

CTS-HPIO Specification

(IR+RF)

*** This radio equipment may be subject to radio interference during operation.**

Model Name: CTS-HPIO-25

Revision 1.0

June18, 2018

Updated By: **KM.JO**

| Approval Signatures: | <input type="checkbox"/> Name (Job Position) | <input type="checkbox"/> Name (Job Position) | <input type="checkbox"/> Name (Job Position) |
|----------------------|---|---|---|
| | Date: | Date: | Date: |
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Revision History:

| Rev | Date/Initials | Location | Description of Change |
|------------|----------------------|-----------------|------------------------------|
| 1.0 | 2018. 06.18./ KM. JO | All | - First edition |
| | | | |
| | | | |
| | | | |

1. PRODUCT OVERVIEW

The CTS-HPIO 2nd (E84 Sensor, PIO) is a communication device used to give and receive 8-bit data without contact according to the semiconductor SEMI-E84, E23 protocol.

In addition, this is a combined product of RF communication and IR (infrared, optical) communication media of 2.4GHz, 5GHz, so it is possible to select and use communication media working stably according to the site situations.

This product is a product, realizing the best operation state without radio disconnection even at sites with severe electromagnetic interference due to electromagnetic noises and diffuse reflections, that can be set with various and convenient additional functions via serial ports and wirelessly and can be used by converting communication media into IR or RF depending on uses.

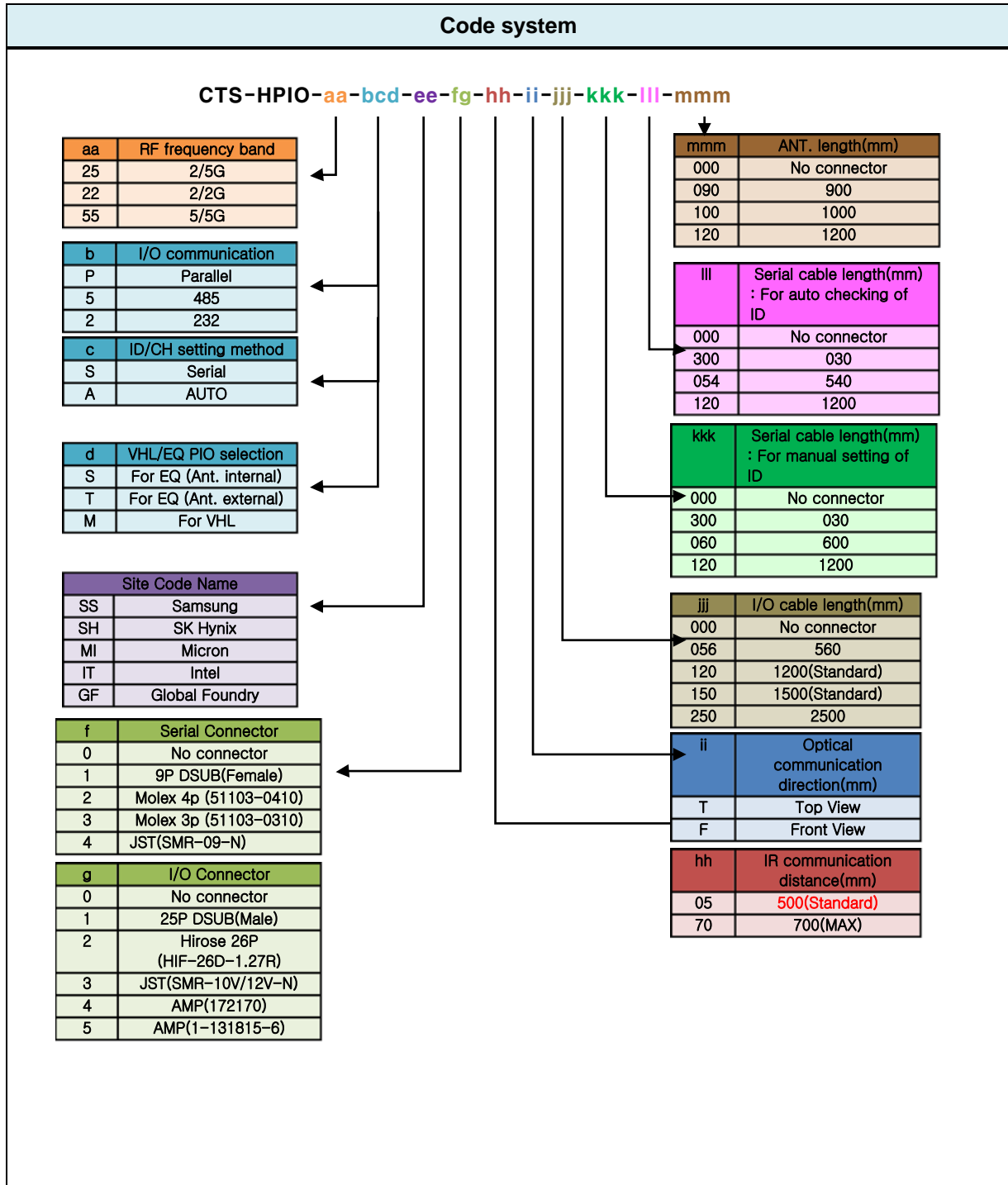
In addition, this product provides various functions to facilitate the prompt grasping of causes and the establishment of countermeasures in case of abnormalities in transmission/reception data during communication.

This device is mainly used for an interchange of control signals between vehicle (master or active device such as AGV/OHT) and equipment (slave or passive device).

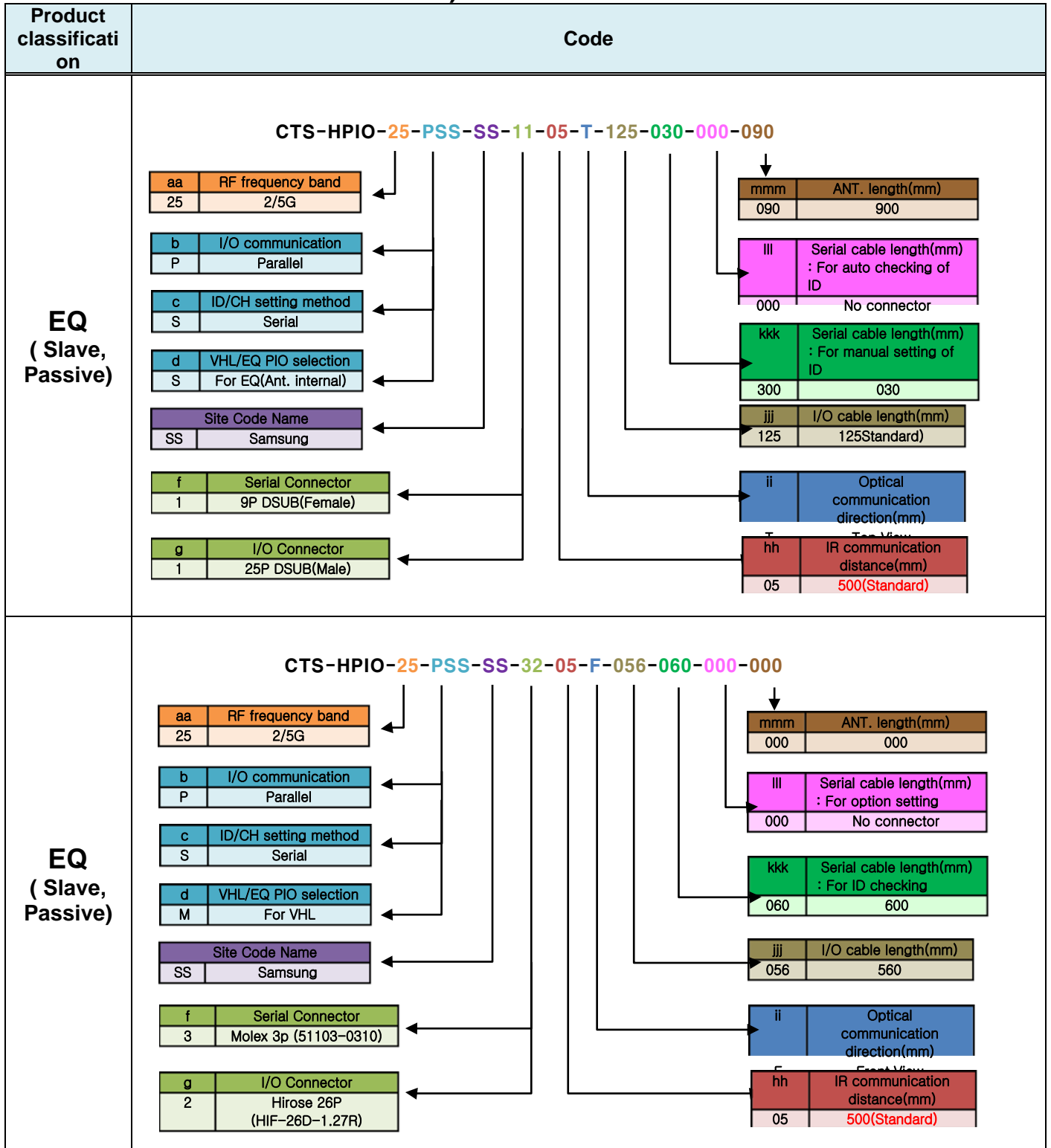
2. PRODUCT FEATURE

- **RF (2.4GHz, 5GHz) and IR (infrared, optical) communication media combined in a product**
- **Exchange of 8-bit input/output signals without contact**
- **Possible to select optimal communication media according to the ambient communication interference environment**
- **2.4/5GHz radio communication: Additional function such as data transmission/reception and F/W downloading**
- **Radio communication working distance used within at most 2m (There shall be no obstacle or electromagnetic noise interference)**
 - **2M distance criterion : A distance for stable communication without radio disconnection at the site environment**
- **Radio communication ID (address) designation: 6 digits (Hexa code)**
- **Storage of various information using large-capacity SRAM: About 100 sets of work such as communication data and error contents, absolute time, signal intensity, etc. (Cancelled when power OFF)**
- **Various additional functions using serial communication functions: Setup change, communication data information receiving, F/W downloading, etc.**

3. PRODUCT CODE CONFIGURATION



PRODUCT CODE EXAMPLE)

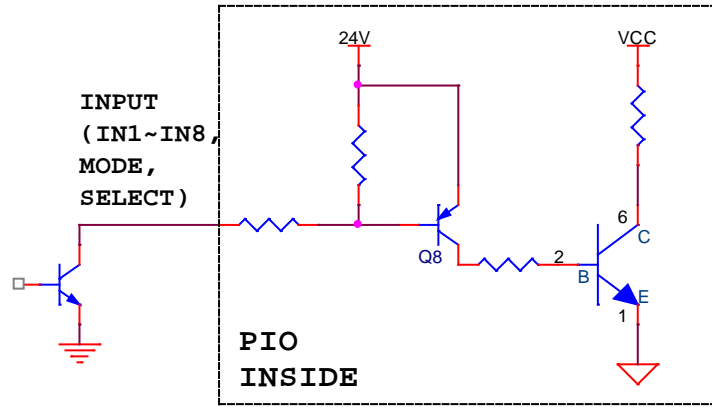


➤ Hybrid-PIO fixed cover code(For Slave)

| Product code | PIO optical communication direction |
|------------------|-------------------------------------|
| CTS-HPIO-COVER-F | Front View |
| CTS-HPIO-COVER-T | Top View |

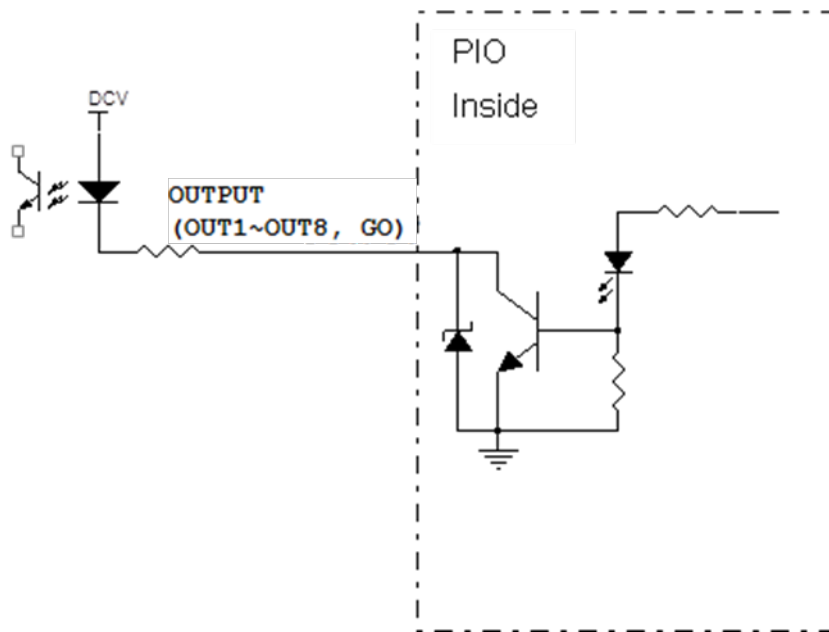
4. INPUT/OUTPUT CIRCUIT

Input circuit : Maximum 10mA, connected with the equipment or OHT output circuits



Output circuit : NPN type Open Collector, maximum operation current 50mA / 30V

V_{CEmax} 100mV / 10mA, connected with the equipment or OHT input circuit



5. MAJOR SPECIFICATION OF THE PRODUCT

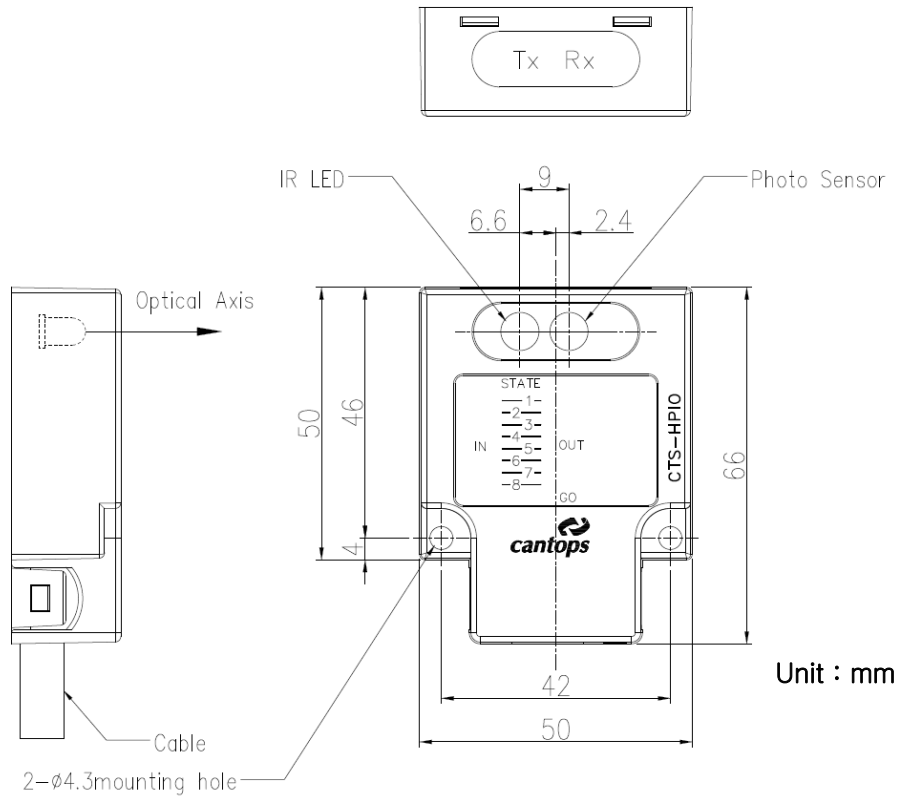
| Division | Specific item | Content | |
|------------------------------------|--|--|---|
| Display part | GO | Turned ON if RF and IR communication starts between the master(OHT, AGV) PIO and the slave(EQ) PIO | |
| | STATE | Flashing as watchdog signals to display the working state | |
| | IN | Display of the working state of the input port(8Bit) | |
| | OUT | Display of the working state of the output port(8Bit) | |
| External device connection | Connector (Optional) | Master(OHT, AGV) PIO: DSUB 25 pins, without connector | |
| | | Slave(EQ) PIO: Hirose 26 pins, JST, Molex, without connector | |
| | Cable | 26AWG x 25C, Shield | |
| | Input | 8 Bit, Transistor IN, 24V On : 10mA, Off : Less than 0.1mA | |
| Output | 8Bit, Open Collector, NPN, 30V Maximum working current 50mA | | |
| IR(optical) communication function | Major function | 8 bit I/O communication | |
| | Communication media | 870nm, Infrared | |
| | Communication distance | 0.5m (0°), 0.25m (+15°, -15°) | |
| | Communication angle | 30° (±15°) | |
| | Communication method | 1:1 communication, Half Duplex | |
| | Communication window position (Optional) | T Type : Top View F Type : Front View | |
| | Optical modulation method | Pulse Modulation | |
| | Communication error check | Parity | |
| Communication cycle | About 23ms | | |
| RF Communication function | Major function | 8 bit I/O communication, F/W and communication data download, set value change, etc. | |
| | Communication media | 2.4GHz, 5GHzISM Band, bandwidth 1MHz | |
| | Frequency band | 2.4G | 2.401~2.480 GHz, 80 channels ^{*1)} |
| | | 5G | 5.727~5.850GHz, 124 channels ^{*1)} |
| Maximum RF | 10mW | | |

| | | |
|----------------------|-----------------------------|--|
| | Output Power | |
| | Safety function | Identification number(ID) checking function, CRC-16 |
| | Communication method | 1:1 communication, Half Duplex |
| | ID setting | PIO identification number(ID) to avoid interference with the neighbor PIO, composed of 6-digit ASCII codes : 000001~FFFFFF |
| | Channel(CH) setting | Communication frequency to be used in radio communication needing frequency management to avoid radio interference with the neighbor PIO, composed of 3-digit ASCII codes |
| | ID setting method | Serial communication command : Set as a release default value(56B9-xxxxxx) |
| | Working distance | Within 2m However, a distance for stable communication without radio disconnection at the site environment, without radio interference in the middle |
| Environment | Storage environment | Storage temperature: -25 ~ 70°C Storage humidity: 5 ~ 95%RH (However, there shall be no dew condensation) |
| | Working environment | Ambient brightness(Condition when IR is used) : 4000lx or less(Incandescent lamp, fluorescent lamp) *) Installed to prevent external light from entering the receptor Working temperature : 0 ~ 40°C Working humidity : 35~85%RH (However, there shall be no dew condensation) Vibration : 4~150 Hz, 4.9m/s ² or less |
| Power | Input voltage | DC 24V±10% |
| | Consumed current | 100mA or less @ 24V |
| Case material | | Polycarbonate |
| Size(W×H×D) | | 50×66×20mm (Except the connector protrusion) |
| Weight | | About 300g (For EQ, IO cable length 1.5m) |

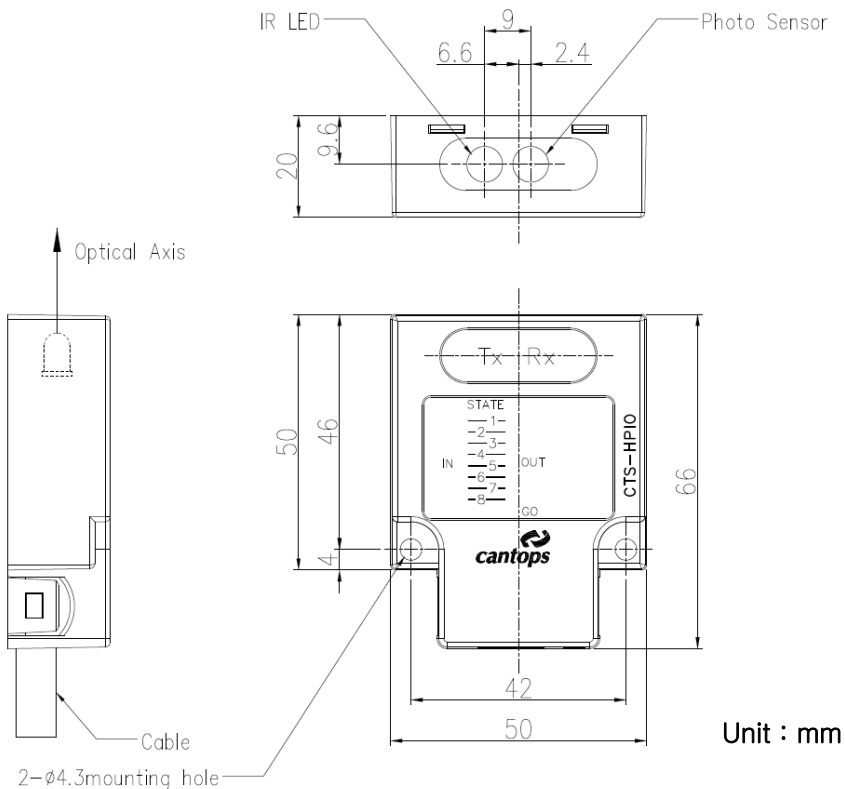
*1) Usable in an environment without frequency interference with other radio equipment(wireless LAN, Bluetooth, etc.)

6. MECHANISM SPECIFICATION AND OPTICAL COMMUNICATION DIRECTION

F Type : Front View



T Type : Top View



7. CONNECTOR CONNECTION SPECIFICATION

1) For equipment (Slave, Passive, EQ)

| Function | DSUB 25Pin No. | Color | Function | DSUB 25Pin No. | Color |
|---------------------------------------|----------------|---------|----------------|----------------|---------|
| IN 1 | 1 | Red 1 | Out1 | 14 | Blue 1 |
| IN 2 | 2 | Red 2 | Out2 | 15 | Blue 2 |
| IN 3 | 3 | Red 3 | Out3 | 16 | Blue 3 |
| IN 4 | 4 | Red 4 | Out4 | 17 | Blue 4 |
| IN 5 | 5 | Green 1 | Out5 | 18 | White 1 |
| IN 6 | 6 | Green2 | Out6 | 19 | White2 |
| IN 7 | 7 | Green3 | Out7 | 20 | White3 |
| IN 8 | 8 | Green4 | Out8 | 21 | Black 1 |
| NC | 9 | - | NC | 22 | - |
| SELECT ^{Note1)} | 10 | NC | +VIN | 23 | Red |
| MODE ^{Note 2)} | 11 (GND) | NC | GND | 24 | Black |
| Go (Ready) | 12 | Black2 | GND | 25 | White |
| NC (No Connection) | 13 | - | - | - | - |
| Serial Connector (DSUB 9P, Female) | | | TxD | 2 | Black |
| | | | RxD | 3 | Brown |
| | | | GND | 5 | Red |
| Cable wiring diagram | | | DSUB 25P, Male | | |
| | | | | | |

Note 1) SELECT : For an always used mode, it is not necessary to control this signal from the outside.

Note 2) MODE signal(No.11) : It is not necessary to control this signal from the outside.

*) For input/output signal criteria, the E84 Sensor(PIO) was used as a criterion.

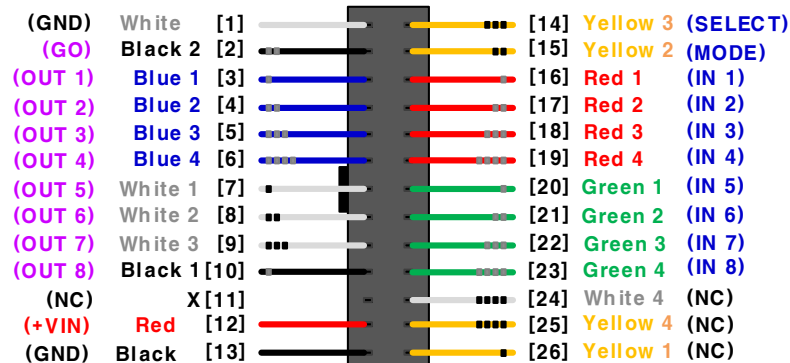
2) OHT (Master, Active, Vehicle)

➤ HIF6-26D-1.27R Connector

| Function | HIF6-26D pin No. | Color | Function | HIF6-26D pin No. | Color |
|------------------|-----------------------|----------|------------|------------------|---------|
| IN 1 | 16 | Red 1 | Out1 | 3 | Blue 1 |
| IN 2 | 17 | Red 2 | Out2 | 4 | Blue 2 |
| IN 3 | 18 | Red 3 | Out3 | 5 | Blue 3 |
| IN 4 | 19 | Red 4 | Out4 | 6 | Blue 4 |
| IN 5 | 20 | Green 1 | Out5 | 7 | White 1 |
| IN 6 | 21 | Green2 | Out6 | 8 | White2 |
| IN 7 | 22 | Green3 | Out7 | 9 | White3 |
| IN 8 | 23 | Green4 | Out8 | 10 | Black 1 |
| SELECT | 14 | Yellow 3 | Ready (Go) | 2 | Black 2 |
| MODE | 15 | Yellow 2 | +VIN | 12 | Red |
| NC | 11, 24 | - | GND | 1 | White |
| NC | 25, 26 | - | GND | 13 | Black |
| Serial Connector | DSUB 9p, Female | | TxD | 2 | Black |
| | | | RxD | 3 | Brown |
| | | | GND | 5 | Red |
| | Molex 4P (5557-04R) | | TxD | 1 | Black |
| | | | RxD | 2 | Brown |
| | | | GND | 3 | Red |
| | Molex 3P (51103-0300) | | TxD | 1 | Black |
| | | | RxD | 2 | Brown |
| | | | GND | 3 | Red |

Cable wiring diagram

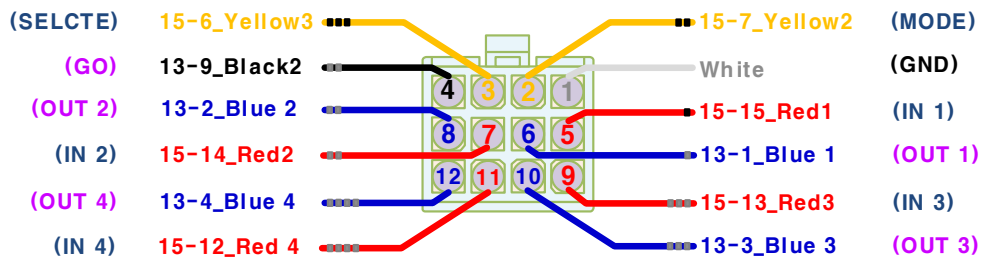
HIF6-26D-1.27R



➤ AMP 12 pin, 172170

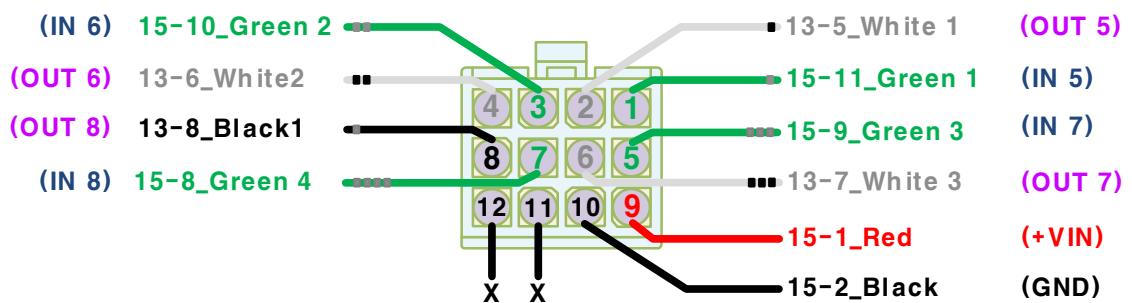
| A Connector | | | | | |
|-------------|---------|----------|------------|---------|---------|
| Function | Pin No. | Color | Function | Pin No. | Color |
| IN 1 | 5 | Red 1 | Out1 | 6 | Blue 1 |
| IN 2 | 7 | Red 2 | Out2 | 8 | Blue 2 |
| IN 3 | 9 | Red 3 | Out3 | 10 | Blue 3 |
| IN 4 | 11 | Red 4 | Out4 | 12 | Blue 4 |
| SELECT | 3 | Yellow 3 | Ready (Go) | 4 | Black 2 |
| MODE | 2 | Yellow 2 | GND | 1 | White |

Cable wiring diagram



| B Connector | | AMP 12 pin, 172170 | | | |
|---------------------------------|---------|--------------------|----------|---------|----------|
| Function | Pin No. | Color | Function | Pin No. | Color |
| IN 5 | 1 | Green 1 | Out5 | 2 | White 1 |
| IN 6 | 3 | Green2 | Out6 | 4 | White2 |
| IN 7 | 5 | Green3 | Out7 | 6 | White3 |
| IN 8 | 7 | Green4 | Out8 | 8 | Black 1 |
| X | 11 | - | +VIN | 9 | Red |
| X | 12 | - | GND | 10 | Black |
| Serial Connector (SMR-09V-N) | | | TxD | 2 | Yellow 1 |
| | | | RxD | 1 | Yellow 4 |
| | | | GND | 5 | White 4 |

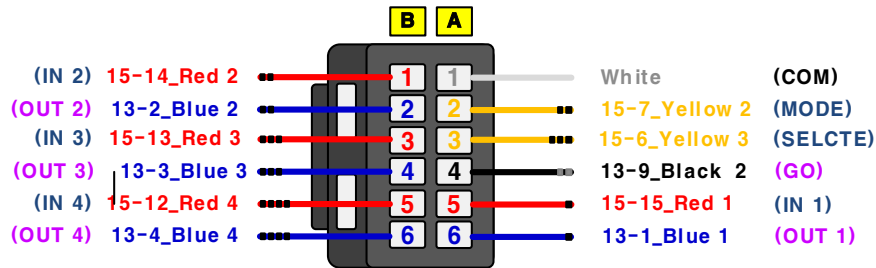
Cable wiring diagram



➤ AMP 12 pin, 1-1318115

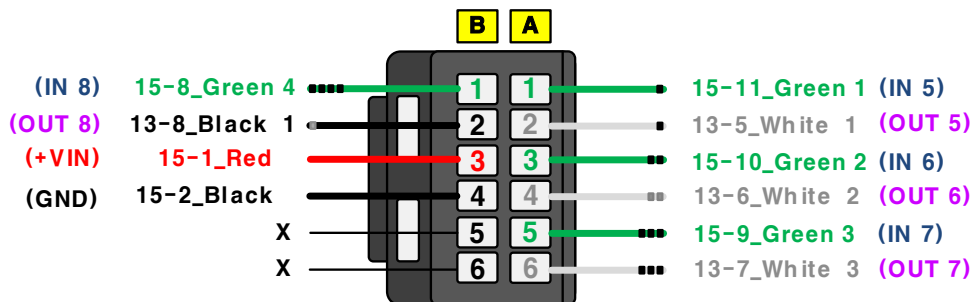
| A Connector | | | | | |
|-------------|---------|----------|------------|---------|---------|
| Function | Pin No. | Color | Function | Pin No. | Color |
| IN 1 | A-5 | Red 1 | Out1 | A-6 | Blue 1 |
| IN 2 | B-1 | Red 2 | Out2 | B-2 | Blue 2 |
| IN 3 | B-3 | Red 3 | Out3 | B-4 | Blue 3 |
| IN 4 | B-5 | Red 4 | Out4 | B-6 | Blue 4 |
| SELECT | A-3 | Yellow 3 | Ready (Go) | A-4 | Black 2 |
| MODE | A-2 | Yellow 2 | GND | A-1 | White |

Cable wiring diagram



| B Connector | | AMP 12 Pin, 1-1318115 | | | |
|---------------------------------|---------|-----------------------|----------|---------|----------|
| Function | Pin No. | Color | Function | Pin No. | Color |
| IN 5 | A-1 | Green 1 | Out5 | A-2 | White 1 |
| IN 6 | A-3 | Green2 | Out6 | A-4 | White2 |
| IN 7 | A-5 | Green3 | Out7 | A-6 | White3 |
| IN 8 | B-1 | Green4 | Out8 | B-2 | Black 1 |
| X | 11 | - | +VIN | B-3 | Red |
| X | 12 | - | GND | B-4 | Black |
| Serial Connector (SMR-09V-N) | | | TxD | 2 | Yellow 1 |
| | | | RxD | 1 | Yellow 4 |
| | | | GND | 5 | White 4 |

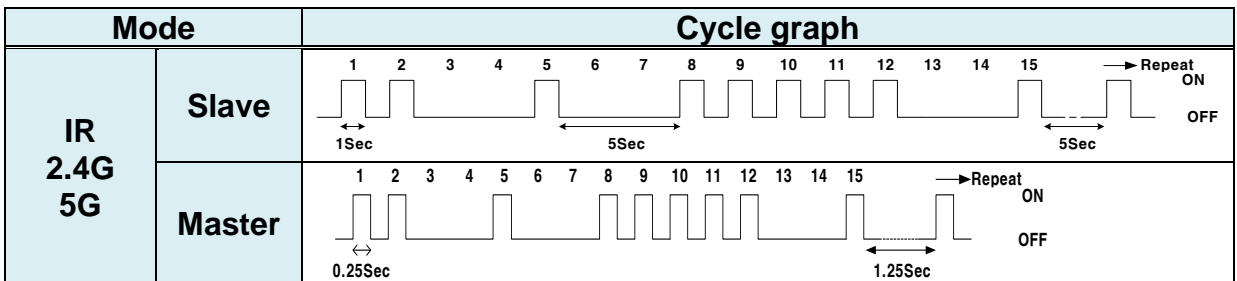
Cable wiring diagram



8. LED DISPLAY CONTENT

| LED name | | Display content |
|------------------------------|-----|---|
| 1~8 | IN | Display of the working state of the input circuit in the PIO, turned ON when a low is inputted |
| | OUT | Display of the output state in the PIO, turned ON when TR On |
| GO | | Turned ON when transmission/reception of data between the master PIO and the slave PIO is realized, the GO LED and output OFF time after disconnection of radio communications is maximum 3 seconds, which can be set up to 0.023 sec~5.5 sec using the <R> command |
| STATE ^{Note 1)} | | Used as a watchdog signal to check the internal state of this product ▪ When working in an IR/RF mode : “2 times ON -> 2 times OFF -> 1 time ON -> 2 times OFF -> 5 times ON -> 2 times OFF -> 1 time ON -> 2 times OFF” cycle, repeated flashing ※ The product working mode can be identified, so see the following diagram |
| *) LED configuration diagram | | |

Note 1) STATE LED working timing



9. MAJOR PIN FUNCTION

| Signal name | Usage |
|----------------|--|
| Mode (Input) | Input to select a PIO mode <ul style="list-style-type: none"> ▪ GND connection: Slave Mode (Connected to the GND from the inside of EQ, PIO, so there is no need to connect anything from the outside) ▪ Open: Master Mode (OHT) |
| Select (Input) | Input to operate the radio/optical communication of PIO <ul style="list-style-type: none"> ▪ GND connection: Pause of the radio communication function of PIO ▪ Open: Working of the radio communication function of PIO |
| GO (Output) | Turned ON if the radio/optical communication between the Master PIO and the Slave PIO is normally realized |

➤ Mode description

| | |
|-------------|---|
| Master Mode | Operating the PIO by opening the Select signals transmits the data entering the input port to the radio/optical. This is a mode installed and used at the OHT or AGV. |
| Slave Mode | Operating the PIO by opening the Select signal only receives the radio/optical, and if the radio/optical signals are received from the master, the received data are outputted to the output port, and the signals entering the input port are transmitted to the master PIO. This is a mode installed and used at the equipment. |

10. COMMUNICATION MEDIA SELECTION METHOD

This product has optical (infrared) and radio (2.4GHz, 5GHz RF) communication media that can communicate without contact. Using radio communication at semiconductor factories can affect the media used by this product due to ambient equipment or sensors to generate communication interference.

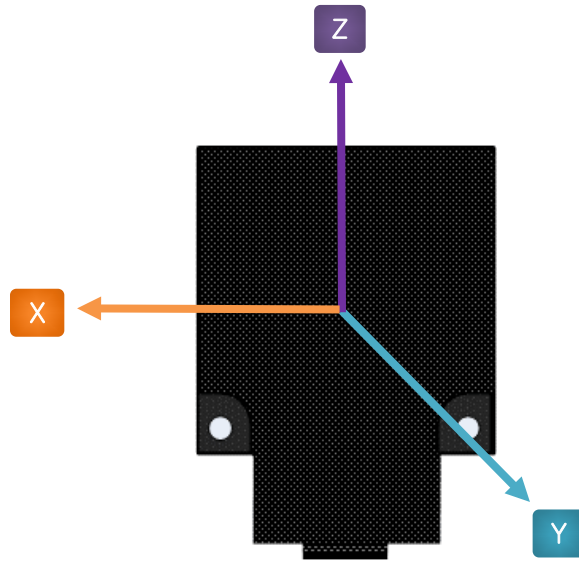
In this case, selecting and using other media without interference can enable more stable radio communications.

The method of selecting communication media is enabled by using serial communication commands (M command), and when radio (RF) is used, various variables such as channel, unique ID, etc. shall be set together.

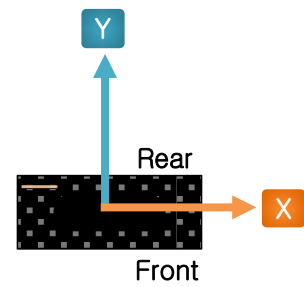
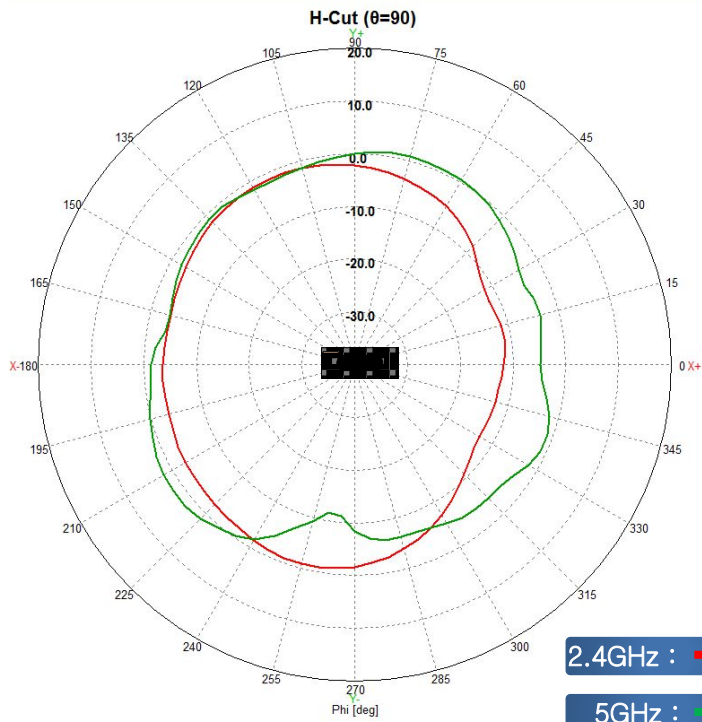
For the command list, see the 14. Serial command list.

11. ANTENNA RADIATION PATTERN

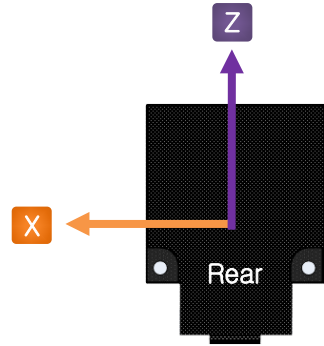
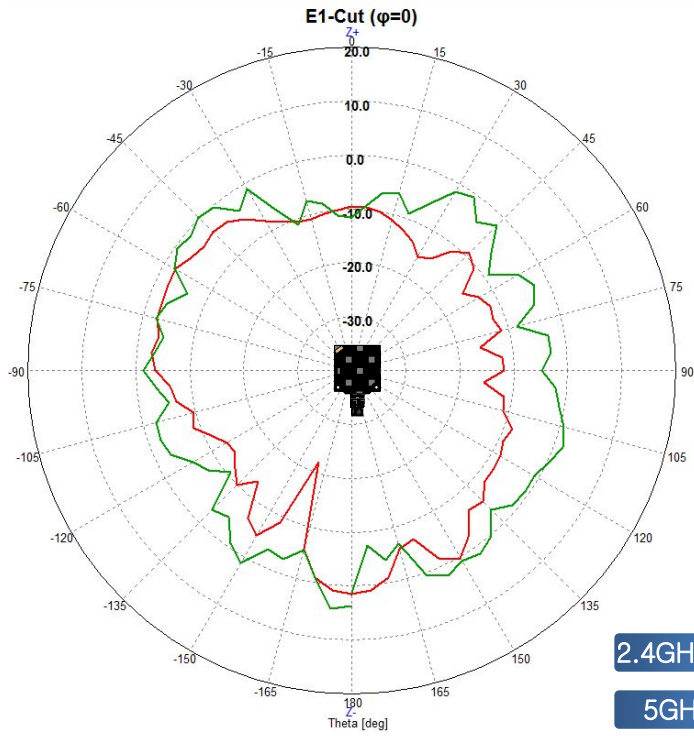
Internal Antenna



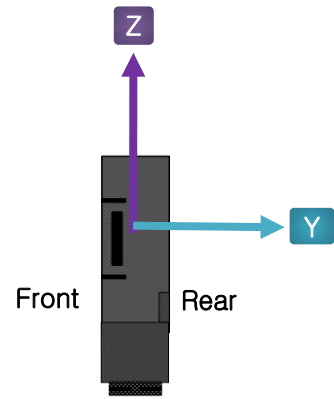
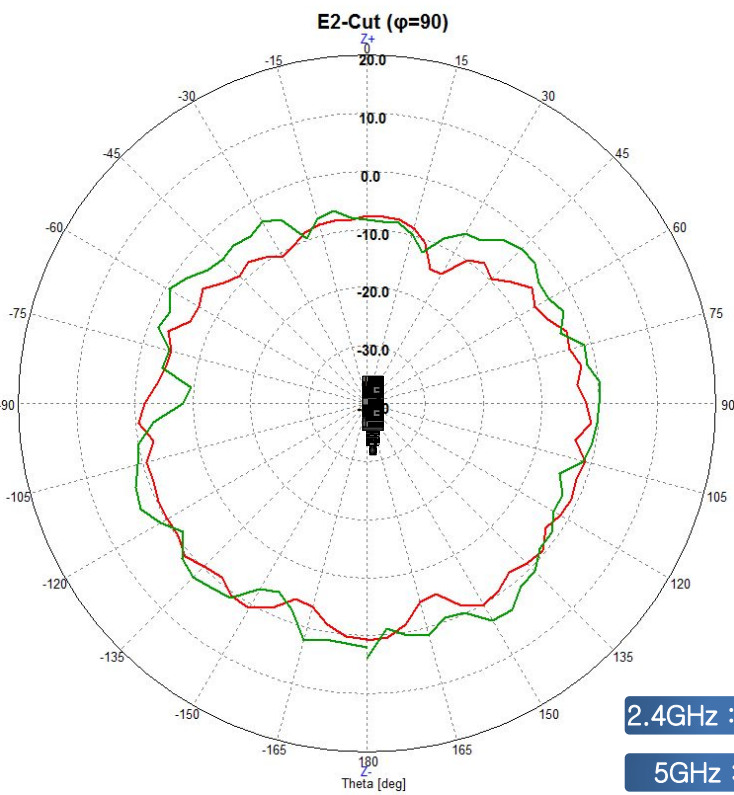
X - Y Plane



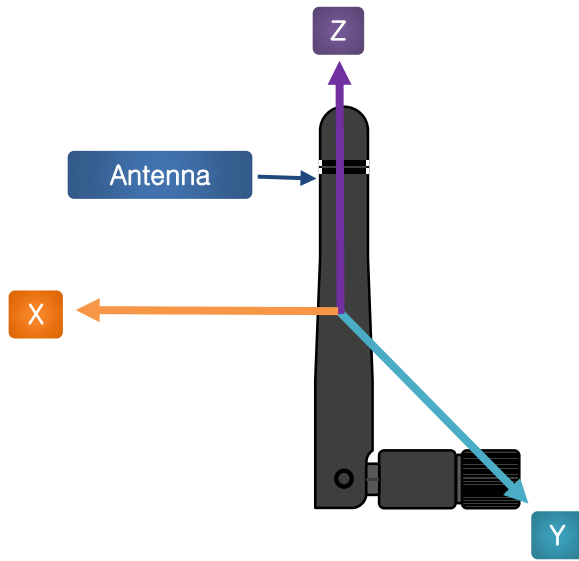
X – Z Plane



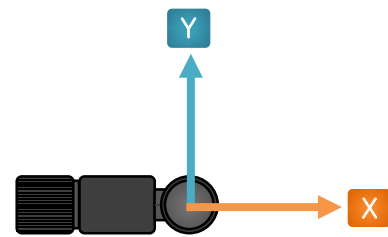
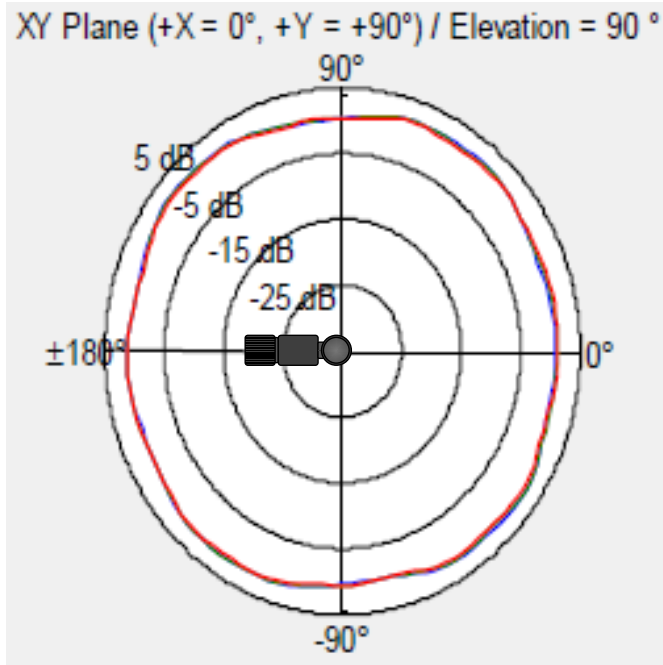
Y – Z Plane



**External Antenna
(2.4GHz)**

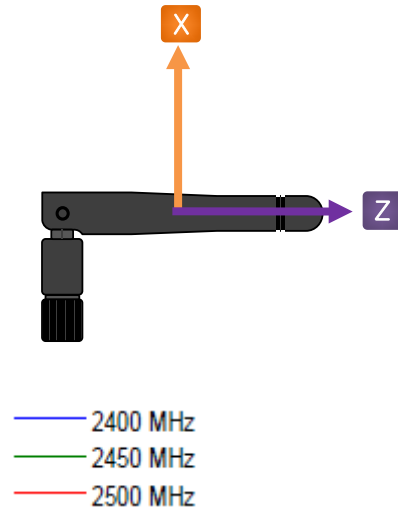
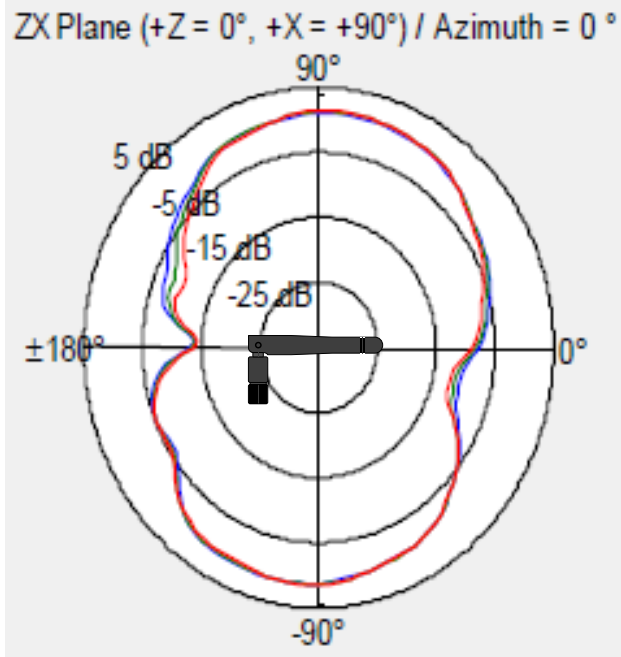


X – Y Plane

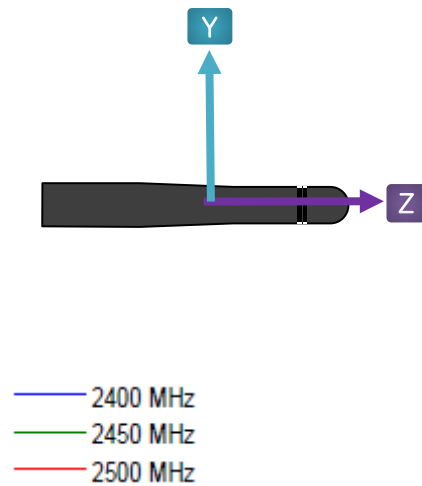
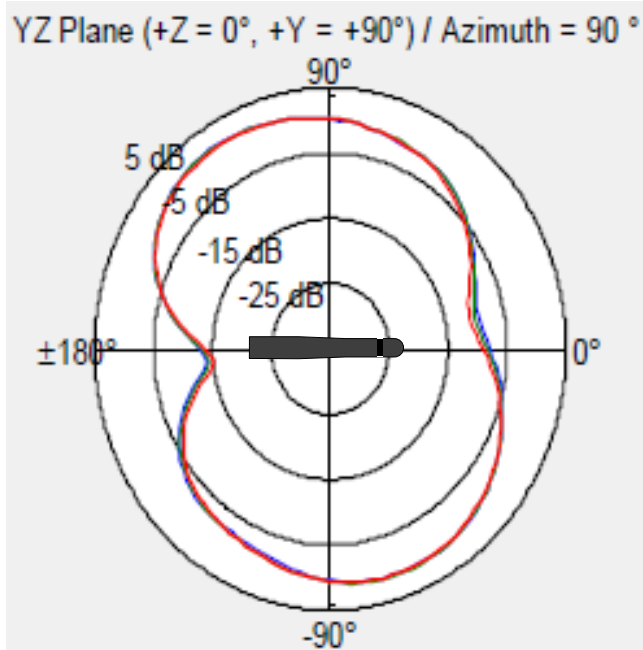


- 2400 MHz
- 2450 MHz
- 2500 MHz

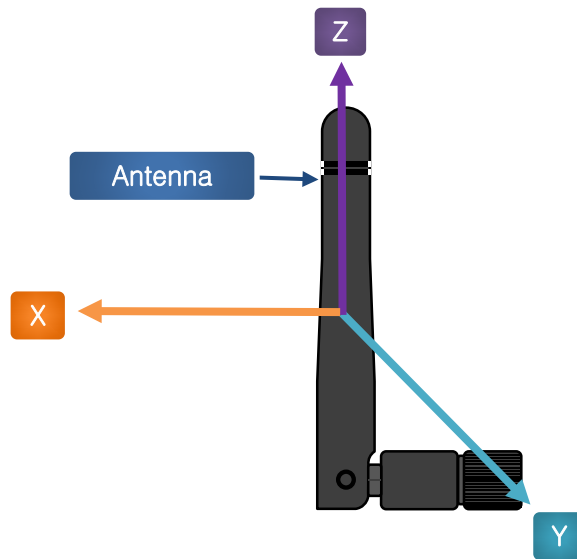
Z – X Plane



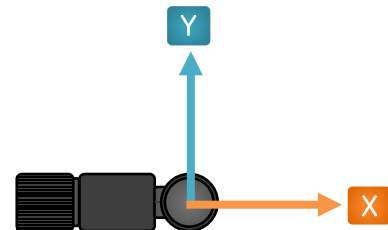
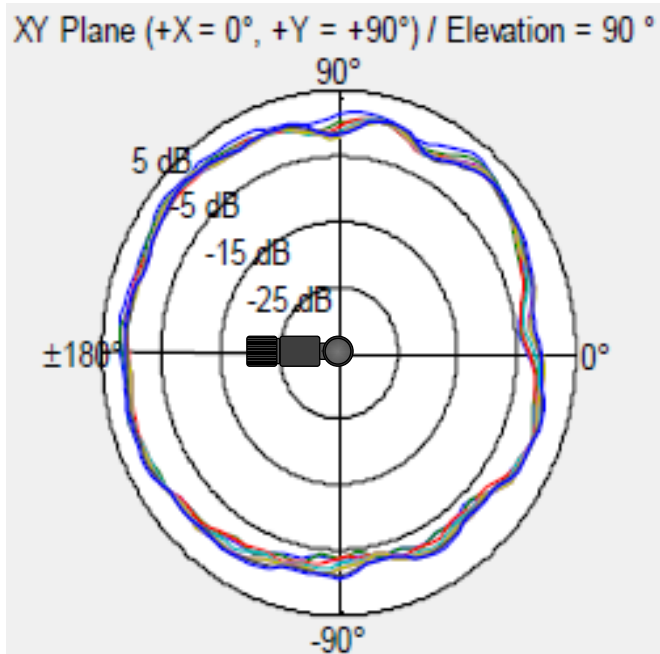
Y – Z Plane



**External Antenna
(5GHz)**

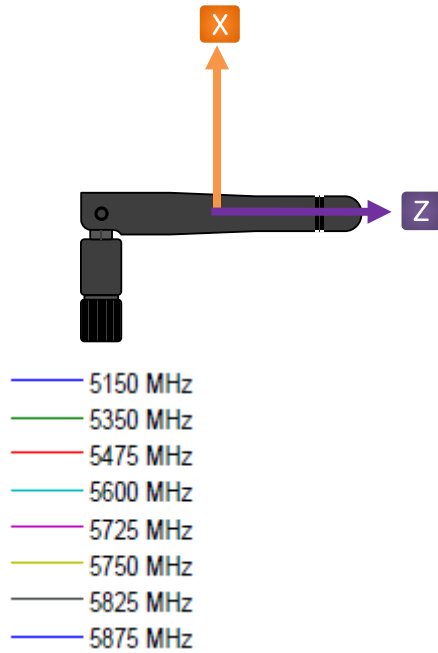
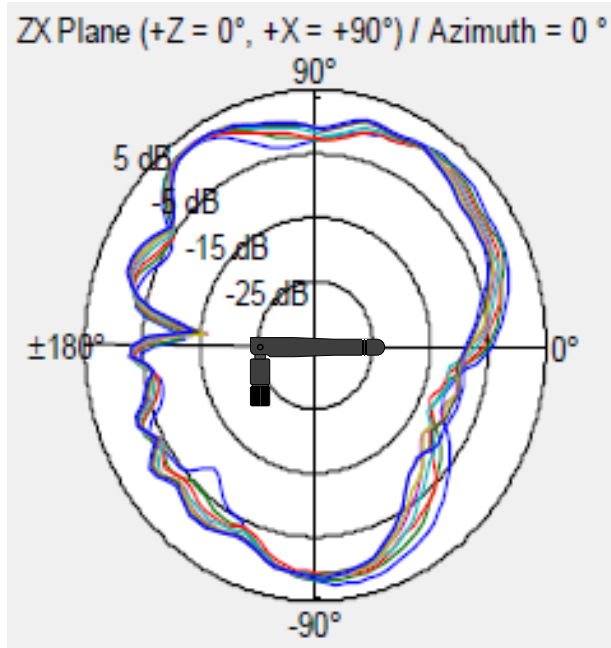


X – Y Plane

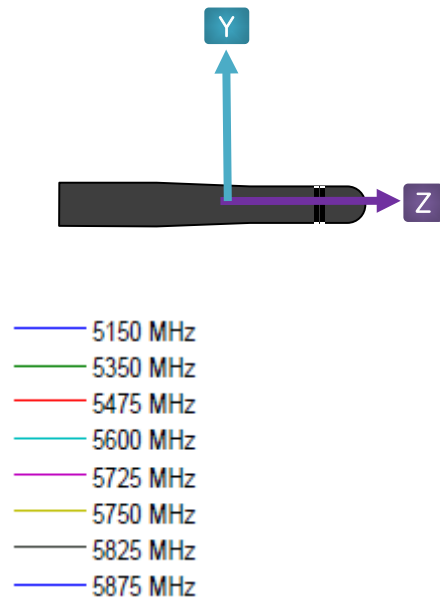
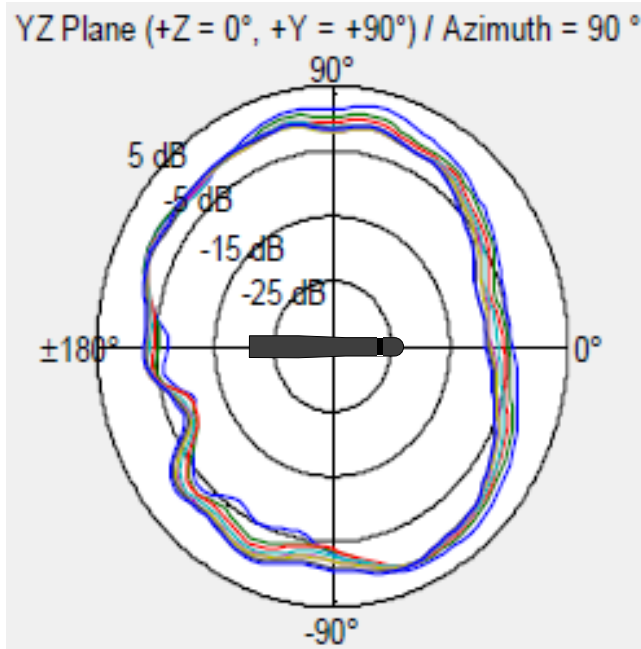


- 5150 MHz
- 5350 MHz
- 5475 MHz
- 5600 MHz
- 5725 MHz
- 5750 MHz
- 5825 MHz
- 5875 MHz

Z – X Plane



Y – Z Plane



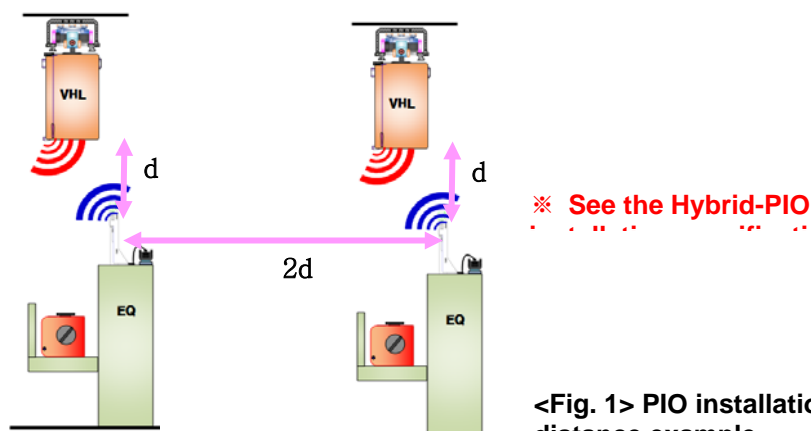
12. RF FUNCTION

RF communication characteristics

- RF communication using 2.4GHz/5GHz of ISM(Industrial Scientific and Medical)Band that can be used without permission
- High speed data communication of 1Mbps per channel
- GFSK modulation type, 1MHz bandwidth
- Excellent expandability with 6 bytes of ID and 3 bytes of frequency selection function
- Communication cycle : About 23ms
- There can happen frequency interference with 2.4GHz/5GHz of radio LAN and other radio communication devices, so it is necessary to set a channel without collision
- RF maximum output power : +10dBm
- Receiving part sensitivity : -90dBm

Caution in installation

- 1) Radio performance drops when there are metals or objects causing electromagnetic troubles in the space of linear distance between two PIOs. Remove obstacles from the radio paths before use.
- 2) There shall be no interference with other radio equipment in an open space for stable use without communication errors.
- 3) Take care so that there may not be metals or other obstacles within 60mm radius around the antenna.
- 4) There can happen frequency interference due to other RF equipment around. Use this product in an environment without frequency interference for stable operation.
- 5) Especially, when using a 2.4GHz/5GHz band in the same space, allot a channel such that the channels(frequencies) are not overlapped.
- 6) If there is equipment emitting electromagnetic noises such as magnetron in the same space, then shield the electromagnetic waves from the corresponding equipment before use by all means.
- 7) Keep the spacing at 30cm when simultaneous work is not done between PIOs for equipment installed at the equipment, and keep the spacing at 50cm when simultaneous work is done.
- 8) Leave 2 times or more distance between PIOs for installation when simultaneous work is done at the VHL(OHT) as shown in the figure.



※ This product uses 2.4GHz/5GHz of radio Wi-Fi band, so there can happen interference when the same frequency band as other radio devices is used. Therefore, to use this product, at least 40MHz of frequency band without interference with other radio equipment is needed.

Radio environment setting method

The CTS-HPIO Series of radio(RF) function is connected with many devices simultaneously due to its characteristics to cause interference, so to communicate with a device(equipment), set the ID and CH(channel) port number of the counter side(slave PIO for equipment) first before starting communication at the Vehicle(OHT, Master PIO). This ID and CH can be set using a serial communication command.

| PIO division | Setting method |
|--------------|---|
| Slave | <ul style="list-style-type: none"> ▪Connection with the PIO serial port => Setting with a communication command (ID and CH, transmission power, etc.) ▪The set data is stored in the internal memory, so once it is set, it doesn't need to be set again even though the power is OFF. |
| Master | <ul style="list-style-type: none"> ▪ Connection with the PIO serial port => Setting with a communication command (VHL device/communication media/ID/CH/PORT, etc.) ▪Select Off(communication permitted)→ On(communication prohibited), then the ID and CH are automatically changed to the initial value, and before the Select Off(communication permitted), be sure to reset the VHL device number, communication media, ID, CH, port number. ※ If data transmission is not prepared for (checked by <Y> command), then data is not transmitted even though Select Off (communication permitted). |

※ For details, see the serial communication specification.

13. IR FUNCTION

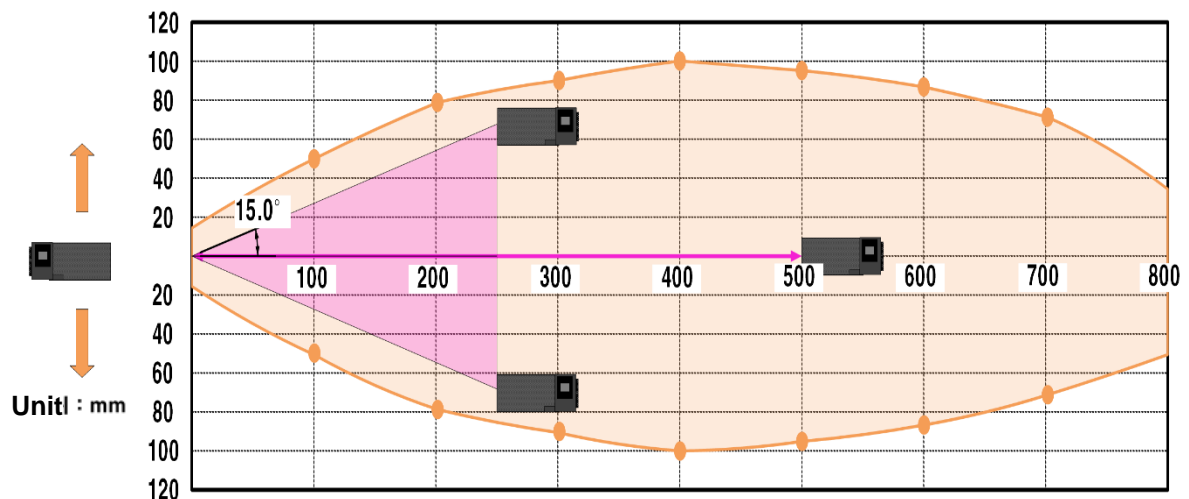
IR communication characteristics

- Wavelength : 870nm (Infrared, optical)
- Ambient brightness : 4000lx or less incandescent lamp and fluorescent lamp, where there is no direct sunlight
- Transmission and reception method : Half Duplex
- Modulation type : Pulse Modulation
- Working distance and angle : 0.5m at 0°, 0.25m at $\pm 15^\circ$
- Communication distance adjustment : Serial/RF communication command
- Reception level adjustment : Serial/RF communication command
(Raising the reception level when ambient noises are introduced can reduce noise interference.)
- Input signal and GO output filtering : Time can be set by a serial command

IR communication range

The IR communication range is $30^\circ(\pm 15^\circ)$, so communication is possible at 25cm distance at $\pm 15^\circ$ and at 50cm distance at 0° . (The figure below shows the data of measuring the actual IR communication distance)

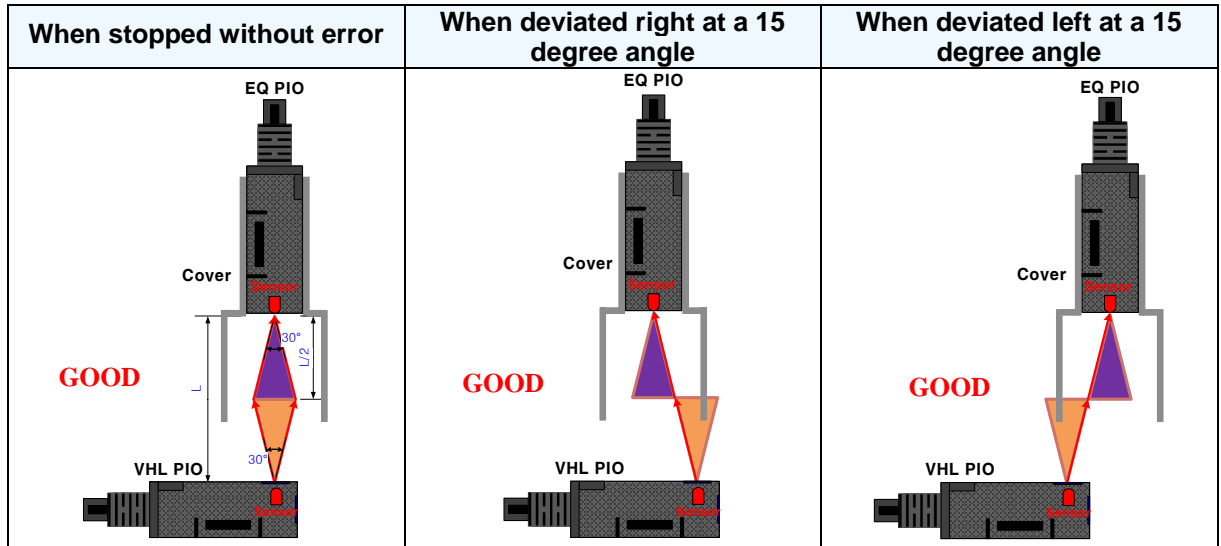
However) loss of communication can happen when the lighting, sunlight, IR remote control, optical sensor, etc. faces the transmission and reception window. In this case, shield the external light before use.



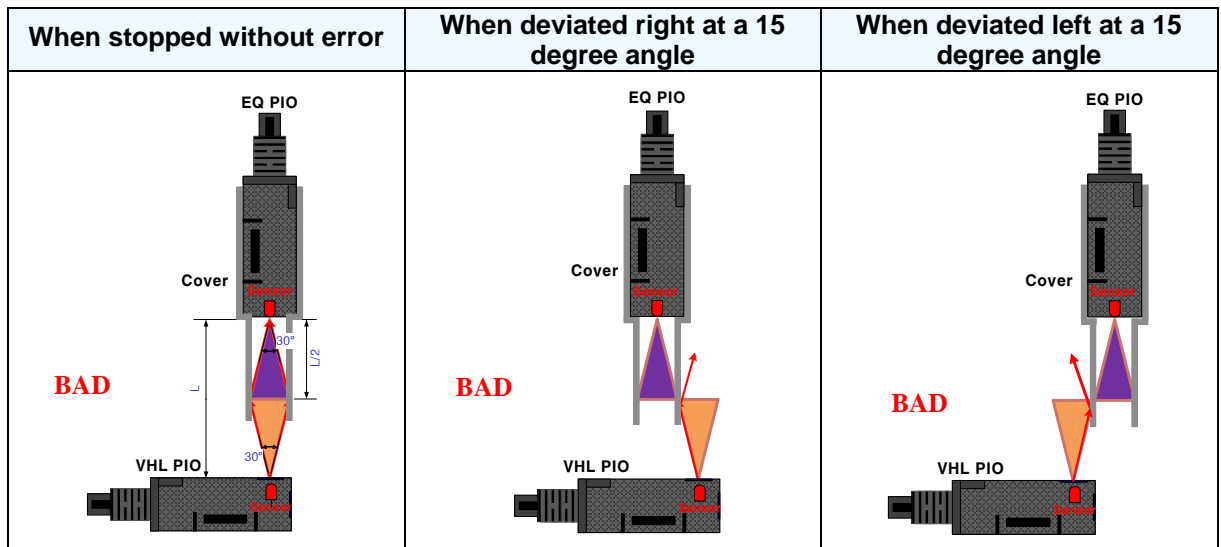
Consideration in installation

Both IR and RF communication methods are used as the communication media of this product. In case of IR (optical, infrared) type, since it uses the invisible infrared rays, when PIO fixing bracket or fixing part intercept the light, the original specification performance will not be used properly.

When stopping without error or stopping within $\pm 15^\circ$ as shown in the figure below, make sure that peripheral equipment does not block PIO light (red arrow).



The following figures show cases that objects around the PIO intercept light, so there is high possibility that PIO communication errors can happen depending on the VHL stop degrees. When stopped without error, PIO communication is normally realized, but when errors become large, light is intercepted by objects to cause abnormal communication. Therefore, take care when designing fixed objects and mechanisms around.



In addition, if there are many optical noises around, then a function of intercepting external interference light through fixed objects is needed.

14. SERIAL COMMAND LIST

| Serial command setting method | | | | |
|---|--|-----------------------------|----------------|---------------|
| <ul style="list-style-type: none"> Serial communication set value : 38400,8,n,1, without flow control The starting letter of all commands is "<", and the ending letter is ">". The starting letter of response to a command is "[", and the ending letter is "]". | | | | |
| Command | Function | Communication media Note 1) | Master Note 2) | Slave Note 2) |
| M | Communication media setting | IR/RF | Keep | Keep |
| R | Communication retrial numbers | IR/RF | Keep | Keep |
| T | Current time setting | IR/RF | Reset | Reset |
| Y | Communication preparation state check | IR/RF | - | - |
| G | GO state check | IR/RF | - | - |
| L | Communication data download | IR/RF | -(No function) | -(Function) |
| S | Communication data state download | IR/RF | -(No function) | -(Function) |
| V | Version check | IR/RF | - | - |
| C | Channel setting | RF | Reset | Keep |
| A | ID setting | RF | Reset | Keep |
| N | Port number setting | RF | Reset | Not used |
| P | RF output intensity | RF | Keep | Keep |
| W | Time to check if there are other devices | RF | Keep | Not used |
| O | OHT device | RF | Keep | Not used |
| DI | Building/floor division | RF | Keep | Keep |
| <p>Note 1) The use of setting value is determined depending on the communication media (optical or radio).</p> <p>Note 2) Cares shall be taken for using the serial command as setting value storage status (If the setting value is stored, the previous setting value is maintained even if power is applied again) is classified according to the mode (Master / Slave).</p> | | | | |

➤ Major contents of serial command setting by mode

| | |
|-------------|--|
| Master Mode | The OHT device number, communication media, ID, CHANNEL, PORT numbers can be set at the Select On(communication prohibited) state only, and for other commands, serial commands can be used anytime. |
| Slave Mode | Serial commands can be used anytime regardless of the Select state. |

※ For details, see the "Serial communication specification".

15. BUILDING/FLOOR DIVISION CODE SETTING

- For radio, signals can be received from more than several meters depending on ambient situations.
- If the same ID and CH are used in the neighbor buildings or on other floors, there may happen interference.
- To avoid this interference, it is possible to use a different code by building and floor.

➤ Application scope

- ✓ **Building : 0~8(number only), floor : 0~9(number only)**

Ex) Building 3 floor 4 :DI=3-4

※ For the detailed description method, see the user manual for the ID/CH setting

➤ Caution

- ✓ **Be sure to use this at the place where the building/floor code set value is equal.**
(Communication disabled when the set value is confused)
- ✓ **When installing at other places after removal of PIO, be sure to reset it to a set value used at the installation place.**
- ✓ **Management history for code setting is needed.**

16. Channel and frequency relationship (5GHz band)

| CH (Channel) | Frequency (MHz) | WLAN Channel | CH (Channel) | Frequency (MHz) | WLAN Channel | CH (Channel) | Frequency (MHz) | WLAN Channel |
|--|-----------------|--------------|--------------|-----------------|--------------|--------------|-----------------|--------------|
| 128 | 5725 | | 168 | 5765 | 153 | 208 | 5805 | 161 |
| 129 | 5726 | | 169 | 5766 | | 209 | 5806 | |
| 130 | 5727 | | 170 | 5767 | | 210 | 5807 | |
| 131 | 5728 | | 171 | 5768 | | 211 | 5808 | |
| 132 | 5729 | | 172 | 5769 | | 212 | 5809 | |
| 133 | 5730 | | 173 | 5770 | | 213 | 5810 | |
| 134 | 5731 | | 174 | 5771 | | 214 | 5811 | |
| 135 | 5732 | | 175 | 5772 | | 215 | 5812 | |
| 136 | 5733 | | 176 | 5773 | | 216 | 5813 | |
| 137 | 5734 | | 177 | 5774 | | 217 | 5814 | |
| 138 | 5735 | 149 | 178 | 5775 | 157 | 218 | 5815 | 165 |
| 139 | 5736 | | 179 | 5776 | | 219 | 5816 | |
| 140 | 5737 | | 180 | 5777 | | 220 | 5817 | |
| 141 | 5738 | | 181 | 5778 | | 221 | 5818 | |
| 142 | 5739 | | 182 | 5779 | | 222 | 5819 | |
| 143 | 5740 | | 183 | 5780 | | 223 | 5820 | |
| 144 | 5741 | | 184 | 5781 | | 224 | 5821 | |
| 145 | 5742 | | 185 | 5782 | | 225 | 5822 | |
| 146 | 5743 | | 186 | 5783 | | 226 | 5823 | |
| 147 | 5744 | | 187 | 5784 | | 227 | 5824 | |
| 148 | 5745 | | 188 | 5785 | | 228 | 5825 | |
| 149 | 5746 | | 189 | 5786 | | 229 | 5826 | |
| 150 | 5747 | | 190 | 5787 | | 230 | 5827 | |
| 151 | 5748 | | 191 | 5788 | | 231 | 5828 | |
| 152 | 5749 | | 192 | 5789 | | 232 | 5829 | |
| 153 | 5750 | | 193 | 5790 | | 233 | 5930 | |
| 154 | 5751 | | 194 | 5791 | | 234 | 5831 | |
| 155 | 5752 | | 195 | 5792 | | 235 | 5832 | |
| 156 | 5753 | | 196 | 5793 | | 236 | 5833 | |
| 157 | 5754 | | 197 | 5794 | | 237 | 5834 | |
| 158 | 5755 | 153 | 198 | 5795 | 161 | 238 | 5835 | |
| 159 | 5756 | | 199 | 5796 | | 239 | 5836 | |
| 160 | 5757 | | 200 | 5797 | | 240 | 5837 | |
| 161 | 5758 | | 201 | 5798 | | 241 | 5838 | |
| 162 | 5759 | | 202 | 5799 | | 242 | 5839 | |
| 163 | 5760 | | 203 | 5800 | | 243 | 5840 | |
| 164 | 5761 | | 204 | 5801 | | 244 | 5841 | |
| 165 | 5762 | | 205 | 5802 | | 245 | 5842 | |
| 166 | 5763 | | 206 | 5803 | | 246 | 5843 | |
| 167 | 5764 | | 207 | 5804 | | 247 | 5844 | |
| <p>*) The shaded area shall be checked for the availability by country. If this band has to be used, please contact us.</p> <p>*) In order to use this product stably, set the channel so that there is no frequency interference with other wireless devices such as wireless LAN or Bluetooth.</p> | | | | | | 248 | 5845 | |
| | | | | | | 249 | 5846 | |
| | | | | | | 250 | 5847 | |
| | | | | | | 251 | 5848 | |
| | | | | | | 252 | 5849 | |
| | | | | | | 253 | 5850 | |
| | | | | | | 254 | 5851 | |
| | | | | | | 255 | 5852 | |

17. CHANNEL AND FREQUENCY RELATIONSHIP(2.4GHZ BAND)

| CH (Channel) | Frequency (MHz) | WLAN Channel | CH (Channel) | Frequency (MHz) | WLAN Channel |
|--------------|-----------------|--------------|--------------|-----------------|--------------|
| 0 | 2400 | | 44 | 2444 | |
| 1 | 2401 | | 45 | 2445 | |
| 2 | 2402 | | 46 | 2446 | |
| 3 | 2403 | | 47 | 2447 | 8 |
| 4 | 2404 | | 48 | 2448 | |
| 5 | 2405 | | 49 | 2449 | |
| 6 | 2406 | | 50 | 2450 | |
| 7 | 2407 | | 51 | 2451 | |
| 8 | 2408 | | 52 | 2452 | 9 |
| 9 | 2409 | | 53 | 2453 | |
| 10 | 2410 | | 54 | 2454 | |
| 11 | 2411 | | 55 | 2455 | |
| 12 | 2412 | 1 | 56 | 2456 | |
| 13 | 2413 | | 57 | 2457 | 10 |
| 14 | 2414 | | 58 | 2458 | |
| 15 | 2415 | | 59 | 2459 | |
| 16 | 2416 | | 60 | 2460 | |
| 17 | 2417 | 2 | 61 | 2461 | |
| 18 | 2418 | | 62 | 2462 | 11 |
| 19 | 2419 | | 63 | 2463 | |
| 20 | 2420 | | 64 | 2464 | |
| 21 | 2421 | | 65 | 2465 | |
| 22 | 2422 | 3 | 66 | 2466 | |
| 23 | 2423 | | 67 | 2467 | 12 |
| 24 | 2424 | | 68 | 2468 | |
| 25 | 2425 | | 69 | 2469 | |
| 26 | 2426 | | 70 | 2470 | |
| 27 | 2427 | 4 | 71 | 2471 | |
| 28 | 2428 | | 72 | 2472 | 13 |
| 29 | 2429 | | 73 | 2473 | |
| 30 | 2430 | | 74 | 2474 | |
| 31 | 2431 | | 75 | 2475 | |
| 32 | 2432 | 5 | 76 | 2476 | |
| 33 | 2433 | | 77 | 2477 | |
| 34 | 2434 | | 78 | 2478 | |
| 35 | 2435 | | 79 | 2479 | |
| 36 | 2436 | | 80 | 2480 | |
| 37 | 2437 | 6 | | | |
| 38 | 2438 | | | | |
| 39 | 2439 | | 83 | 2483 | |
| 40 | 2440 | | 84 | 2484 | 14 |
| 41 | 2441 | | | | |
| 42 | 2442 | 7 | | | |
| 43 | 2443 | | 125 | 2525 | |

***) The specification of this product is subject to changes without prior notice for improvement of performance.**



FCC Warning Statement

FCC Part 15.19

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

FCC Part 15.21

Any changes or modifications (including the antennas) to this device that are not expressly approved by the manufacturer may void the user's authority to operate the equipment.

FCC RF Radiation Exposure Statement

This equipment complies with FCC RF Radiation exposure limits set forth for an uncontrolled environment.

This device and its antenna must not be co-located or operating in conjunction with any other antenna or transmitter.

This equipment should be installed and operated with a minimum distance of 30 cm between the radiator and your body.

Note : This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications, television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Modifications not expressly approved by the manufacturer could void your authority to operate the equipment under FCC rules.