

## AFBR-3905xxRZ

### High-Voltage Galvanic Insulation Link for DC to 5 Mbaud



## Description

The Broadcom® AFBR-3905xxZ is a high-voltage galvanic insulation link for DC to 5 Mbaud. The AFBR-3905xxZ consists of an optical transmitter and receiver operating at a wavelength of 650 nm. A pin-to-pin distance of approximately 25 mm to 101 mm provides transient voltage suppression in the range of 15 kV to 50 kV.

## Applications

- Drives/inverters
- Galvanic insulation on one single PCB
- Medium voltage power distributions
- Regulated distribution transformers
- Smart grid onboard insulations

## Ordering Information

Part Number	Length	mm	Voltage Suppression
AFBR-390525RZ	1 inch	25	15 kV
AFBR-390550RZ	2 inch	50.4	27 kV
AFBR-390575RZ	3 inch	75.8	40 kV
AFBR-390500RZ	4 inch	101.2	50 kV

## Features

- Data transmission at signal rates of DC to 5 Mbaud
- DC-coupled receiver with CMOS/TTL output for easy designs: no data encoding or digitizing circuitry required
- High noise immunity through the receiver IC with integrated photodiode
- RoHS compliant
- Transient voltage suppression in the range of 15 kV to 50 kV according to IEC 60644
- Laser class 1 according to IEC-60825
- Certified according to IEC-60747-5-5
- Housing Material UL-V0 with CTI ≥ 600
- Optional 3.3V or 5V power supply

## Absolute Maximum Ratings

Parameter	Symbol	Min.	Max.	Units
Signaling Rate	$f_s$	DC	5	Mbaud
Storage and Operating Temperature	$T_{S,O}$	-40	+85	°C
Receiver Supply Voltage	$V_{DD}$	-0.5	+5.5	V
Receiver Output Current	$I_{OAV}$	—	10	mA
Transmitter Peak Forward Input Current	$I_{F,PK}$	—	30	mA
Transmitter Reverse Input Voltage	$V_R$	—	3	V
Lead Soldering Cycle <sup>a,b</sup> Temp	$T_{SOL}$	—	+260	°C
Time	—	—	10	sec

a. 1.6 mm below the seating plane; wave soldering only. To guard against solder process fluctuations, the recommended nominal soldering time is 5 seconds.

b. MSL class 3.

**ATTENTION:** Stresses above those listed here may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

## Recommended Operating Conditions

Parameter	Symbol	Min.	Max.	Units
Ambient Temperature	$T_A$	-40	85	°C
Rx Power Supply Voltage <sup>a</sup>	$V_{CC}$	3.135	3.465	V
		4.75	5.25	V
Transmitter Average Forward Current	$I_{F,AV}$	5	10	mA
Signaling Rate	$f_s$	DC	5	Mbaud

a. < 100 mVpp of noise.

**ATTENTION:** All the data in this specification refers to the operating conditions above and over lifetime unless otherwise stated.

## Insulation Characteristics

Parameter	Symbol	Min.	Max.	Units
Apparent charge at Sample Test stage and Type Test stage after subgroup 1 (method a) <sup>a</sup>	$q_{pd}$	—	5	pC
Apparent charge at Routine Test stage and Type Test stage, Preconditioning (method b) <sup>b</sup>	$q_{pd}$	—	5	pC
Maximum Transient Voltage, peak <sup>c</sup>	$V_{IOTM\ 1inch}$	15	—	kV
	$V_{IOTM\ 2inch}$	27		
	$V_{IOTM\ 3inch}$	40		
	$V_{IOTM\ 4inch}$	50		
Maximum Transient Voltage, effective <sup>c</sup>	$V_{ISO\ 1inch}$	10.5	—	kV
	$V_{ISO\ 2inch}$	19		
	$V_{ISO\ 3inch}$	28.1		
	$V_{ISO\ 4inch}$	35.2		
Maximum Working Voltage, peak <sup>d</sup>	$V_{IORM\ 1inch}$	4.25	—	kV
	$V_{IORM\ 2inch}$	8.5		
	$V_{IORM\ 3inch}$	12.75		
	$V_{IORM\ 4inch}$	17.00		
Maximum Working Voltage, effective <sup>d</sup>	$V_{IOWM\ 1inch}$	3	—	kV
	$V_{IOWM\ 2inch}$	6		
	$V_{IOWM\ 3inch}$	9		
	$V_{IOWM\ 4inch}$	12		
Insulation Resistance @ $T_{amb,max}$ , min. 100°C	$R_{IO}$	$10^{11}$	—	$\Omega$
Insulation Resistance @ $T_S$	$R_{IO}$	$10^9$	—	$\Omega$
Creepage Distance	1inch	25	—	mm
	2inch	50.4		
	3inch	75.8		
	4inch	101.2		
Clearance Distance	1inch	25	—	mm
	2inch	50.4		
	3inch	75.8		
	4inch	101.2		
Surge Isolation Voltage	$V_{IOSM}$	12	—	kV
Comparative Tracking Index	CTI	600	—	—
Pollution Degree <sup>e</sup>	—	2	—	—
Climatic Category <sup>f</sup>	—	40/085/21	—	—
Maximum Ambient Safety Temperature	$T_S$	110	—	°C
Maximum Input Current	$I_{SI}$	60	—	mA
Maximum Output Current	$I_{SO}$	30	—	mA
Maximum Input Power Dissipation	$P_{SI}$	330	—	mW
Maximum Output Power Dissipation	$P_{SO}$	165	—	mW

a.  $V_{pd(m)} = 1.6 \times V_{IORM}$  (= 6.8 kV for 1inch, = 13.6 kV for 2inch, = 20.4 kV for 3inch, = 27.2 kV for 4inch),  $V_{ini,a} = V_{IOTM}$ ,  $t_{ini,a} = 60s$ ;  $t_m = 10s$ .

b.  $V_{pd(m)} = 1.875 \times V_{IORM}$  (= 8 kV for 1inch, = 16 kV for 2inch, = 24 kV for 3inch, = 32 kV for 4inch),  $V_{ini,b} = V_{IOTM}$ ,  $t_{ini,b} = 1s$ ;  $t_m = 1s$ .

c. Altitude up to 2000m above sea level.

d. Pollution degree 2; please note that inhomogeneous field conditions may lead to partial discharge through air for these voltages.

e. According to IEC-60664-1.

f. According to IEC-60068-1.

## Electrical Input Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Units
Forward Voltage <sup>a</sup>	$V_F$	1.6	—	2.2	V
Forward Voltage Temperature Coefficient	$\Delta V_F / \Delta T$	—	-1.8	—	mV/°C
Reverse Input Breakdown Voltage <sup>b</sup>	$V_{BR}$	3.0	13	—	V
Diode Capacitance <sup>c</sup>	$C_0$	—	30	—	pF

a.  $I_{F,dc} = 10$  mA

b.  $I_{F,dc} = -10$   $\mu$ A

c.  $V_F = 0$ V;  $f = 1$  MHz

## Electrical Output Signal Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Units
High Level Output Voltage	$V_{OH}$	2.5	$V_{CC}$	$V_{CC} + 0.3$	V
Low Level Output Voltage	$V_{OL}$	—	0.22	0.4	V
Output Risetime (10–90%) <sup>a, b</sup>	$t_r$	—	—	10	ns
Output Falltime (90–10%) <sup>a, b</sup>	$t_f$	—	—	10	ns
Power Supply Noise Immunity <sup>c</sup>	PSNI	0.1	0.4	—	V <sub>pp</sub>
V <sub>CC</sub> Level to Deactivate POR <sup>d</sup>	$V_{POR\_DEACT}$	—	2.8	—	V
V <sub>CC</sub> Level to Activate POR <sup>d</sup>	$V_{POR\_ACT}$	—	2.6	—	V
POR Deactivate Delay Time <sup>d</sup>	$t_{POR\_DEACT\_DEL}$	—	100	—	$\mu$ s

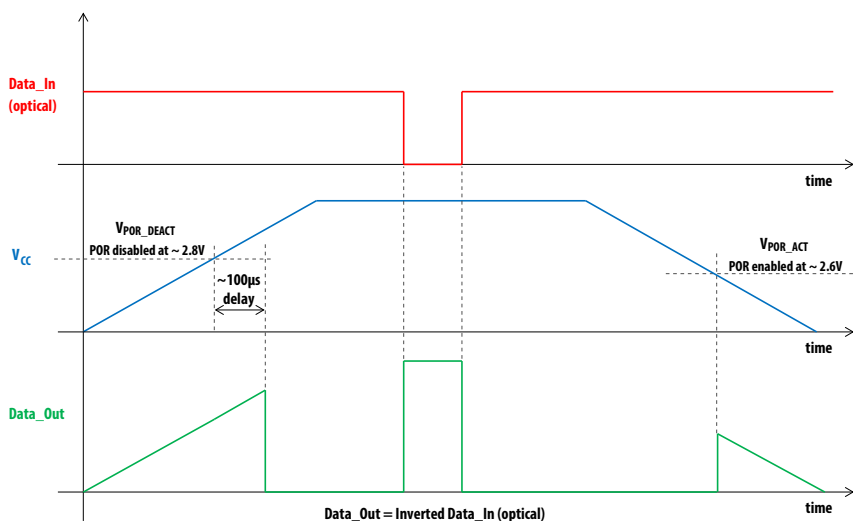
a.  $C_L = 20$  pF,  $R_L = 50$  k $\Omega$ .

b. In the recommended drive circuit.

c. Peak-to-peak sine wave.

d. Power-on reset (POR) is active below  $V_{POR\_DEACT}$ . Once  $V_{POR\_DEACT}$  is reached, the POR remains active for  $t_{POR\_DEACT\_DEL}$ . During power-down, the POR starts at  $V_{POR\_ACT}$ .

Figure 1: Typical Power-On Reset Functionality



## Specified Link Performance

$T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ , DC to 5 Mbaud, unless otherwise noted.

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Signaling Rate	$f_S$	DC	—	5	Mbaud	NRZ
Pulse Width Distortion <sup>a</sup>	PWD	-30	—	30	ns	5 Mbaud
Propagation Delay <sup>b</sup>	$t_D$	—	—	80	ns	5 Mbaud
Skew <sup>c</sup>	$t_S$	—	—	20	ns	5 Mbaud
Supply Current Rx <sup>d</sup>	$I_{CC}$	—	6	10	mA	—

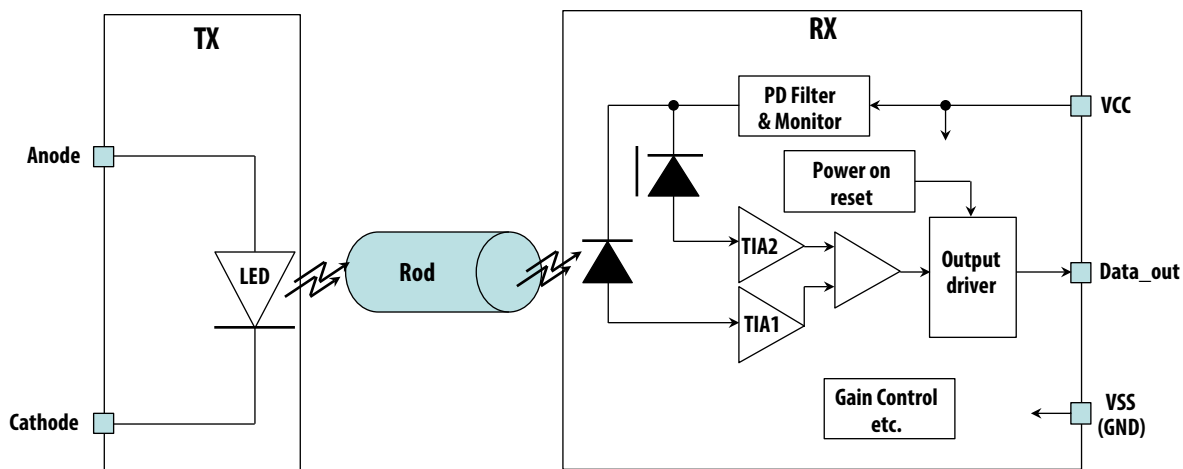
a.  $\pm 15\%$  of the nominal pulse width, provided no pulse width distortion at the electrical input.

b. Determined from 50% of the rising edge of data\_in to 50% of the consecutive rising edge of data\_out.

c. Variations of  $t_D$  between multiple devices measured for the same input conditions and the same external signal delay.

d.  $C_L = 20$  pF,  $R_L = 50$  k $\Omega$ .

## Block Diagram – AFBR-3905xxRZ



The Rx Data\_out signal is inverted, which means that light\_on will lead to Data\_out low.

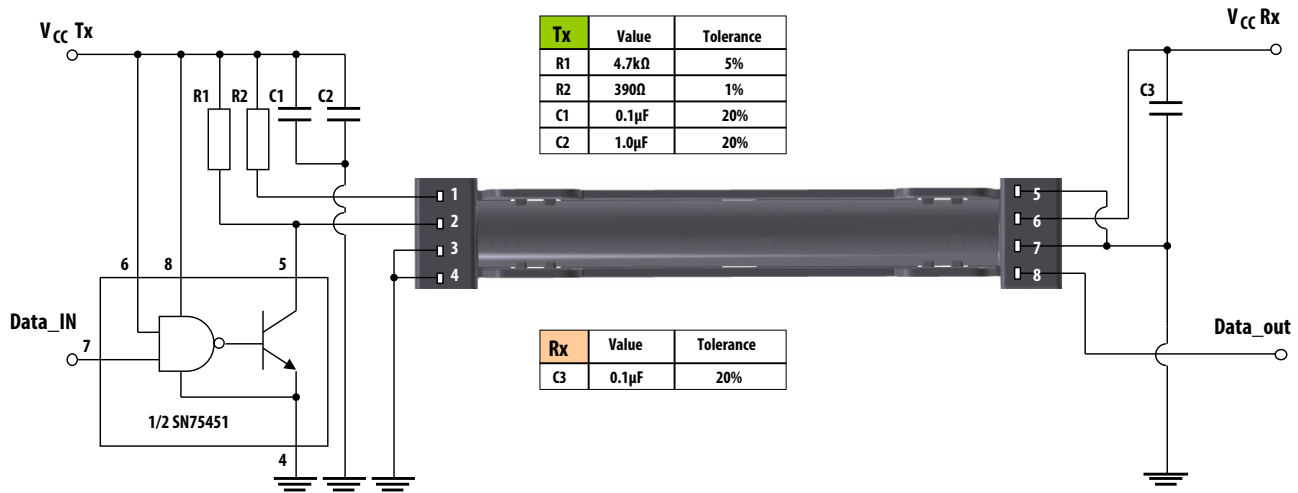
The POR remains active during  $V_{CC}$  power-up, typically until 100  $\mu\text{s}$  after 2.8V is reached. The POR follows  $V_{CC}$  while active.

## Recommended Chemicals for Cleaning and Degreasing

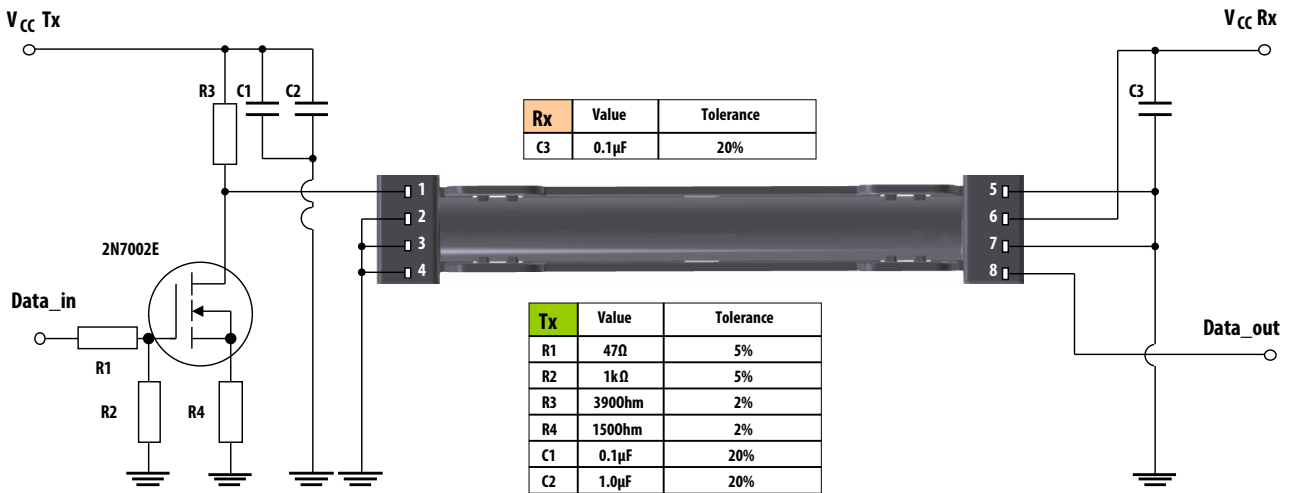
- Alcohols: methyl, isopropyl, isobutyl
- Aliphatics: hexane, heptanes
- Other: soap solution, naphtha

Do not use partially halogenated hydrocarbons, such as 1,1,1 trichloroethane, or ketones, such as MEK, acetone, chloroform, ethyl acetate, methylene dichloride, phenol, methylene chloride, or N-methylpyrrolidone. Also, Broadcom does not recommend the use of cleaners that use halogenated hydrocarbons because of their potential environmental harm.

## Recommended Drive Circuit (a) – Top View



## Recommended Drive Circuit (b) – Top View



## Pin Description

Pin Number	Transmitter
1	Anode
2	Cathode
3	No function <sup>a</sup>
4	No function <sup>a</sup>

a. It is recommended to connect this pin to signal ground.

Pin Number	Receiver
5	No function <sup>a</sup>
6	VCC
7	GND
8	Data_out

## Pinning Schematic

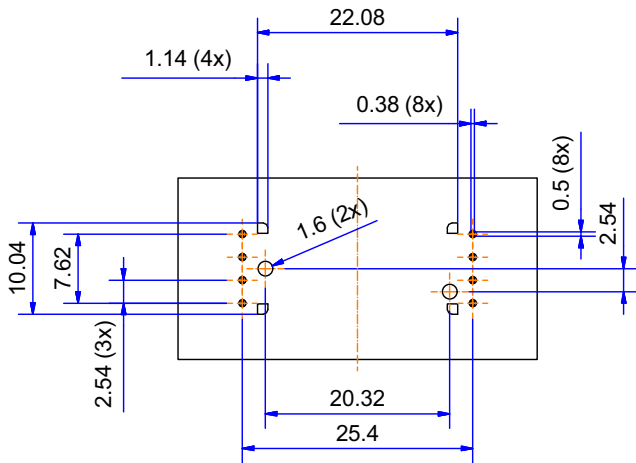
Top View



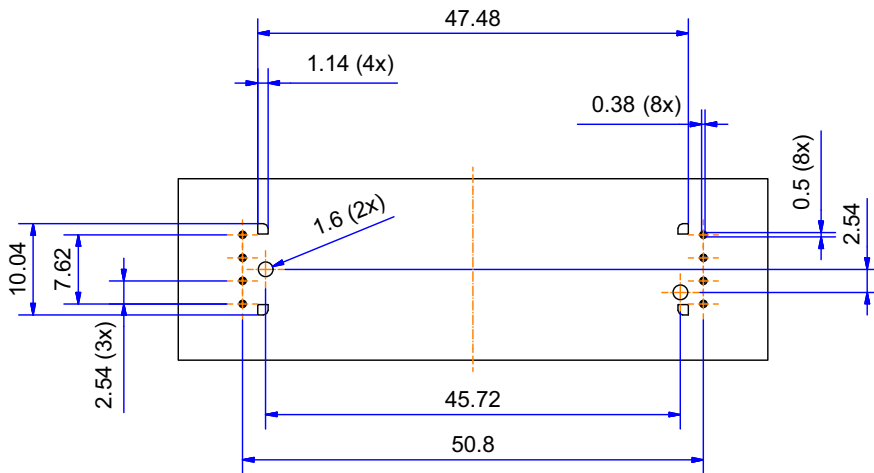
# Footprint (Top View)

Dimensions are in mm.

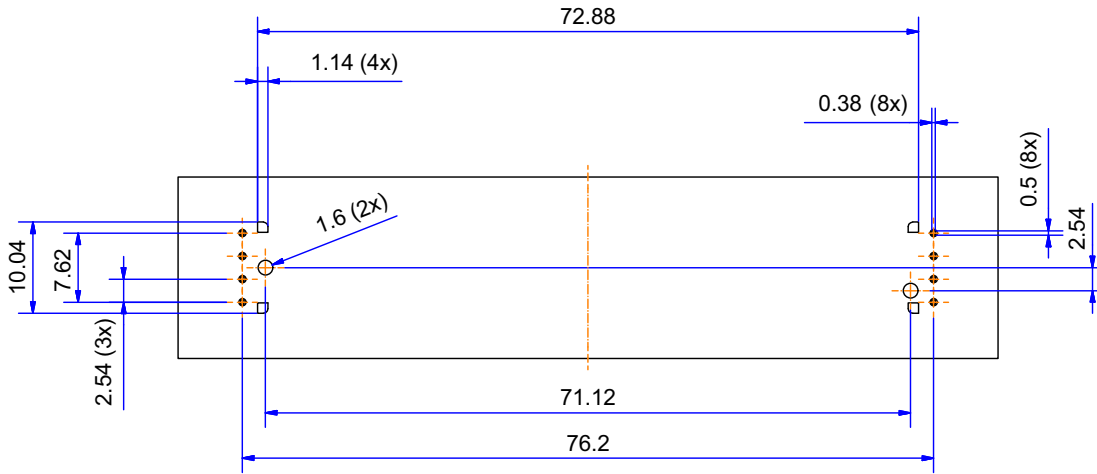
## AFBR-390525RZ



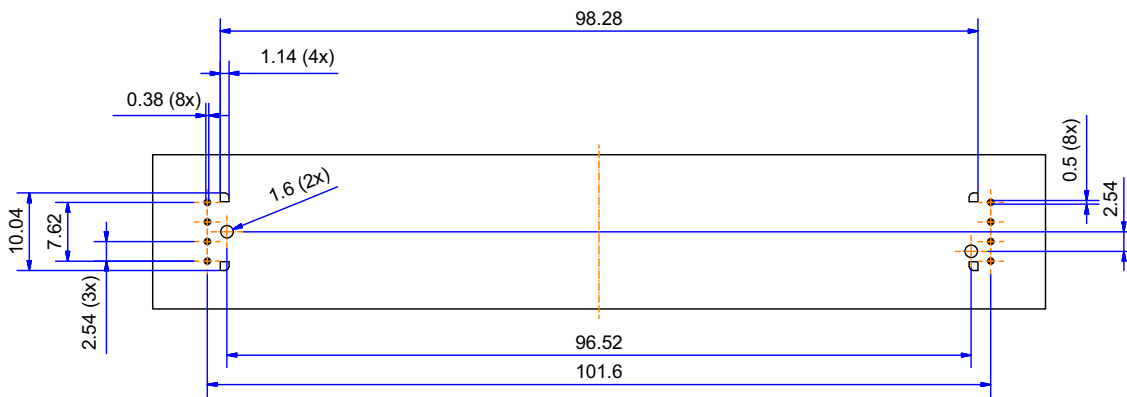
## AFBR-390550RZ



### AFBR-390575RZ



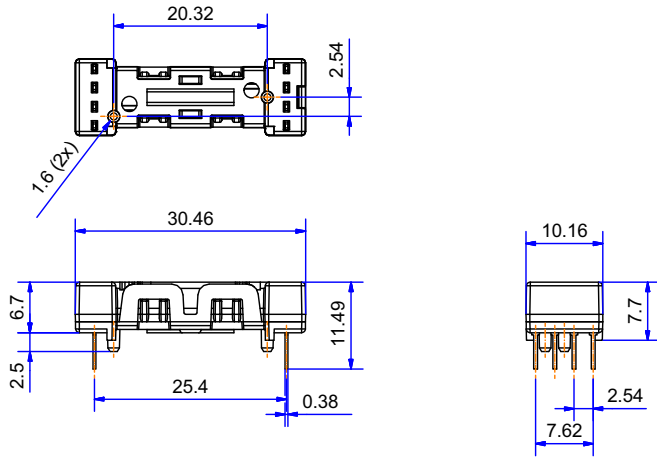
### AFBR-390500RZ



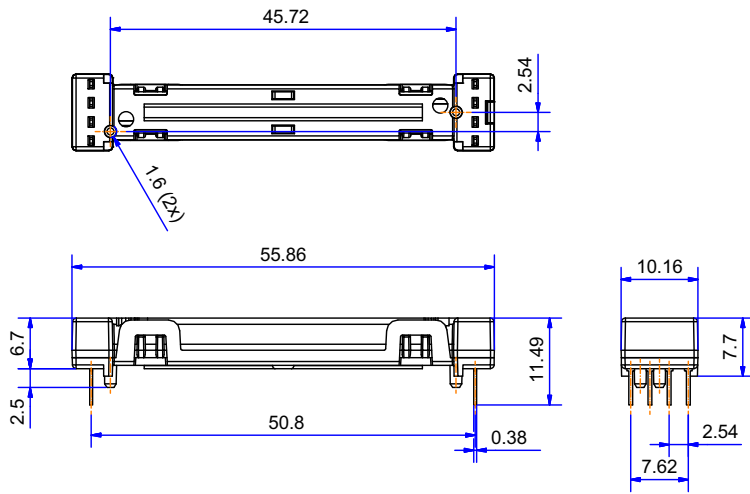
# Mechanical Dimensions

Dimensions are in mm.

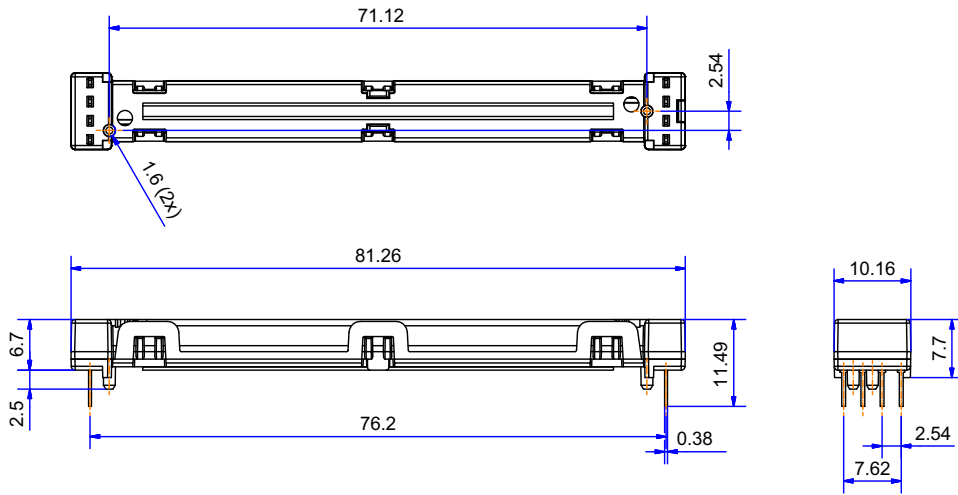
## AFBR-390525RZ



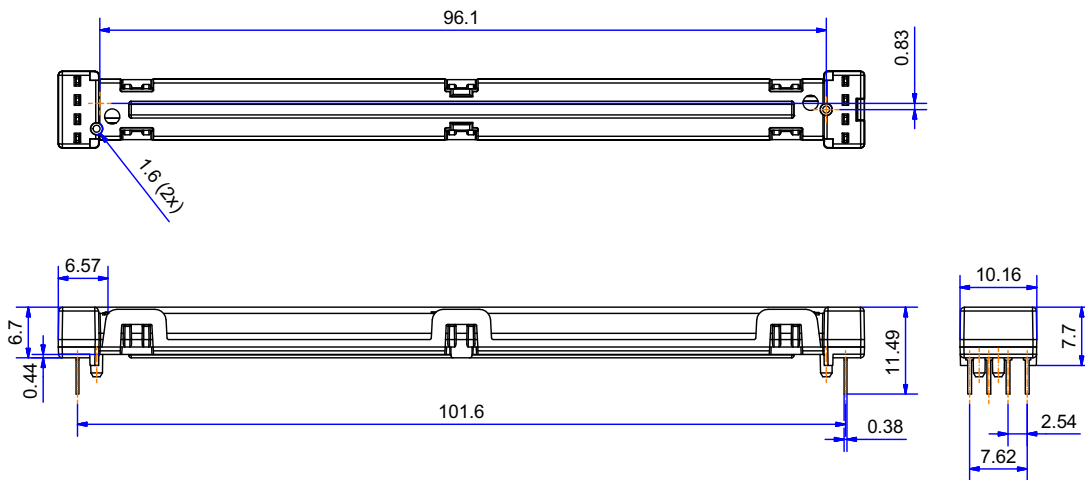
## AFBR-390550RZ



### AFBR-390575RZ



### AFBR-390500RZ



**CAUTION!** AFBR-3905xxRZ devices must not be bent under any circumstances.

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