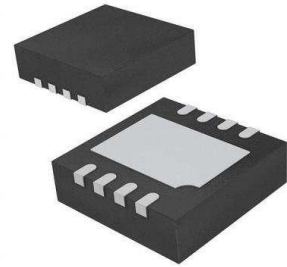


SCM3401B Half-duplex Transceiver

Features

- 5.0V single supply operation
- Baud Rate Up to 1Mbps
- 1/8 Unit Load—Up to 256 Nodes on a Bus
- Low Quiescent Power
 - 0.3mA Active Mode
 - 50nA Shutdown Mode
- Bus-Pin ESD Protection Up to 15 kV
- Driver short circuit protection

Package



Mechanical package: DFN 3X3
(see "Ordering information" for details).

Applications

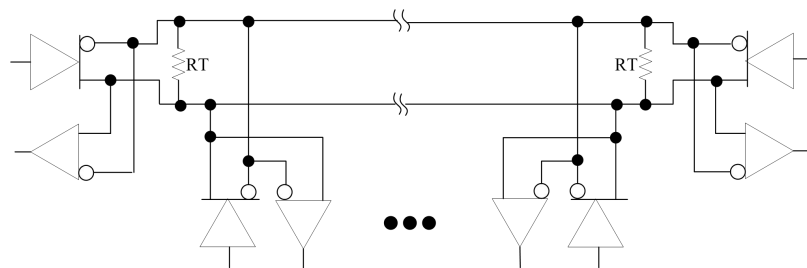
- Industrial Automation
- Building Automation
- Smart Electricity Meter
- Remote Signal Interaction, Transmission

Functional Description

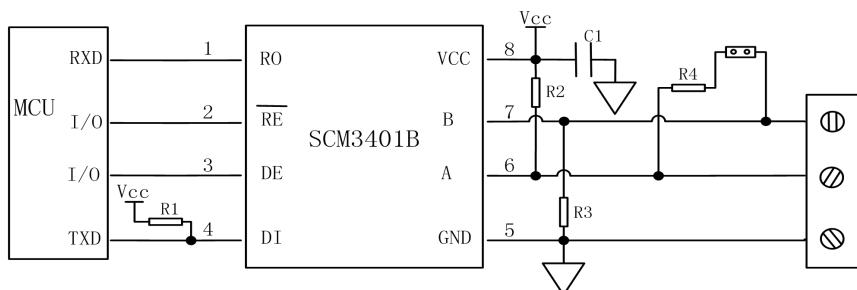
SCM3401B is a half-duplex enhanced transceiver designed for RS-485 data bus networks. Powered by 5V supply, the SCM3401B is fully compliant with TIA/EIA-485A standard and is suitable for data transmission of up to 1 Mbps. Receivers have an exceptionally high input impedance, which places only 1/8 of the standard load on a shared bus and up to 256 transceivers.

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

Typical Application Circuit



Typical Circuit 1: Half-Duplex Network

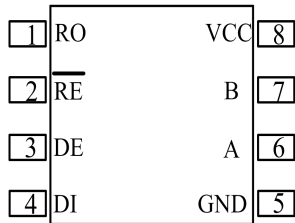


Typical Circuit 2: Application Diagram

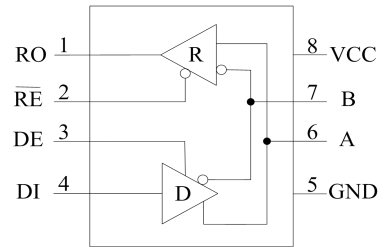
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Pin Connection



Internal Block Diagram



Function table

Driver					Receiver			
Input			Outputs		Input			Output
\overline{RE}	DE	DI	A	B	\overline{RE}	DE	A-B	RO
X	H	H	H	L	L	X	$\geq -10\text{mV}$	H
X	H	L	L	H	L	X	$\leq -200\text{mV}$	L
L	L	X	Z	Z	L	X	Open/Short	H
H	L	X	Z (SHUTDOWN)		H	H	X	Z
					H	L	X	Z (SHUTDOWN)

Pin descriptions

Pin Number	Pin Name	Pin Functions
1	RO	Receiver Output. When \overline{RE} is low and if $(A - B) \geq -10\text{mV}$, RO is high. If $(A - B) \leq -200\text{mV}$, RO is low.
2	\overline{RE}	Receiver Output Enable. When \overline{RE} is low, RO is enabled. When \overline{RE} is high, RO is high impedance. Drive \overline{RE} high and DE low to enter shutdown mode.
3	DE	Driver Output Enable. 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.
4	DI	Driver Input.
5	GND	Ground
6	A	Non-Inverting Driver Output / Receiver input
7	B	Inverting Driver Output / Receiver input
8	VCC	Positive Supply VCC. Bypass to GND with a 0.1uF capacitor.

Absolute Maximum Ratings

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

PARAMETERS	UNIT
Supply voltage range, V_{CC}	-0.3V~+6V
Voltage range at A or B	-8V~+13V
Voltage range at DE、DI、 \overline{RE} 、RO	-0.3V~+6V
Storage Temperature	-55°C~150°C
Lead Temperature (soldering, 10s)	300°C

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

Recommended Operating Conditions	Min.	Nom.	Max.	Unit
Supply Voltage, V_{VCC}	4.5	5	5.5	V
Voltage at any bus terminal (differential or common mode), V_I	-7		12	
High-level input voltage (DI, DE, \overline{RE}), V_{IH}	2		V_{CC}	
Low-level input voltage (DI, DE, \overline{RE}), V_{IL}	0		0.8	
Output current	Driver	-60	60	mA
	Receiver	-8	8	
Differential load resistance	54	60		Ω
Signaling rate			1000	Kbps
Operating ambient temperature, T_A in free-air	-40		85	°C
Operating junction temperature, T_J	-40		125	°C

Electrical Characteristics

General test conditions and $V_{VCC}=5V$, $T_a = 25^\circ C$ (unless otherwise specified).

Electrical characteristics of Transmitter							
Symbol	Parameters	Test condition	Min.	Nom.	Max.	Unit	
$ V_{OD} $	Differential output voltage	No-load			V_{VCC}	V	
		$R_L=54\Omega$, Fig.16	1.5	2.0		V	
		$V_{TEST} = -7 \sim 12V$, Fig.17	1.5		V_{VCC}		
$\Delta V_{OD} $	Change amplitude of differential output	Fig. 16, 17			± 0.2	V	
$V_{OC(SS)}$	Common mode output voltage under steady state	Fig.18	1		3	V	
$\Delta V_{OC(SS)}$	Change amplitude of common mode output voltage under steady state	Fig.18	-0.1		0.1	V	
I_{OSD}	Driver's short circuit current	$-7V \leq V_{OUT} \leq 12V$, Fig.22		± 110	± 250	mA	
Electrical characteristics of Receiver							
Symbol	Parameters	Test condition	Min.	Nom.	Max.	Unit	
V_{IT+}	Differential voltage threshold	$I_O = \pm 8 \text{ mA}$	-200		-10	mV	
V_{IT-}							
V_{hys}	Hysteresis voltage			30		mV	
V_{OL}	Output low level of receiver	$I_{OUT} = 8 \text{ mA}$, $V_{ID} = 200 \text{ mV}$, Fig.23	$V_{VCC}-1.5$			V	
V_{OH}	Output high level of receiver	$I_{OUT} = -8 \text{ mA}$, $V_{ID} = 200 \text{ mV}$, Fig.24			0.4	V	
R_{in}	Input impedance of receiver	A and B connecting to $-7V \leq V_{OUT} \leq 12V$ power supply	96			K Ω	
I_{OSR}	Output short-circuit current of receiver	Ro short circuit GND, $-7V \leq V_{cm} \leq 12V$,	40		110	mA	
$I_{A, B}$	Bus input current (A, B pin)	DE=0, $\overline{RE}=0$, $V_{VCC}=0V$	$V_A=12V$		195	235	μA
			$V_A=-7V$		175	210	μA
		DE=0, $\overline{RE}=0$, $V_{VCC}=5V$	$V_A=12V$		100	120	μA
			$V_A=-7V$		105	126	μA

Power supply and protection features						
Symbol	Parameters	Test condition	Min.	Nom.	Max.	Unit
I _{in1}	Driver and receiver enables operating current	DE = V _{VCC} , $\overline{RE} = 0$, no-load		250	900	uA
I _{in2}	Driver enables while receiver disables operating current	DE = V _{VCC} , $\overline{RE} = V_{VCC}$, no-load		250	900	uA
I _{in3}	Receiver enables while driver disables operating current	DE = 0, $\overline{RE} = 0$, no-load		220	600	uA
I _{in4}	Operating current under shutdown mode	DE = 0, $\overline{RE} = V_{VCC}$, no-load		0.05	1	uA
ESD	Human Body Model	A and B pin to GND		±15		KV
		Other pins		±4		KV
EFT	IEC61000-4-4	A and B pin to GND		±1		KV

Transmission Characteristics

General test conditions and V_{VCC} = 5V, Ta = 25°C (unless otherwise specified).

Switching characteristics of Driver							
Symbol	Parameters	Test condition	Min.	Nom.	Max.	Unit	
1/t _{UI}	Transmission rate	Duty ratio 40% ~ 60%			1000	Kbps	
T _{DPHL}	Driver Propagation Delay	R _L = 54Ω, C _L = 50pF, Fig.19			100	ns	
T _{DPLH}					100	ns	
T _{DR}	Driver Output Rise Time				100	ns	
T _{DF}	Driver Output Fall Time				100	ns	
t _{Dsk(p)}	Differential output delay offset of driver T _{PHL} - T _{PLH}			-50		50	ns
T _{DPZH}	Driver enables to output high level		R _L = 110Ω, $\overline{RE} = 0$, Fig.20, Fig. 21		100	500	ns
T _{DPZL}	Driver enables to output low level			100	500	ns	
T _{DPHZ}	Driver is turned off, output goes from high to low level			50	100	ns	
T _{DPLZ}	Driver is turned off, output goes from low to high level			50	100	ns	
T _{DPZH(SHDN)}	Shutdown mode to driver output active high	R _L = 110Ω, $\overline{RE} = V_{VCC}$, Fig.20		50	100	ns	
T _{DPZL(SHDN)}	Shutdown mode to driver output active low			50	100	ns	
Switching characteristics of Receiver							
Symbol	Parameters	Test condition	Min.	Nom.	Max.	Unit	
T _{RPZH}	Receiver Propagation Delay	C _L = 15pF, Fig.22		50	100	ns	
T _{RPHL}					50	100	ns
t _{Rsk(p)}	Transmission delay offset of receiver			-50		50	ns
T _R	Receiver Output Rise Time	C _L = 15pF, V _{DI} = -1.5V~1.5V, Fig.22		20	50	ns	
T _F	Receiver Output Fall Time			20	50	ns	
T _{RPZH}	Receiver enables to output high level	C _L = 15pF, Fig.23, Fig. 24		20	50	ns	
T _{RPZL}	Receiver enables to output low level			20	50	ns	
T _{RPZH}	The receiver disables the enable delay and the output goes from high to low.			20	50	ns	
T _{RPLZ}	The receiver disables the enable delay and the output goes from low to high.			20	50	ns	
T _{RPZH(SHDN)}	Shutdown mode to receiver's output active high	C _L = 15pF, DE = 0V, Fig.25		500	1000	ns	
T _{RPZL(SHDN)}	Shutdown mode to receiver's output active low			20	1000	ns	
T _d	Time to Shutdown			50		600	ns
Digital input signal: DI, DE and RE							
Symbol	Parameters	Test condition	Min.	Nom.	Max.	Unit	
V _{IH}	Input high voltage		2			V	
V _{IL}	Input low voltage				0.8		

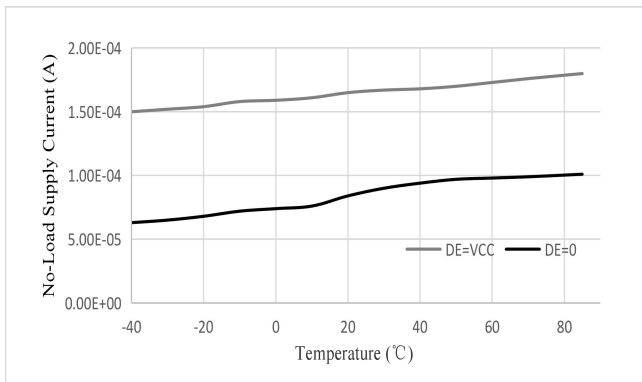


Figure 1 No-Load Supply Current vs. Temperature

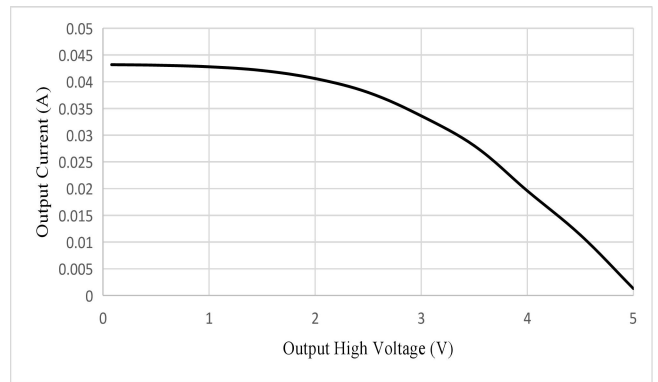


Figure 2 Output Current vs. Receiver Output High Voltage

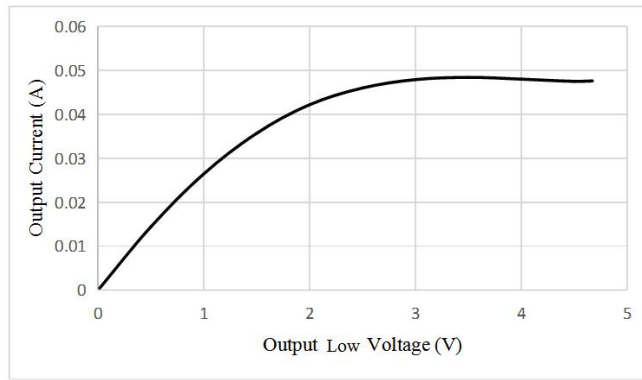


Figure 3 Output Current vs. Receiver Output Low Voltage

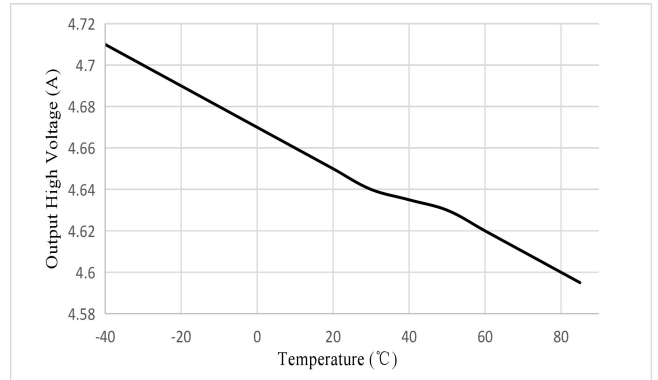


Figure 4 Receiver Output High Voltage vs. Temperature

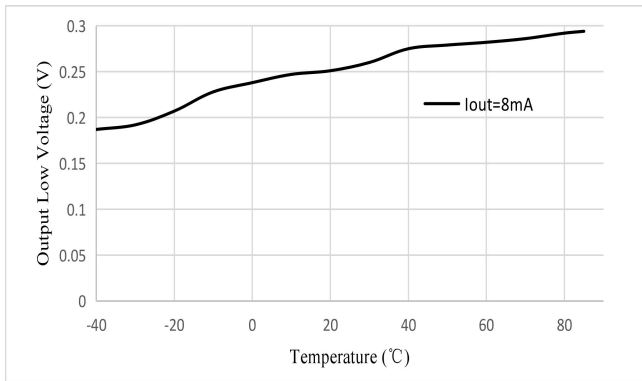


Figure 5 Receiver output low voltage vs. Temperature

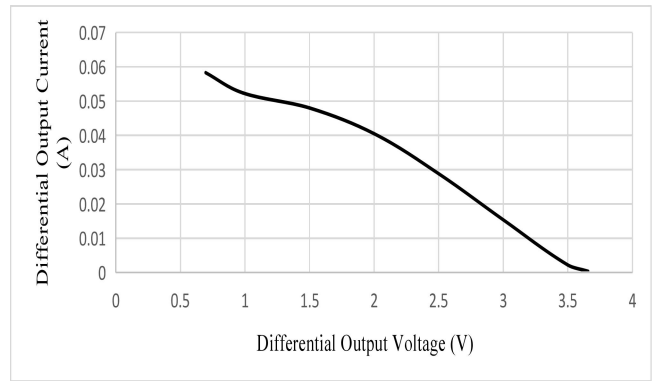


Figure 6 Driver differential output current vs. Differential output voltage

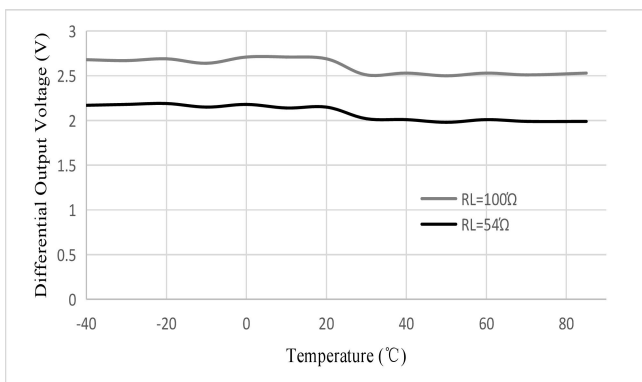


Figure 7 Driver Differential Output Voltage vs Temperature

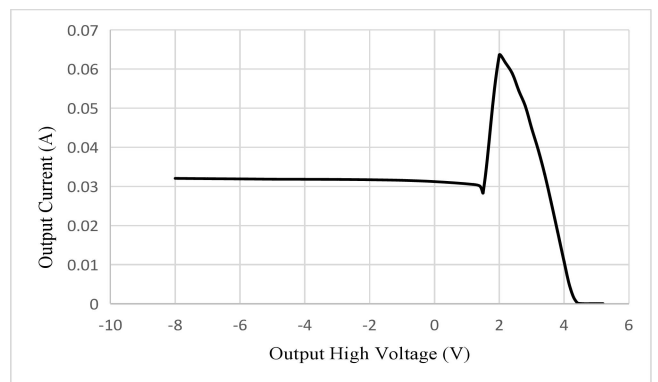


Figure 8 Output current vs. Transmitter output high voltage

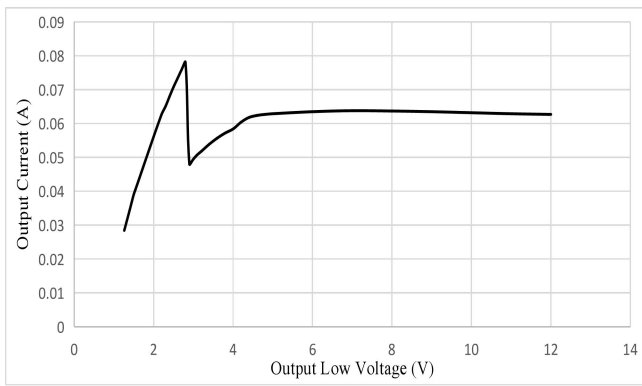


Figure 9 Output current vs. Transmitter output low voltage

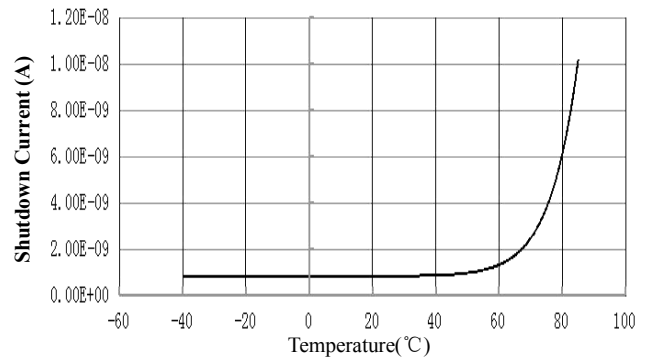


Figure 10 Shutdown Current vs. Temperature

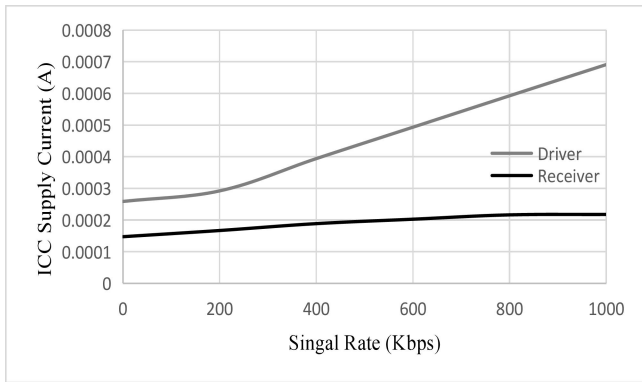


Figure 11 RMS Supply Current vs. Signaling Rate

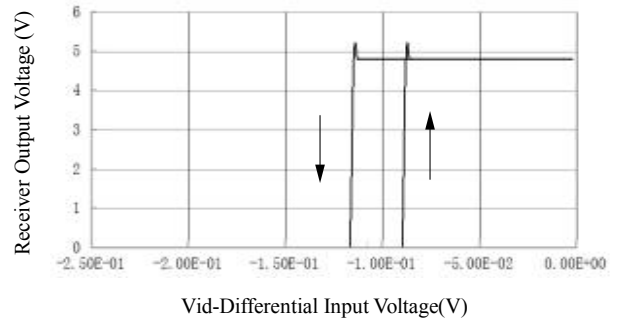


Figure 12 Receiver output voltage vs. Differential input voltage

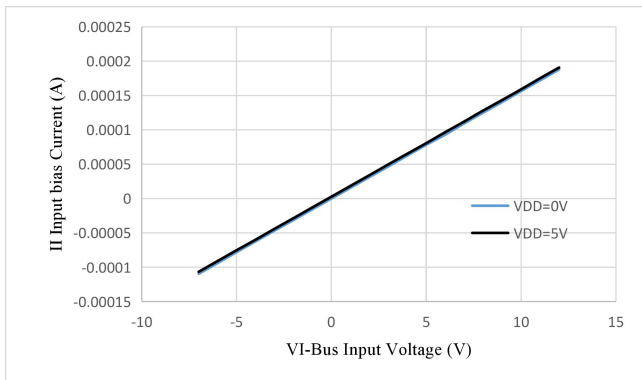


Figure 13 Bus input current vs. Bus input voltage

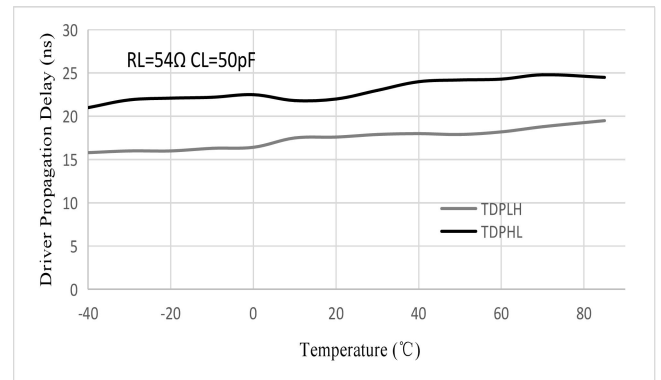


Figure 14 Driver propagation delay vs. Temperature

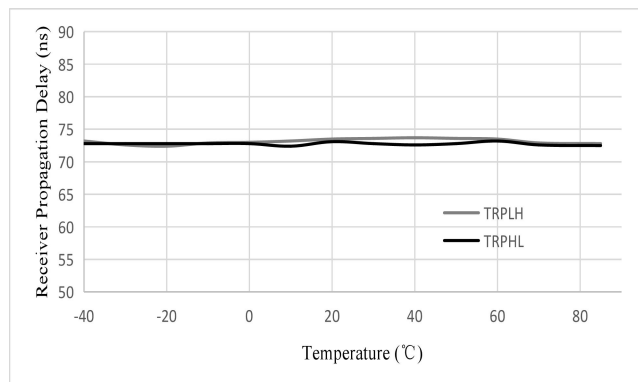


Figure 15 Receiver Propagation Delay vs. Temperature

NOTE: Load test capacitance includes probe and test fixture stray capacitance, unless otherwise specified. Signal generator with following characteristics: Rise and fall time < 6ns, pulse rate 100kHz, 50% duty cycle, Z_O = 50Ω (unless otherwise specified).

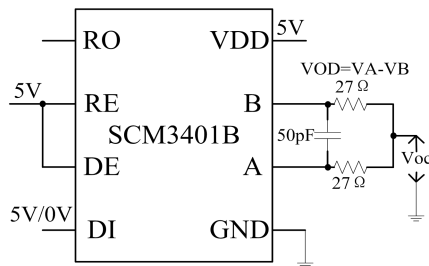


Figure 16 Driver Test Circuit, V_{OD} and V_{OC} Without Common-Mode Loading

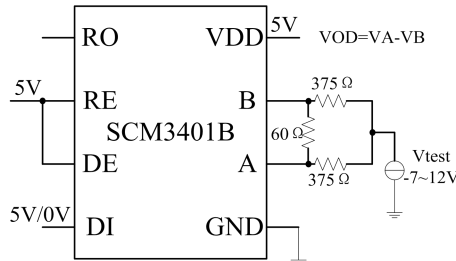


Figure 17 Driver Test Circuit, V_{OD} With Common-Mode Loading

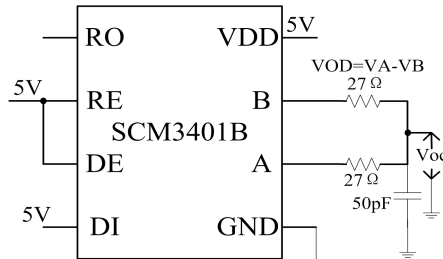


Figure 18 Driver V_{OC} Test Circuit

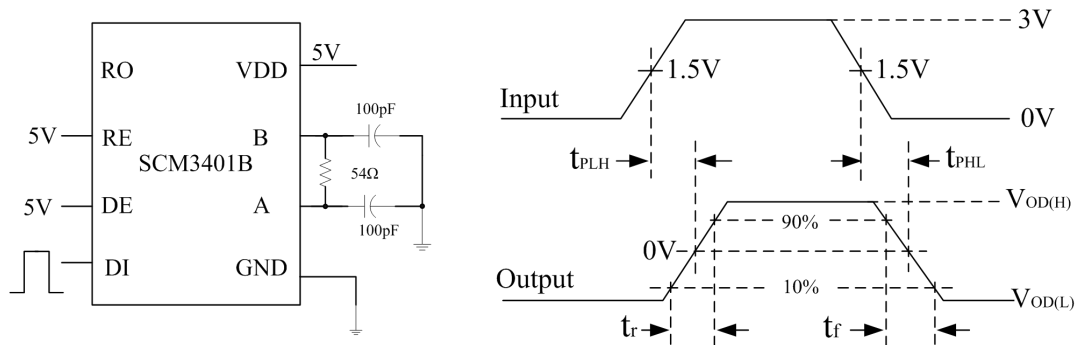


Figure 19 Driver Switching Test Circuit and Waveforms

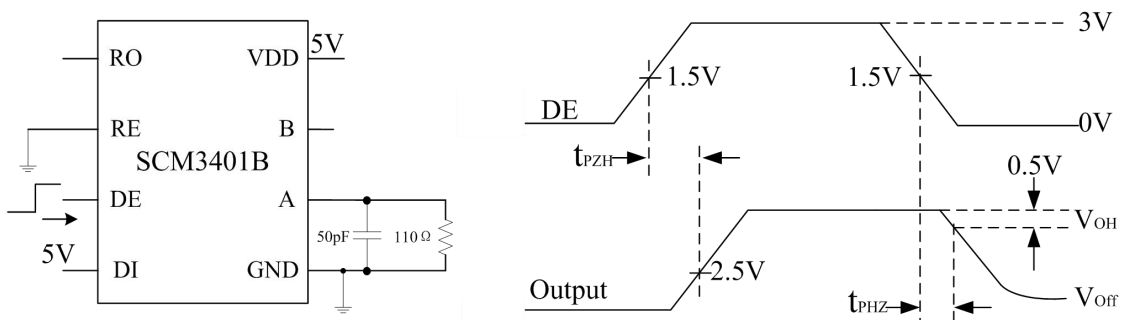


Figure 20 Driver Enable/Disable Test Circuit and Waveforms, High Output

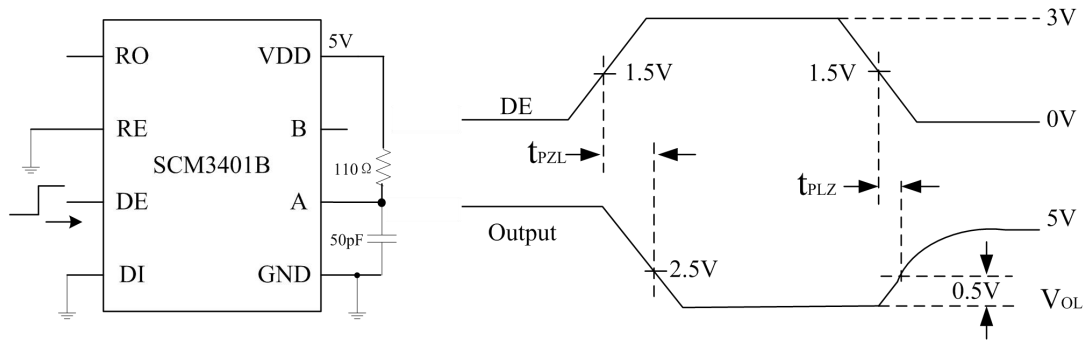


Figure 21 Driver Enable/Disable Test Circuit and Waveforms, Low Output

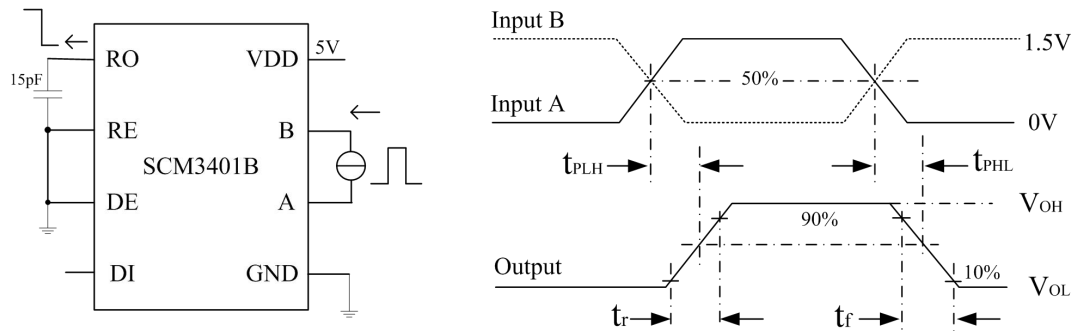


Figure 22 Receiver Switching Test Circuit and Waveforms

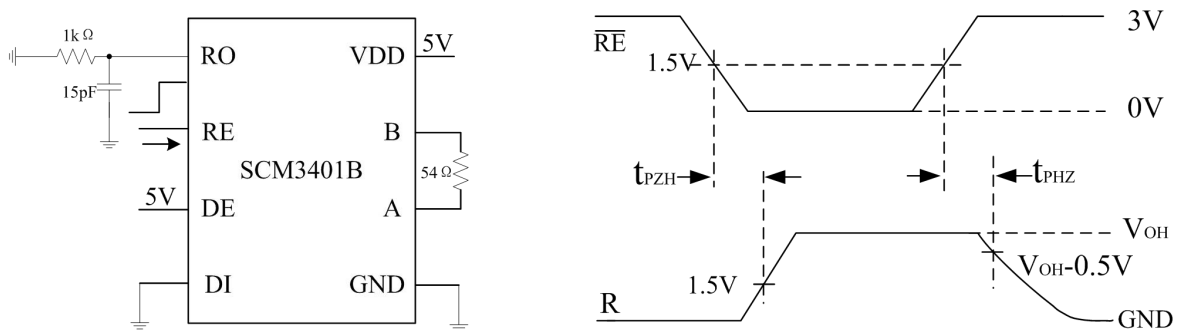


Figure 23 Receiver Enable/Disable Test Circuit and Waveforms, Data Output High

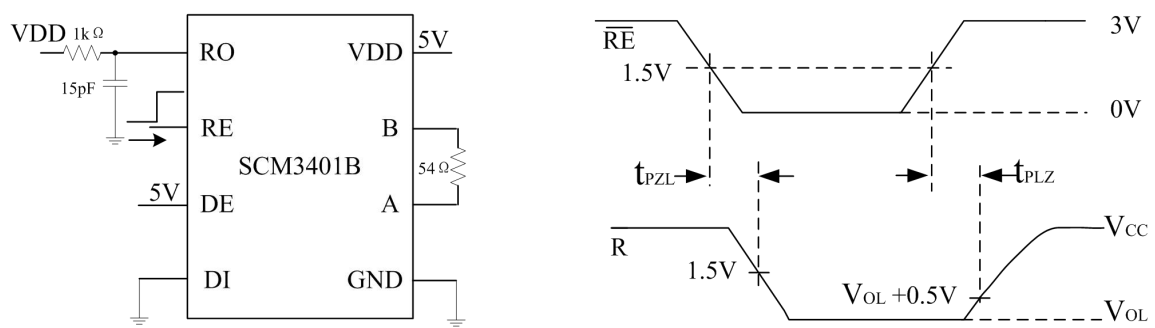


Figure 24 Receiver Enable/Disable Test Circuit and Waveforms, Data Output Low

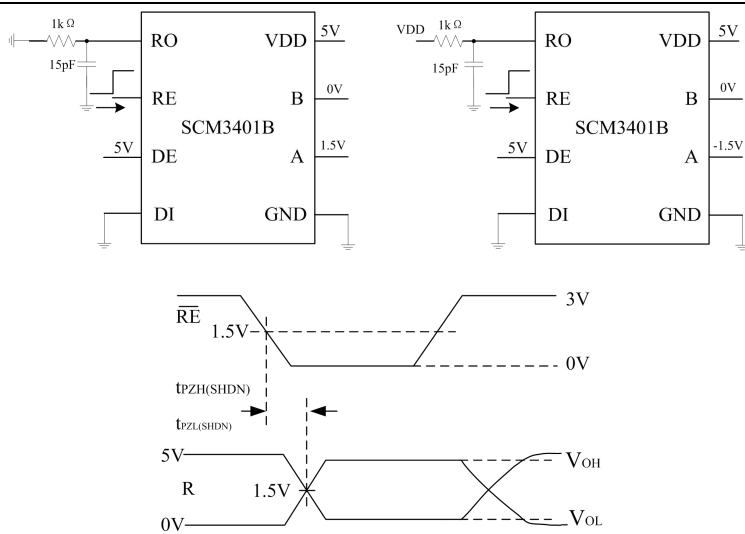


Figure 25 Receiver Enable from Shutdown Test Circuit and Waveforms

Detailed Description

The SCM3401B series are advanced RS-485 transceivers. They each contain one driver and one receiver. These devices feature a fail-safe circuitry that guarantees a high receiver output voltage when the receiver inputs are either open, shorted or when they are connected to a terminated transmission line with all drivers disabled. These devices operate with a single 5.0V supply. Drivers limit the output current by over current protection, to avoid the damage to the transceivers.

Receiver input filter

The SCM3401B receivers have an integrated input filter which enhances noise immunity of the high-speed differential signals. The receiver propagation delay increases due to this filtering.

Bus fail-safe

Ordinary RS485 bus receivers will be in an indeterminate state when $-200\text{mV} < A - B < -10\text{mV}$. This situation can occur whenever the data bus is not being actively driven. The advanced Fail-safe feature of the SCM3401B guarantees a high receiver output voltage if the receiver's differential inputs are either shorted, open circuit, or if they are connected to a termination resistor.

The SCM3401B receiver thresholds are very precise, and the offset between threshold voltage and ground has a margin of at least 10mV. This guarantees that the receiver output is a high voltage even the input differential is zero volts, thus maintaining compliance with the EIA/TIA-485 standard .

Load abilities on the bus (256 nodes)

The standard receiver input impedance of RS-485 is 12kΩ (1 unit load). A standard RS485 driver can drive at least 32 unit loads. The SCM3401B transceiver is design to 1/8th of the standard unit load and the input impedance is higher than 96kΩ, hence allowing up to 256 unit loads, in other words eight times as many. The SCM3401B can work combined with other standard RS485 that use the smaller amount of unit loads.

Low power shut down mode

A low-power shutdown mode is triggered by simultaneously bringing $\overline{\text{RE}}$ high and DE low. During shutdown mode the device supply current is 50nA typical. DE and $\overline{\text{RE}}$ can be directly connected and controlled by the same I/O. The devices are guaranteed not to enter shutdown mode if $\overline{\text{RE}}$ is high and DE is low for less than 50ns. If this state is maintain for at least 600ns, the device will shut down reliably.

Driver output protection

The device prevents excessive output current caused by fault conditions or driver short circuit. A driver current limit on the output stage provides and ensures immediate protection against short circuits over the entire common mode voltage range.

Expansion Output Design

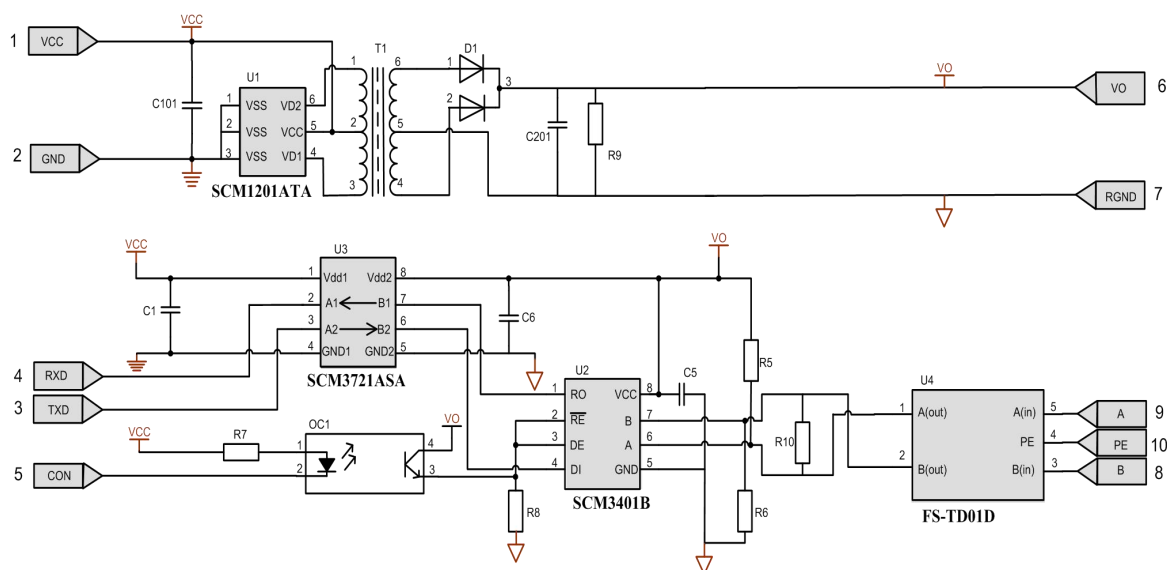


Fig. 26 Schematic diagram of isolation application circuit for UART to RS485 signal

Suggestions for Power Supply

If the input power is a few inches from the SCM3401B, as much as possible, connect a 0.1 μ F bypass capacitor to the VCC pin and a 10 μ F capacitor near the center tap pin of the transformer.

Ordering Information

Part number	Package	Number of pins	Product Marking	Tape & Reel
SCM3401BFA	DFN	8	3401BYM	5K/REEL

Description of product code

SCM3401XYZ :

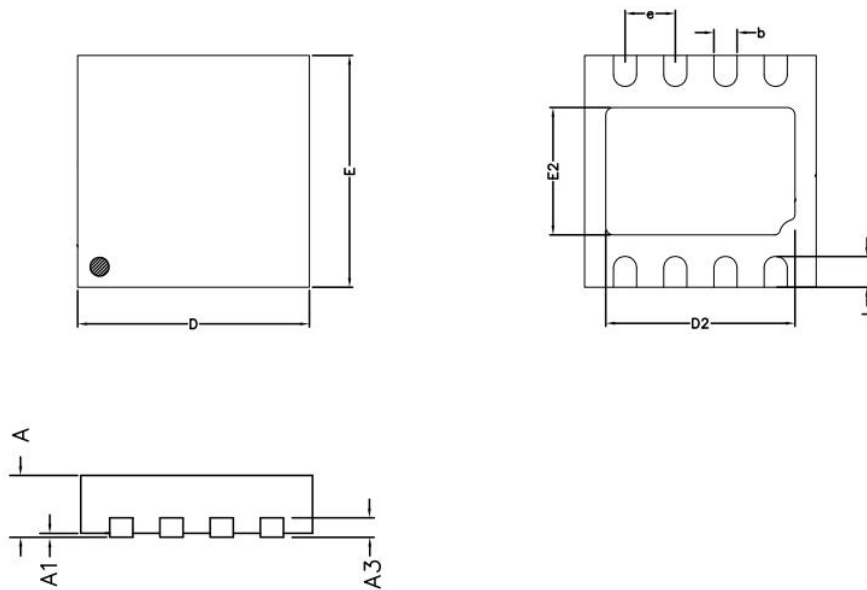
- (1) SCM3401, product code.
- (2) X = A-Z, version code.
- (3) Y = F encapsulation code; F: DFN encapsulation.
- (4) Z = C, I, A, M, temperature grade code; C: 0 $^{\circ}$ C-70 $^{\circ}$ C, I: -40 $^{\circ}$ C-85 $^{\circ}$ C, A: -40 $^{\circ}$ C-125 $^{\circ}$ C, M: -55 $^{\circ}$ C-125 $^{\circ}$ C.

Product marking:

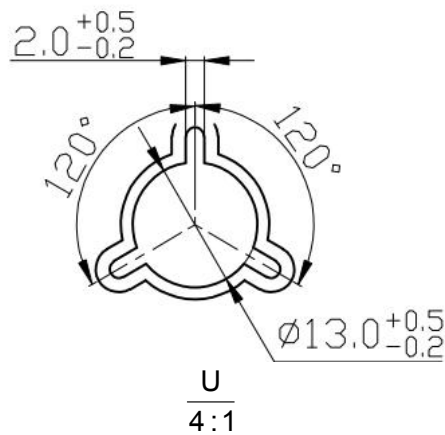
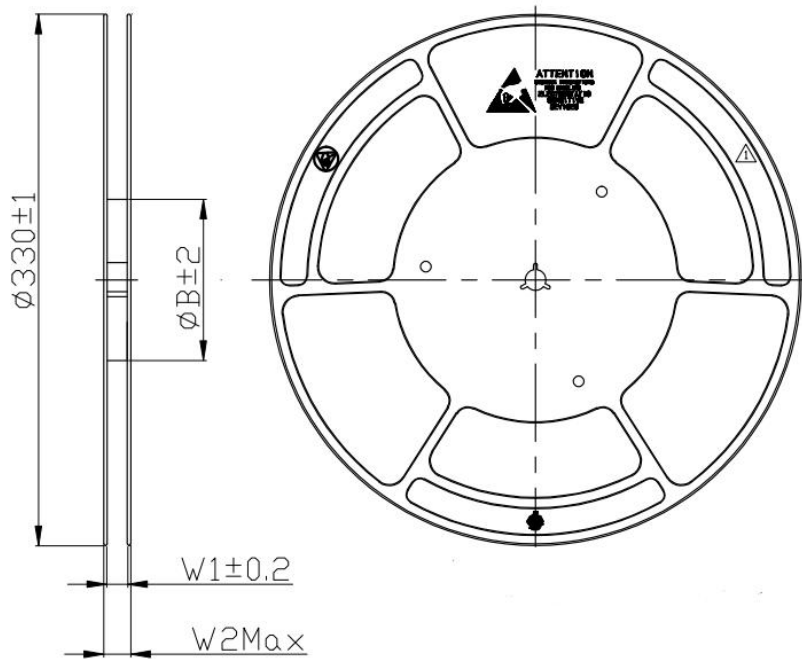
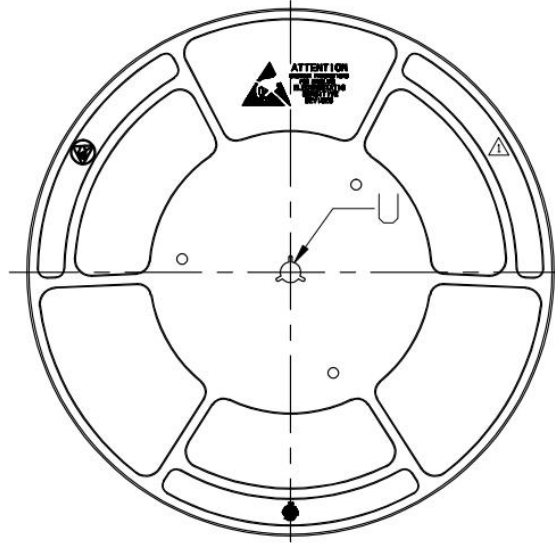
3401XYM

- (1) X = A-Z, version code
- (2) YM: Product traceability code; Y: Code of product production year, M: Code of product production month

Package Information



Identification	Dimensions (mm)		
	Min	Nom	Max
A	0.7	0.75	0.8
A1	0	-	0.05
	0.2 REF		
D	2.95	3.00	3.05
E	2.95	3.00	3.05
b	0.25	0.3	0.35
L	0.30	0.40	0.50
D2	2.3	2.45	2.55
E2	1.50	1.65	1.75
e	0.65 BSC		



Basic Disk Dimensions (mm)				
Package Type	Load Band Width	B	W1	W2Max
DFN8	12	180	12.4	18.4

Technical requirement :

1. Color : Blue (Reference color number :
PANTONE DS 196-1 C ; C100 M70 Y0 K0
PANTONE DS 197-1 C ; C100 M70 Y0 K10
PANTONE DS 205-1 C ; C100 M60 Y0 K20
PANTONE DS 205-2 C ; C85 M50 Y0 K20
PANTONE DS 206-2 C ; C85 M50 Y0 K35
PANTONE DS 219-1 C ; C90 M50 Y5 K15)
2. Dimensions and tolerances according to ANSI/EIA-481-C-2003;
3. Disk surface good finish, no warping deformation ;
4. External packing in good condition, no damage or pollution;

Mornsun Guangzhou Science & Technology Co., Ltd.

No. 5, Kehui St. 1, Kehui Development Center, Science Ave., Guangzhou Science City, Huangpu District, Guangzhou, P. R. China

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