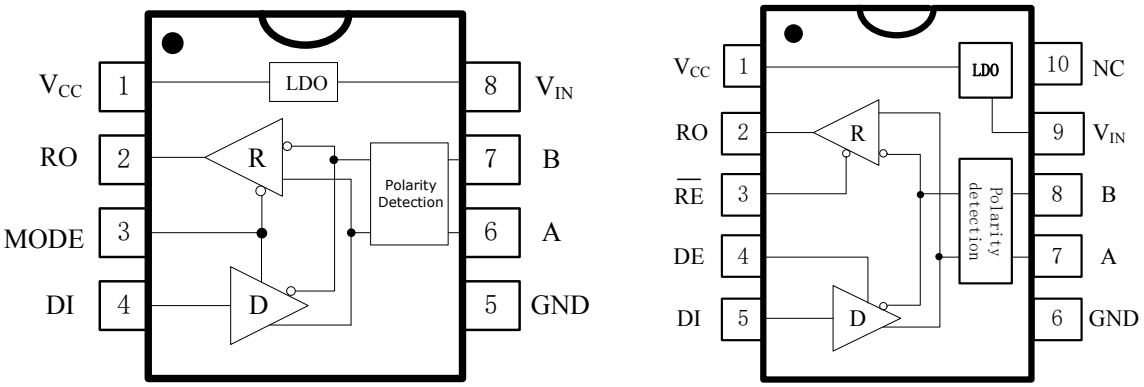


Figure 1-2 V6602H pin location (left), V6603H pin location (right)

No.			Pin	Description
V6602 V6603	V6602H	V6603H		
8	1	1	V_{CC}	V6602/V6603: Power supply, Bypass V_{CC} to GND with a 0.1uF capacitor. V6602H/V6603H: 5V LDO output, main power of system, Bypass V_{CC} to GND with a 10uF capacitor.
1	2	2	RO	Receiver output. When /RE (or MODE) is logic low, if (A-B) >-10mV, RO is logic high; and if (A-B) <-55mV, RO is logic low.
-	3	-	MODE	When MODE is input logic high, the transmitting mode is enabled. When MODE is input logic low, the receiving mode is enabled.
2	-	3	/RE	Receiver output enables. When $\overline{RE}$ logic low, RO is is active. When $\overline{RE}$ logic

No.			Pin	Description
V6602 V6603	V6602H	V6603H		
				high, RO is is in a high impedance state. When $\overline{RE}$ is logic high, and DE is logic low, the device enters low-power shutdown mode.
3	-	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.
4	4	5	DI	Driver input. When Driver output enabled, logic low at DI enforces noninverting output low and inverting output high, and logic high at DI enforces noninverting output high, and inverting output low.
5	5	6	GND	Ground
6	6	7	A	Receiver input / Driver output
7	7	8	B	The polarity of A/B can be decided by chip according to the polarity detection result.
-	8	9	V_{IN}	V6602H/V6603H Positive Supply Input: 3.3V/5.0V/7V~24V Bypass V_{IN} to GND with a 10uF capacitor.
-	-	10	N.C.	Float. No connection inside.

2. Truth Table

Table 2-1 Transmitting of V6602/V6603/V6603H

Input			Output	
/RE	DE	DI	A	B
0	0	X	Z	Z
1	0	X	Shutdown	
Noninverting connection of A/B				
X	1	1	1	0
X	1	0	0	1
Inverting connection of A/B				
X	1	1	0	1
X	1	0	1	0

Table 2-2 Receiving of V6602/V6603/V6603H

Input			Output
/RE	DE	A-B	RO
0	X	Open/shorted	1
1	1	X	Z
1	0	X	Shutdown
Noninverting connection of A/B			
0	X	>-10mV	1
0	X	<-55mV	0
Noninverting connection of A/B			
0	X	<10mV	0
0	X	>55mV	1

Table 2-3 Transmitting of V6602H

Input		Output	
MODE	DI	A	B
0	X	Z	Z
Noninverting connection of A/B			
1	1	1	0
1	0	0	1
Inverting connection of A/B			
1	1	0	1
1	0	1	0

Table 2-4 Receiving of V6602H

Input		Output
MODE	Noninverting Input - Inverting Output	RO
0	Open/shorted	1
1	X	Z
Noninverting connection of A/B		
0	>-10mV	1
0	<-55mV	0
Noninverting connection of A/B		
0	<10mV	1
0	>55mV	0

In the table, **"1"** represents logic high, **"0"** represents logic low, **"Z"** represents high impedance state, and **"X"** represents "Don't care".

3. Specifications

3.1 Absolute Maximum Ratings

For V6602H/V6603H:

Parameter	Symbol	Test Conditions	Min.	Max.	Unit
Supply Voltage	V_{IN}			+29	V
Control Input Voltage	MODE, DE,/RE		-0.3	V_{CC}+0.3	V
Driver Input Voltage	DI		-0.3	V_{CC}+0.3	V

For V6602/V6603:

Parameter	Symbol	Test Conditions	Min.	Max.	Unit
Supply Voltage	V_{CC}			+6	V
Control Input Voltage	DE,/RE		-0.3	+6	V
Driver Input Voltage	DI		-0.3	+6	V

Parameter	Symbol	Test Conditions	Min.	Max.	Unit
Driver Output Voltage	A, B		-8	+13	V
Receiver Input Voltage	A, B		-8	+13	V
Receiver Output Voltage	RO		-0.3	V_{CC}+0.3	V
Continuous Power Dissipation		T_A=+70°C, Derate 5.85 mW/°C above +70°C		471	mW
Operating Temperature			-40	85	°C
Storage Temperature Range			-65	150	°C
Soldering temperature		Sodering, 10s		300	°C

Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications are not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

3.2 Electrical Characteristics

All maximum/minimum specifications apply over the entire recommended operation range, unless otherwise noted. All typical specifications are at T_A=25°C, V_{IN}=15.0V (V6602H/V6603H/) or V_{CC}=5.0V (V6602/V6603/), C_{IN}=10uF, and C_{OUT}=10uF, 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
Operating Voltage							
Power Supply Range	V_{CC}	V6602, V6603	3.3V application	3.0	3.3	3.6	V
			5.0V application	4.5	5.0	5.5	V
	V_{IN}	V6602H, V6603H	3.3V application	3.0	3.3	3.6	V
			5.0V application	4.5	5.0	5.5	V
			High input application	7		24	V
LDO (V6602H/V6603H)							
Power Switch-On Resistance	R_{ON}	V_{IN}=3.3V，I_{OUT}=5mA			13	17	ohm
		V_{IN}=5.0V，I_{OUT}=5mA			12	15	ohm
Output Voltage	V_{CC}	V_{IN}=7V ~ 24V		4.65	5.0	5.35	V
No-load Regulation	$\Delta V_{CC}/V_{CC}$	7V≤V_{IN}≤24V, I_{OUT}=0.5mA			40	70	mV
Load Regulation	$\Delta V_{CC}/V_{CC}$	0.5mA ≤ I_{OUT} ≤ 50mA, V_{IN}=15V			40	110	mV
Maximum Output Current	I_{PK}			100			mA
Minimum Input Voltage in No Load	$V_{IN,MIN}$				7		V
Temperature coefficient of Output Voltage	$\Delta V_{CC}/\Delta T$	I_{OUT}=0.5mA, 50mA			0.225		mV/℃
Driver (Applied for all V660X series, including V6602, V6603, V6602H and V6603H)							
Driver Differential Outputs	V_{OD}	R_L=100Ω		2.5		V_{CC}	V
		R_L=54Ω		1.5	2.2	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}	MODE,DI		3.0			V
Input Threshold Low	V_{IL}	MODE,DI				0.8	V

[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
Input Hysteresis	V_{HYS}	MODE,DI			100		mV
Driver Short-Circuit Output Current	I_{OSD}	$0 \le V_{OUT} \le +12V$			55	100	mA
		$-7V \le V_{OUT} \le V_{CC}$		-100	-55		
Input Current	$I_{A,B}$	DE=0, V_{CC}=0/5V	V_{IN}=12V		96	120	uA
			V_{IN}=-7V	-110	-87		
Thermal-Shutdown Threshold	T_{TS}				150		°C
Thermal-Shutdown Hysteresis	T_{TSH}				30		°C
Receiver (Applied for all V660X series, including V6602, V6603, V6602H and V6603H)							
Receiver Differential Threshold Voltage	V_{TH}	$-7V \le V_{CM} \le 12V$		-55		-10	mV
Receiver Input Hysteresis	ΔV_{TH}				20	30	mV
RO Threshold High	V_{OH}	I_O=-8mA		4			V
RO Threshold Low	V_{OL}	I_O=8mA				0.4	V
Three-State Output Current at Receiver	I_{ORZ}	$0 \le V_O \le V_{CC}$		-1		1	μA
Receiver Input Impedance	R_{IN}	$-7V \le V_{CM} \le 12V$		96			KΩ
Receiver Short-Circuit Output Current	I_{OSR}	$0 \le V_{RO} \le V_{CC}$			40		mA
ESD Protection (Applied for all V660X series, including V6602, V6603, V6602H and V6603H)							
A, B port ESD Protection		Human Body Model (HBM)			±15		KV
		Contact Discharge, IEC 61000-4-2			±15		KV
Temperature (Applied for all V660X series, including V6602, V6603, V6602H and V6603H)							
Operation Temperature	T_A			-40		+85	°C
Storage Temperature	T_S			-65		+150	°C
Lead Temperature (Soldering, 10s)					300		°C

Supply Current

Parameter	Symbol	Test Conditions		Min.	Typ.	Max.	Unit
V6602H							
Supply current	I_{CC}	MODE=V_{CC}	No load,		0.4	0.6	mA
		MODE=0	DI=0/ V_{CC}		0.4	0.6	mA
V6602/V6603/V6603H/							

Parameter	Symbol	Test Conditions		Min.	Typ.	Max.	Unit
Supply current	I_{CC}	$\overline{RE}$ =DE=V_{CC}	No load, DI=0/ V_{CC}		0.4	0.6	mA
		$\overline{RE}$ =DE=0			0.4	0.6	mA
Supply Current in Low-Power Shutdown Mode	I_{SHDN}	$\overline{RE}$ =V_{CC}, DE=0				6	uA

Driver Switching Characteristics

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
V6602/V6602H						
Propagation Delay	t_{DPLH}	R_{DIFF}=54Ω, C_L=50pF			500	ns
	t_{DPHL}				500	ns
Driver Differential Output Rise or Fall Time	t_R, t_F				500	ns
Maximum Data Rate	F_{MAX}		500			kbps
V6603/V6603H						
Propagation Delay	t_{DPLH}	R_{DIFF}=54Ω, C_L=50pF	40		100	ns
	t_{DPHL}		40		100	ns
Driver Differential Output Rise or Fall Time	t_R, t_F			70		ns
Maximum Data Rate	F_{MAX}		2			Mbps

Receiver Switching Characteristics

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
V6602/V6602H						
Propagation Delay	t_{RPLH}	$\|V_A-V_B\|\geq 2.0V$			200	ns
	t_{RPHL}	Rise or fall time is less than 15ns				ns
Receiver Input Rise or Fall Time	t_{RSEW}	$\|V_A-V_B\|\geq 2.0V$			200	ns
		Rise or fall time is less than 15ns				
Maximum Data Rate	F_{MAX}		500			Kbps
V6603/V6603H						
Propagation Delay	t_{RPLH}	$\|V_A-V_B\|\geq 2.0V$		60	80	ns
	t_{RPHL}	Rise or fall time is less than 15ns				ns

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Receiver Input Rise or Fall Time	t_{RSEW}	$\|V_A-V_B\| \geq 2.0V$ Rise or fall time is less than 15ns		60	80	ns
Maximum Data Rate	F_{MAX}		2			Mbps

4. Typical Operating Characteristics

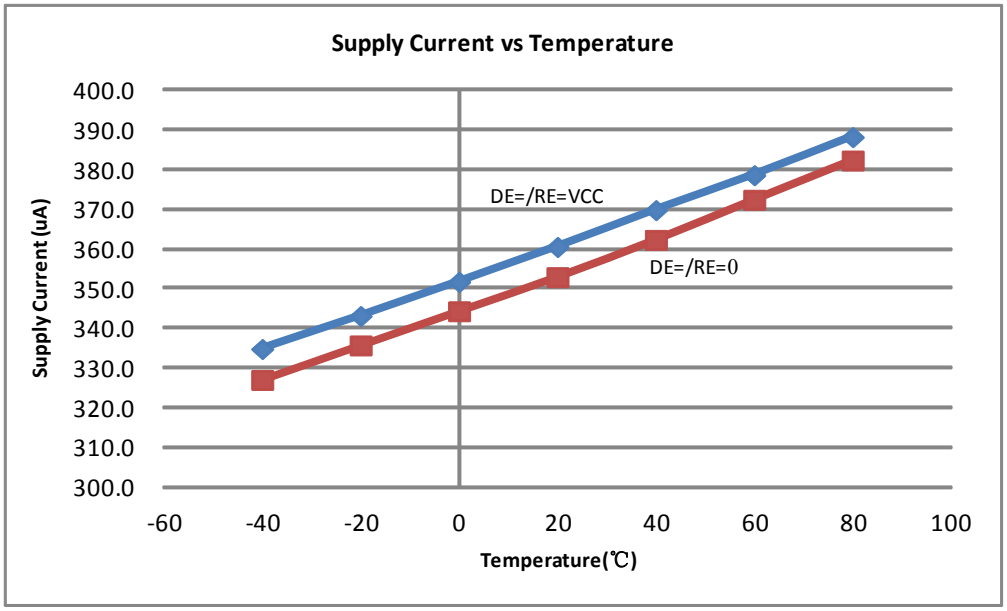


Figure 4-1 Supply Current vs. Temperature (V6602/V6603/V6603H)

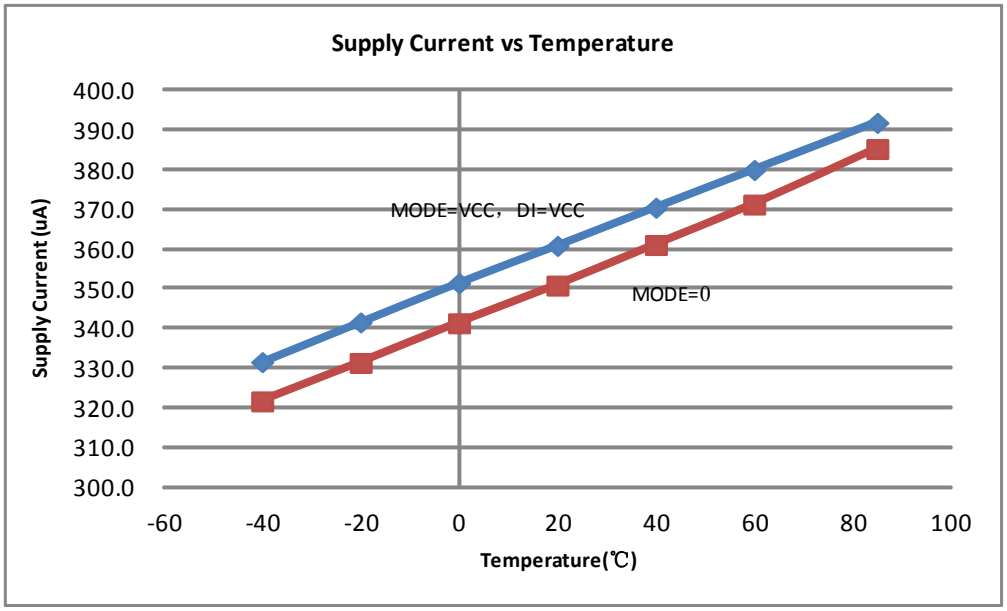


Figure 4-2 Supply Current vs. Temperature (V6602H)

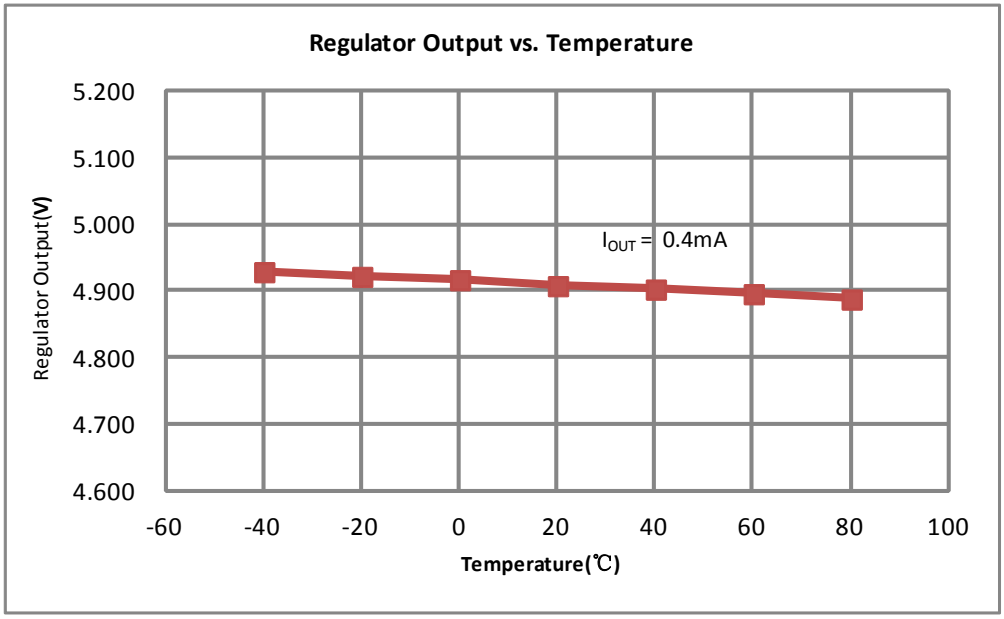


Figure 4-3 Regulator Output Voltage vs. Temperature（V6602H/V6603H）

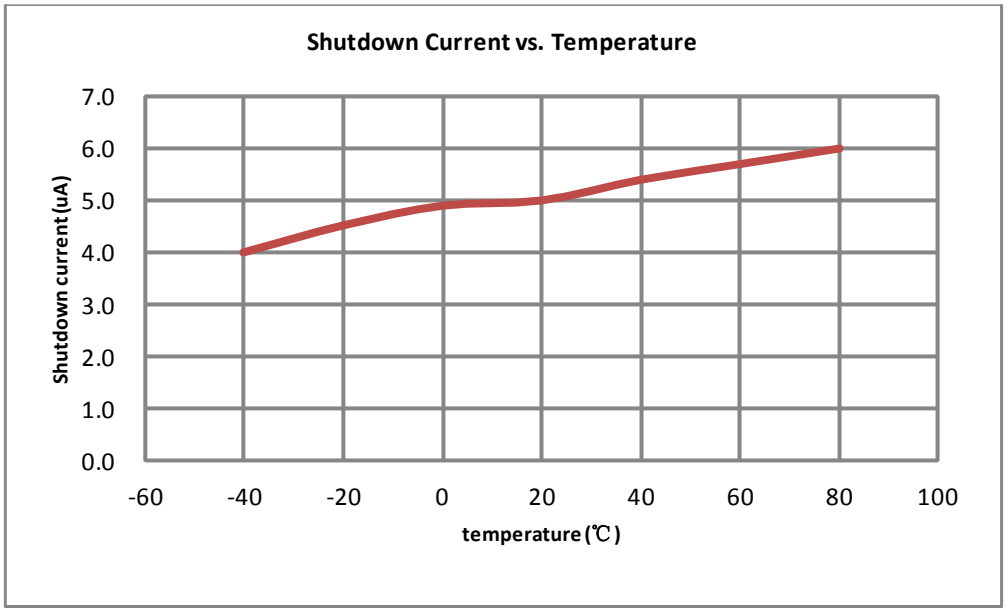


Figure 4-4 Shutdown Current vs. Temperature（V6602/V6603/V6603H）

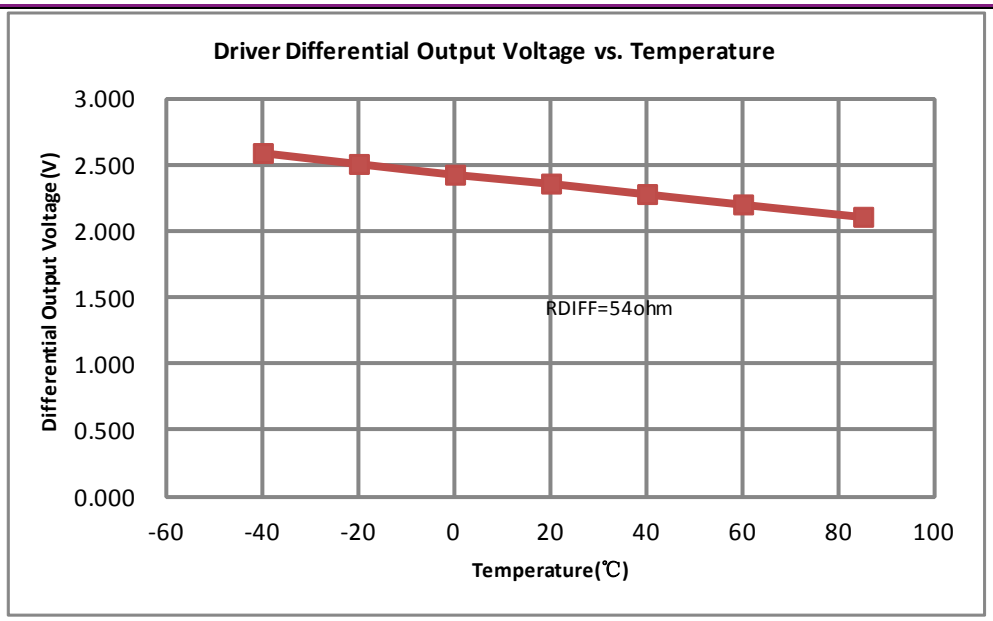


Figure 4-5 Driver Differential Output Voltage vs. Temperature (V6602/V6603)

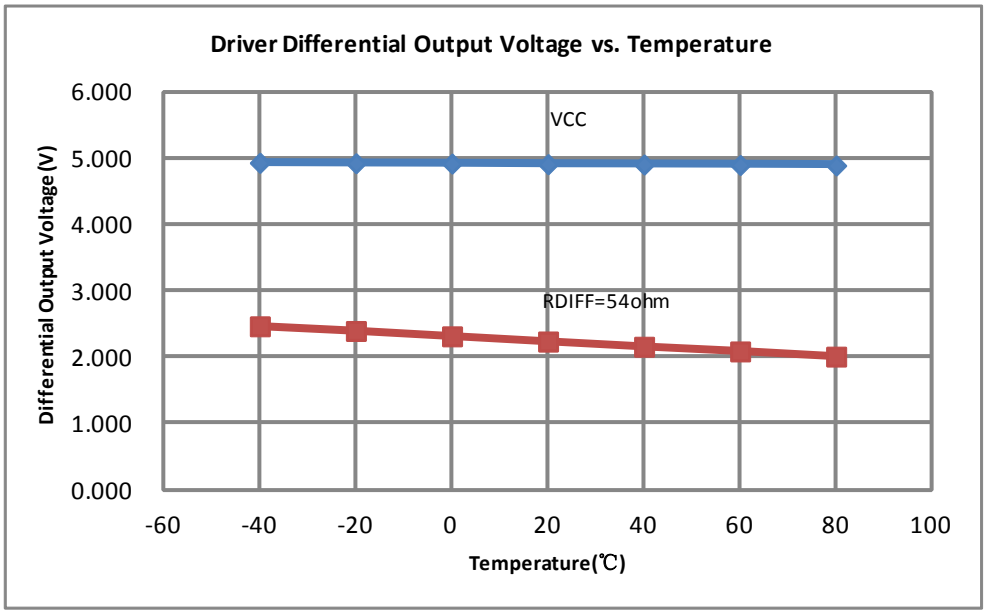


Figure 4-6 Driver Differential Output Voltage vs. Temperature（V6602H/V6603H）

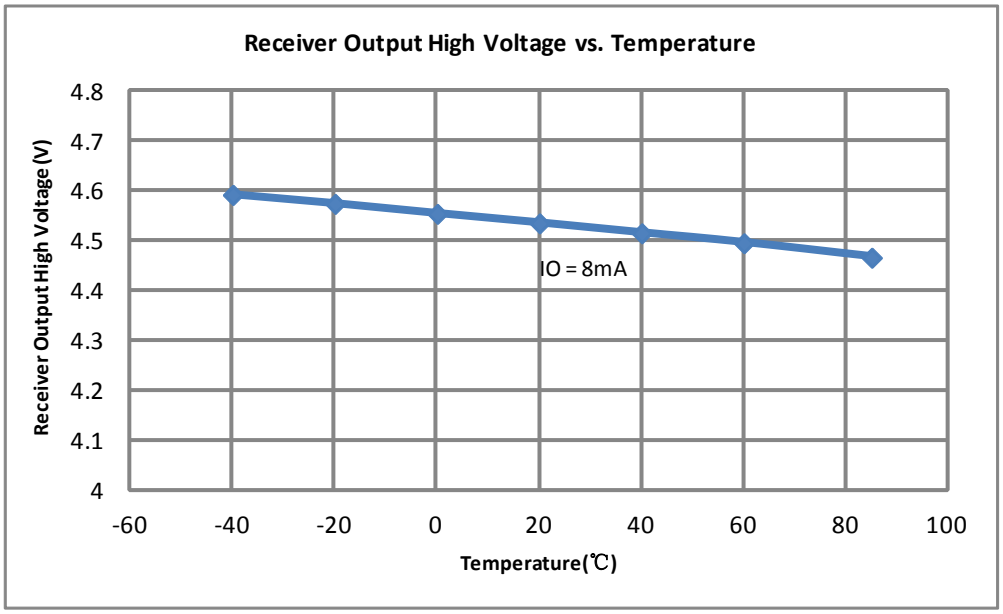


Figure 4-7 Receiver Output High Voltage vs. Temperature（V6602/V6603）

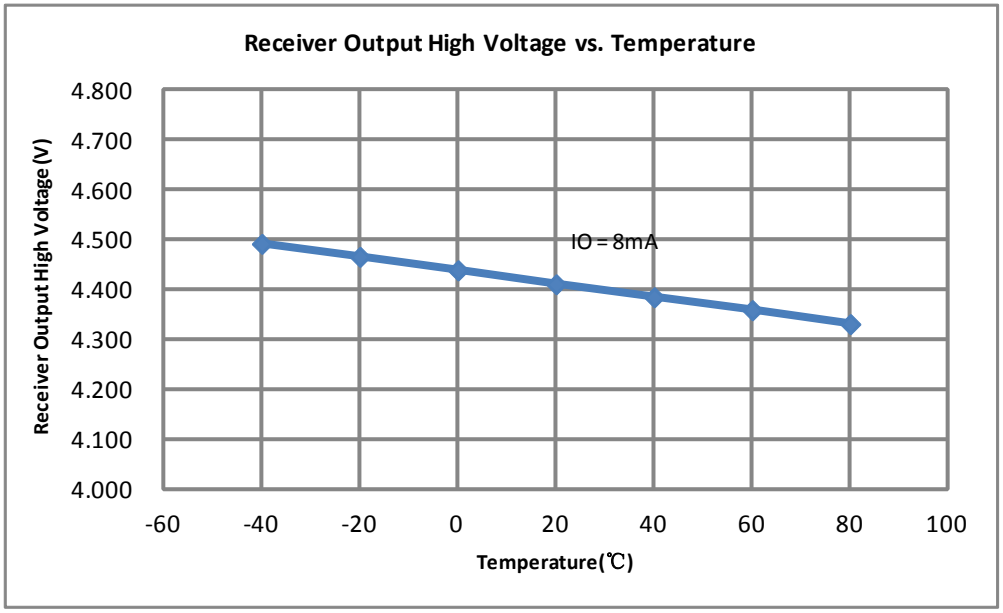


Figure 4-8 Receiver Output High Voltage vs. Temperature（V6602H/V6603H）

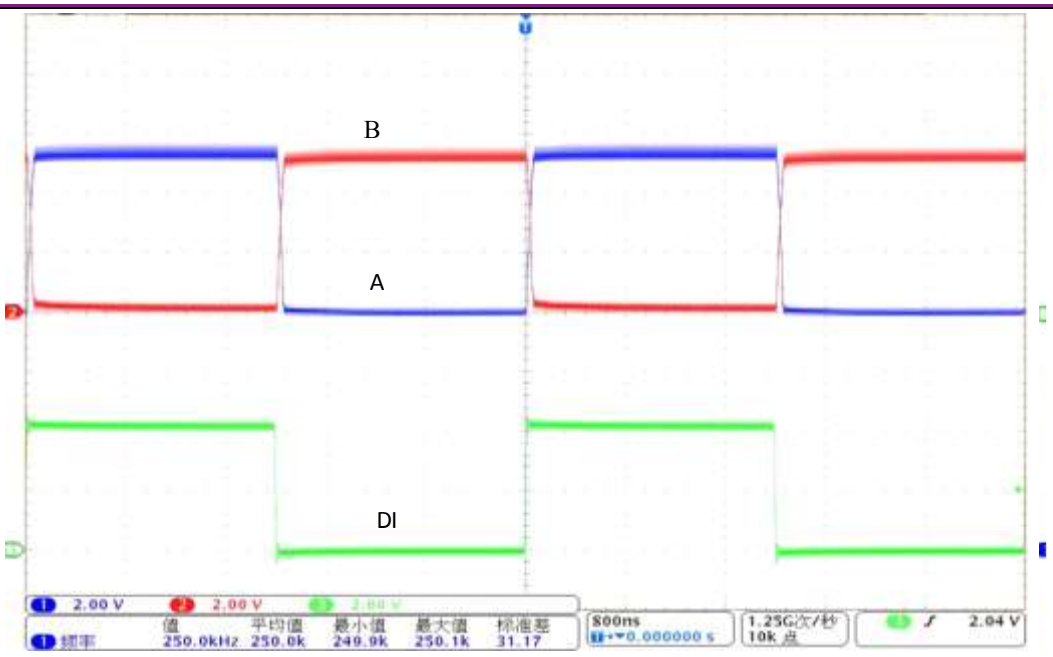


Figure 4-9 Driver Propagation Delay

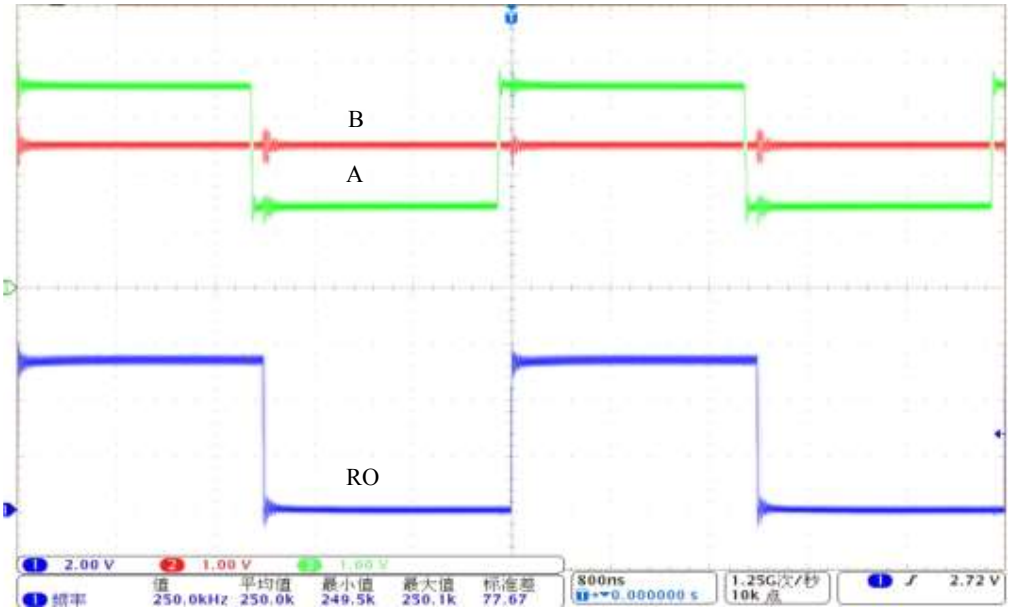


Figure 4-10 Receiver Propagation Delay

5. Test Circuits and Waveform

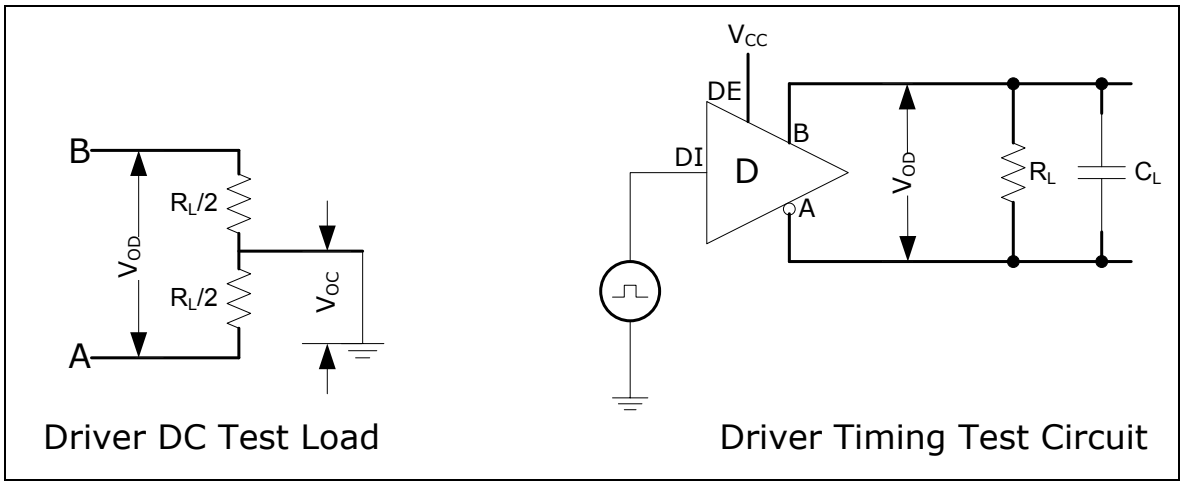


Figure 5-1 Driver Test Circuits

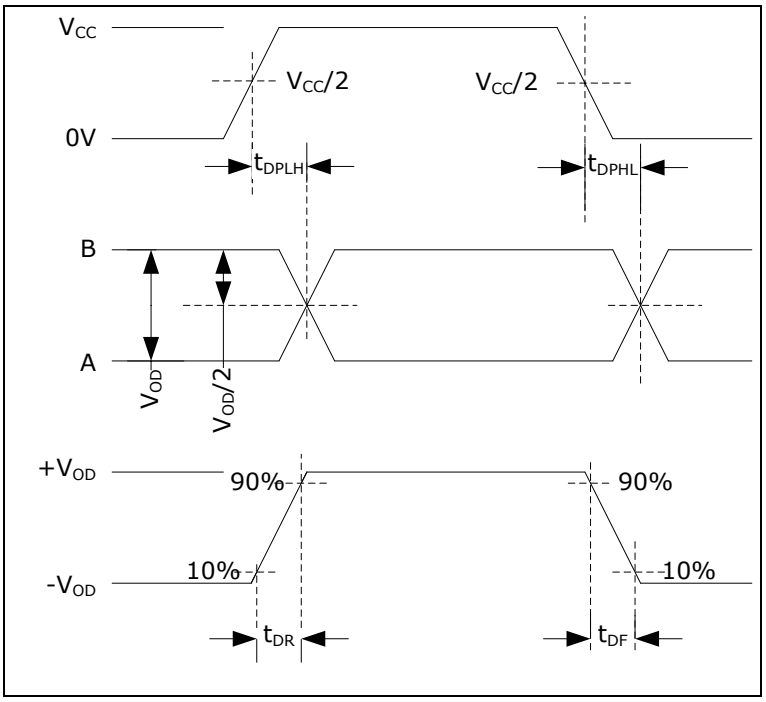


Figure 5-2 Driver Propagation Delay Waveform

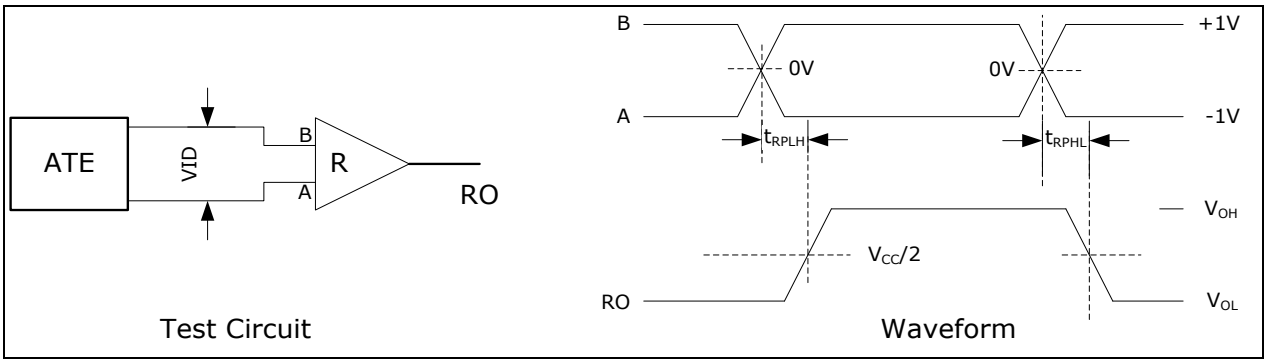


Figure 5-3 Receiver Propagation Delay Test Circuit and Waveform

6. Circuits Description

The V660X are series of RS-485 transceivers featuring half-duplex, low power consumption and high ESD protection. It is completely compliant with the EIA/TIA-485 standard.

The V660X integrates one driver and one receiver. The V660X has high driving capability allowing up to 256 transceivers on the same communication bus.

V6602 and V6602H incorporate low-slew-rate driver which can reduce EMI and reflections caused by inappropriate terminal matching. It can realize the error-free data transmission up to 500 Kbps.

The V6603 and V6603H can support the high-speed communication. The maximum communication speed is up to 2 Mbps.

V6602H and V6603H with built-in LDO can support the wide supply voltage input up to 24V. The output of LDO is 5.0V and can support the driving capability up to 100 mA.

The V660X series have less than 0.6-mA supply current under the no-load condition. In the shutdown mode, the power consumption is less than 6μA.

The V660X series are protected from faults due to shorted or open receiver input, and integrates over-temperature, over-current, over-voltage protection, and real-time polarity detection and adaption.

6.1 Built-in LDO

V6602H and V6603H with built-in LDO can support the wide supply voltage input ranging from 3.3V to 24V. In the application of 3.3V 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 100 mA.

Power supply input (V_{IN}) and LDO output (V_{CC}) should be bypassed to GND with a 10uF capacitor for each.

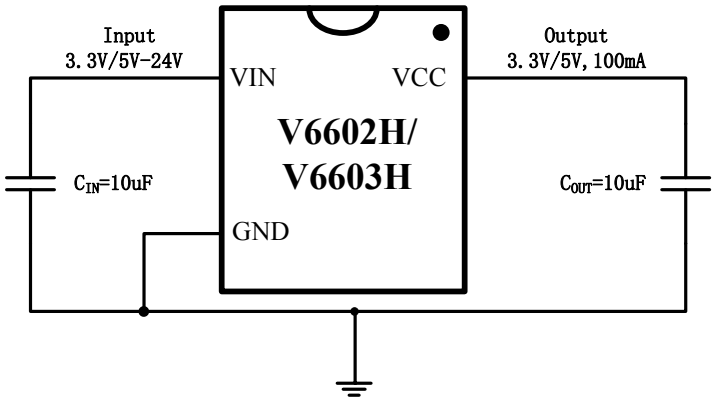


Figure 6-1Typical Application of V660X with built-in LDO

6.2 Fail-Safe Protection

The V660X 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 -55mV. If the differential input of the receiver ($V_{Noninvering}$-$V_{Inverting}$) is higher than -10mV, RO will be logic high. If the differential input of the receiver ($V_{Noninvering}$-$V_{Inverting}$) is lower than -55mV, RO will be logic low. If all the drivers on the terminated cable are disabled, the differential input of the receiver ($V_{Noninvering}$-$V_{Inverting}$) will be pulled down to 0V, and RO will be logic high.

6.3 Over-Temperature Protection

The integrated thermal shutdown circuit in the V660X 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.

6.4 Output Protection

In the V660X, the overvoltage protection is intended to protect the device from over-voltage.

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. When V_A or V_B is less than GND, or V_A or V_B is higher than V_{CC}, the device enters over-voltage protecting mode, and the circuit will protect the device from damage due to the overvoltage faults.

6.5 Polarity Detection and Adaption

The embedded polarity detection and adaption circuit in the V660X enables the device to detect, and define the polarity of both A and B ports continuously when the device works as a receiver.

In an RS-485 network including the V660X, 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.

6.6 Up to 256 Transceivers 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 V660X, the receiver input impedance is higher than 1/8-unit loads (R1>96kΩ), which allows up to 256 tranceivers on the bus. All tranceivers can be connected to one bus in any combination only if the total loads are no more than 32 units.

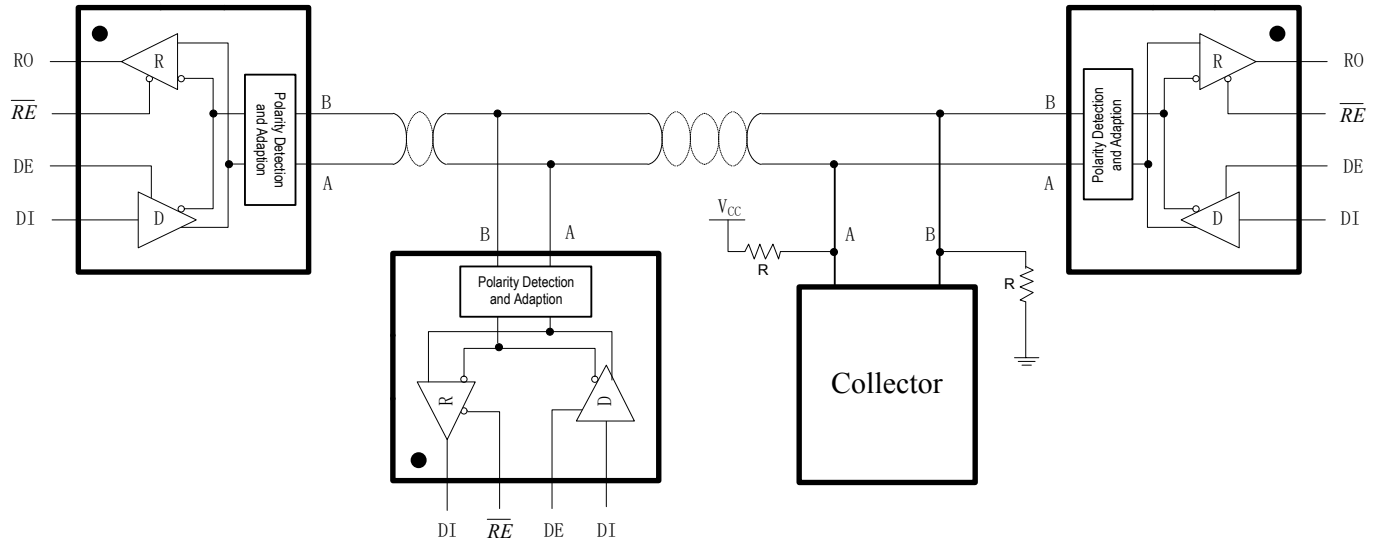


Figure 6-2 RS-485 Network Using V6602/V6603

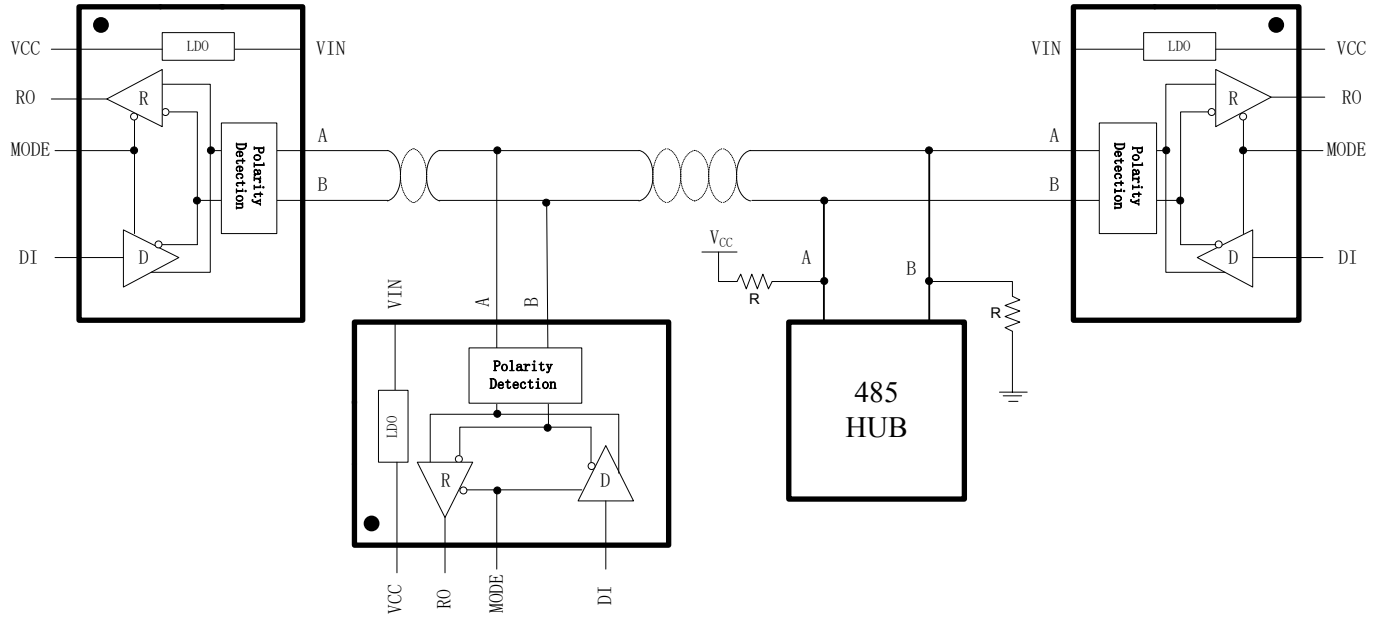


Figure 6-3 RS-485 Network Using V6602H

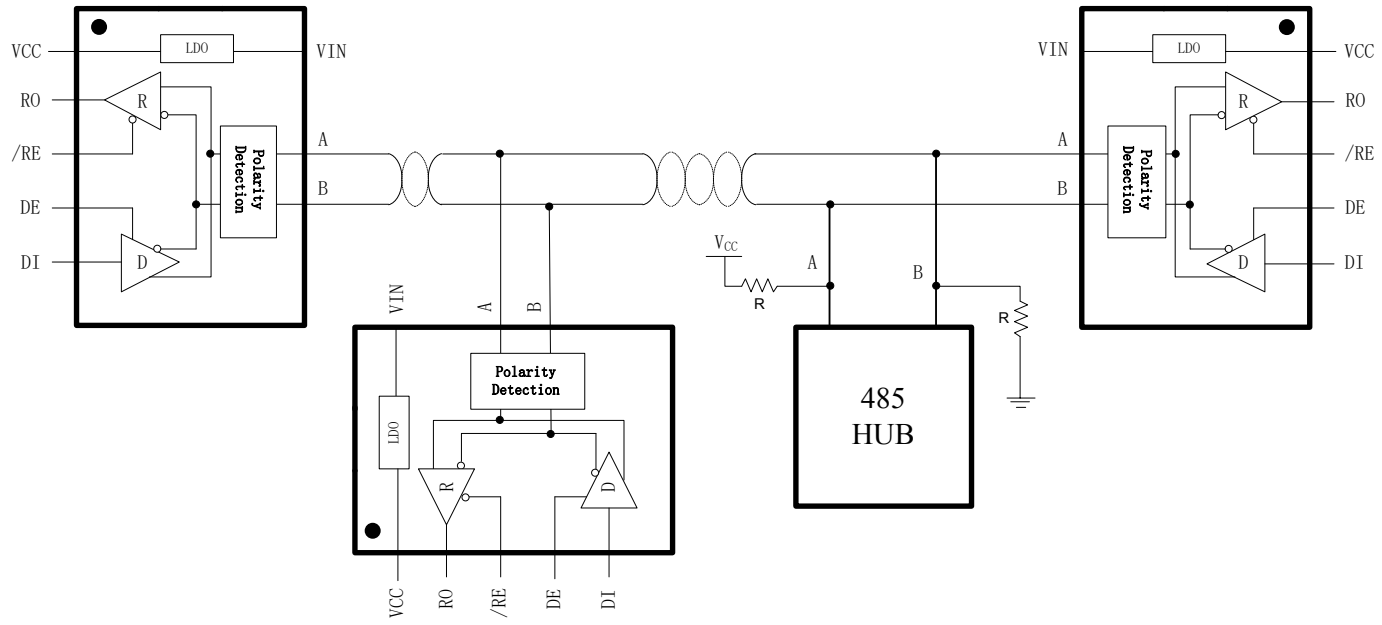
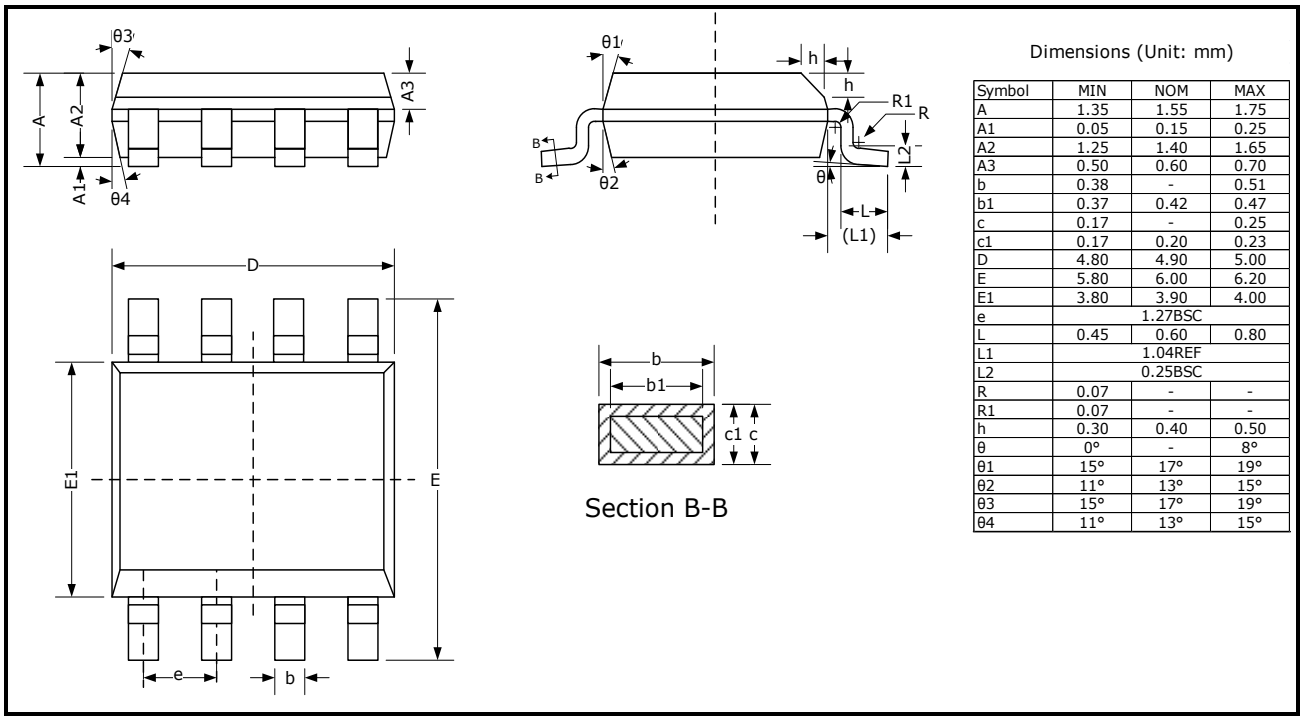


Figure 6-4 RS-485 Network Using V6603H

7. Outline Dimensions



Dimensions (Unit: mm)

Symbol	MIN	NOM	MAX
A	1.35	1.55	1.75
A1	0.05	0.15	0.25
A2	1.25	1.40	1.65
A3	0.50	0.60	0.70
b	0.38	-	0.51
b1	0.37	0.42	0.47
c	0.17	-	0.25
c1	0.17	0.20	0.23
D	4.80	4.90	5.00
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
e	1.27BSC		
L	0.45	0.60	0.80
L1	1.04REF		
L2	0.25BSC		
R	0.07	-	-
R1	0.07	-	-
h	0.30	0.40	0.50
θ	0°	-	8°
θ1	15°	17°	19°
θ2	11°	13°	15°
θ3	15°	17°	19°
θ4	11°	13°	15°

Figure 7-1 SOP8 package（V6602/V6602H/V6603）

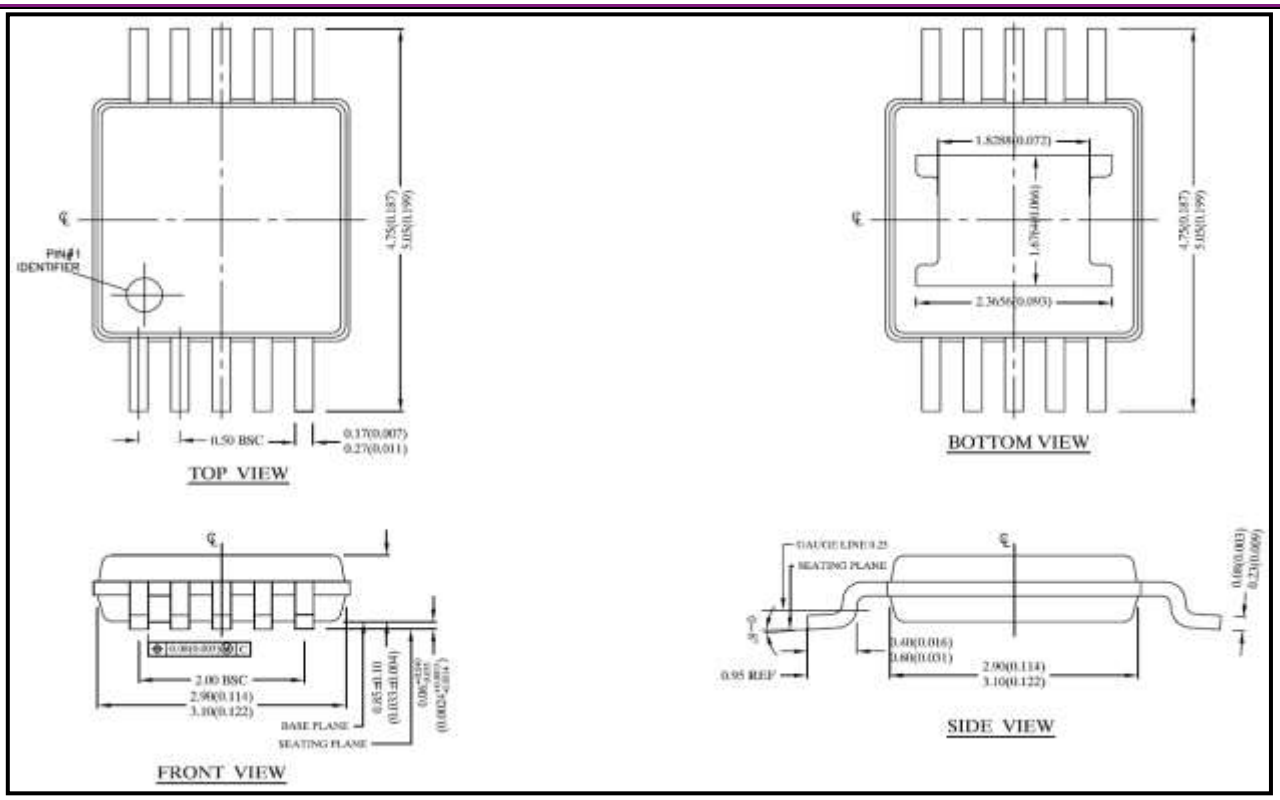


Figure 7-2 MSOP10package（V6603H）