KIKUSUI

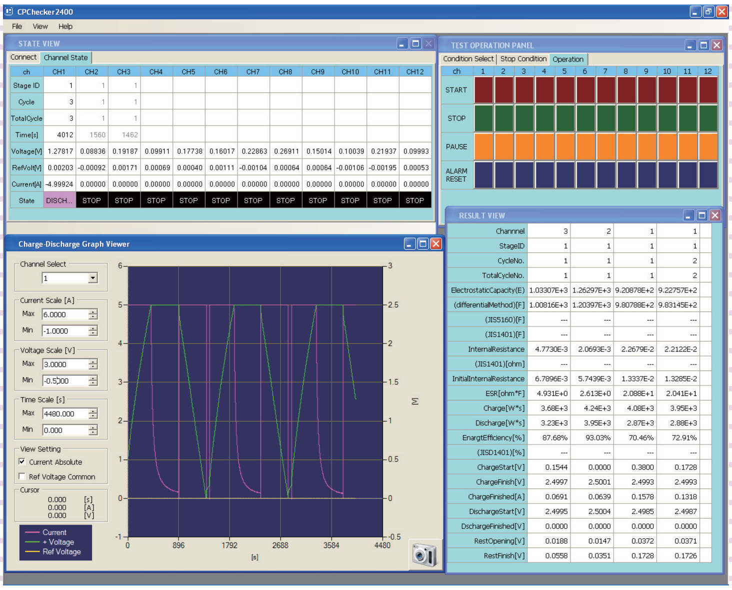
IX000462
Apr. 2012

Operation Guide

Application Software

CPChecker2400

Ver. 3.x



About This Manual

This manual is a PDF version of the Operation Guide that you can use to print the entire manual or a portion of it.

■Copyrights

Introduction

This operation guide explains how to use CPChecker2400 (Capacitor Performance Checker for PFX2400) to perform cycle tests, voltage hold tests, and charge-discharge efficiency tests.

■Product versions that this guide covers

This operation guide covers CPChecker2400 version 3.x. To check the version, on the Help menu, click About.

■Intended readers of this operation guide

This operation guide is intended for users that will perform capacitor charge and discharge tests through the use of the PFX2400 series capacitor testers. The guide is also intended for instructors that will train such users.

It assumes that the reader has knowledge about the electrical aspects of capacitor charging and discharging.

■Notations used in this manual

- In this manual, the PFX2400 series capacitor testers are sometimes referred to as the "PFX2400 Series" or the "PFX2400."
- The term "PC" is used to refer generally to both personal computers and workstations.
- The following markings are used in the explanations in the text.

⚠CAUTION	Indicates a potentially hazardous situation which, if ignored, may result in damage to the product and other property.
NOTE	Indicates information that you should know.

What Is CPChecker2400?

CPChecker2400 is a software application that you use to (1) create test conditions for capacitor cycle tests, voltage hold tests, and charge-discharge efficiency tests and (2) execute these tests on Kikusui's PFX2400 series capacitor testers.

The operation panel contains separate controls for each channel so you can execute different tests on each channel. The Test Setting window has preset options for JIS D 1401 and JIS C 5160. These options enable you to easily set capacitor test conditions according to the JIS standards. Test conditions are saved to text files in CSV format so you can open them using a spreadsheet or a similar application.

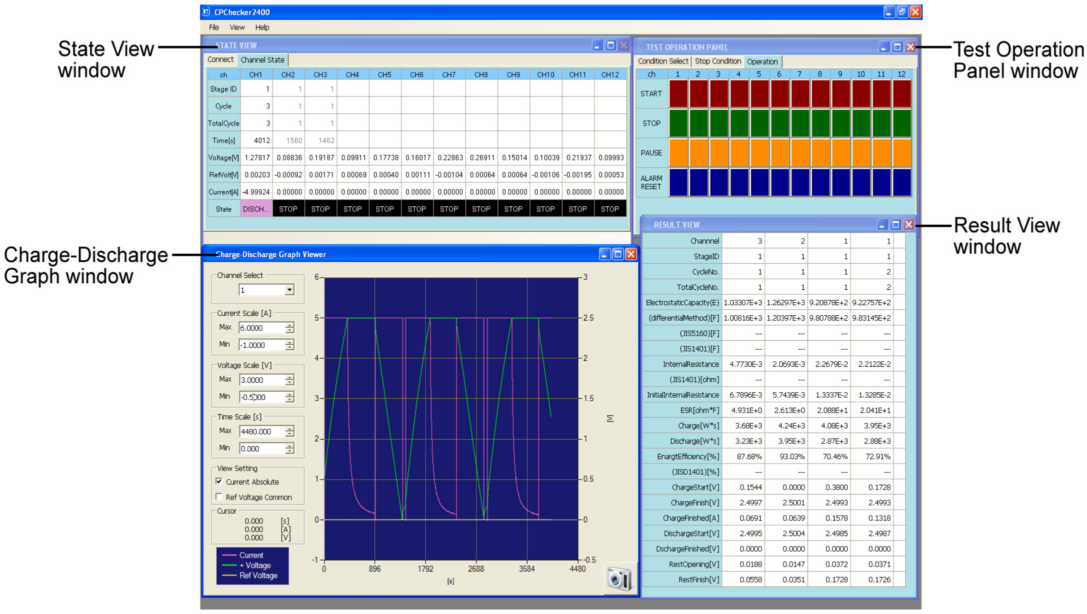
CPChecker2400 has the following features.

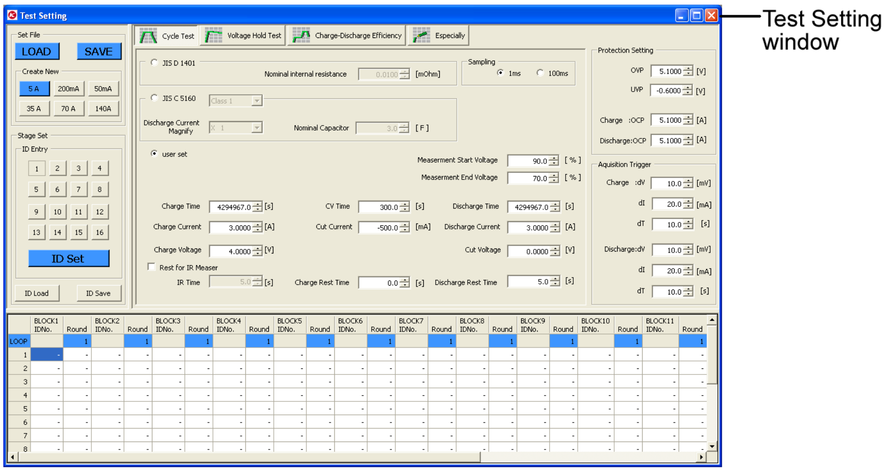
- Multi-channel control[1]
- Channel number assignment
- Test condition configuration and saving
- Test start, stop, pause, and alarm reset
- Test result display
- Test result file creation and saving (CSV format)
- Measured value monitoring (charge and discharge current, terminal voltage, and reference electrode voltage)
- HOVP/HUVP voltage display
- Rest hold

1 The number of channels that can be controlled varies depending on the data acquisition interval. For example, if a test cycle is 600 s, up to 96 channels can be controlled under the following conditions.
• ΔV: 0.5 % of the charge-discharge voltage
• ΔI: 0.5 % of the charge-discharge current
• ΔT: 10 s
The maximum number of channels that can be displayed on a page is 12.

Parts of the Screen

CPChecker2400 consists of four windows for controlling tests and displaying test results and one window for setting test conditions.





Window	Description
State View window	This is the first window that appears when CPChecker2400 is started. CPChecker2400 detects PFX2400 channels and displays their status.
Test Operation Panel window	Use this window to assign test conditions to each channel and to execute tests.
Charge-Discharge Graph window	This window displays measured voltage and current on a graph.
Result View window	This window displays the test results of channels that have finished testing.
Test Setting window	Use this window to set test conditions and save them to files.

Preparation

Connecting to the PFX2400 Series

To execute tests, CPChecker2400 must detect the channels on the connected PFX2400. When you start CPChecker2400, the State View window opens. In this window, you can begin and end communication between the CPChecker2400 and the PFX2400.

CPChecker2400 cannot detect channels whose IP addresses are the same. To connect multiple PFX2400s, you must use IP Configuration Tool to assign a unique IP address to each channel.

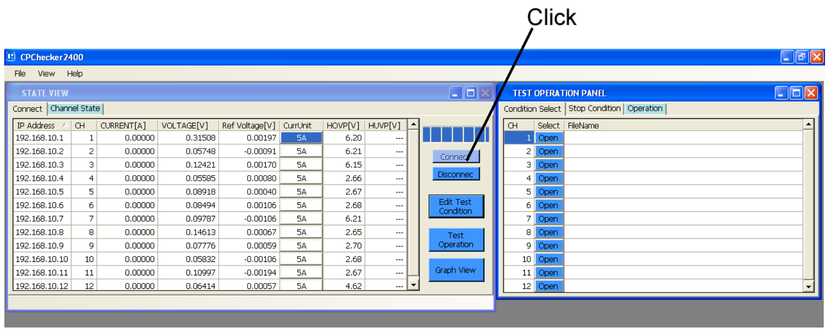
1 **Click Connect.**

A progress bar appears above the button to indicate the progress, and the status of each detected channel is displayed in the window. Then the Test Operation Panel window opens.

2 **Check that all the connected channels are displayed.**

The State View and Test Operation Panel windows each display 12 channels. If you are using more than 12 channels, you can use the scroll bar to view all the channels.

If PFX2400 channels do not appear in the State View window or if only a portion of the channels appear, check that the channel are connected.



Monitoring

CPChecker2400 constantly monitors each channel's measured current, measured voltage, reference electrode voltage*1, HOVP (hardware OVP) status, and HUVP (hardware UVP) status.

For channels that are connected to capacitors, you can read the capacitors' terminal voltages and reference electrode voltages even when the channels are not being tested.

*1 The reference electrode voltage is not displayed for models whose rated charge-discharge current is 35 A or more.

Switching the measured current unit

Click a cell in the A/mA column to switch the corresponding channel's unit of measurement between A and mA.

Changing channel numbers

By factory default, PFX2400 channel numbers are all set to zero. CPChecker2400 uses channel numbers to display each channel's status and to save acquisition data to files. Before starting tests, assign unique numbers to the channels that you are going to use.

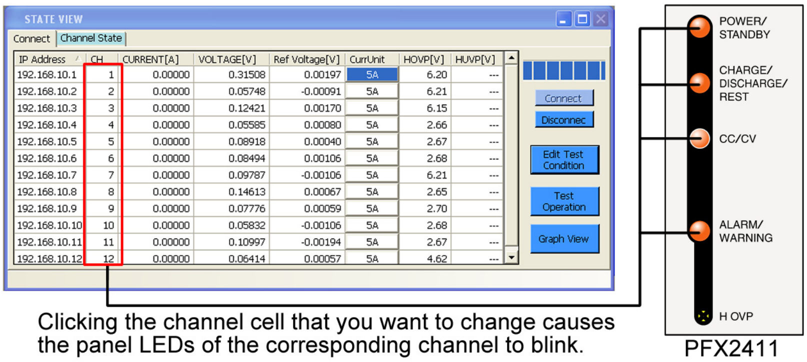
You can change channel numbers when the tests of all channels are stopped.

1 **Click the CH cell that you want to change in the State View window.**

The panel LEDs of the PFX2400 channel that corresponds to the cell that you clicked blink.

2 **Enter a number in the range of 0 to 256 that is different from the numbers that have been assigned to the other channels.**

Click IP Address or CH to sort the channel list.



Configuring HOVP and HUVP

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There are circuits in the PFX2400 for protecting capacitors from overcharging and overdischarging. These protection features are called HOVP (hardware OVP) and HUVP (hardware UVP) to distinguish them from the CPChecker2400 protection settings OVP and UVP.

HOVP and HUVP constantly protect capacitors from overcharging and overdischarging, even when tests are not being executed through CPChecker2400. We recommend that you set (1) the HOVP limit to a value between a voltage that is slightly higher than the OVP setting and the capacitor's maximum allowable voltage and (2) the HUVP limit to a value that is slightly lower than the UVP setting.

NOTE HUVP is available on models whose rated charge and discharge current is 35 A or more. If CPChecker2400 is connected to a model without HUVP, the HUVP cells in the State View window display “---.”

Configuring HOVP and HUVP (continued)

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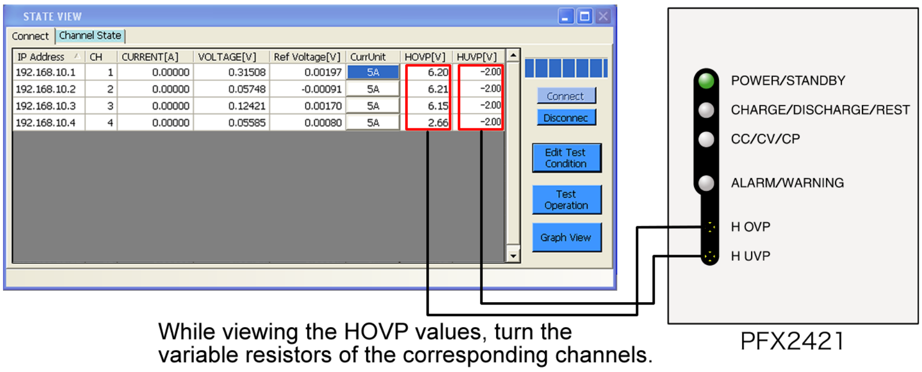
1 While checking the HOVP or HUVP value of the channel that you want to configure in the State View window, adjust the corresponding PFX2400 channel's variable resistor.

You can attain the maximum voltage by turning the variable resistor fully clockwise.

If you set the HOVP value to a voltage less than or equal to the measured voltage (terminal voltage) or the HUVP value to a voltage greater than or equal to the measured voltage (terminal voltage), an alarm occurs. To reset the alarm, set the HOVP or HUVP value to an appropriate value, and then click the corresponding Alarm Reset button on the Operation tab in the Test Operation Window.



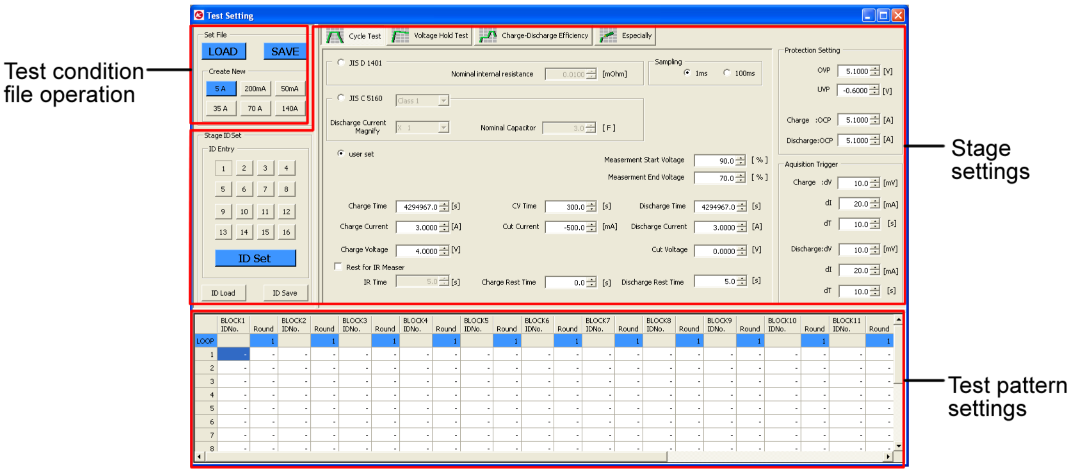
Setting Test Conditions

Test conditions determine what kind of tests to perform on capacitors. Test conditions can be saved to files so you can load test conditions that you created in advance as needed and use them.

Test conditions are assigned separately to each channel. Therefore, you can execute completely different tests on each channel.

Test Setting window

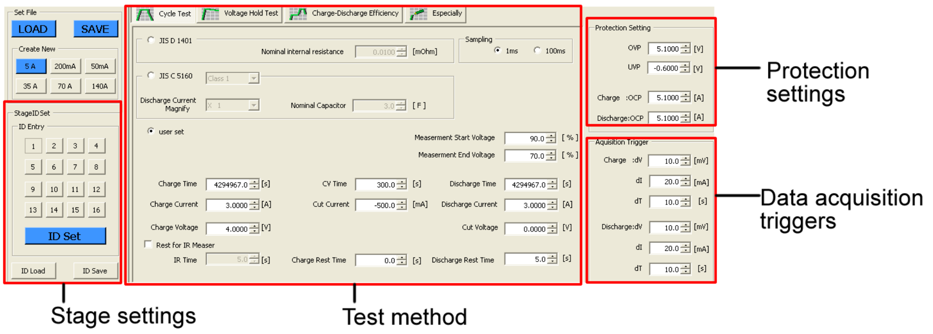
In the State View window, click Edit Test Condition to open the Test Setting window. This window will open even when a PFX2400 is not connected to the PC, so you can create test conditions even when a PFX2400 is not available.



Item	Description
Set File	For saving and loading test condition files. To create a new test condition file, under Create New, click the button that corresponds to your PFX2400 model. For example, the PFX2411's rated charge and discharge current is 5 A, so click 5 A. When you click a button under Create New, the displayed stage settings and test patterns are cleared.
Stage settings	For setting how to charge and discharge. You can register up to 16 stages and use them to create test patterns. You can save each stage as its own file, and load the stages from these files.
Test pattern settings	For creating test patterns by combining registered stages.

Creating a new stage

A test condition file consists of stages and test patterns that are combinations of those stages. Registered stages with assigned numbers can be used to create test patterns. Stages can be saved to files, but stage files cannot be assigned to channels as test conditions.



Item	Description
Protection Setting	Set the protection settings to appropriate values to protect the connected capacitor. OVP (overcharge protection), OCP (overcurrent protection), and UVP (overdischarge protection) When any of the conditions are met, the corresponding channel output turns off.
Acquisition Trigger	Set the conditions for acquiring data from the PFX2400 series. ΔV[1] (save data according to voltage changes), ΔI[1](save data according to current changes), and ΔT (save data according to the elapsed time) When any of the conditions are met, data is acquired.
Test method	Set the parameters for cycle tests, voltage hold tests, and charge-discharge efficiency tests. CPChecker2400 provides sets of parameter settings that can be used to easily create test conditions that are defined in the JIS standards. In addition to the tests that come standard with CPChecker2400, you can create customized tests by setting individual parameters in detail on the Especially tab.
Stage ID Set	Register stages that will be used to create test patterns. You can register up to 16 stages, and each stage can be saved and loaded from its own file.

1 If you set ΔV to 1 mV or less or ΔI to 1 mA or less, the amount of data that is acquired will become large. This will cause CPChecker2400 to run slowly. Furthermore, if it takes a long time to complete the stage that contains such a setting, the PFX2400's data buffer will fill up, and a BUF ERROR will occur.
If you want to set ΔV to 1 mV or less or ΔI to 1 mA or less, divide the corresponding stage into shorter stages. The load on CPChecker2400 can be reduced by narrowing the time interval over which detailed data acquisition is performed.

NOTE

- Stage settings depend on the PFX2400 series model that you are using. First, select the model under Create New under Set File. Changing the model later will affect parameter settings.
- The PFX2400 is equipped with HOVP and HUVP. Set the HOVP and HUVP limits to appropriate values by taking into account the OVP and UVP settings under Protection Setting that you specify here. HUVP can only be set on models whose rated charge and discharge current is 35 A or more.

1 **Under Create New under Set File, select the rated charge and discharge current that corresponds to the PFX2400 model that you are using.**
For example, if you are using the PFX2411, select 5 A.

2 **Set the protection settings to appropriate values to protect the connected capacitor.**
When any of the conditions are met, the corresponding channel output turns off.

3 **Under Acquisition Trigger, set the conditions for acquiring data from the PFX2400.**
When any of the conditions are met, data is acquired.

4 **Click Cycle Test, Voltage Hold Test, or Charge-Discharge Efficiency to select the test method. To perform other tests, click Especially.**
For details, see "Setting the test method."

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5 **Under ID Entry, select a registration number, and click ID Set.**
The ID button that you selected turns blue to indicate that the registration has taken place.

You can save up to 16 stages. To add stages, repeat steps 2 to 5.

If you want to use the stage that you created in other test conditions, save it to a file.

Saving a stage to a file

1 **Display the stage that you want to save, and click ID Save under Stage ID Set.**
The Save As dialog box appears.

2 **Set the save destination and file name.**
By default, the file is saved in the kikusui\CPC24 folder with the name "IDxxxxx.PF24ID" (where xxxxx is a sequence number).

Using a stored stage

1. **Under Stage ID Set, click ID Load.**
   The Open dialog box appears.
2. **Specify the file to load.**
   The extension of stage ID files is .PFD24ID.
3. **Under ID Entry, click a gray ID number.**
   ID numbers that have already been registered are displayed in blue. If you select a blue ID number, the stage settings are overwritten.
4. **Click ID Set.**
   The selected ID number turns blue.

NOTE

If the model selected under Create New under Set File is different from the model in the stage ID file that you are trying to load, the file will not open. A message will appear instead.

Setting the test method

JIS standards define parameters for cycle tests, voltage hold tests, and charge-discharge efficiency tests for capacitors. CPChecker2400 has dedicated tabs to make these parameter settings easy. To perform these tests, select the appropriate test tab.

- Cycle test
- Voltage hold test
- Charge-discharge efficiency test

The Especially tab contains all the parameters for the three tests above. To perform tests other than the three tests above or to set parameters in more detail, select the Especially tab.

If you register a stage ID on the Cycle Test, Voltage Hold Test, or Charge-Discharge Efficiency tab, the settings are applied to the settings on the Especially tab. You can set these settings in more detail on the Especially tab.

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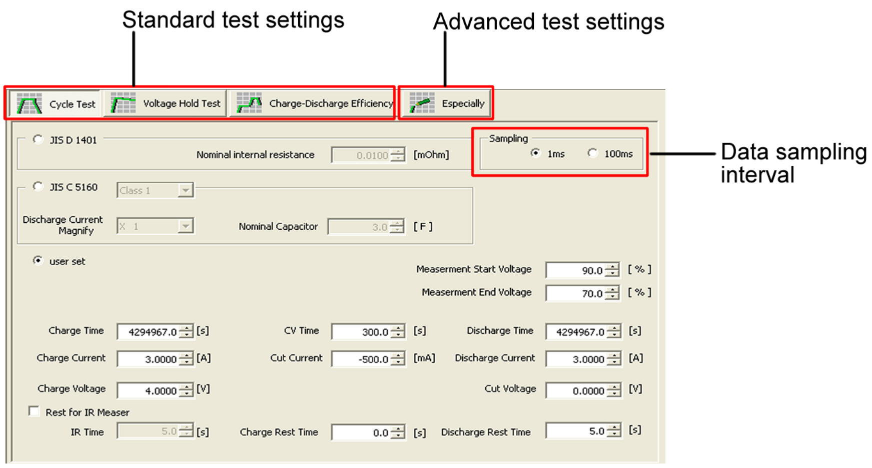
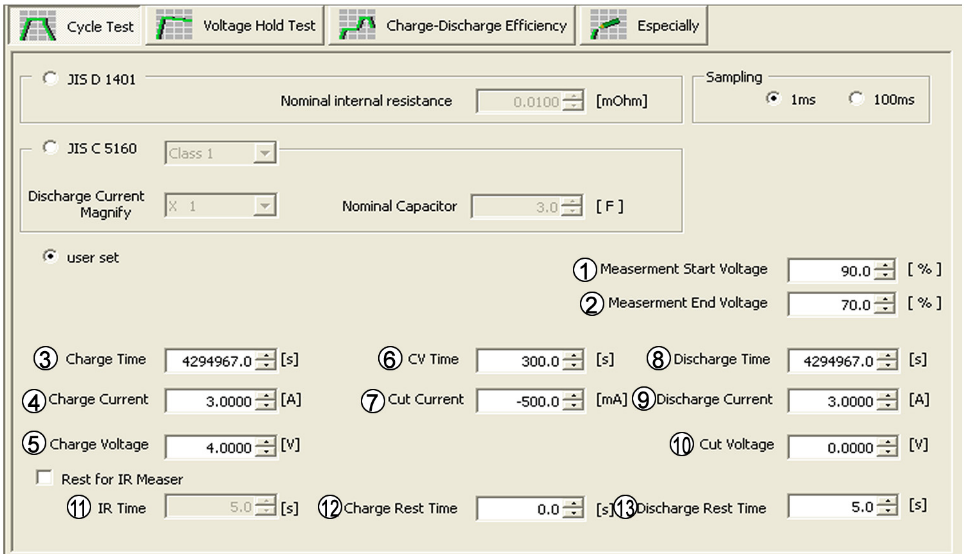
For each test, you can set a data sampling interval. The PFX2400 samples data at the specified interval. The PC acquires sampled data when the conditions under Acquisition Trigger are met.



Cycle test

If you select the JIS D1401 or JIS C 5160 option, you will only be able to change the parameters that pertain to the selected test method.

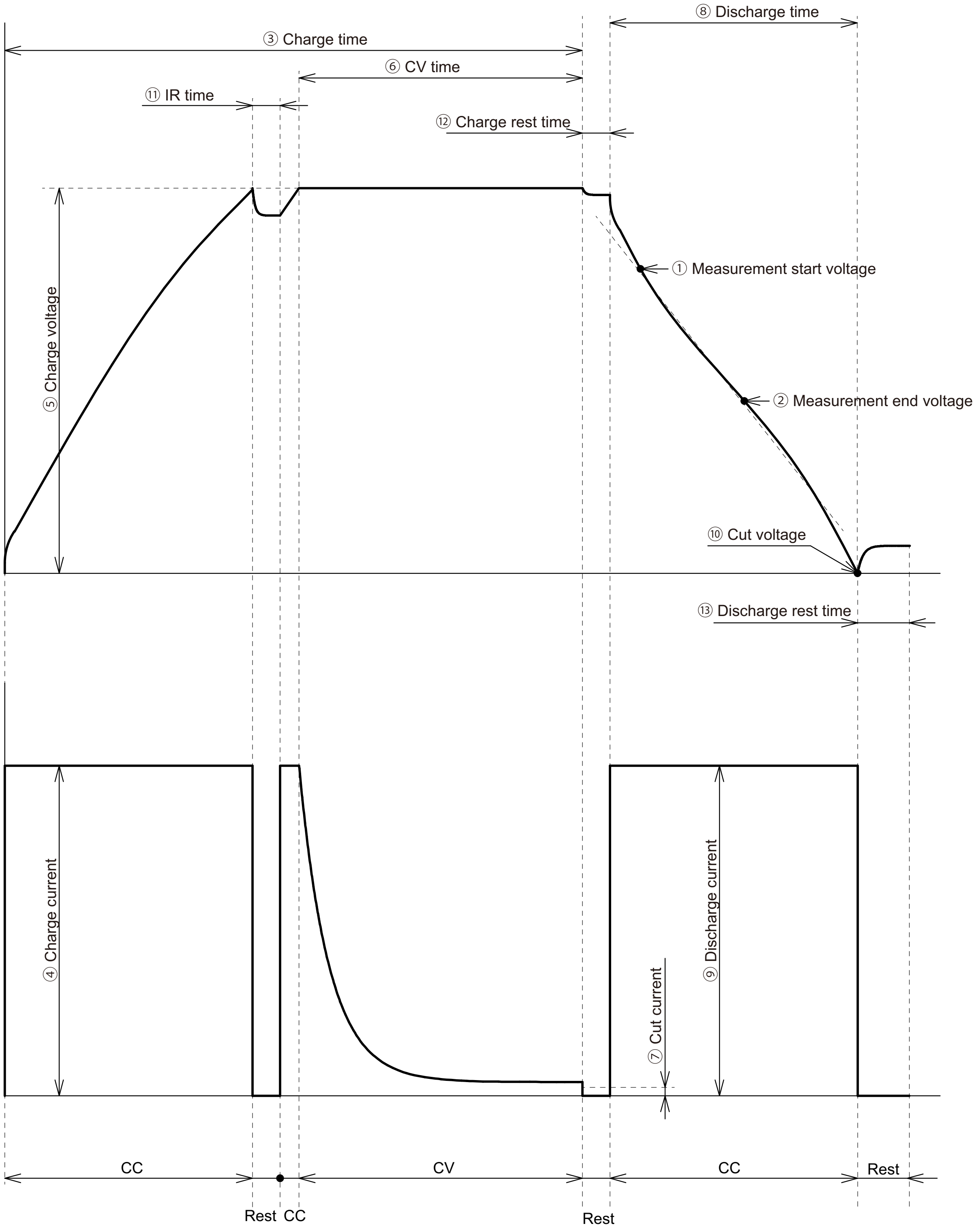
If you select the user set option, you will be able to change all the parameters.



Of the charge time, CV time, and cut current, the value that causes charging to stop is the value that is reached first.

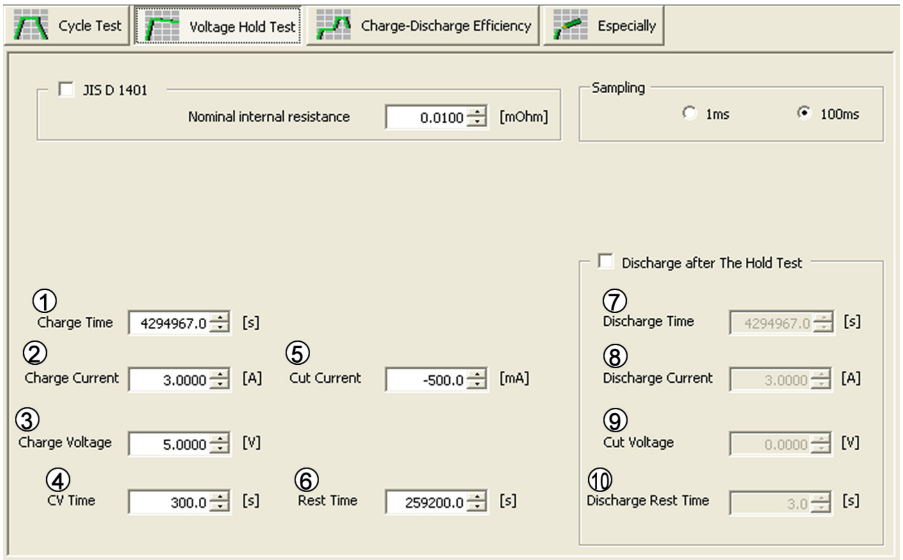
Of the discharge time and cut voltage, the value that causes charging to stop is the value that is reached first.

■Cycle test patterns

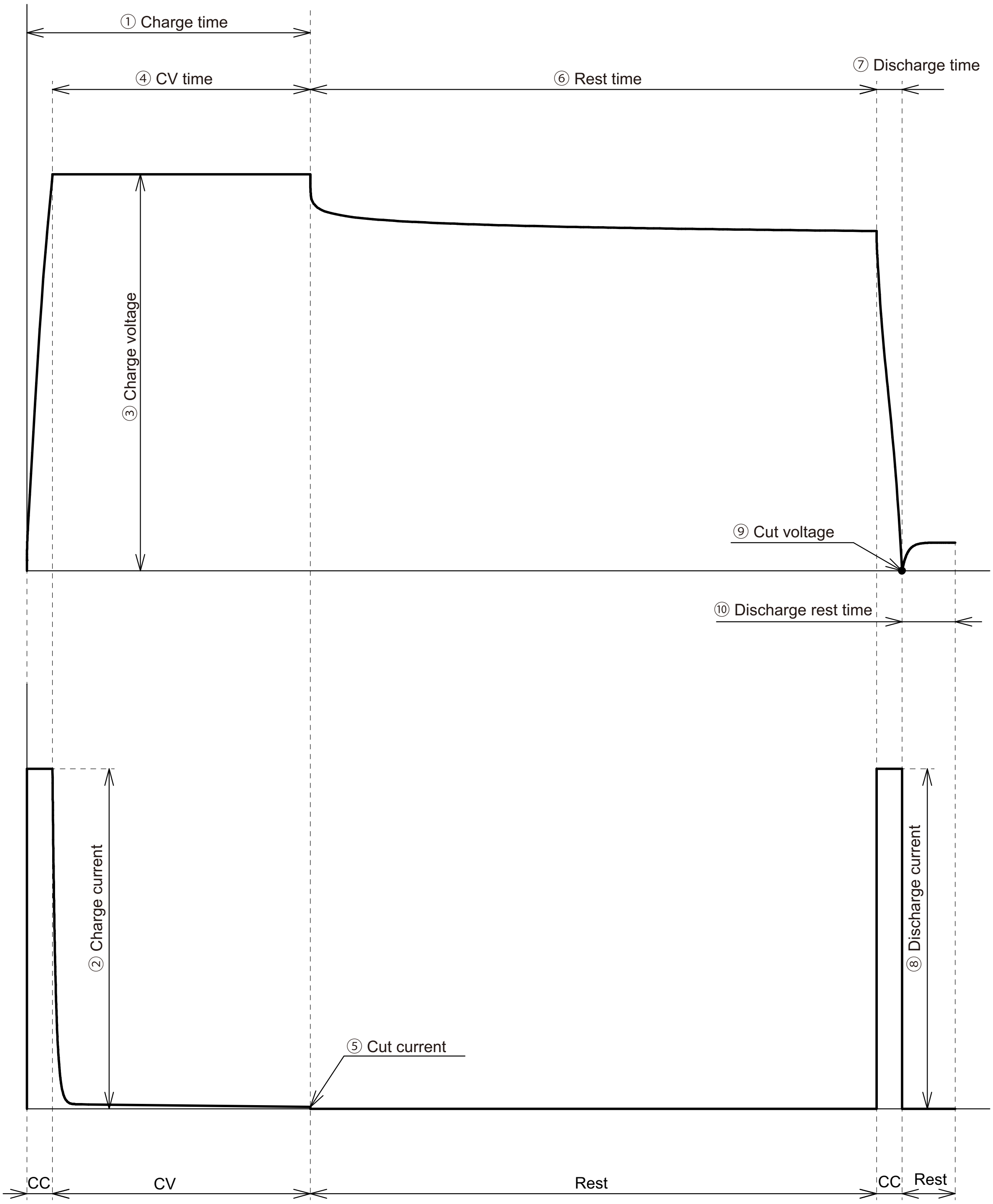


Voltage hold test

If you select the JIS D1401 check box, you will only be able to change the parameters that pertain to the selected test method. If you do not select the check box, you will be able to change all the parameters.

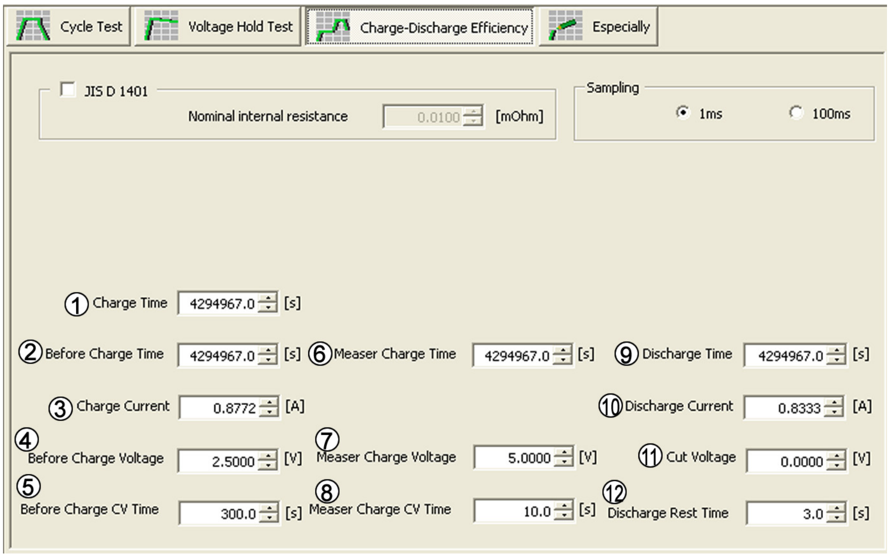


■Voltage hold test patterns

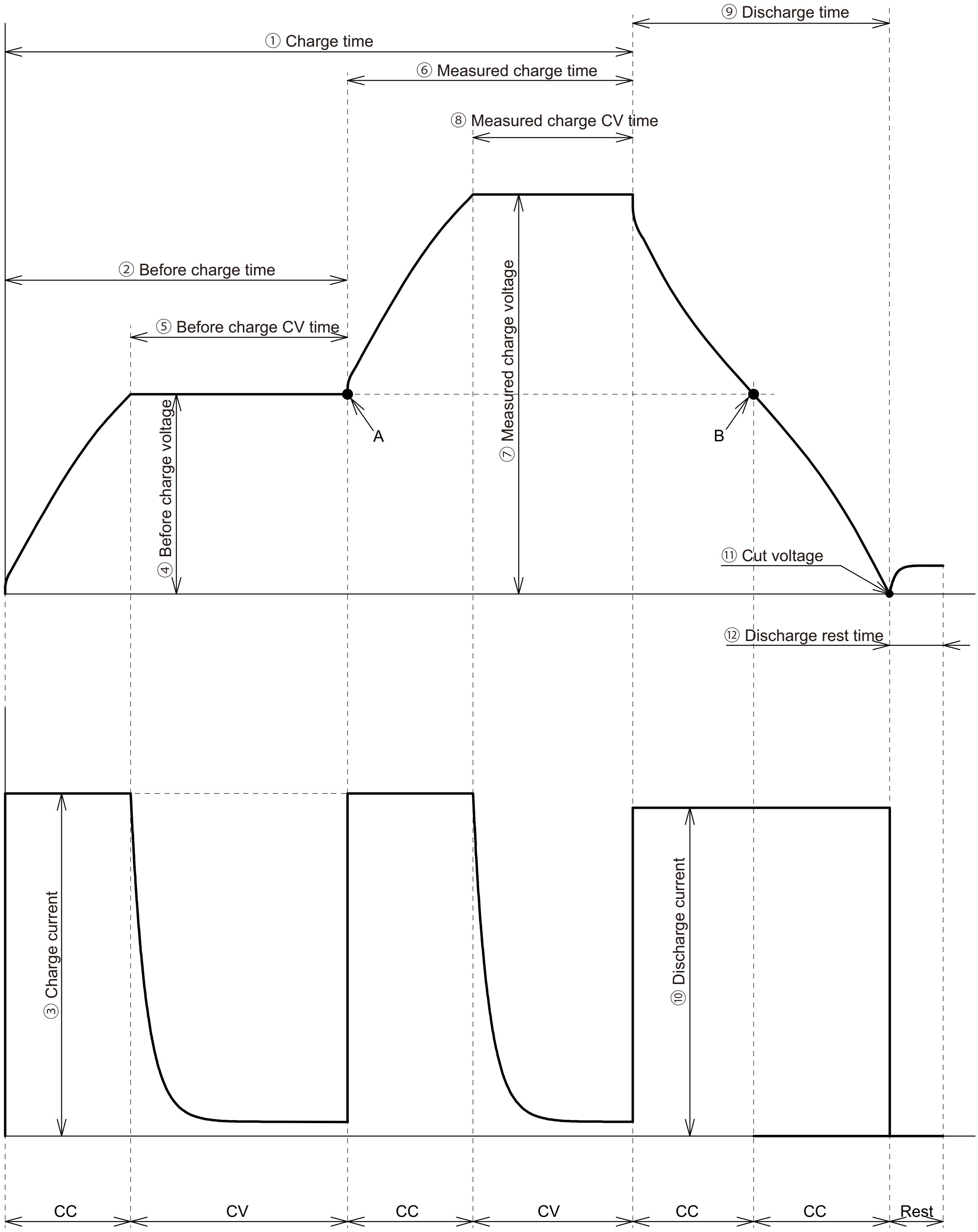


Charge-discharge efficiency test

If you select the JIS D1401 check box, only the parameters that pertain to the test method will be changeable. If you do not select the check box, all parameters will be changeable.



■Charge-discharge efficiency test patterns



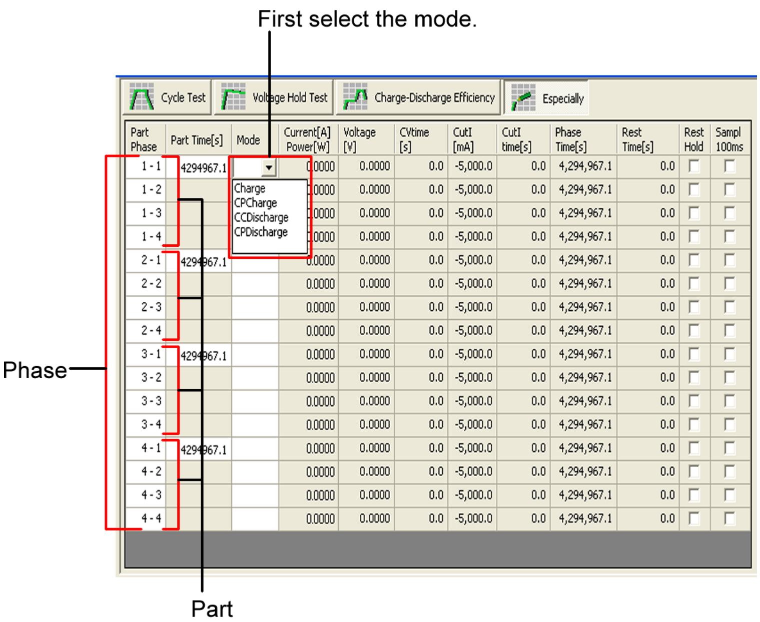
A: Measurement start point of a charge-discharge efficiency test
B: Measurement stop point of a charge-discharge efficiency test

Especially

If you select the Especially tab, a table consisting of 12 colums and 16 rows appears. You can also use this table to set the parameters for cycle tests, voltage hold tests, and charge-discharge efficiency tests. If you set the parameters on one of the other standard test tabs, register the parameters to a stage ID, and then click the Especially tab, the table will contain the settings from the registered stage ID.

On the Especially tab, each line of settings is called a phase, and you can set up to 16 phases in a single stage. In addition, a group of four phases is called a part, and you can manage the maximum time of each part as stop conditions. When the maximum time passes, the test proceeds to the last rest phase of that part.

By setting stages on this tab, you can configure step charge settings, step discharge settings, and step charge and discharge settings (width of 100 ms or more).



To configure a phase, first click a Mode cell, and choose the mode from the list.

- Charge Constant current and constant voltage charge
- CPCharge Constant power charge
- Discharge Constant current discharge
- CPDischarge Constant power discharge
- Space Mode selection reset

When you select a mode, the cells under the items that pertain to the selected mode become available, and you can set them. Current[A] Power[W] cells become current values when the mode is set to Charge or Discharge and power values when the mode is set to CPCharge or CPDischarge.

■Charge stop parameters

CutI (cut current) and It time are parameters that stop charges. In constant voltage (CV) charge operation, the charge phase ends when It time elapses after a current less than or equal to the cut current is detected. If you do not want to end the phase using the cut current parameter, set CutI to a negative value.

NOTE If you want to end the charge phase using the cut current parameter, set an appropriate CV time. The default CV time is 0.0 s, so the charge phase may end before the current reaches the cut current.

■Rest hold feature

Select the Rest Hold check box to keep the test from moving to the next phase even after the current phase's rest time elapses.

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On the Channel State tab in the State View window, the test state will indicate RestCont. To move to the next phase, on the Operation tab in the Test Operation Panel window, click START.

■Data sampling interval

You can set the data sampling interval to 1 ms or 100 ms. If you select 1 ms, data is acquired into the PC at a minimum interval of 1 ms, depending on the test conditions.

If you select 1 ms, the timestamps for data acquisitions will be reset when the timestamp reaches 49.7 days.

For tests that last over 45 days, such as voltage hold tests, we recommend that you set the data sampling interval to 100 ms.

■CV time during discharge

During the CV time during discharge, constant voltage operation is achieved through constant current operation. Therefore, indicators and acquired data are in CC mode during the discharge CV time.

As indicated by the following equation, CPChecker sets the discharge current to 31/32 when the measured voltage reaches the set voltage.

Discharge current = set voltage - (set current/32)

Then, CPChecker checks the measured value every data sampling interval (1 ms or 100 ms). When the measured value is less than or equal to the set voltage, CPChecker reduces the discharge current.

(a) New discharge current = discharge current - (discharge current/32)

(b) New discharge current = discharge current - (set current/1024)

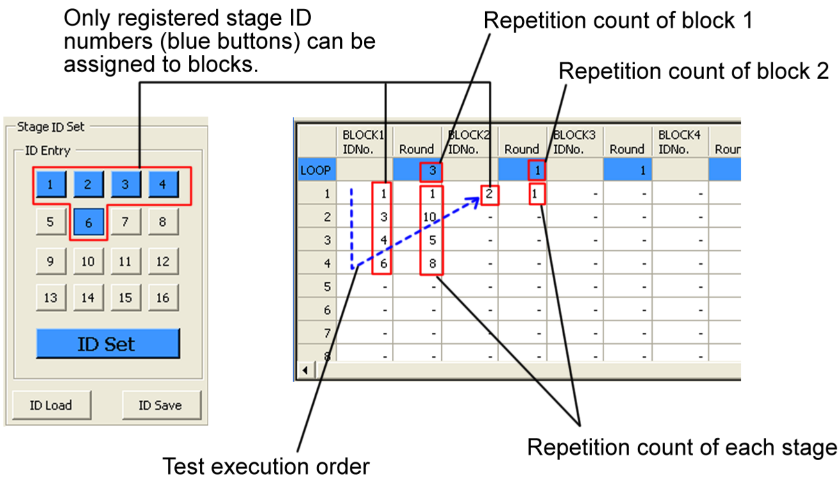
By using (a) or (b), whichever has changed the most from its previous value, CPChecker achieves constant voltage operation.

Setting a test pattern

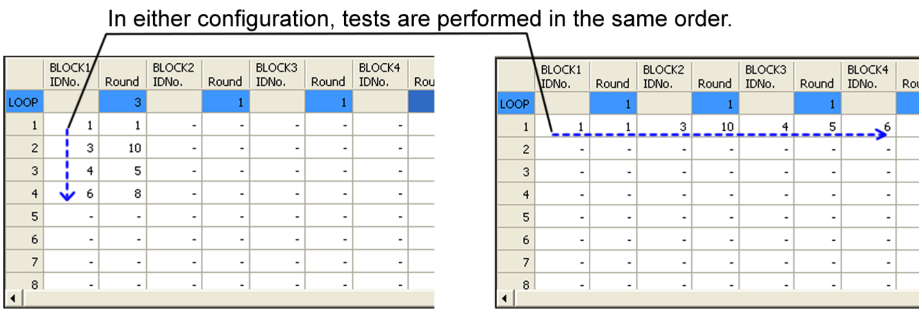
The bottom half of the Test Setting window is used to test patterns. It is a table consisting of columns for arranging blocks 1 to 16 and rows for assigning up to 16 stages to each block.

To create a test condition file, you must assign at least one stage to one block. Stage files cannot be assigned directly to channels as test conditions.

To repeat a stage that has been assigned to a block, enter the repeat count in the cell to the right of the stage's cell. To repeat an entire block, enter the repeat count in the appropriate cell in the LOOP line.



The test starts from block 1. When the execution of all the stages assigned to a block is complete, the test proceeds to the next block. If there are no block repetitions, you will obtain the same result whether you assign all the stages to the same block or assign stages to different blocks.



Saving test conditions to a file

1 **Under Set File, click Save.**
The Save As dialog box appears.

2 **Set the save destination and file name.**
By default, the file is saved in the kikusui\CPC24 folder with the name "SETxxxxx.PF24SET" (where xxxxx is a sequence number).

Editing saved test conditions

1 **Under Set File, click Load.**
The Open dialog box appears.

2 **Specify the file to load.**
The extension of test condition files is .PF24SET.

NOTE

- If you change a phase that is already registered, first check that the target stage ID number is selected. Then, click ID Set to overwrite the stage, and save the test condition file. If you don't overwrite the stage, the change will not be reflected in the test condition file.
- If the model selected under Create New under Set File is different from the model in the test condition file that you are trying to load, the file will not open. A message will appear instead.

Clearing the displayed test conditions

1 **Under Set File, click one of the buttons under Create New.**
The displayed stage IDs, stage settings, and test pattern are all reset to their default conditions. This is the same as opening a new test condition window.

Executing Tests

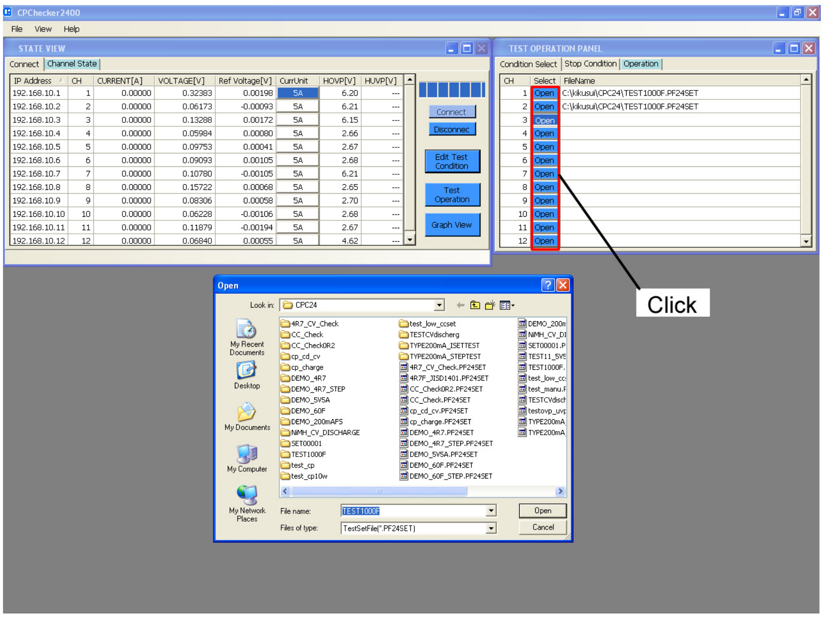
Assignment of test conditions and all operations such as the starting and stopping of tests are handled separately for each channel.

Assigning test conditions

1 **In the Test Operation Panel window, select the Condition Select tab.**

2 **Click Open for the channel that you want to assign test conditions to.**
The Open dialog box appears.

3 **Select a test condition file.**
The extension of test condition files is .PF24SET.
The path to the assigned file appears in the FileName cell.
Click CH or FileName to sort the channel list.



NOTE

- When a test condition file is assigned to a channel, the file is duplicated, and CPChecker2400 uses the duplicated copy as the test condition file. After you assign a test condition file to a channel, even if you change the test condition file and overwrite it, the changes will not be applied to the channel. If you want to apply the changes, reassign the test condition file to the channel.
- If you start communication with a PFX2400 that is already executing tests, the FileName cells on the Condition Select tab in the Test Operation Panel window will show Select Continue File, and the test will pause. If you assign the same test condition files, you can resume the tests. If you don't want to resume the tests, click Stop.
- When IP addresses are displayed on the Connect tab, and “connect miss” appears in a Current cell, you may be able to start communication if you click Connect after waiting about 2 minutes.

Starting Tests

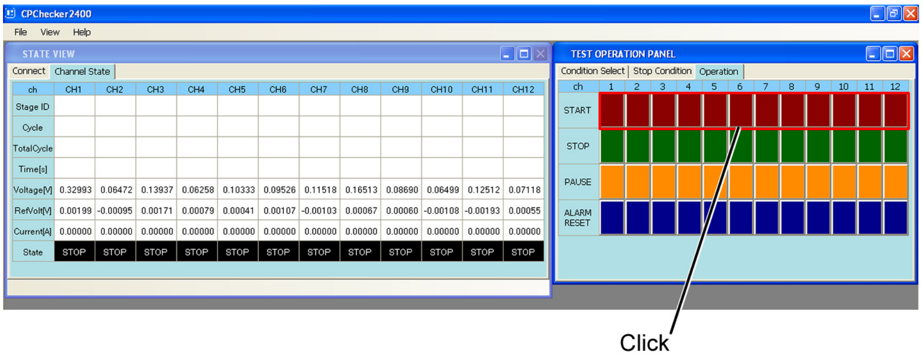
1 **On the Connect tab in the State View window, click Test Operation.**

The State View windows switches to the Channel State tab, and the Test Operation Panel switches to the Operation tab.

2 **On the Operation tab, click Start for the channel that you want to start a test on.**

The color of the START button changes from red to grey.

Messages appear for channels that don't have test conditions assigned to them.



The color of the START button indicates the status.

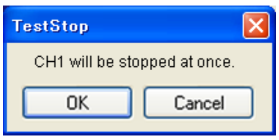
Red: Testing is stopped.
Yellow: Testing is paused.
Grey: Testing is in progress.
Purple: The PFX2400 is idling.

Stopping Tests and Resetting Alarms

Stopping a Test

1 **Click STOP.**

The TestStop window appears.



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You can prevent this message from appearing by clearing the "**Enable Stop Message**" check box in the Stop Condition tab.

Stopping Tests and Resetting Alarms (continued)

Stopping All Channels at Once

You can stop testing on all channels by closing CPChecker2400.

1 Click on the right side of the title bar in the CPChecker2400 window.

To pause a test that is being executed

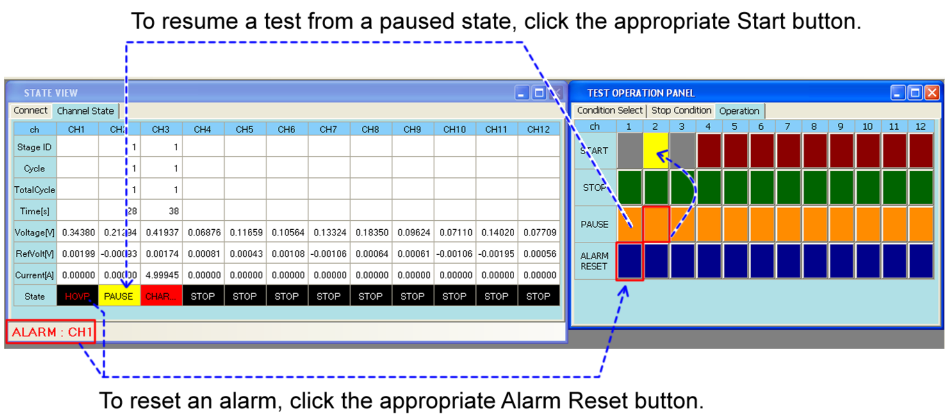
1 Click the appropriate Pause button.
To resume the test, click the appropriate Start button.

To reset an alarm

When an alarm occurs, the channel that the alarm occurred on is displayed in the State View window.

1 Press Alarm Reset.

NOTE If you don't eliminate the cause of the alarm, the alarm will recur when you resume the test.



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In phases where the Rest hold feature is enabled, when the rest time elapses, the state changes to "RestCont," and the test remains in the rest state. To move to the next phase, click the appropriate START button.

Information displayed during testing

State View window

On the Channel State tab, the stage ID, cycle count (number of repetitions), and other test information is displayed.

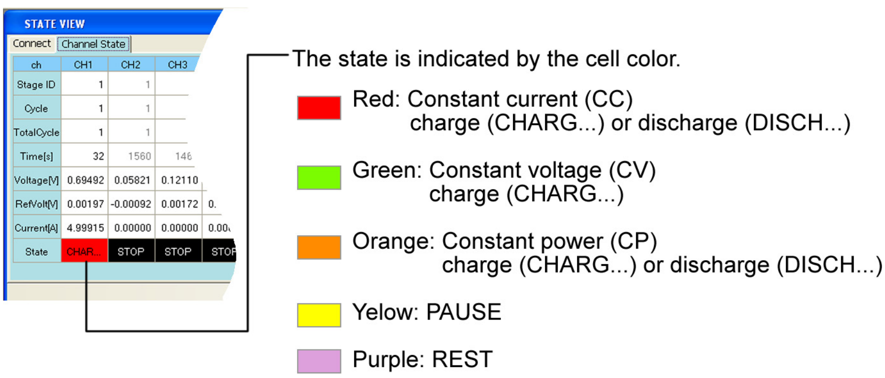
- TotalCycle — This is the number of repetitions that have taken place since the start of the test.
- Time — This is the time elapsed since the start of the test. The time is updated only when data is acquired so it is different from the actual time.[1]
- Voltage and current — These values are updated every second.
- State[2] — The state is indicated by the cell color.
  If an alarm occurs, its cause is displayed.

See p. 10

1 Immediately after charge or discharge is started, data is acquired frequently according to ΔV or ΔI so the elapsed time is also updated frequently. As the test progresses and the values stabilize, the data is acquired according to ΔT. For example, if ΔT is set to 30 seconds, the elapsed time may only be updated once every 30 seconds.

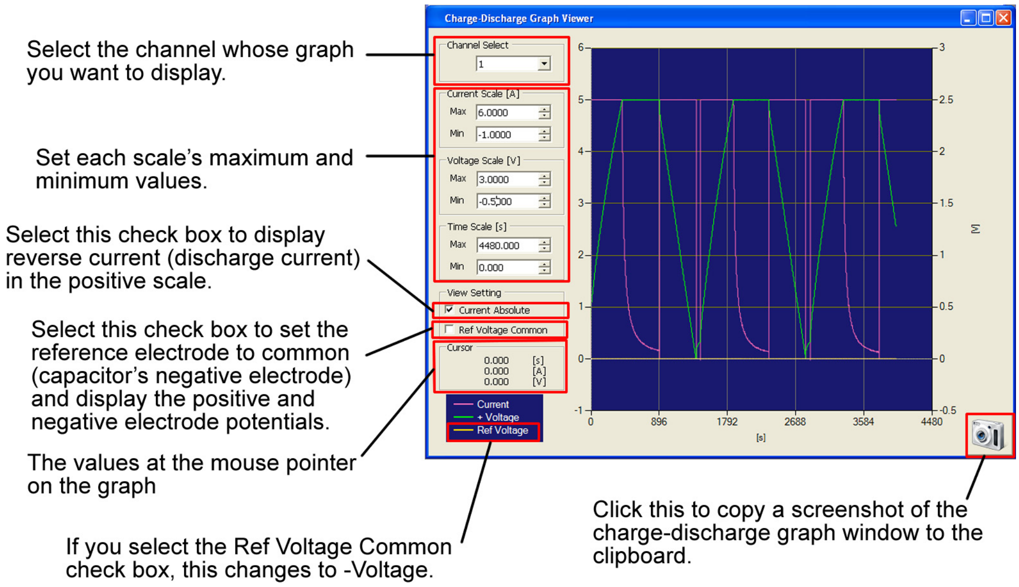
2 Items that appear in the State cells

Display	Description
STOP	The test has been stopped.
PAUSE	The test is paused.
CHARGE	Charging.
DISCHARGE	Discharging.
RestCont See p. 21	The Rest hold feature is active.
HVP See p. 7	The measured voltage exceeded the HOVP (hardware OVP) limit or fell below the HUVP (hardware UVP) limit. This may be detected even when the PFX2400 is not executing tests.
OCP	During testing, the measured value exceeded the OCP limit.
O/UVP	During testing, the measured value exceeded the OVP limit or fell below the UVP limit.
OHP	The inside of the PFX2400 has overheated. This may be detected even when the PFX2400 is not executing tests.
EXT	An alarm signal was received from an external contact.
COM	The LAN cable has been disconnected, or the PC has been turned off.
BUF	The test was aborted because of a buffer overflow error. In the Test Operation Panel window, click Alarm Reset to clear the buffer.



Charge-Discharge Graph window

The graph displays the data of the channel whose test was started most recently (only one channel is displayed on the graph). You can change the display parameters even while the test is in progress.



Result View window

This window displays the test results of channels that have finished testing. The test results of channels that you have stopped by pressing their Stop buttons are also displayed.

For a description of the displayed items, see "Terminology."

See p. 43

Results of the channel whose test ended most recently

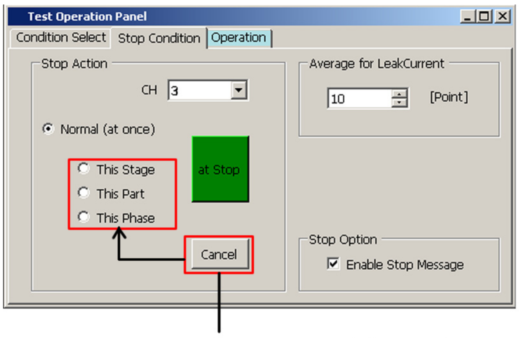
Result View

Channel	3	3
StageID	1	1
CycleCount	1	2
TotalCycleCount	1	2
ElectrostaticCapacity(E)	3.42321E+0	3.42847E+0
(DifferentialMethod)[F]	3.53051E+0	3.53527E+0
(JIS5160)[F]	---	---
(JIS1401)[F]	---	---
InternalResistance	2.3485E-1	2.3401E-1
(JIS1401)[ohm]	---	---
InitialInternalResistance	2.1098E-1	2.1050E-1
ESR[ohm*F]	8.039E-1	8.023E-1
ChargeAccumulatedElectricPower[W*s]	2.11E+0	2.10E+0
DischargeAccumulatedElectricPower[W*s]	1.71E+0	1.71E+0
EnargyEfficiency[%]	81.02%	81.68%
(JISD1401)[%]	---	---
ChargeStart[V]	0.0731	0.0139
ChargeFinished[V]	0.9998	0.9997
ChargeFinished[A]	0.0018	0.0016
DischargeStart[V]	0.9997	0.9996
DischargeFinished[V]	0.0000	0.0000
RestOpening[V]	---	---
RestFinished[V]	---	---
MaintainVoltageRate[%]	---	---
LeakCurrent[A]	0.0881	0.0884
ChargeInternalResistance[ohm]	2.8863E-1	2.8140E-1

Stop condition

On the Stop Condition tab in the Test Operation Panel window, you can stop tests independent of the test stop conditions that you specified in the test conditions.

Select one of the four options on the left side of the tab, set CH to the channel that you want to stop, and click **at Stop**.



You can select Cancel to cancel the option that you specified before the corresponding stage, part, or phase ends.

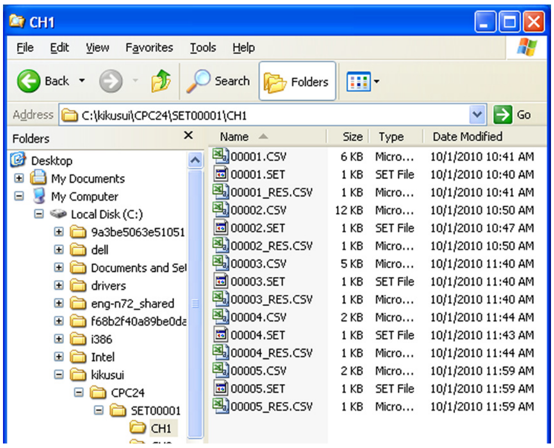
Item	Description
Normal (at once)	This is the same as clicking Stop on the Operation tab.
This Stage This Part This Phase	Test conditions consist of stages, parts, and phases. These options specify the end of these components.
Average for Leak Current	The leak current is the average current calculated over the range from the specified number of data points before the end of charging to the end of charging. If you specify 0, the leak current is the current flowing at the end of charging.
Enable Stop Message See p. 25	When the check box is selected, a message appears when you click STOP in the Test Operation Panel window.

Data Files That Are Saved

CPChecker2400 creates CHxx folders (where xx is the channel number) for channels whose tests have been executed. These folders are created in the folder with the same name as the test condition file. The following three types of files are created in the CHxx folder.

- Test condition files (.SET extension)
- Graph data files (.CSV extension)
- Data files for displaying analysis results (.CSV extension)

These three files are created as a set for each test. The file names are assigned sequence numbers according to each set.



Test condition files

These are copies of the test condition files that users have created. When a test condition file is assigned to a channel, CPChecker2400 copies the test condition file and uses the copy. Therefore, after you assign a test condition file to a channel, if you change the test condition file and overwrite it, the changes will not be applied to the file that was assigned to the channel.

Graph data files

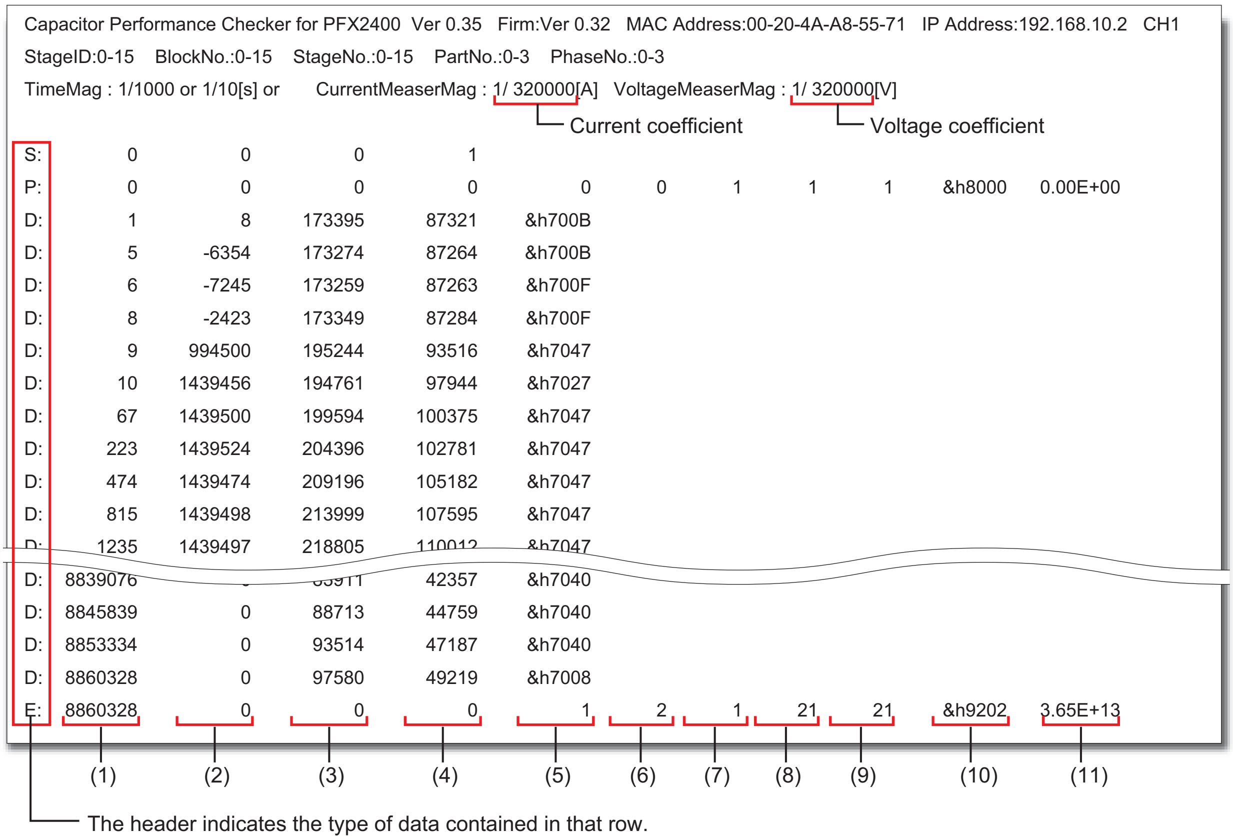
A graph data file contains graph data. Because these are text files (in CSV format), you can use a spreadsheet application to open these files and draw their graphs.

The maximum file size is 1 MB. If the file exceeds 1 MB, it is divided as follows:

xxxxx.CSV File that data is currently being written to
xxxxx_001.CSV The first 1 MB of data
xxxxx_002.CSV The next 1 MB of data
→ Whenever 1 MB is exceeded, a new CSV file is created.

File content

The following figure is a sample of a graph data file.
The leftmost row is the header. The header indicates the type of data contained in that row.



There are the following seven types of headers.

Header	Time of acquisition
S:	At the start of a test
P:	At the start of a phase
D:	When an acquisition trigger condition (ΔV, ΔI, or ΔT) is met or when a state change occurs
R:	When a test enters the rest state
E:	At the end of a test
ALM:	When an alarm occurs
PAUSE:	When a test is paused

S:

This is acquired once at the start of a test.

S: timestamp | starting part | starting phase | starting absolute cycle

Data component	Description
(1) Timestamp	This is the the time elapsed since the start of the test. It is always zero.
(2) Starting part	This is the part at the start of the test.
(3) Starting phase	This is the phase at the start of the test.
(4) Starting absolute cycle	This is the absolute cycle count at the start of the test.

Graph data file (continued)

P:

This is acquired at the start of each phase.

P: timestamp | stage ID | block No. | stage No. | part No. | phase No. | block loop count | stage cycle count | absolute cycle count | state | integrated power

Data component		Description
(1)	Timestamp	This is the the time elapsed since the start of the test. When the state samp bit is zero, the elapsed time is in units of 1 ms. When the samp bit is 1, the elapsed time is in units of 100 ms.
(2)	Stage ID	This indicates the stage ID number of this phase. 0 to 15[1]
(3)	Block No.	This indicates which block number this phase belongs to. 0 to 15[1]
(4)	Stage No.	This indicates which stage number in that block this phase belongs to. 0 to 15[1]
(5)	Part No.	This indicates which part number in that stage this phase belongs to. 0 to 3[1]
(6)	Phase No.	This indicates which phase number of that part this phase corresponds to. 0 to 3[1]
(7)	Block loop count	This indicates the current block loop count. 1 to 65535
(8)	Stage cycle count	This indicates the current stage cycle count. 1 to 65535
(9)	Absolute cycle count	This indicates the current cycle count. 1 to 999999
(10)	State	See the bit assignments below.
(11)	Integrated power	This is the integrated power from the start to the end of this phase.

1 In the Test Setting window, the stage ID, block No., stage No., part No., and phase No. are all counted from 1. However, in P data, these parameters are counted from zero. Therefore, the values that you set in the Test Setting window are one greater than the above parameter values.

- Bit assignments

MSB	14	13	12	11	10	9	8	7	6	5	4	3	2	1	LSB
1	1	End		End Condition				samp	Rh	-	-	-	-	-	-

Assignment	Description
End	The test stop option setting. 00 : Normal (stop according to the test stop conditions) 01 : Stop after executing the current stage 10 : Stop after executing the current part 11 : Stop after executing the current phase
End Condition	Event that caused the test to pause 1000 : Maximum part time 0100 : Maximum phase time 0010 : CV time (including the stop voltage) 0001 : Cut current (including It time)
samp	0 : 1 ms sampling, 1: 100 ms sampling
Rh	When rest hold is selected, this is set to 1.
Other bits	Not used

D:

The data when an acquisition trigger condition (ΔV, ΔI, or ΔT) is met or the data when a state change occurs (including data before and after the state change)

D: timestamp | current | voltage | reference electrode voltage | state

Data component	Description
(1) Timestamp	This is the the time elapsed since the start of the test. When the state samp bit is zero, the elapsed time is in units of 1 ms. When the samp bit is 1, the elapsed time is in units of 100 ms.
(2) Current	Multiplying by the current coefficient*1 gives the actual value (A). A minus sign appears when the value is negative.
(3) Voltage	Multiplying by the C*1 gives the actual value (V).* A minus sign appears when the value is negative.
(4) Reference electrode voltage	Multiplying by the voltage coefficient*1 gives the actual value (V).* A minus sign appears when the value is negative. (only on the model whose rated charge/discharge current is 5 A)
(5) State	See the bit assignments below.

1 Coefficients are described in the third line from the top in a Graph data file.

See p. 31

- Bit assignments

MSB	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
-	-	-	-	-	-	-	-	-	-	-	-	-	-	SCV	CP

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	LSB
Rc	-	-	EXT-in	HOVP	OHP	OCP	VP	samp	ΔV	ΔI	ΔT	state	CC/CV	C/D	on/off

Assignment	Description
SCV	The display status. 0 : CC, charge CV or CP, 1 : discharge CV
CP	The operating status of the PFX2400. 0 : CC or CV, 1 : CP
Rc	When the test enters the rest hold state, this is set to 1.
EXT-in	This is normally set to 1. When an external alarm signal is received continuously for 50 ms, this is set to zero.
HOVP	Hardware overcharge and overdischarge protection state. When activated, this is set to 1.
OHP	Overheat protection state. When activated, this is set to 1.
OCP	Overcurrent protection state. When activated, this is set to 1.
VP	Overcharge and overdischarge protection state. When activated, this is set to 1.
samp	Timestamp unit. 0 : 1 ms, 1: 100 ms
ΔV	When the data acqusition trigger ΔV condition is met, this is set to 1.
ΔI	When the data acquisition trigger ΔI condition is met, this is set to 1.
ΔT	When the data acquisition trigger ΔT condition is met, this is set to 1.
state	When the state changes, such as when the mode switches from CC to CV, this is set to 1.
CC/CV	PFX2400 operating state 0 : Constant voltage (CV), 1: Constant current (CC)
C/D	Test state 0 : Discharge, 1: Charge
on/off	PFX2400 load connection state 0 : OFF, 1: ON
Other bits	Not used

Graph data file (continued)

R:

This is acquired at the start of each rest period.

R: timestamp | state

Data component	Description
(1) Timestamp	This is the the time elapsed since the start of the test.
(2) State	See the bit assignments below.

- Bit assignments

MSB	14	13	12	11	10	9	8	7	6	5	4	3	2	1	LSB
1	1	End		End Condition				samp	Rh	-	-	-	-	-	-

Assignment	Description
End	The test stop option setting. 00 : Normal (stop according to the test stop conditions) 01 : Stop after executing the current stage 10 : Stop after executing the current part 11 : Stop after executing the current phase
End Condition	Event that caused the test to pause 1000 : Maximum part time 0100 : Maximum phase time 0010 : CV time (including the stop voltage) 0001 : Cut current (including It time)
samp	0 : 1 ms sampling, 1: 100 ms sampling
Rh	When rest hold is selected, this is set to 1.
Other bits	Not used

E:

This is acquired once at the end of a test.

E: timestamp | stage ID | block No. | stage No. | part No. | phase No. | block loop count | stage cycle count | absolute cycle count | state | integrated power

Data component		Description
(1)	Timestamp	This is the time elapsed since the start of the test.
(2)	Stage ID	This indicates the stage ID number of the phase at the end of the test. 0 to 15[1]
(3)	Block No.	This indicates the block number that the phase at the end of the test belongs to. 0 to 15[1]
(4)	Stage No.	This indicates which stage number in that block that the phase at the end of the test belongs to. 0 to 15[1] If a test ends without it being executed because of an alarm or unconfigured test conditions, CPChecker2400 returns 65535 or 65534.
(5)	Part No.	This indicates which part number in that stage that the phase at the end of the test belongs to. 0 to 3[1]
(6)	Phase No.	This indicates which phase number of that part the phase at the end of the test corresponds to. 0 to 3[1]
(7)	Block loop count	This indicates which block loop count the test ended at. 1 to 65535
(8)	Stage cycle count	This indicates which stage cycle count the test ended at. 1 to 65535
(9)	Absolute cycle count	This indicates which cycle count the test ended at. 1 to 999999
(10)	State	See the bit assignments below.
(11)	Integrated power	This is the integrated power from the start to the end of the test.

1 In the Test Setting window, the stage ID, block No., stage No., part No., and phase No. are all counted from 1. However, in E data, these parameters are counted from zero. Therefore, the values that you set in the Test Setting window are one greater than the above parameter values.

- Bit assignments

MSB	14	13	12	11	10	9	8	7	6	5	4	3	2	1	LSB
1	1	End		End Condition				Test End Condition							

Assignment	Description
End	The test stop option setting. 00 : Normal (stop according to the test stop conditions) 01 : Stop after executing the current stage 10 : Stop after executing the current part 11 : Stop after executing the current phase
End Condition	Event that caused the test to pause 1000 : Maximum part time 0100 : Maximum phase time 0010 : CV time (including stop voltage) 0001 : Cut current (including It time)
Test End Condition	Event that caused the test to end 10000000 : Warning 01000000 : Input buffer overflow 00000100 : Alarm 00000010 : Stop button 00000001 : Normal (scheduled finish) 00000000 : Ended without the test being executed because of unconfigured test conditions[2]

2 If a test is started when test conditions have not been configured, only “E” data is created, and the test is not executed. In this situation, all the Test End Condition bits are set to zero.

Graph data files (continued)

ALM:

This is acquired once when an alarm occurs.

ALM: timestamp | current | voltage | reference electrode voltage | state

Data component	Description
(1) Timestamp	When an alarm occurs, data is acquired even before 100 ms elapses, so the state may be different even when the timestamp is the same as the previous "D" data.
(2) Current	The current at the time the alarm occurred. The value is the average current over 100 ms during testing and the instantaneous current (a 1 ms sample) otherwise. Divide this value by 320000 to obtain the current in units of 3.125 µA. If the value is negative, a minus sign is included.
(3) Voltage	The voltage at the time the alarm occurred. The value is the average voltage over 100 ms during testing and the instantaneous voltage (a 1 ms sample) otherwise. Divide this value by 320000 to obtain the actual voltage in units of 3.125 µV. If the value is negative, a minus sign is included.
(4) Reference electrode voltage	Divide this value by 320000 to obtain the actual voltage in units of 3.125 µV. If the value is negative, a minus sign is included.
(5) State	See the bit assignments below.

- Bit assignments

MSB	14	13	12	11	10	9	8	7	6	5	4	3	2	1	LSB
-	-	-	-	HOVP	OHP	OCP	VP	-	EXT-in	-	-	-	CC/CV	C/D	on/off

Assignment	Description
HOVP	When hardware overcharge or overdischarge protection is activated, this is set to 1.
OHP	When overheat protection is activated, this is set to 1.
OCP	When overcurrent protection is activated, this is set to 1.
VP	When overcharge or overdischarge protection is activated, this is set to 1.
EXT-in	When an external alarm signal is received continuously for 50 ms, this is set to 1.
CC/CV	PFX2400 operating state. 0 : Constant voltage (CV), 1: Constant current (CC)
C/D	Test state. 0 : Discharge, 1: Charge
on/off	PFX2400 load connection state. 0 : Disconnected, 1: Connected
Other bits	Not used

- ALM:BUF

If, for some reason, the size of the acquisition data exceeds the size of the PFX2400 internal RAM, "ALM:BUF" is recorded at the end of the RAM area, and the test stops. If this happens, unlike other alarms, the PFX2400 ALARM LED blinks in red, because the alarm state information cannot be retrieved. Click Alarm Reset to start the test again.

See p. 38

If you create a test condition file for the remainder of the test by following the procedure outlined in "What to Do When a Power Failure Occurs," you can resume the test from the point where "ALM:BUF" was recorded. Note that it may take a few hours to retrieve all the data when the buffer is full.

PAUSE:

This is acquired when a test is paused. There is no accompanying data.

Data files for displaying analysis results

This acquisition data is used to display analysis results. "_RES" is appended to the file name to distinguish this data from graph data. Because this is a text file (in CSV format), you can open it with a spreadsheet application to analyze it.

The following figure is a sample of a data file for displaying analysis results.

See p. 43

The items displayed in the Result View window are arranged horizontally in the file. For a description of the items, see Terminology.

Capacitor Performance Checker for PFX2400 Ver 0.35 Firm:Ver 0.32 MAC Address:00-20-4A-A8-55-7
StageID:1-16

Channel	Stage ID	Cycle No.	Total Cycle No.	Electrostatic Capacity (E)	(differential Method) (F)	(JIS5160) (F)	(JIS1401) (F)	Internal Resistan	harge shed [A]	Discharge Finished [V]	Rest Opening [V]	Rest Finish [V]
1	1	1	1	1.97E+02	0.00E+00	---	---	2.83E-0	2.49E+00	0.00E+00	6.08E-02	2.85E-01
1	1	2	2	1.98E+02	0.00E+00	---	---	2.79E-	2.49E+00	-2.50E-05	6.05E-02	2.86E-01
1	1	3	3	1.98E+02	0.00E+00	---	---	2.77E-	2.49E+00	-9.38E-06	6.02E-02	2.87E-01
1	1	4	4	1.98E+02	0.00E+00	---	---	2.76E-	2.49E+00	-3.44E-05	6.00E-02	2.88E-01
1	1	5	5	1.99E+02	0.00E+00	---	---	2.75E-	2.49E+00	-3.44E-05	5.99E-02	2.89E-01
1	1	6	6	1.99E+02	0.00E+00	---	---	2.74E-	2.49E+00	-3.13E-06	5.99E-02	2.90E-01
1	1	7	7	1.99E+02	0.00E+00	---	---	2.74E-	2.49E+00	-1.88E-05	5.98E-02	2.91E-01
1	1	8	8	1.99E+02	0.00E+00	---	---	2.74E-0	.49E+00	-2.19E-05	5.97E-02	2.92E-01
1	1	9	9	1.99E+02	0.00E+00	---	---	2.73E-0	49E+00	-2.50E-05	5.97E-02	2.94E-01
1	1	10	10	1.99E+02	0.00E+00	---	---	2.74E-02	49E+00	-3.13E-06	5.98E-02	2.95E-01
1	1	11	11	1.99E+02	0.00E+00	---	---	2.73E-02	9E+00	-1.25E-05	5.98E-02	2.96E-01
1	1	12	12	1.99E+02	0.00E+00	---	---	2.74E-02	9E+00	-6.25E-06	5.98E-02	2.97E-01
1	1	13	13	1.99E+02	0.00E+00	---	---	2.74E-02	9E+00	-1.25E-05	5.98E-02	2.98E-01
1	1	14	14	1.99E+02	0.00E+00	---	---	2.74E-02	9E+00	-3.13E-05	5.98E-02	2.99E-01
1	1	15	15	1.99E+02	0.00E+00	---	---	2.74E-02	9E+00	-9.38E-06	5.99E-02	3.00E-01
1	1	16	16	1.99E+02	0.00E+00	---	---	2.74E-02	49E+00	-1.56E-05	5.99E-02	3.01E-01
1	1	17	17	1.99E+02	0.00E+00	---	---	2.74E-02	49E+00	-6.25E-06	5.99E-02	3.02E-01
1	1	18	18	2.00E+02	0.00E+00	---	---	2.74E-0	.49E+00	-6.25E-06	5.99E-02	3.03E-01
1	1	19	19	2.00E+02	0.00E+00	---	---	2.74E-0	2.49E+00	0.00E+00	6.00E-02	3.03E-01
1	1	20	20	2.00E+02	0.00E+00	---	---	2.74E-	2.49E+00	0.00E+00	5.99E-02	3.04E-01
1	1	21	21	2.00E+02	0.00E+00	---	---	2.74E-	2.49E+00	-2.81E-05	5.99E-02	3.05E-01

The items displayed in the Result View window are arranged horizontally in the file.

What to Do When a Power Failure Occurs

This section explains what to do if a power failure occurs during testing (this also includes the case in which the PFX2400 Series is turned off by mistake).

Recovering from a power failure

When a power failure occurs during testing, if the PC is still on, a COM error occurs, and the test is stopped. To recover from this state, follow the procedure below.

1. **Supply power to the PFX2400 Series.**

2. **In the State View window, click Disconnect, and then click Connect.**
   The progress bar above the button is filled in, and the states of the channels that have been recognized by the window are displayed.

If following the above procedure does not establish a connection, turn off the PFX2400 Series, and exit CPChecker2400. Restart CPChecker2400, and then follow the above procedure.

Executing the remainder of a test

If a power failure occurs during a test, the result data acquired before the failure is saved. From the graph data file that has been saved, you can create a test condition file that can be used to execute the remainder of the test.

1 **In the Test Setting window, open the test condition file that was being executed when the power failure occurred.**

2 **Using a spreadsheet or other application, open the graph data file of the test that the power failure occurred in. Find the "P:" line that is closest to the last line of the file.**

The information in this line is the content of the phase that was being executed when the power failure occurred.

3 **If the block number of the "P:" line is greater than zero, enter zeroes in the loop cells (blue cells) up to that block number.**

See p. 32

When you set a loop number to zero, "-" appears.

Block numbers in the "P:" line range from 0 to 15. Block numbers in the Test Setting window range from 1 to 16.

After setting the loop cells of the blocks up to the block number indicated in the "P:" line to zeros (-), you can specify the loop cells of the remaining blocks.

If the block number in the "P:" line is zero, the block number for the block that was being executed was 1, so you do not have to specify any loops.

4 **Look at the first block column whose loop is not "-." If the stage number of the "P:" line is greater than zero, enter zeroes in the repetition count cells up to the row that has that stage number.**

When you set a repetition count to zero, "-" appears.

Stage numbers in the "P:" line range from 0 to 15. Stage numbers in the Test Setting window range from 1 to 16.

After setting the repetition counts of the stages up to the stage number indicated in the "P:" line to zeros (-), you can specify the repetition counts for the remaining stages.

If the stage number in the "P:" line is zero, the stage number for the stage that was being executed was 1, so you do not have to specify any repetition counts.

5 **Look at the cell of the first stage row whose repetition count is not "-" in the first block column whose loop is not "-." If the stage cycle count in the "P:" line is greater than 1, set the value of the cell to "the set value - the stage cycle count in the 'P:' line + 1."**

6 **If preliminary charging is needed, use the blocks or stages that were disabled to configure it.**

7 **Save the test conditions to a separate file (for example, name this file by adding "_cont" to the name of the test condition file that you opened in step 1).**

8 **Open the test condition file that you saved in step 7 , and check its contents.**

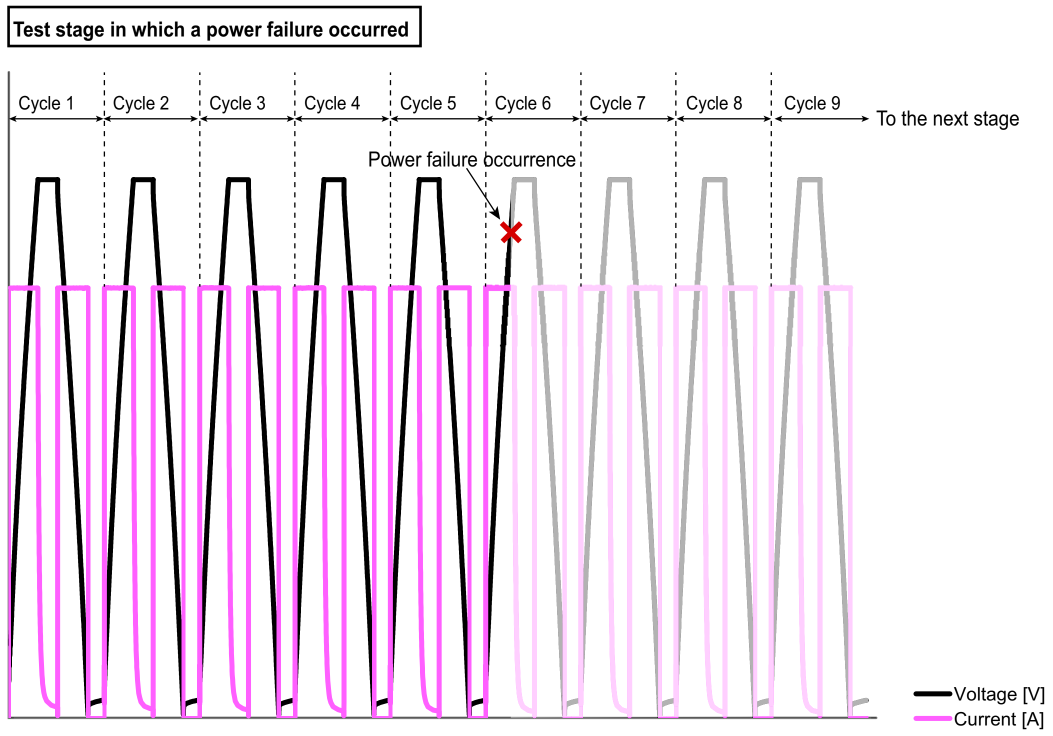
By using this test condition file, you can execute the remainder of the test.

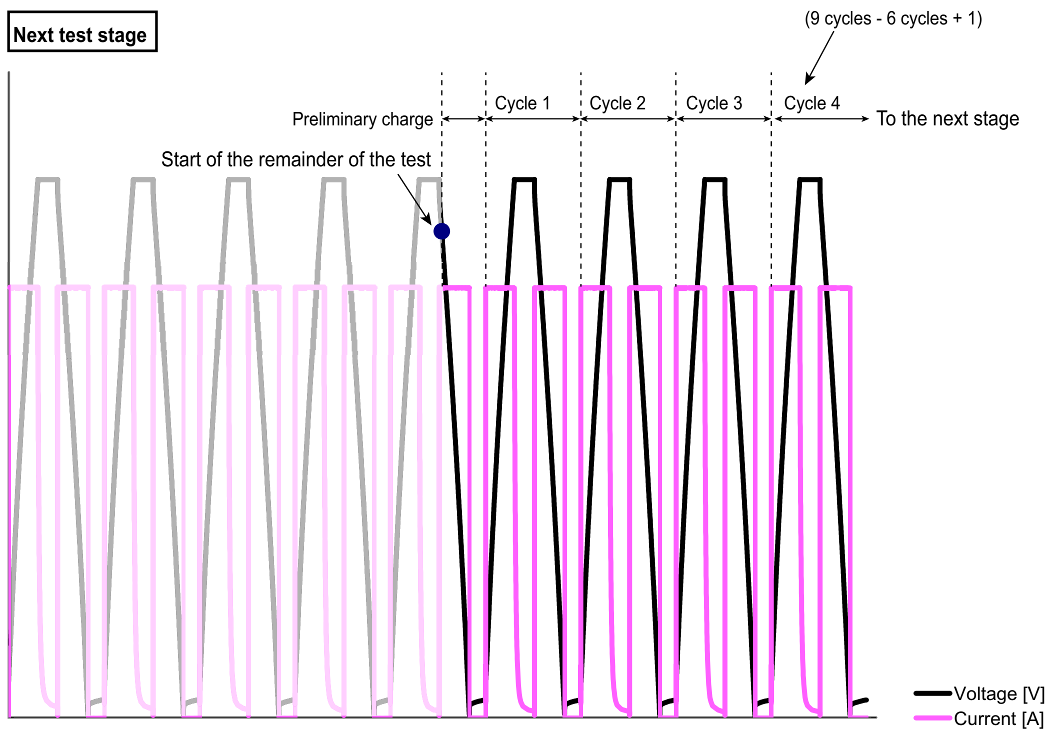
Because the test condition file is saved with a new name, the result data will be saved to a different location. After the test is complete, concatenate the test result data files using a spreadsheet or other application.

Executing the remainder of a test (continued)

■Example of a test in which a power failure occurred

In this example, a power failure occurred in the sixth cycle of a stage consisting of nine cycles. To continue the test, you must set the test conditions so that the sixth cycle becomes the first cycle, the remaining four cycles are executed, and the test then moves on to the next stage. By adding a preliminary discharge cycle before the first cycle, you can start the test in the discharge state.





Recovering Data When Communications Fail

When a test starts, the PFX2400 acquires data in accordance with the testing conditions assigned to each channel and stores the data in various memory locations. The stored data is sent to the PC when a request is received from CPChecker2400.

In this manner, after testing starts, the PFX2400 operates autonomously. Therefore, during testing, if a problem occurs, such as the LAN cable being disconnected or the PC freezing, the PFX2400 will continue acquiring data until its memory is full. When a problem occurs, the approximately 100 items of test data in the communication buffer will be lost, but the rest of the data will be stored in the memory. After you fix the problem, you can follow a series of procedures to recover the data stored on the PFX2400.

NOTE If a test is completed while the PFX2400 is operating autonomously, you cannot recover the data.

●Amount of Data That Can Be Stored in the Memory

In a normal cycle test in which 1 cycle produces about 30 kB of data[1], the PFX2400 can store approximately 400 cycles of data for each channel to its memory.

1 * This is the amount of data when, aiming for a measurement accuracy of 0.5 %, the user sets ΔV and ΔI to 1/200 of the set voltage and current values, respectively. Each data cycle has approximately 700 data items.

Recovering the Data Stored on the PFX2400

The following procedure is for recovering the data stored on the PFX2400 if a problem occurs, such as the LAN cable being disconnected or the PC freezing.

1 **Fix the problem.**
For example, connect the LAN cable, or restart the PC.

2 **Follow the normal procedure for starting CPChecker2400.**

See p. 6

3 **Connect the PFX2400.**
Restore the communication of the channel whose data you want to recover.
If "Firm Err" is displayed in the State View window, exit CPChecker2400. Wait 1 minute, and then repeat steps 2 and 3 until "Firm Err" is no longer displayed.

See p. 24

4 **Assign the test conditions that you executed before the problem to the channel whose communication you have restored.**

5 **Start testing.**
The PC will load the data stored in the memory.
If the channel's memory is not full, testing will continue, but the data will be stored under a different file name.

Now that you have recovered the data stored in the memory, you can use it on the PC. You can process the recovered data using a spreadsheet application, such as Excel, but unlike normal data, the recovered data will be missing some information, such as the header.

To correctly connect the data acquired before the problem occurred to the recovered data, you should use a text editor such as WordPad to paste the recovered data to the end of the data acquired before the problem occurred.

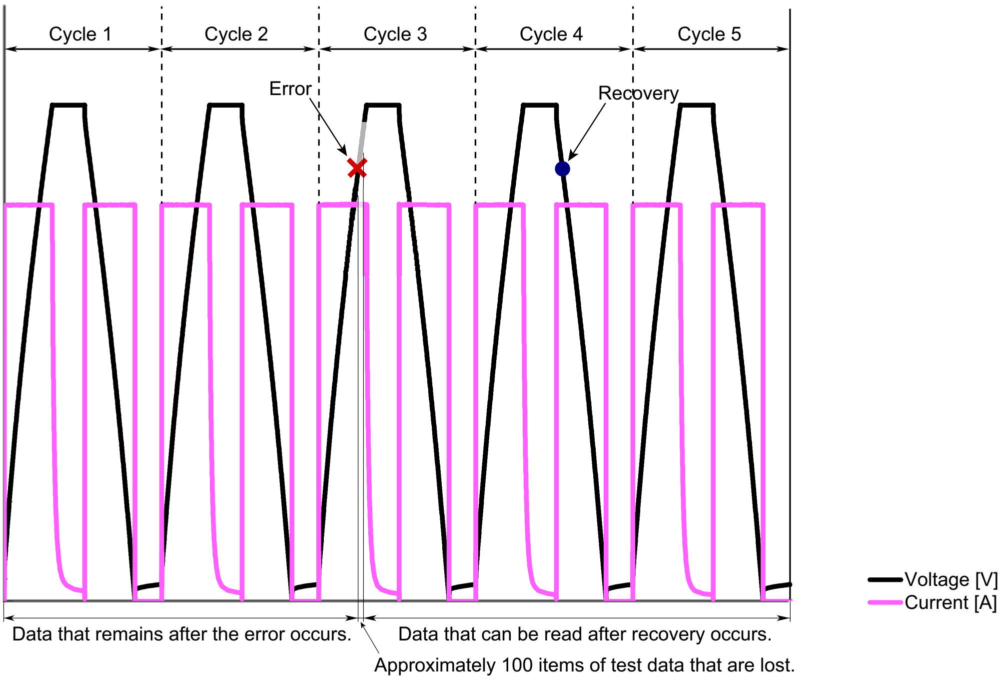
Recovering the Data Stored on the PFX2400 (continued)

■Example of a test during which a communication error occurs

This example explains the case in which a communication error occurs during the third cycle of a stage that is composed of five cycles.

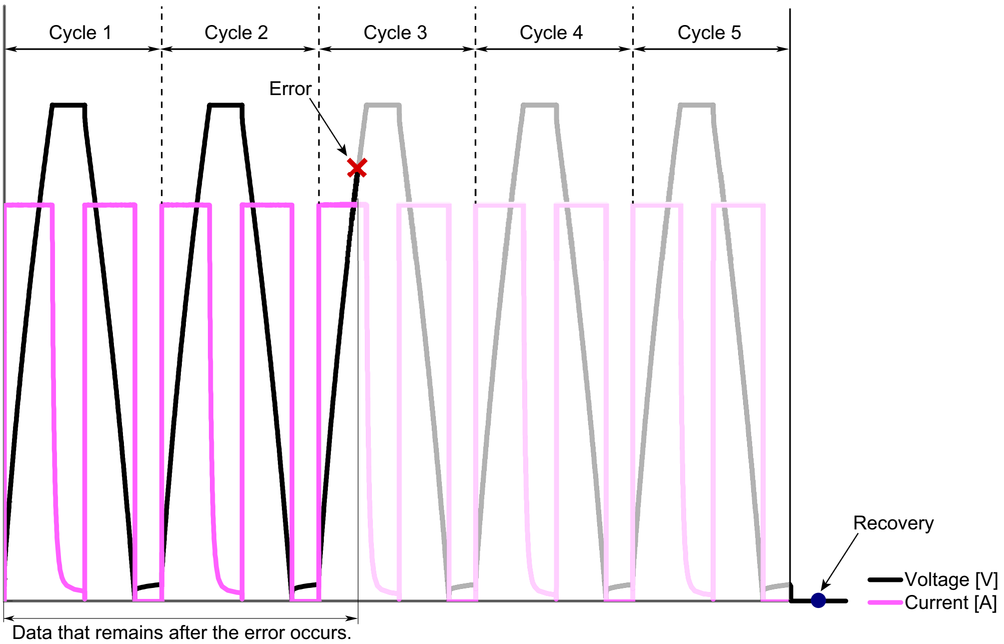
Case in which data can be recovered

When the PFX2400 is operating autonomously, if it recovers from the error and continues to perform the test, the data can be read. (In this example, recovery occurs during the fourth cycle.)



Case in which data cannot be recovered

When the PFX2400 has finished operating autonomously, if it recovers from the error and continues to perform the test, the data can not be read.



Terminology

Term	Description
Charge accumulated electric energy	This is the integrated value of the charge power from the start to the end of charging. The integrated power from t_n to t_{n+1} is derived from $\Delta P = \frac{(V_n + V_{n+1})}{2} \times \frac{(I_n + I_{n+1})}{2} \times (t_{n+1} - t_n)$, where t_n is a given time during charge, V_n and I_n are the voltage and current at that time, t_{n+1} is the time of the next sampled data, and V_{n+1} and I_{n+1} are the voltage and current of the next sampled data. Charge accumulated electric energy is the power obtained by using the above equation to integrate from the start to the end of charging. $P = \sum_{t=0}^{n} \Delta Pn$
Discharge accumu-lated electric energy	This is the integrated value of the discharge power from the start to the end of discharging. The calculation is the same as the charge accumulated electric energy.
Charge-discharge efficiency (or Energy efficiency)	Charge-discharge efficiency is the value obtained by dividing the discharge accumulated electric energy by the charge accumulated electric energy. This includes losses due to internal resistance. The value varies depending on the discharge current.
Electrostatic capacity (energy)	The energy stored in an electric double-layer capacitor is proportional to the square of its voltage. Therefore, the change in energy that occurs when the capacitor voltage changes from discharge start voltage V_1 to discharge stop voltage V_2 is derived from the following equation. $\Delta P = \frac{1}{2} CV_1^2 - \frac{1}{2} CV_2^2 = \frac{1}{2} C(V_1^2 - V_2^2)$ [J] Because the value of this equation is equal to the discharge accumulated electric energy, we obtain the following equation. $C = \frac{2 \times (\text{Integrated discharge power})}{(V_1^2 - V_2^2)}$ [F] The value calculated using this equation is the electrostatic capacity (energy).
Electrostatic capacity (differentiatial)	The charge stored in a capacitor is proportional to its voltage. $Q = CV$ [C] The amount of charge movement is the current, so we obtain the following equation. $I = C\frac{dV}{dt}$ The electrostatic capacity is calculated using the above equation on all sample intervals from one point before the start of discharge to the end of discharge. The average of all the calculated values is the electrostatic capacity (differentiatial).
Charge Internal Resistance	The charge internal resistance is calculated by dividing the voltage drop during the IR measurement period (this is equal to the charge stop voltage - the minimum voltage during the IR measurement period) by the charge current.
Initial internal resistance	The initial internal resistance is the value of the voltage drop that occurs at the point when the current has risen immediately after the start of discharge (this is equal to the charge stop voltage - the discharge start voltage) divided by the current.
Internal resistance	A linear approximation using the least square method is taken on the discharge voltage data from the start of discharge to the end of the specified range (from the calculation start voltage to the calculation stop voltage), and the voltage at the intersection of this line and the time line at the start of discharge is calculated. The internal resistance is the value obtained by dividing the difference between this voltage and the charge stop voltage by the discharge current.
ESR	The ESR is the product of the internal resistance and the electrostatic capacity (energy).
Maintain voltage rate	If V_1 represents the first point and V_2 represents the last point of the rest time in a voltage hold test, the maintain voltage rate can be determined using the following equation. $\frac{V_2}{V_1} \times 100$ [%]
Leak current	The leak current is the average current calculated over the range from the specified number of data points before the end of charging to the end of charging.

Menu Reference

Menu		Description
File		
	Exit	Exits CPChecker2400
View		
	Test Condition Setting	Opens the Test Setting window.
	Test Operation Panel	Opens the Test Operation Panel window
	Charge-Discharge Waveform	Opens the Charge-Discharge Graph window
	Result Viewer	Opens the Result View window
Help		
	Contents J	Opens the CPChecker2400 Japanese Operation Guide.
	Contents E	Opens the CPChecker2400 English Operation Guide.
	About	Shows CPChecker2400 version information