

BF4-IR2 Series

0.05~6.25 Gbps

Compact E/O,O/E Built-In Bidirectional IO Connector Design Note (Specification)



Revision History

Version No.	Changed Points
0.9	Specifications preliminary version
1.0	First Edition(Official version)
1.1	Add BF4-IR2 Receptacle Product Materials
1.2	Add Dual LC Plug Handling Method

	COUNT	DESCRIPTION OF REVISIONS	DESIGNED	CHECKED	DATE
	4	DIS-K-00003981	NK. ISHIDA	TS. YAMAZAKI	20210617
TITLE BF4-IR2 Design note			 HIROSE ELECTRIC CO., LTD.		
			APPROVED	YY. HIYAMA	20201005
			CHECKED	TS. YAMAZAKI	20201005
			DESIGNED	TH. KIKUCHI	20201005
			WRITTEN	SK. AOYAMA	20201005
TECHICAL SPECIFICATION			ETAD-K0794-00		 1 / 34

— Table of Contents —

1. Introduction.....	4
1.1. Overview	4
1.2. Product Features.....	4
1.3. Application.....	4
1.4. Laser Class	4
2. Product Information	5
2.1. Product Number Creation	5
2.2. Product Dimensions	6
2.3. Product Materials	10
2.4. Packaging Style	12
2.5. Block Diagram	13
2.6. Pin Assignment	14
2.7. Pin Function	14
2.8. Recommended PCB Layout and Temperature Profile	15
2.9. Typical Layout	16
3. Operational Characteristics	17
3.1. Absolute Maximum Rating	17
3.2. Recommended Operating Conditions	17
3.3. DC Characteristics	17
3.4. AC Characteristics	18
3.5. Optical Characteristics	18
4. Functional Description.....	19
4.1. Functioning Confirmation LED	19
4.2. Termination Resistor (EO-DATA+/-)	19
4.3. DC Balance	20
4.4. Active/Sleep Mode Function(EO-ACT)	20
4.5. Signal Detect Function(OE-SDn)	21
4.6. PD Current Monitoring Status Function(ANDATA)	22
5. Typical Characteristics	23
5.1. Eye Pattern by Transmission Speed.....	23
5.2. Characteristics Variation in Fiber Length	24
5.3. Temperature Characteristics	25

6. Notes..... 26

6.1. Fiber Optic Cable Handling 26

6.2. Countermeasures Against Static Electricity 27

6.3. Connector Mating Method 27

6.4. Connector Unmating Method 29

6.5. Fail-Safe Design..... 31

6.6. Notes On Handling the Product 32

6.7. Notes on the Use of the Product 33

7. Revision History 34

1. Introduction

1.1. Overview

Hirose has developed a bidirectional transmission type active optical connector for wiring inside and between devices known as the BF4-IR2 Connector. By incorporating two BF4MC series connectors into the plug side connector, it allows for significantly lower power consumption, bending durable optical cables as well as the advantages of optical transmissions “long-distance transmission, electromagnetic noiseless, and isolation” are all easily packaged inside of a bidirectional, dual core optical transmission interface connector. It can be used in a wide range of fields including medical equipment and industrial equipment.

1.2. Product Features

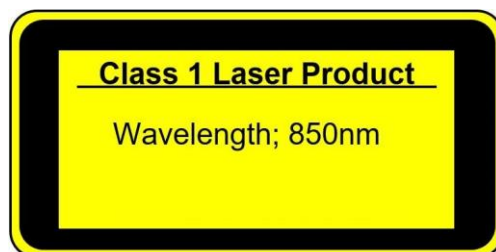
- Using Optical Fibers to Achieve 6.25 Gbps High Speed Transmissions
- Bidirectional Transmission
- Built-In LED for Operational Confirmation (LED Color : Green/Amber)
- Bending Durable Fiber
- Low Power Consumption (160mW or Less/ Plug)

1.3. Application

- E/O, O/E Conversion Data Transmission(High Speed, Isolated Transmission)
- FPGA Application(Clock Transmission、Data Transmission[8B10B Encoded])

1.4. Laser Class

This product has a built-in laser product that is classified as “Class 1 Laser Product” under the IEC 60825-1 Edition3.0 standard. Class 1 laser systems are generally considered safe to the human body. When using this product, please use specification that match those describe in this document and avoid use above specified ratings or disassembly of the product.



2. Product Information

2.1. Product Number Creation

Please use when determining the product number and product specification.

■ Plug Harness Product Number Creation

BF4 - IR2 IR2 - 01 - 1 M

① ② ③ ④ ⑤ ⑥

Table 2.1(A). Plug Harness Product Number Creation

①	Series Name
②	One side (first) connector designation IR2:BF4-IR2 Plug
③	Connector designation on the other side (second) IR2:BF4-IR2 Plug LCD: Dual core LC connector
④	Optical cable used 01: SWCC GI50/80 x 2 cores, Φ2
⑤	Cable length designation
⑥	Cable unit designation M: metric designation

■ Receptacle Product Number Creation

BF4-IR2 - 16P- 0.5 SH *

① ② ③ ④ ⑤

Table 2.1(B). Receptacle Product Number Creation

①	Series Name
②	Pin Count
③	Contact Pitch
④	SMT Horizontal Mating Type
⑤	Product specifications (packing, etc.) None: 150 pcs/RL (01) : 10 pcs/Pack

2.2. Product Dimensions

■ Plug Harness

▪ Both Ends BF4-IR2 Plug Harness

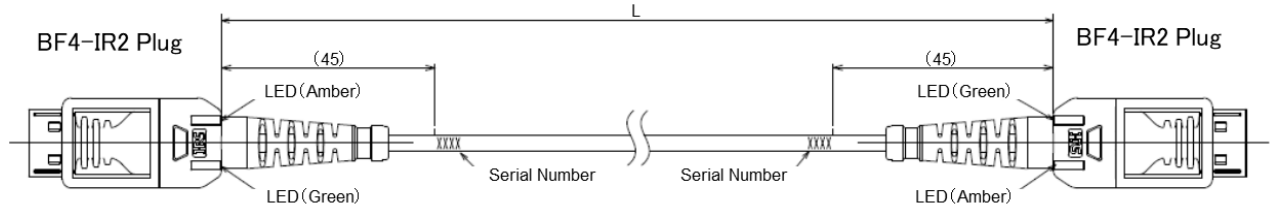


Fig. 2.2(A). Both Ends BF4-IR2 Plug Harness

▪ One End BF4-IR2 Plug-One End Dual LC Plug Harness

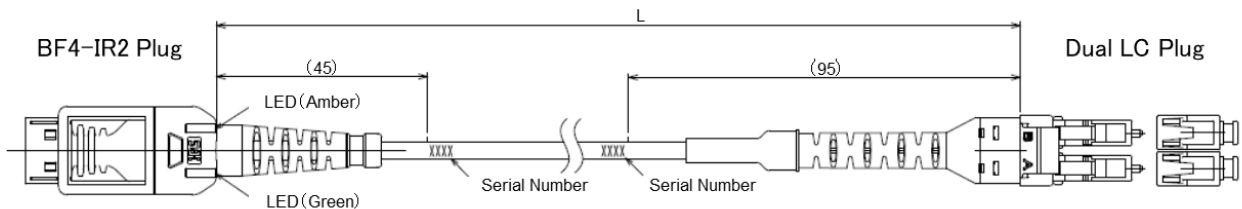


Fig. 2.2(B). One End BF4-IR2 Plug-One End Dual LC Plug Harness



The serial number can be found in either of the two figures.

Tabel 2.2(A). Plug Harness Product Information

HRS No.	Product Name	Harness length L
0831-1272-0 00	BF4-IR2IR2-01-1M	1m
0831-1273-0 00	BF4-IR2LCD-01-1M	1m

Length(L) of the Plag Harness :

- We will do our best to accommodate harness lengths not listed above.
Please contact our sales department for the desired harness length.

■ Plug

▪ BF4-IR2 Plug Section (Expanded)

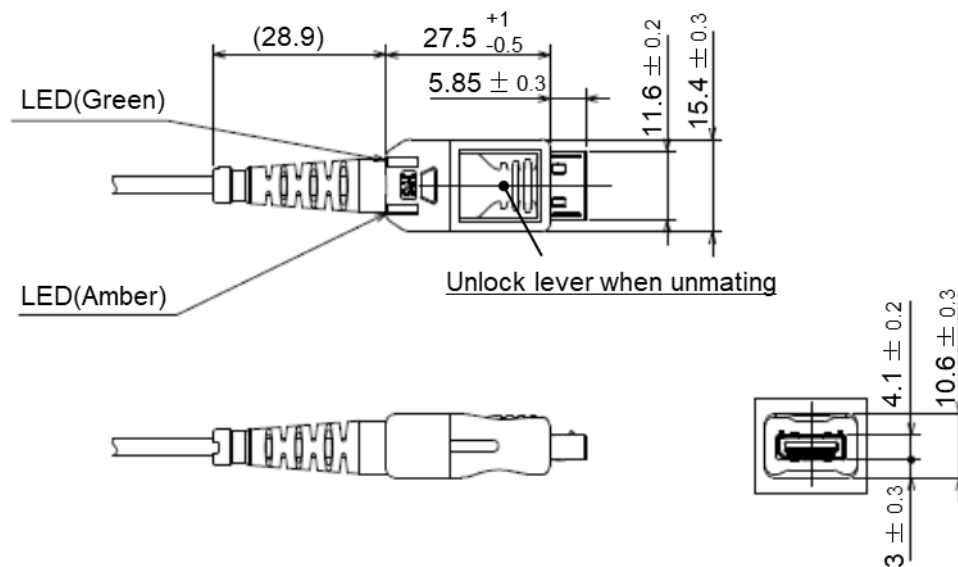


Fig. 2.2(C). BF4-IR2 Plug Section (Expanded)

▪ Dual LC Plug (Expanded)

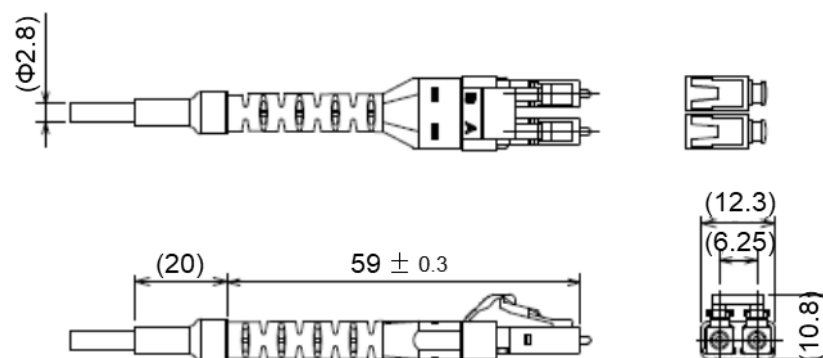


Fig. 2.2(D). Dual LC Plug (Expanded)

■ BF4-IR2 Receptacle (Expanded)

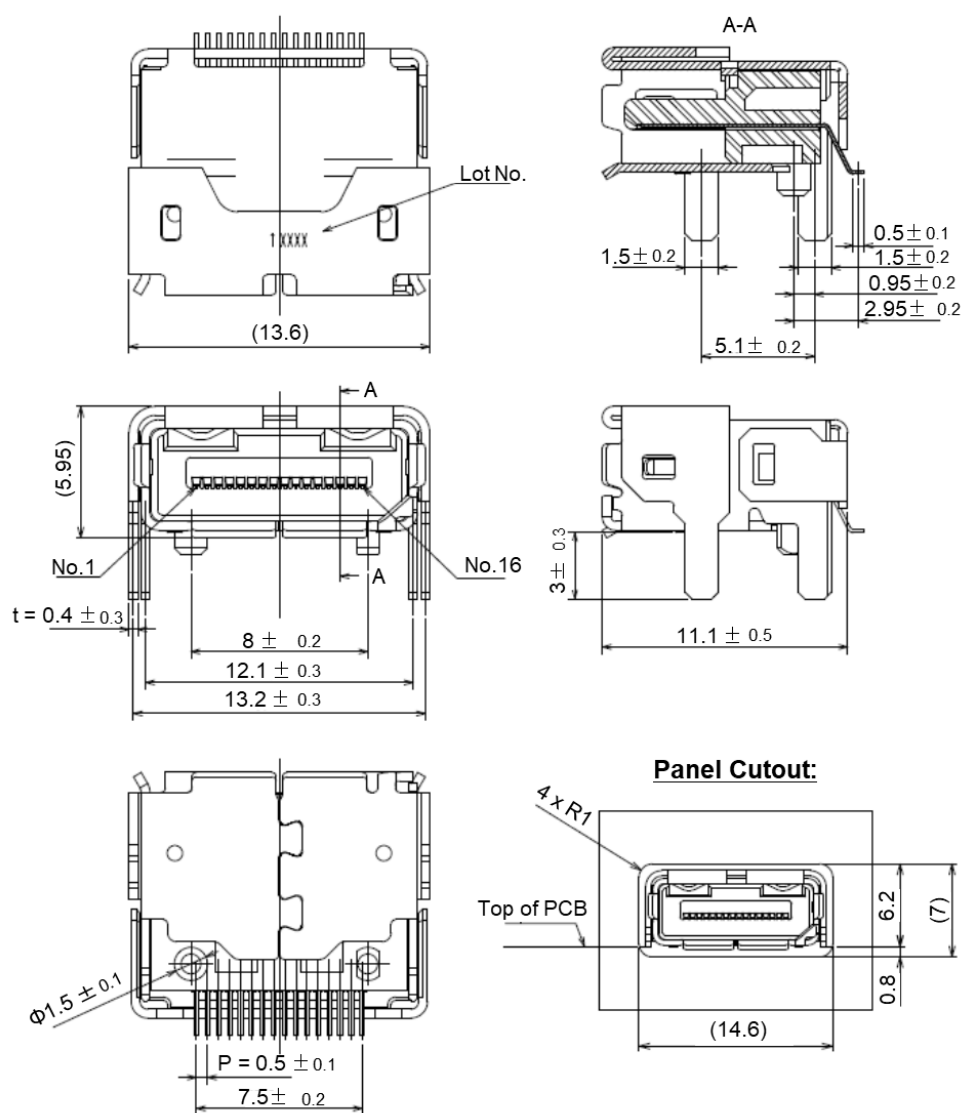


Fig. 2.2(E) . BF4-IR2 Receptacle (Expanded)

Table 2.2 (B). BF4-IR2 Receptacle Product Information

HRS No.	Product Name	Packing specification
0831-1020-0 00	BF4-IR2-16P-0.5SH	1Reel / 150pcs
0831-1020-0 01	BF4-IR2-16P-0.5SH(01)	1Pack / 10pcs

Packaging and Number of BF4-IR2 Receptacles:

If you require other than the above for packaging and quantity of BF4-IR2 receptacles, please contact our sales department.

■ Optical Fiber Cable(Cord)

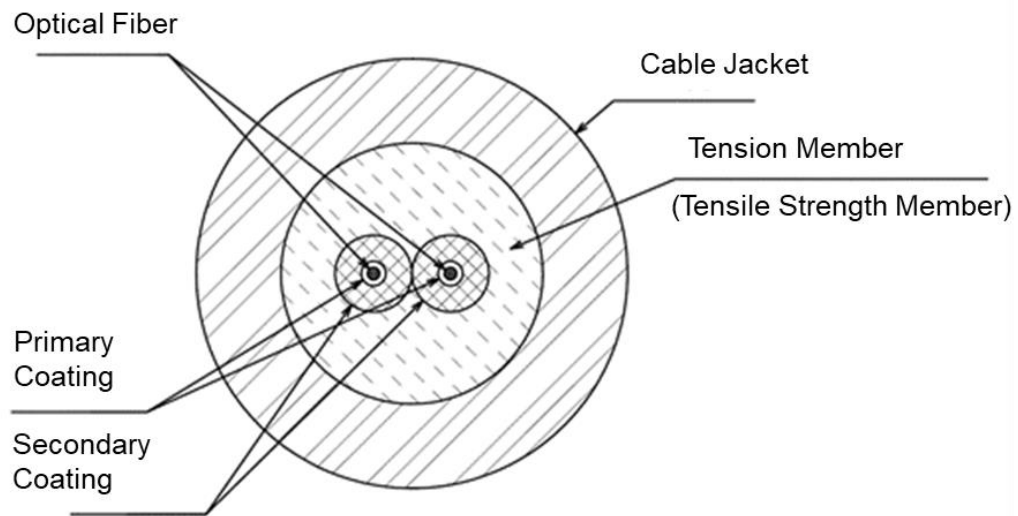


Fig. 2.2(F). Optical Fiber Cable(Cord)

Table 2.2(C). Optical Fiber Cable (Cord) Detailed Information

Item	Details	
Optical Fiber	Fiber Type	G(50/80)
	Material	Silica Glass
	Numerical Aperture (NA)	0.275±0.015
	Core Diameter	50um
	Clad Diameter	80um
Primary Coating	Material	UV Cureable Resin
	Outer Diameter	165±10um
	Color	Red/Blue
Secondary Coating	Material	Thermoplastic Resin
	Outer Diameter	500um
	Color	Clear
Tension Member (Tensile Strength Member)	Material	Aramid Fiber (Kevlar)
	Color	Yellow
Cable Jacket	Material	PVC
	Cable Jacket Diameter	2.8mm
	Color	Orange

2.3. Product Materials

The plug harness and BF4-IR2 receptacle product materials are indicated below in table 2.3(A) and table 2.3(B).

Table 2.3(A). Plug Harness Product Materials

Parts	Details
BF4-IR2 Plug	Housing
	PBT(Black)
	Printed Circuit Board
	FR-4
	BF4-TX-14DS-0.5V
	PCB Mounting (*Note 1)
	BF4-RX-14DS-0.5V
	PCB Mounting (*Note 1)
	Insulation Case
	PA
	Lock Plate
	Steel Alloy
Dual LC Plug	Contact
	Copper Alloy
	Shell
	Steel Alloy
	Cable Clamp
	Copper Alloy
	Clamp Ring
	Aluminium Alloy
	Heat Shrink Tube
	Polyolefin
	Light Guide Plate
	PC
Optical Fiber Cord	Boots
	Polyester Elastomer (Blue)
	Housing
	PEI(Beige)
	Extender Cap
	PEI(Beige) , Aluminium Alloy
	LC Ferrule
	Zirconia, Steel Alloy
	Spring
	Steel Alloy
	Side Clip
	PP(Beige)
Optical Fiber Cord	Boots
	Polyester Elastomer (Blue)
	Boots Holder
	Copper Alloy
	Cable Clamp
	Copper Alloy
	Clamp Ring
	Copper Alloy
	Heat Shrink Tube
	Polyolefin (Black)
	Cap
	PP(Black)
Optical Fiber Cord	BF4MC-6GTXP-1
	(*Note 1)
	BF4MC-6GRXP-1
	(*Note 1)
	Lens Protector
	Copper Alloy (Ni Plating)
	Fixing Ring
	Copper Alloy
	Optical Cord
	Materials Below (*Note 2)
	-Optical Fiber
	Quartz Fiber(GI50/80)
	-Primary Coating
	UV Cureable Resin
	-Secondary Coating
	Thermoplastic Resin
	-Tension Member
	Aramid Fiber (Kevlar)
	-Outer Jacket
	PVC(Orange)

***Note 1:** In regards to the BF4MC Plug Harness/Receptacle please reference the BF4MC design note (ETAD-K0671).

***Note 2:** The optical fiber is coated with a dibutyltin compound (DBT) intentionally added as a catalyst within the range of the REACH regulation value (1000PPM tin conversion).

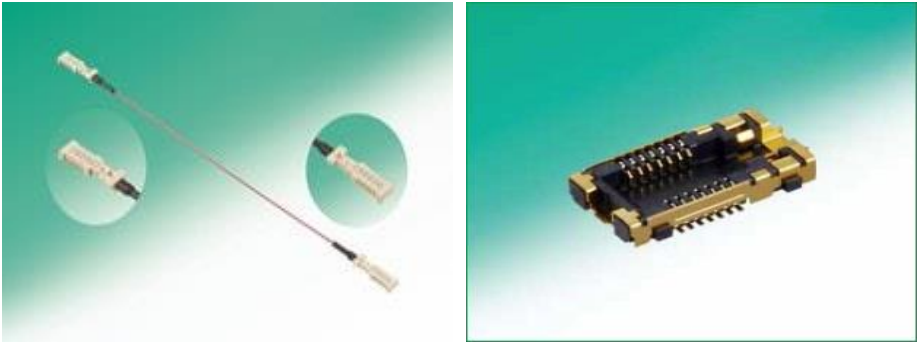
Table 2.3(B). BF4-IR2 Receptacle Product Materials

Parts		Details
BF4-IR2 Receptacle	Insulation Case	PA
	Contact	Copper Alloy
	Shell	Steel Alloy

*For the product details of the BF4MC plug harness/receptacle which is referred to in this design note, please view the product catalog on our company’s home page or the BF4MC design note (ETAD-K0671).

(For questions about the product, please contact your local Hirose sales representative)

BF4M Series URL: <https://www.hirose.com/product/jp/products/BF4M/>



BF4M Series

2.4. Packaging Style

■ Plug Harness Packing Form

•Individual Product Packaging

The product will be individually placed into an anti-static plastic bag and the bag will be sealed closed.

•Packaging Box

The packing box will be a standard Hirose cardboard box and the size and shape will be determined by the product type and the size of the order.

•Cushioning Material

Inside the packing box will be an anti-static air cap cushioning material.

■ BF4-IR2 Receptacle Packing Form (Reel ,Pack and Embossed Shape)

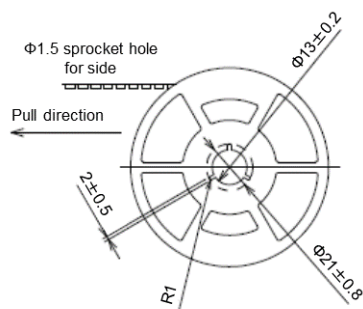


Figure 2.4 (A). Shape of a Reel

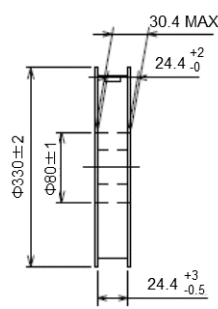


Figure 2.4 (B). Shape of a Pack

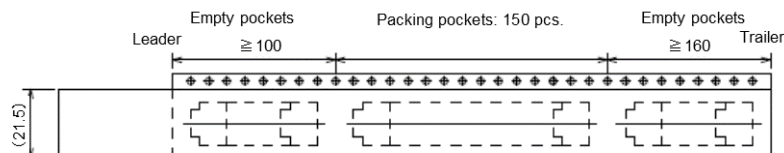
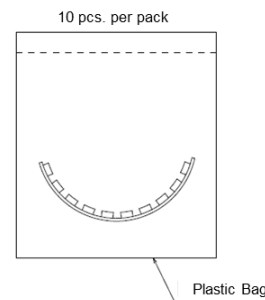


Figure 2.4 (C). Taping Direction

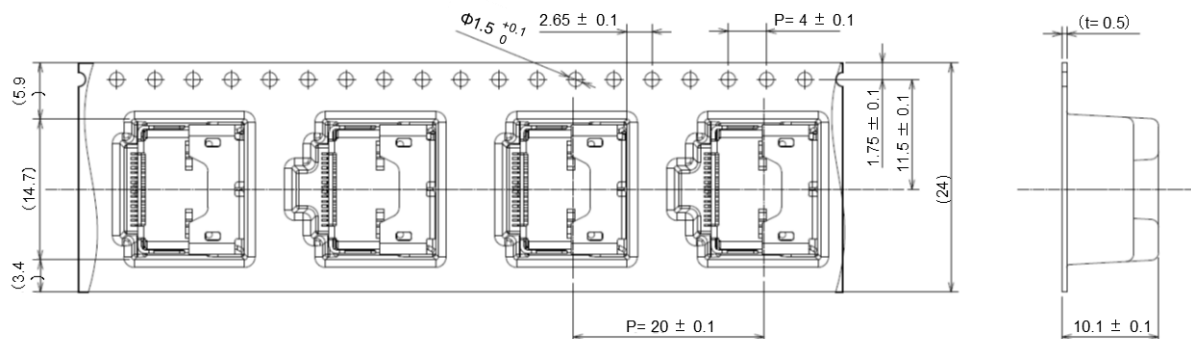


Figure 2.4(D). Embossed Packaging

2.5. Block Diagram

The BF4-IR2 plug block diagram is described below in fig. 2.5.

*For details on the BF4-IR2 plugs internal BF4MC-TX/RX, please refer to the BF4MC design note (ETAD-K0671).

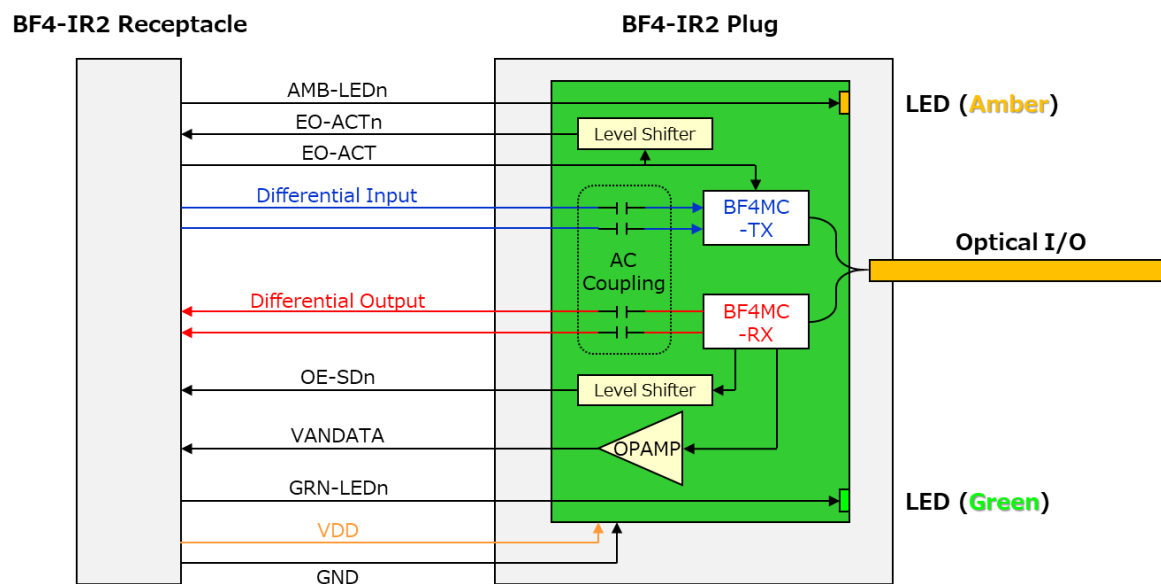


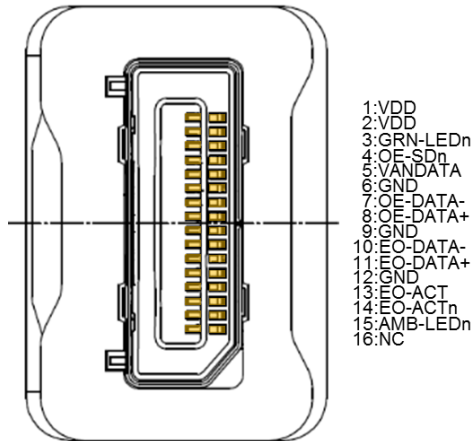
Fig. 2.5. BF4-IR2 Plug Block Diagram

2.6. Pin Assignment

■ BF4-IR2 Pin Assignment

The BF4-IR2 plug/receptacle pin assignment is displayed below in fig. 2.6.

BF4-IR2 Plug Pin Assignment



BF4-IR2 Receptacle Pin Assignment

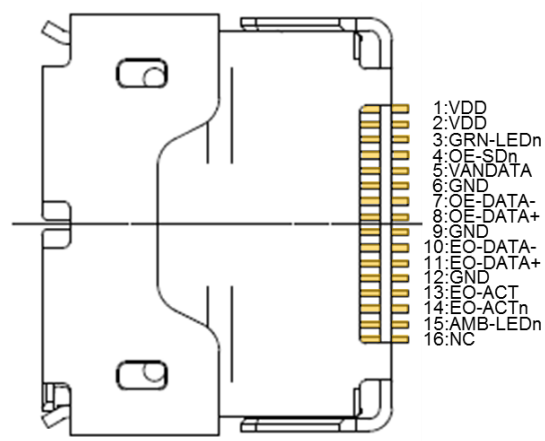


Fig. 2.6. BF4-IR2 Plug/Receptacle Pin Assignment

2.7. Pin Function

The BF4-IR2 Plug Pin description is detailed below in table 2.7.

*I/O Notation (Type) is the direction that can be seen on the **BF4-IR2 plug**.

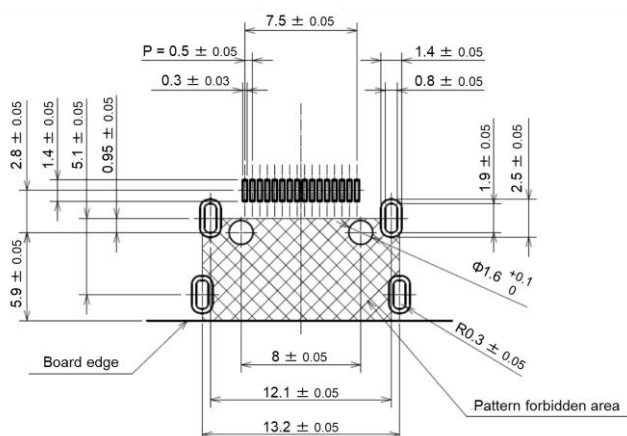
Table 2.7. BF4-IR2 Plug Pin Description

Pin No	Symbol	Name	Type	Details
1	VDD	Vsupply	Power	Power Supply +3.3V
2	VDD	Vsupply	Power	
3	GRN-LEDn	Green LED Control	Input	Green LED emission control 0V: Emitting, 3.3V: Not emitting
4	OE-SDn	OE Signal Detect	Output	OE signal detect status 0:Detected, 1:Undetected (+3.3V CMOS)
5	ANDATA	Analog Data	Output	PD current monitor of OE module
6	GND	Ground	Ground	Ground
7	OE-DATA-	OE Data Output-	Output	SLVS output
8	OE-DATA+	OE Data Output+	Output	
9	GND	Ground	Ground	Ground
10	EO-DATA-	EO Data Input-	Input	SLVS input
11	EO-DATA+	EO Data Input+	Input	
12	GND	Ground	Ground	Ground
13	EO-ACT	EO Active Detect	Input	1:Active Mode, 0: Sleep (+3.3V CMOS)
14	EO-ACTn	EO Active	Output	EO active detect status 0:Detected, 1:Undetected
15	AMB-LEDn	Amber LED control	Input	Amber LED emission control 0: Emitting, 1: Not emitting(+3.3V CMOS)
16	NC	NC	-	Non Connect Pin

2.8. Recommended PCB Layout and Temperature Profile

■ Recommended PCB Layout

Recommended PCB Land pattern dimensions



Recommended metal mask dimensions
(Mask Thickness : 120 μm)

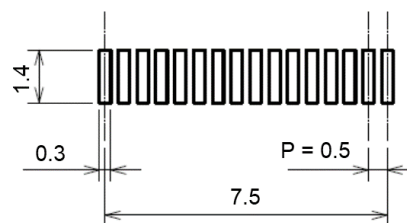


Fig. 2.8(A). Land pattern and metal mask recommended for BF4-IR2 receptacles

■ Recommended Temperature Profile

The maximum reflow temperature condition (Connector's Upper Surface Temperature) and recommended temperature reflow profile (Lead Free Solder) are described below in Fig 2.8(B) and Fig 2.8(C).

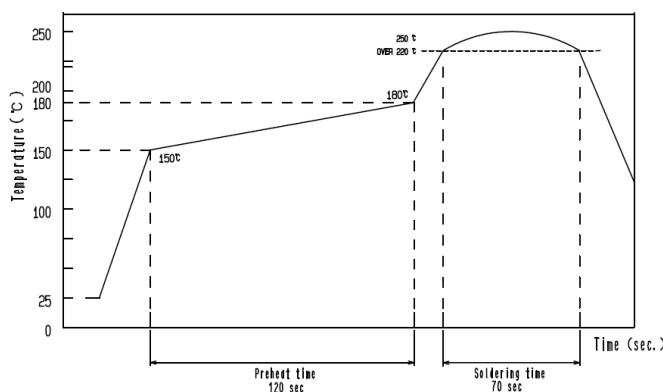


Fig.2.8(B). Maximum Reflow Temperature Conditions
(Connector's Upper Surface)

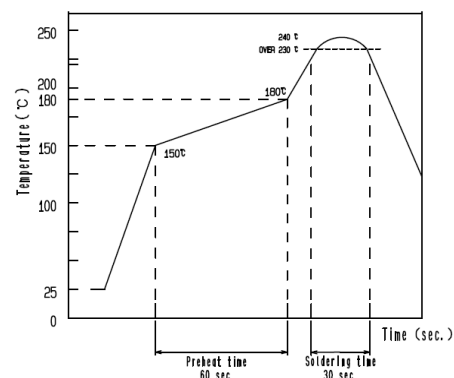


Fig.2.8(C). Recommended Reflow Temperature Profile
(Lead Free Solder)

2.9. Typical Layout

The typical layout of the BF4-IR2 receptacle board connection is displayed below in Fig. 2.9.

■ BF4-IR2 Receptacle Connection Example

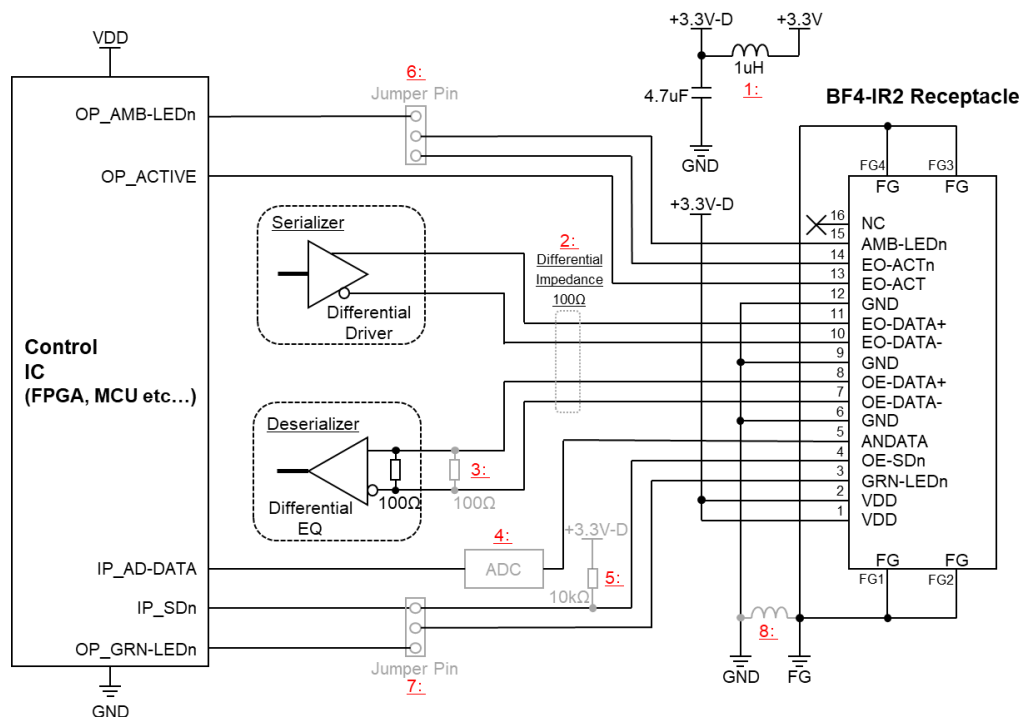


Fig 2.9. BF4-IR2 Receptacle Connection Example

Design Points:

- 1:** Please apply 3.3V to the BF4-IR2 with a liner regulator or low noise power source made by LDO.
- 2:** Please design a 100 ohm differential impedance controlled PCB pattern between Serdes(Serializer/Deserializer) and BF4-IR2 receptacle.
- 3:** In case there is no 100 ohm termination in Deserializer(Differential EQ), please insert a 100 ohm external termination.
- 4:** ANDATA signal is an analog signal. If the control IC is not able to accept analog signals, please convert it from an analog to digital signal with an AD convertor.
- 5:** Since OE-SDn signals is unstable without the BF4-IR2 plug being mated, please connect a 10k ohm pull up resistor with power source.
- 6:** In the case of controlling LED (Amber) emission, please connect with control IC. If you don't need to control it, a short connection between EO-ACTn and AMB-LEDn is recommended.
- 7:** In the case of controlling LED(Green) emission, please connect with control IC. If you don't need to control it, a short connection between OE-SDn and GRN-LEDn is recommended.
- 8:** It is recommended to use an inductor or ferrite bead for connection to GND as a measure to prevent noise from flowing in from FG.

3. Operational Characteristics

3.1. Absolute Maximum Rating

Table 3.1. BF4-IR2 Plug Harnesses Absolute Maximum Rating

Symbol	Parameter	Min	Max	Unit
VDD	Maximum supply voltage	- 0.3	+ 4.5	V
VDIN	Maximum voltage at EO-DATA +/-	- 0.3	+ 1.8	V
VACT	Maximum voltage at EO-ACT	- 0.3	+ 3.6	V
S-Temp	Storage temperature range	- 40	+ 85	°C
VESD	Electrostatic discharge voltage capability	-	2	kV

*Note 3

*Note 3: Value when a discharge is applied to each pin.

*When using, please design the circuit so that the absolute maximum rated value listed about in table 3.1 is not exceeded.

3.2. Recommended Operating Conditions

Table 3.2. BF4-IR2 Plug Harness Recommended Operating Conditions

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
VDD	Supply voltage		+ 3.0	+ 3.3	+ 3.6	V
GND	Ground			0	+ 0.4	V
Vnoise	Maximum allowed supply noise on Supply	0 < fnoise < 10 GHz			100	mVp-p
Temp	Operating temperature range		- 10		+ 85	°C

3.3. DC Characteristics

Each BF4-IR2 plug's DC characteristics are displayed below in table 3.3.

Table 3.3. BF4-IR2 Plug's DC Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
VDD	Supply voltage		+ 3.0	+ 3.3	+ 3.6	V
IDD	Supply current	VDD = +3.3V, Temp = 25°C			80	mA
Isleep	Sleep Mode Supply Current	Bidirectional sleep. (All sleep)			50	uA
		TX sleep (Non active)			45	mA
		RX sleep (No signale detect)			35	mA
Vact H	Activation high input voltage level (high = "1")		1.0		VDD	V
Vact L	Activation low input voltage level (low = "0")		0		+ 0.4	V
Vsdn H	SD output voltage logic level high (high = "1")	No signale detect	+ 3.0		VDD	V
Vsdn L	SD output voltage logic level low (low = "0")	Signal detect	0		+ 0.4	V
Andata	Mirrored photodiode current montor	Operating at 6.25Gbps data input	40			mV

*Note 4

*Note 4: Regarding the minimum output value of Andata.

Regardless of whether the BF4-IR2 plug is normal or abnormal, it may drop below 40 [mV] due to loss of the relay cable. The output required for normal operation is 40 [mV] or more, so be careful of the Andata value when using it.

3.4. AC Characteristics

Each BF4-IR2 plug's AC characteristics are displayed below in table 3.4.

Table 3.4. BF4-IR2 Plug's AC Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
BR	Bit rate	8B10B	0.05		6.25	Gbps
VIN_CM	Input common mode voltage	BF4-IR2 internal AC coupling (0.1uF)	0			mV
VIN_Diff	Differential input voltage		200		1400	mVp
			400		2800	mVp-p
ZIN	Differential input impedance at Din+ and Din-			100		ohm
tD_ACT	Activation delay time				500	us
tD_DEACT	De-activation delay time				50	us
BER	Bit error rate	BR = 6.25Gbps, 8B10B PRBS7		10 ⁻¹²		
tr	Output data rise time	20%-80%			45	ps
tf	Output data fall time	20%-80%			45	ps
VO_CM	Output common mode voltage	BF4-IR2 internal AC coupling (0.1uF)	0			mV
VO_Diff	Output voltage swing		160		330	mVp
			320		660	mVp-p
VO_H	Single ended output high voltage				660	mV
JP	Jitter peak to peak	BR = 6.25Gbps, 8B10B PRBS7			65	ps
ZO	Output impedance at DOUT+/-			100		ohm
tSD_AT	SD assert time				0.5	us
tSD_DT	SD de-assert time				50	us

3.5. Optical Characteristics

Each BF4-IR2 plug's optical characteristics are displayed below in table 3.5.

Table 3.5. BF4-IR2 LC Plug Harness Optical Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
P _{AVE}	Average Launch Power (Transmitter)	T=25 °C (LC Plug)	182			uW
λ	Optical Wavelength (Transmitter)	(LC Plug)		850		nm
R	Responsivity (Receiver)	λ=850nm (LC Plug)	0.35			A/W

4. Functional Description

The BF4-IR2 series main function is described below.

4.1. Functioning Confirmation LED

As a recommended usage,

On the board, short the 14th pin (AMB-LEDn) and 13th pin (EO-ACTn) of the BF4-IR2 receptacle and short the 3rd pin (GRN_LEDn) and 4th pin (OR-SDn) of the plug. By doing so, you can check the operating status of the plug with the LED.

In case of the above recommended connection, LED (Amber) lights when ACTIVE signal is ON (High=+3.3V), and LED (Green) lights when SDn signal (*Note 5) is ON (Low=0V).

***Note5:** Confirmation about received signals or optical fiber disconnection can be done but, data confirmation cannot be done. For actual data confirmation, the customer will have to confirm it is correct.

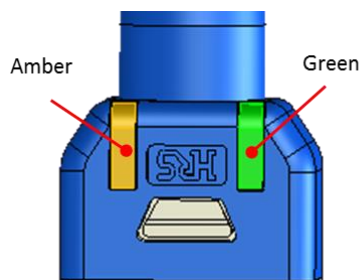


Fig. 4.1. Operational Confirmation LED

4.2. Termination Resistor (EO-DATA+/-)

The BF4-IR2 plug has a built-in 100Ω termination resistor in the differential input section (EO-DATA+/-).

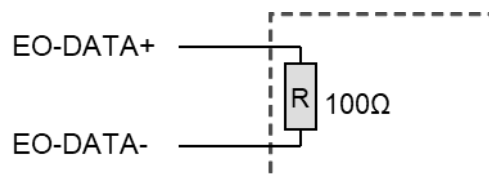


Fig. 4.2. Termination Resistor

4.3. DC Balance

The data transmission of the BF4-IR2 series demonstrates the best performance by inputting DC balanced signals. For the encoding format, 8B/10B is recommended (***Note 6**).

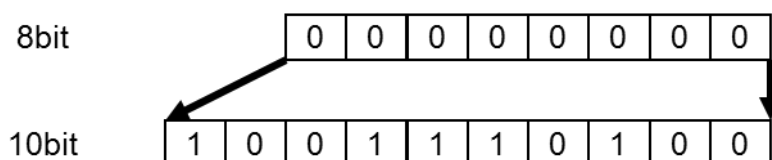


Fig. 4.3. DC Balance (Encoding Format 8B/10B)

***Note 6:** In regards to 8B/10B Encoding,

In 8-bit data, all are "0", but by executing 8B / 10B conversion (Encoding), symbols where "0" and "1" are not consecutive for 5 bits or more can be obtained.

4.4. Active/Sleep Mode Function(EO-ACT)

The BF4-IR2 has an optical output (Transmission Side) mode switching function. (3.3VCMOS Input)

The mode switching control table and the mode switching timing chart are described below in Table 4.4 and Fig. 4.4.

Table 4.4. EO-ACT Mode Switching Control Table

	Active	Sleep
EO-ACT	High(3.3V)	Low(0V)

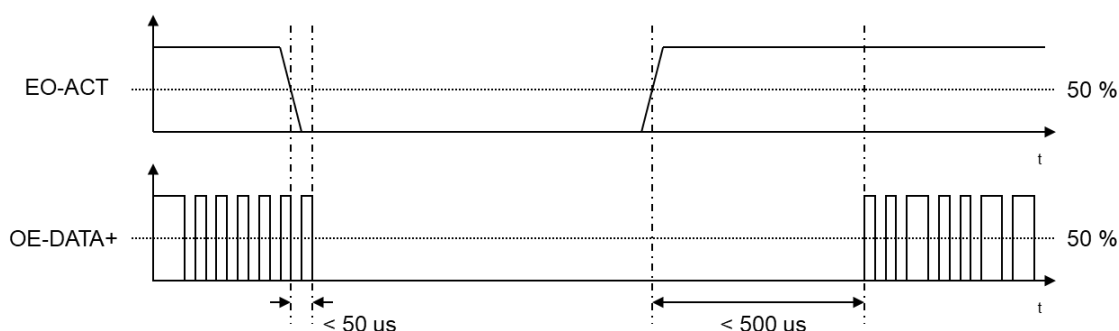


Fig. 4.4. EO-ACT Mode Switching Timing Chart

4.5. Signal Detect Function(OE-SDn)

The BF4-IR2 has an optical input detection status function for optical input (Receiver Side). (3.3VCMOS Output) The optical input detection status table and EO-ACT-OE-SDn timing charts are shown below in table 4.5 and Fig. 4.5(*Note 7).

Table 4.5. Optical Input detection Status Table

	Detect	Un-detect
OE-SDn	Low(0V)	High(3.3V)

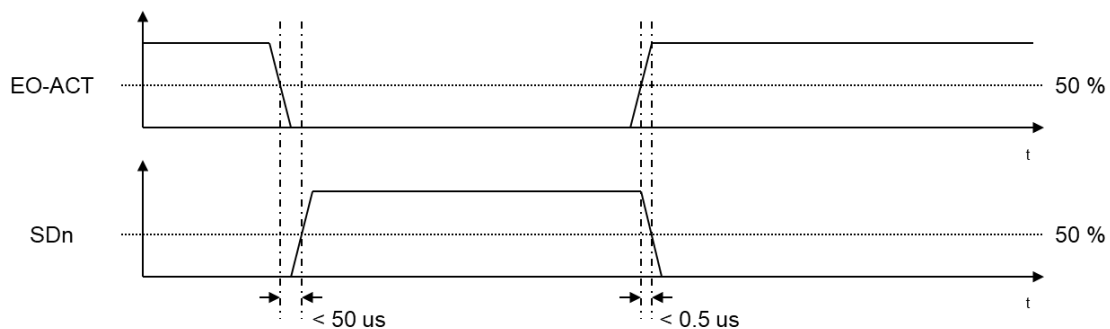


Fig. 4.5. EO-ACT-OE-SDn Timing Chart

***Note 7 :** In regards to SDn, the reason why the logic is reversed from the BF4MC design note (ETAD-K0671) is because the level is converted from + 1.5V to + 3.3V with a transistor. (SD = 1.5V => SDn = 3.3V)

4.6. PD Current Monitoring Status Function(ANDATA)

The built-in PD (Photodiode) on the receiver side of the BF4MC-RX can function as a current monitoring system (Analog Output). An operational voltage follower should be placed between as a buffer so the voltage change and input impedance of the connection destination (User I/F Side) is not affected. The ANDATA circuit configuration is displayed below in Fig. 4.6.

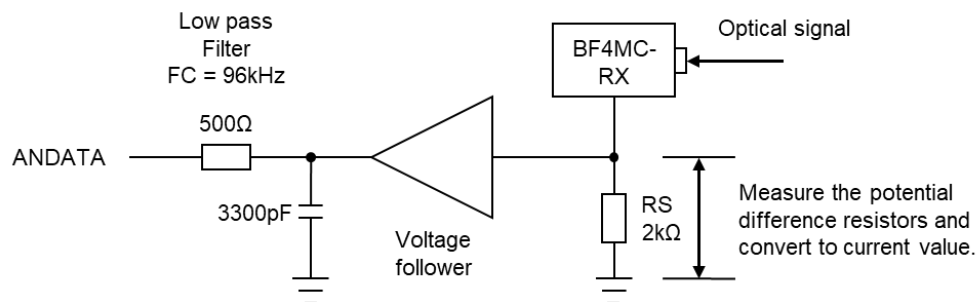


Fig. 4.6. ANDATA Circuit Configuration

- The ANDATA output voltage (Vandata) to PD current calculations are shown below.

$$\text{PDcurrent}[\mu\text{A}] = \text{Vandata} [\text{mV}] / \text{RS} [\text{k}\Omega]$$

$$= \text{Vandata} [\text{mV}] / 2 [\text{k}\Omega]$$
- Since ANDATA output is a low frequency signal, a low pass filter is inserted so that high frequency noise components are cut.

$$\text{Cut Off Frequency FC} [\text{Hz}] = 1 / (2\pi\text{RC}) [\text{Hz}]$$

5. Typical Characteristics

5.1. Eye Pattern by Transmission Speed

The measurement connection diagram for transmission speed and the eye diagram for 3.0 Gbps and 6.25 Gbps of BF4-IR2 are shown below.

(Conditions: Ambient temperature = 25°C, Fiber length = 1m fixed)

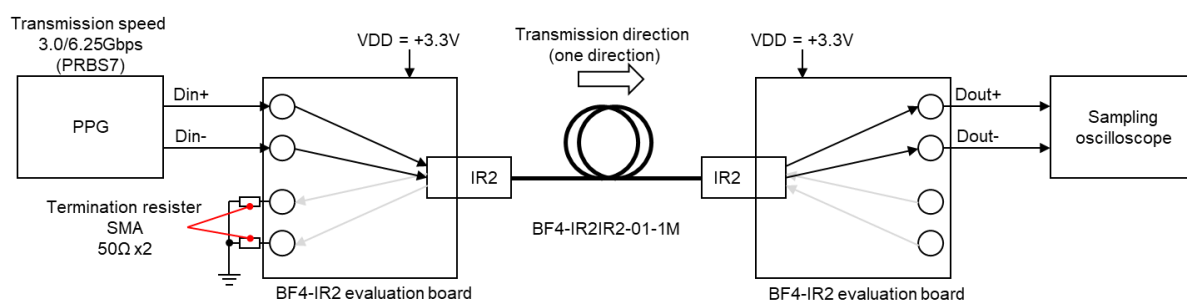


Figure 5.1 (A) Measurement connection diagram for transmission speed

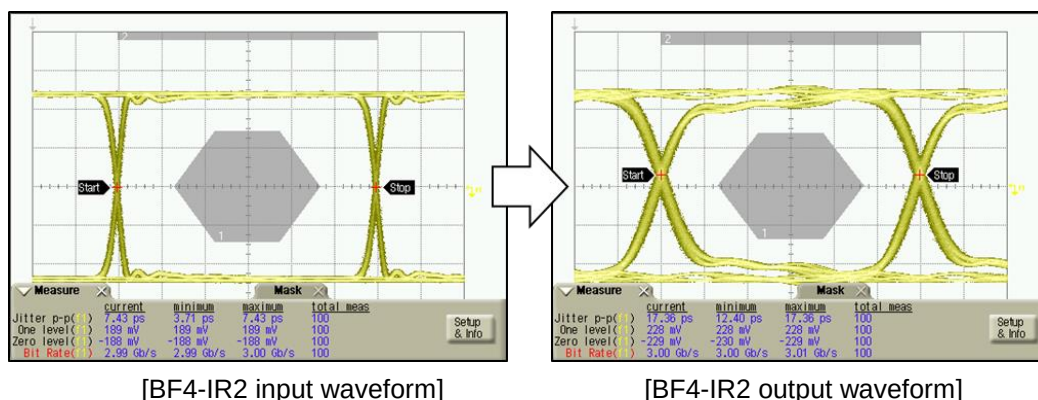


Figure 5.1(B). BF4-IR2 plug harness eye pattern example (3.0Gbps)

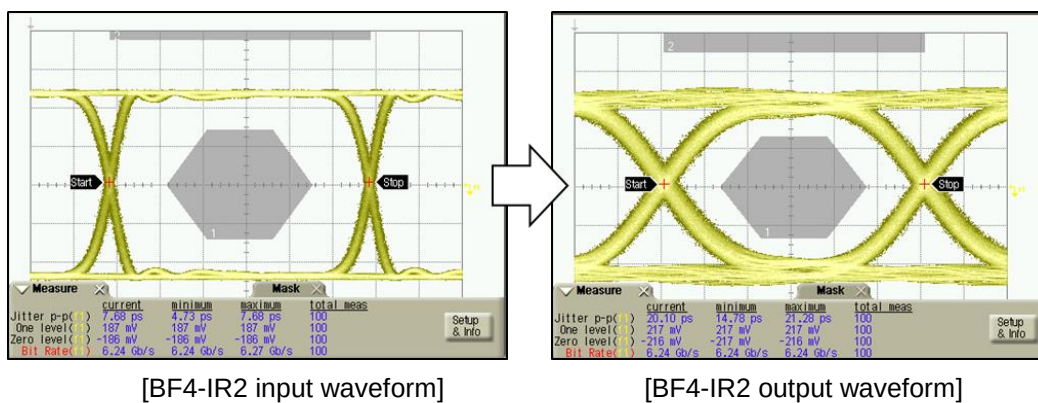


Figure 5.1(C). BF4-IR2 plug harness eye pattern example (6.25Gbps)

5.2. Characteristics Variation in Fiber Length

The measurement connection diagram over different fiber length and the eye diagram for transmission over 5 m, 25 m, 45 m and 65 m of BF4-IR2 are shown below.

(Conditions: Ambient temperature = 25°C, Transmission speed = 6.25Gbps)

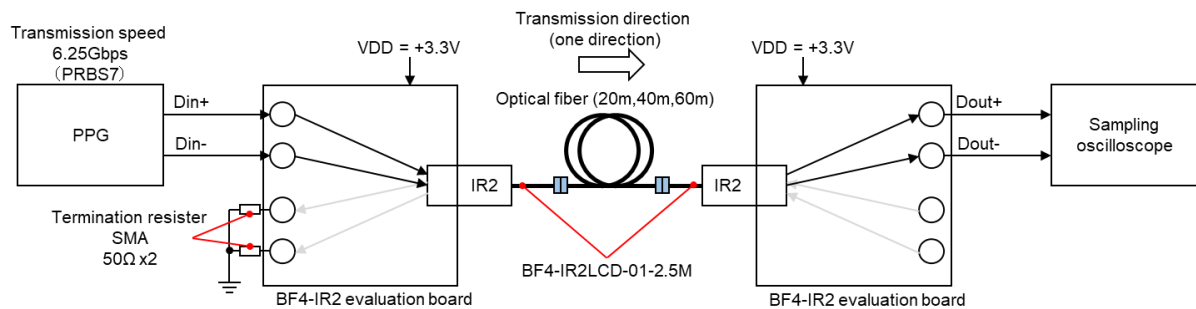


Figure 5.2 (A)

Measurement connection diagram for Characteristics variation in fiber length

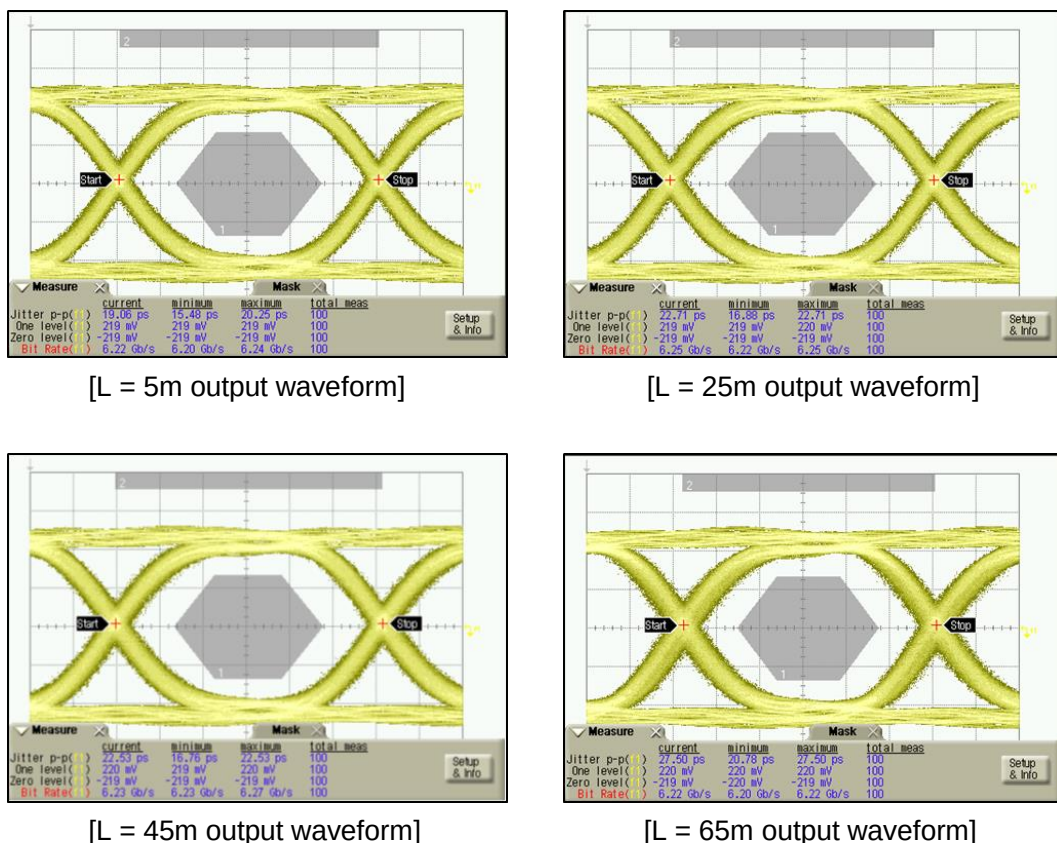


Figure 5.2(B). Eye pattern example by fiber length

*For the input waveform, see [BF4-IR2 input waveform] in Figure 5.1 (C).

5.3. Temperature Characteristics

The measurement connection diagram of the temperature performance and the eye diagram for transmission at the ambient temperature of -10°C and +85°C of BF4-IR2 are shown below.

(Conditions: Fiber length = 1m, Transmission speed = 6.25 Gbps)

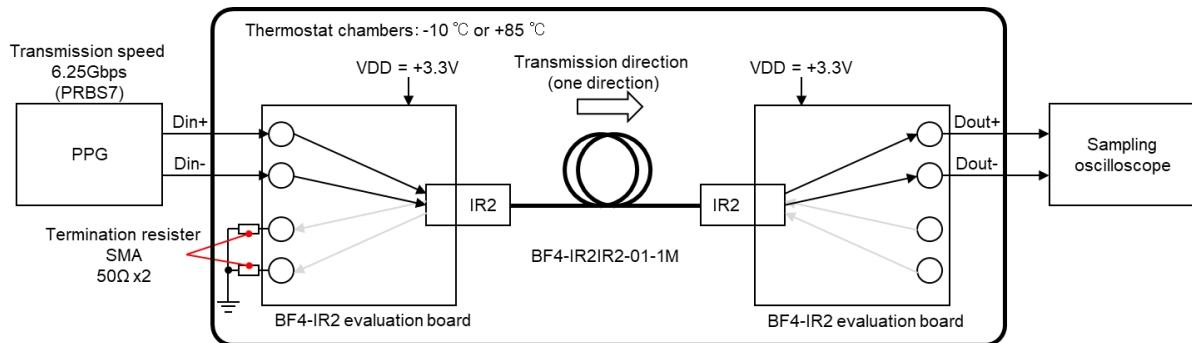
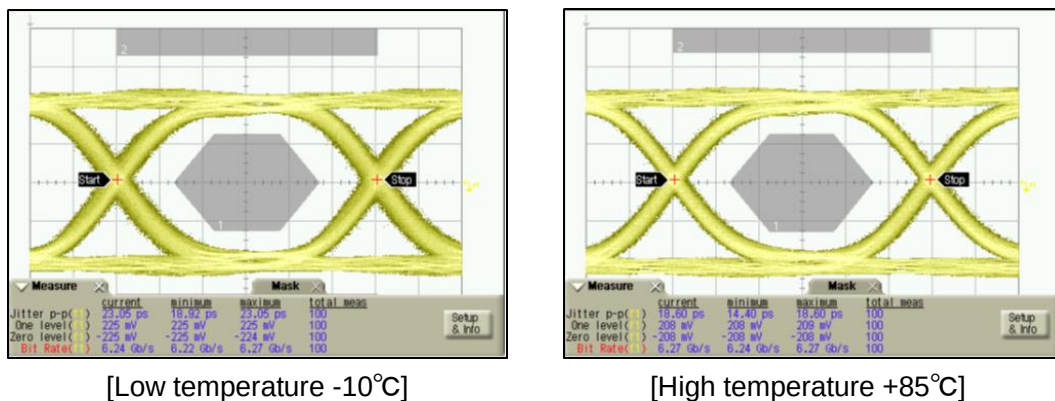


Figure 5.3(A). Measurement connection diagram for temperature characteristics



[Low temperature -10°C]

[High temperature +85°C]

Figure 5.3(B). Temperature characteristics eye pattern example

*For the input waveform, see [BF4-IR2 input waveform] in Figure 5.1 (C).

6. Notes

This product uses an optical fiber as a transmission medium. The optical fiber is made of quartz glass and requires more careful handling compared to an electric wire of the same size. In addition, precautions should be made against static electricity since the BF4MC-TX/RX plugs are equipped with internal semiconductor chips.

6.1. Fiber Optic Cable Handling

Sudden bending, excessive tensile stress, stress from external lateral pressure applied to Fiber Optic cable may affect the functional performance of the product.

Optical Fiber Bending Radius

Fiber optical cable bending radius will have an influence over the failure rate (Lifetime). When wiring, if there is a sudden bending there is a possibility of shortening the products life so, wiring with a bending radius of over 10 mm is recommended (Devices Internal Assembly).

Optical Fiber Bending Tension

It is recommended to wire the fiber (for arrangement within a device) so that tensile stress is not applied to bent section of the fiber.

Tensile Stress to the Connector

After wiring is complete, confirm that the tension applied to the connector from the optical fiber cables are zero. In regards to the connector, bending tension stress that is in the lateral or longitudinal direction is caused by damage from the optical fiber cable.

Lateral Pressure

Make sure to avoid stress on the optical fiber cable side when wiring.

【Example】 Optical fiber cable getting caught between two parts.

Optical fiber cable getting caught between board and enclosure.

Optical fiber cable getting bound and tied with other parts or electric cables.

6.2. Countermeasures Against Static Electricity

This product is equipped with an internal semiconductor and care must be taken against static electricity when handling. In the design of this product when in use the signal terminals sections are hard to touch and as an static electricity counter measure the connectors internal board have undergone some ESD resistant measures however, additional precaution against static electricity are recommended

- 【Example】 Wearing electrically conductive (Antistatic) gloves during work.
Wearing a wrist strap.
Grounding/Using ESD protective sheet on the work table.

6.3. Connector Mating Method

When mating be care not hold the optical fiber cable or the cable fixing section.

When mating the BF4-IR2 plug, make sure to hold onto the body. If the plug is held by the cable or cable fixture, there is a chance that excessive force can be applied to the connector causing some damage.

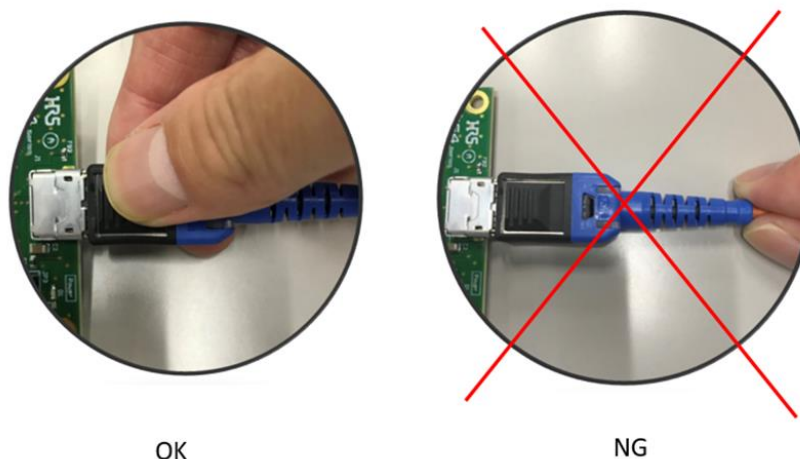


Fig 6.3. BF4-IR2 Mating Method

Do not mate while the power is on.

Make sure to turn off the power when mating the BF4-IR2 plug. Hot swapping may lead to damage occurring to the connector.

Plug Mating Durability

The BF4-IR2 plug and receptacle mating durability is not to exceed **1000 times**.

**Dual LC Plug****When mating, be careful not to hold the optical fiber cable or the cable fixing section.**

When mating the Dual LC plug, make sure to hold onto the plug itself. If the plug is held by the cable or cable fixture, there is a chance that excessive force can be applied to the connector causing some damage.

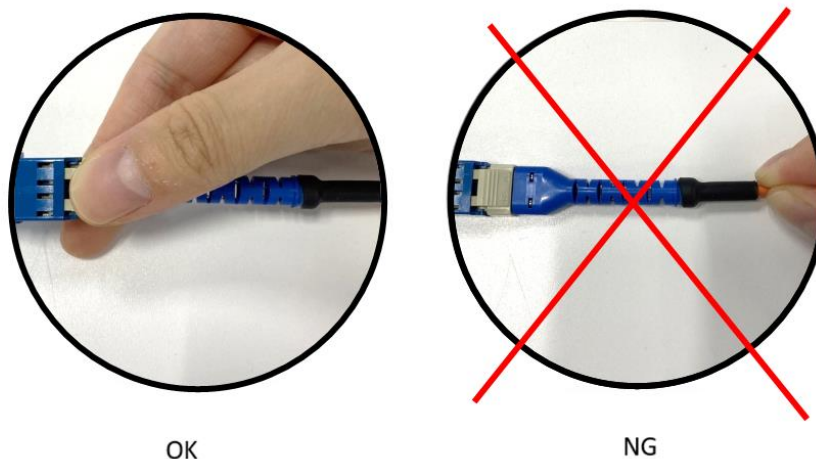


Fig 6.3(B) . BF4-IR2 Mating Method

Do not touch the tip of the mating part directly.

The Dual LC plug is configured two LC connectors. The basic handling is the same as the LC connector. Touching the connection section, located at the tip of the mating part, may cause dirt and scratches.

Plug Mating Durability

The Dual LC plug and receptacle mating durability is not to exceed **100 times**.

6.4. Connector Unmating Method

When unmating make sure while push on the lock (unlocking) on the BF4-IR2 plug while removing the plug.

When Un-mating the BF4-IR2 plug, make sure to push down on the lock while removing the plug. If the lock is not pushed when trying to remove the plug or if the cable or cable fixture is pulled on, there is a chance of excessive force being applied to the connector and cause damage.

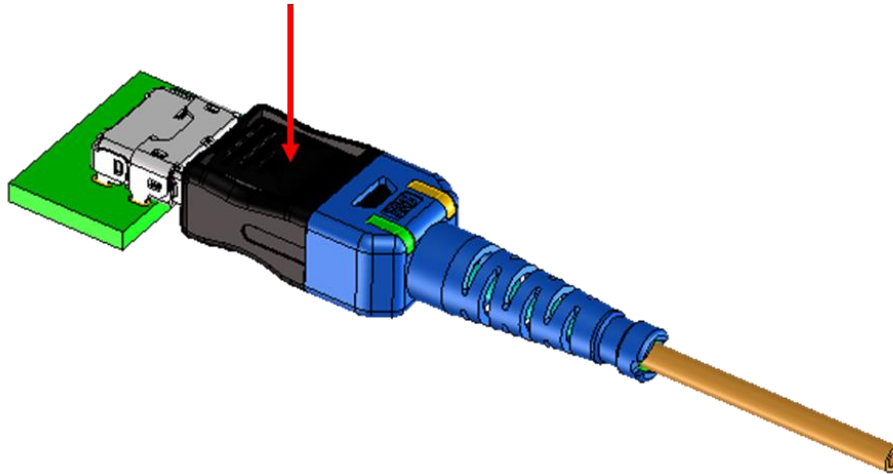


Fig. 6.4(A). BF4-IR2 Plug Lock Location

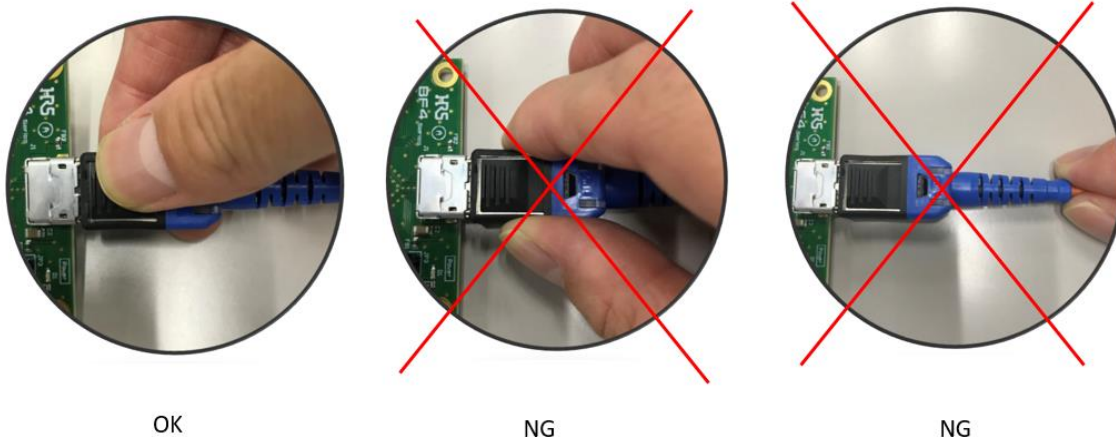


Fig. 6.4(B). BF4-IR2 Plug Removal Method

Do not unmate while the power is on.

Make sure to turn off the power when unmating the BF4-IR2 plug. Hot swapping may lead to damage occurring to the connector.



Dual LC Plug

When unmating, make sure to push down on the Dual LC plug lock (unlocking) while removing the plug.

When Un-mating the Dual LC plug, make sure to push down on the lock while removing the plug. If the lock is not pushed when trying to remove the plug or if the cable / cable fixture is pulled on, there is a chance of excessive force being applied to the connector and cause damage.

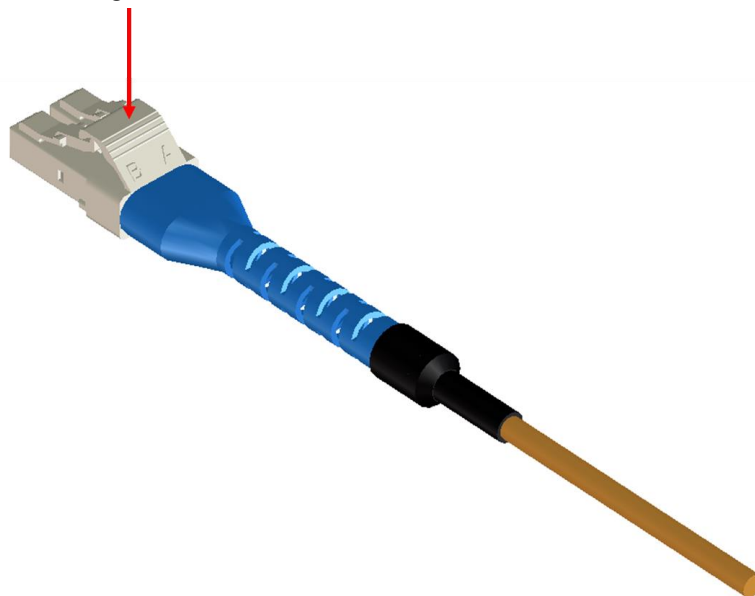


Fig 6.4(C) . Dual LC Plug Lock Location

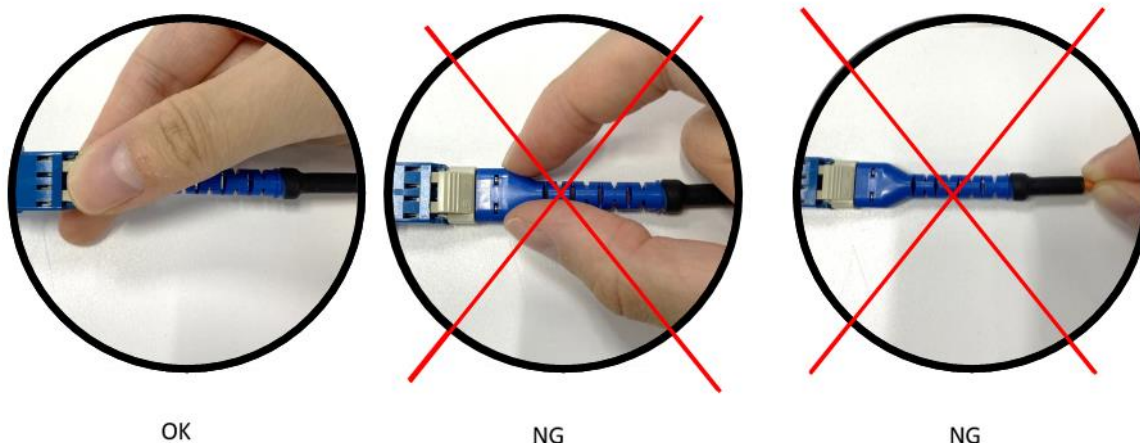


Fig 6.4(D) . Dual LC Plug Removal Method

6.5. Fail-Safe Design

The Product is equipped with a semiconductor for optical-electrical conversion.

Although HRS stands behind the quality and reliability of its products, semiconductor products have specific characteristics such as the occurrence of failure at a certain rate and malfunctions under certain use conditions.

Please be sure to implement safety measures to guard them against the possibility of physical injury, or injury in the event of the failure of a Hirose product, such as safety design including but not limited to redundancy, malfunction prevention or any other appropriate measures.

In the unlikely event a problem occurs due to the occurrence of failure, we respond appropriately and promptly after consultation.

6.6. Notes On Handling the Product

(Notes on Change of Information)

- The content of this document including the information regarding of the connector (Hereafter, The Product) is subject to change without prior notice.

(Prohibition of Reproduction)

- No part of this document may be copied or reproduced without prior written consent of Hirose Electric Co., LTD. (Hereafter, Hirose). Even if written consent of Hirose is obtained, it is prohibited to amend any part of this document and copy or reproduce it. Hirose shall assume no obligation or liability in connection With such amended information or reproductions.

(Responsibilities for Design Safety)

- Hirose shall assume no responsibilities for the support for the application of the product or the product design of the customer. The customer shall be responsible for the product and application of the customer in which the product is used. The customer shall take appropriate design and operational safety measures in order to minimize the potential risks predicted for the product and application of the customer in which the product is used.

(Responsibilities for the Determination of Suitability)

- When using the product, the customer shall ensure safe design at his/her own responsibility so that malfunction or failure of the product would never cause an infringement on the life, body or property. For design or use of the product, make sure to refer to the materials (including the catalog, specifications, and design note) and follow the same. When using information including the product data provided in the document, technical data or circuit examples shown in the figures and tables, the customer shall evaluate the information on the customer's product and determine the suitability at the customer's own responsibility.

(Responsibilities for Specific Applications)

- Make sure to consult with our sales representative in advance when considering the use of specific applications that require extremely high quality and reliability (I.E. Nuclear Equipment, Aerospace Systems, Transportation Equipment and Various Safety Related Equipment).

(Prohibition of Replication)

- Do not disassemble, reverse-engineer, modify, analyze or replicate this product.

(Prohibition of the Application of Prohibited Products)

- The product must not be used for any products that the manufacturing, sale or use is prohibited by domestic or international laws, regulations or ordinances.

(Notes on Guarantee and License)

- The technical data provided in the materials of the product is intended to describe the representative behaviors and application of the product. It is not to guarantee or license the intellectual property rights or any other rights of Hirose nor a third party.

(Notes on the Warranties for the Contract)

- Unless otherwise provided in a written contract or other documents (specifications) agreed between the customer and Hirose, Hirose makes no warranties of any kind (Including but not limited to, warranties of the function and operation, warranties of merchantability, warranties of suitability for a specific application or purpose and warranties of correctness of information).

(Notes on Export)

- To export the product to other countries, the exporter shall conduct the applicability determinations based on the Foreign Exchange and Foreign Trade Act of Japan. If you wish to have the applicability determination sheet issued by Hirose, contact our sales representative. Note that in the export arrangement, the customer shall be an exporter and responsible for compliance with all the applicable laws, regulations, terms and conditions of the agreement with Hirose.

6.7. Notes on the Use of the Product

(Notes on the Specification Range)

- Using the product under conditions beyond the specification range (For voltage, current and temperature) provided in this document may result in an accident (Including ignition, heat generation and smoking). Confirm the document thoroughly and make sure to use the product within the specified range.

(Notes on the Laser Beam)

- A laser beam is emitted from the end-face of the optical fiber in operation. It may cause eye injuries or loss of sight if it enters the eyes. Do not stare directly into the end-face of the optical fiber. The laser beam is emitted from the VCSEL in operation. It may not be visible depending on its wavelength but none the less it may cause eye injuries or loss of sight if the laser beam or its reflected beam enters the eye. Do not stare (look into) the laser beam directly.

(Notes on the Fracture of the Optical Fiber)

- In case of the fracture of the optical fiber used in the Product, turn off the power immediately.
In addition, use care when handling it to avoid injury from fractured parts or fragments.

(Notes on Use of GaAs)

- The Product is equipped with a semiconductor within the connector and contains gallium arsenide (GaAs). Vapor and powder of GaAs is harmful to the human body and the environment, please note the following.
 - When disposing of the product, the following disposal process is recommended.
 - To consign the disposal to a disposer licensed to collect, transport and dispose of materials containing gallium arsenide.
 - To separate from general industrial waste and household waste and handle as special industrial waste material until final disposal.

(Notes on Waterproofing)

- The product is not waterproof and a failure due to condensation or exposure to water is not warranted. If condensation or exposure to water may occur, take appropriate waterproofing measures.

(Notes on Use of Chemicals)

- Avoid environments where acidic chemicals, alkaline chemicals and organic solvents are present or directly used on the product. The product may deteriorate and affect the features described above.

(Notes on Environment Where Gases are present)

- Avoid using the product in environments where gasses such as chlorides or sulfides are present. The product may deteriorate and affect the features described above.

(Notes on Storage)

- Store the product out of range of corrosive substances, corrosive gases, high temperature, humidity and direct sunlight. Do not apply excessive pressure or vibration to the product as it may cause deterioration, deformation, damage or failure of the product.

(Notes on Resin Molding)

- The resin molding section of the product may contain black spots or the coloring may be slightly different, but this has no effect of the products performance.

7. Revision History

Table7. Revision history

Revision No.	Description (Major changes)	Date
0.9	Specifications preliminary version release. *Official release at the start of sale.	2020.10.02
1.0	Initial release.(Official version)	2020.11.12
1.1	Add IR2 Receptacle Product Materials. Table 2.3 Plug Harness Product Materials =>Table 2.3(A) Plug Harness Product Materials Table 2.3(B) Receptacle Product Materials 6.6.Notes On Handling the Product → Partial Removal	2021.01.07
1.2	Add due to addition of instruction manual for Dula LC plug. 6.3. Connector Mating Method => Dual LC plug 6.4. Connector Unmating Method => Dual LC plug	2021.06.17