RS232 to RS422/RS485
Serial Converting Transceiver

SB200

Revision 1.04

SystemBase Co., Ltd.

Contents

1. General Description

1.1 General Information

SB200 is a high-performance serial signal-converting transceiver. This chip is the best solution for converting RS232 signals to RS422 or RS485 signals and vice versa. Since multiple serial transceivers are integrated into one chip, a high-performance compact serial converter can be easily manufactured. SB200 converts data received through the RS232 standard into RS422 standard or RS485 standard data and transmits the received RS422 or RS485 data through RS232.
The SB200 provides one transmitter and one receiver for RS232 communication and RS422 (Full-Duplex/4-wire) or RS485 (Half-duplex/2-wire) communication at up to 1Mbps. SB200 provides an automatic output open/close control function that can be useful in RS422/485 communication. SB200 reduces the inconvenience of using the termination resistor by connecting it to the external terminal by integrating a termination resistor inside the IC. In addition, SB200 provides a port-powered function that generates internal operating power through RS232 signal lines (TXD, RTS, DTR), providing conversion communication between RS232 and RS422/485 without an external power supply. It can also be operated using an external power supply. All serial transmission and reception pins of the SB200 provide ESD protection so that it can be used in environments requiring reliability. SB200 offers a very small size, 6mm x 6mm with a QFN-40 package applied.

1.2 Applications

- RS232 to RS422/RS485 Serial Signal Converter
- Utility Meters
- Industrial Controls
- Industrial Motor Drives
- Lighting Systems
-Telecom
- Security Systems
- Instrumentation

2. Features

2.1 Converting

SB200 is the best one-chip serial converter solution that converts RS232 signals into RS422/RS485 signals and vice versa, and supports up to 1Mbps communication speed. The RS422/RS485 side consists of one driver and one receiver supporting both full-duplex(4-wire) and half-duplex(2-wire) communication. It also has a 1/8-unit load receiver input impedance, so you can connect up to 256 nodes (transceivers) on the bus.

2.2 External and Internal Port Powered Power Supply Support

SB200 is a port-powered serial converter chip that operates by generating power from the RS232 signal line without an external power supply. This is the case when extracting sufficient power required is impossible. In these cases, it can be used as an operating power supply by receiving external power using a 9~12VDC adapter.

2.3 RS232 Interface

- Max Data Rate of 1Mbs
- 1 Driver, 1 Receiver for RS232

2.4 RS422/RS485 Interface

- Max Data Rate of 1Mbps (RS485/422)
- 1 Driver, 1 Receiver for RS485(Half-duplex)/422(Full-duplex)
- No external resistor required for RS485/422 termination
- 1/8th Unit-Load, up to 256 receivers on bus

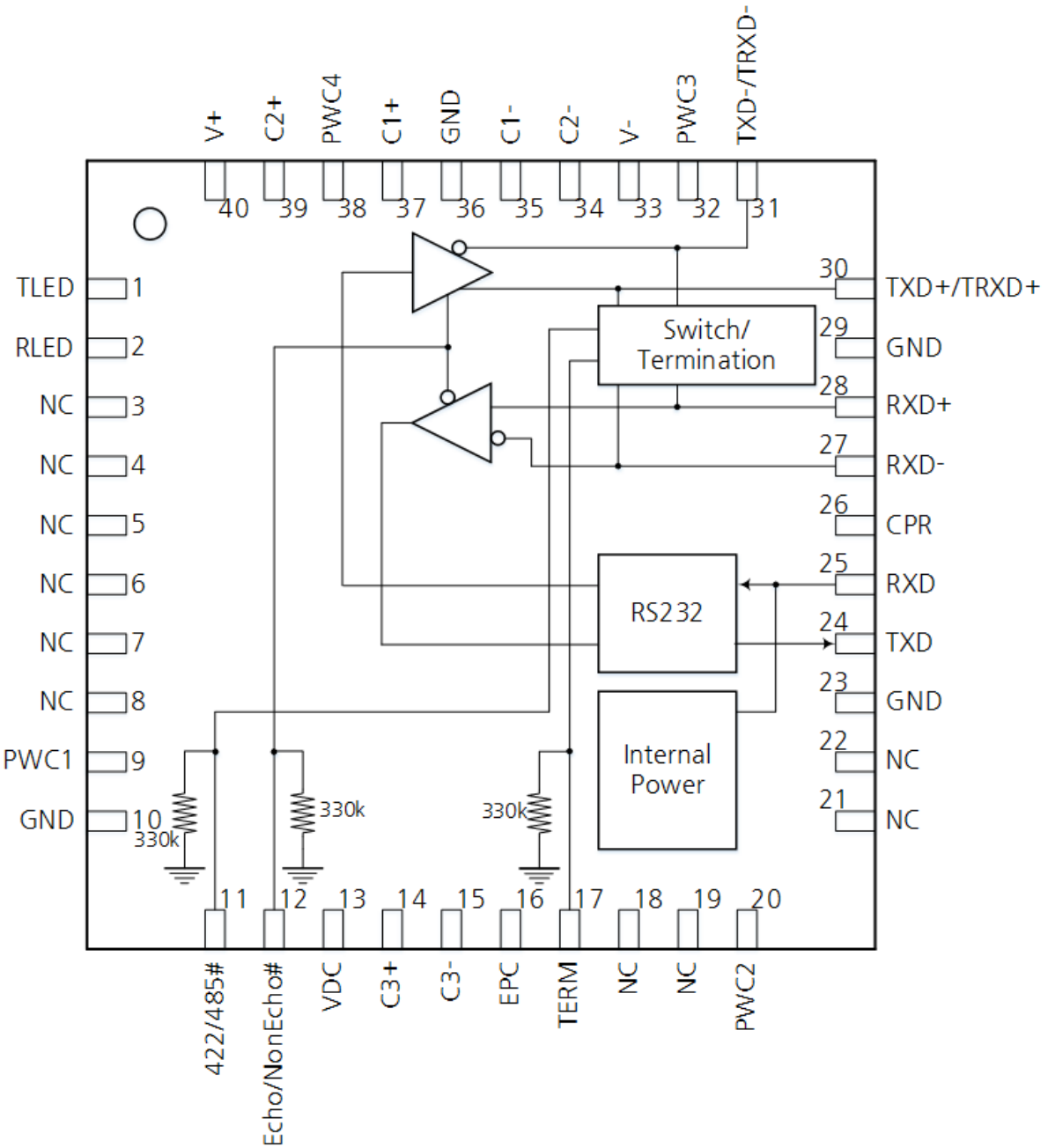
2.5 Electrical & Mechanical Information

- Built-in port-powered function (TXD, RTS, DTR Port Powered on RS232)
- External 9V ~ 12V Single Supply Operation
- ESD Protection on bus pins
  ±15kV HBM on the serial interface pins
  ±2kV HBM on all other pins except serial interface pins
  ±4kV IEC 61000-4-2 (Air Gap) on the serial interface pins
  ±10kV IEC 61000-4-2 (Contact) on the serial interface pins
- LED Outputs for Serial TXD, RXD indicating
- 6mm x 6mm QFN-40 Package (QFN: Quad Flat No-lead)

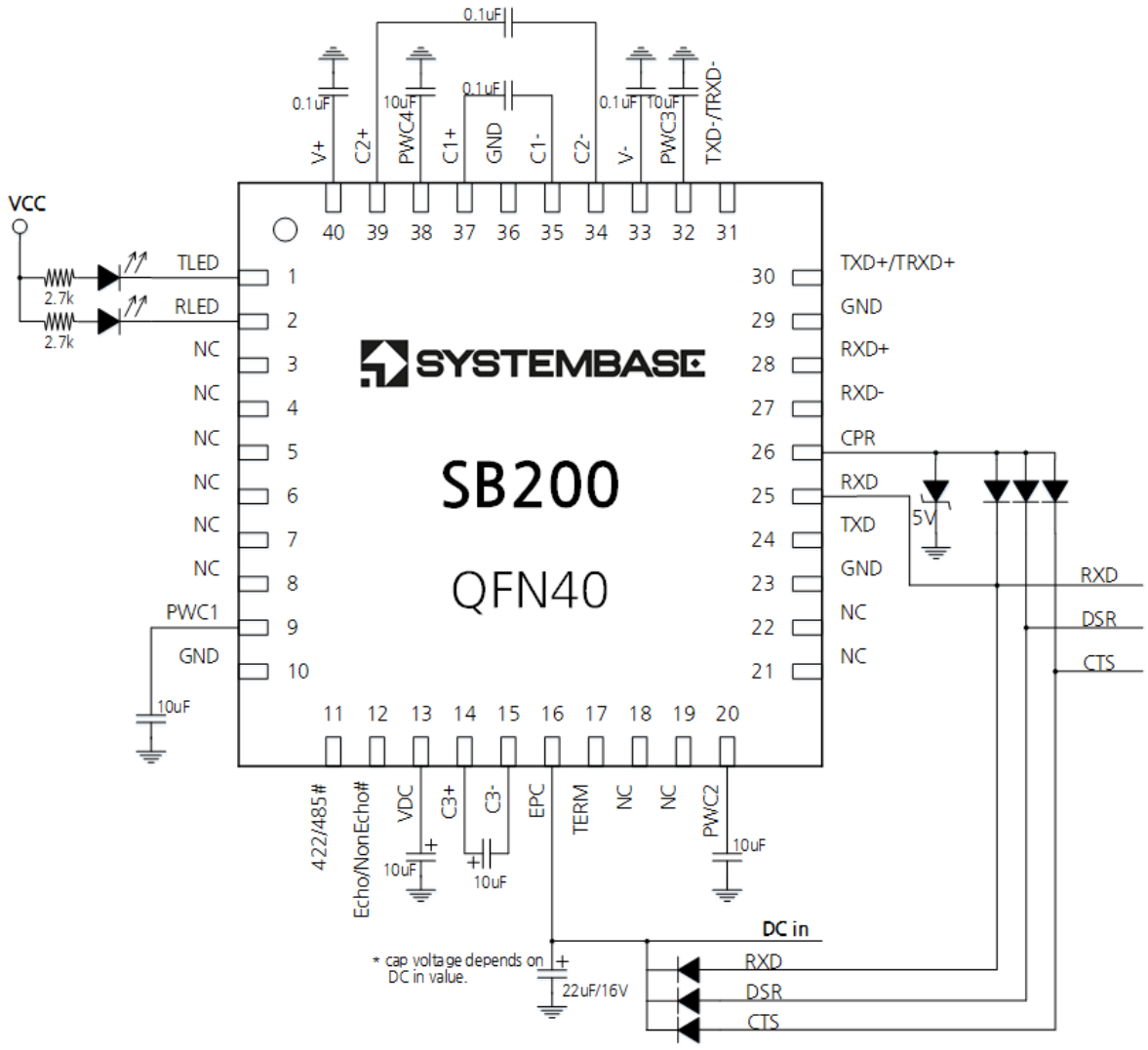
3. Ordering Information

Part Number	Operating Temperature	RoHS	Package	Packaging
SB200	-40°C ~ +85°C	Y	40-pin QFN (6mm x 6mm)	Tray

4. Block Diagram

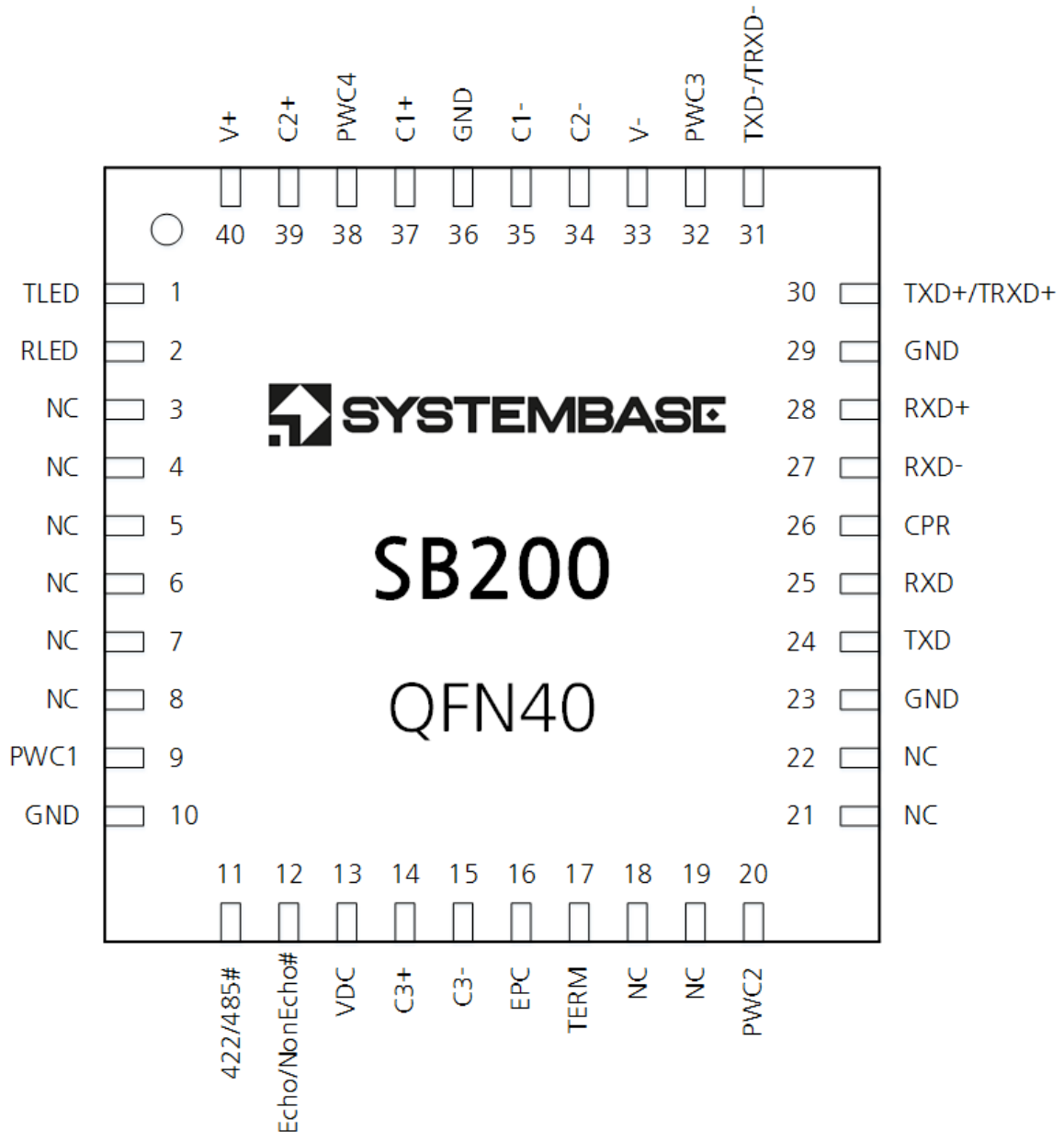


5. Applications



6. Pin Configuration

6.1 Pin Configuration for 40-pin QFN Package



6.2 Pin Description

No.	Name	I/O	Description
1	TLED	O	Transmit data LED drive pulses low when transmitting data via RS232.
2	RLED	O	Receive data LED drive pulses low when transmitting data via RS232.
3	NC	-	No connect
4	NC	-	No connect
5	NC	-	No connect
6	NC	-	No connect
7	NC	-	No connect
8	NC	-	No connect
9	PWC1	P	This Pin must be connected a reservoir capacitor of 10 µF capacitors to ground.
10	GND	P	Ground
11	422/485#	I	RS422/RS485# Mode Selection Pin. Logic level low selects RS485
12	ECHO/NONECHO#	I	RS485 Echo/NonEcho# Selection Pin. Logic level low selects RS485 NonEcho.
13	VDC	-	Internal Voltage Doubler output. This Pin must be connected a reservoir capacitor of 10 µF capacitors to ground.
14	C3+	-	Positive Terminal of the Flying Capacitor for Internal Voltage Doubler. This Pin must be connected capacitor of 10 µF capacitors to C3-
15	C3-	-	Negative Terminal of the Flying Capacitor for Internal Voltage Doubler
16	EPC	P	External Power (DC 9 ~ 12V) supply Pin. This Pin must be connected capacitor of 10 µF capacitors to ground
17	TERM	I	Active-High Termination 120Ω Resistor Enable. Drive TERM high to enable the internal termination resistor
18	NC	-	No connect
19	NC	-	No connect

No.	Name	I/O	Description
20	PWC2	P	This Pin must be connected a capacitor of 10 µF capacitors to ground.
21	NC	-	No Connect
22	NC	-	No Connect
23	GND	P	Ground
24	TXD	O	RS232 transmit data. The pin must be connected to an external RS232 RXD
25	RXD	I	RS232 receive data. The pin must be connected to an external RS232 TXD
26	CPR	P	Charge Pump Reference This pin must be connected 4.8V~5.5V Zener Diode to Ground as the application schematic.
27	RXD-	I	RS422 Inverting receive input. It is required to use proper external pull-up & pull-down resistors for fail-safe on RS422 mode.
28	RXD+	I	RS422 Noninverting receive input. It is required to use proper external pull-up & pull-down resistors for fail-safe on RS422 mode.
29	GND	P	Ground
30	TXD+/TRXD+	I/O	RS422/RS485 Noninverting Driver Output and Noninverting Receiver Input It is required to use proper external pull-up & pull-down resistors for fail-safe on RS485 mode.
31	TXD-/TRXD-	I/O	RS422/RS485 Inverting Driver Output and inverting Receiver Input It is required to use proper external pull-up & pull-down resistors for fail-safe on RS485 mode.
32	PWC3	P	This Pin must be connected a capacitor of 10 µF capacitors to ground.
33	V-	-	-5.5V generated by the charge pump. This Pin must be connected capacitor of 0.1 µF capacitors to GND

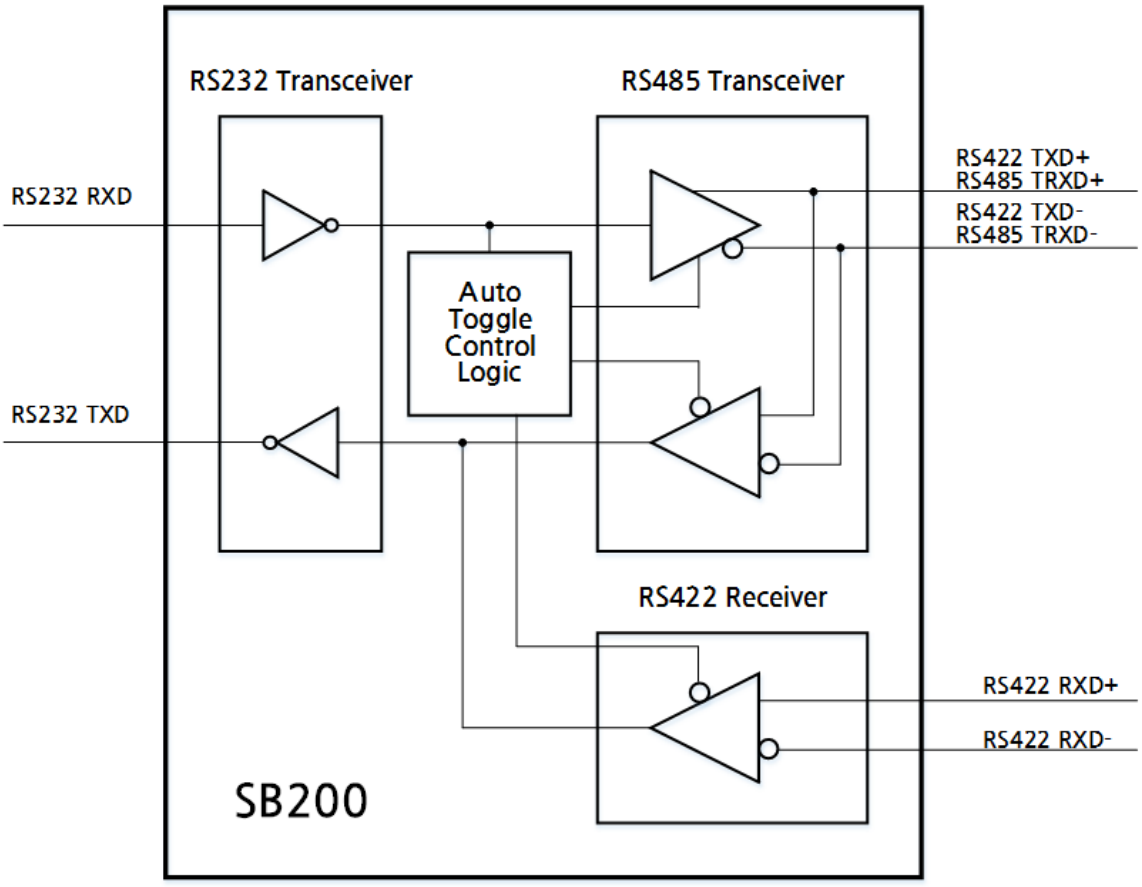
No.	Name	I/O	Description
34	C2-	-	Negative terminal of inverting Charge-Pump Capacitor. This Pin must be connected capacitor of 0.1 µF capacitors to C2+
35	C1-	-	Negative terminal of inverting Charge-Pump Capacitor. This Pin must be connected capacitor of 0.1 µF capacitors to C1+
36	GND	P	Ground
37	C1+	-	Positive terminal of inverting Charge-Pump Capacitor
38	PWC4	P	This Pin must be connected a capacitor of 10 µF capacitors to ground.
39	C2+	-	Positive terminal of inverting Charge-Pump Capacitor
40	V+	-	+5.5V generated by the charge pump. This Pin must be connected capacitor of 0.1 µF capacitors to ground.

7. Chip Function

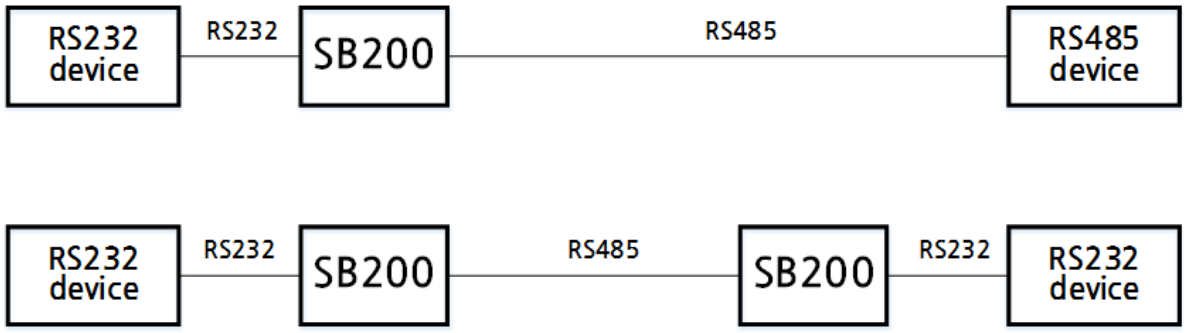
7.1 Basic Operations

Serial Converting Transceiver (RS232 to RS422/RS485, vice versa)

SB200 is a serial converting transceiver. It converts RS232 signals to RS422/RS485 signals and RS422/RS485 signals to RS232 signals. You can easily make a serial converter because it includes RS232, RS422, and RS485 transceivers in one chip. Because it is very small and integrated, it will be the smallest and most powerful serial converter solution.



SB200 is used in two cases.
One is signal converting. If you have two devices and one is an RS232 device and the other is an RS485 device, you can't connect. In this case, SB200 can connect and convert between the RS232 device and the RS485 device.
The other is the extended communication distance of RS232 devices. RS232 standard devices carry out a short-distance communication of approximately 15 meters. If you need to connect an RS232 device to another RS232 device in a far, you can extend the range using SB200 pairs in between two RS232 devices.

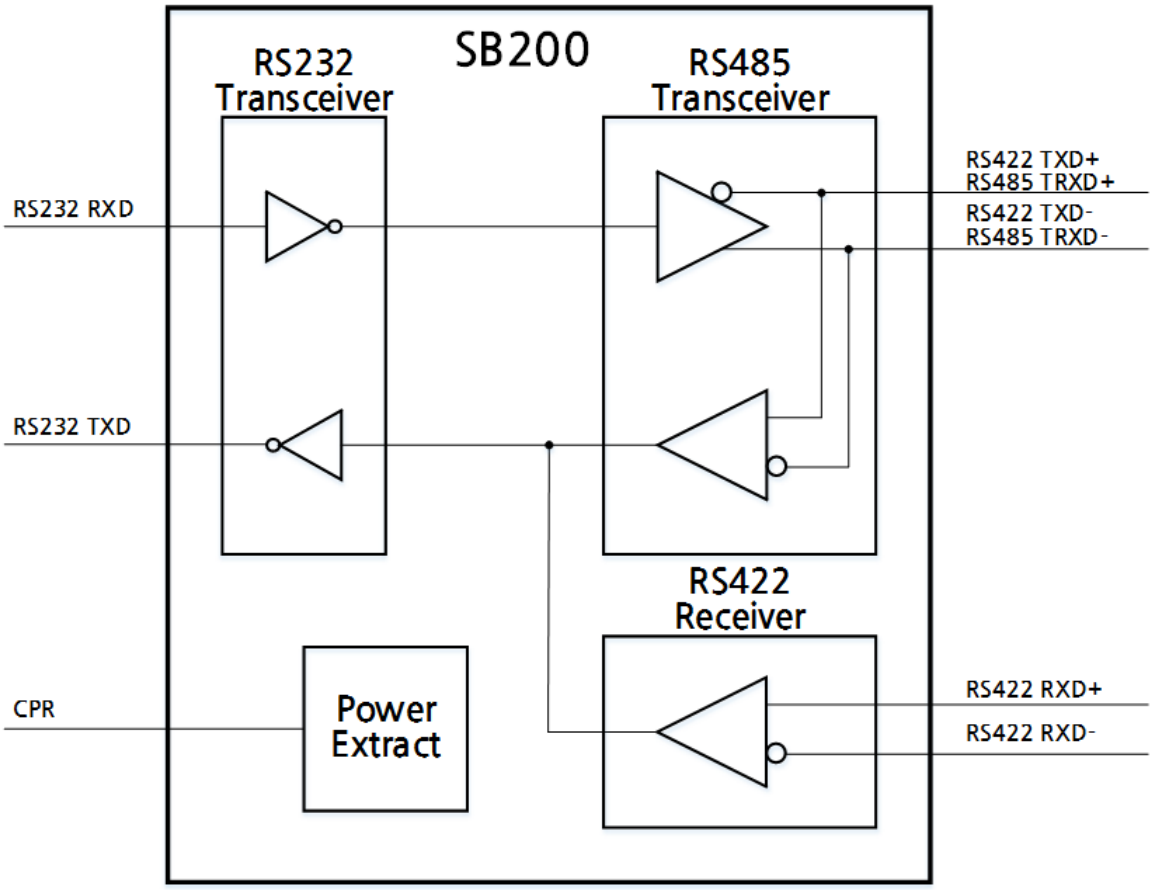


AutoToggle Control Logic

In RS422 and RS485 communications, it is necessary to control the activation of transmit and receive in synchronization.
Originally, transmit and receive control is the role of the UART controller or the others and the S/W must control the enabling signal via the RTS or DTR signal. However, the SB200 has automatic toggle control logic, eliminating the need for the user to control RS422 and RS485 activations either in software or manually. Therefore, the user simply sends and receives data via the SB200 without any control.

Built-in the Port-Powered Power Supply

SB200 has power extract circuits that can make a supply power and it works as if it doesn't need any external power. SB200 extracts power from RXD, DSR, and CTS Ports of the RS232 transmission line. If the RS232 device on the opposite side does not output any signal of DTR, RTS port, SB200 can't extract supply power from the DSR, CTS port. In this case, it needs an external power supply.



7.2 Operational Modes

SB200 have 3 operational modes.

- Converting between RS232 and RS422 (point-to-point & multi-drop)
- Converting between RS232 and RS485 non-echo
- Converting between RS232 and RS485 echo

PIN 11	PIN 12	Operational Mode
1	X	Converting between RS232 and RS422 (irregardless PIN 12 settings)
0	0	Converting between RS232 and RS485 non-Echo
0	1	Converting between RS232 and RS485 Echo

('X' is don't care)

Converting between RS232 and RS422

Between RS232 to RS422 and RS232 to RS485 can be selected according to the input value of pin 11 '422/485#'. If the Logic '1' (High) value is input to Pin 11, Converting between RS232 and 422 operation mode can be set. In this case, since the SB200 becomes an auto toggle (in other words, automatic direction control) operation for RS422, it can be used in RS422 point-to-point mode and multi-drop mode.

Converting between RS232 and RS485 non-echo

If Logic '0' (Low) value is input to pin 11 '422/485#' input, SB200 can be set to converting between RS232 and RS485 operation mode. Depending on the input value of pin 12 'ECHO/NONECHO#', you can select between Echo mode and Non-Echo mode among RS485 operation modes. If Logic '0' (Low) value is input to pin 12 'ECHO/NONECHO#' input, SB200 can be set to convert between RS232 and RS485 with non-echo operation mode. In this case, the data sent by itself does not receive echo messages.

Converting between RS232 and RS485 echo

If Logic '0' (Low) value is input to pin 11 '422/485#' input, SB200 can be set to converting between RS232 and RS485 operation mode. Depending on the input value of pin 12 'ECHO/NONECHO#', you can select between Echo mode and Non-Echo mode among RS485 operation modes. If Logic '1' (Low) value is input to pin 12 'ECHO/NONECHO#' input, SB200 can be set to convert between RS232 and RS485 with echo operation mode. In this case, the data sent by itself does receive echo messages.

7.3 Power Supply

SB200 has a built-in power extractor block that can generate power from the RS232 signal lines. So, it is a port-powered serial converter chip solution that operates by extracting its own operating power from the TXD, DTR, and RTS signal lines of RS232 (DTE mode) devices. So, the serial converter can be operated without a separate external power supply.

However, there are usually two cases where the required driving power cannot be obtained from the RS232 port. The first is when a signal level is so small that operating power cannot be extracted from the TXD, DTR, and RTS signal lines of the RS232 ports, and the second is when 3- or 5-wire RS232 cabling is used and only TXD or TXD and RTS signal lines are connected to the chip. This is

the case when extracting sufficient power required is impossible. In these cases, it can be used as an operating power supply by receiving external power using a 9~12VDC adapter.

7.4 Various Functions

Termination Resistor

The SB200 has a selectable internal termination resistor. Drive the TERM input High to enable the internal termination resistor 120Ω. Drive the TERM input low to disable the internal termination resistor 120Ω.

Fail-Safe

A standard RS485 receiver will be guaranteed a logic-high receiver output(RO) when the receiver differential inputs are open or Hi-Z(undriven from opposite driver) regarding EIA/TIA-485 standard Fail-Safe, have ±200mV. However, there are no internal pull-up and pull-down resistors in SB200 that are fail-safe. It is necessary to guarantee logic-high input data when the receiver inputs are open. In this case, it is easily affected by external cable noise; therefore, it is required to use proper external pull-up and pull-down resistors outside of SB200 for Fail-Safe. The value of the external pull-up and pull-down resistors is related to the idle voltage value on the bus (A-B). It also depends on how the line is terminated and how many nodes are on the bus. The value of the fail-safe resistor must guarantee that the idle voltage on the bus (A-B) is greater than the standard RS-485 receiver threshold voltage (±200mV).

Indicating TXLED, RXLED

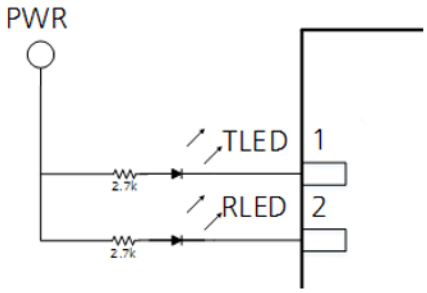


Figure 1

An example of using the SB200 to drive LEDs is shown in Figure 1. These pins are used to indicate transmission of data (TXLED#) and another is used to indicate receiving data (RXLED#). When data is being transmitted or received the pins will drive from High to low in order to provide an indication on the LEDs of data transfer.

ESD Protection

ESD protection structures were incorporated on all pins to protect against electrostatic discharges encountered during handling and assembly. The driver outputs and receiver inputs of SB200 have extra protection against static electricity. The ESD structures withstand high ESD in all states: normal operation, shutdown, and power down. After an ESD event, the SB200 keeps working without latch-up or damage. ESD protection can be tested in various ways. The transmitter outputs and receiver inputs of SB200 are characterized for protection to the following limits:

- ±10kV using the contact discharge method specified in IEC 61000-4-2

Human Body Model

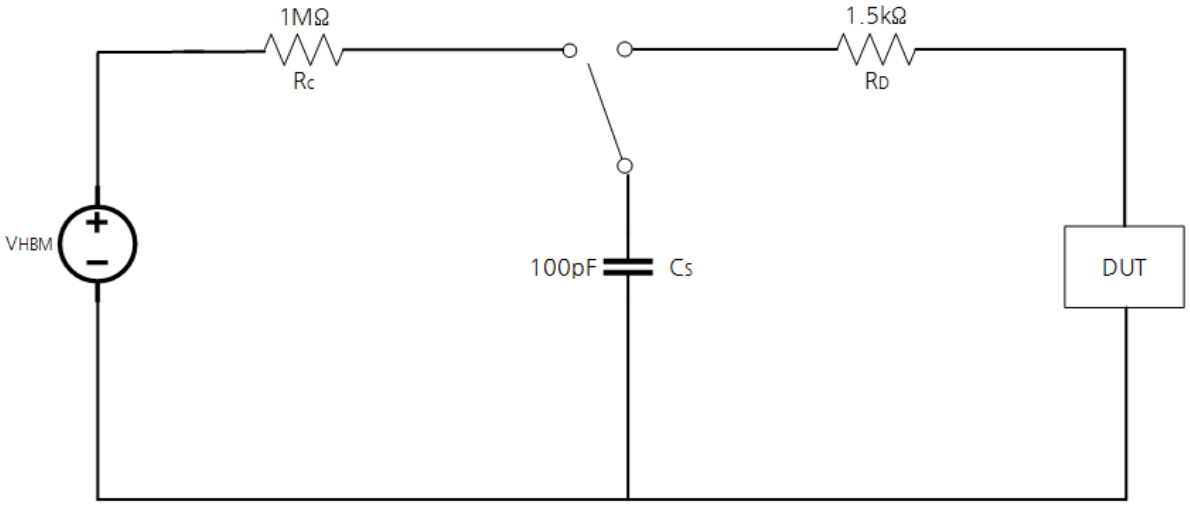


Figure 2

Figure 2 shows the Human Body Model, and Figure 3 shows the typical current waveform it generates when discharged into a low impedance.
This model consists of a 100pF capacitor charged to the ESD voltage of interest, which is then discharged into the test device through a 1.5kΩ resistor.

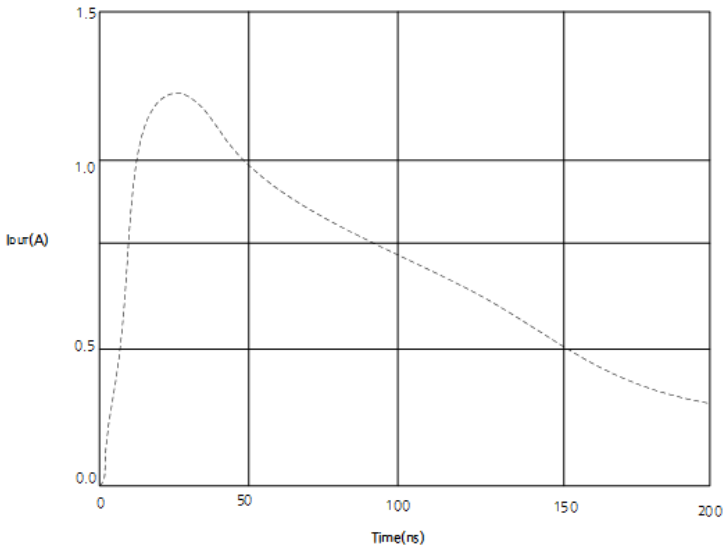


Figure 3

Figure 3 shows the discharge graph, which is the waveform of the discharge current over time. As you can see from the discharge graph, the discharge ends within 200ns.

IEC 61000-4-2

The IEC 61000-4-2 standard covers the ESD testing and performance of the finished equipment. However, it does not specifically refer to integrated circuits. SB200 helps equipment designs meet IEC 61000-4-2 without the need for additional ESD protection components. The major difference between tests performed using the Human Body Model and IEC 61000-4-2 is the higher peak current in IEC 61000-4-2 because the series resistance is lower in the IEC 61000-4-2 model. Hence, the ESD withstand voltage measured to IEC 61000-4-2 is generally lower than that measured using the human body model. Figure 4 shows the IEC 61000-4-2 model, and Figure 5 shows the current waveform for the IEC 61000-4-2 ESD Contact Discharge test

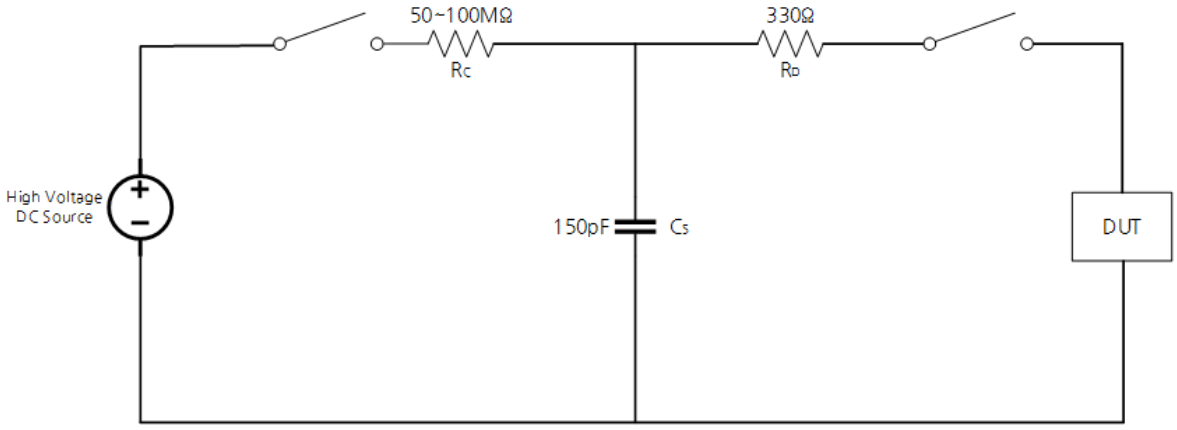


Figure 4

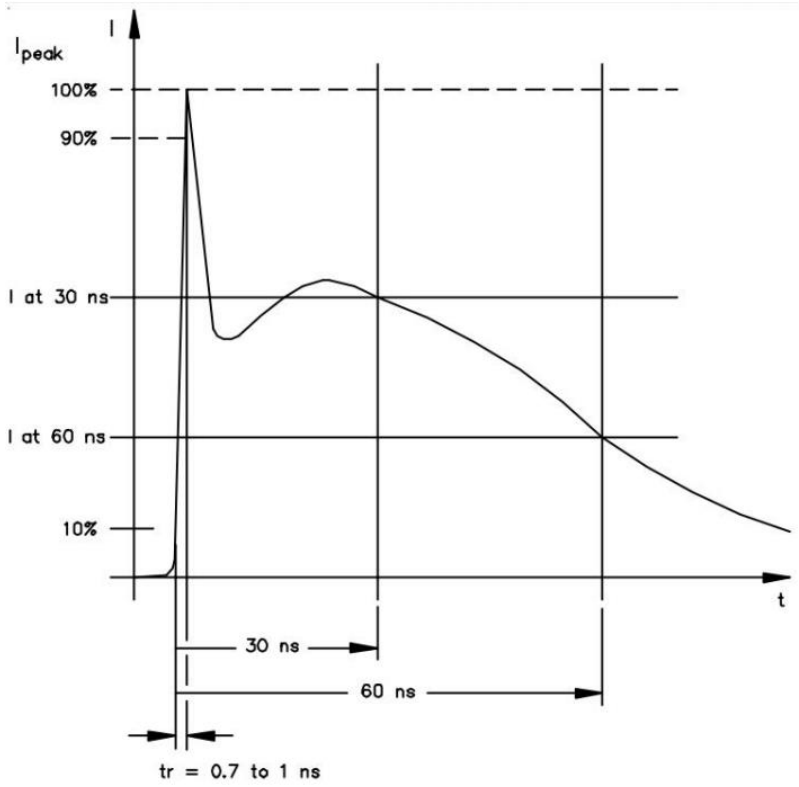


Figure 5

8. Electrical Information

8.1 Absolute Maximum Ratings

over operation free-air temperature range, T_A=25℃ (unless otherwise noted)

Parameter	Symbol	Value	Unit
Supply Voltage	V_{CC}	-0.3~13.2	V
Receiver Input Voltage (from Ground)	V_{RI}	±18	V
Driver Output Voltage (from Ground)	V_O	±18	V
Voltage at TLL Input/Output Pins		-0.3~6.0	V
Short Circuit Duration, TX out to Ground		Continuous	
Operating Junction Temperature Range	T_J	-40~85	℃
Storage Temperature Range	T_{STG}	-65~150	℃
Power Dissipation		500	mW

Notice

1) Exposure to conditions other than the Absolute Maximum Ratings above may cause permanent damage to the product, and operation under conditions other than those specified above is not guaranteed.

2) Long-term exposure to Absolute Maximum Ratings may affect product reliability.

3) This product is sensitive to ESD, so care must be taken when handling this product. In addition, this product should be stored under an appropriate storage environment using dedicated storage materials.

8.2 Recommended Operating Conditions

Parameter	Symbol	Value		Unit
		Min	Max	
External Supply voltage	V_{CC}	9	12	V
Operating free-air temperature	T_A	-40	+85	℃

8.3 ESD Characteristics

Mode	Characteristic			Unit
	min	typ	max	
HBM (Human Body Model) - Serial interface pins	-15	-	+15	kV
HBM (Human Body Model) - All other pins	-2	-	+2	kV
IEC61000-4-2 Air Gap Discharge - Serial interface pins	-4	-	+4	kV
IEC61000-4-2 Contact Discharge - Serial interface pins	-10	-	+10	kV

※ Serial interface pins are RS232 and RS422/485 signal pins

8.4 DC Characteristics

V_{CC}=9V±5% or 12V±5%, T_A=Tmin to Tmax, (Unless otherwise noted) Typical values are at V_{CC} =9V, T_A=25℃

Characteristics	Symbol	Condition	Value			Unit
			Min	Typ	Max	
DC Characteristics						
External Supply Voltage Range	V_{CC}		9		12	V
Supply Current (No load)	I_{CC}			5.5	10	mA
Logic Input: Pins 11, 12, 17						
High-level input voltage	V_{IH}		2.4			V
Low-level input voltage	V_{IL}				0.8	V
Logic Input Leakage Current Low	I_{IL}	Input Low (V_{IN}=0V)			1	uA
Pull-down Input Current	I_{PD}	Input Low(Vin=VCC), Pins 11,12,17			50	uA
Logic Input Hysteresis	V_{HYS}			200		mV
RS232 Receiver Inputs						
Input Voltage Range	V_{IN}		-15		15	V
Input Threshold Low	V_{IL}		0.8	1.5		V
Input Threshold High	V_{IH}			1.8	2.4	V
Input Hysteresis	V_{HYS}			0.3		V
Input Resistance	R_{IN}		3	5	7	kΩ
RS232 Driver Outputs						
Output Voltage Swing	V_O	Output loaded with 3kΩ to GND	±6	±7		V
		No load			±12	V
Short Circuit Current	I_{SC}				±60	mA
Output Resistance	Ro	V_{CC}=0V, V_O=±2V	300	10M		Ω

Characteristics	Symbol	Condition	Value			Unit
			Min	Typ	Max	
RS422/485 Receiver Inputs						
Receiver Input Resistance	R_{IN}	TERM=0V, $-7V \le V_{IN} \le 12V$	96			kΩ
Receiver Differential Threshold Voltage	V_{TH}	$-7V \le V_{IN} \le 12V$	-200	-125	-50	mV
Receiver Input Hysteresis	ΔV_{TH}			25		mV
Receiver Input Current	I_{IN}	V_{IN}=+12V			125	uA
		V_{IN}=-7V	-100			uA
Tri-State Output Current at Receiver	I_{OZR}	$0V \le V_O \le V_{CC}$			±1	uA
Receiver Output Short-Circuit Current	I_{OSR}	$0V \le V_O \le V_{CC}$			±80	mA
Termination Resistance	R_{TERM}			120		Ω
Characteristics	**Symbol**	**Condition**	**Value**			**Unit**
			Min	**Typ**	**Max**	
RS422/485 Driver Outputs						
Differential Driver Output	V_{OD}	R_L=100Ω (RS422)	2		V_{CC}	V
		R_L =54Ω (RS485)	1.5		V_{CC}	V
		$-7V \le V_{CM} \le +12V$	1.5		V_{CC}	V
		No load			V_{CC}	V
Change in Magnitude of Driver Differential Output Voltage	ΔV_{OD}	R_L=54Ω or 100Ω	-0.2		0.2	V
Driver Common-Mode Output Voltage	V_{OC}	R_L=54Ω or 100Ω		V_{CC}/2	3	V
Change in magnitude of Common mode output voltage	ΔV_{OD}	R_L =54Ω or 100Ω			0.2	V
Driver Output Short Circuit Current	I_{OSD}	$0V \le V_O \le +12$	50		250	mA
		$-7V \le V_O \le 0V$	-250		-50	mA

8.5 Timing Characteristics

V_{CC}=9V±5% or 12V±5%, T_A=Tmin to Tmax, (Unless otherwise noted) Typical values are at V_{CC} =9V, T_A=25℃

Characteristics	Symbol	Condition	Value			Unit
			Min	Typ	Max	
RS-485/RS-422 input -> RS-232 Output						
Maximum Data Rate		RL=3kΩ, CL=250pF	1			Mbps
Driver Propagation Delay	t_{DHL},t_{DLH}	RL=3kΩ, CL=1000pF		350		ns
Driver Propagation Delay Skew	$\|t_{DHL}-t_{DLH}\|$				150	ns
Transition Region Slew Rate from 3V to -3V or -3V to 3V	Ts	RL=3kΩ to 7kΩ, CL=150pF to 1000pF	24		150	V/us
RS-232 input -> RS-485/RS-422 Output						
Maximum Data Rate		RL=54Ω, CL=50pF	1			Mbps
Driver Propagation Delay	t_{DHL},t_{DLH}	RL=54Ω, CL=50pF		130	200	ns
Driver Propagation Delay Skew	$\|t_{DHL}-t_{DLH}\|$				110	ns
Driver Rise and Fall Time	t_{DR},t_{DF}			10	20	ns
Driver Output Enable Time	t_{DEN}	RL=500Ω, CL=50pF			200	ns
Driver Output Disable Time	t_{DDIS}				200	ns

9. Application Note

The SB200 is a high quality with industrial-grade port-powered or externally powered bi-directional RS232 to 2-wire RS485 or 4-wire RS422 converting transceiver with ±15kV ESD protection. This SB200 feature is port powered or can use optional 9~12V external power and selectable built-in 120Ω termination.

9.1 Application Information

RS232 Transceiver

The SB200 device consists of three transmitters, five receivers, and a charge-pump circuit with ±15kV ESD (HBM) protection.

The SB200 meets the requirements of TIA/EIA-232-F and provides the electrical interface between an asynchronous communication controller and the serial-port connector. This combination of drivers and receivers matches what is needed for the typical serial port used in an IBM PC, AT, or compatible device.

RS422/485 Transceiver

The SB200 transceiver is designed for RS422 full-duplex, bidirectional data communications on point-to-point or multipoint bus transmission lines (Figure 6). The SB200 transceiver is designed for RS485 half-duplex, bidirectional data communications on point-to-point or multipoint bus transmission lines (Figure 7).

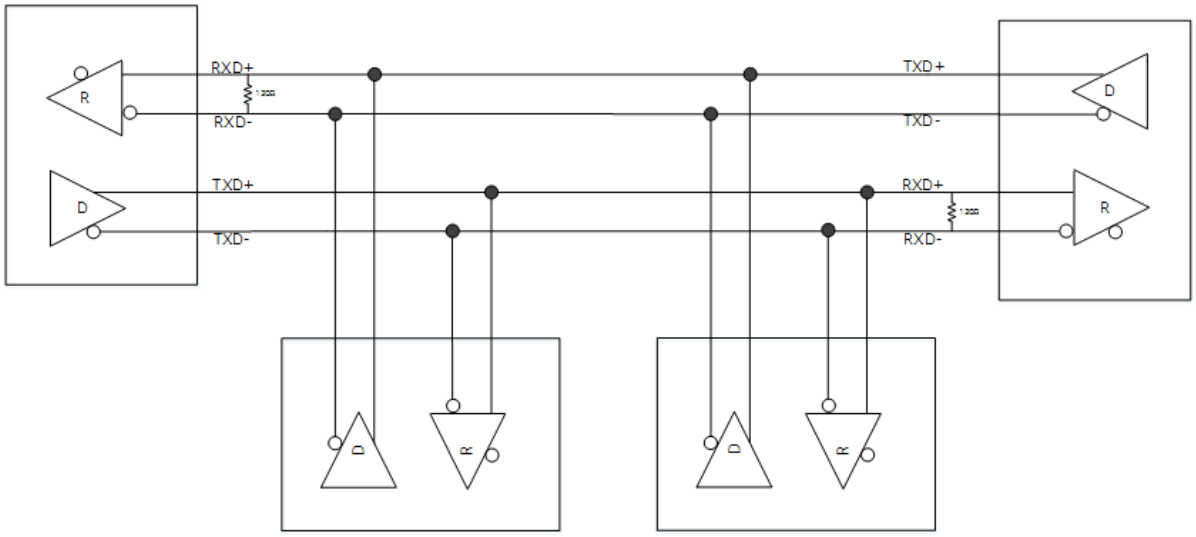


Figure 6

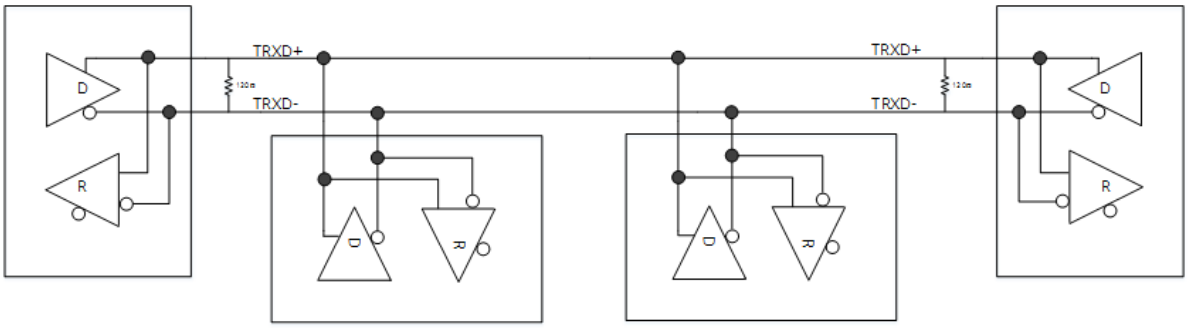
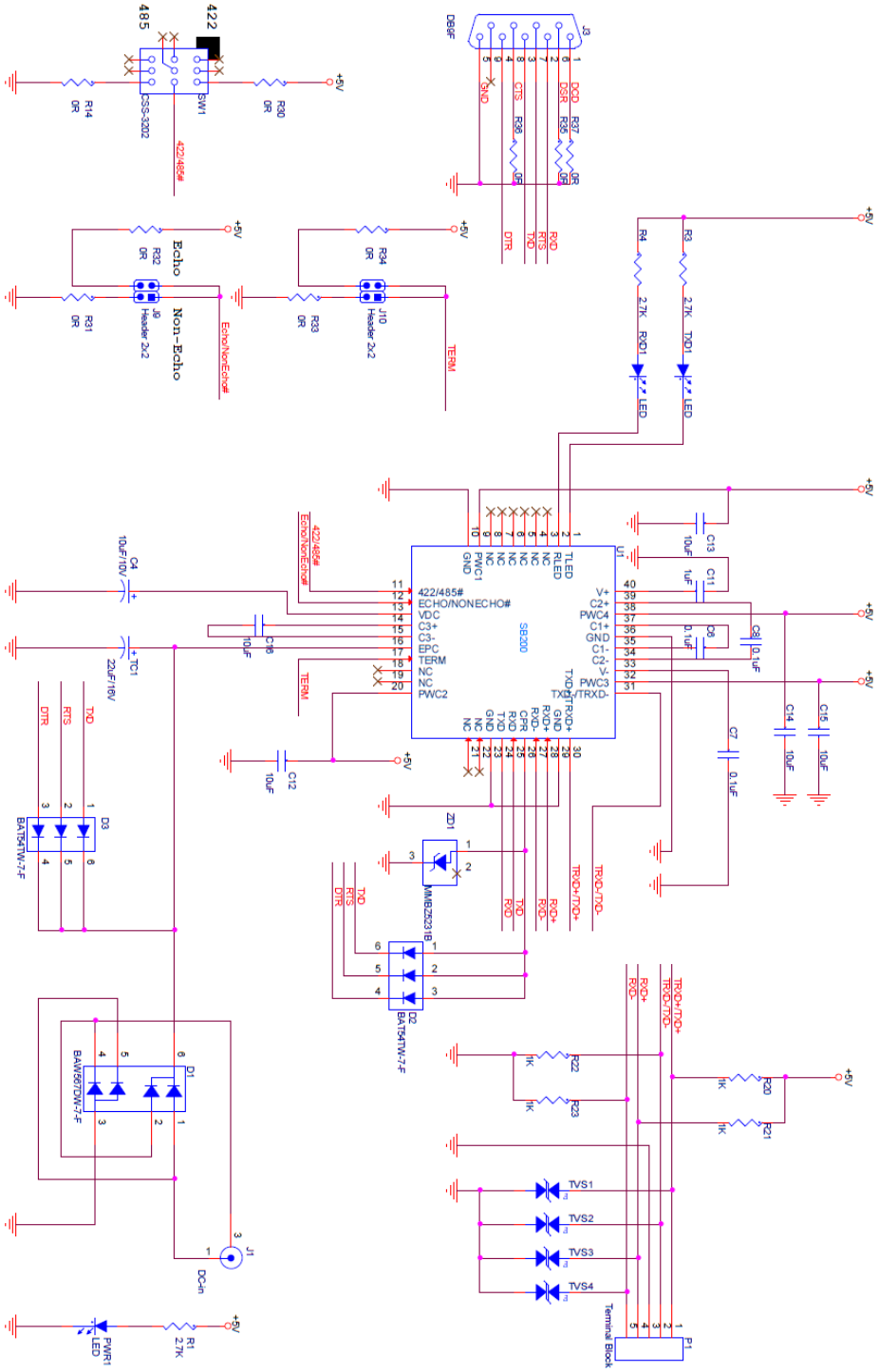


Figure 7

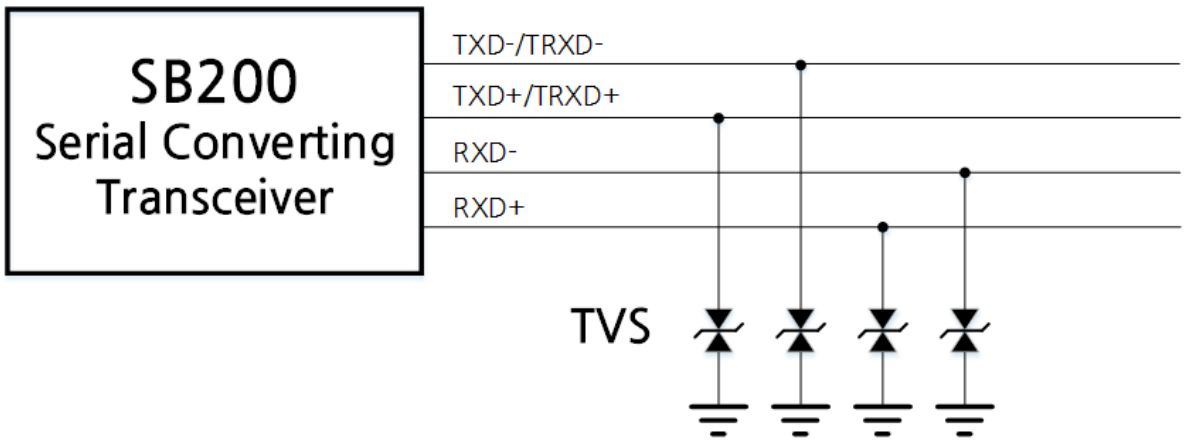
256 Transceivers on the Bus

The standard RS485 receiver input impedance is one unit load, and the standard driver can drive up to 32 unit loads. The SB200 has a 1/8-unit load receiver input impedance, allowing up to 256 transceivers to be connected in parallel on one communication line. Any combination of these devices, as well as other RS485 transceivers with a total of 32-unit loads or fewer, can be connected to the line.

9.2 Application Circuits



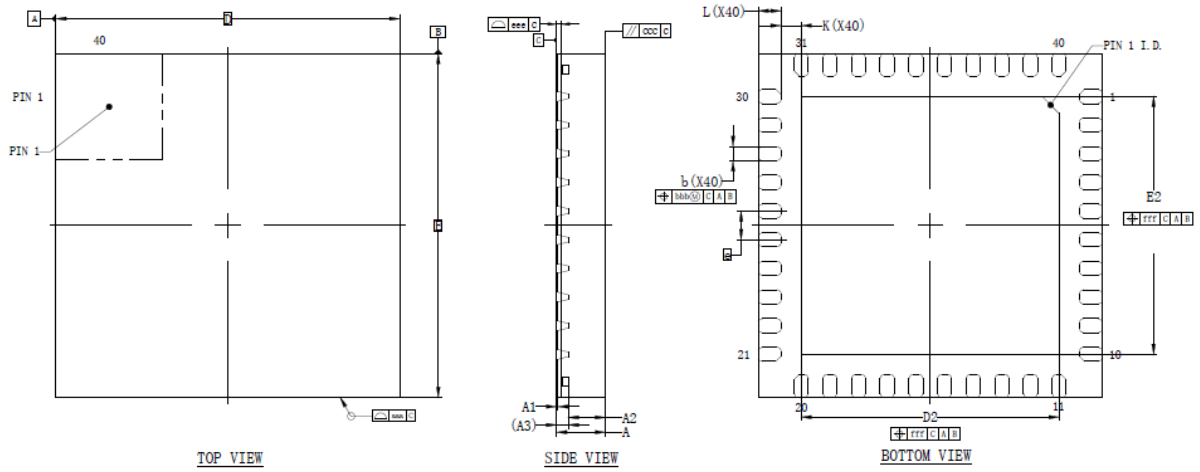
9.3 ESD reinforcement



Users can build up the surge protection of SB200 using TVS(Transient Voltage Suppressor) components. In the RS422 and RS485 modes, TVS components are used on the RS422 and RS485 bus like an upper reference circuit.

10. Mechanical Dimensions

10.1 QFN-40 foot print

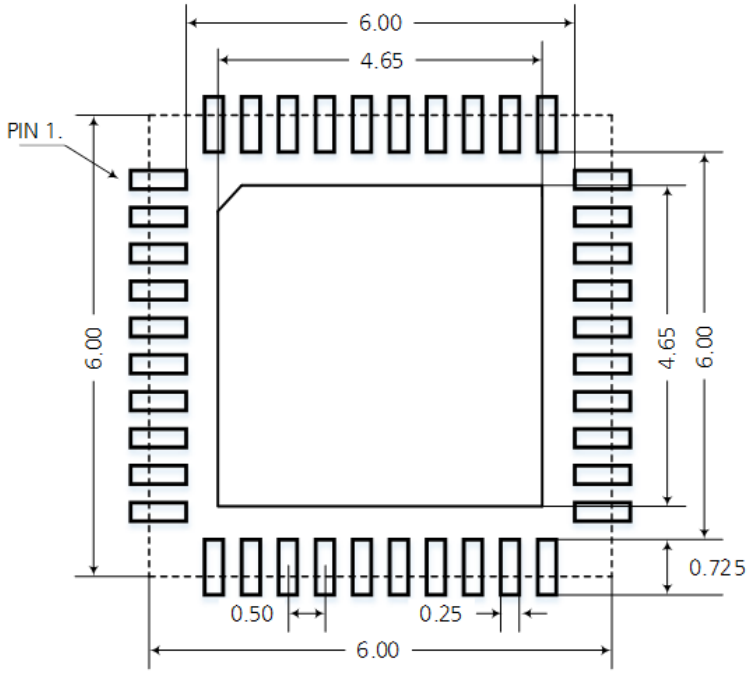


Item		Symbol	Minimum	Normal	Maximum
Body Size	X	D		6.0 BSC	
	Y	E		6.0 BSC	
Exposed Pad Size	X	D2	4.40	4.50	4.60
	Y	E2	4.40	4.50	4.60
Total Thickness		A	0.80	0.85	0.90
Stand Off		A1	0	0.02	0.05
Molding Thickness		A2		0.65	
LF Thickness		A3		0.203 REF	
Lead Width		b	0.20	0.25	0.30
Lead Length		L	0.30	0.40	0.50
Lead Pitch		e		0.5 BSC	
Lead tip to Exposed Pad		K		0.35 REF	
Package Edge Tolerance		aaa		0.10	
Lead Offset		bbb		0.10	
Molding Flatness		ccc		0.10	
Coplanarity		eee		0.08	
Exposed Pad Offset		fff		0.10	

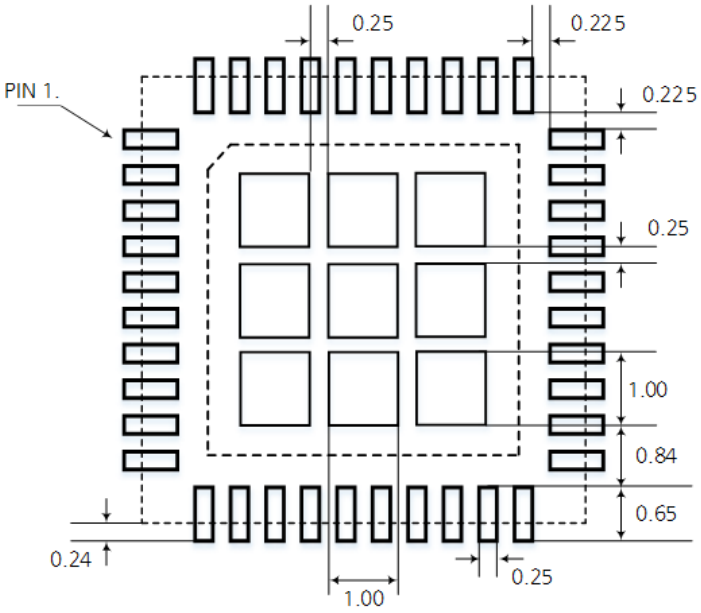
Note :

1.Refer to JEDEC Standard MO-220 WJJD-4

10.2 Artwork Guideline for QFN-40 package



TYPICAL RECOMMENDED LAND PATTERN



TYPICAL RECOMMENDED STENCIL

Revision History		
Data	**Revision**	**Description**
Oct 17 2024	Ver 1.00	Initial release
Nov 11 2024	Ver 1.01	Revised mechanical dimensions
Dec 11 2024	Ver 1.02	Modifying Contents
Feb 07 2025	Ver 1.03	Modifying Contents
Apr 22 2025	Ver 1.04	Revised Application Circuits

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