

*Preliminary*

## Features

- Integrated Transient Voltage Suppressor (TVS) in the Transceiver IC
- TVS Protection for Bus Terminals :  
±15 kV IEC 61000-4-2, Contact Discharge  
±18 kV IEC 61000-4-2, Air-Gap Discharge  
±15 kV EIA/JEDEC Human Body Model
- HBM ±4kV ESD Protection for all pins
- MM ±400V ESD Protection for all pins
- Latchup immunity up to ±400mA for all pins.
- High CDM protection up to ±1kV for all pins.
- Meet the Requirements of the EIA/TIA-485 Standards with 5V Power Supply
- True Fail-Safe Receiver While Maintaining EIA/TIA-485 Compatibility(RXP=0V)
- Polarity Control to Correct for Bus Reversal through RXP/TXP Pins
- Hot-Swap Glitch free Protection on Control Inputs
- High driving ability of VOD2
- Up to 256 Transceivers on the Bus

## Applications

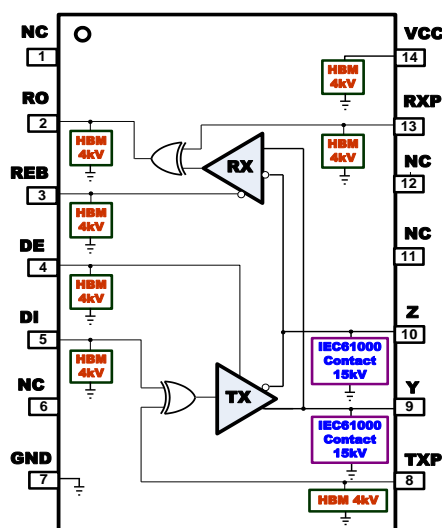
- Lighting Systems
- Industrial Control
- Security Systems
- Instrumentation
- Profibus Application

## Description

The AZRS5054PB is a ±15kV IEC 61000-4-2 contact discharge protected half-duplex RS485 transceiver IC, which contains one transmitter and one receiver inside. This device is fully compliant with the EIA/TIA-485 standard with 5V power supply.

The AZRS5054PB features a fail-safe receiver, which guarantees the output of the receiver to be logic high when the differential inputs (bus pins, A and B) of the receiver are open, short or idle when RXP=0V.

The AZRS5054PB features a hot-swap glitch-free design which guarantees outputs of the transmitter and the receiver in a high impedance state and even no short current event during the power up period. The AZRS5054PB has the thermal shutdown and the current limited function in the transmitter to protect the device from damage by system fault conditions during normal operating condition. The AZRS5054PB is designed 1/8 unit load with minimum 96kohm of input impedance, which can connect 256 devices on a bus at most. The AZRS5054PB is also a high reliable device with built-in system level ESD protected devices against high-energy noise transients without requiring any external components.



**Functional Block of AZRS5054PB**

Part Number	Duplex	Tx/Rx	Supply (V)	Max Data Rate (Mbps)	Fail- safe	Rx Input Filtering	HBM on A,B	IEC 61000-4-2 Contact on A,B	Package Type
AZRS5054PB	Half	1/1	5	10	Yes	Yes	±15kV	± 15kV	SOP-14L

*Preliminary*

## ABSOLUTE MAXIMUM RATINGS

PARAMETER	PARAMETER	RATING	UNITS
Power Supply Vcc	Vcc	-0.3 to 8.0	V
Control Input Voltage	REB, DE	-0.3 to (Vcc+ 0.3)	V
Receiver Input Voltage	A, B	±13	V
Receiver Output Voltage	RO	-0.3 to (Vcc+ 0.3)	V
Transmitter Output Voltage	A, B	±13	V
Transmitter Input	DI	-0.3 to (Vcc+ 0.3)	V
Operating Temperature	T <sub>OP</sub>	-40 to +85	°C
Storage Temperature	T <sub>STO</sub>	-65 to +150	°C

## DC ELECTRICAL CHARACTERISTICS

(Vcc=5V ±5% with T<sub>AMB</sub>= T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted. Typical values are at Vcc=5V and T<sub>AMB</sub>= 25 °C.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
<b>Transmitter</b>						
Differential Transmitter Output	V <sub>OD1</sub>	No load			Vcc	V
Differential Transmitter Output	V <sub>OD2</sub>	Fig.1, R <sub>L</sub> = 27 Ω	2.3	3.0		V
Change in Magnitude of Differential Output Voltage	Δ V <sub>OD</sub>	Fig.1, R <sub>L</sub> = 27 Ω			0.2	V
Transmitter Common- Mode Output Voltage	V <sub>OC</sub>	Fig.1, R <sub>L</sub> = 27 Ω			3	V
Change in Magnitude of Common- Mode Voltage	Δ V <sub>OC</sub>	Fig.1, R <sub>L</sub> = 27 Ω			0.2	V
Input High Voltage	V <sub>IH</sub>	DE, DI, REB	2.0			V
Input Low Voltage	V <sub>IL</sub>	DE, DI, REB			0.8	V
Input Current	I <sub>IN1</sub>	DE, DI, REB			±2	μA
Input Current	I <sub>IN2</sub>	TXP, RXP			40	μA
Input Current for A and B	I <sub>IN3</sub>	DE=0, Vcc=0V or 5.25V	V <sub>IN</sub> =12V		125	uA
			V <sub>IN</sub> =-7V	-100		
Transmitter Short-Circuit Output Current	I <sub>OSD</sub>	-7V ≤ V <sub>OUT</sub> ≤ 12V, Vcc=5.0V	-250		250	mA
<b>RECEIVER</b>						
Receiver Differential Threshold Voltage	V <sub>TH</sub>		-200		-50	mV
Receiver Input Hysteresis	Δ V <sub>TH</sub>			20		mV
Receiver Output High Voltage	V <sub>OH</sub>	I <sub>o</sub> = -4mA, VID= 200mV	Vcc-0.6			V

**Preliminary**

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	
Receiver Output Low Voltage	V <sub>OL</sub>	I <sub>o</sub> = 4mA, V <sub>ID</sub> = -200mV			0.4	V	
Three-State Output Current at Receiver	I <sub>OZR</sub>	REB=V <sub>cc</sub>			±1	µA	
Receiver Input Resistance	R <sub>IN</sub>	-7V ≤ V <sub>CM</sub> ≤ +12V	96			kΩ	
Receiver Output Short-Circuit Current	I <sub>OSR</sub>	Fig. 6, 0V ≤ V <sub>RO</sub> ≤ V <sub>cc</sub>			±95	m A	
SUPPLY CURRENT							
Supply Current	I <sub>cc</sub>	No load, REB= GND, DI= V <sub>cc</sub> or GND.	DE= V <sub>cc</sub>		600	900	µA
			DE= GND		600	900	µA
Supply Current in Shutdown Mode	I <sub>SHDN</sub>	REB= V <sub>cc</sub>	DE= GND			10	µA

**SWITCHING CHARACTERISTICS**

( $V_{CC} = 5\text{V} \pm 5\%$  with  $T_{AMB} = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted. Typical values are at  $V_{CC} = 5\text{V}$  and  $T_{AMB} = 25^\circ\text{C}$ .)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Transmitter Input to Output	$t_{DPLH}$ , $t_{DPHL}$	Fig.2 and 7, $R_{DIFF} = 54\Omega$ , $C_{L1} = C_{L2} = 100\text{pF}$			50	ns
Transmitter Output Skew $ t_{DPLH} - t_{DPHL} $	$t_{DSKEW}$	Fig.2, Fig.7, $R_{DIFF} = 54\Omega$ , $C_{L1} = C_{L2} = 100\text{pF}$		10		ns
Transmitter Rise or Fall Time	$t_{DF}$ , $t_{DR}$	Fig.2, Fig.7, $R_{DIFF} = 54\Omega$ , $C_{L1} = C_{L2} = 100\text{pF}$			20	ns
Data Rate	$f_{Data}$				10	Mbps
Transmitter Enable to Output Low	$t_{DZL}$	Fig.4, Fig.8, $C_{DL} = 100\text{pF}$ , S1 closed			70	ns
Transmitter Enable to Output High	$t_{DZH}$	Fig.4, Fig.8, $C_{DL} = 100\text{pF}$ , S2 closed			70	ns
Transmitter Disable Time from Low	$t_{DLZ}$	Fig.4, Fig.8, $C_{DL} = 15\text{pF}$ , S1 closed			70	ns
Transmitter Disable Time from High	$t_{DHZ}$	Fig.4, Fig.8, $C_{DL} = 15\text{pF}$ , S2 closed			70	ns
Transmitter Enable from Shutdown to Output Low	$t_{DZL(SHDN)}$	Fig.4, Fig.8, $C_{DL} = 50\text{pF}$ , S1 closed			1800	ns
Transmitter Enable from Shutdown to Output High	$t_{DZH(SHDN)}$	Fig.4, Fig.8, $C_{DL} = 50\text{pF}$ , S2 closed			1800	ns
Time to shutdown	$t_{SHDN}$		50	800	1200	ns
Receiver Input to Output	$t_{RPLH}$ , $t_{RPHL}$	Fig.5, Fig.9, $ V_{ID}  \geq 2.0\text{V}$ ; rise and fall time of $V_{ID} \leq 15\text{ns}$		120	200	ns

**Preliminary**

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
$ t_{RPLH} - t_{RPHL} $ Different Receiver Skew	$t_{RSKD}$	Fig.5, Fig.9, $ V_{ID}  \geq 2.0V$ ; rise and fall time of $V_{ID} \leq 15ns$		10		ns
Receiver Enable to Output Low	$t_{RZL}$	Fig.3, Fig.10, $C_{RL} = 15pF$ , S1 closed			50	ns
Receiver Enable to Output High	$t_{RZH}$	Fig.3, Fig.10, $C_{RL} = 15pF$ , S2 closed			50	ns
Receiver Disable Time from Low	$t_{RLZ}$	Fig.3, Fig.10, $C_{RL} = 15pF$ , S1 closed			50	ns
Receiver Disable Time from High	$t_{RHZ}$	Fig.3, Fig.10, $C_{RL} = 15pF$ , S2 closed			50	ns
Receiver Enable from Shutdown to Output Low	$t_{RZL(SHDN)}$	Fig.3, Fig.10, $C_{RL} = 15pF$ , S1 closed			1800	ns
Receiver Enable from Shutdown to Output High	$t_{RZH(SHDN)}$	Fig.3, Fig.10, $C_{RL} = 15pF$ , S2 closed			1800	ns
Time to shutdown	$t_{SHDN}$		50	400	700	ns

**PIN FUNCTION DESCRIPTION**

Pin Number	Mnemonic	Function
1, 6, 11, 12	N.C.	No Connect.
2	RO	Receiver Output: When REB is low and if $(A - B) \geq -50mV$ , RO is high; if $(A - B) \leq -200mV$ , RO is low. (Please see the Function Table for detail)
3	REB	Receiver Output Enable: REB is low to enable the Receiver; REB is high to disable the Receiver.
4	DE	Transmitter Output Enable: DE is high to enable the transmitter; DE is low to disable the transceiver.
5	DI	Transmitter Input: When DE is high, a low on DI forces A output low and B output high. Similarly, a high on DI forces A output high and B output low.
7	GND	Ground pin. Must be connected to 0V.
8	TXP	Transmitter Phase: TXP is low or leave unconnected for normal transmitter polarity; TXP is high to invert the transmitter polarity.
9	Y	Non-inverting Receiver Input and Non-inverting Transmitter Output
10	Z	Inverting Receiver Input and Inverting Transmitter Output

**Preliminary**

13	RXP	Receiver Phase: RXP is low or leave unconnected for normal receiver polarity; RXP is high to invert the receiver polarity.
14	VCC	Power Supply Input 5V. Must adding a 100nF decoupling capacitor as close to the VCC pin as possible.

**FUNCTION TABLE**

TRANSMITTING					
INPUTS				OUTPUTS	
TXP	REB	DE	DI	Y	Z
0	X	1	0	0	1
0	X	1	1	1	0
1	X	1	0	1	0
1	X	1	1	0	1
X	0	0	X	HIGH- Z	HIGH- Z
X	1	0	X	Shutdown	

X= Don't care  
HIGH- Z= High impedance

RECEIVING				
INPUTS				OUTPUTS
RXP	REB	DE	Y - Z	RO
0	0	0	$\geq -0.05V$	1
0	0	0	$\leq -0.2V$	0
1	0	0	$\geq -0.05V$	0
1	0	0	$\leq -0.2V$	1
0	0	0	Open/Shorted	1
1	0	0	Open/Shorted	0
X	1	X	X	HIGH- Z
X	1	0	X	Shutdown

X= Don't care  
HIGH- Z= High impedance



## Detail Description

The AZRS5054PB is a half-duplex RS-485 transceiver IC with IEC61000-4-2 contact  $\pm 15\text{kV}$  ESD protection for bus pins (A and B), which contains one transmitter and one receiver inside with 5V power supply. This device is fully compliant with the EIA/TIA-485 standard.

The AZRS5054PB features the hot-swap glitch free design which guarantees the outputs of the transceiver in a high impedance state during the power-up period until the supply voltage has stabilized. The AZRS5054PB with whole chip ESD protected design for all of the I/O pins has robust ESD protection up to both HBM  $\pm 4\text{kV}$  and MM  $\pm 400\text{V}$ . Moreover, the latchup immunity of the AZRS5054PB is up to  $\pm 400\text{mA}$  for all of the pins. For IC self discharge issue, the CDM protection level of the AZRS5054PB is up to  $\pm 1\text{kV}$ .

## Transmitter

The design of the transmitter is a non-inverted translator that converts the single-ended TTL input signal to differential EIA/TIA-485 signal level. The transmitter of the AZRS5054PB guarantees 10Mbps data rate communication. When the transmitter is active (DE= HIGH), the single-end TTL input signals of transmitter will be transported to differential output RS485 signals of the transmitter. Under the disable state (DE= LOW), the outputs of transmitter keep at high impedance state. The differential output voltage VA-VB(VOD2) of the AZRS5054PB is 3.0V with 54 ohm load under  $V_{cc} = 5.0\text{V}$ ,  $T = 25^\circ\text{C}$ .

## Receiver

The receiver of the AZRS5054PB converts the differential EIA/TIA-485 signals to single-end output TTL signal when receiver is in active state (REB=LOW), which incorporates input filtering in addition to input hysteresis. The input filtering

enhances the noise immunity under normal operating condition. When the receiver is disable (REB=HIGH), the output of the receiver keeps in high impedance state no matter what the input of the receiver is.

## True Fail-Safe

The AZRS5054PB guarantees a receiver output high when the receiver inputs are short, open or idle, that is true fail-safe when  $RXP=0\text{V}$  only. The threshold voltage of receiver input is between  $-50\text{mV}$  and  $-200\text{mV}$ . If the differential input voltage (A - B) of receiver is greater than or equal to  $-50\text{mV}$ , receiver output (RO) is logic-high. If (A - B) is less than or equal to  $-200\text{mV}$ , RO is logic-low. In the case of a terminated bus with all transmitters disabled, the receiver's differential input voltage (A - B) is 0V, so the RO is logic-high at that time.

## 1/8 Unit Load

The AZRS5054PB transceiver has a  $96\text{k}\Omega$  input impedance (1/8 unit load) of the receiver, allowing up to 256 or fewer devices to be connected in parallel on the RS485 bus.

## Polarity Control

The AZRS5054PB has two pins that control the polarity of the transmitter and the receiver. In the normal operation(Y/Z connects correctly), both the TXP and RXP keeps in the Logic-low state. Once the Y/Z connects incorrectly, the AZRS5054PB will keep normal communication after the TXP/RXP forced to logic-high. The most important is that the AZRS5054PB has no true fail safe receiver function while RXP is logic-high. In other words, the output of the receiver will be logic-low when the receiver inputs are short, open or idle when  $RXP=\text{high}$ . The detail conditions shows in the FUNCTION TABLE.



*Preliminary*

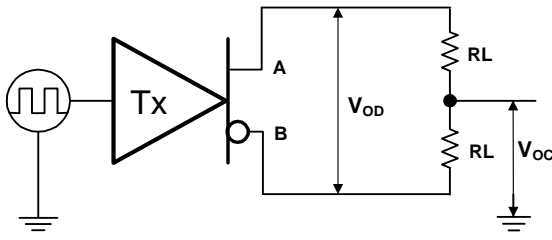


Fig.1 Transmitter DC test circuit

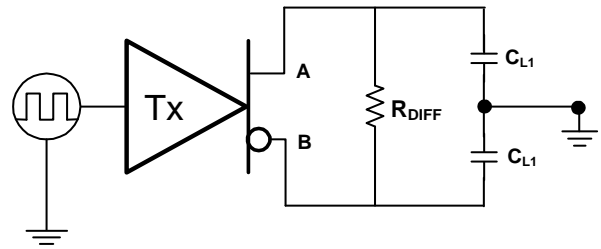


Fig.2 Transmitter timing test circuit

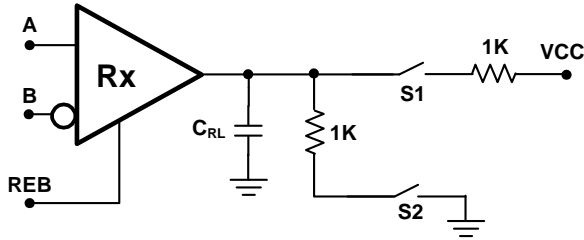


Fig.3 Receiver enable/disable timing test load

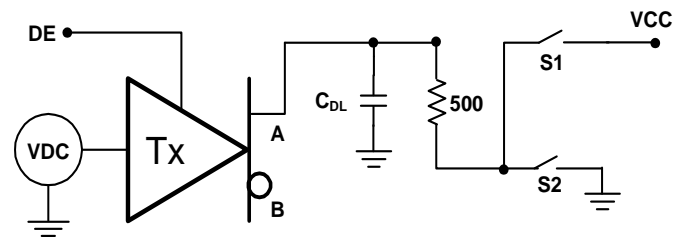


Fig.4 Transmitter enable/disable timing test load

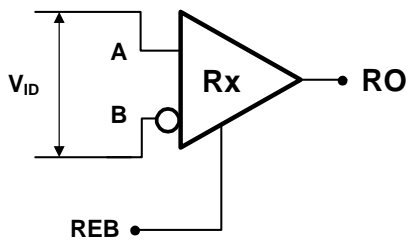


Fig.5 Receiver timing test circuit

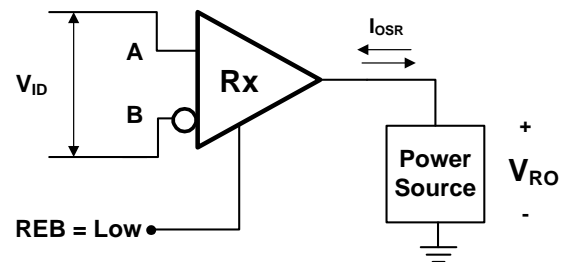


Fig.6 Receiver output short circuit

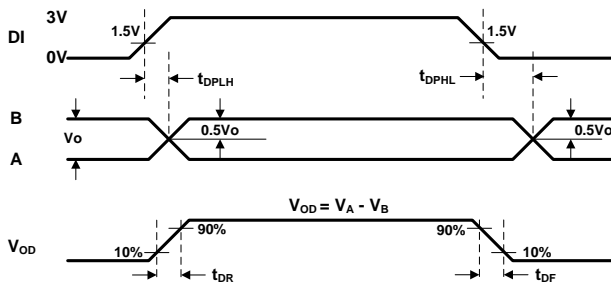


Fig.7 Transmitter Propagation Delays

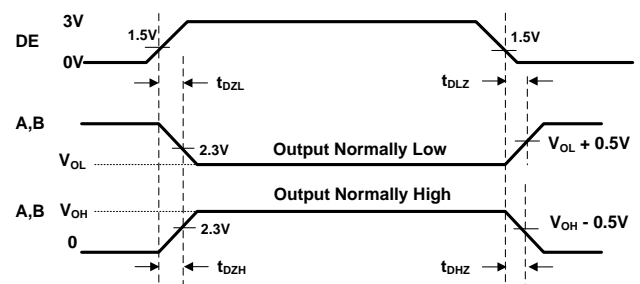


Fig.8 Transmitter Enable and Disable Times

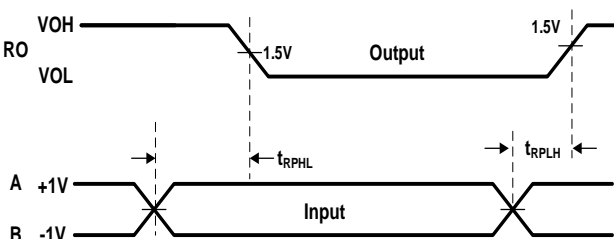


Fig.9 Receiver Propagation Delays

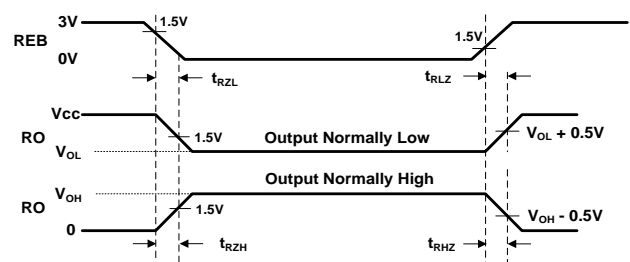


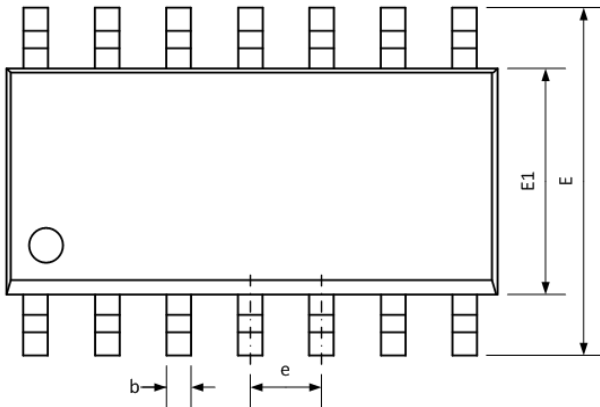
Fig.10 Receiver Enable and Disable Times



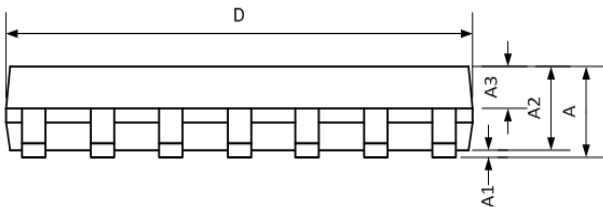
*Preliminary*

## Mechanical Details

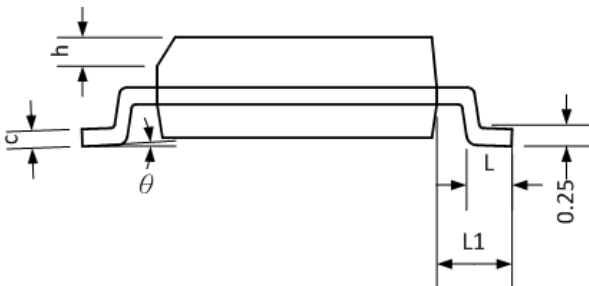
**SOP-14L**  
**PACKAGE DIAGRAMS**  
**TOP VIEW**



**SIDE VIEW**



**END VIEW**



## PACKAGE DIMENSIONS

SYMBOL	MILLIMETERS		
	MIN.	NOM.	MAX.
A	-	-	1.75
A1	0.05	-	0.225
A2	1.30	1.40	1.50
A3	0.60	0.65	0.70
b	0.39	-	0.47
c	0.20	-	0.24
D	8.55	8.65	8.75
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
e	1.27 BSC		
h	0.25	-	0.50
L	0.50	-	0.80
L1	1.05 REF		
θ	0	-	8

## MARKING CODE



RS5054PB = Device Code

WW = Date Code

XX = Control Code

G = Green Part Indication

Part Number	Marking Code
AZRS5054PB.RDG	RS5054PB WWXXG

**Preliminary****Ordering Information**

PN#	Material	Type	Reel size	MOQ/interal box	MOQ/carton
AZRS5054PB.RDG	Green	T/R	13 inch	1 reel=2,500/box	5 boxes=12,500/carton

**Revision History**

Revision	Modification Description
Revision 2022/11/15	Preliminary Release.