Part No. Z1-002-582, IB003127
May. 2016

OPERATION MANUAL

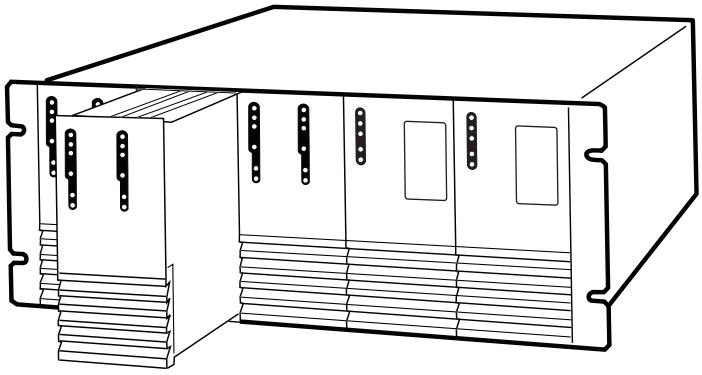
Charge/Discharge Battery Test System
PFX2000 Series

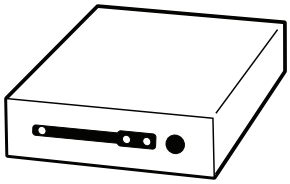
PFX2011 5V-5A 2-ch Charge/Discharge Power Supply Unit

PFX2021 20V-10A Charge/Discharge Power Supply Unit

PFX2121 120-ch Communication Control Unit

PFX2332 5-Unit Large Capacity Frame





When the charge/discharge system controller PFX2500 series is used with the communication control unit PFX2121, please refer to the operation manual of the PFX2500 series.

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Use of Operation Manual

Please read through and understand this Operation Manual before operating the product. After reading, always keep the manual nearby so that you may refer to it as needed. When moving the product to another location, be sure to bring the manual as well.

If you find any incorrectly arranged or missing pages in this manual, they will be replaced. If the manual gets lost or soiled, a new copy can be provided for a fee. In either case, please contact Kikusui distributor/agent, and provide the "Kikusui Part No." given on the cover.

This manual has been prepared with the utmost care; however, if you have any questions, or note any errors or omissions, please contact Kikusui distributor/agent.

⚠ Safety Symbols

For the safe use and safe maintenance of this product, the following symbols are used throughout this manual and on the product. Understand the meanings of the symbols and observe the instructions they indicate (the choice of symbols used depends on the products).

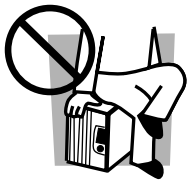
	**Indicates that a high voltage (over 1 000 V) is used here. Touching the part causes a possibly fatal electric shock. If physical contact is required by your work, start work only after you make sure that no voltage is output here.**
DANGER	**Indicates an imminently hazardous situation which, if ignored, will result in death or serious injury.**
	**Indicates a potentially hazardous situation which, if ignored, could result in death or serious injury.**
	**Indicates a potentially hazardous situation which, if ignored, may result in damage to the product and other property.**
	**Shows that the act indicated is prohibited.**
	**Is placed before the sign "DANGER," "WARNING," or "CAUTION" to emphasize these. When this symbol is marked on the product, see the relevant sections in this manual.**
	**Indicates a protective conductor terminal.**
	**Indicates a chassis(frame) terminal.**
	On (supply)
	**Off (supply)**
	**In position of a bi-stable push control**
	**Out position of a bi-stable push control**

⚠ Safety Precautions

The following safety precautions must be observed to avoid fire hazard, electrical shock, accidents, and other failures. Keep them in mind and make sure that all of them are observed properly. Using the product in a manner that is not specified in this manual may impair the protection functions provided by the product.

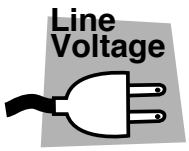
Users

- This product must be used only by qualified personnel who understand the contents of this operation manual.
- If it is handled by disqualified personnel, personal injury may result. Be sure to handle it under supervision of qualified personnel (those who have electrical knowledge.)
- This product is not designed or manufactured for general home or consumer use.



Purposes of use

- Do not use the product for purposes other than those described in the operation manual.

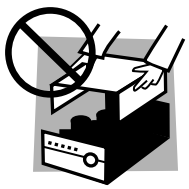


Input power

- Use the product with the specified input power voltage.
- For applying power, use the AC power cord provided. Note that the provided power cord is not use with some products that can switch among different input power voltages or use 100 V and 200 V without switching between them. In such a case, use an appropriate power cord.

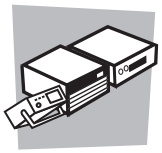
Fuse

- With products with a fuse holder on the exterior surface, the fuse can be replaced with a new one. When replacing a fuse, use the one which has appropriate shape, ratings, and specifications.



Cover

- There are parts inside the product which may cause physical hazards. Do not remove the external cover.



Installation

- When installing products be sure to observe “Installation” described in this manual.
- To avoid electrical shock, connect the protective ground terminal to electrical ground (safety ground).
- When connecting the AC power cord to a switchboard, be sure work is performed by a qualified and licensed electrician or is conducted under the direction of such a person.
- When installing products with casters, be sure to lock the casters.

Relocation

- Turn off the power switch and then disconnect all cables when relocating the product.
- Use two or more persons when relocating the product which weights more than 18 kg. The weight of the products can be found on the rear panel of the product and/or in this operation manual.
- Use extra precautions such as using more people when relocating into or out of present locations including inclines or steps. Also handle carefully when relocating tall products as they can fall over easily.
- Be sure the operation manual be included when the product is relocated.

Operation

- Check that the AC input voltage setting and the fuse rating are satisfied and that there is no abnormality on the surface of the AC power cord. Be sure to unplug the AC power cord or stop applying power before checking.
- If any abnormality or failure is detected in the products, stop using it immediately. Unplug the AC power cord or disconnect the AC power cord from the switchboard. Be careful not to allow the product to be used before it is completely repaired.
- For output wiring or load cables, use connection cables with larger current capacity.
- Do not disassemble or modify the product. If it must be modified, contact Kikusui distributor/agent.

Maintenance and checking

- To avoid electrical shock, be absolutely sure to unplug the AC power cord or stop applying power before performing maintenance or checking.
- Do not remove the cover when performing maintenance or checking.
- To maintain performance and safe operation of the product, it is recommended that periodic maintenance, checking, cleaning, and calibration be performed.

Service

- Internal service is to be done by Kikusui service engineers. If the product must be adjusted or repaired, contact Kikusui distributor/agent.

Contents

Preface

About This Manual

This operation manual describes the functions related to controlling of the following models (PFX2000 series) using by the communication control uni PFX2121.

- PFX2011 5-V/5-A 2-ch Charge/Discharge Power Supply Unit
- PFX2021 20-V/10-A Charge/Discharge Power Supply Unit
- PFX2332 5-Unit Large Capacity Frame

When the charge/discharge system controller PFX2500 series is used with the communication control unit PFX2121, please refer to the operation manual of the PFX2500 series.

The PFX2000 Series Charge/Discharge Battery Test System is controlled using BPChecker2000, an application software. For a description of the operation of the system, see the *BPChecker2000 User's Manual*.

Product Overview

This battery charge/discharge test system is capable of meeting various needs of the user by allowing the user to select the required units from different types of units grouped by functionality and combine the required number of those units.

The basic system consists of charge/discharge power supply units installed in unit frames, a control unit, a PC, and an application software.

Consideration has been given to the expandability of the charge/discharge power supply unit, the unit frame, and the control unit. Additionally, a functional expansion unit that enables impedance measurement is provided.

Each unit excluding the control unit is designed on the assumption that it be installed in a rack. This allows support for large-scale systems.

The USB is used to connect between the PC and the control unit. The TP-BUS is used to connect between each unit. All units can be controlled from BPChecker2000.

NOTE

- For details on the minimum PC requirements, see the *BPChecker2000 User's Manual*.

Features

Charge/discharge power supply unit

- **Pulse charge function**
  Provides pulse charge mode that allows sophisticated charger simulation and research and development of various charge methods.
- **Temperature measurement function**
  Equipped with a simplified temperature measurement function using a thermistor as a temperature sensing element. This enables temperature measurement on each channel. In addition, you can set OTP (overtemperature protection) as a protection function as well as specify dT/dt (temperature increase per unit time) and MaxTemp (maximum temperature) as charge cutoff conditions.
- **Charge/discharge power supply units replaceable without shutting down the power to the frame**
  When in STANDBY status, you can switch charge/discharge power supply units without having to shut down the power to the unit frame.
- **Battery voltage detection terminals of high input resistance**
  The battery voltage detection terminals have high input resistance achieving extremely small leakage currents. This prevents batteries from being discharged during rest.
- **Reliability for long continuous operation**
  MOSFET is used for switching between charge, discharge, and rest securing reliability for long continuous operations.
- **Versatile charge/discharge cut off conditions**
  Allows you to specify voltage, time, temperature, and other parameters for the charge cutoff and/or discharge cutoff conditions.
- **Improved system reliability**
  Provides a variety of protection functions, including OVP (overvoltage (overcharge) protection), UVP (undervoltage (overdischarge) protection), and OHP (overheat protection), and a watchdog timer (for system monitoring) to improve system reliability. Especially for OVP and UVP, double protection through software protection and hardware protection is provided.
- **High precision measurements**
  Adopts the 24-bit A/D converter for measuring voltage and current enabling high-precision measurements. In addition, the built-in reference voltage circuit with temperature control secures high stability.
  In pulse charge/discharge, generation of complicated current waveforms, voltage measurement at arbitrary points, and measurement of pulse current are possible by exploiting the use of the 16-bit D/A converter and high-speed A/D converter.
- **Two independent channels on a single unit (PFX2011 only)**
  The two channels are completely independent. You can set different test conditions to each channel.
- **Power regeneration function (PFX2021 only)**
  Equipped with a regeneration function that uses the power obtained from an internal loss for operation, if the internal loss reaches a certain level during the discharge test. Contributes to the downsizing of the system, saving of power, and reduction of waste heat.
- **Faithfully measures the average pulse current (PFX2021 only)**
  Equipped a V/F converter dedicated to measuring average current. The transient

state of pulse current can be faithfully measured. The current measurement error caused by the imbalance of rising and falling edges is suppressed to its minimum.

- **20-value CP pulse discharge function (PFX2021 only)**
  Equipped with a 20-value CP pulse discharge function through high-speed computation (software) control.
- **20-value CC pulse discharge function (PFX2021 only)**
  Pulse settings can be assigned up to 20 different values, which enables the support for discharge simulations of packed batteries.

Unit frame

- **TP-BUS connection**
  Uses the TP-BUS for connecting between unit frames for easy connection. When removing a frame from the TP-BUS, you do not have to shut down other frames.
- **Large capacity support**
  Equipped with a large capacity AC line filter and a power bus for sharing the regenerated power between charge/discharge power supply units.

Communication control unit

- **Multichannel support**
  A single control unit supports up to 120 channels (when using the PFX2011 Charge/Discharge Power Supply Unit).
- **USB connection**
  The USB is used to connect with the PC. Thus, other interface boards are not needed if your PC has USB ports.
  Up to two units can be connected to a single PC.

System Configuration

Fig. P-1 and Fig. P-2 show system configuration examples.

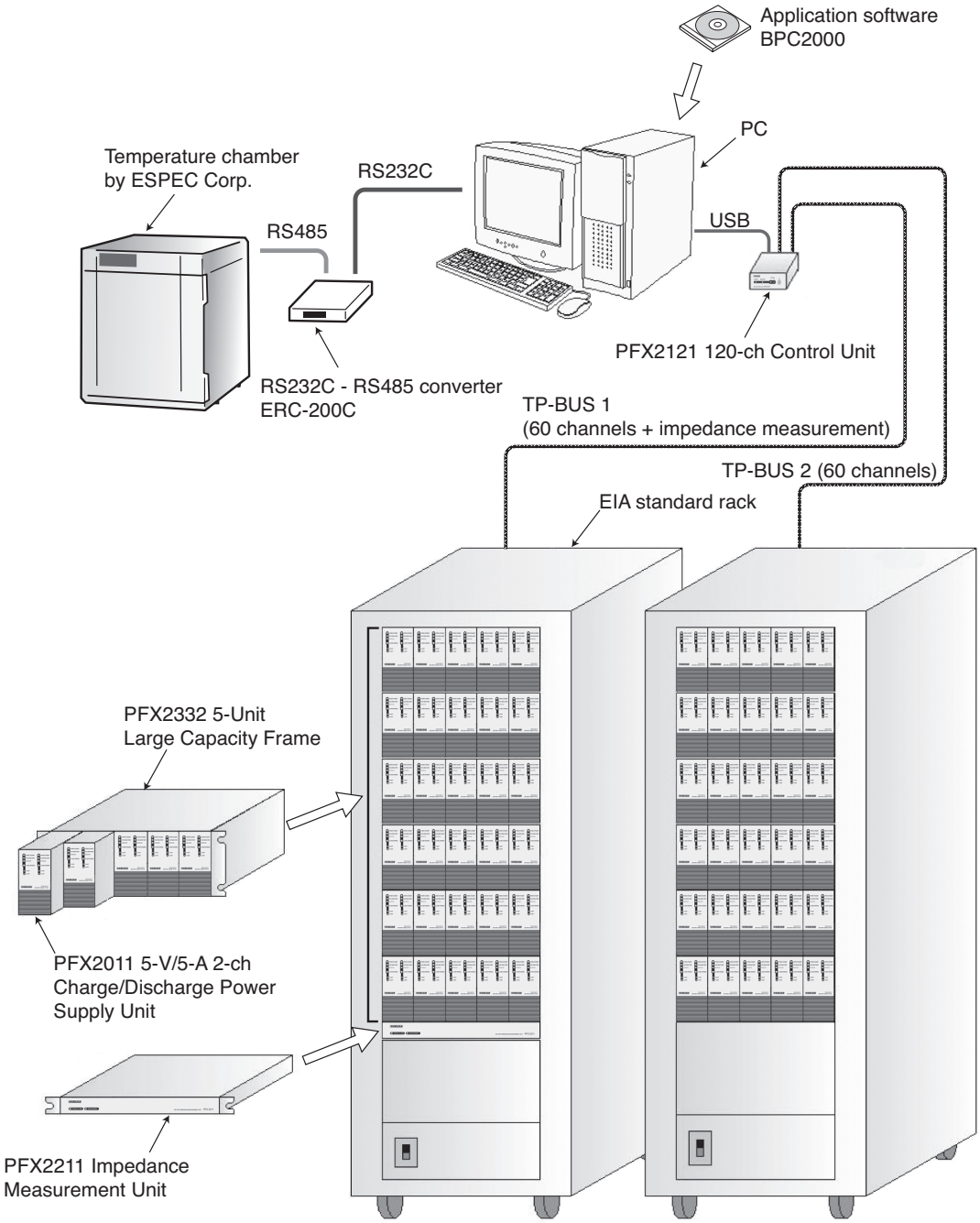


Fig. P-1 120-channel system configuration example

In the example of Fig. P-1, a 120-channel system is configured using one control unit, 12 PFX2332 unit frames, and 60 PFX2011 charge/discharge power supply units. In addition, one PFX2211 Impedance Measurement Unit is included enabling impedance measurements of all batteries connected to the 120 channels. Moreover, Fig. P-1 shows that synchronized testing with a temperature chamber is possible by RS232C.

Since up to two control units can be connected to a single PC, a system consisting of up to 240 channels can be constructed.

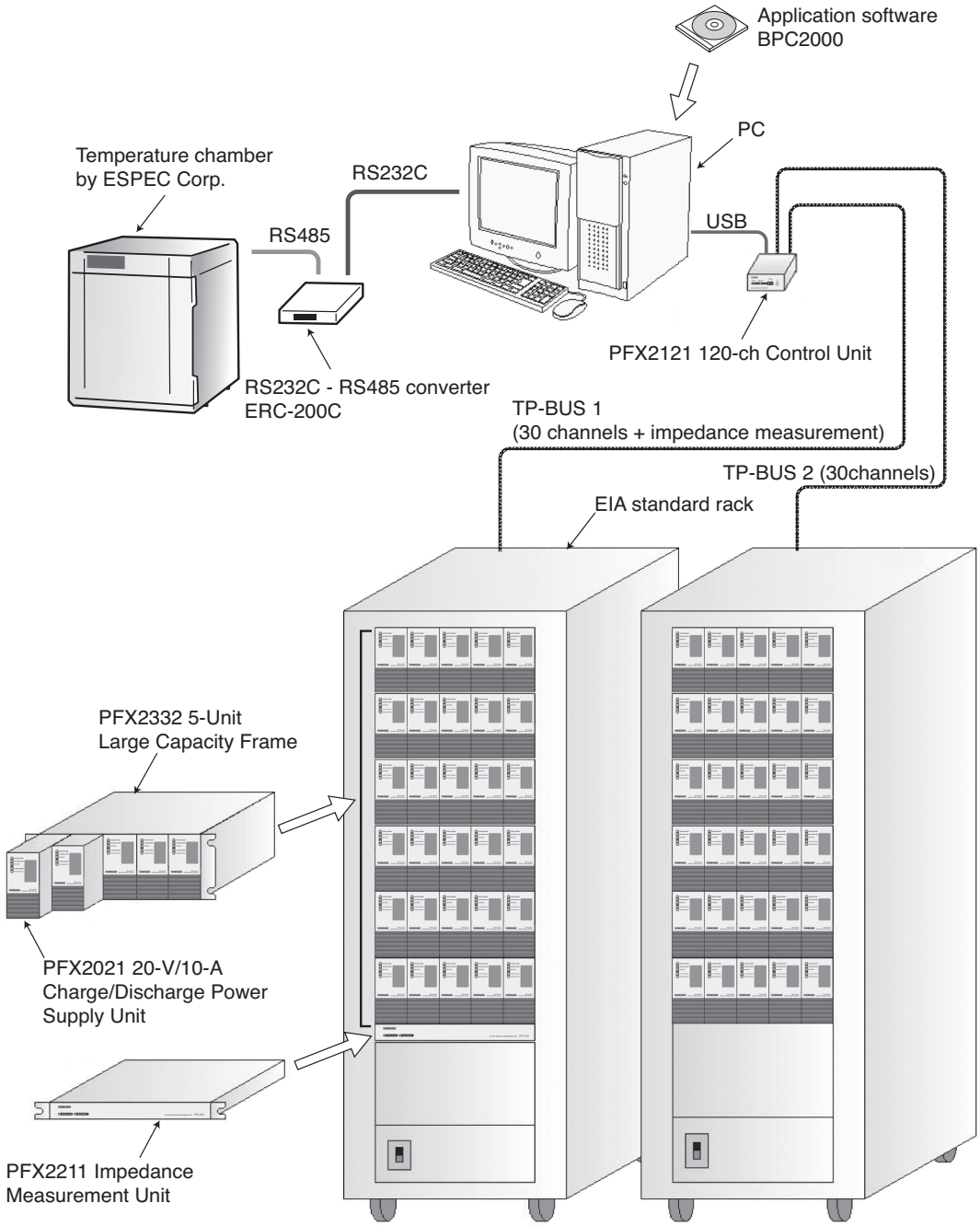


Fig. P-2 60-channel system configuration example

In the example of Fig. P-2, a system similar to Fig. P-1 is configured using PFX2332 unit frames and PFX2021 charge/discharge power supply units. However, because two channels on the PFX2021 are equivalent to one channel on the PFX2011, this is a 60-channel configuration.

Chapter 1 Setup

This chapter describes the steps taken before actually using the product such as unpacking, installation, etc.

1.1 Checking the Package Contents

When you receive the product, check that all accessories are included and that the product and accessories have not been damaged during transportation.

If any of the accessories are damaged or missing, contact your Kikusui agent or distributor.

NOTE

- It is recommend that all packing materials be saved, in case the product needs to be transported at a later date.

Table1-1 Control Unit Accessories

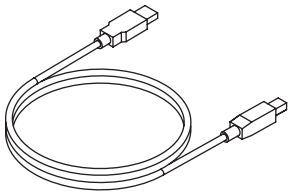
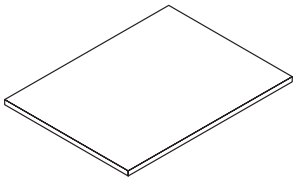
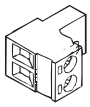
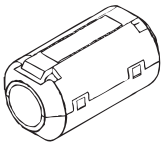
PFX2121	Product	Quantity	Figure	Note
☐	USB cable 2 m	1 piece		91-80-9300
☐	PFX2000 Series Battery Test System Operation Manual (This manual)	1 piece		Z1-002-582
☐	TP-BUS connector	2 pieces		84-61-5102
☐	TP-BUS core	2 pieces		67-90-0080

Table 1-2 Charge/Discharge Power Supply Unit Accessories

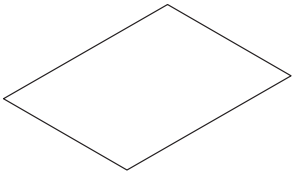
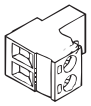
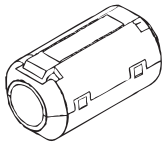
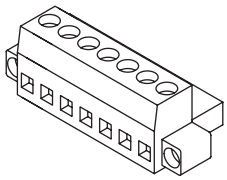
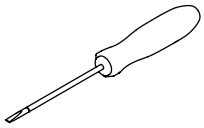
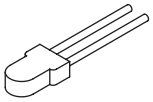
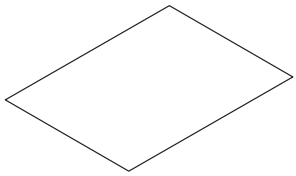
PFX2011	PFX2021	Product	Quantity	Figure	Note
☐	☐	Handling of the Product	1 sheet		Z9-000-053

Table 1-3 Unit Frame Accessories

PFX2332	Product	Quantity	Figure	Note
☐	Rack mount oval head screw M5x14	4 pieces		M2-102-002
☐	Rack mount cup washer	4 pieces		M5-003-031
☐	Unit attachment screw M3x8	10 pieces*1		M3-112-013
☐	TP-BUS connector	1 piece		84-61-5102
☐	TP-BUS core	1 piece		67-90-0080
☐	Output connector	10 pieces		84-61-5207
☐	Screwdriver	1 piece		Y2-000-002
☐	Thermistor	10 pieces		38-00-0160
☐	Handling of the Product	1 sheet		Z9-000-054

*1. Includes spares.

1.2 Installation

This section describes precautions concerning installation location of the PFX2000 system and rack mounting of the unit frame.

1.2.1 Precautions Concerning Installation Location

This section describes the precautions to be taken when installing the product. Make sure to observe them.

■ Do not use the product in a flammable atmosphere.

To prevent the possibility of explosion or fire, do not use the product near alcohol or thinner or in an atmosphere containing such vapors.

■ Avoid locations where the product is exposed to high temperature or direct sunlight.

Do not place the product near a heater or in areas subject to drastic temperature changes.

Operating temperature range: 0 °C to +40 °C (+32 °F to +104 °F)

Storage temperature range: -10 °C to +60 °C (+14 °F to +140 °F)

■ Avoid locations of high humidity.

Do not place the product in high-humidity locations, i.e., near a boiler, humidifier, water supply, etc.

Operating humidity range: 30 % to 80 % RH (no condensation)

Storage humidity range: 20 % to 80 % RH (no condensation)

Condensation may occur even in the operation humidity range. In such case, do not use the product until the condensation dries up completely.

■ Do not place the product in a corrosive atmosphere.

Do not install the product in a corrosive atmosphere or in environments containing sulfuric acid mist, etc. This may cause corrosion of various conductors and bad contacts of connectors inside the product leading to malfunction and failure, or in the worst case, a fire.

■ Do not place the product in a dusty location.

Accumulation of dust can lead to electric shock or fire.

■ Do not use the product where ventilation is poor.

The charge/discharge power supply unit is cooled by forced-air cooling. Secure adequate space around the unit frame to prevent the intake and exhaust ports from being obstructed. Obstruction of the ports can lead to fire or malfunction caused by accumulation of heat.

■ Do not place objects on top of the product.

Placing objects on top of the product can cause failures (especially heavy objects).

■ Do not place the product on an inclined surface or location subject to vibrations.

The product may fall or tip over causing damages and injuries.

■ Do not use the product in a location subject to strong magnetic or electric fields.

The product may malfunction and cause electric shock or fire.

■ Do not use the product near highly sensitive measuring instruments or transceivers.

The noise generated by the product may affect them.

■ Use the product in an industrial environment.

The product may cause interference if used in residential areas. Such use must be avoided unless the user takes special measures to reduce electromagnetic emissions to prevent interference to the reception of radio and television broadcasts.

1.2.2 Rack Mounting

The PFX2332 unit frame is designed on the assumption that they be rack mounted in an EIA standard rack.

The PFX2011 and PFX2021 charge/discharge power supply units can be installed or removed even if the unit frame is rack mounted.

⚠ CAUTION • If you do not need to rack mount the unit frame, attach rubber feet (sold separately) to the bottom of the frame. If you install the unit frame on a desktop, for example, without attaching the rubber feet, the surface may be damaged.

If you need rubber feet [P5-000-017], contact your Kikusui agent or distributor.

Attach the rubber feet to the appropriate locations at the four corners of the bottom of the unit frame. Wipe the dirt or oil content thoroughly from the location where the rubber feet are to be attached beforehand.

Kikusui provides the system-racks for sale. For details, contact your Kikusui agent or distributor.

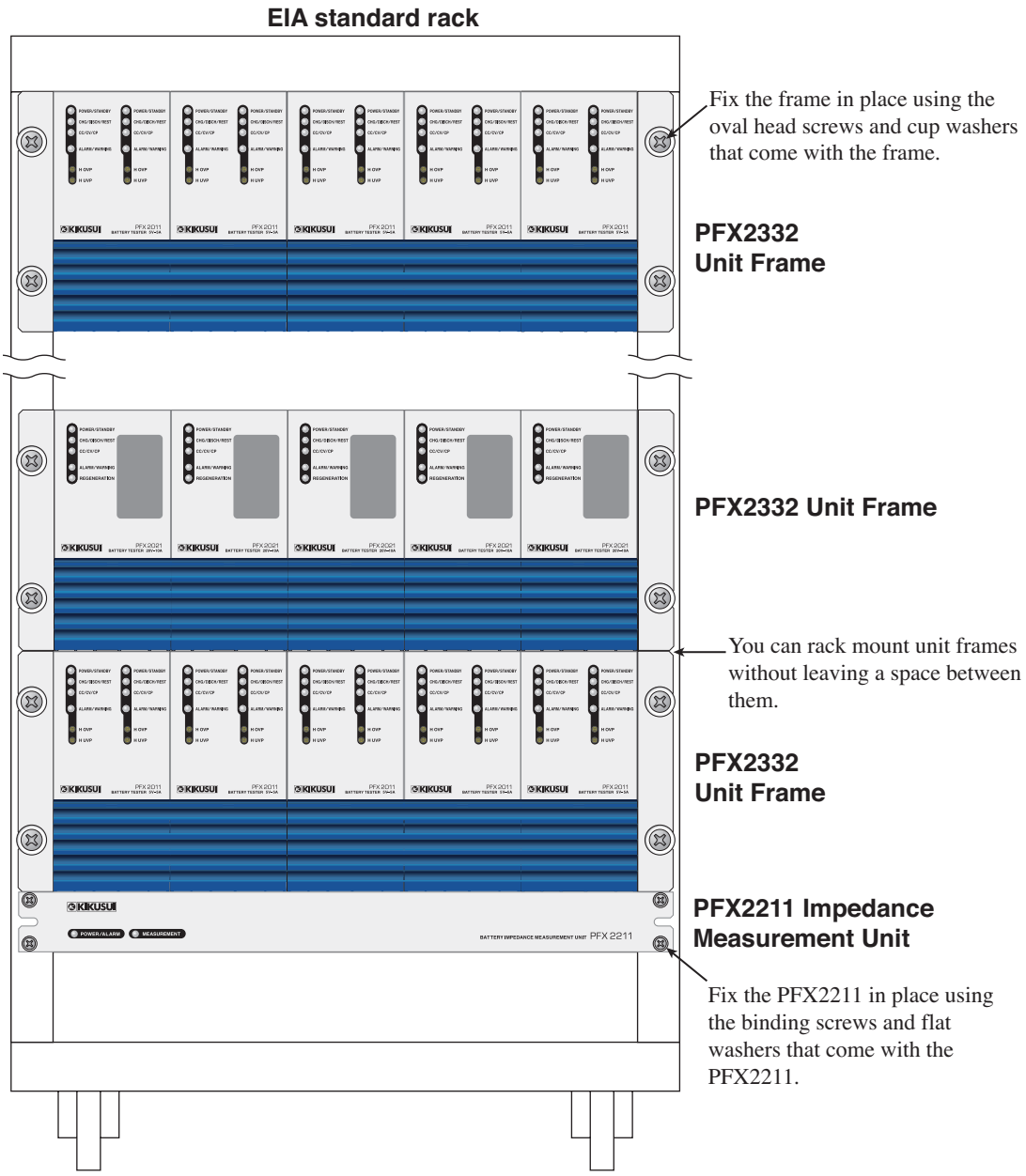


Fig. 1-1 Rack Mounting

1.3 Precautions When Moving the Product

When moving the product to the installation location or when transporting the unit, note the following points.

■ Turn off the power switch.

Moving the product while the power is turned on can cause electric shock or damage to the unit.

■ Remove wiring.

Moving the product with the cables connected can cause wires to break or injuries if the product is dropped.

■ When transporting the product, be sure to use the original packing materials.

Otherwise, damage may result from vibrations or from the product falling during transportation.

1.4 Connecting the Power Cord of the PFX2332

This section describes the connection of the power cord of the unit frame PFX2332. The power to the control unit is supplied through the USB; you do not have to connect the power cord to it.

The power cord of the unit frame cannot be removed from the unit.

The unit frame is designed as an equipment of IEC Overvoltage Category II (energy- consuming equipment supplied from the fixed installation).

⚠WARNING Possible electric shock.

- The unit frame is an IEC Safety Class I equipment (equipment with a protective conductor terminal). Be sure to ground (earth) the unit.
- Connect the protective conductor terminal to earth ground.
- Turn off the circuit breaker of switchboard before connecting the power cord.

Possible fire.

- Have a qualified engineer connect the power cord to the switchboard.
- The breaker of switchboard is required to meet following requirement.

⚠CAUTION

- Inside the product, protective circuits including input fuses are connected to match the polarity of the input terminal. Make sure the colors of the wires connected to the corresponding input terminals (L, N, and ⏚ (GND)) are correct.

NOTE

- Turn off the circuit breaker of switchboard to disconnect the unit frame from the AC line in an emergency.

■ Circuit breaker of switchboard requirement

- Rated current: 30 A per one unit frame (The circuit breaker of which the rated current is more than 30 A is disabled for safety.)
- Dedicate the circuit breaker for the unit frame.
- Keep the switchboard easily accessible at any time.
- Require labeling to identify that the circuit breaker is dedicated for the unit frame and disconnecting device.

1. Check that the AC line meets the nominal input specifications of the PFX2332.

Nominal input rating: 200 VAC to 240 VAC, 50/60 Hz, single phase
Power consumption: 4000 VA (at rated output)

2. Turn off the power switch.

3. Attach crimp terminals to the power cord.

4. Turn off the circuit breaker of switchboard.

5. Connect the power cord to the switchboard.

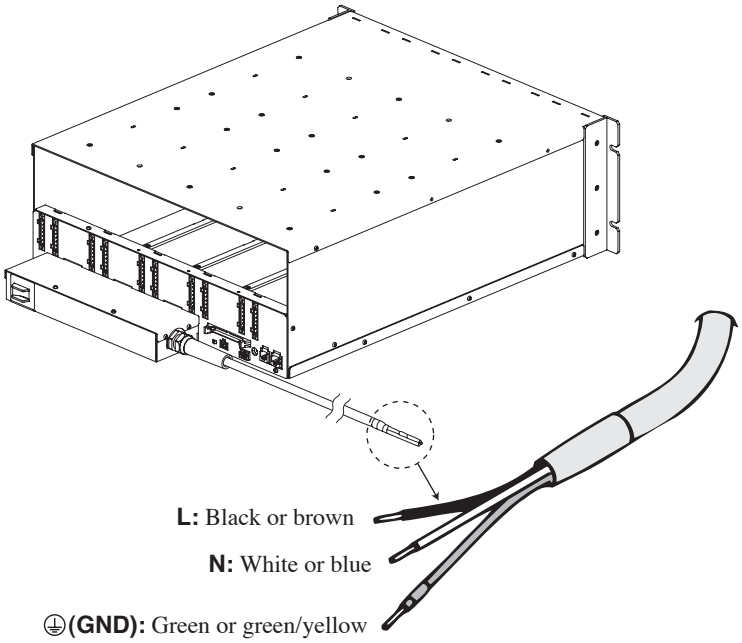


Fig. 1-2 Power cord of the PFX2332

1.5 Installing and Removing Charge/Discharge Power Supply Units

The charge/discharge power supply units can be installed or removed even if the unit frame is rack mounted. Furthermore, if the charge/discharge power supply unit is in the STANDBY status, you can install or remove the unit even if the power switch of the unit frame is on. Consequently, if a charge/discharge power supply unit malfunctions during a test, you can replace the unit without affecting the other units.

1.5.1 Installation Procedure

The procedure below uses the PFX2011 charge/discharge power supply unit as an example. The procedure is similar for the PFX2021.

The two types of charge/discharge power supply units can be installed simultaneously to a single PFX2332.

1. Remove the louver. See Fig. 1-3.
2. Pull down the lever toward you.
3. Carry the charge/discharge power supply unit with both hands as shown in Fig. 1-3, and slowly insert the unit into the desired slot.

   When you insert the unit a third of the way in, a lock mechanism is activated and you can no longer insert the unit.
4. When the lock mechanism is activated, lift the unit using the hand under the unit and press in.

   The lock is released. Insert the unit until the lever you pulled forward (the section marked with an asterisk in Fig. 1-3) touches the unit frame.
5. Pull up on the lever and push the unit in further.

   If power to the unit frame in on, all the LEDs on the unit's panel illuminate in orange, and then all LEDs except the POWER/STANDBY LED turn off. If the unit does not enter this status (STANDBY status), there is a problem on the unit.
6. Check that the panel surface of the unit is nearly flat with the rack mount bracket surface.
7. Use the screws that comes with the unit frame to fix the unit to the frame.

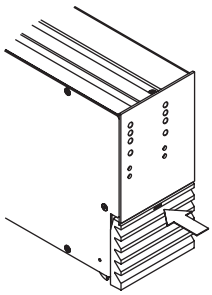
⚠WARNING • The unit is securely grounded to the frame by fixing the unit to the frame using screws.

For safety reasons, be sure to fix the unit using screws.

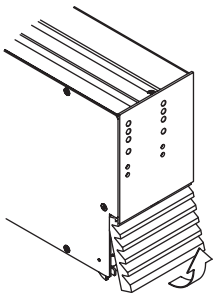
---

8. Attach the louver.

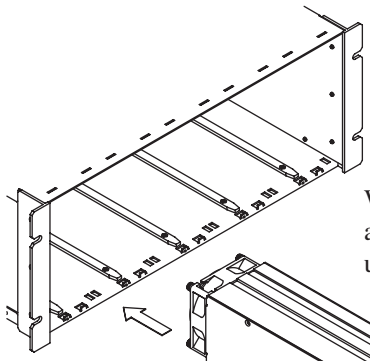
1.



a Push the top section of the louver (indicated with an arrow) to lift the bottom section.

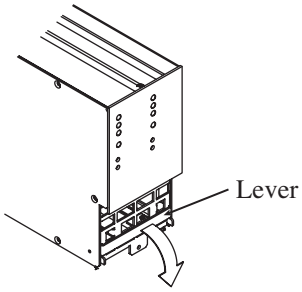


b Remove the louver by holding the lifted section and pulling in the direction of the arrow.

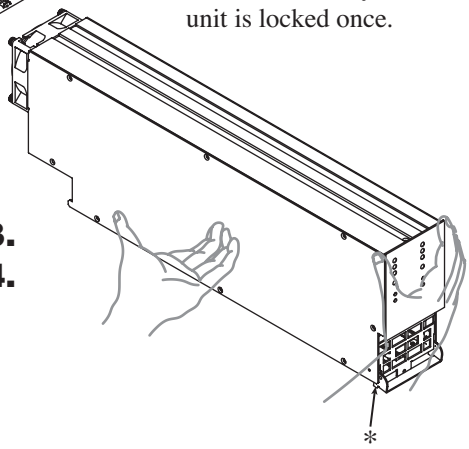


When the unit is inserted a third of the way in, the unit is locked once.

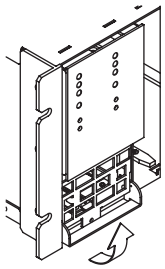
2.



3.
4.

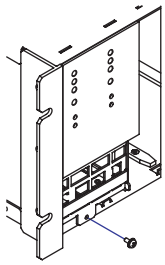


5.



Push the lever until the panel surface of the unit is flat with the rack mount bracket surface.

7.



Fix the unit to the frame using the screws that came with the package.

Fig. 1-3 Installing the Charge/Discharge Power Supply Unit (PFX2011 Example)

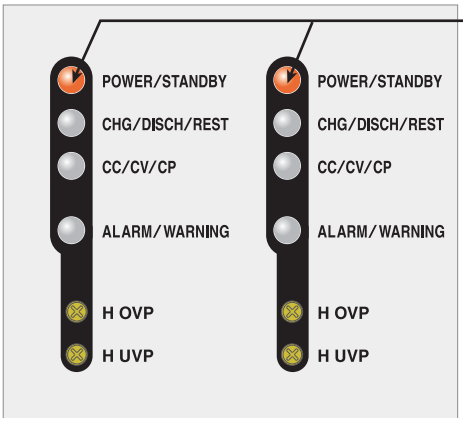
1.5.2 Removal Procedure

The procedure below uses the PFX2011 charge/discharge power supply unit as an example. The procedure is similar for the PFX2021.

⚠CAUTION

- Never remove the charge/discharge power supply unit from the unit frame if the POWER/STANDBY LED is illuminated in green (POWER ON status).
- Removing and inserting the unit in a short time interval can cause a malfunction. If you wish to insert the unit that you just removed, wait at least 5 seconds.

1. Check that the POWER/STANDBY LEDs on the charge/discharge power supply unit that you wish to remove are illuminated in orange (STANDBY status).



Illuminated in green: POWER ON status
Illuminated in orange: STANDBY status

Remove the unit only when these LEDs are off or illuminated in orange.

Fig. 1-4 POWER/STANDBY LED (PFX2011 Example)

NOTE

- If the charge/discharge power supply unit that you wish to remove is under the control of BPChecker2000 (the application software), you must perform unplug on BPChecker2000 to switch the unit into STANDBY status.

  For the procedure in unplugging the unit, see the *BPChecker2000 User's Manual*.

2. Remove the louver. See Fig. 1-5.

3. Unfasten the screws that are fixing the unit in place and pull down the lever towards you.

The unit pops out slightly and the power to the unit is turned off.

The screws that you removed are needed when you install the unit again. Be sure to store them in a safe place (do not lose them).

4. Slowly pull the unit out.

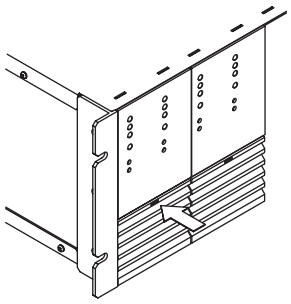
When you pull the unit two-thirds of the way out, a lock mechanism is activated and you can no longer pull the unit out.

5. When the lock mechanism is activated, lift the unit by placing the hand under the unit and pull out.

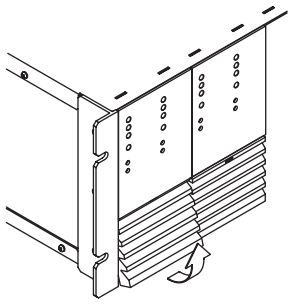
The lock is released. Hold the unit with both hands as shown in Fig. 1-5, and pull it slowly out of the slot.

6. Attach the louver to the unit that you removed.

2.

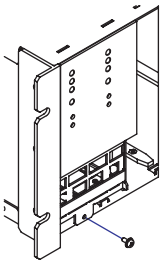


a Push the top section of the louver (indicated with an arrow) to lift the bottom section.

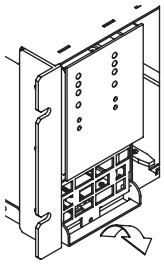


b Remove the louver by holding the lifted section and pulling in the direction of the arrow.

3.

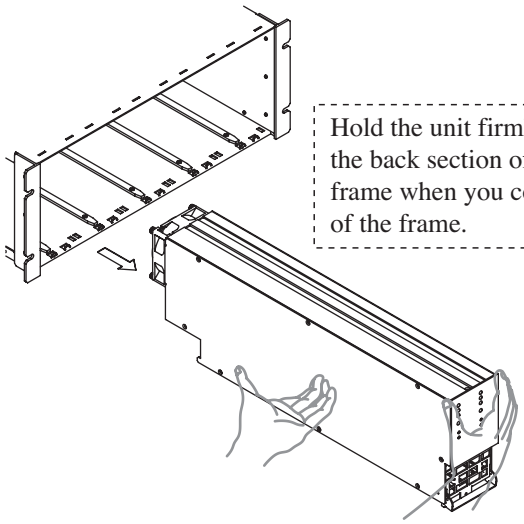


a Remove the screw that is fixing the unit in place.



b Pull down the lever toward you.

4.
5.



Hold the unit firmly with both hands so that the back section of the unit does not hit the frame when you completely pull the unit out of the frame.

Fig. 1-5 Removing the Charge/Discharge Power Supply Unit (PFX2011 Example)

1.6 Setting the Frame Address

A unique address must be assigned to all devices on the TP-BUS for the control unit to identify the unit frames connected to the TP-BUS. This address is called frame address.

⚠ CAUTION

- The frame address of the unit frame is set to 1 when it is shipped from the factory. If multiple unit frames are connected to the TP-BUS without changing the factory default setting, the control unit cannot control them correctly. If DUTs (batteries) are connected, erroneous operation can damage the DUTs.

NOTE

- You do not have to set the TP-BUS address on the control unit.

Set the frame address according to the following procedure.

1. Turn off the power switch on the unit frame.
2. Use the rotary switch (FRAME) on the rear panel to set the frame address.

   Set the address using the hexadecimal notation of the FRAME switch. See Fig. 1-6. Of the 0 to E settings indicated on the switch, the valid settings are 1 to C. These values convert to 1 to 12 in decimal notation. The Control Unit can not identify the address setting of 0, D or E.

   In addition, the frame addresses that you can assign to the unit frames connected to TP-BUS 1 and TP-BUS 2 are prescribed as follows:

   Frame connected to TP-BUS 1: 1 to 6

   Frame connected to TP-BUS 2: 7 to C

   Make sure the addresses indicated above are unique on each TP-BUS.
3. Turn on the power switch on the unit frame.

   The specified frame address takes effect when the power switch is turned on.

Assign addresses 1 to 6 to frames that are connected to TP-BUS 1; assign addresses 7 to C to frames that are connected to TP-BUS 2.

Fig. 1-6 Example in Which the Frame Address Is Set to “6”

Node number

Unique numbers are assigned to the charge/discharge power supply units that are installed in the unit frame. This number is called node number.

Node numbers are assigned according to the frame address and physical address as shown in Fig. 1-7.

Physical address refers to the address that is determined by the slot position of the unit frame. The left most slot as viewed from the front of the unit frame is assigned addresses 1 and 2. The address increases towards the right. The right most slot is assigned addresses 9 and 10.

Frame addresses are set in hexadecimal notation. Thus, A and B denote 10 and 11, respectively.

Fig. 1-7 shows an example in which the maximum number of PFX2011 Charge/ Discharge Power Supply Units is connected to a single control unit.

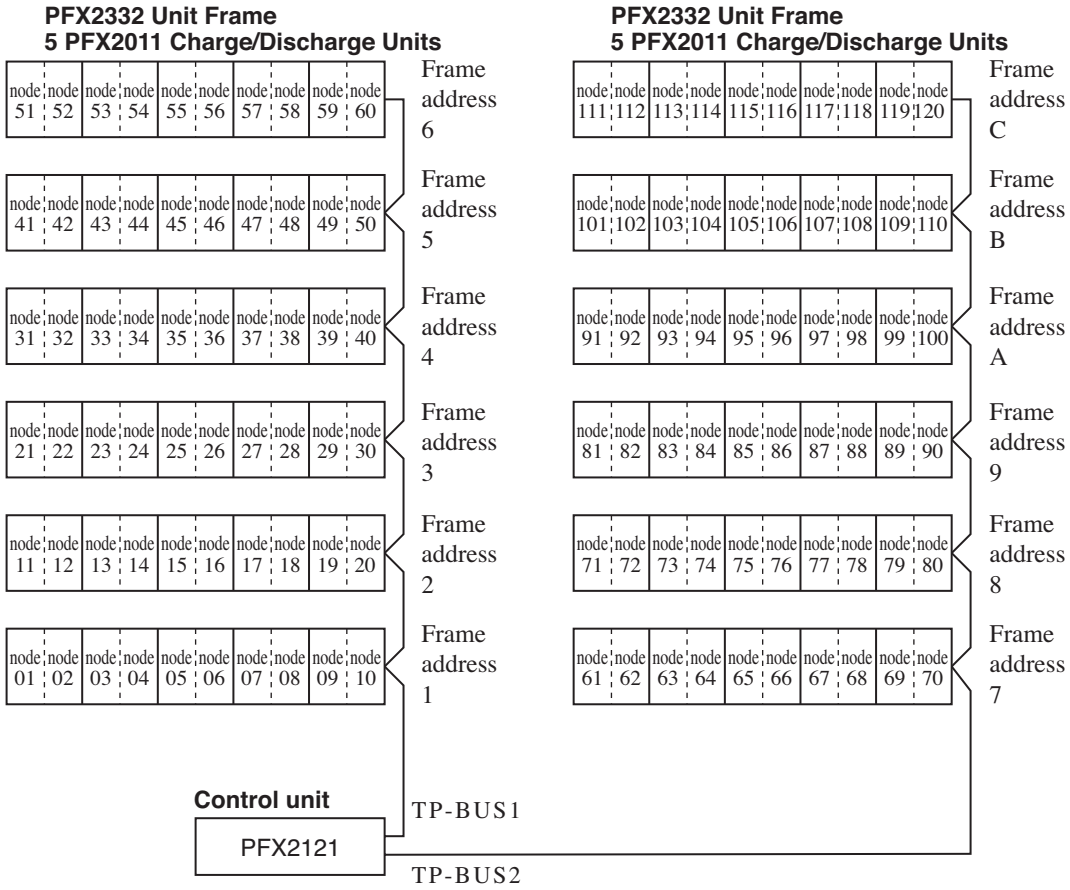


Fig. 1-7 Frame Addresses and Node Numbers
(Example of 120-Channel Connection Using PFX2011s)

Fig. 1-8 shows an example in which the maximum number of PFX2021 Charge/Discharge Power Supply Units is connected to a single control unit.

The maximum number of unit frames that can be connected to a single control unit is 12. The PFX2021 has one channel per unit. Therefore, the maximum number of channels that can be connected to a single control unit is 60. If the PFX2021 is installed, only odd node numbers are valid.

If a system is configured so that all of the charge/discharge power supply units are PFX2021s, the maximum number of channels that the control unit can control is 60.

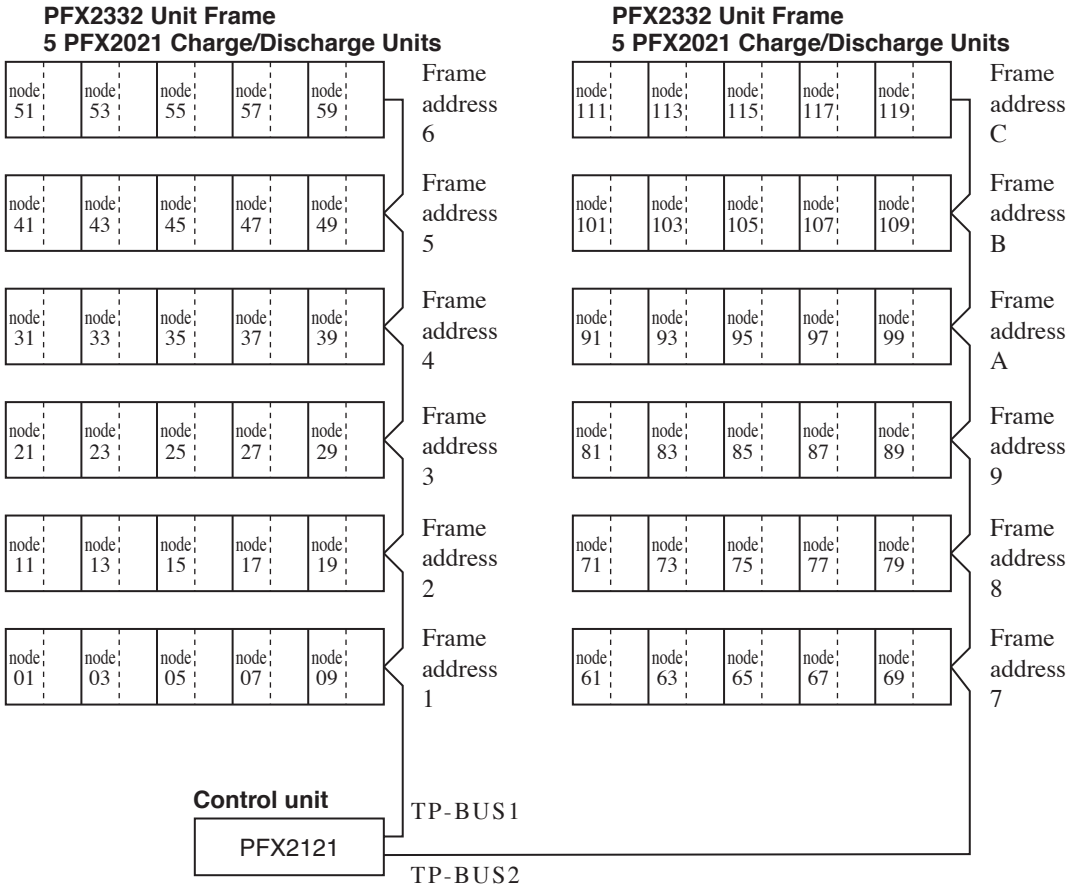


Fig. 1-8 Frame Addresses and Node Numbers
(Example of 60-Channel Connection Using PFX2021s)

■ When a mixture of PFX2011 and PFX2021 Charge/Discharge Power Supply Units are installed in a PFX2332 Unit Frame

The example below shows the case when two PFX2021s and three PFX2011s are installed to the PFX2332. The node numbers for the section where the PFX2021 is installed are odd numbers only. Therefore, the node numbers are assigned as shown in Fig. 1-9.

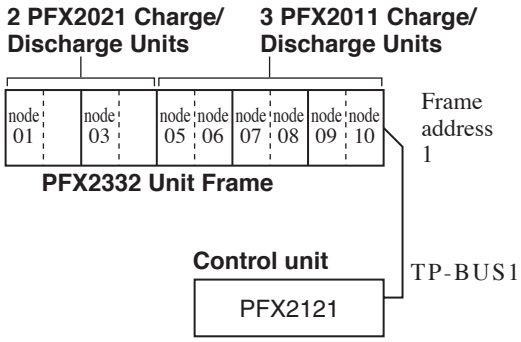


Fig. 1-9 Example When a Mixture of PFX2021s and PFX2011s Are Installed

1.7 Connecting the TP-BUS

1.7.1 Connecting TP-BUS Cables

The control unit and unit frames PFX2332 are connected using the TP-BUS. The TP-BUS is connected in a chain by connecting twisted-pair cables to the TP-BUS connectors (plug) provided. Fig. 1-10 shows a TP-BUS connection example including the impedance measurement unit.

You can connect 12 unit frames and one impedance measurement unit to the control unit.

NOTE

- The control unit is a dedicated controller for the PFX2000 Series. You cannot connect Kikusui power supplies (such as the PMR Series) with the TP-BUS interface and control them.

■ Wires and tools required for connection

- Wires

  Stranded wire: AWG22 (0.32 mm^2)
  Solid wire: AWG22 (ϕ 0.65)

- Flat-blade screwdriver

  Use the screw driver that comes with the package.

- Wire stripper

  Wire stripper suitable for the wires described above.

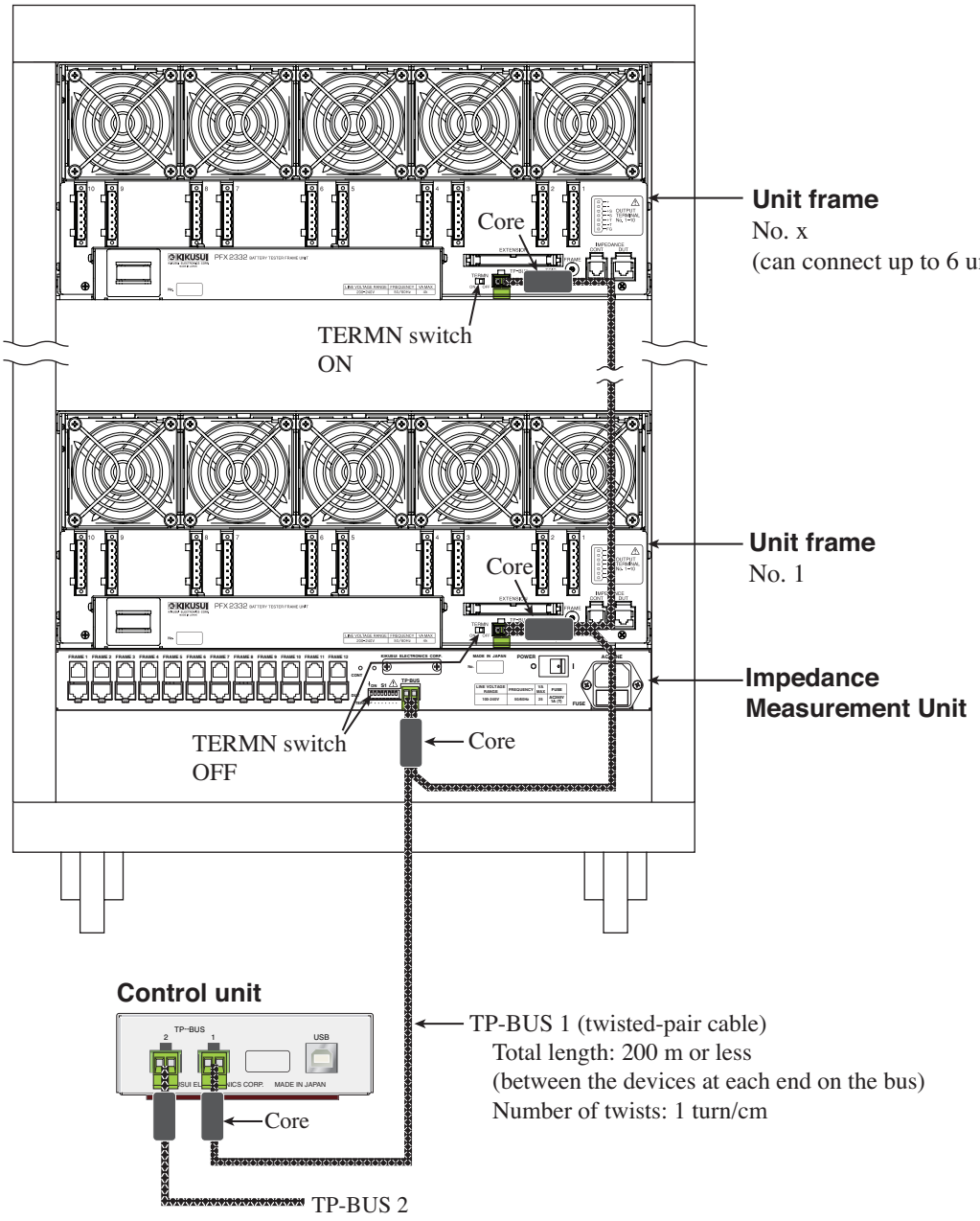


Fig. 1-10 TP-BUS Connection

NOTE

- Connect unit frames with frame addresses 1 to 6 to TP-BUS 1; connect unit frames with frame addresses 7 to C to the TP-BUS 2.
- If you are using the impedance measurement unit, be sure to connect it to TP-BUS 1.

TP-BUS connection procedure

■ Wiring the TP-BUS connector

⚠CAUTION
- The TP-BUS allows hot plug. You can insert or remove the TP-BUS connector even when the power to the device is on.

  However, do not insert or remove connectors while the charge/discharge test is in progress as this may cause a malfunction.

NOTE
- Connect the control unit so that it is at the end of the TP-BUS. The control unit does not have a TERMN switch and the termination is always on. Therefore, it must be connected to the end of the TP-BUS. For details, see section 1.7.2, "Setting the TERMN Switch."
- Allow extra length of cable between devices. After wiring the TP-BUS connector, you will wrap the TP-BUS cable once around a core that cames with the package. If extra length of cable is not available, you will not be able to attach the core.

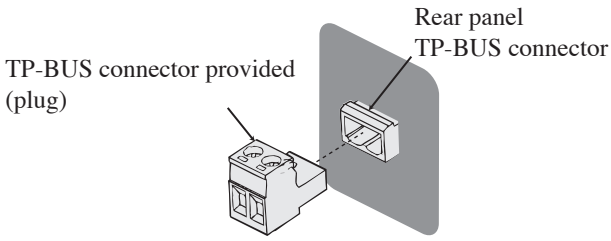
1. Insert the TP-BUS connector (plug) provided to the TP-BUS connector on the rear panel. See Fig. 1-11 (a).

   The succeeding work involved in connecting the wires becomes easier by fixing the connector.
2. Use a wire stripper to remove 7 mm of the covering from the wires.
3. Insert the wires into the connectors as shown in Fig. 1-11 (b) and (c).

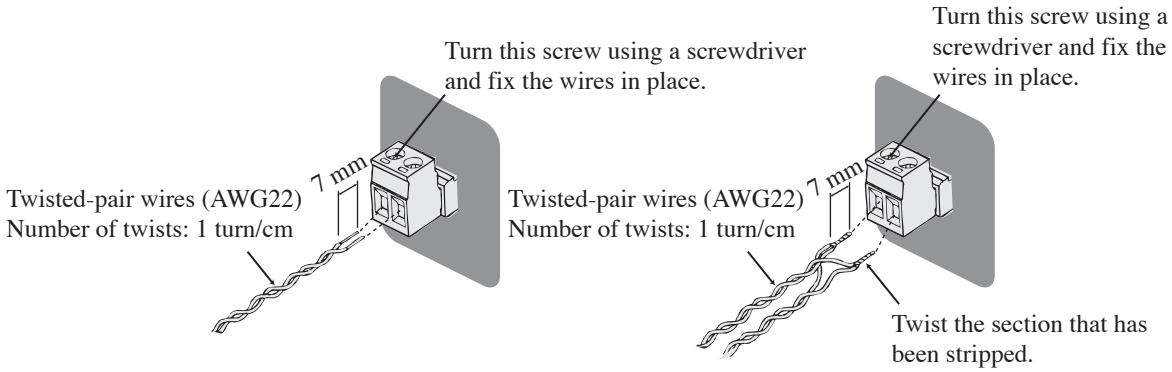
   TP-BUS has no polarity. You do not have to match the polarities between units.
4. Use the screwdriver to turn the connector screw and fix the wires in place.
5. Check that the wires do not come loose.

⚠CAUTION
- Check that the wires are not short-circuited.
- Check that the conducting sections of the wires are not touching the chassis. If it is, damage to the device may result.

6. Connect the other connectors in a similar fashion.



(a) Insert the plug



(b) Connect the devices at each end of the bus

(c) Connect the devices in the middle on the bus

Fig. 1-11 TP-BUS Connector Connection

■ Attaching the TP-BUS core

1. Remove the lock indicated in Fig. 1-12 (a) and split the core into halves.
2. Wrap the twisted pair wire once around one of the core halves.

   Wrap the wire so that the distance between the core and the connector is within 30 mm. See Fig. 1-12 (b).
3. Close the core keeping the twisted pair wire from being wedged in between.

   See Fig. 1-12 (c).
4. Check that the core is securely locked.
5. Attach other cores in a similar fashion.

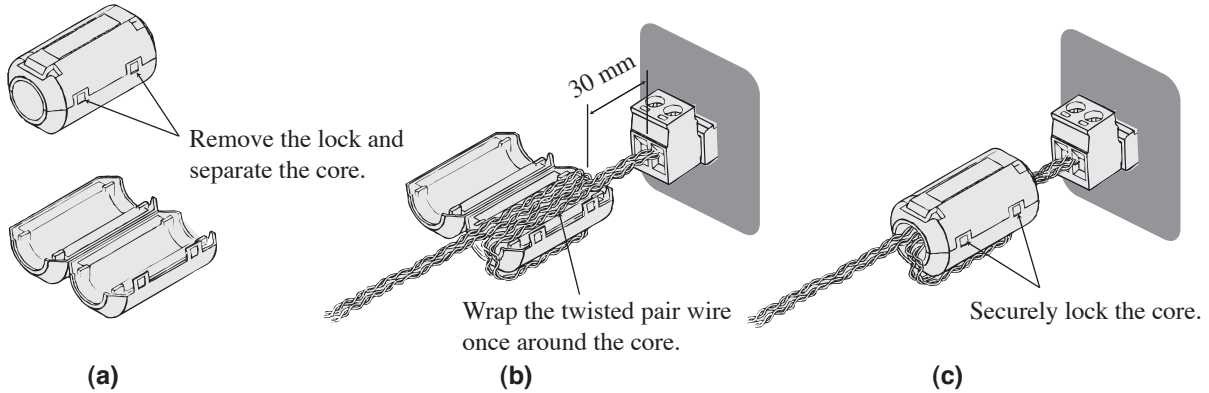


Fig. 1-12 TP-BUS Core Attachment

1.7.2 Setting the TERMN Switch

⚠ CAUTION • If the TERMN switch is not set properly, communications become unstable and erroneous operation may result.

Set the TERMN (termination) switch on the device at the end of the TP-BUS located opposite to the control unit.

Taking Fig. 1-10 as an example, the TERMN switch on the unit frame at the end of the TP-BUS is turned on, and the TERMN switches on all other units are turned off.

There is no TERMN switch on the control unit. This is because the control unit is designed on the assumption that it be connected to the end of the TP-BUS. The internal termination of the control unit is always on.

1.8 Connecting the USB

1.8.1 Connecting the USB Cable

The control unit and the personal computer (PC) are connected via the USB.

The control unit is a high-powered device that operates by receiving power (5 V, 300 mA) from the USB. Connect the control unit directly to the USB port on the PC (recommended) or through a self-powered USB hub to the PC. You cannot use a bus-powered USB hub.

⚠ CAUTION

- Do not insert or remove the USB connector while the system is in operation. In addition, securely connect the USB connector, so it does not accidentally come loose.

NOTE

- It is recommended that the control unit be connected directly to the USB terminal on your PC as shown in Fig. 1-13.

  If you are connecting the control unit to a hub, do not connect devices that transmit large amounts of data such as a printer or a camera.

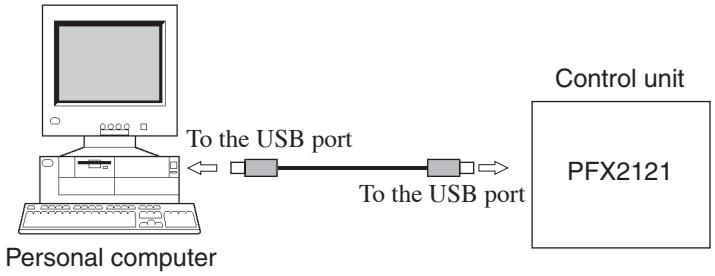


Fig. 1-13 Direct Connection to the PC

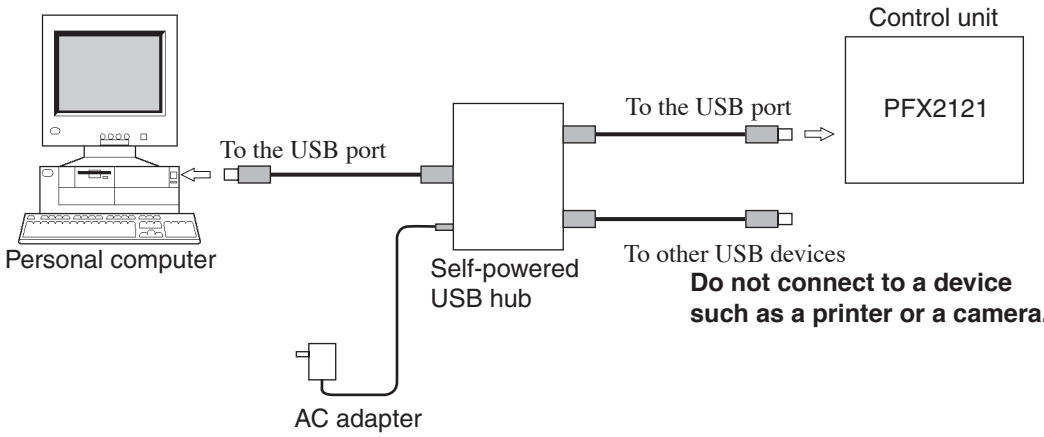


Fig. 1-14 Connection via the USB Hub

1.8.2 USB Driver

A dedicated USB driver must be installed in the PC for the PC to identify the control unit on the USB. The driver software is included in the BPChecker2000 package. For details on the installation, see the *BPChecker2000 User's Manual*.

1.8.3 Instrument ID

If the PC has multiple USB ports or if you are using a self-powered USB hub, you can connect up to two control units on a single USB. In this case, you must set a different ID to each control unit so that the PC can identify the two control units. This ID is called instrument ID.

Use the ID switch on the front panel of the control unit to set the instrument ID to 1 or 2.

NOTE

- If you are using a single control unit, be sure to set the instrument ID to 1. The control unit will not operate at any other value.

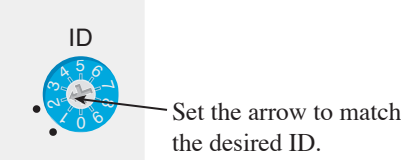


Fig. 1-15 ID Switch

Fig. 1-16 shows a connection example of two control units.

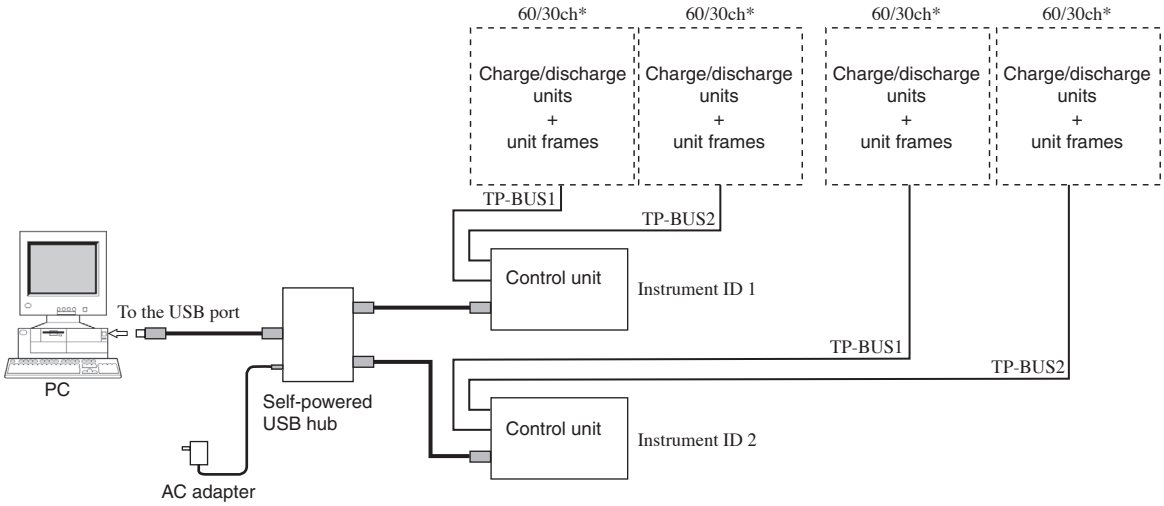


Fig. 1-16 Connection Example of Two Control Units

* The combination of PFX2011 Charge/Discharge Power Supply Units and PFX2332 Unit Frames results in a maximum of 60 channels. The combination of PFX2021 Charge/Discharge Power Supply Units and PFX2332 Unit Frames results in a maximum of 30 channels.

Chapter 2 Operating Procedure

This chapter describes the power-up procedure, the connection to the DUTs, and the trip connector.

The system is controlled using BPChecker2000, an application software. For details on how to use the application, see the *BPChecker2000 User's Manual*.

2.1 Turning On the Power

There is no particular order for turning on the PFX2000 Series Battery Test System. You turn on any of the control units first or any of the unit frames first. This also holds true for a system that have the impedance measurement units connected. In addition, there is no particular order for shutting off the power to the system.

Control unit

Since the control unit receives power from the USB, power is supplied to it if the USB cable is connected and the PC is turned on. If the control unit is connected via a self-powered USB hub, supply power to the hub.

When the control unit receives power from the USB, the POWER LED on the panel blinks in green.

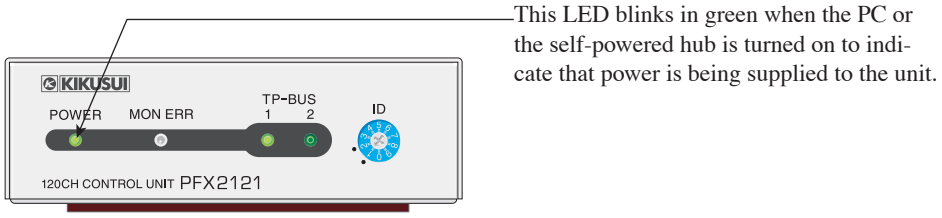


Fig.2-1 Control Unit Status after Power On

Unit frame

1. Check that the power cord is correctly connected.
2. Turn on the power switch on the rear panel.

   All the LEDs on the panel of the charge/discharge power supply unit illuminate, and then all LEDs except the POWER/STANDBY LED turn off.

   This status is the STANDBY status in which the unit waits for commands from BPChecker2000.

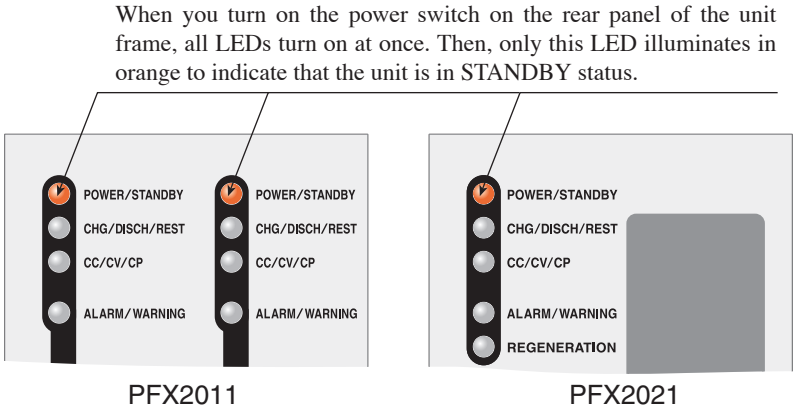


Fig. 2-2 Charge/Discharge Power Supply Unit Status after Power On

2.2 Connecting the Output Cables

The package containing the unit frame does not include cables for connecting to the DUT (battery). Only plugs that comply with the output connector on the rear panel are included. Prepare the wires and tools described on Page 2-4 to construct the output cables appropriate for the DUTs.

⚠CAUTION

- **System in which the PFX2331 old-type unit frames and PFX2332 unit frames are mixed**
  Connectors for large capacity currents, marked “HC” on the side, come with the PFX2332. See Fig. 2-3.
  In a system in which the PFX2331 and PFX2332 are mixed, beware of the connectors and wires that are connected to each frame.
  Connect output cables assembled with HC type connectors to the PFX2332.
- **Allowable temperature of cables and other accessories**
  If the output cables are exposed to high temperature such as when using the DUT in a temperature chamber, beware of the allowable temperature of the output cables. If the heat resistance of the output cables, battery holders, and other items is inadequate, a dangerous condition will result due to inadequate insulation and increased contact resistance. (The allowable temperature of the cable sold separately is 105 °C.)

NOTE

- Cable length
  If appropriate wires (see Table 2-1) are used, the output cable length can be extended **up to 7 m**.
- When performing large current pulse charge/discharge
  If you are performing large current pulse charge/discharge (6 A or greater) using the PFX2021, try to keep the output cable length less than or equal to 5 m as much as possible. At longer lengths, constant current control becomes unstable and accurate capacity measurement may be affected. If you must use a cable that is longer than 5 m, it is recommended that you use the cable sold separately (7 m).

■ Wires and tools required for connection

• Wires (7 m maximum)

Table 2-1 Wires Required for Connection

Wires		For the PF2332	
	Length	AWG	mm^2
Current wires (stranded)			
	Up to 3 m	18 to 12	0.82 to 3.31
	Up to 7 m	16 to 12	1.31 to 3.31
Sensing wires			
	Up to 7 m	24 to 20	0.20 to 0.52

• Flat-blade screwdriver

Use the screw driver that comes with the package.

• Wire stripper

Wire stripper suitable for the wires described above.

Cable sold separately

Sensing wires, current wires, and preassembled output cables (see Fig. 2-3) are also available for purchase separately.

If you require them, contact your Kikusui agent or distributor.

Constructing output cables

Construct output cables as shown in Fig. 2-3 using the wires that you prepared.

Remove 7 mm of the covering from all wires and securely fasten the screws so that the wires do not come loose from the connector.

Current wire

- As a guideline, twist the wires three times every 10 cm, and keep the wires less than 7 m in length in the twisted condition.
- Connect the end of the wires to terminal 1 (+) and terminal 2 (-).

Voltage sensing wire

- Connect the end of the wires to terminal 3 (+S) and terminal 4 (-S).
- Connect the shield to terminal 7 (FG) of the connector. Prepare the wire so that the shield on the DUT side is not connected to anything.

Temperature sensing wire

- Connect the end of the wires to terminal 5 (+T) and terminal 6 (-T).
- There is no polarity.
- Connect the shield to terminal 7 (FG) of the connector. Prepare the wire so that the shield on the thermistor side is not connected to anything.

Table 2-2 Output Connector Pin Arrangement

Pin No.	Symbol	Description
1	+	Positive current terminal. Connect to the positive terminal of the DUT (battery).
2	-	Negative current terminal. Connect to the negative terminal of the DUT (battery).
3	+S	Positive voltage terminal. Connect to the positive terminal of the DUT (battery).
4	-S	Negative voltage terminal. Connect to the negative terminal of the DUT (battery).
5	+T	Temperature measurement terminal. Connect to the thermistor that comes with the package.
6	-T	Temperature measurement terminal. Connect to the thermistor that comes with the package.
7	FG	Shield grounding terminal. It is connected to the chassis of the unit frame. Do not connect the shielding potential to any part of the DUT (battery).

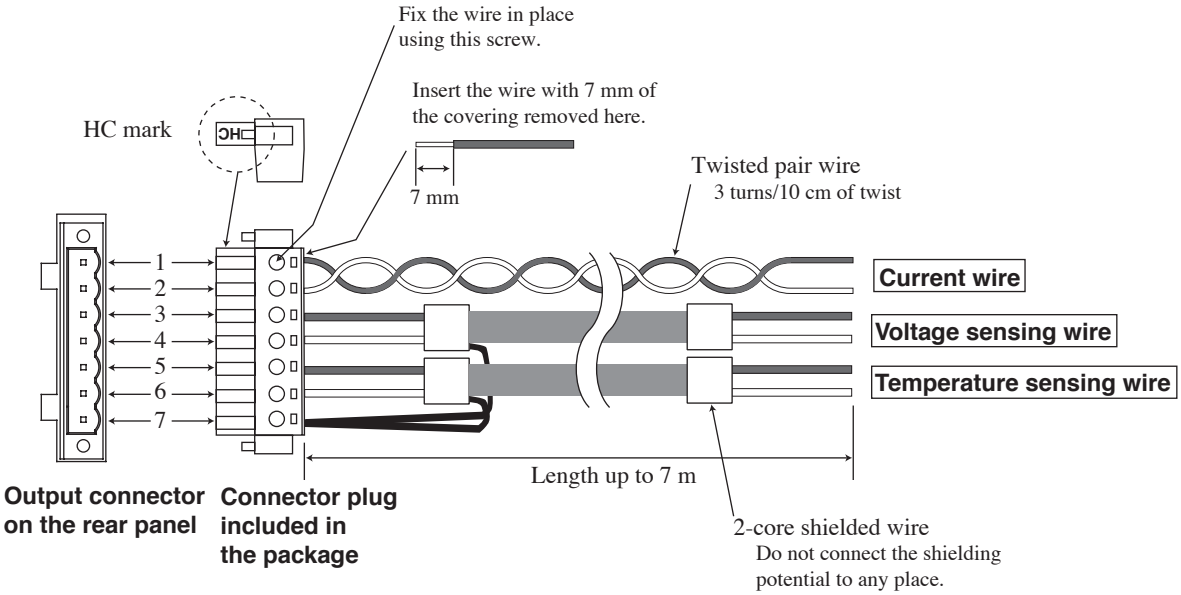


Fig. 2-3 Output Cable Example

NOTE

- Twisting the current wire
  For the current wire, prepare a positive wire and a negative wire of the same length and twist them so that the length of both wires stay the same at all times. The operation of the power supply unit may become unstable if only one of the wires is twisted.
- HC mark on the connector
  The output connectors that come with the PFX2332 unit frame have an “HC (High Current)” mark attached to the side. This indicates that the connector is larger in current capacity than that of the connector that comes with the PFX2331 old-type unit frame.

Attaching the thermistor (Fig. 2-4)

- Solder the thermistor lead to the tip of the temperature sensing wire.
  As a guideline, the time for soldering the thermistor included in the package should be less than 7 seconds at the position at least 5 mm away from the root of the lead using a soldering iron (50 W) at 340 °C.
- There is no polarity on the thermistor.
- Be sure to insulate the thermistor lead such as by using an heat-shrinkable tubing.

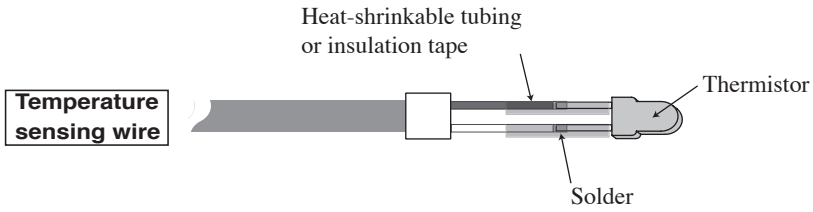


Fig. 2-4 Thermistor Attachment

You can use thermistors other than the ones provided (103AT-2 by Ishizuka Electronics Corp.) as long as they are equivalent. For the specifications of the thermistor included in the package, see “Temperature Measurement” in chapter 5, “Specifications.”

Connecting the output cables

Connect the output connectors of the unit frame to the DUTs using the output cables you constructed.

⚠ CAUTION

- Connection to the output connectors must be performed in the STANDBY status or with the power switch turned off.
- Fix the output connectors in place by fastening the top and bottom screws.
- Do not leave the DUT (battery) connected for a long time with the power switch turned off. The DUT may discharge minute current. (This is not a problem in STANDBY status.)
- In a system in which the PFX2331 old-type unit frames and PFX2332 unit frames are mixed, connect the output cable assembled with the HC type connector to the PFX2332.

NOTE

- Keep the output cable as short as possible. Tying the cable in bundles or entangling the cable can cause unstable operation of the product. Be sure to use the optimum length of cable especially for pulse operation, because it is prone to instability.
- Avoid attaching cores and filters on the output cable. The operation of the power supply unit may become unstable.

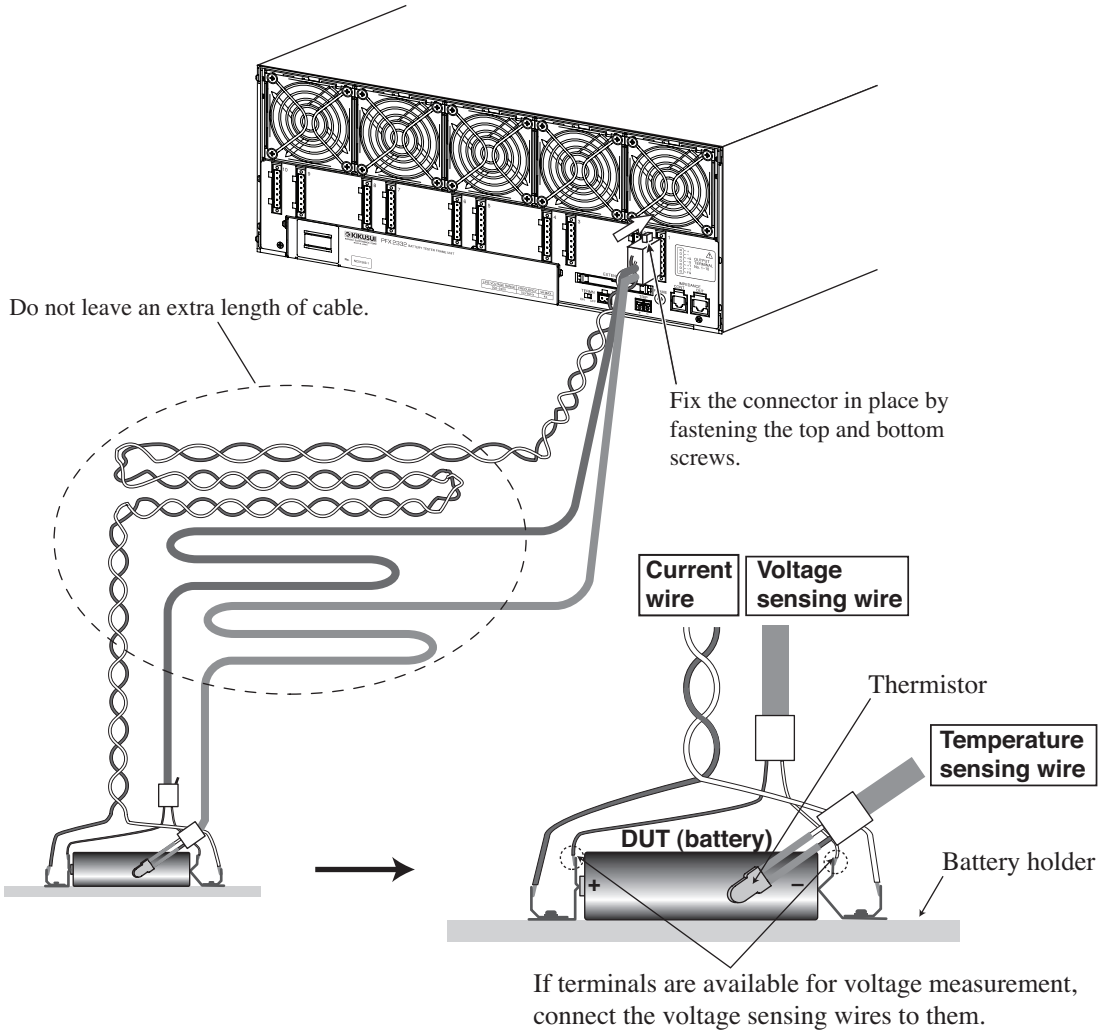


Fig. 2-5 Output Cable Connection

Connection when using the PFX2021

When using the PFX2021 Charge/Discharge Power Supply Unit, connect the output cables to the odd-numbered output connectors on the unit frame. Even-numbered output connectors cannot be used.

Combination of the PFX2332 Unit Frame and 5 PFX2021 Charge/Discharge Power Supply Units

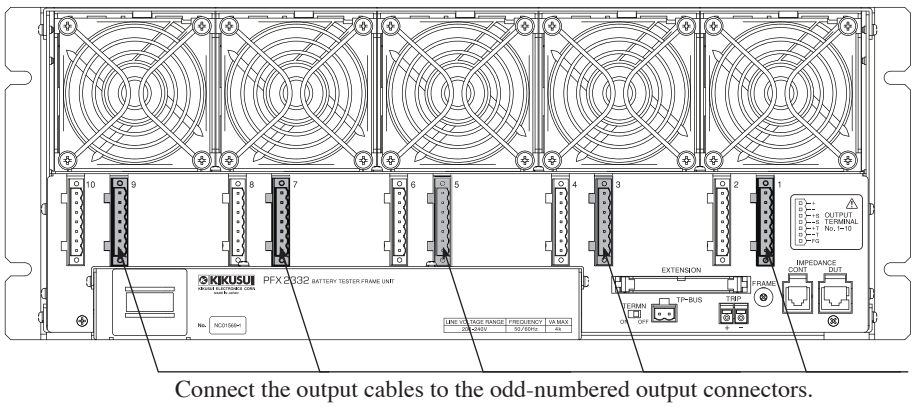


Fig. 2-6 Connection When Using the PFX2021

2.3 Using the Trip Connector

You can externally shut off the power switch on the unit fame by using a trip connector. The power switch is turned off when the positive and negative terminals of the trip connector are shorted.

■ Wires and tools required for connection

• Wires

Stranded wire: AWG22 to 20 (0.33 mm^2 to 0.52 mm^2)

• Flat-blade screwdriver

Use the screw driver that comes with the package.

• Wire stripper

Wire stripper suitable for the wires described above.

■ Electrical specifications

Use a floating contact signal or an open-collector output that meets the electrical specifications of the TRIP.

When opened	24 VDC
When shorted	300 mA
Time of application	2 s maximum

⚠ CAUTION

- Connection to the power connector must be performed while the power switch is turned off.
- Be sure the exposed section of the wire does not touch the chassis or the wires of the adjacent connector.
- After connecting the wire, pull on it lightly to check that it does not come loose.

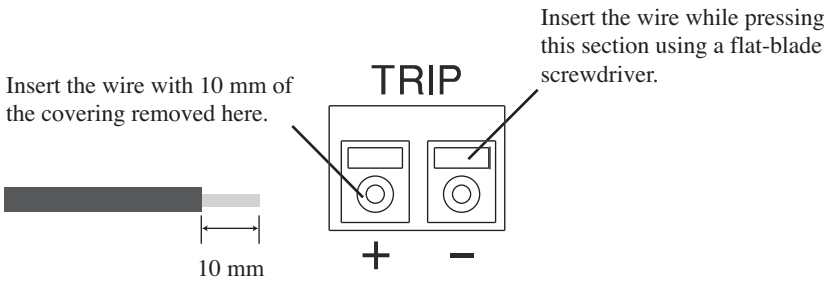


Fig. 2-7 Trip Connector Connection

3

Chapter 3 Names and Functions of Parts

This chapter describes the names and functions of switches, displays, connectors, and other parts of the panels.

Read this chapter to learn about the details of the ⚠ (alert) marks inscribed on the panel.

3.1 Names and Functions of Parts

3.1.1 Unit Frame

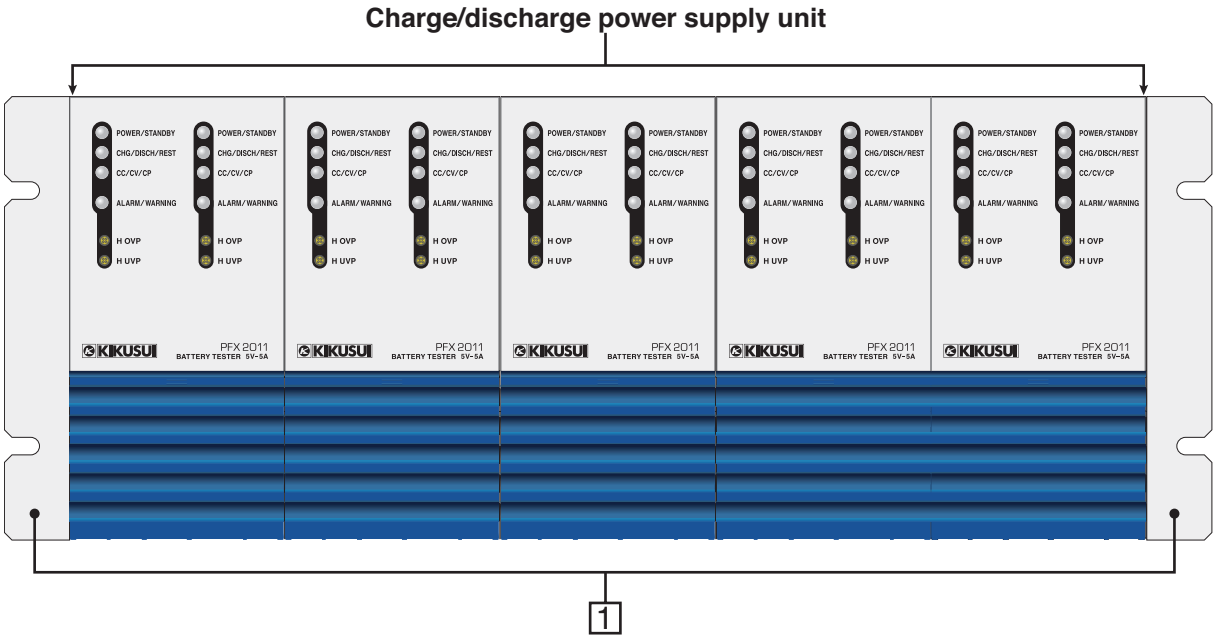


Fig.3-1 PFX2332 Front Panel

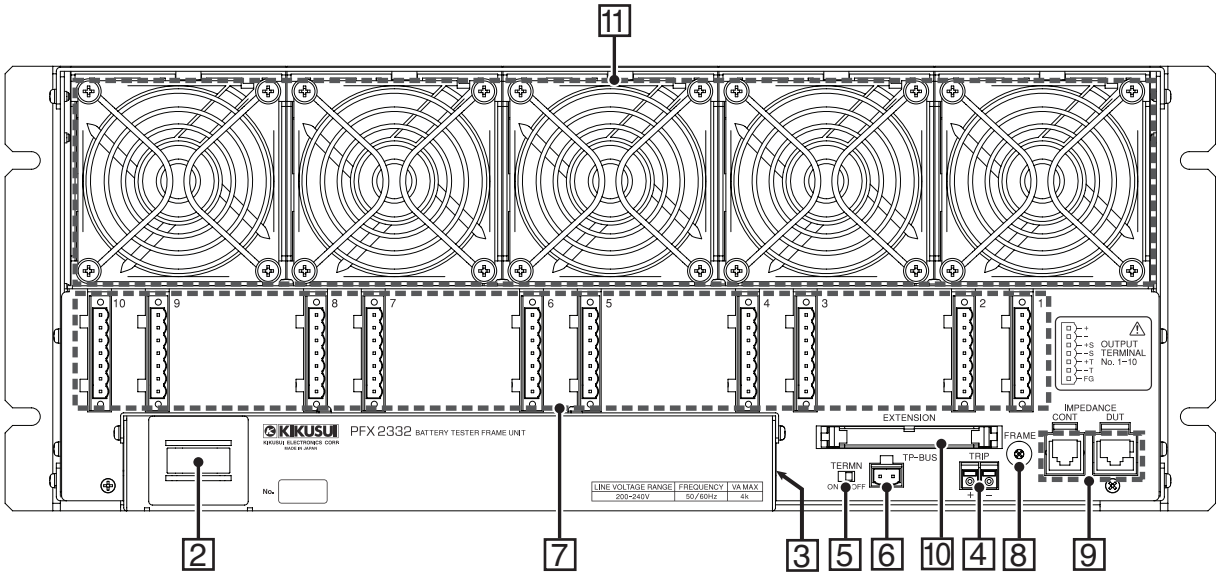


Fig. 3-2 PFX2332 Rear Panel

[1] Bracket

Bracket for racking the unit on an EIA standard rack. For details on rack mounting, see section 1.2.2, “Rack Mounting.”

[2] Power switch

Power switch on the unit frame. "|" side is on; "○" side is off.

The power switch on the PFX2332 Unit Frame illuminates when power is on.

[3] AC LINE

The power cord cannot be removed from the PFX2332 Unit Frame.

⚠WARNING • Improper handling can lead electric shock. When connecting the power cord, be sure to read section 1.4, "Connecting the Power Cord of the PFX2332."

---

[4] TRIP

The power switch on the unit frame is shut off when the terminals (+ and -) are shorted. You can use this as an external interlock. For details, see section 2.3, "Using the Trip Connector."

[5] TERMN

Switch for turning on/off the TP-BUS termination. For details, see section 1.7.2, "Setting the TERMN Switch."

[6] TP-BUS

Connector for connecting the TP-BUS cable. For details, see section 1.7, "Connecting the TP-BUS."

[7] OUTPUT TERMINAL⚠

Output connector.

The right most connector as viewed from the rear is the output for physical address 1. The address increases as you move toward the left. The left most connector is the output for physical address 10.

For a description of the physical address, see "Node address" in section 1.6, "Setting the Frame Address."

For a description of the connection, see section 2.2, "Connecting the Output Cables."

[8] FRAME

Switch for setting the frame address. For details, see section 1.6, "Setting the Frame Address."

[9] IMPEDANCE

Connector for connecting the PFX2211 Impedance Measurement Unit. For the connection procedure, see the operation manual for the impedance measurement unit.

[10] EXTENSION

A connector for functional expansion. The connector cannot be used currently.

[11] Exhaust port

Exhaust port used to exhaust the internal heat using a fan. Provide sufficient space around the unit frame to allow air to flow.

3.1.2 Charge/Discharge Power Supply Unit

Assuming that the LED display and variable resistor on the left side of the PFX2011 Charge/ Discharge Power Supply Unit are for channel n, those on the right side are for channel n+1.

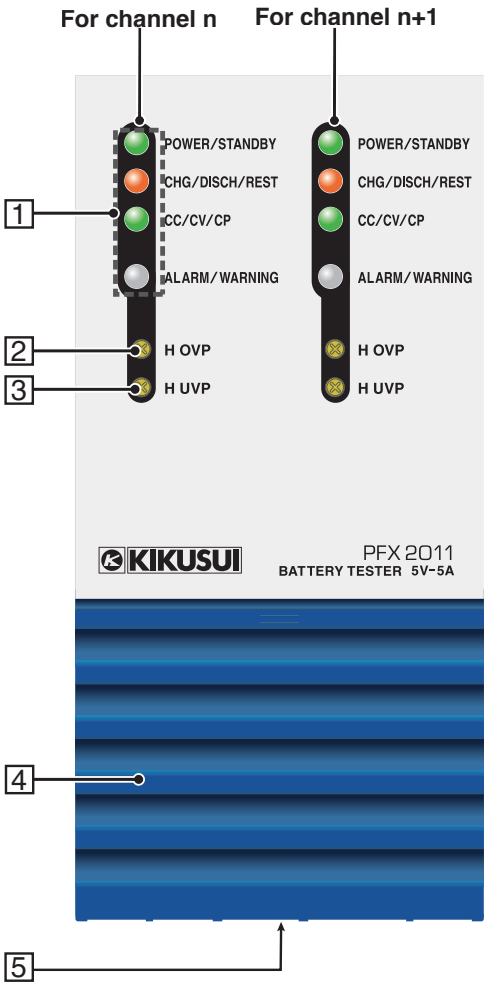


Fig. 3-3 PFX2011 Front Panel

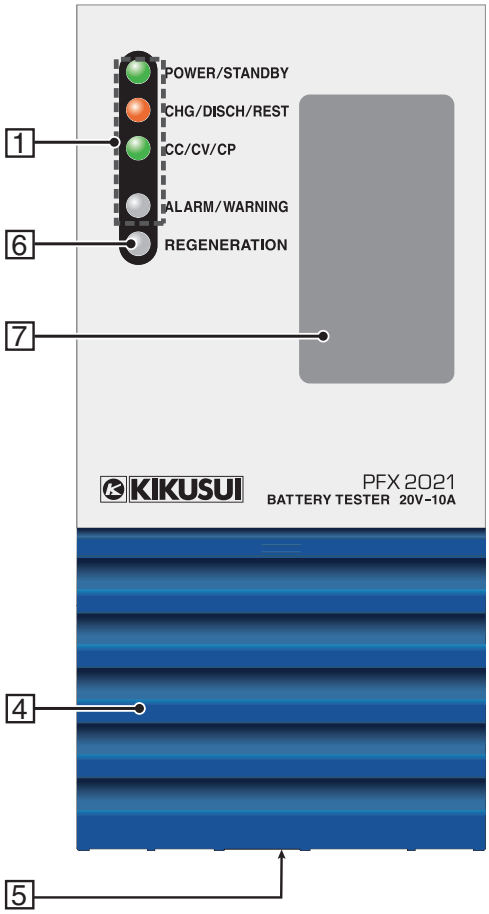
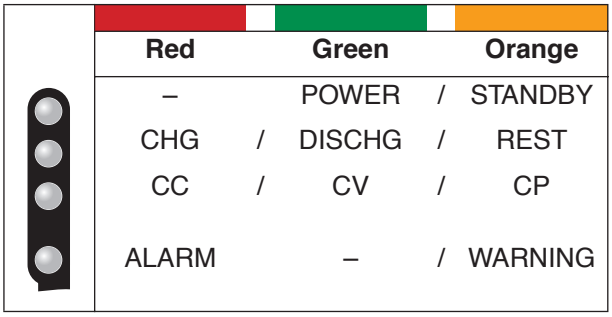


Fig. 3-4 PFX2021 Front Panel

[1] Status indication LED

Indicates the operation status of the charge/discharge power supply unit using LED colors.

Table 3-1 Color and Operation Status of the Status Indication LED



Red	Green	Orange
–	POWER /	STANDBY
CHG /	DISCHG /	REST
CC /	CV /	CP
ALARM	– /	WARNING

POWER/STANDBY LED

- Illuminated in green: Indicates the power is being supplied to the channel.
- Illuminated in orange: Indicates that the channel is in STANDBY status.

CHG/DISCH/REST LED

- Illuminated in red: Indicates that the channel is in charge (CHG) status.
- Illuminated in green: Indicates that the channel is in discharge (DISCH) status.
- Illuminated in orange: Indicates that the channel is in rest status.

CC/CV/CP LED

- Illuminated in red: Indicates that the channel is in constant current (CC) operation status.
- Illuminated in green: Indicates that the channel is in constant voltage (CV) operation status.
- Illuminated in orange: Indicates that the channel is in constant power (CP) operation status.

ALARM/WARNING LED

- Illuminated in red: Indicates that the channel is in ALARM status. You cannot start test in ALARM status.
- Illuminated in orange: Indicates that the channel is in WARNING status. If you execute the test in this condition, it may change to ALARM status.

[2] H OVP (PFX2011 only)

Variable resistor for setting hardware overvoltage (overcharge) protection (OVP) to each channel. For details on how to set it, see the *BPChecker2000 User's Manual*.

[3] H UVP (PFX2011 only)

Variable resistor for setting hardware undervoltage (overdischarge) protection (UVP) to each channel. For details on how to set it, see the *BPChecker2000 User's Manual*.

[4] Louver

Inlet port used to cool the internal heat using a fan.

A dust filter is furnished on the inside. Clean the dust filter periodically. For details, see section 4.1.2, “Cleaning the Dust Filter.”

[5] Attachment screw

Screw used to fix the charge/discharge power supply unit to the unit frame. Normally, this screw is hidden under the louver.

⚠ WARNING • Improper handling can lead electric shock. To install or remove the charge/discharge power supply unit, be sure to refer to section 1.5, “Installing and Removing Charge/Discharge Power Supply Units.”

---

[6] REGENERATION LED (PFX2021 only)

Illuminates in blue when the regeneration function is active.

The PFX2021 is operating in power saving mode when this LED is illuminated.

[7] Air inlet (PFX2021 only)

Takes in air to cool the internal heat using a fan.

Clean the dust filter periodically. For details, see section 4.1.2, “Cleaning the Dust Filter.”

3.1.3 Control Unit

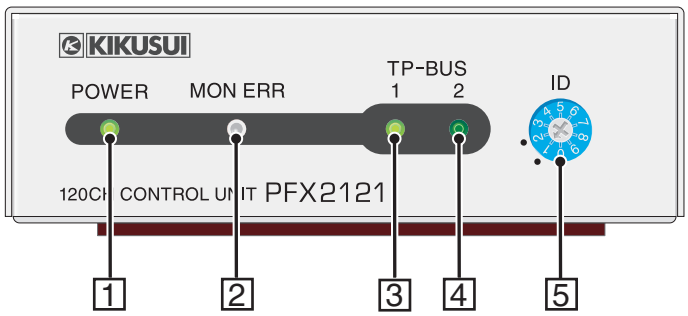


Fig. 3-5 Front Panel of the PFX2121

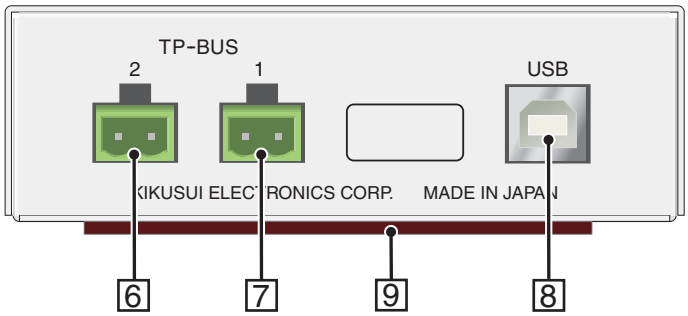


Fig. 3-6 Rear Panel of the PFX2121

[1] POWER LED

Blinks (in green) when the USB cable is connected, and power is being supplied from the bus.

Illuminates (in green) when the control unit is detected by BPChecker2000 and is in an operable condition.

[2] MON ERR LED

Illuminates (in red) if an error occurs in the periodic monitor communication with the application.

[3] TP-BUS 1 LED

Illuminates (in green) when communicating with the charge/discharge power supply unit of node numbers 1 to 60 or the impedance measurement unit.

[4] TP-BUS 2 LED

Illuminates (in green) when communicating with the charge/discharge power supply unit of node numbers 61 to 120.

[5] ID

Switch for setting the ID number that allows two PFX2121 Control Units to be connected to a single USB. For details, see section 1.8.3, “Instrument ID.”

[6] TP-BUS 2

TP-BUS 2 connector. Connect unit frames with a frame address between 7 and C to TP-BUS 2. For details, see section 1.7, “Connecting the TP-BUS.”

[7] TP-BUS 1

TP-BUS 1 connector. Connect unit frames with with a frame address between 1 and 6 and the PFX2211 Impedance Measurement Unit to TP-BUS 1. For details, see section 1.7, “Connecting the TP-BUS.”

[8] USB

USB connector. For details, see section 1.8.1, “Connecting the USB Cable.”

[9] Magnet

The bottom of the unit is magnetic. You can fix the control unit using the magnet (to the metal section of the PC case, for example).

⚠ CAUTION • Do not bring magnetic disks such as floppy disks near the magnet. Such act can damage the data.

Chapter 4 Maintenance

This chapter describes maintenance and calibration of the product.

⚠WARNING • Some parts inside the product may cause physical hazards. Do not remove the external cover.

4.1 Cleaning

⚠WARNING • Be sure to turn off the power switch on the device and the switchboard switch.

4.1.1 Cleaning the Panels

If the panel needs cleaning, gently wipe using a soft cloth with water-diluted neutral detergent.

⚠CAUTION • Do not use volatile solvents such as thinner or benzine. They may discolor the surface or erase the printed characters.

4.1.2 Cleaning the Dust Filter

A dust filter is installed on the front panel of the charge/discharge power supply unit. See Fig. 4-1. Periodically clean the dust filter to prevent clogging.

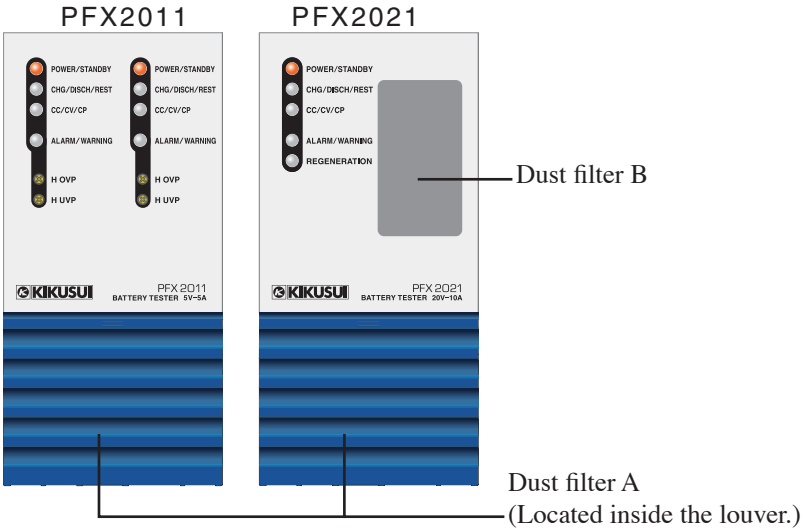


Fig.4-1 Dust Filter Position

⚠CAUTION • Clogged dust filters hinder the cooling of the inside of the unit and can cause malfunction and shortening of the service life.

1. Remove the dust filter by referring to Fig. 4-2.

2. Remove the dust on the filter such as by using a vacuum cleaner.

If the filter is extremely dirty, clean it using a water-diluted neutral detergent and dry it completely.

⚠CAUTION • When the charge/discharge power unit is in operation, air is sucked through the dust filter to cool the unit. If moisture is included in the filter, the temperature or humidity inside the unit increases and may cause a malfunction.

3. Attach the dust filter (louver) to its original position.

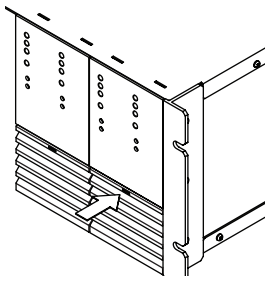
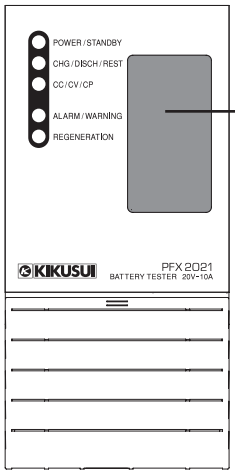
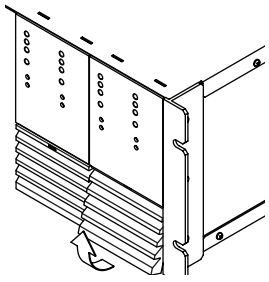
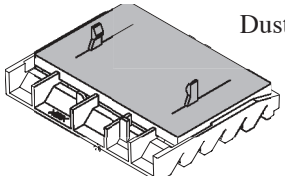
Dust filter A	Dust filter B
 a. Push the top section of the louver (indicated with an arrow) to lift the bottom section.	 Pinch dust filter B and remove it from the panel.
 b. Remove the louver by holding the lifted section and pulling in the direction of the arrow.	
 c.Remove dust filter A from the louver.	

Fig. 4-2 Removal of the Dust Filter

4.2 Inspection

Power cord

Check that the insulation coating is not broken, that the crimp terminal is not loose, and that the wire is not broken.

⚠WARNING

- Be sure to turn off the power switch on the device and the switchboard switch.
- Breaks in the insulation coating may cause electric shock. If a break is found, stop using it immediately.

To purchase accessories, contact your Kikusui agent or distributor.

4.3 Calibration

The product is calibrated at the factory before shipment. However, periodic calibration is necessary due to changes that occur after extended use.

For calibration, contact your Kikusui agent or distributor.

4.4 Malfunctions and Causes

This section describes remedies for malfunctions encountered during the use of the product.

Typical symptoms and check items are indicated. In some cases, the problem can be solved quite easily.

If you find an item that corresponds to your case, follow the remedy for the item. If the remedy does not solve the problem or if your case does not match any of the items, contact your Kikusui agent.

Symptoms related to the charge/discharge power supply unit

Symptom 1: The STANDBY LEDs of all charge/discharge power supply units do not illuminate when the power is turned on.

Check Item	Cause and Remedy
☐ The power cord is not connected properly.	Connect the wires correctly by referring to section 1.4, “Connecting the Power Cord of the PFX2332.”
☐ The unit frame’s protection fuse is blown.	Check to see if the power switch is illuminated in green. If it is not, the fuse may be blown. Contact your Kikusui agent for repairs.

Symptom 2: The STANDBY LED of a particular charge/discharge power supply unit does not illuminate when the power is turned on.

Check Item	Cause and Remedy
☐ The charge/discharge power supply unit is not installed properly.	Insert the unit properly by referring to section 1.5, “Installing and Removing Charge/Discharge Power Supply Units.”
☐ The charge/discharge power supply unit’s protection fuse is blown.	Check that the cooling fan on the rear panel of the charge/discharge power supply unit is rotating. If it is not rotating, the fuse may be blown. Contact your Kikusui agent or distributor for repairs.

Symptom 3: When the power is turned on, the ALARM/WARNING LED blinks in red.

Check Item	Cause and Remedy
☐ The protection function has tripped.	When the power is turned on, the ALARM/WARNING LED may sometimes blink in red. This is a result of the power disruption detection tripping due to the timing when the power switch is turned on (this is not a failure). Turn off the power switch once and turn it back on after waiting for at least 5 seconds.

Symptom 4: The ALARM/WARNING LED is blinking in red.

Check Item	Cause and Remedy
☐ The LED starts blinking immediately after the power is turned on. The LED continues to blink even after the unit is power-cycled.	The power supply circuitry may have malfunctioned. Immediately stop using the product and contact your Kikusui agent or distributor for repairs.
☐ The LED starts blinking immediately after starting charge/discharge.	The power supply circuitry may have malfunctioned. Immediately stop using the product and contact your Kikusui agent or distributor for repairs.
☐ The LED starts blinking in the middle of the test.	The overheat protection function of the power supply circuit may have tripped. The ambient temperature may exceed the operating ambient temperature, the intake or exhaust port may be blocked, the dust filter may be clogged, or the fan may have malfunctioned. If there is no problem in the operating environment and the LED is blinking, immediately stop using the product and contact your Kikusui agent or distributor for repairs.

Symptom 5: Channels are not identified.

Check Item	Cause and Remedy
☐ The STANDBY LED is not illuminated.	Check that the charge/discharge power supply unit is installed properly. Also check the power switch and power cord on the unit frame. If the condition does not improve even after correcting the problem, the charge/discharge power supply unit may have malfunctioned.
☐ The STANDBY LED is illuminated.	Check the TP-BUS wiring. In addition, check that the frame address setting on the unit frame is not the same as other frames. If the condition does not improve, remove the charge/discharge power supply unit from the unit frame and check that dust is not present on the bottom of the rear panel of the unit. In addition, check that dust is not present on the inside of the unit frame (section where the unit engages with the frame)*1.

*1. This is to eliminate optical communication obstruction between the unit frame and the charge/discharge power supply unit.

Symptom 6: The ALARM/WARNING LED is illuminated in orange in the Idle status.

Check Item	Cause and Remedy
☐ The protection function has tripped.	Some of the protection functions (H_OVP, H_UVP, and Conn) of the charge/discharge power supply unit are functional even when the charge/discharge test is not in progress (Idle). Correct the problem by referring to “Cause of Alarms and Their Correction” in the *BPChecker2000 User’s Manual*.

Symptom 7: Correct voltage/current is not indicated.

Check Item	Cause and Remedy
☐ The readout error is large.	• The error may be large immediately after the power is turned on due to initial temperature drift. Check again after waiting for the readout to stabilize (approximately 10 minutes). • There is a tendency for the error to become large in minute voltage or current measurements due to effects from peripheral noise or internal power supply noise. In this case, using the moving average setting sometimes improves the situation. The moving average can be set by the Test Condition Editor Program (Test Condition > Module) of the BPChecker2000. See the *BPChecker2000 User's Manual*. • In average pulse current measurements, the error sometimes become large depending on the pulse time width or current setting. • If the dust filter is clogged and the internal temperature of the charge/discharge power supply unit rises abnormally, the error increases due to the temperature drift of the measurement circuit and other components. Clean the dust filter. • If the error is large under all conditions, the calibration may be off. Contact your Kikusui agent or distributor to have the unit calibrated.
☐ The voltage readout is unstable.	• If you connect an object other than a battery as a DUT, the voltmeter readout may be unstable. • If the power to the frames is supplied by a source other than a commercial AC power supply, the voltmeter readout may be unstable. Connect to a commercial AC power supply. • If the GND wire of the power cord is not connected, the voltmeter readout may be unstable. Ground the unit correctly by referring to section 1.4, "Connecting the Power Cord of the PFX2332."

Symptom 8: Correct temperature is not indicated.

Check Item	Cause and Remedy
☐ The readout error is large.	• The readout error will be large, if you are not using the specified thermistor or if other components such as a capacitor is attached to the thermistor. Use only the specified thermistor. • Check the contact between the DUT and the thermistor. Even a slight gap will greatly affect the measurement result.

Symptom 9: After the test is started, the ALARM/WARNING LED blinks in red.

Check Item	Cause and Remedy
☐ An alarm indication is active.	The charge/discharge power supply unit has detected some kind of error and the test was aborted and is in an alarm status. Correct the problem by referring to "Cause of Alarms and Their Correction" in the *BPChecker2000 User's Manual*.

Symptoms related to the control unit

Symptom 10: The POWER LED does not illuminate even if the control unit is connected to the PC via the USB.

Check Item	Cause and Remedy
☐ The PC is not turned on. Or, the OS is booting up.	• The control unit receives power from the USB. Thus, turn on the PC. Also, wait until the OS boots up completely. • The USB port may not be properly identified on the PC. See "If the Test Executive Cannot Identify Controllers" in the *BPChecker2000 User's Manual*.
☐ The self-powerd USB hub is not turned on.	Turn on the hub.

Symptom 11: The MON ERR LED remains illuminated.

Check Item	Cause and Remedy
☐ An error occurred in the communication control of the application software.	Check whether the application software is running normally. If there is a problem, restart the application software. You may need to restart your PC. When the communication control by the application software returns to normal, the MON ERR LED turns off.

Chapter 5 Specifications

This chapter describes the electrical and mechanical specifications of this product.

5.1 Charge/Discharge Power Supply Unit Specifications

5.1.1 Functional Specifications

Charge function

Item			PFX2011	PFX2021
Static				
	Constant current/ constant voltage CC-CV	Settings	Constant current value (Current)	
			Constant voltage value (CV Voltage)	
		Cutoff condition	Specified time after charge start (Charge Time)	
			Specified time after constant voltage operation (CV Time)	
			Specified current after constant voltage operation (It Current)	
			Specified time after the current falls below It Current (It Time)	
		Rest	Specified time after charge end (Rest Time)	
	Constant current CC	Settings	Constant current value (Current)	
		Cutoff condition	Specified time after charge start (Charge Time)	
			Battery voltage (Max Voltage)	
			Battery voltage drop (-dV)	
			Battery temperature (Max Temp)	
			Temperature increase per unit time (dT/dt)	
		Rest	Specified time after charge end (Rest Time)	
Pulse				
	PWM pulse CC-PWM	Settings	Constant current value (Current)	
			Constant pulse current (Pulse Current)	
			Pulse time during constant pulse current (Pulse Time)	
			Maximum voltage during PWM pulse operation (Max Voltage)	
			Minimum voltage during PWM operation (Min Voltage)	
			ON current during PWM pulse operation (ON Current)	
			OFF current during PWM pulse operation (OFF Current)	
			Current on time during PWM pulse operation (ON Time)	
			Current off time during PWM pulse operation (OFF Time)	
		Transition condition	CC to CC Pulse and CC Pulse to PWM Transition condition voltage (Max Voltage)	
		Cutoff condition	Specified time after charge start (Charge Time)	
			Specified time after PWM charge start (Max Time)	
			Specified time after OFF current start (It Time)	
		Rest	Specified time after charge end (Rest Time)	

Discharge function

Item			PFX2011	PFX2021
Static				
	Constant current CC	Setting	Constant current value (Current)	
		Cutoff condition	Specified time after discharge start (Discharge Time)	
			Battery voltage (Cutoff Voltage)	
		Rest	Specified time after discharge end (Rest Time)	
	Constant power CP	Setting	Constant power value (Wattage)	
		Cutoff condition	Specified time after discharge start (Discharge Time)	
			Battery voltage (Cutoff Voltage)	
		Rest	Specified time after discharge end (Rest Time)	
Pulse				
	Constant pulse current CC Pulse	Setting	Constant pulse current (Pulse Current)	
			Pulse time (Pulse Time)	
		Cutoff condition	Specified time after discharge start (Discharge Time)	
			Battery voltage (Cutoff Voltage)	
		Rest	Specified time after discharge end (Rest Time)	
	Constant pulse power CP Pulse	Setting	–	Constant pulse power value (Pulse Wattage)
				Pulse time (Pulse Time)
		Cutoff condition		Specified time after discharge start (Discharge Time)
				Battery voltage (Cutoff Voltage)
		Rest		Specified time after discharge end (Rest Time)

Measurement function

Item		PFX2011	PFX2021
Static			
	Battery voltage	Average voltage value for each 500 ms.	
	Charge/discharge current	Average voltage value for each 500 ms.	
	Battery temperature	Simplified temperature measurement function using a thermistor as a temperature sensing element (Temperature).	
	Capacity	Integration of the calculated value for the current against the elapsed time.	
	Time	Integrated time since charge (discharge) start during measurement.	
Pulse			
	Battery voltage	Maximum voltage and minimum voltage in one cycle (PeakPoint).	
		Set arbitrary points to measure the voltage (Multi Point).	
	Charge/discharge current	Average current (Average)	
	Battery temperature	Simplified temperature measurement function using a thermistor as a temperature sensing element.	
	Capacity	The product of the measured current (average current) and the elapsed time.	
	Time	Integrated time since charge (discharge) start during measurement.	

Protection function

Item		PFX2011	PFX2021
Overvoltage (over-charge) protection	Software OVP	Shuts OFF the output of the corresponding channel. Released by resetting the alarm.	
	Hardware OVP	Shuts OFF the output of the corresponding channel. Released by resetting the alarm.	
Undervoltage (overdischarge) protection	Software UVP	Shuts OFF the output of the corresponding channel. Released by resetting the alarm.	
	Hardware UVP	Shuts OFF the output of the corresponding channel. Released by resetting the alarm.	
Overcharge capacity protection (OAH)		Shuts OFF the output of the corresponding channel. Released by resetting the alarm.	
DUT overtemperature protection (OTP)		Shuts OFF the output of the corresponding channel. Released by resetting the alarm.	
PS board error (PS Alm)		Hardware overvoltage and overheat	
CD board overheat (OHP)		Reverts to idle status after changing to normal temperature.	
CD board error (CD Alm)		Occurs due to causes such as an open-circuit in the current line or line drop of the current line.	
DUT (battery) connection error (Connection Error)		Displays a warning before the execution of the test, if battery is not connected.	
Communication error		Internal communication error	
Watchdog timer		Shuts off the output when tripped and the test is aborted. 419 ms cycle.	
AC power line error (AC off)		Detects short interruption of approx. 50 ms. Shuts off the output of the corresponding channel.	
Alarm monitoring		OVP, UVP, OAH, OTP, PS Alm, OHP, CD Alm, Connection Error, Communication Error, and AC off.	

Other functions

Item			PFX2011	PFX2021
Range switching				
	Current range	High	0.0 mA to 5000.0 mA	–
		Low	0.00 mA to 500.00 mA	
Power saving function				
	Discharge power regeneration		–	Regeneration operation in the battery voltage range specified for discharging.
	Main power short circuit mode		–	Short-circuits the main power supply when the battery voltage is high during discharge.
	Vce control		Controls to keep the loss at the electronic load section constant.	
	Fan control		Turns ON at approximately 45 °C or more (fast), OFF at 40 °C or less (slow).	
	Standby mode		Shuts off the main power supply input when in standby mode.	Stops the main power supply operation.
Auto fine function		Correctable range	±30 digits (Enable/disable selectable. Normally disabled. During constant current.)	
Update rate			120 ch/1 s Max (when using two USB ports (two control units) with 30 channels per port)	60 ch/1 s Max (when using two USB ports (two control units) with 15 channels per port)
Expansion function			DC impedance measurement of batteries. (when the PFX2211 is connected)	
Status monitoring				
	Standard State		Power OFF, Idle, Idle (DUT Connection Warning), Idle (Protection Warning) , H Protection, Charge, Charge Rest, Charge SYNC, Charge End, Discharge, Discharge Rest, Discharge SYNC, and Discharge End	
	Operate		OFF, CC, CV, CP, Power Limit, and CC Pulse	

5.1.2 Electrical Specifications

Unless specified otherwise, the specifications are for the following conditions.

- After the warm-up time of 30 minutes has elapsed

Rated output

Item	PFX2011	PFX2021
Number of outputs	2 ch	1 ch
Charge current range	0.0 mA to 5000.0 mA (High range) 0.00 mA to 500.00 mA (Low range)	0 mA to 10000 mA
Charge voltage range	0.0000 V to 5.0000 V	0.000 V to 20.000 V
Discharge current range	0.0 mA to 5000.0 mA (High range) 0.00 mA to 500.00 mA (Low range)	0 mA to 10000 mA
Discharge voltage range	-0.5000 V to 5.0000 V	-2.000 V to 20.000 V
Maximum charge/discharge power	25.00 W	200.00 W

Accuracy of settings

Item			PFX2011	PFX2021
Static				
	Constant current charge/ discharge	Range	0.0 mA to 5000.0 mA (High range) 0.00 mA to 500.00 mA (Low range)	0 mA to 10000 mA
		Accuracy[aj]	±(0.05 %+1.0 mA) (High range) ±(0.05 %+0.10 mA) (Low range)	±(0.15 %+2.0 mA)
		Resolution	0.1 mA (High range) 0.01 mA (Low range)	1 mA
		Ripple[bj]	1 mA rms (High/Low range)	3 mA rms
	Constant voltage charge	Range	0.0000 V to 5.0000 V	0.000 V to 20.000 V
		Accuracy[cj]	±(0.03 %+1.0 mV)	±(0.10 %+3.0 mV)
		Resolution	0.1 mV	1 mV
		Ripple[bj]	2 mV rms	5 mV rms

Item			PFX2011	PFX2021
Static (continued)				
	Constant power discharge	Range	0.01 W to 25.00 W (High range) 0.001 W to 2.500 W (Low range)	0.02 W to 200.00 W
		Accuracy[dj]	±(0.10 %+10.0 mW) (High range) ±(0.10 %+2.0 mW) (Low range)	±(0.50 %+20.0 mW))
		Resolution[e]	10 mW (High range) 1 mW (Low range)	10 mW
Pulse				
	Constant current discharge	Range	0.0 mA to 5000.0 mA (High range) 0.00 mA to 500.00 mA (Low range)	0 mA to 10000 mA
		Resolution	0.1 mA (High range) 0.01 mA (Low range)	1 mA
		Accuracy[aj]	±(0.07 %+1.0 mA) (High range) ±(0.07 %+0.10 mA) (Low range)	±(0.15 %+3 mA)
		Number of settings	8 values	20 values
		Response[fj]	50 µs (typical)	70 µs (typical)
	Time width	Range[g]	0.50 ms to 65000.00 ms	
		Accuracy[j]	±(0.05 %+0.05 ms)	
		Resolution	10 µs	
	Constant power discharge	Range	–	0.02 W to 200.00 W
		Resolution		10 mW
		Accuracy[j]		±(0.5 %+20.0 mW)[h]
		Number of settings		20 values
		Update rate		2 ms (typical)[i]
	Time width	Range	–	5.00 ms to 65000.00 ms
		Accuracy[j]		±(0.05 %+0.05 ms)
		Resolution		10 µs

Item			PFX2011	PFX2021
Pulse (continued)				
	PWM charge	Range	0.0 mA to 5000.0 mA (High range)	0 mA to 10000 mA
			0.00 mA to 500.00 mA (Low range)	
		Resolution	0.1 mA (High range)	1 mA
			0.01 mA (Low range)	
		Accuracy[aj]	±(0.07 %+1.0 mA) (High range)	±(0.15 %+3.0 mA)
			±(0.07 %+0.10 mA) (Low range)	
		Response[fj]	50 µs (typical)	70 µs (typical)
	Time width	Range[g]	0.50 ms to 65000.00 ms	
		Accuracy[j]	±(0.05 %+0.05 ms)	
		Resolution	10 µs	

a. With respect to the specified current within the rated range.
b. Maximum value at 10 Hz to 500 kHz.
c. With respect to the specified voltage within the rated range.
d. With respect to the specified power at a battery voltage of 0.5 V or greater on the PFX2011, or 2 V or greater on the PFX2021.
e. Voltage operation range of constant power discharge (warranted value) 0.5 V to 5 V on the PFX2011, 2 V to 20 V on the PFX2021.
f. At 10 % to 90 % of the pulse current waveform when rated current is set. Short-circuit at the tip of the 7-m load cable.
g. The pulse time width is measured at the mesial point of the pulse.
h. With respect to the specified power at a battery voltage of 2 V or greater.
i. Indicates the update rate of the control current by software computation. It is always a fixed time regardless of the pulse time width.
j Ambient temperature: 18 °C to 28 °C

Measurement accuracy

Item			PFX2011	PFX2021
Static				
	Current measurement	Range	0.0 mA to 5000.0 mA (High range)	0.0 mA to 10000.0 mA
			0.00 mA to 500.00 mA (Low range)	
		Accuracy[ag]	±(0.04 %+0.8 mA) (High range)	±(0.15 %+1.5 mA)
			±(0.04 %+0.08 mA) (Low range)	
		Resolution	0.1 mA (High range)	0.1 mA
			0.01 mA (Low range)	
	Voltage measurement	Range	-0.5000 V to 5.0000 V	-2.0000 V to 20.0000 V
		Accuracy[ag]	±(0.02 %+1.0 mV)	±(0.10 %+2.0 mV)
		Resolution	0.1 mV	

Item			PFX2011	PFX2021
Static (continued)				
	Capacity calculation	Range	0.0000 Ah to 119.3000 Ah (High range) 0.00000 Ah to 11.93000 Ah (Low range)	0.0000 Ah to 200.0000 Ah
		Resolution	0.1 mAh (High range) 0.01 mAh (Low range)	0.1 mAh
		Accuracy[g]	Depends on the current measurement accuracy and the accuracy of the CPU clock.	
	Time	Clock accuracy[g]	±50 PPM	
Pulse				
	Charge/ discharge current	Range	0.0 mA to 5000.0 mA (High range) 0.00 mA to 500.00 mA (Low range)	0.0 mA to 10000.0 mA
		Accuracy[g]	±(0.10 %+1.0 mA) (High range) ±(0.10 %+0.10 mA) (Low range)	±(0.20 %+3.0 mA)
		Resolution	0.1 mA (High range) 0.01 mA (Low range)	0.1 mA
		Measured value[b]	Average current	
	Battery voltage	Range	-0.5000 V to 5.0000 V	-2.0000 V to 20.0000 V
		Accuracy[g]	±(0.05 %+1.0 mV)	±(0.15 %+2.0 mV)
		Resolution	0.1 mV	
		Measurement point	High voltage[c]	
			Low voltage[d]	
			Arbitrary[e]	
	Capacity calculation	Range	0.0000 Ah to 119.3000 Ah (High range) 0.00000 Ah to 11.93000 Ah (Low range)	0.0000 Ah to 200.0000 Ah[f]
		Resolution	0.1 mAh (High range) 0.01 mAh (Low range)	0.1 mAh
		Accuracy[g]	Depends on the current measurement accuracy and the accuracy of the CPU clock.	
	Time	Clock accuracy[g]	±50 PPM	

a. With respect to the actual value within the rated range.
b. Measures the average current every 500 ms.
c. Indicates the maximum battery voltage in one cycle.
d. Indicates the minimum battery voltage in one cycle.
e. Arbitrary pulse current point in one cycle.
f. Continuous measurement using an A/D converter (VF converter) dedicated to pulse current measurement on the PFX2021.
g. Ambient temperature: 18 °C to 28 °C

Temperature measurement

When using the thermistor provided (103AT-2 by Ishizuka Electronics Corp.) as a temperature sensing element

Item		PFX2011	PFX2021
Resistance (temperature) measurement section[a]			
	Measurable range[b]	-40.0 °C to 100.0 °C	
	Measurement resolution[b]	0.1 °C	
	Measurement accuracy[bce]	±0.5 °C at measurement temperature of 0 °C to 40 °C	
		±1 °C at measurement temperature of -20 °C to 80 °C	
Reference (temperature sensing element: thermistor)			
	Model	103AT-2 by Ishizuka Electronics Corp.	
	R_{25}[d]	10.0 kΩ	
	Operating temperature range	-50 °C to 110 °C	
	Temperature accuracy[e]	±0.5 °C at measurement temperature of 0 °C to 40 °C	
	Tolerance	±1 %	
	B value	3435 K±1 % at 25 °C	

a. The temperature measurement does not trace the absolute temperature.
b. Temperature derived by converting the resistance
c. Excluding errors in the temperature sensing element.
d. Nominal resistance value at 25 °C.
e. Ambient temperature: 18 °C to 28 °C

Protection function

Item			PFX2011	PFX2021
Overvoltage (overcharge) protection				
	Software OVP	Range	0.0000 V to 5.1000 V	0.000 V to 21.000 V
		Accuracy[ao]	±(0.02 %+1.0 mV)	±(0.10 %+2.0 mV)
		Resolution	0.1 mV	1 mV
		Time to trip	150 ms maximum	
	Hardware OVP	Range	0.1 V to 6.0 V	0.1 V to 22.0 V
		Accuracy[bo]	±(1 %+20 mV)	–
		Error[c]	±50 mV	±100 mV
		Resolution[d]	100 mV	
		Time to trip[eo]	100 µs maximum	
Undervoltage (overdischarge) protection				
	Software UVP	Range	-2.1000 V to 5.0000 V	-2.100 V to 19.000 V
		Accuracy[ao]	±(0.02 %+1.0 mV)	±(0.10 %+2.0 mV)
		Resolution	0.1 mV	1 mV
		Time to trip	150 ms maximum	

Item			PFX2011	PFX2021
Undervoltage (overdischarge) protection (continued)				
	Hardware UVP	Range[f]	-1.2 V to 4.2 V	-2.1 V to 20.0 V
		Accuracy[go]	±(1 %+20 mV)	–
		Error[c]	±50 mV	±100 mV
		Resolution[d]	100 mV	
		Time to trip[ho]	100 µs maximum	
Overcurrent protection				
	Load shorting protection[i]		7 A	15 A
Capacity (overcharge/overdischarge) protection				
	Software OAH	Range	100 % to 1000 %[j]	
		Accuracy[o]	Depends on the current measurement accuracy and the accuracy of the CPU clock.	
		Resolution	1 %	
Overtemperature protection (DUT)				
	Software OTP	Range	-40.0 °C to 100.0 °C	
		Resolution	0.1 °C	
Overtemperature protection (inside the device)				
	CD Board		95 °C[k]	
	PS Board		100 °C[k]	95 °C[k]
AC input overcurrent protection				
	Keel Board		3 A[l]	4 A[l]
	PS Board		3 A[m]	–
	subPS Board		1 A[n]	4 A[n]

a. Same as the voltage measurement accuracy.
b. With respect to the preset value.
c. With respect to the preset value when set using the application software.
d. When set using the application software.
e. From the point when overvoltage is detected to when test abort operation starts.
f. The upper limit is the hardware OVP preset value.
g. With respect to the actual value.
h. From the point when undervoltage is detected to when test abort operation starts.
i. Protects the DUT from overdischarge by a short circuit inside the device. Depends on the fuse at the output end.
j. Sets the capacitance that the application calculates by multiplying the specified percentage to the known nominal capacitance.
k. Internal heatsink temperature
l. Depends on the fuse in the AC input block.
m. Depends on the input fuse of the main power supply board.
n. Depends on the input fuse of the sub power supply board.
o Ambient temperature: 18 °C to 28 °C

Status indication

Item		PFX2011	PFX2021
Power supply status			
	POWER	Illuminated in green: Test execution possible.	
	STANDBY	Illuminated in orange: Standby status (unit removable from the frame).	
Charge/discharge status			
	CHG	Illuminated in red: Charge operation status	
	DISCHG	Illuminated in green: Discharge operation status	
	REST	Illuminated in orange: Rest status	
Control status			
	CC	Illuminated in red: Constant current operation	
	CV	Illuminated in green: Constant voltage operation	
	CP	Illuminated in orange: Constant power operation	
Warnings			
	ALARM	Illuminated in red: Abnormal status. Illuminates when the protection function has tripped.	
	WARNING	Illuminated in orange: Warning. Illuminates when starting the test would trip the protection function.	
Regeneration status			
	REGENERATION	–	Illuminated in blue: Regeneration operation status

5.1.3 General Specifications

Item			PFX2011	PFX2021
Temperature range	Operating temperature range		0 °C to 40 °C (+32 °F to 104 °F)	
	Storage temperature range		-10 °C to 60 °C (+14 °F to 140 °F)	
Humidity range	Operating humidity range		30 % to 80 % RH (no condensation)	
	Storage humidity range		20 % to 80 % RH (no condensation)	
Insulation resistance	Between AC input and chassis		100 MΩ or more at 500 VDC	
	Between unit output and chassis		20 MΩ or more at 50 VDC	
Withstand voltage	Between AC input and chassis		1500 VAC for 1 minute at 50 mA or less	
AC input			Received from the dedicated frame.	
	Power consumption	At rated output	400 VAmax when two channels are charged at their specified ratings.	800 VAmax when charged at the specified rating (1 unit alone).
		At no-load	60 VAmax when two channels are in standby status.	50 VAmax in standby status (1 unit alone).
TP-BUS interface		Addresses	1 to 120	1 to 119 (odd numbers only)
Safety[a]			Complies with the requirements of the standard below. IEC61010-1:2001 Class I[b] Pollution degree 2[c]	
Miscellaneous	Dimensions (Approx.)		85.5 W x 177 H x 523 D mm (3.37 W x 3.97 H x 20.59 D inch) 85.5 W x 177 H x 560 D mm maximum (3.37 W x 3.97 H x 22.05 D inch maximum)	
	Weight		Approx. 4 kg (8.82 lbs)	Approx. 4.5 kg (9.92 lbs)
	Accessories		Handling of the Product: 1 sheet	

a. Safety is designed and evaluated with the charge/discharge power supply unit installed in the dedicated frame.
b. This product is a Class I instrument. Be sure to ground the protective conductor terminal of the product. The safety is not guaranteed unless the product is grounded properly.
c. Pollution is addition of foreign matter (solid, liquid or gaseous) that may produce a reduction of dielectric strength or surface resistivity. Pollution degree 2 assumes that only non-conductive pollution will occur except for an occasional temporary conductivity caused by condensation.

5.2 Unit Frame Specifications

5.2.1 Functional Specifications

Item		PFX2332
Function	Number of installable units	5 units
	Channel signal transmission[a]	1 to 120 ch
	Impedance measurement scanner[b]	10 channels
	TP-BUS terminator[c]	1 circuit
Protection function	External trip	Short the TRIP+ and TRIP- terminals. Power switch OFF.

a. Signal generation function for automatic identification of channels.
b. Impedance measurement scanner function (with malfunction protection function)
c. TP-BUS terminator

5.2.2 Electrical Specifications

Item			PFX2332
Protection function	AC input overcurrent protection[a]		20 A minimum
	External trip	Open-circuit voltage	24 V
		Exciting current[b]	300 mA
		Time of application	2 s maximum

a. Depends on the fuse in the AC input block.
b. Indicates the short-circuit current when the TRIP terminals are shorted.

Input/output connector

Pin No.	Signal Name	Description
OUTPUT TERMINAL		
1	+	Positive current terminal. Connect to the positive terminal of the DUT (battery).
2	-	Negative current terminal. Connect to the negative terminal of the DUT (battery).
3	+S	Positive voltage terminal. Connect to the positive terminal of the DUT (battery).
4	-S	Negative voltage terminal. Connect to the negative terminal of the DUT (battery).
5	+T	Temperature measurement terminal. Connect to the thermistor that came with.
6	-T	Temperature measurement terminal. Connect to the thermistor that came with.
7	FG	Shield grounding terminal. It is connected to the chassis of the unit frame.
DUT connector		
1	FG	Chassis ground (for sensing wire shield)
2	FG	Chassis ground (for sensing wire shield)
3	AC SRC P	Current terminal for measurment (+)
4	AC SENSE P	Impedance detection terminal (+)
5	AC SENSE N	Impedance detection terminal (-)
6	AC SRC N	Current terminal for measurment (-)
7	+5VR	Power to the unit frame scanner.
8	GND	Power to the unit frame scanner.
CONT connector		
1	NC	
2	CHSEL 0	Unit frame scanner control logic (bit 0)
3	CHSEL 1	Unit frame scanner control logic (bit 1)
4	CHSEL 2	Unit frame scanner control logic (bit 2)
5	CHSEL 3	Unit frame scanner control logic (bit 3)
6	NC	

5.2.3 General Specifications

Item			PFX2332
Temperature range	Operating temperature range		0 °C to 40 °C (+32 °F to 104 °F)
	Storage temperature range		-10 °C to 60 °C (+14 °F to 140 °F)
Humidity range	Operating humidity range		30 % to 80 % RH (no condensation)
	Storage humidity range		20 % to 80 % RH (no condensation)
Insulation resistance	Between AC input and chassis		50 MΩ or more at 500 VDC
	Between output and chassis		20 MΩ or more at 50 VDC
Withstand voltage	Between AC input and chassis		1500 VAC for 1 minute at 50 mA or less
AC input	Nominal input rating		200 VAC to 240 VAC, 50/60 Hz, single phase
	Input voltage range		180 VAC to 250 VAC
	Power consumption	At rated output	4000 VA[a]
		At no-load	30 VA[b]
Dimensions			See section 5.2.3, “Outline Drawing”
Weight			13 kg (292.11 lbs)
Accessories			Rack mount oval head screw: 4 pcs.
			Rack mount cup washer: 4 sheets
			Unit attachment screw: 10 pcs.
			TP-BUS connector: 1 pc.
			TP-BUS core: 1 pc.
			Output connector: 10 pcs.
			Screwdriver: 1 pc.
			Thermistor: 10 pcs.
			Handling of the Product: 1 sheet

a. When the 5 PFX2021 (5 channels) units are operating at their specified ratings.
b. When the unit frame is not installed.

5.2.4 Outline Drawing

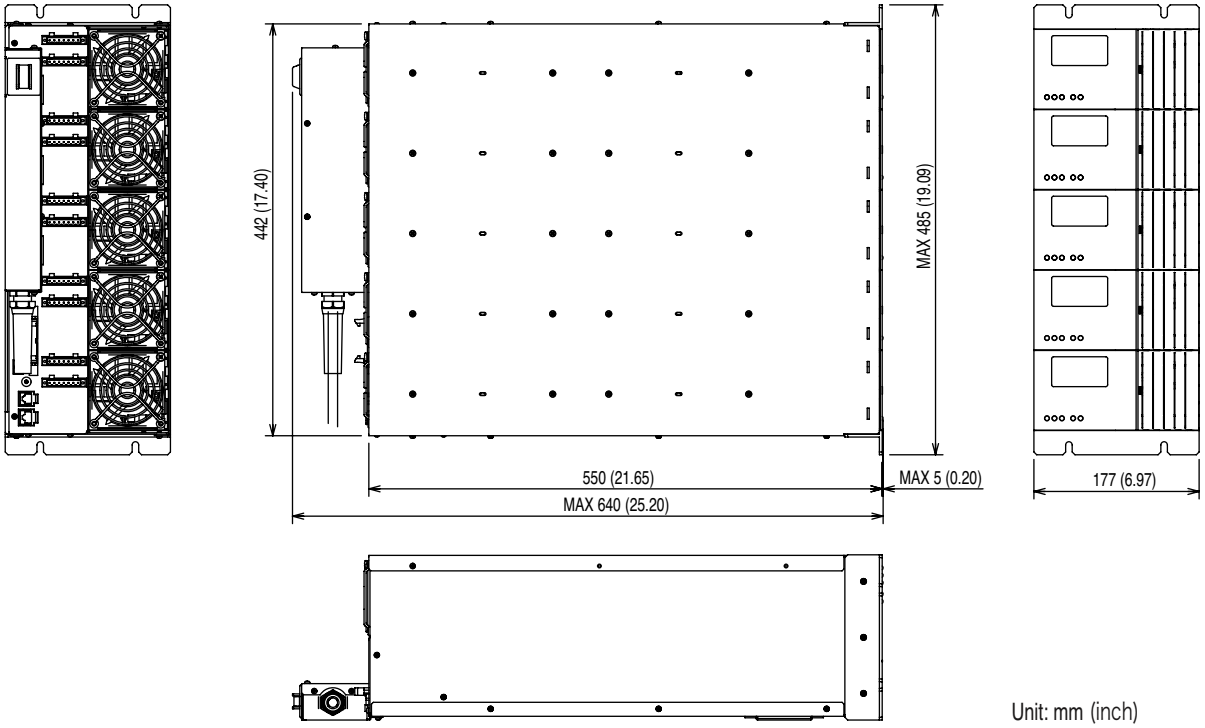


Fig. 5-1 PFX2332 Unit Frame
(The figure shows the case when PFX2021s are installed)

5.3 Control Unit Specifications

5.3.1 Electrical Specifications

Item			PFX2121
USB	Number of lines		1 line
	Communication specifications		Complies with USB1.1
	Data rate		Full speed12 Mbps maximum
	Connection		Connect to a PC using the USB cable that is included in the package.[a]
TP-BUS	Number of lines		2 lines TP-BUS1/TP-BUS2
	Connection		60 channels/line Using the TP-BUS connector included in the package. Total length of a single line: 200 m or less Number of twists: 1 turn/cm
	Polarity		None
	Applicable wire size	Solid wire	ϕ 0.65 (AWG22)
		Stranded wire	0.32 mm^2
Update rate	1 to 30 channels/port (TP-BUS)		Every 1 s[b]
	31 to 60 channels/port (TP-BUS)		Every 2 s[c]
Indication	POWER		Green Blinking: Indicates the status in which connection is established via the USB. Illuminated: Indicates that the device has been opened and that it can operate as a controller.
	MON ERR		Red Illuminated: Indicates that an error occurred in the periodic monitoring communication with the application.
	TP-BUS1		Green Illuminated: Indicates that communication is taking place with channels 1 to 60 or the impedance measurement unit.
	TP-BUS2		Green Illuminated: Indicates that communication is taking place with channels 61 to 120.
Power requirement			5 V, 300 mA or less, received from the USB.

a. Connectable to the USB port on the PC or a self-powered USB hub.
This product is a high-powered device (BUS powered). You cannot connect the product to a bus-powered USB hub.
b. USB 2 port (two controllers), update possible at 120 channels/1 s when 30 channels are connected to each port.
c. USB 2 port (two controllers), update possible at 240 channels/2 s when 60 channels are connected to each port.

5.3.2 General Specifications

Item		PFX2121
Temperature range	Operating temperature range	0 °C to 40 °C (+14 °F to 140 °F)
	Storage temperature range	-10 °C to 60 °C (+32 °F to 104 °F)
Humidity range	Operating humidity range	30 % to 80 % RH (no condensation)
	Storage humidity range	20 % to 80 % RH (no condensation)
Dimensions		See section 5.3.3, “Outline Drawing”
Weight		Approx. 500 g (1.95 lbs)
Accessories		USB cable 2 m: 1 pc.
		TP-BUS connector: 2 pcs.
		TP-BUS core: 2 pcs.
		Operation manual: 1 pc.

5.3.3 Outline Drawing

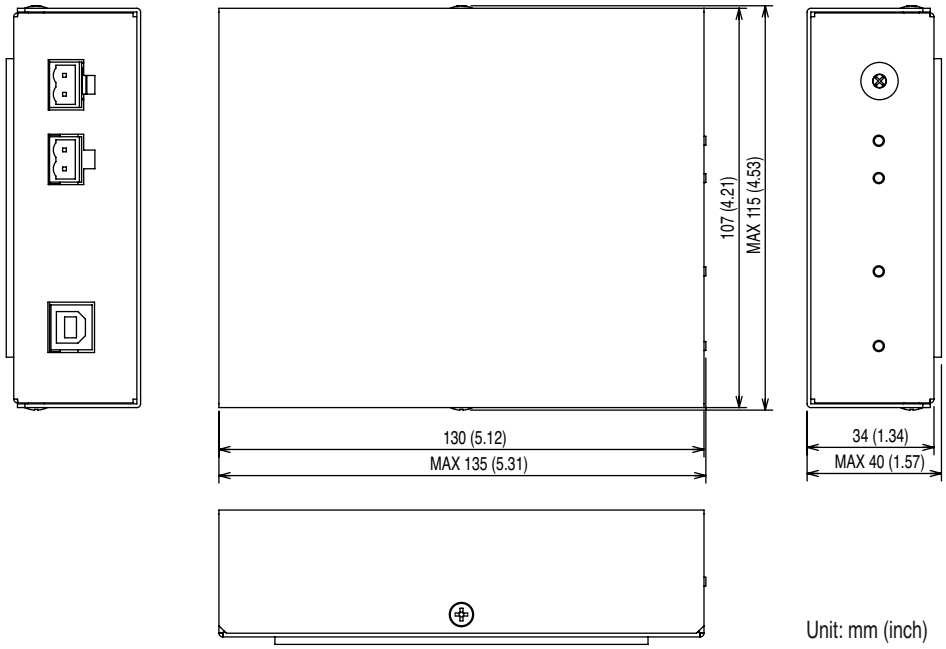


Fig. 5-2 PFX2121 120-ch Control Unit

Appendix

A.1 Measurement Function of the Charge/ Discharge Power Supply Unit

This section describes the method and the characteristics of voltage and current measurement on the charge/discharge power supply unit.

A.1.1 Overview

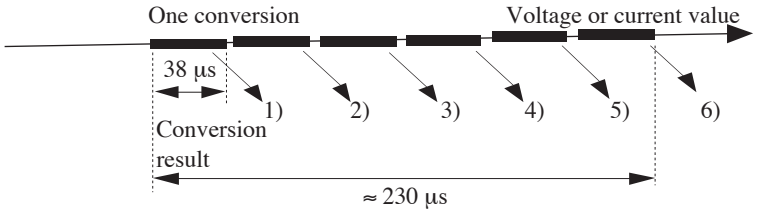
This unit is equipped with a 26-kHz high-speed A/D converter with 24-bit resolution for making measurements. This allows high-speed and high-accuracy measurements at high resolution.

In addition, the PFX2021 is equipped with a voltage-to-frequency converter (VF converter) for measuring pulse charge/discharge currents which enables capacity calculations at high accuracy even during pulse charge/discharge operation.

A.1.2 Measurements during Normal Operation

■ High-speed conversion and averaging

To obtain highly accurate measurement results using the high-speed A/D converter that performs one conversion in 38 μs, this unit performs six consecutive conversions as shown in Fig. A-1 and uses the average value as the measurement result. This conversion method applies both to voltage and current measurements.



Measurement result = 1)+2)+3)+4)+5)+6)/6

Fig.A-1 Analog-to-Digital Conversion Method

■ Noise rejection and sampling interval

On the voltage sensing line, there are various noise components that are superimposed on the signal in addition to the DC voltage that needs to be measured.

To minimize the effects of hum noise, this unit measures voltage in synchronization with the commercial power supply period as illustrated by Fig. A-2. Therefore, the measurement interval (sampling interval) is equal to the power supply period (except during pulse operation). This makes stable measurement possible even when the voltage sensing line is extended to 7 m.

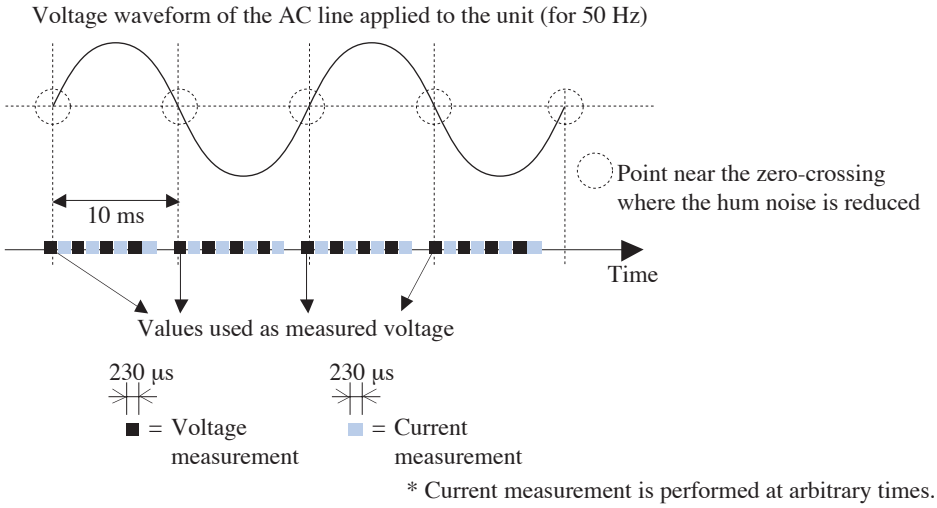


Fig. A-2 Measurement Interval

■ Auto fine function

The auto fine function brings the current value set by the constant current operation and the current that actually flows closer together through automatic adjustment. You can eliminate the error caused by the accuracy of the constant current setting by enabling this function. This function is effective when you need higher accuracy of constant current performance or when you wish to suppress the current error between channels.

Operating principle

As explained in section A.1.1, “Overview,” this unit is equipped with a high-resolution A/D converter. The auto fine function uses the highly accurate current measurement performance to correct the D/A converter output so that “measured current = constant current setting” is achieved. By adopting a correction converter as shown in Fig. A-3, the resolution of the D/A converter is effectively increased to approximately the same level as the resolution of the A/D converter.

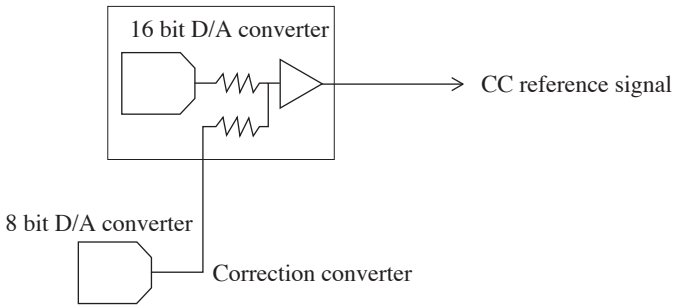


Fig. A-3 Correction Converter

Fig. A-4 is an example of the auto fine operation when the current is set to 3.0000 A.

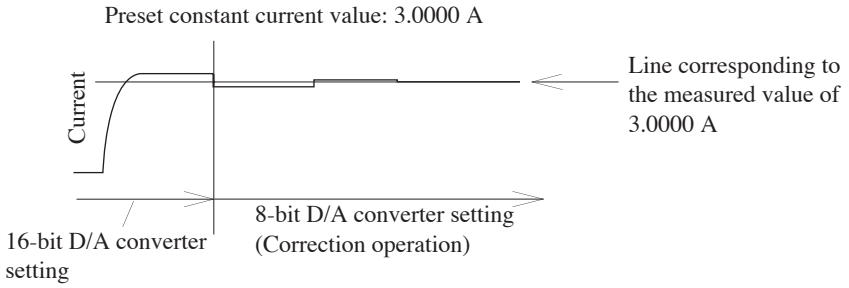


Fig. A-4 Auto Fine Operation Example

Operation

- The auto fine function is active only during constant current (CC) operation. During CC-CV operation, auto fine operates only during the CC period. It does not operate during pulse charge/discharge operation.
- The range of correction is limited to ±30 digits. For example, if the difference between the preset value and the measured value is 40 digits, correction is performed up to 30 digits. In this case, the difference between the preset value and the measured value is 10 digits. This limitation makes identification of abnormality easier when the accuracy of the settings is off by an extreme amount for some reason.
- The preset value and the measured value never are completely the same. For performance reasons, the operation stops after correcting the values within approximately 3 digits.
- Correction is performed at 1-s cycle. It may take from several seconds to several tens of seconds for the correction to complete.
- The auto fine function can be set by the Test Condition Editor Program (Test Condition > Module) of the BPChecker2000. See the *BPChecker2000 User's Manual*.

■ Measurements during pulse charge/discharge operation

The measurement method during pulse charge/discharge operation differs between the PFX2011 and the PFX2021.

PFX2011

During pulse charge/discharge operation, the unit makes measurements at the following times.

If the specified pulse time is greater than or equal to 1.5 ms, the current and then the voltage are measured immediately before the next current value is set as shown in Fig. A-5. Otherwise, the voltage and then the current are measured as shown in Fig. A-6.

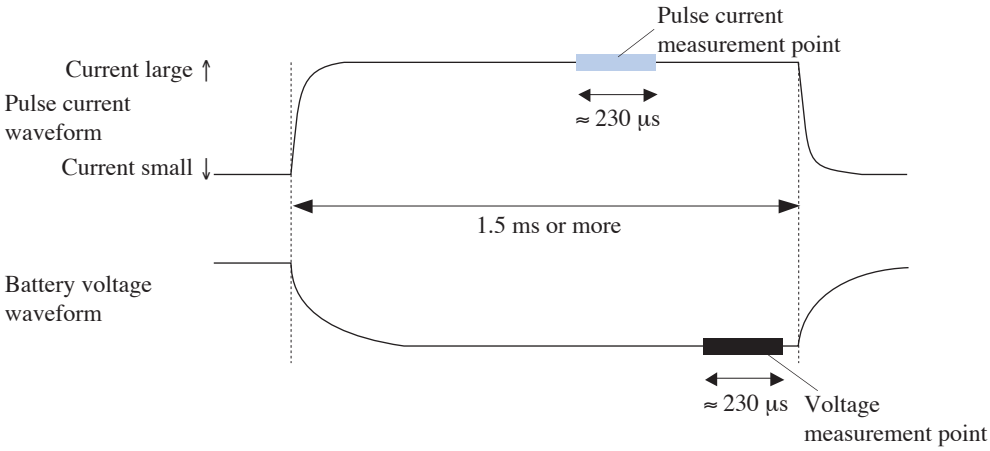


Fig. A-5 Example 1 during Pulse Charge (when the pulse time is greater than or equal to 1.5 ms)

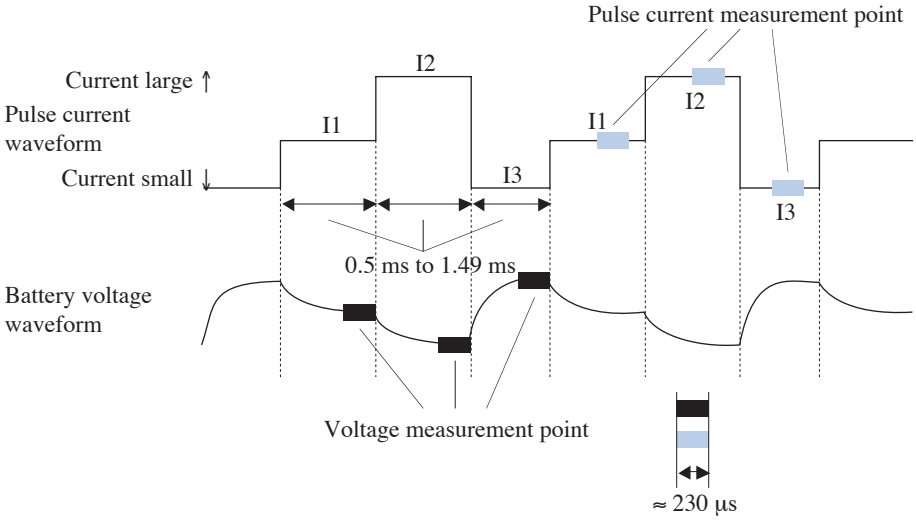


Fig. A-6 Example 2 during Pulse Charge (when the pulse time is less than 1.5 ms)

PFX2021

As shown in Fig. A-7, voltage measurement and current measurement are performed independently at the same time regardless of the specified pulse time width.

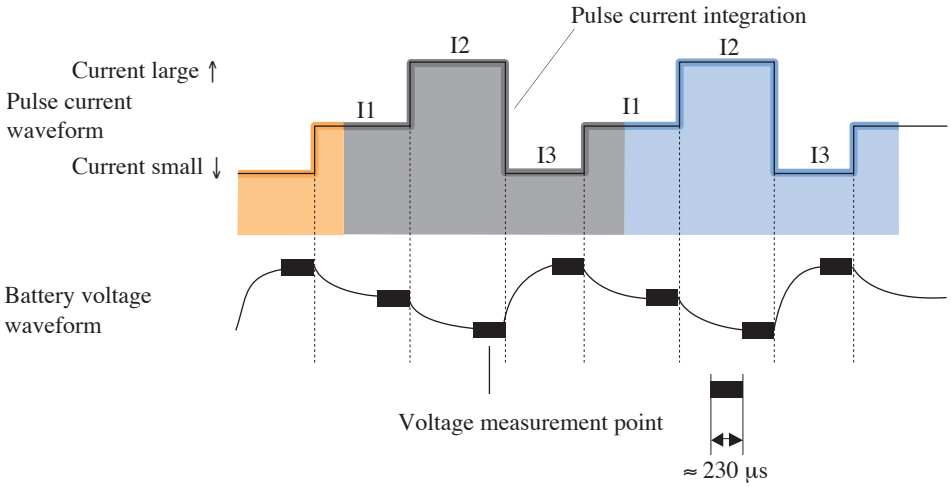


Fig. A-7 Example 3 during Pulse Charge

■ Pulse voltage measurement

PFX2011 and PFX2021

The following two types of measurement modes are available for pulse voltage measurement.

1. Peak measurement

   Measures the maximum and minimum voltages in one pulse cycle. If a pulse current with a short time width is repeated, this measurement method is often used.

2. Point measurement

   Measurement is performed according to the specified measurement points (2 points). This is useful when you wish to arbitrary fix the measurement point.

NOTE

- If the battery voltage fluctuation is large with respect to the change in the pulse current as shown in Fig. A-8, the measured voltage returns an average value within the conversion period.

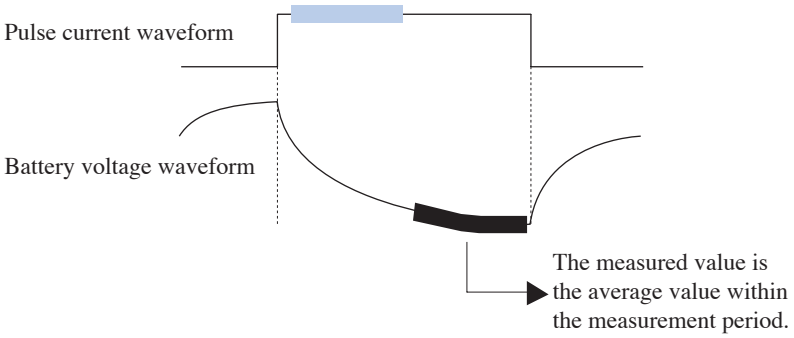


Fig. A-8 When the Voltage is Fluctuating during the Measurement Period

■ Pulse current measurement

PFX2011

In pulse current measurement, each pulse current is measured and the average current is calculated over a unit time.

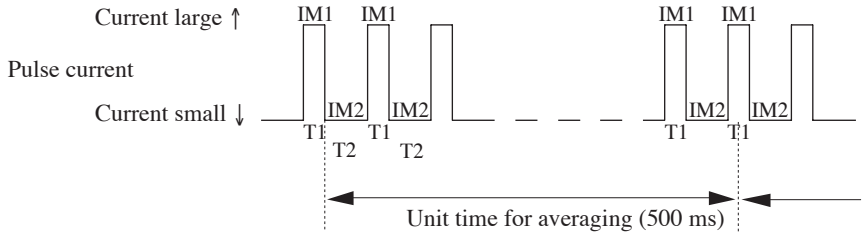
$$\text{Average current} = \frac{IM1 \bullet T1 + IM2 \bullet T2 + IM3 \bullet T3 + IM4 \bullet T4}{Tave} \quad \text{(Equation 1)}$$

IMn: Measured value of each pulse current
Tn: Time width of each pulse
Tave: Unit time for averaging (fixed to 500 ms)

Below is an explanation using an actual waveform.

Fig. A-9 is an example for a pulse waveform with a pulse time width that is shorter than the unit time for averaging.

In this case, the average current is derived by summing the product of the measured pulse current and the pulse time width until the unit time is reached (numerator of Equation 1). When the unit time is reached, the sum is divided by the unit time to derive the average current.

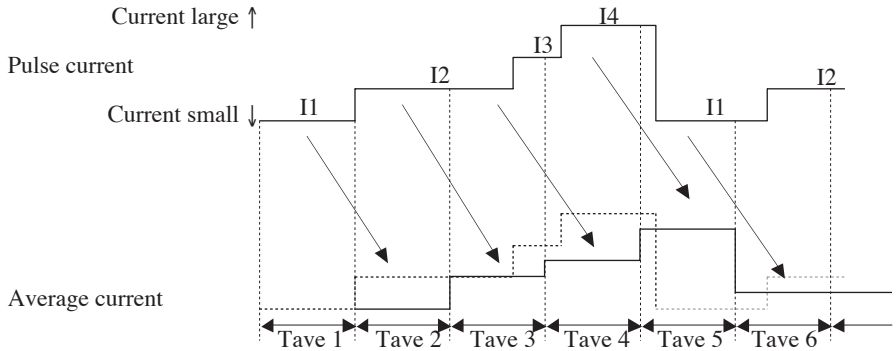


Average calculation

Average current = IM2 • T2+IM1 • T1+IM2 • T2+IM1 • T1+ ••• +IM1 • T1/500 ms

Fig. A-9 Averaging Example 1 of Pulse Current Measurement

Fig. A-10 is an example for a pulse waveform with a pulse time width that is longer than or approximately the equal as the unit time for averaging. Similar to Fig. A-9, the measured value of the current that flows during the unit time for averaging is used to calculate the average current.



Tave n: Unit time for averaging (fixed to 500 ms)

Fig. A-10 Averaging Example 2 of Pulse Current Measurement

NOTE

- **Points to note concerning the PFX2011 pulse current measurement**
- The calculation result of the average current is output after the relevant unit time for averaging has elapsed (this is also the same as the case shown in Fig. A-9). The average current calculation function of the unit is operating asynchronously with the period of the specified pulse waveform. Therefore, the current value that is displayed does not indicate the average current over each pulse period. This is the reason why the measured value of the average current during operation does not indicate a constant value.
- The accuracy of the pulse current measurement varies depending on the response (rise and fall times) of the pulse current that actually flows. The response (rise and fall times) varies depending on the length of the output line to the DUT, the characteristics of the DUT, and the pulse current setting. The pulse current measurement function of the unit takes these delay elements into consideration and makes measurements at the point when the current has sufficiently settled.

  In the case of the shortest pulse time width (500 μs), the allowable response is up to approximately 200 μs. If the delay is longer than this time, the error in the current measurement accuracy increases. If you are setting a short pulse time width (1 ms or less), you need to take measures to cut down the delay such as by minimizing the length of the output line.

PFX2021

Because there is a need to measure the pulsed-shaped current that changes greatly with high accuracy continuously, frequency per unit time is measured by applying the detected current signal to a dedicated voltage-to-frequency converter (VFC).

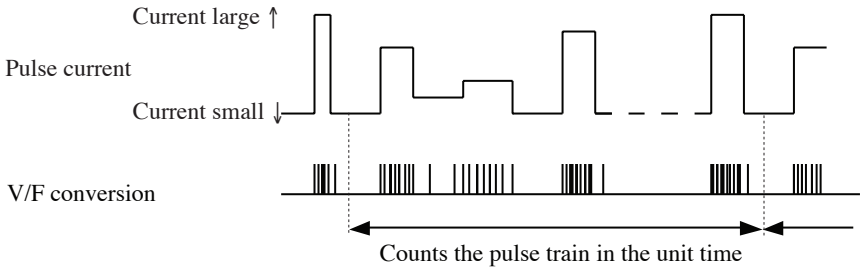


Fig. A-11 Example of Integrated Current Measurement Using the VFC

Each pulse current is continuously integrated and the average current is calculated per unit time.

$$\text{Average current} = \frac{\text{IVFn}}{\text{Tave}} \qquad \text{(Equation 2)}$$

IVFn: Integrated current per unit time
Tave: Unit time for averaging (fixed to 500 ms)

An explanation is given using an actual waveform.

Because continuous measurement is possible even when the current fluctuates within one pulse such as the current during CP pulse discharge, the capacity can be measured with higher accuracy.

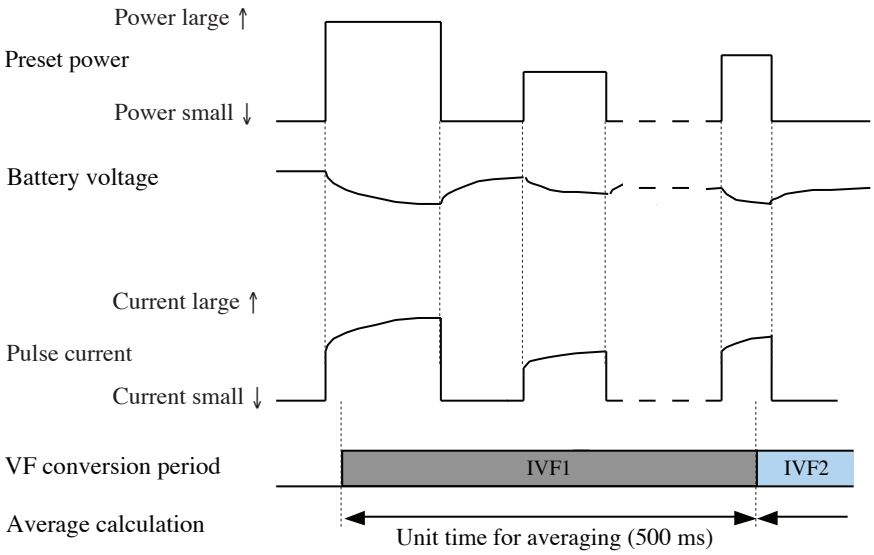


Fig. A-12 CP Pulse Discharge Example

NOTE

- **Points to note concerning the PFX2021 pulse current measurement**
- The calculated result of average current is output after the respective unit time for averaging elapses.
- The average current measurement function operates asynchronously with the pulse waveform period. Therefore, the current value that is displayed does not indicate the average current over each pulse period. This is the reason why the measured value of the average current during operation does not indicate a constant value.

■ Moving average process

You can decrease the fluctuation of the measured value even further by performing moving average. The unit allows you to select the average count from n = 0 (OFF), 2, 4, and 8. Fig. A-13 shows an example of the moving average process when n is set to 4.

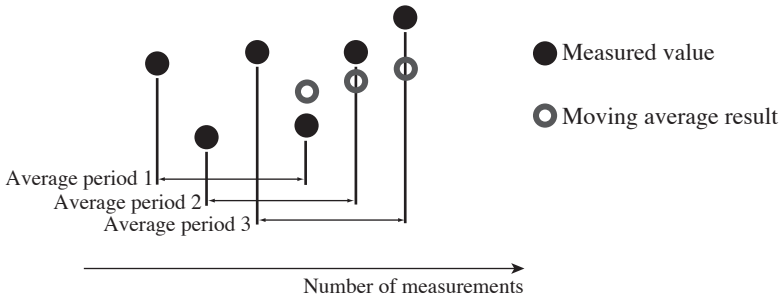


Fig. A-13 When the Average Count is Set to 4

By default, the average count is set 0 (OFF). The moving average can be set by the Test Condition Editor Program (Test Condition > Module) of the BPChecker2000. See the BPChecker2000 User's Manual.

NOTE

- The moving average also functions during pulse charge/discharge operation. Note that the updating of the measurement result takes longer, if the moving average is enabled when the pulse time width is set large.

A.2 Power Regeneration Function

The power consumption can be reduced on the PFX2021 system (combination of the PFX2021 and PFX2332) using the regeneration function. This function extracts a portion of the battery discharge power from a discharging charge/discharge power supply unit and uses the power to run the fan or to charge other batteries of other units in the same frame.

When the regeneration function is active, the REGENERATION LED (blue) on the front panel illuminates.

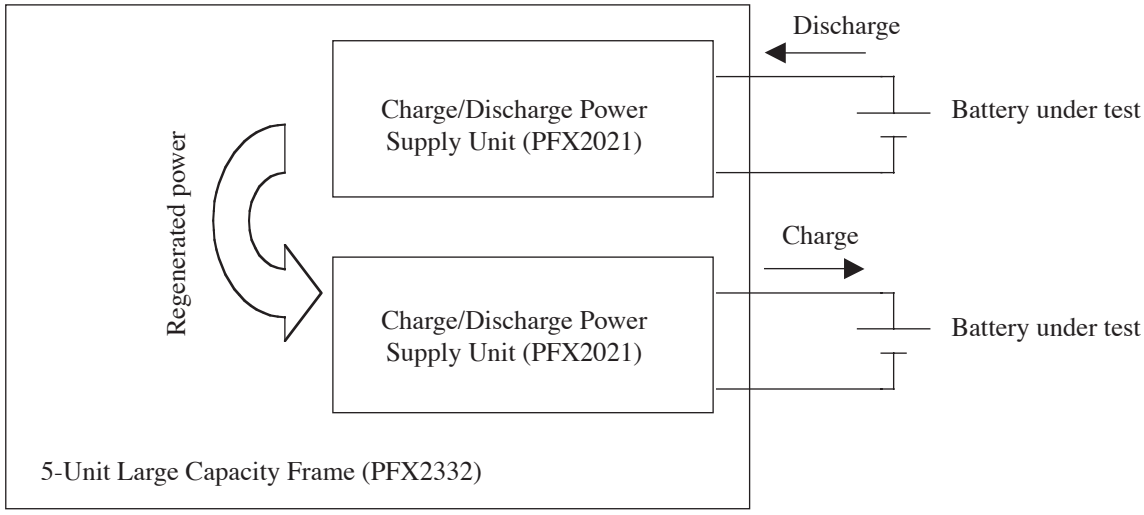


Fig. A-14 Regeneration Function on the PFX2021 System

Power regeneration is normally performed on a discharging unit under the following conditions.

Batter voltage greater than or equal to 12 V
Discharge current greater than or equal to 1 A

The regenerated power is used within the frame; it is not fed back to the commercial power supply system. Therefore, the regenerated power that is left over turns into heat as with the conventional unit, and the heat is dissipated by the fan. Therefore, more power is reused when charge tests and discharge tests are mixed in a single frame.

Power saving effect by the regeneration function

It is difficult to express the power saving effect produced by the regeneration function on the entire system, because the operation of each unit on the charge/discharge system changes frequently.

As an example, if there are two units that are discharging (regenerating power) and one unit that is charging at the specified ratings in the same frame, the power supplied to the system (200 VAC input) may be reduced to 1/3 as compared with a system without the regeneration function. See Fig. A-15.

This effect not only reduces the amount of power used to run the system, but also suppresses the heat dissipation of the entire system.

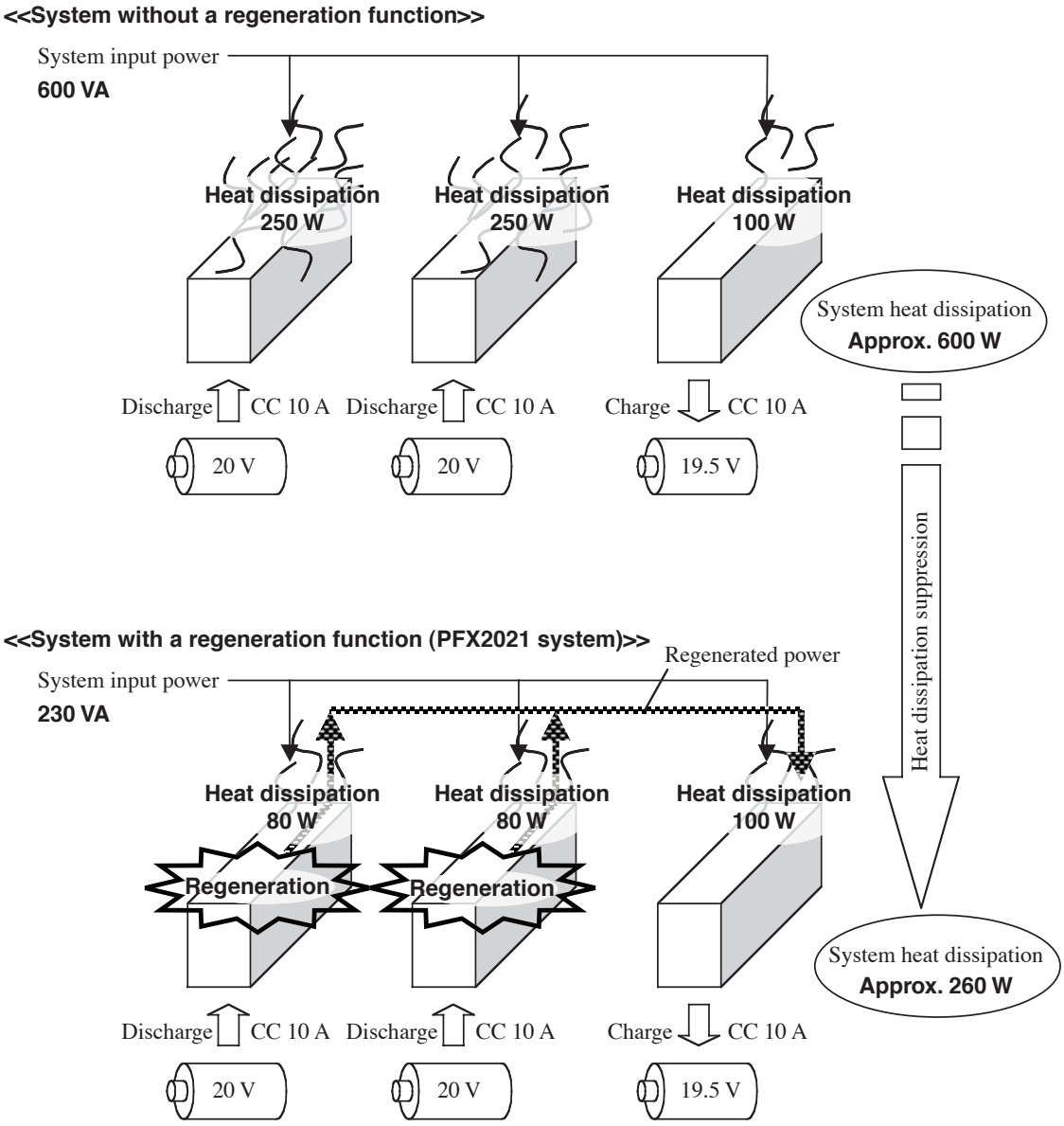
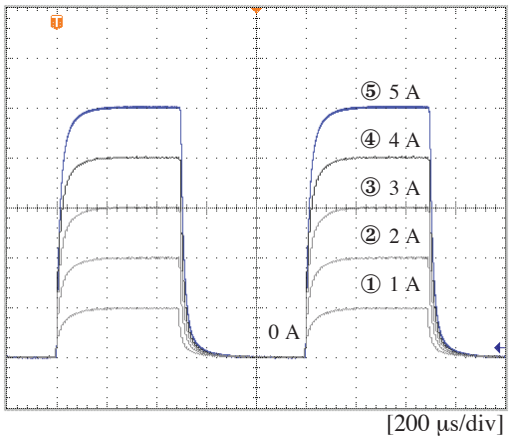


Fig. A-15 Example of the Power Saving Effect

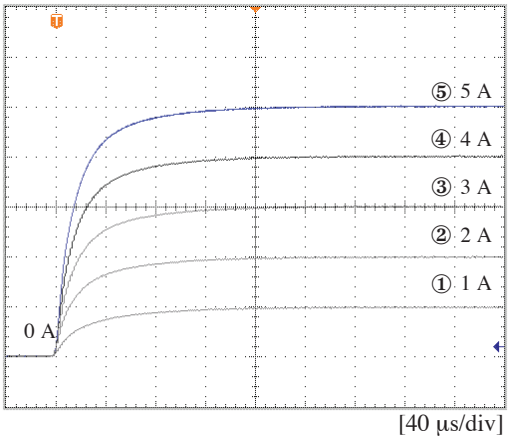
- The above example is used only to explain the effect of the regeneration function. In the actual operation, the amount of heat dissipation and input power of each unit may be different from the values given in the figure.
- The regeneration function operates even when a single unit is discharging on the PFX2021. In this case, the regenerated power is used for control inside the unit.
- When multiple units in a frame are discharging (regenerating power) simultaneously, each unit switches to regeneration operation. However, a function that automatically suppresses the regeneration efficiency is activated to suppress the generation of excessive regenerated power.
- The regeneration operation is controlled automatically. You cannot manually turn ON/OFF the regeneration operation.

A.3 Reference Data

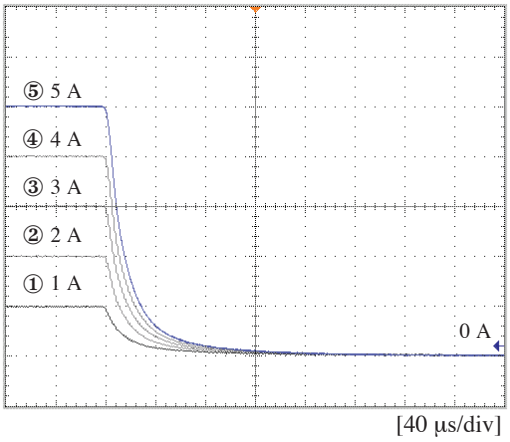
A.3.1 Pulse Current Waveform



Pulse current waveform



Pulse current rising waveform



Pulse current falling waveform

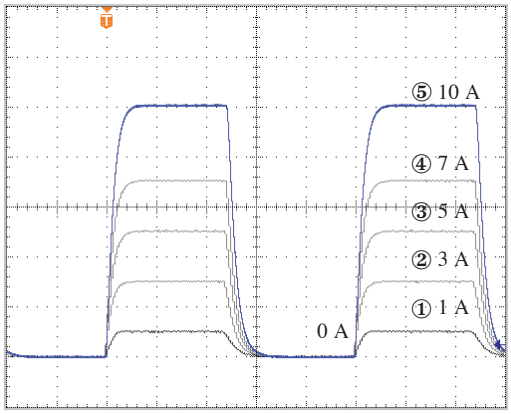
Setup conditions

2-value pulse discharge	①	②	③	④	⑤
Pulse current I1	0 A				
Pulse current I2	1 A	2 A	3 A	4 A	5 A
Pulse time T1	0.5 ms				
Pulse time T2	0.5 ms				

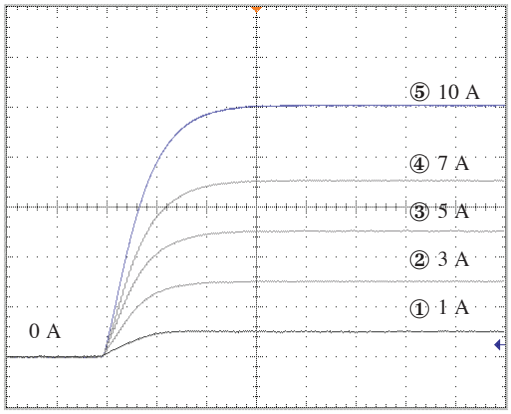
Measurement conditions

Load	Load cable shorted	
Instrument	Oscilloscope	TDS3014 (Tektronix)
	Current probe	TCP202 (Tektronix)

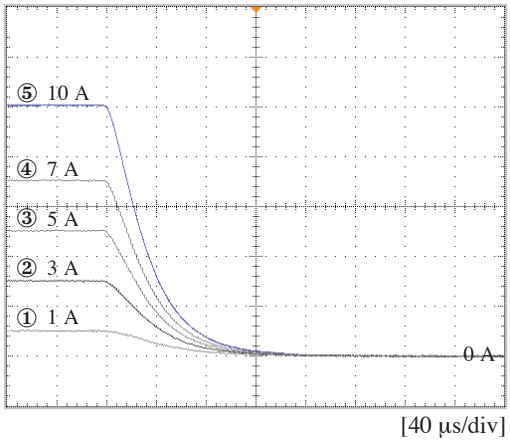
Fig. A-16 PFX2011 Pulse Current Waveform



Pulse current waveform



Pulse current rising waveform



Pulse current falling waveform

Setup conditions

2-value pulse discharge	①	②	③	④	⑤
Pulse current I1	0 A				
Pulse current I2	1 A	3 A	5 A	7 A	10 A
Pulse time T1	0.5 ms				
Pulse time T2	0.5 ms				

Measurement conditions

Load	Load cable shorted	
Instrument	Oscilloscope	TDS3014 (Tektronix)
	Current probe	TCP202 (Tektronix)

Fig. A-17 PFX2021 Pulse Current Waveform

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