DRW171479AA

Autonics

Digital Fiber Optic Sensor
BF5 SERIES (Dual Display)
INSTRUCTION MANUAL

Thank you for choosing our Autonics product.
Please read the following safety considerations before use.

▣ Safety Considerations

※Please observe all safety considerations for safe and proper product operation to avoid hazards.
※⚠ symbol represents caution due to special circumstances in which hazards may occur.

⚠ **Warning** Failure to follow these instructions may result in serious injury or death.
⚠ **Caution** Failure to follow these instructions may result in personal injury or product damage.

⚠ Warning

1. **Fail-safe device must be installed when using the unit with machinery that may cause serious injury or substantial economic loss. (e.g. nuclear power control, medical equipment, ships, vehicles, railways, aircraft, combustion apparatus, safety equipment, crime/disaster prevention devices, etc.)**
   Failure to follow this instruction may result in fire, personal injury, or economic loss.
2. **Install the unit on DIN rail to use.**
   Failure to follow this instruction may result in fire.
3. **Do not connect, repair, or inspect the unit while connected to a power source.**
   Failure to follow this instruction may result in fire.
4. **Check 'Connections' before wiring.**
   Failure to follow this instruction may result in fire.
5. **Do not disassemble or modify the unit.**
   Failure to follow this instruction may result in fire.

⚠ Caution

1. **Use the unit within the rated specifications.**
   Failure to follow this instruction may result in fire or product damage.
2. **Use dry cloth to clean the unit, and do not use water or organic solvent.**
   Failure to follow this instruction may result in fire.
3. **Do not use the unit in the place where flammable/explosive/corrosive gas, humidity, direct sunlight, radiant heat, vibration, impact, or salinity may be present.**
   Failure to follow this instruction may result in fire or explosion.

▣ Ordering Information

Model	Light source	Display part	Control output
BF5R-D1-N	Red LED	Dual display type	NPN open collector output
BF5R-D1-P			PNP open collector output
BF5G-D1-N	Green LED		NPN open collector output
BF5G-D1-P			PNP open collector output
BF5B-D1-N	Blue LED		NPN open collector output
BF5B-D1-P			PNP open collector output

▣ Unit Description

1. **Control output indicator(Red)**
   Used to indicate control output provided by comparing SV and actual incident light level.
2. **Sensitivity setting key**
   Used to execute each operation and to set sensing sensitivity.
3. **PV display part(4digit, Red, 7-segment)**
   Used to indicate incident light level and parameters.
4. **SV display part(4digit, Green, 7-segment)**
   Used to indicate SV and setting data.
5. **Up/Down key**
   ●Used to up/down setting values
   ●Used to fine-adjust sensitivity
6. **MODE key**
   ●Used to enter into program mode / data bank mode.
   ●Used to move each parameter.
7. **Lock lever**

▣ Control Output Circuit Diagram and Connections

	Fiber optic sensor circuit	Connection
NPN open collector output	Main circuit; Output short over current protection circuit; Load	(Brown)+V; (Black)Output; (Blue)0V; Load; Max. 100mA; 12-24VDC
PNP open collector output	Main circuit; Output short over current protection circuit; Load	(Brown)+V; (Black)Output; (Blue)0V; Load; Max. 100mA; 12-24VDC

※**The above specifications are subject to change and some models may be discontinued without notice.**
※**Be sure to follow cautions written in the instruction manual and the technical descriptions (catalog, homepage).**

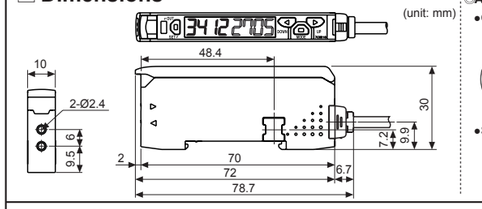
▣ Specifications

Model	NPN open collector output	**BF5R-D1-N**	**BF5G-D1-N**	**BF5B-D1-N**
	PNP open collector output	**BF5R-D1-P**	**BF5G-D1-P**	**BF5B-D1-P**
Light source		Red LED(660nm, modulated)	Green LED(530nm, modulated)	Blue LED(470nm, modulated)
Response time		Ultra Fast: 50μs, Fast: 150μs, STD: 500μs, Long: 4ms, Ultra Long: 10ms		
Power supply		12-24VDC⎓ ±10%		
Current consumption		Max. 50mA		
Operation mode		Light ON/Dark ON Selectable		
Control output		NPN or PNP open collector output • Load voltage: Max. 24VDC⎓ • Load current: Max. 100mA • Residual voltage - NPN: Max. 1V, PNP: Max. 3V		
Protection circuit		Power reverse polarity protection circuit, output short over current protection circuit, surge protection circuit		
Display method		• Incident light level: Red, 4digit, 7-segment • SV: Green, 4digit, 7-segment • Control output indicator: Red LED		
Display function		Incident light level / SV display [4,000/10,000 resolution], Percentage display, High/Low peak value display, Normal / Reversed display		
Sensitivity setting		Manual sensitivity setting, Teaching sensitivity setting(Auto-tuning, One-point, Two-point, Positioning)		
Mutual interference prevention		Max. 8 unit sets(Automatically set regardless of response time)		
Initializing		Initializing to factory mode		
Energy saving		Normal / Energy saving 1 / Energy saving 2		
Timer		OFF, OFF Delay, ON Delay, One-shot		
Insulation resistance		Over 20MΩ(at 500VDC megger)		
Dielectric strength		1,000VAC 50/60Hz for 1 min		
Vibration		1.5 mm amplitude at frequency of 10 to 55Hz(for 1 min) in each X, Y, Z direction for 2 hours		
Shock		500m/s²(Approx. 50G) in each X, Y, Z direction for 3 times		
Environment	Ambient illumination	Incandescent lamp: Max. 3,000ℓx, Sunlight: Max. 11,000ℓx(received illumination)		
	Ambient temperature	-10 to 50℃, Storage: -20 to 70℃		
	Ambient humidity	35 to 85%RH, Storage: 35 to 85% RH		
Protection structure		IP40(IEC standard)		
Material		Case: PBT, Cover: PC		
Fiber cable tightening torque		Min. 2kgf		
Accessories		Connector type wire(Ø4mm, 3-wire, 2m / AWG22, Core diameter: 0.08mm, Number of cores: 60, Insulator diameter: Ø1.25mm), Side connector		
Approval		CE		
Weight※1		Approx. 138g(approx. 20g)		

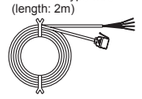
※1: The weight is with packaging and the weight in parenthesis is only unit weight.
※The temperature or humidity mentioned in Environment indicates a non freezing or condensation environment.

▣ Dimensions

(unit: mm)



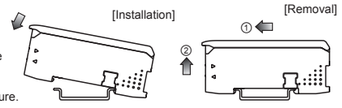
◎**Accessories**
●Connector type wire (length: 2m)



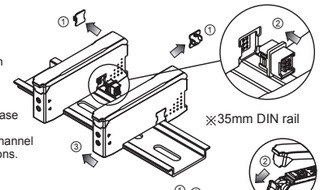
●Side connector

▣ Installations

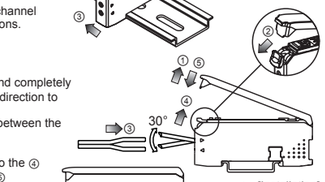
◎**Amplifier unit mounting**
●Installation: Hang up the backside holder on the DIN rail and press the unit toward the DIN rail.
●Removal: Slide the back part of the unit as the ① figure and lift up the unit as the ② figure.



◎**Amplifier unit connection**
●Remove the side cover at the connecting side as the figure ① and connect the side connector as the figure ②.
※Be sure that if connecting a side connector with excessive force, it may cause extruded pins.
●After mounting the unit on the DIN rail, push gently both units to fasten each other.
※Make sure that connections between the unit case and connectors correctly.
Improper connection may cause malfunction of channel setting and mutual interference prevention functions.
※Do not supply the power while connecting / disconnecting amplifier units.



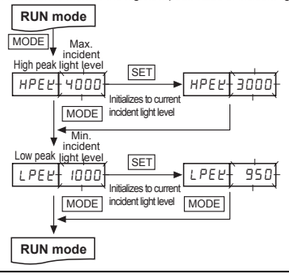
◎**Fiber cable connection**
●Lift up the protective cover to the ① direction and completely lower the lock lever to the direction of to the ② direction to release the lock setting.
●Insert the cable to the ③ direction and adhere between the cable and the inside of the amplifier unit.
(Insert depth: Approx. 13mm)
●Place up the lock lever to lock the lock setting to the ④ direction and close the protective cover to the ⑤ direction.



◎**Wire connector connection**
●Insert the connector into the amplifier unit until it clicks into the right position.
●When removing the connector, pull out the connector to the ① direction with pressing the lever downside to the ② direction.

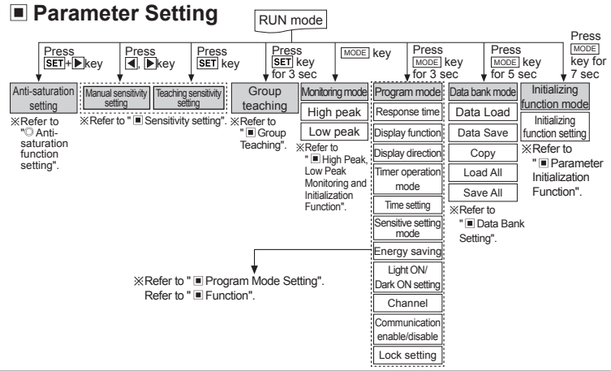
▣ High Peak, Low Peak Monitoring and Initialization Function

A function to monitor the high/low peak value of incident light level. The monitored high/low peak value can be initialized.



①Press the MODE key for a sec to monitor max/min incident light level.
②Press the SET key to initialize max/min value to current incident light level during monitoring.
③Press the MODE key to return to RUN mode.

▣ Parameter Setting

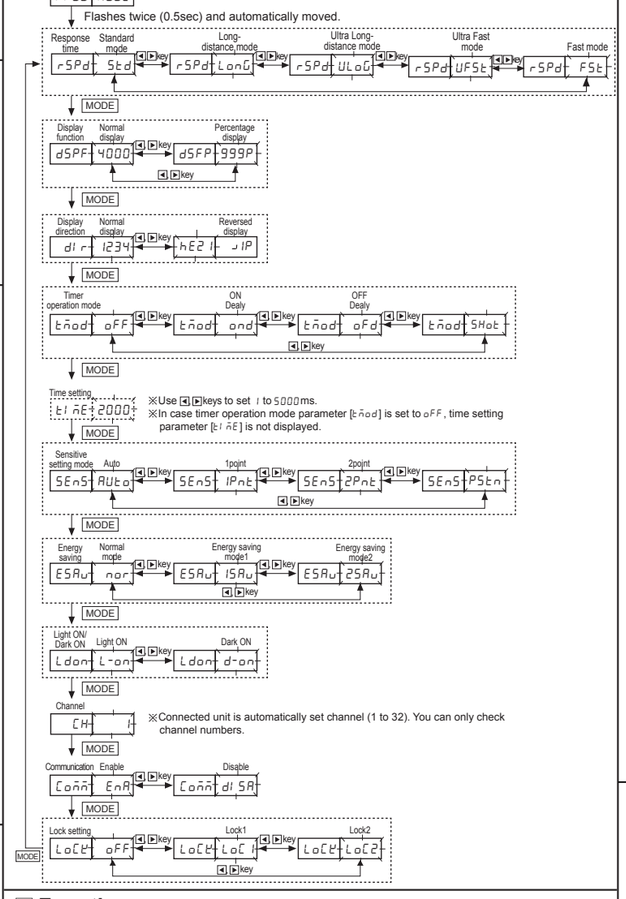


▣ Program Mode Setting

◎When entering into program mode, the parameter turns ON on the PV display part and the setting value flashes every 0.5 sec on the SV display part. Use the ◀, ▶ keys to set each setting value.
◎Press the MODE key one time after setting each parameter to save the setting and enter into next mode.
◎If the key lock is set, unlock the key lock before setting parameters.

●**Program mode flow**

※Refer to "▣ Program mode function" for more information of each parameter.
※Press the MODE key for 3 sec to return to RUN mode while in program mode.



▣ Function

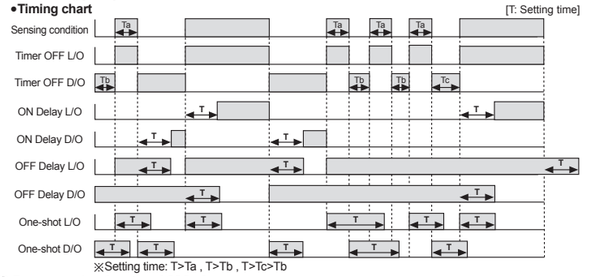
◎**Response time setting [rSPd]**
A function to set the response time of control output - 4 response modes selectable.
●Ultra Fast [UFSt]: 50μs ●Fast [FSt]: 150μs
●Standard [Std]: 500μs ●Long distance [LonG]: 4ms ●Ultra Long distance [ULoG]: 10ms

◎**Display function [dSPF]**
A function to select display mode for incident light level on the PV display part.
: Standard display (4000) / Percentage display (999P)
●Display range of standard mode: 0 to 4000 (0 to 9999, in case of long distance mode)
●Display range of percentage mode: 0P to 999P(Decimal point is not displayed)

◎**Display direction setting function [dir]**
A function to reverse the display direction to suit the unit installation location.
: Normal display / Reversed display selectable.
※Reversed display is upside-down(180˚) display of normal display.

◎**Timer function [Timer operation mode: tnod, Time setting: tIME]**
Used when the external device's response time is too late or when control output time is too short due to small sensing object - 3 modes available.
●Timer OFF [oFF]
●ON Delay [ond]: A mode in which control output ON time is delayed for a certain period of setting time.
●OFF Delay [oFd]: A mode in which control output OFF time is delayed for a certain period of setting time.
●One-shot [SHot]: A mode in which control output becomes ON or OFF within a certain period of setting time.
●Time setting [tIME]: 1 to 5000ms

●**Timing chart** [T: Setting time]



※Setting time: T>Ta , T>Tb , T>Tc>Tb

◎**Energy saving function [ESAv]**
A function to save unit's power consumption by reducing power supplying to display parts in case of no setting input within 60 sec.
●Selectable from 2 energy saving modes
- Normal mode[nor]: Control output indicator(OUT), PV/SV display parts ON
- Energy saving mode 1[1SAv]: Control output indicator(OUT) and PV display part ON
- Energy saving mode 2[2SAv]: Control output indicator(OUT) ON

◎**Light ON / Dark ON switching function [Ldon]**
A function to set Light ON - control output is ON when incident light level is higher than setting value and Dark ON - control output is ON when incident light level is lower than setting value.

◎**Communication write enable / disable setting function [Conn]**
A function to set communication write [enable[EnA] / disable[diSA]] for Slave amplifier units while certain instructions(Load/Save/Copy) or Group teaching is in progress by the Master amplifier unit.

◎**Lock function [LocK]**
Two types of key lock setting available in order to prevent SV changes due to careless.

	oFF	Loc1	Loc2
Sensitivity setting	●	◐	◐
Data bank mode	●	○	○
Program mode	●	◐	○
Parameter initialization	●	○	○

※●:**Check / Setting both available**
◐:**Check available**
○:**Check / Setting both unavailable**

●In case of LoC2 mode, it is required to disable the lock function first to enter into parameter mode.

◎**Amplifier units connection using side connector**
In case multiple amplifier units are connected, supply the power for one unit and the power is also supplied to the other connected units.

◎**Auto channel setting function**
●The channel for each amplifier unit - connected by side connector - is automatically set in a certain direction (→) as soon as power is supplied. Channel number is increasing one by one.
●The automatically set channel can be checked in channel parameter in program mode.
●Channel range : 1 to 32
※**Note that the automatically set channel cannot be changed and the channel number of each amplifier unit is not saved in case of power OFF.**

◎**Mutual interference prevention function**
A function to set different light receiving time for each amplifier unit in case the adjacent fiber cable is installed in order to prevent mutual interference occurring. (Set automatically when power is turned ON.)
※Mutual interference function is allowed up to maximum 8 amplifier units regardless of the unit model and response time.

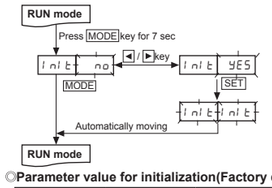
◎**Anti-saturation setting function**
●When the sensing target comes too close and it is saturation status, this function corrects the optimize status.
●Press the SET+▶ keys one time and anti-saturation function operates automatically. There are max. 10 levels.
●Press the SET+▶ keys one time again and anti-saturation function is cleared.
●During anti-saturation, the SV display part displays current level.
●When response mode is ultra fast [UFSt], fast [FSt] or standard [Std] and incident light level is lower than 2200, this function is cleared and this unit returns RUN mode automatically. When response mode is long distance [LonG], ultra long distance [ULoG] and incident light level is lower than 5500, this function is cleared and this unit returns RUN mode automatically.
※This function is not operated when incident light is lower by each mode (UFSt, FSt, Std: 2200, ULoG, LonG: 5500).
※If saturation status is too high and it does not reach the target value, it stops at level 10 and this unit returns RUN mode.
※When anti-saturation function is set, control output operation may be changed.

Anti-stauration function ON	Anti-stauration function OFF
RUN mode 4000 2000 Press SET+▶ 3500 ---1 Level 1 3000 ---2 Level 2 2000 ---3 Level 3 2000 --oE Flashes twice (0.5 sec cycle) RUN mode	RUN mode 2000 1500 Press SET+▶ 4000 S_oF Flashes twice (0.5 sec cycle) RUN mode

▣ Parameter Initialization Function

●A function to initialize all parameters in memory to default value in case the possibility of missetting or misoperation.
●Set lock function [LocK] to oFF to execute parameter initialization.
●High peak value[HPEA] and low peak value[LPEA] is not initialized.

◎**Parameter Initialization flow**



①Press the MODE key for 7sec in RUN mode. [Init] parameter turns ON on the PV display part and no flashes every 0.5sec on the SV display part.
②Press the MODE key once again to return to RUN mode not to execute the initialization.
③Select YES using ◀, ▶ keys and press the SET key. Init flashes twice on both the PV and SV display parts.
④When parameter initialization is completed, it is automatically returned to RUN mode.

◎**Parameter value for initialization(Factory default)**

Parameter	Factory default	Parameter	Factory default	Parameter	Factory default
rSPd	Std	tnod	oFF	Ldon	L-on
dSPF	4000	SEnS	AUto	Conn	EnA
dir	1234	ESAv	nor	LocK	oFF
SV: 2000, Bank 0 to 2: Initialized					

▣ Sensitivity Setting

※There are two methods available for sensitivity setting - manual/teaching sensitivity setting. Select the method most suitable for your application.

◎Manual sensitivity setting(Fine-adjusting sensitivity)

- This setting is to set the sensitivity manually.
- Used to fine-adjust sensitivity after the teaching sensitivity setting.
- Incident light level is still displayed on the PV display part during setting.

①Press the ◄ and ► key to set the value.
②There is no additional key for completing the setting. If there is no key input for 3sec after completing setting, last set value flashes twice(every 0.5sec) and automatically saved it and returned to RUN mode.

◎Teaching sensitivity setting(Auto-tuning, One-point, Two-point, Positioning)

- How to enter into sensitivity setting mode in RUN mode
  Press the SET key once in RUN mode and teaching starts. When teaching is complete, it returns RUN mode automatically.
- During teaching, the PV display part displays the set teching mode parameter and the SV display part displays progressing status.

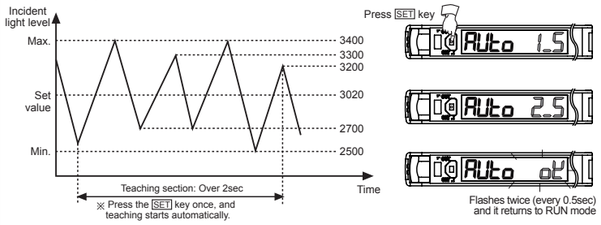
※ Refer to the below for the each teaching sensitivity setting.

1. Auto-tuning teach mode

※Suitable when incident level of sensing object is not stable or when sensing fast moving objects.
※Auto-tune automatically sets the sensitivity using the average value of the incident light level within a certain time period.

$$Set\_value=\frac{P1+P2+\cdots+Pn-1+Pn}{n}$$

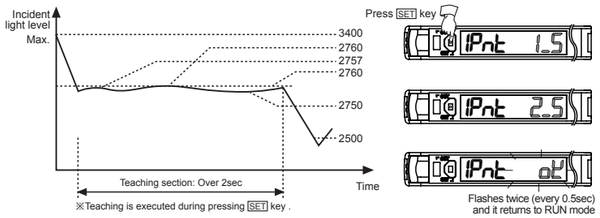
- Set Teaching mode parameter [SEnS] to AUto.



2. One-point teach mode

※One of teaching modes that sets the maximum sensitivity by teaching one sensitivity setting point when setting the SV with no sensing object (Reflective) or when setting the SV with incident light level 0(Through-beam) / Suitable for the applications required little effect of dust or background.

- Set Teaching mode parameter [SEnS] to 1Pnt.



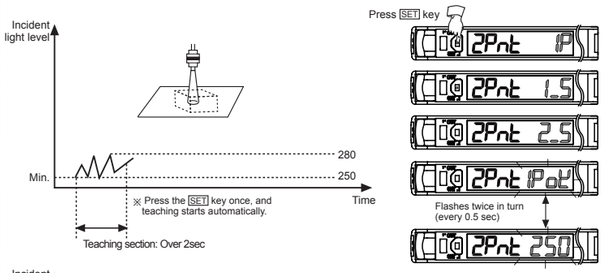
※SV range for sensing distance.

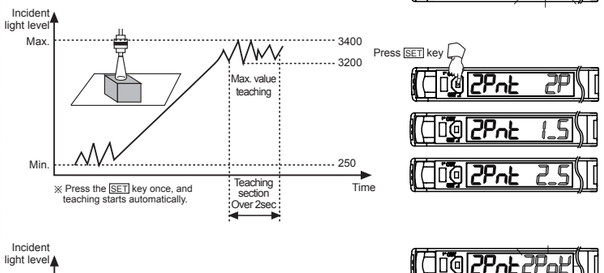
Response time	Teaching when incident light level is 0	Teaching when incident light level is saturated
UFSt FSt Std	In case incident light level is 0, set to 10digit.	In case incident light level is saturated, set to 3980digit.
LoG ULoG	In case incident light level is 0, set to 5digit.	In case incident light level is saturated, set to 9980digit.

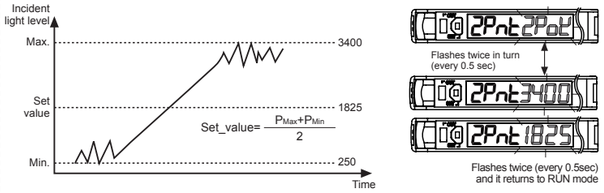
3. Two-point teach mode

※Suitable when incident light level is stable or when sensing object is slow or at stopped position.
※One of teaching modes that sets the sensitivity using the average value of two incident light levels obtained from two point teaching - one point with a sensing object and the other point without a sensing object.

- Set Teaching mode parameter [SEnS] to 2Pnt.





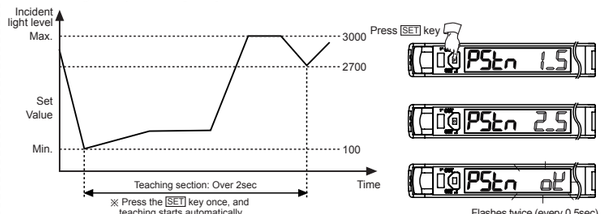


※Make sure that two point teaching must be done within 60sec after one point teaching. If not, teaching mode is cancelled and it returns to RUN mode.

4. Positioning teach mode

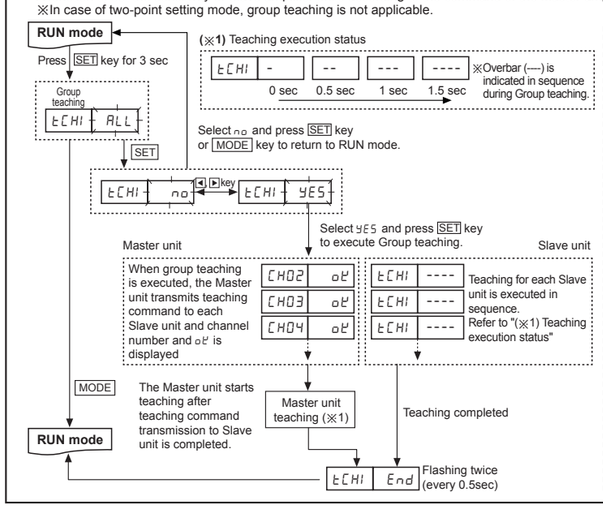
※One of teaching modes that sets the sensitivity to 90% of max. incident light level when sensing an object with a hole on the surface (Through-beam) or sensing a moving object having curve (Reflective).

- Set teaching mode parameter [SEnS] to PSEn.



▣ Group Teaching

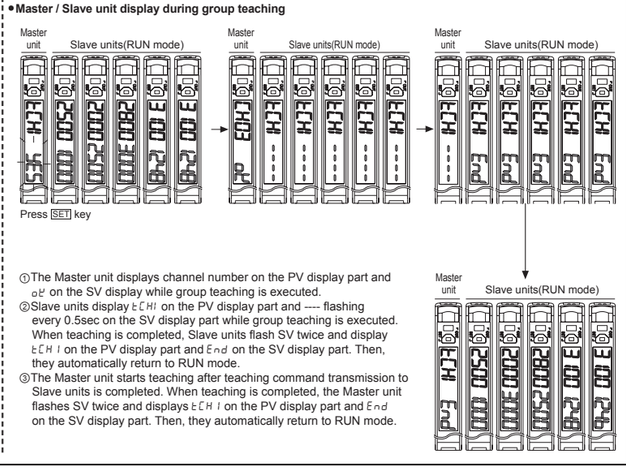
A function to set the sensitivity of Slave amplifier units according to the command of the Master amplifier unit(a certain amplifier unit) in a successive and collective way.
※In case of two-point setting mode, group teaching is not applicable.



(※1) Teaching execution status

Select no and press SET key or MODE key to return to RUN mode.

●Master / Slave unit display during group teaching



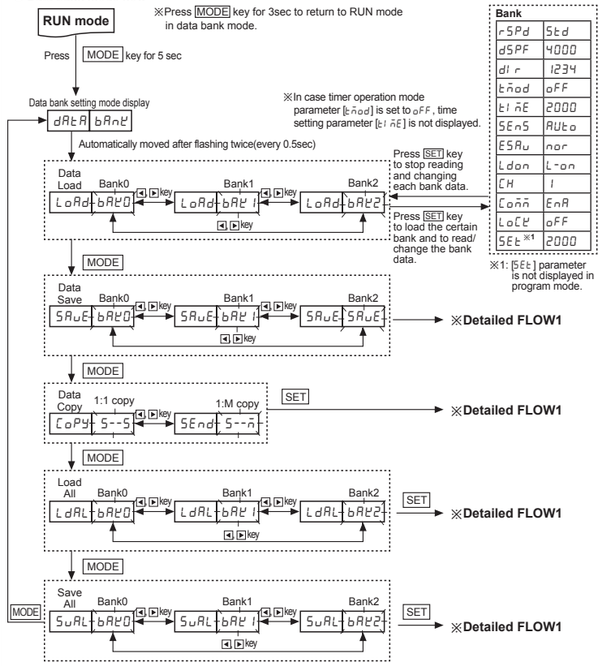
▣ Data Bank Setting

A function to save settings for group amplifier units in each data bank by using Master unit's command or by adjusting one amplifier unit's setting and to load required data bank when it is necessary without resetting for each unit's parameters and setting values.

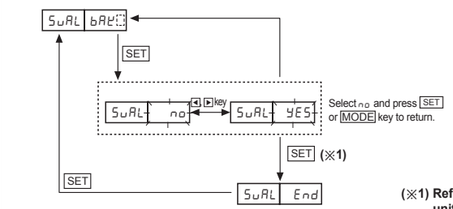
- Load[LoAd]: Loads one of the preset databanks[bAnU, 1, 2] and applies it to the amplifier unit.
  Detailed bank parameters can be read and changed.
- Save[SAvE]: Saves one amplifier unit settings in one of the databanks[bAnU, 1, 2].
- Copy[CoPY]: Copies the currently loaded bank by Master's instructions to the other amplifier unit (1:1) or the whole amplifier units (1:M)
- Load All[LdAL]: Selects one databank by Master's instructions loads it to entire group units.
- Save All[SuAL]: Selects one databank by Master's instructions and saves it in entire group units.

※For BF5□-D1-□,three data banks are available ([bAnU], [bAn 1] and [bAn2]) so that three different sensing object information can be saved. Each Bank can be read and changed. It allows users to detect three different sensing objects with one amplifier unit without resetting each parameter.
※Data bank function can be executed only if all amplifier units are in RUN mode.
※Copy/Load All/Save All functions are available only if multiple amplifier units are connected.
※If lock function is set (LoC 1/LoC2) on amplifier units or if the Slave unit commanded bank Load and Save by the connected amplifier unit is disable to communication write, the command is not executed.

◎ Data bank mode flow

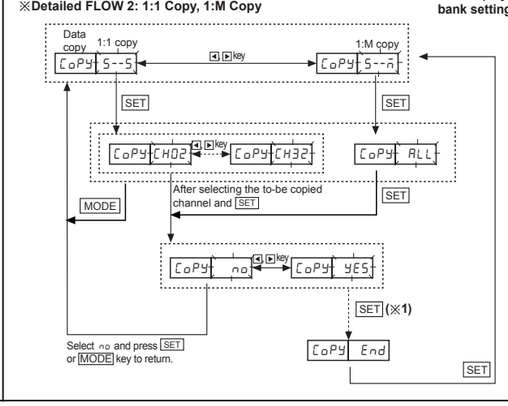


※Detailed FLOW 1: Data Save, Save All, Load All
This flow is to set Save [SAvE], Save All [SUAL], and Load All[LdAL].



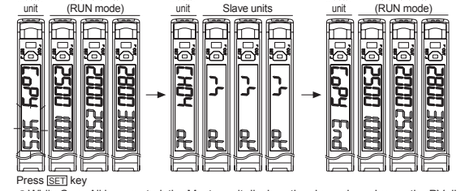
(※1) Refer to "●Master/Slave unit display during data bank setting"

※Detailed FLOW 2: 1:1 Copy, 1:M Copy



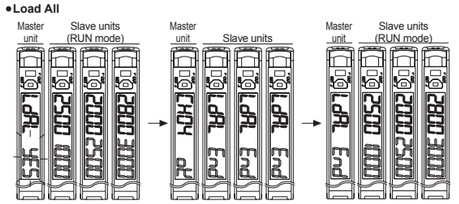
◎Master / Slave unit display during data bank setting

●Copy All



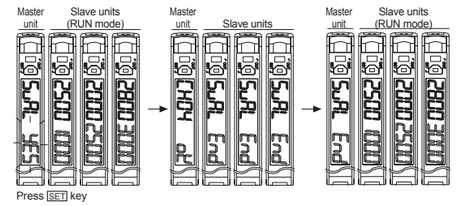
Press SET key
①While Copy All is executed, the Master unit displays the channel number on the PV display part and oU on the SV display part.
②While Copy All is executed, the Slave units display rUn on the PV display part and oU on the SV display part and they return to RUN mode.
③When Copy All is completed, the Master unit displays CoPY on the PV display part and End on the SV display part. Press the SET key to return to Data Copy mode.
※In case of 1:1 Copy, it progresses as same.

●Load All



Press SET key
①While Load All is executed, the Master unit displays the channel number on the PV display part and oU on the SV display part.
②While Load All is executed, the Slave units display LdAL on the PV display part and End on the SV display part and they return to RUN mode.
③When Load All is completed, the Master unit displays LdAL on the PV display part and End on the SV display part. Press the SET key to return to Load All mode.

●Save All



Press SET key
①While Save All is executed, the Master unit displays the channel number on the PV display part and oU on the SV display part.
②While Save All is executed, the Slave units display SuAL on the PV display part and End on the SV display part and they return to RUN mode.
③When Save All is completed, the Master unit displays SuAL on the PV display part and End on the SV display part. Press the SET key to return to Save All mode.

※If communication write enable / disable parameter [Conn] for the Slave unit is set to disable dI SA while Save All, Load All or Copy is executed, the master unit displays channel number on the PV display part and dI SA on the SV display part.

▣ Error Code

Error code	Cause	Troubleshooting
Err	In case overcurrent inflow occurs into the output circuit.	Remove the overcurrent due to the overload.
Erb	●In case the slave is failed to execute the Master's instructions due to unstable communication line connection during Copy All/Load All/Save All/Group teaching. ●In case other communication errors occur.	●Check the amplifier units' connection again. ●Check the circuit and the hardware around the side connector.

▣ Cautions during Use

1. Follow instructions in 'Cautions during Use'. Otherwise, it may cause unexpected accidents.
2. 12-24VDC power supply should be insulated and limited voltage/current or Class 2, SELV power supply device.
3. When connecting DC relay or other inductive load to the output, remove surge by using diode or varistor.
4. Wire as short as possible and keep away from high voltage lines or power lines, to prevent surge and inductive noise.
5. Use the product, after 3 sec of supplying power.
6. When using switching mode power supply to supply power, ground F.G. terminal and connect a condenser between 0V and F.G. terminal to remove noise.
7. Since external disturbance light (sunlight, fluorescent lighting, etc.) can cause product malfunction, use the product with a light shield or slit.
8. When sensing an object with the maximum sensitivity, sensing distance error can occur due to deviation of each feature.
9. When installing the fiber optic cable, refer to the radius of allowable stress for bending written in the catalogue.
   If installing the fiber optic cable under the rated radius of allowable stress for bending, light extinction occurs and sensing distance is shortened.
10. Be cautious that a cross section of the fiber optic cable not be scratched.
11. Do not pull the cable, when the fiber optic cable is connected to an amplifier unit.
12. This unit may be used in the following environments.
    ①Indoors (in the environment condition rated in 'Specifications') ②Altitude max. 2,000m
    ③Pollution degree 2 ④Installation category III

▣ Major Products

■ Photoelectric Sensors
■ Fiber Optic Sensors
■ Door Sensors
■ Door Side Sensors
■ Area Sensors
■ Proximity Sensors
■ Pressure Sensors
■ Rotary Encoders
■ Connector/Sockets
■ Switching Mode Power Supplies
■ Control Switches/Lamps/Buzzers
■ I/O Terminal Blocks & Cables
■ Stepper Motors/Drivers/Motion Controllers
■ Graphic/Logic Panels
■ Field Network Devices
■ Laser Marking System (Fiber, CO_2, Nd: YAG)
■ Laser Welding/Cutting System
■ Temperature Controllers
■ Temperature/Humidity Transducers
■ SSRs/Power Controllers
■ Counters
■ Timers
■ Panel Meters
■ Tachometer/Pulse (Rate) Meters
■ Display Units
■ Sensor Controllers

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