

Keysight Technologies B1506A Power Device Analyzer for Circuit Design

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Declaration of Conformity

To get the latest version of the declaration of conformity, go to <http://www.keysight.com/go/conformity> and type in the product number in the Search field.

Latest Information

To get the latest firmware/software/electronic manuals/specifications/support information, go to www.keysight.com and type in the product number in the Search field at the top of the page.

COMPLIANCE WITH GERMAN NOISE REQUIREMENTS

This is to declare that this product is in conformance with the German Regulation on Noise Declaration for Machines (Lärmangabe nach der Maschinenlärminformation-Verordnung -3.GSGV Deutschland).

- **Herstellerbescheinigung**

GERÄUSCHEMISSION

Lpa < 70 dB

am Arbeitsplatz

normaler Betrieb

nach DIN 45635 T. 19

- **Manufacturer's Declaration**

ACOUSTIC NOISE EMISSION

Lpa < 70dB

operator position

normal operation

per ISO 7779

South Korean Class A EMC declaration

This equipment is Class A suitable for professional use and is for use in electromagnetic environments outside of the home.

A급 기기

(업무용 방송통신기자재)

이 기기는 업무용(A급) 전자파적합기기로서 판매자 또는 사용자는 이 점을 주의하시기 바라며, 가정외의 지역에서 사용하는 것을 목적으로 합니다.

WARNING



High Voltage

is used in the operation of this equipment.

LETHAL VOLTAGE on CONTACT

may be present at measurement terminals,
if you fail to take in all safety precautions!

- When the RED indicator lights, lethal voltage (± 3000 V dc/pulse) may appear at measurement terminals.
- **Usually use the interlock function.**
- Do not operate the instrument unless another person is around the work space who is familiar with instrument operation and hazards or administering first aid.
- Potentials less than ± 500 V may cause death under certain conditions. Therefore, adequate preventive measures must be taken at all times!

FIRST AID FOR ELECTRIC SHOCK

SPECIAL ATTENTION TO RESCUE IN SAFETY

- Never rush into an accidental situation.
- Take special attention to the following notices to prevent second accident.
 - Do NOT touch the CASUALTY or conductive surface with your hands unprotected.
 - Shut off high voltage at once.
 - Disconnect AC mains.
- If it is unsure to make safe, the following procedure will help to protect your lives during the CASUALTY is rescued.
 - Stand on a dry insulating material; use a dry wooden or plastic implement to free the CASUALTY from contact with hazardous electrical source.
 - Ground the circuit to de-energize.

- Free the CASUALTY from the LIVE conductor

CALL EMERGENCY

- Call your local Emergency number immediately, if any of signs or symptoms shown in the following table will be found.

http://en.wikipedia.org/wiki/Emergency_telephone_number#Emergency_numbers


DELAYED SYMPTOMS

- In some cases, electric shock can cause injuries that are not evident and symptoms may be delayed.
- Burns to the CASUALTY may be greater than they appear on the surface.
- For these reasons, all electric shock CASUALTY should be taken to hospital for advanced observation.

<i>English</i>	<i>Deutsch</i>	<i>French</i>	<i>Japanese</i>	<i>Korean</i>	<i>Simplified Chinese</i>	<i>Traditional Chinese</i>
Symptoms	Symptome	Symptômes	兆候	징후	征候	徵候
Cardiac arrest	Herz-Kreislauf-Stillstand	Arestation cardiopulmonaire	心肺停止	심폐 정지	心肺停止	心肺停止
Abnormal cardiac rhythm	Arrhythmia	Arythmie	不整脈	부정맥	脉律不齐	脈律不齊
Respiratory failure (difficult or absent breathing)	Respiratorischer Mißerfolg	Échec respiratoire	呼吸不全	호흡 부전	呼吸不全	呼吸不全
Muscle pain and contractions	Muskelschmerz und Zusammenziehungen	Douleur du muscle et contractions	筋肉痛 / 痙攣	근육통 / 수축	肌肉痛 / 痙攣	肌肉痛 / 痙攣
Seizures (heart beat stopped)	Herzlähmung	Paralysie cardiaque	心臟麻痺	심장 마비	心脏麻痹	心臟麻痺
Numbness and tingling	Eine Taubheit / Stachel	Un engourdissement / Une épine	痺れ / 刺痛	저리다 / 가시痛	发麻 / 刺痛	發麻 / 刺痛
Unconsciousness	Bewusstlosigkeit	Évanouissement	意識不明	의식 불명	意识不明	意識不明
Entrance and exit wound burns	Eine elektrische Schockspur	Une trace du choc électrique	感電跡	감전 자국	触电痕迹	觸電痕跡

First Aid for Electric Shock Procedure

Do not give compression-only CPR to infants and children — all infants and children who have a sudden cardiac arrest need conventional CPR. Also should not be used for adults whose cardiac arrest is from respiratory causes, or for an unwitnessed cardiac arrest.

D	Danger	Check for DANGER, make SAFE first to YOU, Others, and the CASUALTY.	
R	Response	Check for a RESPONSE.	
		Leave on back. If not conscious, <ol style="list-style-type: none"> 1. Ask others to emergency CALL for an ambulance immediately. 2. HELP to bring AED, ASAP. 3. Start CPR by YOU. 	
C	CPR for ADULT only	Start the center of chest compressions (>100 compressions per minute) without stopping until emergency medical services arrive.	
		One of the most famous chest compression-only CPR is AHA Hands-Only CPR which is without mouth-to-mouth rescue breaths. http://handsonlycpr.org/ http://www.youtube.com/watch?v=zuJkRpJ7Fyg	
		Rhythm of chest compression: http://www.heart.org/HEARTORG/CPRAndECC/CommunityTraining/CommunityPrograms/CPR-Week_UCM_427219_SubHomePage.jsp http://www.youtube.com/watch?v=n5hP4DIBCEE&feature=player_detailpage	
		Continue CPR until <ul style="list-style-type: none"> ● Signs of life return. ● AED is ready to use. ● Medical services arrive and take over. 	
If YOU have a trained rescue skill, should apply the following step. If not, only keep chest compression until others help.			
A	Airway	No foreign material Leave on back, open airway.	Foreign material Place in the recovery position, clear of objects.
B	Breathing	30 compress & 2 breaths	
D	Defibrillator 	Apply AED with following voice prompts. If no AED available, continue CPR until qualified personnel arrives.	

- ※AED: Automated External Defibrillator
- ※CPR: Cardio Pulmonary Resuscitation
- ※AHA: American Heart Association, Inc.

Reference

- AHA CPR & Emergency Cardiovascular Care (ECC)
(http://www.heart.org/HEARTORG/CPRAndECC/CPR_UCM_001118_SubHomePage.jsp)
- AHA Hands-only CPR (<http://handsonlycpr.org/>)
- Save a Life
(http://www.heart.org/HEARTORG/CPRAndECC/CommunityTraining/CommunityPrograms/CPR-Week_UCM_427219_SubHomePage.jsp)
- AHA CPR Translated Website
(http://www.heart.org/HEARTORG/CPRAndECC/International/TranslatedWebsites/Translated-Websites_UCM_303149_SubHomePage.jsp)
Deutsch (<http://www.american-heart.de/startseite>)
Japanese (<http://eccjapan.heart.org/>) available as of March, 2012))
- Chain of Survival
(http://www.heart.org/HEARTORG/CPRAndECC/WhatisCPR/ECCIntro/Chain-of-Survival_UCM_307516_Article.jsp)
- ECC Guidelines Highlights 2010
English (http://eccjapanheart.org/pdf/ECC_Guidelines_Highlights_2010.pdf)
Japanese (http://eccjapanheart.org/pdf/ECC_Guidelines_Highlights_2010JP.pdf)
Deutsch (http://www.american-heart.at/fileadmin/downloads/Guidelines2010-Highlights_D/Guidelines2010-Highlights_D.pdf)

International

- ILCOR (<http://www.ilcor.org/home/>)
- ILCOR CoSTR 2010 Consensus
(<http://www.ilcor.org/consensus-2010/costr-2010-documents/>)

Europe

- ERC (<https://www.erc.edu/>)
- ERC Guidelines 2010 (<http://www.cprguidelines.eu/2010/>)
Local language translation (<https://www.erc.edu/index.php/doclibrary/en/185/1/>)

America

- AHA (<http://www.americanheart.org/>)
- AHA Guidelines 2010 (<http://guidelines.ecc.org/2010-guidelines-for-cpr.html>)

Safety Summary

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual may impair the protections provided by the instrument. In addition, it violates safety standards of design, manufacture, and intended use of the instrument. Keysight Technologies assumes no liability for customer's failure to comply with these requirements.

Product manuals may be provided on CD-ROM or in printed form. Printed manuals are an option for many products. Manuals may also be available on the Web. Go to www.keysight.com and type the product model number in the Search field at the top of the page.

NOTE

Do not use this instrument in any manner not specified by the manufacturer. The protective features of this instrument may be impaired if it is used in a manner not specified in the operation instructions.

This instrument is an INDOOR USE product.

This instrument complies with INSTALLATION CATEGORY II for mains input and INSTALLATION CATEGORY I for measurement input terminals, and POLLUTION DEGREE 2 defined in IEC 61010-1.

If an instrument is marked CAT I (IEC Measurement Category I), or it is not marked with a measurement category, its measurement terminals must not be connected to line-voltage mains.

- *DANGEROUS PROCEDURE WARNINGS*

Warnings, such as example below, shall be complied. Procedures throughout in this manual prevent you from potentially hazard. Their instructions contained in the warnings must be followed.

WARNING

Hazardous voltage, instrument maximum output voltage may appear at the measurement terminals (High, Force, Guard, and Sense) if Interlock terminal is closed. Open the Interlock terminal when the measurement terminals are accessible. Voltage applied to the terminals will be limited up to ± 42 V.

Do not work the interlock function intentionally in order to bring the output voltage to the safe level. While the high voltage indicator is lit, the dangerous voltage by the output voltage or the residual charge appears on the measurement terminal.

- *BEFORE APPLYING POWER*

Verify that all safety precautions are taken. Make all connections to the instrument before applying power. Note the instrument's external markings described under "Safety Symbols".

- *GROUND THE INSTRUMENT*

This is Safety Class I instrument. To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The power terminal and the power cable must meet International Electrotechnical Commission (IEC) safety standards.

- *DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE*

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

- *DO NOT REMOVE COVERS*

No operator serviceable parts inside. Refer servicing to qualified personnel. To prevent electrical shock do not remove covers.

- *IN CASE OF DAMAGE*















Instruments that appear damaged or defective should be made inoperative and secured against unintended operation until they can be repaired by qualified service personnel. Return the instrument to a Keysight Technologies sales or service office for services and repair to ensure that safety features are maintained.

- *USE ONLY THE SPECIFIC ACCESSORIES*

Specific accessories satisfy the requirements for specific characteristics for using the instrument. Use the specific accessories, cables, adapters, and so on for safety reasons.

Safety Symbols

The general definitions of safety symbols used on equipment or in manuals are listed below.

-  Direct current.
-  Alternating current.
-  Earth (ground) terminal.
-  Protective conductor terminal. For protection against electrical shock in case of a fault. Used with field wiring terminals to indicate the terminal which must be connected to ground before operating equipment.
-  Frame or chassis terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.
-  Grounded terminal which indicates the earth potential.
-  On supply.
-  Off supply.
-  Standby supply. The equipment will be marked with this symbol is not completely disconnected from AC mains when power switch is in the standby position.
-  In position of a bi-stable push switch.
-  Out position of a bi-stable push switch.
-  Hazardous voltage and potential for electrical shock. Do not touch terminals that have this symbol when the equipment is on.
-  Hot surface. Avoid contact. Surfaces are hot and may cause personal injury if touched.
-  Caution, refer to accompanying documentation. The equipment will be marked with this symbol when it is necessary for the user to refer to the instruction manual.

WARNING

The warning sign denotes a hazard. It calls attention to a procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in injury or death to personal.

CAUTION

The caution sign denotes a hazard. It calls attention to an operating procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the equipment.

CAT I IEC Measurement Category I



The CE mark shows that the product complies with all applicable European Directives.



The CSA mark is a registered trademark of the Canadian Standards Association.



The RCM mark is a registered trademark of the Australian Communications Authority. This signifies compliance with the Australian EMC Framework Regulations under the terms of the Radio communications Act.

ICES/NMB-001

This ISM device complies with Canadian ICES-001.

Cet appareil ISM est conforme à la norme NMB-001 du Canada.

ISM GROUP 1 CLASS A

This is the symbol for an Industrial, Scientific and Medical, Group 1 Class A product. (CISPR 11)



Korea's safety and EMC mark



China RoHS - Environmentally Green Product Label



China RoHS - Product with Toxic Substance 40 yr EPUP



The Chinese mark for paper-based packaging materials; Paperboard and Corrugated Fiberboard

CFB



Plastic Material Coding Identification

PET



Low temperature or freezing conditions. Avoid contact. Surfaces are cold and may cause personal injury if touched.

Power Supply and Measurement Safety

- Power Supply Safety

This instrument can output high currents and voltages. Make sure that the load or device under test can safely handle the output current and voltage. Also, make sure that the connection leads can safely withstand the expected currents and are insulated for the expected voltages.

The instrument outputs may be connected so as to float relative to earth ground. Isolation or floating voltage ratings are indicated on the instrument, near the output terminal or the Circuit Common terminal. There is the danger of electric shock by touching the floated measurement terminals. Keep in mind it to protect yourself. And it is a reason of using the recommended accessories.

- Voltage/Current Measurement Safety

Multimeters and other instruments capable of measuring high voltages and currents are subject to specific safety concerns because of the circuits to which they may be connected. To safely use these instruments, you need to understand the markings on the instrument near the input terminals, which include the Protection Limits and the IEC Measurement Category.

- Protection Limits

Keysight multimeters and other voltage measurement instruments provide protection circuitry to prevent damage to the instrument and to protect against the danger of electric shock, provided the Protection Limits are not exceeded. To ensure safe operation of the instrument, do not exceed the Protection Limits shown on the input terminals.

- Source/Monitor Terminals

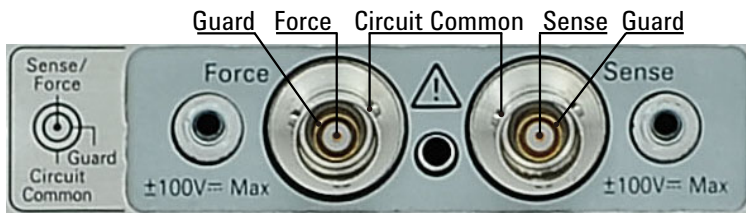
Source/monitor unit, SMU, can simultaneously perform DC voltage or current output and measurement. Typical SMU has the Force, Guard, Sense, and Circuit Common terminals as shown below. Normally the Force, Guard, and Sense terminals are the same potential. Voltage marked around the terminals indicates the Protection Limits.

Force and Sense must be connected to a terminal of a device under test for the Kelvin connection which is effective for high current measurement and low resistance measurement. For the non-Kelvin connection to ease the connections, connect Force only. Do not connect Sense. It must be opened.

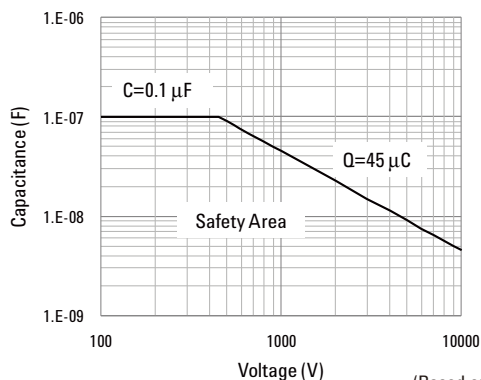
Guard should be extended to around the device terminal for reducing leakage current caused by a coaxial cable used. Guard must be never connected to anything at the device side.

Circuit Common should be connected to shielding of the coaxial cable used.

The following image is the Kelvin triaxial connector of Medium Power SMU.



- To Avoid Risk of Residual Charge



(Based on standards IEC60950-1 and IEC61010-1.)

This graph shows the load capacitance vs voltage characteristics generally considered as safety. Use the instrument within the safety area up to 0.1 μF or 45 μC according to the voltage. Also do not connect the capacitive load over the maximum load capacitance specified for the instrument, for example 10 nF for HVSMU.

Before touching the measurement terminal, confirm that it has been discharged enough. For that, ground and discharge the terminals over 10 seconds after stopping the high voltage output, and confirm that they have been safety voltage by using another volt meter.

If abnormal end of measurement, breaking of cable, or device damage occurs, do not touch the terminals until they are discharged enough.

Also if a series resistor is connected, do not touch the terminal until it is discharged enough.



High Voltage Shock Hazard

Keysight B1506A can force dangerous voltages (± 3000 Vdc for HVSMU and ± 100 Vdc for MPSMU) at the High, Force, Guard, and Sense terminals. To prevent electric shock hazard, the following safety precautions must be observed during the use of Keysight B1506A.

- Connect the instrument to an electrical ground (safety ground) by using three-conductor AC power cable.
- Before performing measurement, connect the interlock circuit to the Interlock terminal of this instrument.
- Confirm periodically that the interlock function works normally.
- Before touching the connections of the High, Force, Guard, and Sense terminals, turn the instrument off and discharge any capacitors of the measurement path. If you do not turn the instrument off, complete “all” of the following items, regardless of any instrument settings.
 - Terminate measurement by pressing the Stop key, confirm that the Measurement status indicator is not lit.
 - Confirm that the High Voltage indicator is not lit.
 - Open the Interlock terminal.
 - Discharge any capacitors if the capacitance is connected to an SMU.
- Warn workers in the vicinity of the instrument about hazardous conditions.



Gefahr durch Hochspannung

Von den Geräten Keysight B1506A können Spannungen an den Anschlüssen “High”, “Force”, “Guard” und “Sense” von bis zu 3000 V ausgehen. Um elektrischem Schlag vorzubeugen, ist bei der Benützung der Geräte Keysight B1506A folgendes zu beachten.

- Verwenden Sie ein dreiphasiges AC-Stromkabel für die Gerätsteckvorrichtung (Eingang) und schließen Sie das Instrument an eine Erdung an (Sicherheitserdung).
- Vor der Messung verbinden Sie den Verriegelungsstromkreis mit dem Interlock-Anschluss dieses Instruments.
- Prüfen Sie in regelmäßigen Abständen, dass die Verriegelungsfunktion ordnungsgemäß funktioniert.
- Bevor Sie die Verbindungen zu den Anschlüssen “High”, “Force”, “Guard” und “Sense” berühren, schalten Sie das Instrument aus und entladen alle Kondensatoren des Messwegs. Wenn Sie das Instrument nicht ausschalten, führen Sie, unabhängig von den Instrumenteinstellungen, alle folgenden Schritte durch.
 - Beenden Sie die Messung, indem Sie auf die Taste “Stop” drücken. Stellen Sie sicher, dass die Statusanzeige “Measurement” nicht leuchtet.
 - Stellen Sie sicher, dass die Anzeige “High Voltage” nicht leuchtet.
 - Öffnen des Interlock-Anschlusses.
 - Entladen Sie alle Kondensatoren, wenn die Kapazität mit einer SMU verbunden ist.
- Warnen Sie Mitarbeiter in der Umgebung des Instruments vor den Gefahren.



Danger de choc dû à une haute tension

Une tension dangereuse (max. \pm pour HVSMU; 3000 Vdc, max. \pm pour MPSMU; 100 Vdc) émanant du dispositif Keysight B1506A peut être sortie aux bornes High, Force, Guard et Sense. Les précautions suivantes doivent être observées contre commotion électrique accidentelle.

- Utilisez un câble d'alimentation CA à trois conducteurs vers le coupleur secteur (entrée) et branchez l'instrument sur une mise électrique à la terre (prise de terre de sécurité).
- Avant de procéder aux mesures, connectez le circuit de sécurité à la borne Interlock de l'instrument.
- Vérifiez régulièrement le bon fonctionnement de la fonction de sécurité.
- Avant de toucher les connexions des bornes High, Force, Guard et Sense, mettez l'instrument hors tension et déchargez tout condensateur du chemin de mesure. Si vous ne mettez pas l'instrument hors tension, effectuez « toutes » les opérations ci-dessous, quels que soient les paramètres de l'instrument.
 - Terminez les mesures en appuyant sur la touche Stop ; vérifiez que l'indicateur d'état Measurement est éteint.
 - Vérifiez que le témoin High Voltage est éteint.
 - Ouvrez la borne Interlock.
 - Déchargez les éventuels condensateurs si la capacité est connectée à une unité SMU.
- Informez les personnes travaillant à proximité de l'instrument des conditions.



高電圧感電注意

Keysight B1506A の High、Force、Guard、Sense 端子には、危険電圧が出力されることがあります (HVSMU の場合は最大 ± 3000 Vdc、MPSMU の場合は最大 ± 100 Vdc)。感電事故防止のため、Keysight B1506A の使用時には必ず以下の事柄を守ってください。

- 3 極電源ケーブルを使用して本器を接地してください。
- 測定を開始する前にはインターロック回路を本器の Interlock 端子に接続してください。
- インターロック機能が正常であることを定期的に確認してください。
- High、Force、Guard、Sense 端子に繋がる接続部に触れる前には、本器の電源をオフしてください。また、測定系のキャパシタを放電してください。電源をオフしない場合は、以下の事項を全て実施してください。
 - Stop キーを押して Measurement インジケータが消灯したことを確認してください。
 - 高電圧警告 (High Voltage) インジケータが消灯していることを確認してください。
 - Interlock 端子を開放してください。
 - キャパシタが SMU に接続されているならば、キャパシタを放電してください。
- 周囲のほかの作業者に対しても、高電圧危険に対する注意を徹底してください。

Product Stewardship



- Waste Electrical and Electronic Equipment (WEEE) Directive 2002/96/EC

This product complies with the WEEE Directive (2002/96/EC) marking requirements. The affixed label indicates that you must not discard this electrical/ electronic product in domestic household waste.

Product Category: With reference to the equipment types in the WEEE directive Annex 1, this product is classified as a “Monitoring and Control instrumentation” product.

Do not dispose in domestic household waste.

To return unwanted products, contact your local Keysight office or visit the following website for more information.

<http://about.keysight.com/en/companyinfo/environment/>

- LCD Fluorescent Lamp

Certain products sold by Keysight contain a liquid crystal display (LCD); backlighting for the LCD is provided by a fluorescent lamp which contains mercury, and must be managed, recycled, and/or disposed in accordance with all applicable laws, ordinances and regulations.

For information on how to recycle or dispose of the fluorescent lamp contained in your own product, visit the following website.

http://about.keysight.com/en/quality/env_compliance.shtml

If you live in the U.S., also visit the following websites.

<http://www.lamprecycle.org>

<http://www.eiae.org>

If you have additional questions, please visit the following website.

<http://www.keysight.com/go/contactus>

- Perchlorate Information

Perchlorate Material - special handling may apply. Visit the following website.

<http://www.dtsc.ca.gov/hazardouswaste/perchlorate/>

Equipment's real-time clock battery or coin cell battery may contain perchlorate and may require special handling when recycled or disposed of in California.

Precautionary Statement

Keysight B1506A Power Device Analyzer for Circuit Design operates in the Microsoft Windows environment. Keysight B1506A requires Keysight Easy Test Navigator software, a specially-designed Windows application program.

- About guarantee and support for Keysight B1506A

Keysight Technologies guarantees and supports the performance of Keysight B1506A for the same condition as the preload condition when shipped from the factory.

- About updating Keysight Easy Test Navigator and the Windows Update

Keysight Technologies confirms the operation of Easy Test Navigator patch programs and important Windows security patches, and provides recommended update information. Visit Keysight B1506A support site, download the patches, and perform the software update.

- About Windows application programs and peripherals (including driver)

Using commercial products on Keysight B1506A is your responsibility. Keysight Technologies cannot provide compatibility information for commercial products. If problems arise, perform Keysight B1506A system recovery.

- About servicing

Bench repair service is available at your nearest Keysight Technologies service center. Be aware that the B1506A configuration might be updated to the latest one without notice because of support issues.

The internal hard disk drive (HDD) might be initialized during servicing. If peripherals are connected, they will be removed.

When Keysight B1506A is returned, the internal HDD might be initialized. Peripherals will be returned separately.

- Other notes

- Back up the internal HDD to prevent loss of data by accident or failure.
- Protect Keysight B1506A from computer viruses.
- If you connect Keysight B1506A to the network, take care to protect it from computer virus.

Working in Comfort

To optimize your comfort and productivity, it is important that you set up your work area correctly and use your instrument properly. With that in mind, we have developed some set-up and use recommendations for you to follow based on established ergonomic principles. Improper and prolonged use of keyboards and input devices are among those tasks that have been associated with repetitive strain injury (RSI) to soft tissues in the hands and arms. If you experience discomfort or pain while using the instrument, discontinue use immediately and consult your physician as soon as possible. For more information on RSI you may wish to consult the *About Repetitive Strain Injury* section. Please study the recommendations described below. Included there are references to relevant parts of international standards, regulations and guidelines, such as ISO 9241 and the European Community Display Screen Equipment directive. You may also wish to consult your employer's human resources department or other relevant departments for guidance specific to your company.

About Repetitive Strain Injury

Because your comfort and safety are our primary concern, we strongly recommend that you use the instrument in accordance with established ergonomic principles and recommendations. Scientific literature suggests that there may be a relationship between injury to soft tissues -especially in the hands and arms- and prolonged improper use of keyboards or other equipment requiring repeated motions of the hands and forearms. This literature also suggests that there are many other risk factors that may increase the chance of such injury, commonly called Repetitive Strain Injury.

What is RSI?

Repetitive Strain Injury (RSI -also known as cumulative trauma disorder or repetitive motion injury) is a type of injury where soft tissues in the body, such as muscles, nerves, or tendons, become irritated or inflamed. RSI has been a reported problem for those who perform repetitive tasks such as assembly line work, meatpacking, sewing, playing musical instruments, and computer work. RSI also has been observed in those who frequently engage in activities such as carpentry, knitting, housework, gardening, tennis, windsurfing and lifting children.

What causes RSI?

The specific causes of RSI have not been established. Nevertheless, the incidence of RSI has been associated with a variety of risk factors, including:

- Too many uninterrupted repetitions of an activity or motion.
- Performing an activity in an awkward or unnatural posture.

- Maintaining static posture for prolonged periods.
- Failing to take frequent short breaks.
- Other environmental and psychosocial factors.

In addition, there have been reports associating the occurrence of RSI with the use of keyboards, mice, and other input devices. Also, certain medical conditions, such as rheumatoid arthritis, obesity and diabetes, may predispose some people to this type of injury.

What if I experience discomfort?

If you are experiencing any discomfort, seek professional medical advice immediately. Typically, the earlier a problem is diagnosed and treated, the easier it is to resolve.

Mice and Other Input Devices

Various aspects of using mice and other input devices may increase your risk of discomfort or injury. Observing the following recommendations may reduce that risk.

- Try to keep your hand, wrist, and forearm in a neutral position while using your mouse or other input device.
- If you use your thumb to rotate the ball on a trackball or spaceball, keep it in a relaxed, natural shape, and maintain a neutral posture in your hand, wrist, and forearm.
- Hold the mouse gently by draping your fingers over it. Keep your hand relaxed and fingers loose. Do not grip the mouse tightly.
- It takes very little pressure or force from your fingers to activate the buttons or scroll wheel on your mouse, scrolling mouse, trackball, or other input device. Using too much force can place unnecessary stress on the tendons and muscles in your hands, wrists, and forearms.
- If you are using a scrolling mouse, be sure to keep your fingers and hand in a relaxed, neutral position when activating the scroll wheel. Also, this type of mouse features software that can minimize the number of mouse movements or button clicks.
- When using a mouse, trackball, or other input device, position it as close to the keyboard as possible, and keep it at the same level as you do not have to stretch while using it.
- Be sure to keep your mouse and trackball clean. Regular removal of accumulated dust and dirt helps ensure proper tracking and reduces unnecessary hand and wrist motions.

In This Manual










This manual describes the product overview, installation information, measurement operation, and software reference information of Keysight Technologies B1506A.

This manual consists of the following chapters:

- Chapter 1, “Introduction”
This chapter describes basic features of Keysight B1506A.
- Chapter 2, “Installation”
This chapter describes installation and maintenance.
- Chapter 3, “How To Perform Measurement”
This chapter explains how to perform measurement by using Keysight B1506A.
- Chapter 4, “GUI Reference”
This chapter provides the reference information of Keysight Easy Test Navigator software.

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1

Introduction

Introduction

This chapter describes the basic functions and features of Keysight B1506A Power Device Analyzer for Circuit Design, and consists of the following sections.

- “Overview”
- “Mainframe Front View”
- “Mainframe Rear View”
- “Test Fixture Front View”
- “Test Fixture Rear View”
- “Software”
- “Accessories”
- “Options”
- “Measurement Resources”

Overview

Keysight B1506A Power Device Analyzer for Circuit Design is a complete solution that can help power electronic circuit designers maximize the value of their power electronics products by enabling them to select the correct power devices for their applications. It can evaluate all relevant device parameters under a wide range of operating conditions, including IV parameters such as breakdown voltage and on-resistance, as well as three terminal FET capacitances, gate charge and power loss. The B1506A has a wide range of capabilities that help it identify substandard devices under actual circuit operating conditions, including a wide voltage and current range (3 kV and 1500 A), a wide temperature measurement range ($-50\text{ }^{\circ}\text{C}$ to $+250\text{ }^{\circ}\text{C}$), fast pulsing capability, and sub-nA level current measurement capability. Its unique software interface presents the user with a familiar device data sheet format that makes it easy to characterize devices without going through any formal training. Integrated switching circuitry within the test fixture supports fully automated testing, with the ability to automatically change between both high voltage and high current testing as well as between IV and CV measurements. In addition, a unique plug-in style device test fixture socket adapter eliminates cable connection and other human-related errors. The B1506A also supports the complete automation of thermal characterization. This can be accomplished either through the integrated Thermostream control or via the Thermal Plate. Since the DUT is in close proximity to the B1506A's measurement resources, the large parasitics caused by cable extensions leading to a temperature chamber do not exist. For this reason, oscillation free ultra-high currents of up to 1500 A can be accurately evaluated at both low and high temperature.



Introduction

Overview

Keysight B1506A provides the following packages.

- B1506A-H21: 20 A/3 kV/C-V/Gate Charge/Thermal Fixture Package
- B1506A-H51: 500 A/3 kV/C-V/Gate Charge/Thermal Fixture Package
- B1506A-H71: 1500 A/3 kV/C-V/Gate Charge/Thermal Fixture Package

Each package contains the mainframe, the test fixture, the connection cables, and the control software. For the furnished accessories, see Table 1-1.

Mainframe

Mainframe is equipped with the measurement resources listed below, the 15-inch touch screen LCD panel, hard disk drive, DVD drive, USB, LAN, GPIB, GPIO interfaces, and so on. For more information on the measurement resources, see “Measurement Resources” on page 1-26.

- HVSMU, high voltage source/monitor unit, 1 ea.
- HCSMU, high current source/monitor unit, 1 ea. for the B1506A-H21, 0 ea. for the B1506A-H51/H71
- MCSMU, medium current source/monitor unit, 2 ea. for the B1506A-H21, 4 ea. for the B1506A-H51/H71
- MFCMU, multi frequency capacitance measurement unit, 1 ea.
- MPSMU, medium power source/monitor unit, 1 ea.
- GNDU, ground unit, 1 ea.

The B1506A provides an intuitive graphical user interface, touch screen LCD, stylus pen, USB keyboard, and USB mouse for easy and effective measurement and analysis on the Windows environment, and supports the following B1506A control software. For more information, see “Software” on page 1-20.

- Easy Test Navigator software
- EasyEXPERT software

Test Fixture

The test fixture is required to connect your device under test (DUT). The following furnished accessories are available.

- Socket module for connecting a 3-pin inline package device
- Accessories for connecting other type of device
 - Blank silicon plate
 - Connection wire
 - Clip
 - Banana pin adapter
- Socket adapter for performing gate charge measurement
- Thermocouple for performing temperature measurement

Also, the test fixture initially installs the selector for switching the measurement resource connected to the collector/drain terminal of the DUT. The measurement resource will be the MFCMU, the HVSMU, the MPSMU, or the HCSCMU for the B1506A-H21 or the ultra high current unit (UHCU) for the B1506A-H51/H71.

The B1506A-H51/H71 configures the UHCU by using the test fixture and two MCSMU installed in the mainframe. And the B1506A-H51 supports up to 500 A and the B1506A-H71 supports up to 1500 A.

Additionally, for controlling temperature of DUT, the test fixture can be equipped with Thermal Plate inside the fixture cover or Thermostream by using the B1506A-T01 Thermal Test Enclosure.

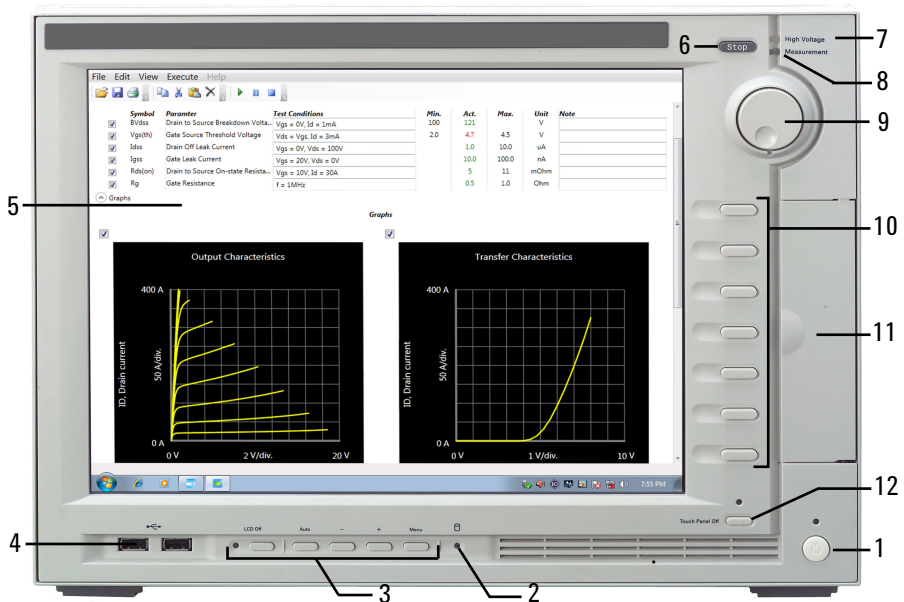
For the Thermal Plate and the Thermostream, contact inTEST Corporation.

NOTE

Selector may emit a noise sound during operation. However it is not abnormal status.

Mainframe Front View

This section describes the front view of the mainframe.



1. Standby switch

Turns on/off the mainframe. Pressing the button in the ON state makes it in the standby state. The green LED lights when it is in the ON state.

NOTE

Opening measurement terminals

Open the measurement terminals at the device side when turning the B1506A on. Also disconnect the device from the measurement terminals and open the measurement terminals after the measurement. If you leave the connection with the device, the device may be damaged by unexpected operations or charge-up of measurement cables.

2. HDD access indicator

This green LED lights in the access status of HDD or DVD drive. Do not turn the instrument off during this LED lights.

3. LCD adjustment keys

LCD Off enables or disables the LCD panel. The green LED lights when the LCD is disabled.

Four keys are available for adjusting brightness. Use + and - to adjust it and then press *Set* to fix it. Pressing *Cancel* instead of *Set* cancels the adjustment.

4. USB interfaces

USB, 2 ports. For keyboard, mouse, and so on.

To remove USB devices from the instrument, use “Safely Remove Hardware” on Windows taskbar. If it is not used, the instrument may cause the internal USB communication error. If the error occurs, turn the instrument off and disconnect the power cable from it. Leave it about 30 seconds before rebooting it, and connect the power cable again, and then turn the instrument on.

5. LCD panel

15 inch TFT XGA display, 1024 × 768 resolution. Displays the Windows screen, the B1506A control software window, and so on. Touch screen operation is available when the Touch Panel Off indicator does not light.

To adjust the touch panel, use Microchip TSHARC Control Panel which is opened by selecting *Microchip TSHARC Control Panel* from the Start menu.

6. Stop key

Stops the present measurement or source output immediately.

7. High voltage status indicator

This red LED lights when a source channel applies dangerous voltage.

8. Measurement status indicator

This green LED lights when a measurement channel performs measurement.

9. Rotary knob

Works on the execution environment of the B1506A control software. Rotating the knob moves the marker on the graph, or increases/decreases/changes the value in the active entry field. Pressing the knob sets or enters the value.

10. Softkeys

Seven softkeys are available for the B1506A control software. Used to select an alternative for the entry field specified or the dialog box.

Introduction

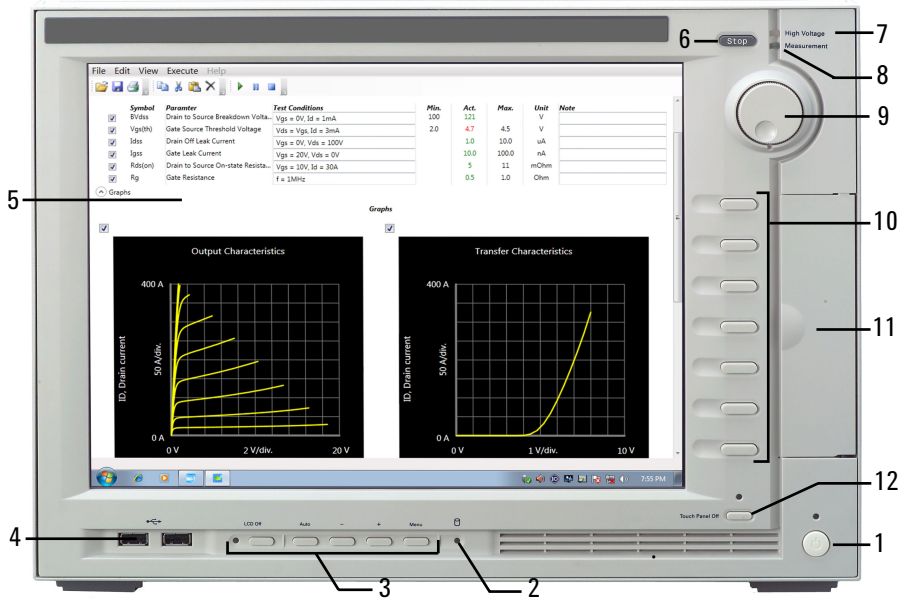
Mainframe Front View

11. DVD-R drive

For data backup, software update, and so on. With the option DR1, the drive is changed to the DVD-ROM drive.

12. Touch Panel Off key

Works on the execution environment of the B1506A control software. Enables or disables the touch screen operation. The green LED lights when the touch screen is disabled.



Mainframe Rear View

This section describes the rear view of the mainframe.

WARNING



To avoid electrical shock and instrument damage, turn the all instruments off before connecting or disconnecting measurement cable.

Mettez la machine hors tension pour fixer le connecteur ou pour retirer le connecteur de l'unité centrale.

WARNING



There are potentially hazardous voltages (± 3000 Vdc for HVSMU and ± 100 Vdc for MPSMU) present at the High, Force, Sense, and Guard terminals of the instruments. To prevent electrical shock, the following safety precautions must be observed during the use of instruments.

- Connect the instrument to an electrical ground (safety ground) by using three-conductor AC power cable.
- Connect the mainframe Interlock terminal to the test fixture Interlock terminal by using an interlock cable.
- Confirm periodically that the interlock function works normally.
- Before touching the connections on the High, High Force, High Sense, and Guard terminals in the test fixture, turn the instruments off and discharge any capacitors. If you do *not* turn the instruments off, complete *all* of the following items, regardless of the instrument settings.
 - Press the front panel Stop key to set the source output off.
 - Confirm that the front panel High Voltage indicator is not lit.
 - Open the Interlock terminal (open the fixture cover).
 - Discharge any capacitors connected to a measurement resource.
- Warn persons working around the instruments about dangerous conditions.

Introduction
Mainframe Rear View

B1506A-H51/H71



1. Serial number

You need this *serial number* when using Keysight Technologies telephone assistance program.

2. LED status indicator

For troubleshooting. Followings are some examples.

- Both LEDs turn off:
The instrument is in the standby state and Standby switch is OFF position.
- One LED turns green:
Power supply works normally.
- Both LEDs turn orange:
The instrument is in the standby state and Standby switch is ON position.

3. LINE input receptacle

AC power cable is connected to this receptacle.

4. GPIB interface




Use an Keysight 82357A USB/GPIB interface or Keysight 10833A/B/C/D GPIB cable to connect to an external computer or equipment.

5. Video output terminal

VGA connector. For an external display. Signal to the built-in LCD is also applied to this terminal.

6. Measurement Resources

See A to F described later.

 7. Circuit Common () and frame ground () terminals

Normally, connect the terminals together by using the shorting bar. For floating measurement, remove the shorting bar.

WARNING

If the Circuit Common terminal is *not* connected to the frame ground terminal (for floating measurement), a potential shock hazard may present. Do not touch any of measurement circuit at any time while a floating measurement is in progress.

CAUTION

For floating measurement, do not apply dangerous voltage to the Circuit Common terminal. Failure to heed this caution may result in damage to the instrument.

8. Zero Check terminal

Ground reference point of the instrument.

CAUTION

The Zero Check terminal can be used for the service purpose only. For the normal operation, leave this terminal open and do not connect anything to this terminal. Connecting anything can damage the instrument.

9. GNDU terminal

0 V constant voltage source. Used for the reference of measurement ground. Triaxial connector.

10. LAN interface

RJ45 connector.

11. USB interfaces

USB, 2 ports. For keyboard, mouse, or peripherals.

To remove USB devices from the instrument, use “Safely Remove Hardware” on Windows taskbar. If it is not used, the instrument may cause the internal USB communication error.

Introduction

Mainframe Rear View

If the error occurs, turn the instrument off and disconnect the power cable from it. Leave it about 30 seconds before rebooting it, and connect the power cable again, and then turn the instrument on.

12. Ext Trig terminals

Two BNC connectors, one for trigger input, and one for trigger output. For details about the trigger function, see *Programming Guide*.

13. Digital I/O terminal

Used to connect the test fixture.

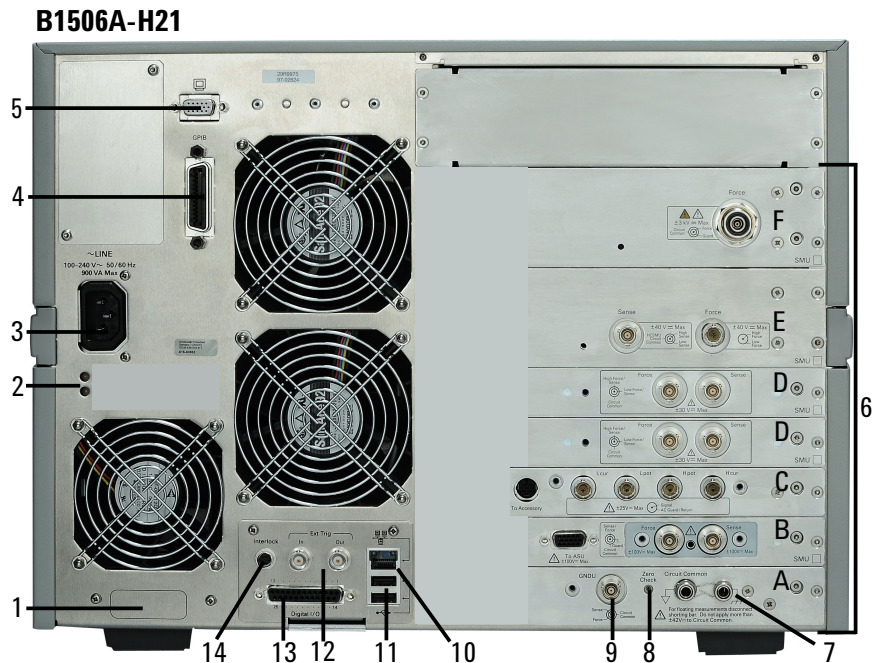
14. Interlock terminal




Used to connect the test fixture. If the fixture cover is open, maximum output is limited to ± 42 V.

To verify the interlock function, perform the Interlock Open/Close test on the Main Frame tab screen of the EasyEXPERT Configuration window.

WARNING




Dangerous voltage, instrument maximum output voltage may appear at High, Force, Sense, and Guard terminals if the fixture cover is closed.



-  A. GNDU/ADC
Ground unit (GNDU) and A/D converter.
-  B. MPSMU
Medium power source/monitor unit (MPSMU) has two triaxial connectors, force and sense, for the Kelvin connections.
-  C. MFCMU
Multi frequency capacitance measurement unit (MFCMU) has four coaxial connectors, Lcur, Lpot, Hpot, and Hcur, for the four-terminal pair connection.

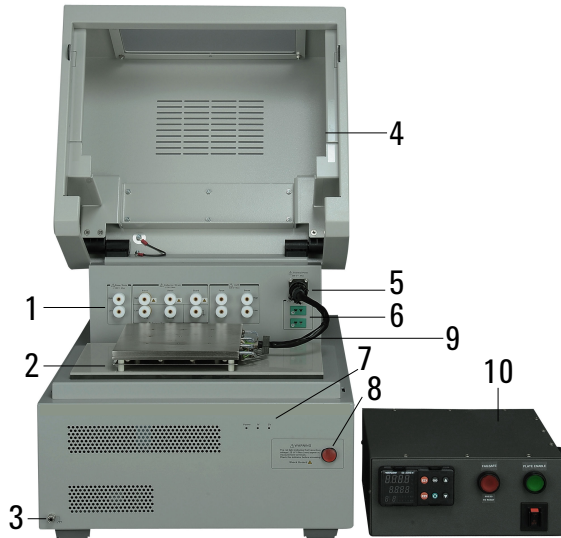
CAUTION


Do not apply voltage more than ± 25 V to the MFCMU input terminals. Failure to heed this caution may result in damage to the MFCMU.

-  D. MCSMU
Medium current source/monitor unit (MCSMU) has two triaxial connectors, force and sense, for the Kelvin connections.
-  E. HCSMU for B1506A-H21
High current source/monitor unit (HCSMU) has the force coaxial connector and the sense triaxial connector, for the Kelvin connections.
-  F. HVSMU
High voltage source/monitor unit (HVSMU) has the force connector.

Test Fixture Front View

This section describes the front view of the test fixture.



-  1. Measurement terminals
Connects the connection wire or attaches the socket module/adapter for connecting your device under test (DUT). For more information, see “Measurement Terminals” on page 1-16.
2. DUT stage
In the above picture, the Blank Silicon Plate is set on the stage, and the Thermal Plate is placed on the Blank Silicon Plate. For the Thermal Plate, contact inTEST Corporation.
3. Terminal for connecting wrist strap
4. Fixture cover
The fixture cover should be closed to avoid electrical shock by touching measurement terminals and to prevent a device under test from external noise.
When the fixture cover is open, maximum output voltage is limited to ± 42 V.

WARNING

Hazardous voltage, instrument maximum output voltage may appear at the High, High Force, High Sense, and Guard terminals if the fixture cover is closed.

WARNING



Make sure that the cover is closed properly before starting measurement. Do not perform the measurement when a wire is protruding from the fixture cover.

Assurez-vous que le couvercle est fermé correctement avant de commencer la mesure. Ne pas effectuer la mesure lorsqu'un câble dépasse du couvercle de l'appareil.



5. Thermal Plate connector

This connector is used to connect the cable from the Thermal Plate. For the Thermal Plate, contact inTEST Corporation.



6. Thermocouple terminals

For connecting thermocouple to measure temperature around a DUT. Temperature range is $-50\text{ }^{\circ}\text{C}$ to $300\text{ }^{\circ}\text{C}$.

7. Status indicator

Power LED turns yellow when the AC power is applied to the test fixture.

Power LED turns green when the test fixture is ready to use.

IV LED lights when the B1506A is in the IV measurement condition.

CV LED lights when the B1506A is in the capacitance measurement condition.



8. Hazardous voltage status indicator

This red LED lights when a measurement resource applies dangerous voltage. This indicator is connected to the mainframe via the Interlock terminal and works with the High Voltage indicator on the mainframe front panel.

Warning labels written in French, German, and Japanese are furnished. Attach the label to the front panel of the fixture if you need.

WARNING



The red light indicates that hazardous voltage (maximum $\pm 3000\text{ Vdc}$) may appear at measurement terminals. Check this indicator before accessing.

Le témoin rouge indique qu'une tension dangereuse ($\pm 3000\text{ V Max}$) risque d'apparaître au niveau des bornes de mesure. Vérifiez cet indicateur avant d'accéder.

9. Thermal Plate

Introduction
Test Fixture Front View

Contact inTEST Corporation.

10. Temperature controller of Thermal Plate

Contact inTEST Corporation.

Measurement Terminals

WARNING

Set the instrument output off before connecting or disconnecting connection wire.

Press the mainframe front panel Stop key to set the source output off. And confirm that the mainframe front panel High Voltage indicator is not lit.

WARNING



Do not connect or disconnect your device under test (DUT) while Keysight B1506A is applying voltage or current. Otherwise, the DUT may be damaged.

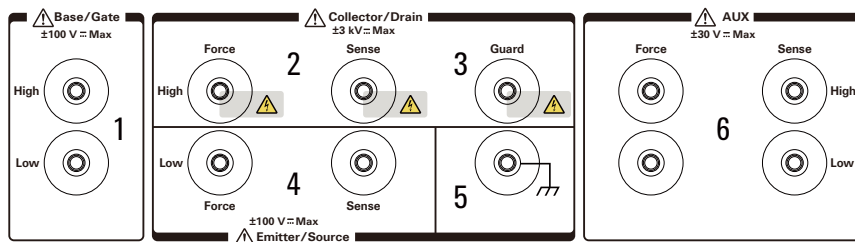
When you touch the DUT after measurement, devise a countermeasure of residual charge and heat to prevent electrical shock and burn. Use glove and any tool. Also have enough time for discharge and radiation.

Pour éviter toute électrocution et tout risque d'endommagement de l'appareil, ne retirez pas les câbles pendant le fonctionnement.

Lorsque vous touchez le MST après la mesure, élaborer une contre-mesure de la charge résiduelle et du chauffage afin d'éviter tout choc électrique et toute brûlure. Utilisez des gants et des outils. Prévoyez également du temps pour la décharge et la radiation.

CAUTION

Never connect the High, High Force, High Sense, or Guard terminal to any output, including circuit common and chassis ground. Connecting other output may damage the connected one.



NOTE

To use the 3-pin Inline Package Socket Module, attach it to the Base/Gate, Collector/Drain, and Emitter/Source terminals. Then do not use the Guard terminal.

NOTE

To use the Gate Charge Socket Adapter, attach it to the Base/Gate, Collector/Drain, Emitter/Source, and AUX Force terminals. Then do not use the AUX Sense terminals.

If you do not use the 3-pin Inline Package Socket Module or the Gate Charge Socket Adapter, connect your device under test (DUT) to the terminals by using connection wire, clip, adapter, and so on. Then set the Blank Silicon Plate on the DUT stage.

1. Base/Gate High and Low terminals

Connect High to the gate or base terminal of DUT.

Connect Low to the source or emitter terminal of DUT.

2. Collector/Drain High Force and Sense terminals

Connect Force and Sense to the drain or collector terminal of DUT.

Force and Sense must be connected together at the terminal of DUT for making the Kelvin connection.

3. Collector/Drain Guard terminal

Guard of Collector/Drain High. The guard has the same potential as the Collector/Drain High. You may extend the guard as close as possible to the drain or collector terminal of DUT to reduce the leakage current caused by the cable. Open the guard at the end of the cable. Never connect it to anything.

4. Emitter/Source Low Force and Sense terminals

Connect Force and Sense to the source or emitter terminal of DUT.

Force and Sense must be connected together at the terminal of DUT for making the Kelvin connection.

5. Chassis common terminal

Use for grounding or shielding.

6. AUX High Force and Sense terminals and Low Force and Sense terminals

Output terminals internally connected to the AUX input connectors. The measurement resource is the SMU3 (MCSMU) installed in the mainframe.

Connect High Force and Sense to the high terminal of DUT.

Connect Low Force and Sense to the low terminal of DUT.

Force and Sense must be connected together at the terminal of DUT for making the Kelvin connection.


Test Fixture Rear View

This section describes the rear view of the test fixture. For connecting the cables, see “To Connect Test Fixture” on page 2-11.



1. Power switch
Turns on/off the test fixture.
2. LINE input receptacle
AC power cable is connected to this receptacle.
3. Option number label
4. Serial number label
You need this *serial number* when using Keysight Technologies telephone assistance program.
- ⚠ 5. Connectors for connecting the system cable
The following measurement resources in the mainframe are connected by using the system cable.
 - HVSMU
 - HCSMU for B1506A-H21
 - MCSMU


- MPSMU
- GNDU

 6. Connectors for connecting the CMU cable

The connectors are used to connect the CMU cable from the MFCMU in the mainframe.

7. Digital I/O terminal

This terminal is used to connect the Digital I/O cable from the mainframe Digital I/O terminal.

 8. Earth terminal


Screw terminal for earthing.

WARNING



Connect a wire from an electrical ground (safety ground) to this terminal.

Connecter un fil depuis une mise à la terre électrique (mise à la terre de sécurité) à la borne de terre.

 9. Interlock terminal

This terminal is used to connect the interlock cable from the mainframe Interlock terminal. The interlock cable is included in the system cable.

WARNING

Potentially hazardous voltage may be present at the High, Force, Sense, and Guard terminals when the interlock terminals are shorted on test fixture, prober station, and such.

 10. Thermal Plate connector

This connector is used to connect the cable from the temperature controller of the Thermal Plate. For the Thermal Plate, contact inTEST Corporation.

Software

Keysight B1506A realizes easy and effective measurement and analysis on the Windows environment using an intuitive graphical user interface, touch screen LCD, stylus pen, keyboard, and mouse. The following software is previously installed or stored in the mainframe.

- “Easy Test Navigator Software”
- “EasyEXPERT Software”
- “Utility Software”

Easy Test Navigator Software

The Easy Test Navigator software provides measurement control programs for power device characterization. It supports various types of measurement task with ease-of-use and simple operation. Some of the functions are listed below. For more information on the Easy Test Navigator software, see Chapters 3 and 4.

- Programs included:
 - Datasheet characterization program
 - I/V characteristics measurement program
 - Three-terminal device capacitance measurement program
 - Gate charge measurement program
 - Thermal monitor/control program
 - Device power loss calculation program
- Ready-to-use measurement templates for typical power device characteristics measurements
- Ability to automatically accumulate measurement data on the HDD in exportable formats

EasyEXPERT Software

The EasyEXPERT software is an application program for controlling Keysight B1500 series. Some of the functions are listed below. For more information, see Keysight EasyEXPERT *User's Guide*.

- Single measurement, repeat measurement, and append measurement
- Module selector control
- Measurement/setup data management by workspace
- Graph display and analysis with markers, cursors, and lines; and auto analysis
- Data import/export capability, data output by CSV/XML format, and graph output by EMF/BMP/GIF/PNG format
- Maintenance; self-test and self-calibration
- Remote control function from an external computer

The EasyEXPERT has the following measurement execution environments.

- Application test
- Classic test
- Tracer test
- Quick test

NOTE

Application Library

The EasyEXPERT contains an application library that is a set of test definitions. The application test can be performed by selecting a test definition and setting the test condition for the actual DUT (device under test).

All test definitions are just sample. If the samples damage your devices, Keysight Technologies is NOT LIABLE for the damage.

Utility Software

Followings are the utility software available for the B1506A. For more information on the utility software, see Keysight EasyEXPERT *User's Guide Vol. 2*.

- Desktop EasyEXPERT software
EasyEXPERT software runs on an external Windows PC. Not installed.
- 4155/4156 setup file converter

Introduction

Software

Program for converting the 4155/4156 measurement setup files (file extension MES or DAT) into EasyEXPERT classic test setup files. This program is stored in the following folder.

<program folder>\Agilent\B1500\EasyEXPERT\415xC\Conversion\

- MDM file converter

Program for converting EasyEXPERT data files (file extension XTR or ZTR) into Keysight IC-CAP MDM files. This program is stored in the following folder.

<program folder>\Agilent\B1500\EasyEXPERT\IC-CAP Support\MDM\

- Prober control programs

Execution files for controlling the probers listed below. The files are stored in the following folder.

<program folder>\Agilent\B1500\EasyEXPERT\Utilities\

Probers supported:

- Cascade Microtech Summit 12K or S300
 - SUSS MicroTec PA200 or PA300
 - Vector Semiconductor VX-2000 or VX-3000
- sleep.exe program

Execution file for inserting a wait time in the test execution flow of an EasyEXPERT application test. This file is stored in the following folder.

<program folder>\Agilent\B1500\EasyEXPERT\Utilities\

NOTE

Notations

<program folder> is as follows. Then, <system drive> is the drive the B1506A control software has been installed.

For Windows 7 64 bit version, <system drive>:\Program Files (x86)

For Windows 7 32 bit version, Vista, or XP, <system drive>:\Program Files

Accessories

Furnished accessories and the available accessories for Keysight B1506A are listed in Tables 1-1 and 1-2.

Table 1-1

Furnished Accessories

Description	Quantity
System cable	1
CMU cable	1
Digital I/O cable	1
Blank silicon plate	1
3-pin inline package socket module	1
Gate charge socket adapter	1
Thermocouple (high temperature resistant, 75 cm)	2
Connection wire with mini alligator clip, 200 mm	8
Connection wire with mini alligator clip, 300 mm	6
High current connection wire, 200 mm	2
High current connection wire, 300 mm	2
Clip for high current connection wire, large alligator	4
Banana pin adapter for connection wire	18
Spare clip, mini alligator	14
USB keyboard	1
USB mouse	1
Stylus pen	1
Power cable	2
Product Reference CD-ROM	1

Table 1-2

Available Accessories

Model Number	Option Item	Description
16444A		Accessories for B1500 series
	16444A-001	USB keyboard
	16444A-002	USB mouse
	16444A-003	Stylus pen
16493G		Digital I/O connection cable
	16493G-001	1.5 m length
	16493G-002	3 m length
N1300A		CMU connection cable
	N1300A-001	1.5 m length
	N1300A-002	3 m length

Options

Options available for Keysight B1506A are listed in Table 1-3.

Table 1-3

Options

Option Item	Description
Power Device Analyzer for Circuit Design	
B1506A-H21	20 A/3 kV/C-V/Gate Charge/Thermal Fixture Package
B1506A-H51	500 A/3 kV/C-V/Gate Charge/Thermal Fixture Package
B1506A-H71	1500 A/3 kV/C-V/Gate Charge/Thermal Fixture Package
Thermal enclosure	
B1506A-T01	Thermal Test Enclosure (Thermostream Compatible)
Calibration	
B1506A-A6J	ANSI Z540-1-1994 Calibration
B1506A-UK6	Commercial calibration certificate with test data
Documentation	
B1506A-ABA	User's Guide, English
B1506A-ABJ	User's Guide, Japanese
Drive option	
B1506A-DR1	Replace a built-in DVD-R drive with a read-only DVD drive

Measurement Resources

Keysight B1506A is equipped with the following measurement resources.

- “GNDU - Ground Unit”
- “MPSMU - Medium Power SMU”
- “HVSMU - High Voltage SMU”
- “MCSMU - Medium Current SMU”
- “HCSMU - High Current SMU”
- “UHCU - Ultra High Current Unit”
- “MFCMU - Multi Frequency CMU”

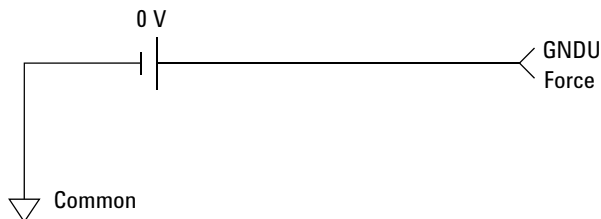
See Keysight EasyEXPERT *User’s Guide Vol. 1* for the functions available for the EasyEXPERT software. See *Programming Guide* for the functions available for the GPIB remote mode.

GNDU - Ground Unit

The ground unit (GNDU) is a 0 V constant voltage source, and used for the reference of measurement ground. Also the GNDU can sink up to ± 4.2 A, so it is effective for using MPSMU or HVSMU. When the HCSMU, MCSMU, or UHCU is used, the GNDU must be connected to the Low terminal side to apply the reference zero voltage. Figure 1-1 is a simplified circuit diagram of GNDU.

Figure 1-1

Simplified GNDU Circuit Diagram



About SMU

Source/monitor unit (SMU) can apply DC voltage or current, and can measure DC current or voltage. Figure 1-2 is a simplified SMU circuit diagram.

The MPSMU can perform the following operations:

- Apply voltage and measures current or voltage
- Apply current and measures current or voltage

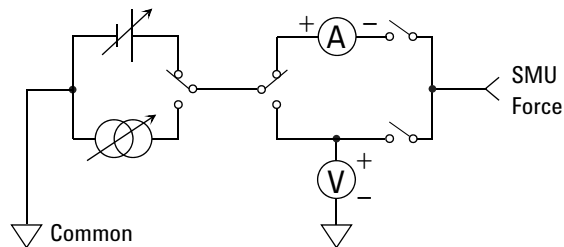
The HCSMU, MCSMU, and HVSMU can perform the following operations:

- Apply voltage and measures current and/or voltage
- Apply current and measures current and/or voltage

NOTE

To select the SMU operation mode in the GPIB remote condition, enter the CMM command.

Figure 1-2 Simplified SMU Circuit Diagram



Compliance

The SMU has a compliance feature that limits output voltage or current to prevent damage to the device under test. When the SMU applies voltage, you can specify current compliance. When the SMU applies current, you can specify voltage compliance. For details on the compliance, see Keysight EasyEXPERT *User's Guide Vol. 1*.

MPSMU - Medium Power SMU

This section describes typical specification of the medium power source/monitor unit (MPSMU).

- Maximum voltage, current, output power: ± 100 V, ± 100 mA, 2 W
- Minimum range: 0.5 V, 1 nA
- Output/measurement value and resolution: see Table 1-4 to Table 1-7.

Figure 1-3

MPSMU Output and Measurement Ranges

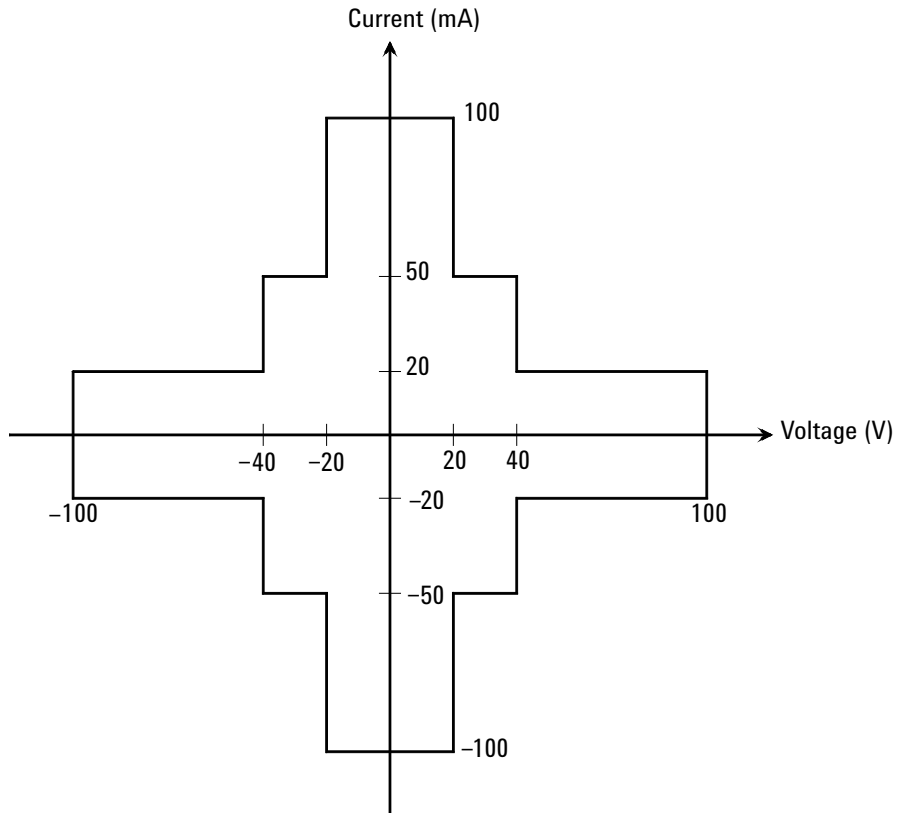


Table 1-4 **MPSMU Output Voltage Ranges and Resolutions**

Range	Output Value	Setting Resolution	Maximum Current
0.5 V	$0 \leq V \leq 0.5 \text{ V}$	25 μV	$\pm 100 \text{ mA}$
2 V	$0 \leq V \leq 2 \text{ V}$	100 μV	$\pm 100 \text{ mA}$
5 V	$0 \leq V \leq 5 \text{ V}$	250 μV	$\pm 100 \text{ mA}$
20 V	$0 \leq V \leq 20 \text{ V}$	1 mV	$\pm 100 \text{ mA}$
40 V	$0 \leq V \leq 20 \text{ V}$	2 mV	$\pm 100 \text{ mA}$
	$20 \text{ V} < V \leq 40 \text{ V}$	2 mV	$\pm 50 \text{ mA}$
100 V	$0 \leq V \leq 20 \text{ V}$	5 mV	$\pm 100 \text{ mA}$
	$20 \text{ V} < V \leq 40 \text{ V}$	5 mV	$\pm 50 \text{ mA}$
	$40 \text{ V} < V \leq 100 \text{ V}$	5 mV	$\pm 20 \text{ mA}$

Table 1-5 **MPSMU Output Current Ranges and Resolutions**

Range	Output Value	Setting Resolution	Maximum Voltage
1 nA	$0 \leq I \leq 1.15 \text{ nA}$	50 fA	$\pm 100 \text{ V}$
10 nA	$0 \leq I \leq 11.5 \text{ nA}$	500 fA	$\pm 100 \text{ V}$
100 nA	$0 \leq I \leq 115 \text{ nA}$	5 pA	$\pm 100 \text{ V}$
1 μA	$0 \leq I \leq 1.15 \mu\text{A}$	50 pA	$\pm 100 \text{ V}$
10 μA	$0 \leq I \leq 11.5 \mu\text{A}$	500 pA	$\pm 100 \text{ V}$
100 μA	$0 \leq I \leq 115 \mu\text{A}$	5 nA	$\pm 100 \text{ V}$
1 mA	$0 \leq I \leq 1.15 \text{ mA}$	50 nA	$\pm 100 \text{ V}$
10 mA	$0 \leq I \leq 11.5 \text{ mA}$	500 nA	$\pm 100 \text{ V}$
100 mA	$0 \leq I \leq 20 \text{ mA}$	5 μA	$\pm 100 \text{ V}$
	$20 \text{ mA} < I \leq 50 \text{ mA}$	5 μA	$\pm 40 \text{ V}$
	$50 \text{ mA} < I \leq 100 \text{ mA}$	5 μA	$\pm 20 \text{ V}$

Table 1-6 MPSMU Measurement Voltage Values and Resolutions

Range	Measurement Value ^a	Measurement Resolutions	
		High Speed ADC	High Resolution ADC
0.5 V	$0 \leq V \leq 0.55 \text{ V}$	25 μV	0.5 μV
2 V	$0 \leq V \leq 2.2 \text{ V}$	100 μV	2 μV
5 V	$0 \leq V \leq 5.5 \text{ V}$	250 μV	5 μV
20 V	$0 \leq V \leq 22 \text{ V}$	1 mV	20 μV
40 V	$0 \leq V \leq 44 \text{ V}$	2 mV	40 μV
100 V	$0 \leq V \leq 100 \text{ V}$	5 mV	100 μV

Table 1-7 MPSMU Measurement Current Values and Resolutions

Range	Measurement Value ^a	Measurement Resolutions	
		High Speed ADC	High Resolution ADC
1 nA	$0 \leq I \leq 1.15 \text{ nA}$	50 fA	10 fA
10 nA	$0 \leq I \leq 11.5 \text{ nA}$	500 fA	10 fA
100 nA	$0 \leq I \leq 115 \text{ nA}$	5 pA	100 fA
1 μA	$0 \leq I \leq 1.15 \text{ }\mu\text{A}$	50 pA	1 pA
10 μA	$0 \leq I \leq 11.5 \text{ }\mu\text{A}$	500 pA	10 pA
100 μA	$0 \leq I \leq 115 \text{ }\mu\text{A}$	5 nA	100 pA
1 mA	$0 \leq I \leq 1.15 \text{ mA}$	50 nA	1 nA
10 mA	$0 \leq I \leq 11.5 \text{ mA}$	500 nA	10 nA
100 mA	$0 \leq I \leq 100 \text{ mA}$	5 μA	100 nA

a. This column is applied to the auto ranging or the limited auto ranging.
For fixed ranging, maximum measurement value is **Range** column value.

HVSMU - High Voltage SMU

This section describes typical specification of the high voltage source/monitor unit (HVSMU).

- Maximum voltage/current: 3000 V/4 mA, -3000 V/-4 mA, 1500 V/8 mA, or -1500 V/-8 mA
- Maximum output power: 12 W
- Minimum range: 200 V, 1 nA
- Output/measurement value and resolution: see Table 1-8 and Table 1-9.

CAUTION

Never connect the HVSMU Force and Guard terminals to any output, including circuit common, chassis ground, or any other measurement resource such as SMU. Connecting other measurement resource may damage the connected one.

Figure 1-4

HVSMU Output and Measurement Ranges

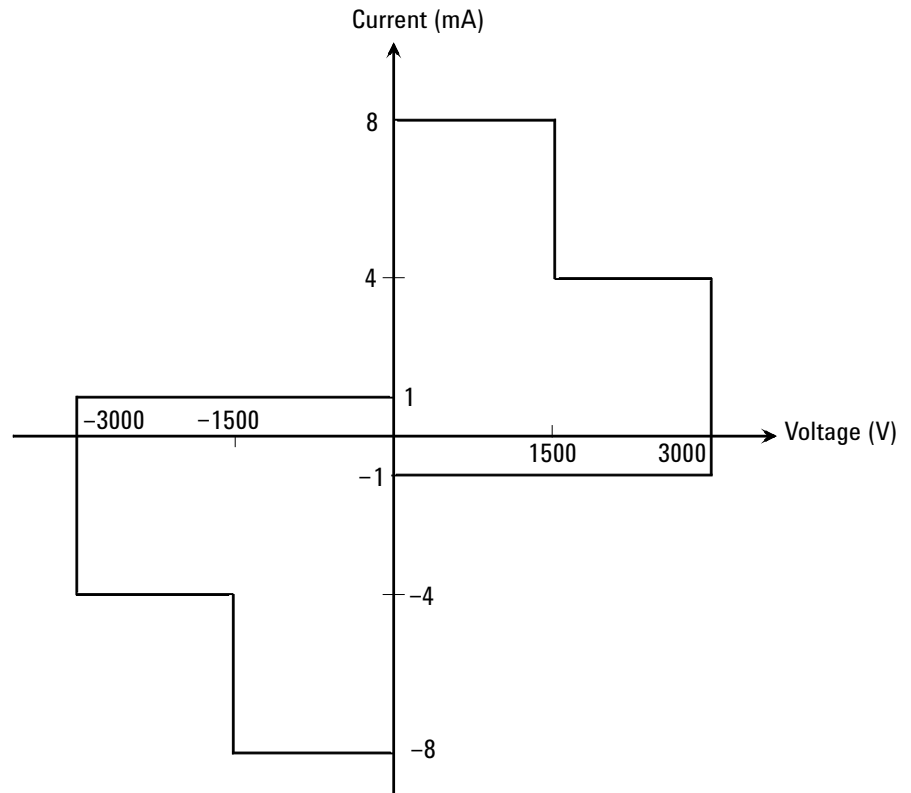


Table 1-8 HVSMU Voltage Ranges and Resolutions

Range	Output Value and Measurement Value	Setting/ Measurement Resolution	Maximum Current Imax
200 V	$0 \leq V \leq 200 \text{ V}$	200 μV	8 mA
500 V	$0 \leq V \leq 500 \text{ V}$	500 μV	8 mA
1500 V	$0 \leq V \leq 1500 \text{ V}$	1.5 mV	8 mA
3000 V	$0 \leq V \leq 3000 \text{ V}$	3 mV	4 mA

Table 1-9 HVSMU Current Ranges and Resolutions

Range	Output Value and Measurement Value	Setting/ Measurement Resolution	Maximum Voltage Vmax
1 nA ^a	$0 \leq I \leq 1.15 \text{ nA}$	10 fA	3000 V
10 nA	$0 \leq I \leq 11.5 \text{ nA}$	100 fA	3000 V
100 nA	$0 \leq I \leq 115 \text{ nA}$	100 fA	3000 V
1 μA	$0 \leq I \leq 1.15 \mu\text{A}$	1 pA	3000 V
10 μA	$0 \leq I \leq 11.5 \mu\text{A}$	10 pA	3000 V
100 μA	$0 \leq I \leq 115 \mu\text{A}$	100 pA	3000 V
1 mA	$0 \leq I \leq 1.15 \text{ mA}$	1 nA	3000 V
10 mA	$0 \leq I \leq 8 \text{ mA}$	10 nA	1500 V
	$0 \leq I \leq 4 \text{ mA}$		3000 V

a. DC only

MCSMU - Medium Current SMU

This section describes typical specification of the medium current source/monitor unit (MCSMU).

- Maximum current: ± 1 A (pulse), ± 0.1 A (DC)
- Maximum voltage: ± 30 V
- Maximum output power: 30 W (pulse), 3 W (DC)
- Minimum range: 0.2 V, 10 μ A
- Minimum pulse width: 10 μ s
- Output/measurement value and resolution: see Table 1-10 and Table 1-11.

Figure 1-5

MCSMU Output and Measurement Ranges

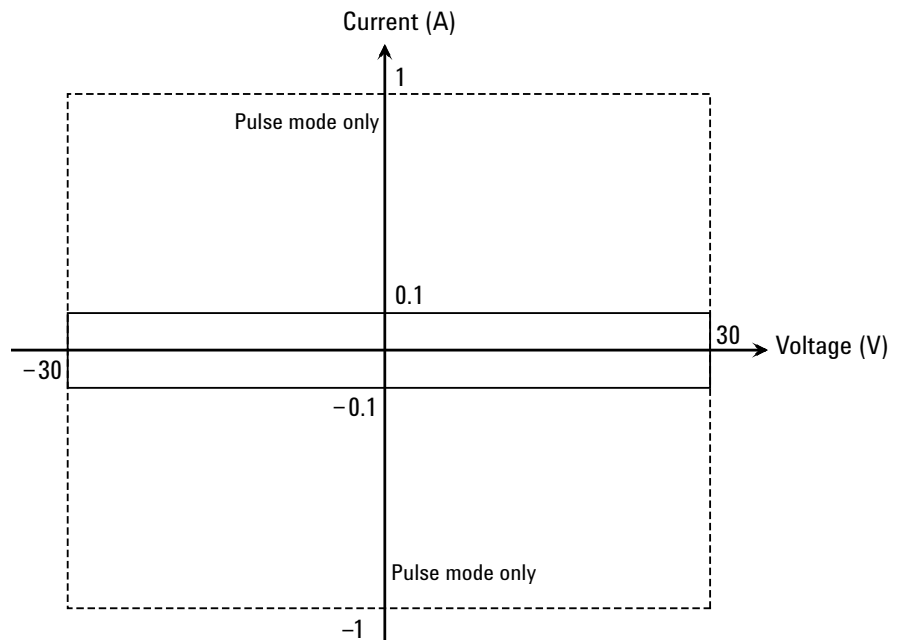


Table 1-10 MCSMU Voltage Ranges and Resolutions

Range	Output Value and Measurement Value	Setting/ Measurement Resolution	Maximum Current	Maximum Pulse Base Value
0.2 V	$0 \leq V \leq 0.2 \text{ V}$	200 nV	100 mA, 1 A ^a	$\pm 0.2 \text{ V}$
2 V	$0 \leq V \leq 2 \text{ V}$	2 μV		$\pm 2 \text{ V}$
20 V	$0 \leq V \leq 20 \text{ V}$	20 μV		$\pm 20 \text{ V}$
40 V	$0 \leq V \leq 30 \text{ V}$	40 μV		$\pm 30 \text{ V}$

a. For pulse.

Table 1-11 MCSMU Current Ranges and Resolutions

Range	Output Value and Measurement Value	Setting/ Measurement Resolution	Maximum Voltage	Maximum Pulse Base Value
10 μA	$0 \leq I \leq 11.5 \mu\text{A}$	10 pA	$\pm 30 \text{ V}$	$\pm 10 \mu\text{A}$
100 μA	$0 \leq I \leq 115 \mu\text{A}$	100 pA		$\pm 100 \mu\text{A}$
1 mA	$0 \leq I \leq 1.15 \text{ mA}$	1 nA		$\pm 1 \text{ mA}$
10 mA	$0 \leq I \leq 11.5 \text{ mA}$	10 nA		$\pm 10 \text{ mA}$
100 mA	$0 \leq I \leq 100 \text{ mA}$, $0 \leq I \leq 115 \text{ mA}$ ^a	100 nA		$\pm 100 \text{ mA}$
1 A ^b	$0 \leq I \leq 1 \text{ A}$	1 μA		$\pm 50 \text{ mA}$

a. For pulse.

b. For pulse. Maximum pulse width and duty cycle are 100 ms and 5 % respectively.

HCSMU - High Current SMU

This section describes typical specification of the high current source/monitor unit (HCSMU). The HCSMU is available for the B1506A-H21.

- Maximum current: ± 20 A (pulse), ± 1 A (DC)
- Maximum voltage: ± 40 V, ± 20 V only for the pulse over ± 1 A
- Maximum output power: 40 W
- Minimum range: 0.2 V, 10 μ A
- Minimum pulse width: 50 μ s
- Output/measurement value and resolution: see Table 1-12 and Table 1-13.

NOTE

Do not put any conductor on the HCSMU Low Force and Low Sense terminals, outer conductor of the coaxial connectors. Putting conductor of circuit common, chassis ground, or any potential on causes the measurement error.

Figure 1-6

HCSMU Output and Measurement Ranges

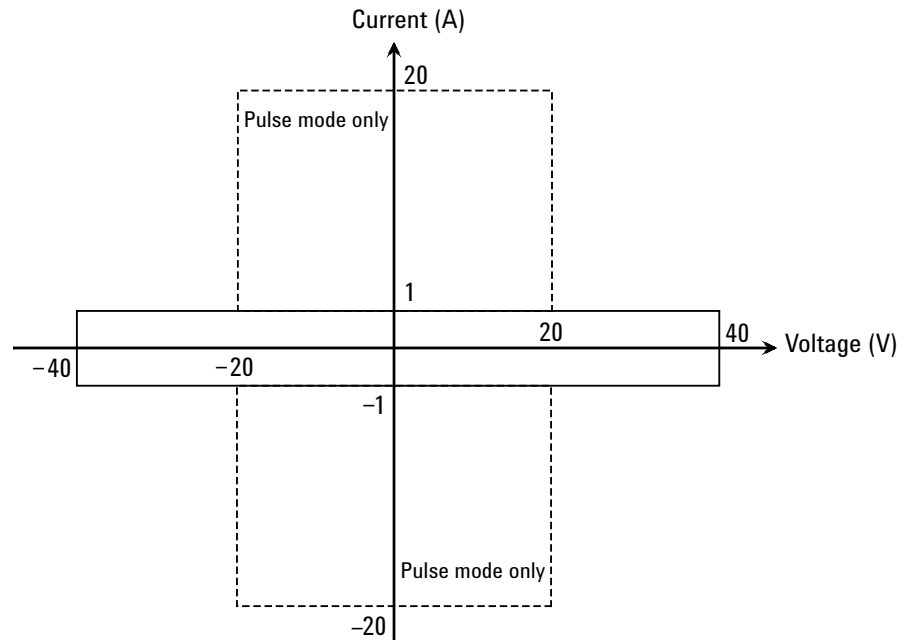


Table 1-12 HCSMU Voltage Ranges and Resolutions

Range	Output Value and Measurement Value	Setting/Measurement Resolution	Maximum Current	Maximum Pulse Base Value
0.2 V	$0 \leq V \leq 0.2 \text{ V}$	200 nV	$\pm 20 \text{ A} / \pm 40 \text{ A}$	$\pm 0.2 \text{ V}$
2 V	$0 \leq V \leq 2 \text{ V}$	2 μV	$\pm 20 \text{ A} / \pm 40 \text{ A}$	$\pm 2 \text{ V}$
20 V	$0 \leq V \leq 20 \text{ V}$	20 μV	$\pm 20 \text{ A} / \pm 40 \text{ A}$	$\pm 20 \text{ V}$
40 V	$0 \leq V \leq 40 \text{ V}$	40 μV	$\pm 1 \text{ A} / \pm 2 \text{ A}$	$\pm 40 \text{ V}$

Table 1-13 HCSMU Current Ranges and Resolutions

Range	Output Value and Measurement Value	Setting/Measurement Resolution	Maximum Voltage	Maximum Pulse Base Value
10 μA	$0 \leq I \leq 11.5 \mu\text{A}$	10 pA	$\pm 40 \text{ V}$	$\pm 10 \mu\text{A}$
100 μA	$0 \leq I \leq 115 \mu\text{A}$	100 pA	$\pm 40 \text{ V}$	$\pm 100 \mu\text{A}$
1 mA	$0 \leq I \leq 1.15 \text{ mA}$	1 nA	$\pm 40 \text{ V}$	$\pm 1 \text{ mA}$
10 mA	$0 \leq I \leq 11.5 \text{ mA}$	10 nA	$\pm 40 \text{ V}$	$\pm 10 \text{ mA}$
100 mA	$0 \leq I \leq 115 \text{ mA}$	100 nA	$\pm 40 \text{ V}$	$\pm 100 \text{ mA}$
1 A	$0 \leq I \leq 1.15 \text{ A}^{\text{a}}$	1 μA	$\pm 40 \text{ V}$	$\pm 1 \text{ A}$
20 A	$0 \leq I \leq 20 \text{ A}$	20 μA	$\pm 20 \text{ V}$	$\pm 100 \text{ mA}$

a. Maximum value is 1 A for DC output or measurement.

UHCU - Ultra High Current Unit

This section describes typical specification of the ultra high current unit (UHCU). The UHCU is available for the B1506A-H51/H71.

- Output: voltage pulse or current pulse
- Measurement: current or voltage
- Maximum current: ± 500 A (B1506A-H51) or ± 1500 A (B1506A-H71)
- Maximum voltage: ± 60 V
- Maximum power: 7.5 kW for 500 A range, or 22.5 kW for 2000 A range
- Minimum pulse width: 10 μ s
- Maximum pulse duty: 0.4 % for 500 A range, or 0.1 % for 2000 A range
- Output/measurement value and resolution: see Table 1-14 and Table 1-15.

Figure 1-7

UHCU Output and Measurement Ranges

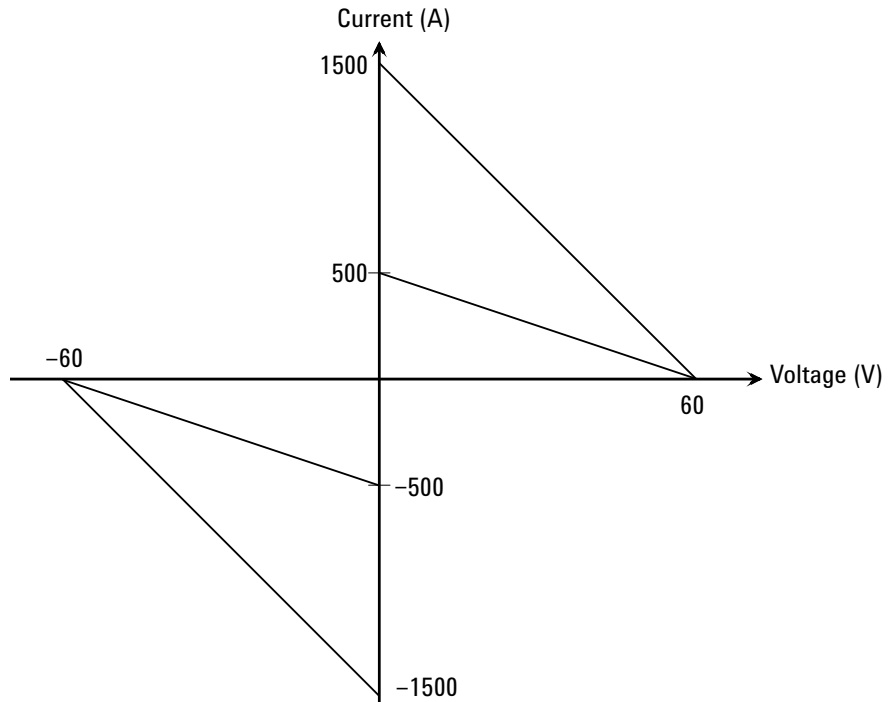


Table 1-14 UHCU Voltage Ranges and Resolutions

Range	Output Value	Measurement Value	Setting Resolution	Measurement Resolution	Maximum Current
100 V	$0 \leq V \leq 60 \text{ V}^a$	$0 \leq V \leq 60 \text{ V}$	200 μV	100 μV	$\pm 500 \text{ A}$, $\pm 1500 \text{ A}^b$

a. Pulse base value is always 0 V.

b. Only for the B1506A-H71.

Table 1-15 UHCU Current Ranges and Resolutions

Range	Output Value	Measurement Value	Setting Resolution	Measurement Resolution	Maximum Voltage
500 A	$0 \leq I \leq 500 \text{ A}^a$	$0 \leq I \leq 500 \text{ A}$	1 mA	500 μA	$\pm 63 \text{ V}^b$
2000 A ^c	$0 \leq I \leq 1500 \text{ A}$	$0 \leq I \leq 1500 \text{ A}$	4 mA	2 mA	

a. Pulse base value is always 0 A.

b. This is the maximum voltage compliance value.

c. Only for the B1506A-H71. Pulse base value is always 0 A.

MFCMU - Multi Frequency CMU

This section describes typical specification of the multi frequency capacitance measurement unit (CMU). The CMU performs the impedance measurement and returns the specified measurement data such as Cp-G.

- Measurement parameters: See Table 1-16.
- AC signal, output frequency:
1 kHz to 5 MHz
Setting resolution: 1 mHz (1 kHz to), 10 mHz (10 kHz to), 0.1 Hz (100 kHz to), or 1 Hz (1 MHz to 5 MHz)
- AC signal, output level:
10 mVrms to 250 mVrms, 1 mV resolution
- DC bias:
0 to ± 25 V, using MFCMU internal DC bias
0 to ± 3000 V, using HVSMU and high voltage bias-tee
- Measurement range:
For the fixed ranging mode, measurement range (impedance range) must be specified to perform measurement. Table 1-17 shows the available measurement ranges and the corresponding impedance value. And Figure 1-8 shows the calculation example of the impedance vs frequency characteristics of a capacitive load. Use these information to decide the measurement range.

Impedance Z is calculated by the following formula.

$$Z = 1 / (2\pi f C)$$

where f is frequency (Hz) and C is capacitance (F).

Table 1-16

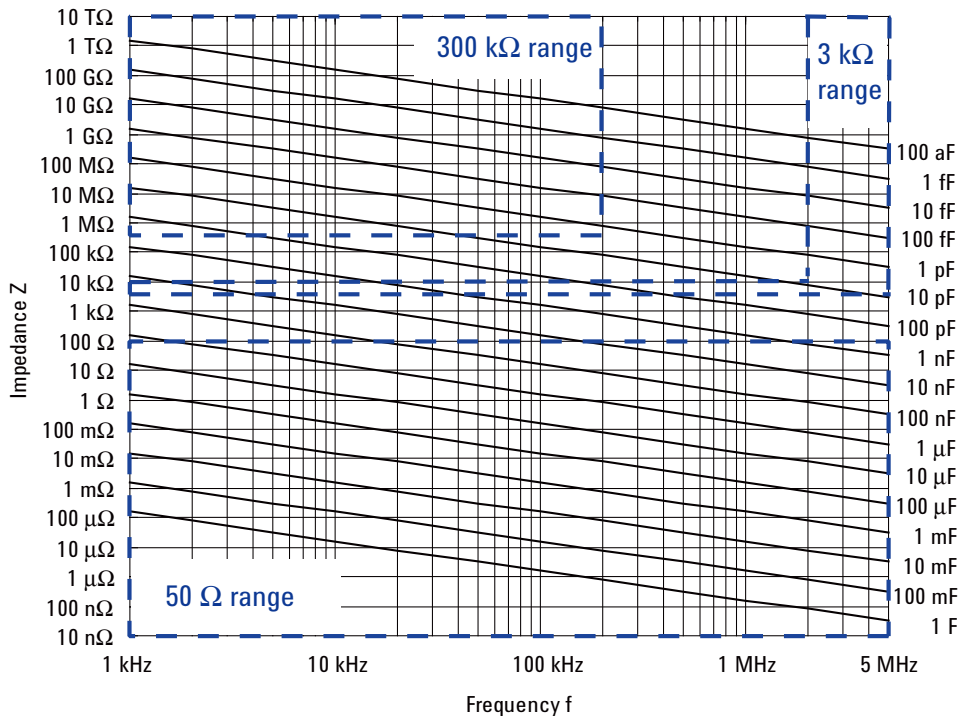
Measurement Parameters

Primary Parameter	Secondary Parameter
R (resistance, Ω)	X (reactance, Ω)
G (conductance, S)	B (susceptance, S)
Z (impedance, Ω)	θ (phase, radian)
Z (impedance, Ω)	θ (phase, degree)
Y (admittance, S)	θ (phase, radian)
Y (admittance, S)	θ (phase, degree)
Cp (parallel capacitance, F)	G (conductance, S)
Cp (parallel capacitance, F)	D (dissipation factor)
Cp (parallel capacitance, F)	Q (quality factor)
Cp (parallel capacitance, F)	Rp (parallel resistance, Ω)
Cs (series capacitance, F)	Rs (series resistance, Ω)
Cs (series capacitance, F)	D (dissipation factor)
Cs (series capacitance, F)	Q (quality factor)
Lp (parallel inductance, H)	G (conductance, S)
Lp (parallel inductance, H)	D (dissipation factor)
Lp (parallel inductance, H)	Q (quality factor)
Lp (parallel inductance, H)	Rp (parallel resistance, Ω)
Ls (series inductance, H)	Rs (series resistance, Ω)
Ls (series inductance, H)	D (dissipation factor)
Ls (series inductance, H)	Q (quality factor)

Table 1-17 Measurement Range for Fixed Ranging Mode

Impedance Z	Measurement range (impedance range)		
	1 kHz ≤ f ≤ 200 kHz	200 kHz < f ≤ 2 MHz	2 MHz < f ≤ 5 MHz
0 ≤ Z < 100 Ω	50 Ω	50 Ω	50 Ω
100 Ω ≤ Z < 300 Ω	100 Ω	100 Ω	100 Ω
300 Ω ≤ Z < 1 kΩ	300 Ω	300 Ω	300 Ω
1 kΩ ≤ Z < 3 kΩ	1 kΩ	1 kΩ	1 kΩ
3 kΩ ≤ Z < 10 kΩ	3 kΩ	3 kΩ	3 kΩ
10 kΩ ≤ Z < 30 kΩ	10 kΩ	10 kΩ	
30 kΩ ≤ Z < 100 kΩ	30 kΩ	30 kΩ	
100 kΩ ≤ Z < 300 kΩ	100 kΩ		
300 kΩ ≤ Z	300 kΩ		

Figure 1-8 Impedance vs Frequency Characteristics of Capacitive Load, Calculation Example



Introduction
Measurement Resources

2

Installation

Installation

This chapter describes how to install Keysight B1506A.

- “Requirements”
- “Inspection and Installation”
- “Connecting Accessories”
- “Maintenance”
- “Before Shipping to Service Center”

WARNING

To avoid electrical shock and instrument damage, turn the all instruments off before connecting or disconnecting measurement cable.

Mettez la machine hors tension pour fixer le connecteur ou pour retirer le connecteur de l'unité centrale.

WARNING

The mainframe and the test fixture are heavy and require a two person lift.

Le châssis principale et l'équipement de test sont lourds et nécessitent un levage par deux personnes.

CAUTION

Do not grab the fixture cover when lifting the test fixture.

WARNING

There are potentially hazardous voltages (± 3000 Vdc for HVSMU and ± 100 Vdc for MPSMU) present at the High, Force, Guard, and Sense terminals of the instruments. To prevent electrical shock, the following safety precautions must be observed during the use of instruments.

- Connect the instrument to an electrical ground (safety ground) by using three-conductor AC power cable.
 - Connect the mainframe Interlock terminal to the test fixture Interlock terminal by using an interlock cable.
 - Confirm periodically that the interlock function works normally.
 - Before touching the connections on the High, Force, Guard, and Sense terminals in the test fixture or the shielding box, turn the instruments off and discharge any capacitors. If you do *not* turn the instruments off, complete *all* of the following items, regardless of the instrument settings.
 - Press the front panel Stop key to set the source output off.
 - Confirm that the front panel High Voltage indicator is not lit.
 - Open the Interlock terminal (open the fixture cover or the shielding box access door).
 - Discharge any capacitors connected to a measurement resource.
 - Warn persons working around the instruments about dangerous conditions.
-

Requirements

This section describes the requirements for the environment this instrument is used.

- “Power Requirements”
- “Operating Environment”
- “Storing/Shipping Environment”
- “Installation Requirements”
- “Power Cable”

Power Requirements

This instrument can operate from any single-phase AC power source supplying 100/240 V ($\pm 10\%$) at 50/60 Hz. The maximum power consumption is shown below.

- Mainframe: 900 VA
- Test fixture of B1506A-H21: 130 VA
- Test fixture of B1506A-H51/H71: 470 VA

Operating Environment

This instrument must be operated within the following environmental conditions:

Temperature: +5 °C to +40 °C, +5 °C to +30 °C if Thermal plate is used, or +20 °C to +30 °C if Thermostream is used

Humidity: 20 % to 70 % RH or 20 % to 50 % RH if the Thermostream setting temperature is +20 °C or below. No condensation.

Altitude: 0 to 2,000 m (6,561 ft.)

Storing/Shipping Environment

This instrument must be stored/shipped within the following environmental conditions:

Temperature: -20 °C to +60 °C

Humidity: 10 % to 90 % RH, no condensation

Altitude: 0 to 4,600 m (15,092 ft.)

Installation Requirements

WARNING

Do not operate the instrument in dusty environment, or in the presence of flammable gasses, corrosive gasses, or fumes.

Ne pas utiliser l'appareil dans un endroit poussiéreux, ou en présence de gaz inflammables, corrosifs ou de fumée.

- Environmental conditions for this instrument are documented in the previous page. In principle, this instrument should only be operated indoors in a controlled environment.
- Install the instrument horizontal place then face the roof up.
- The dimensions of this instrument are shown below. Fan cools the instrument by drawing air through the sides and exhausting it out the back. The instrument must be installed in a location that allows sufficient space at the sides and back of the instrument for adequate air circulation.
 - Mainframe: 420 mm (W) × 575 mm (D) × 330 mm (H)
 - Test fixture: 420 mm (W) × 575 mm (D) × 360 mm (H)

If the airflow is restricted, the internal operating temperature will be higher. This may reduce the instrument's reliability, or cause the thermal-protection circuits to turn the instrument off.

- Make sure that there is enough space for connecting/disconnecting the power cable easily.

Power Cable

WARNING

FIRE HAZARD: Use only the power cable supplied with your instrument. Using other types of power cable may cause overheating of the power cable, resulting in fire.

SHOCK HAZARD: The power cable provides the chassis ground through a third conductor. Be sure to connect to a three-conductor type power outlet with the correct pin grounded.

RISQUE D'INCENDIE : utilisez uniquement le câble d'alimentation fourni avec votre appareil. L'utilisation d'autres types de câble d'alimentation peut provoquer une surchauffe du câble d'alimentation et provoquer un incendie.




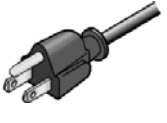

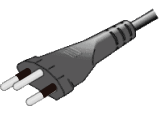


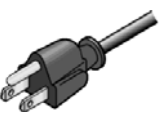





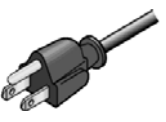
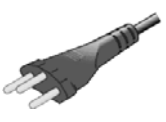
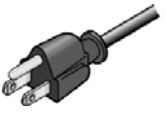

RISQUE DE CHOC ÉLECTRIQUE: le câble d'alimentation fournit la masse du châssis par le biais d'un troisième conducteur. Assurez-vous de connecter la prise d'alimentation de type trois conducteurs avec la broche correcte mise à la terre.

NOTE

The detachable power cable may be used as an emergency disconnecting device. Removing the power cable will disconnect AC input power to the instrument.

Connect the power cable to the IEC 320 connector on the rear of the instrument. If the wrong power cable was shipped with your instrument, contact your nearest Keysight Sales and Support Office.

The AC input on the back of your instrument is a universal AC input. It accepts nominal line voltages in the range of 100 to 240 VAC.

<p>Option 900</p>  <ul style="list-style-type: none"> • Plug: BS 1363/A, 250 V, 10 A • PN: 8120-4420 	<p>Option 901</p>  <ul style="list-style-type: none"> • Plug: AS/NZS 3112, 250 V, 10 A • PN: 8120-4419 	<p>Option 902</p>  <ul style="list-style-type: none"> • Plug: IEC 60277-1, 250 V, 10 A • PN: 8121-1226 	<p>Option 903</p>  <ul style="list-style-type: none"> • Plug: NEMA 5-15P, 125 V, 10 A • PN: 8120-6825
<p>Option 904</p>  <ul style="list-style-type: none"> • Plug: NEMA 6-15P, 250 V, 10 A • PN: 8120-3996 	<p>Option 906</p>  <ul style="list-style-type: none"> • Plug: SEV 1011, 250 V, 10 A • PN: 8120-4416 	<p>Option 912</p>  <ul style="list-style-type: none"> • Plug: SB 107-2-D1, 250 V, 10 A • PN: 8121-1655 	<p>Option 917</p>  <ul style="list-style-type: none"> • Plug: IS 1293 and IS 6538, 250 V, 10 A • PN: 8121-1690
<p>Option 918</p>  <ul style="list-style-type: none"> • Plug: JIS C 8303, 125 V, 12 A • PN: 8121-0743 	<p>Option 919</p>  <ul style="list-style-type: none"> • Plug: Israel SI 32, 250 V, 10 A • PN: 8121-0724 	<p>Option 920</p>  <ul style="list-style-type: none"> • Plug: IRAM 2073, 250 V, 10 A • PN: 8121-0725 	<p>Option 921</p>  <ul style="list-style-type: none"> • Plug: CEI 23-16, 250 V, 10 A • PN: 8121-0722
<p>Option 922</p>  <ul style="list-style-type: none"> • Plug: GB 1002 figure 3, 250 V, 10 A • PN: 8120-8376 	<p>Option 923</p>  <ul style="list-style-type: none"> • Plug: SANS 164-1, 250 V, 10 A • PN: 8121-0564 	<p>Option 927</p>  <ul style="list-style-type: none"> • Plug: NEMA WD-6, 250 V, 10 A • PN: 8120-0674 	<p>Option 930</p>  <ul style="list-style-type: none"> • Plug: NBR 14136, 250 V, 10 A • PN: 8121-1809
<p>Option 931</p>  <ul style="list-style-type: none"> • Plug: CNS 10917-2, 125 V, 10 A • PN: 8121-1635 	<p>Option 932</p>  <ul style="list-style-type: none"> • Plug: CS 0017, 250 V, 10 A • PN: 8121-1638 		

Inspection and Installation

Do the following when this instrument arrived.

- “To Inspect Shipment”
- “To Perform Initial Setup”
- “To Connect Test Fixture”
- “To Check Operation of Test Fixture”

Do the following setup if you need.

- “To Change Windows Logon Setting”
- “To Change GPIB Address”
- “To Enable System Controller”

To Inspect Shipment

1. Before unpacking any components, inspect all boxes for any signs of damage that might have occurred during shipment, such as:
 - dents
 - scratches
 - cuts
 - water marks

If you suspect any damage, contact Keysight Technologies.

2. When you open the boxes that contain the instrument and accessories, check the components against the contents lists attached to the boxes.

If anything is missing, contact Keysight Technologies.

After the inspection, move the instrument and accessories to the installation site. For the requirements for the installation site, see “Requirements” on page 2-4.

To Perform Initial Setup

1. Place the mainframe at the installation site.
2. Make sure that the Standby switch is set to off.
3. On the rear panel, connect the Circuit Common terminal to the frame ground terminal by using a shorting-bar.
4. If you use the furnished USB keyboard and/or USB mouse, connect it to an USB port of the mainframe.
5. Connect the power cable from the mainframe to an AC power outlet.
6. Open the measurement terminals and press the Standby switch to turn on the mainframe.

If the mainframe is operating correctly, the power-on self-test is automatically performed. If problems arise, contact Keysight Technologies.

7. Follow the Windows setup wizard and complete the initial setup.
 - a. Set the system display language to English. The language must be English. If you set another language, you must perform the system recovery of the B1506A. See *Keysight EasyEXPERT User's Guide Vol. 2* for the system recovery.
 - b. Set Country or region, Time and currency, and Keyboard layout.
If you use the furnished USB keyboard, the Keyboard layout must be US.
 - c. Accept the End User License Agreement.
 - d. Set Time zone, date and time.

If the mainframe has been already connected to your site LAN, you can proceed the network connection setup. If you connect the mainframe to the network, take care to protect it from computer virus.

NOTE

Other Windows setup

You can set other setup of Windows after the initial setup. It is your responsibility.

NOTE

Keysight Technologies cannot guarantee the performance and provide compatibility information for all B1506As under several conditions. If problems arise, perform Keysight B1506A system recovery.

To perform recovery, see *Keysight EasyEXPERT User's Guide Vol. 2*.

Installation
Inspection and Installation

Users listed in Table 2-1 are available just after the initial setup.

Table 2-1

Users Available Just After the Initial Setup

User Account	Description
Keysight B1500 User	Account for automatic logon. Password is not set to this account.
keysightOnly	Account for Keysight service personnel. Do not delete this account. This account is password protected.
Administrator	Administrator. Password is not set to this account.

You can add users after the initial setup. Add users as you need.

To Connect Test Fixture

WARNING

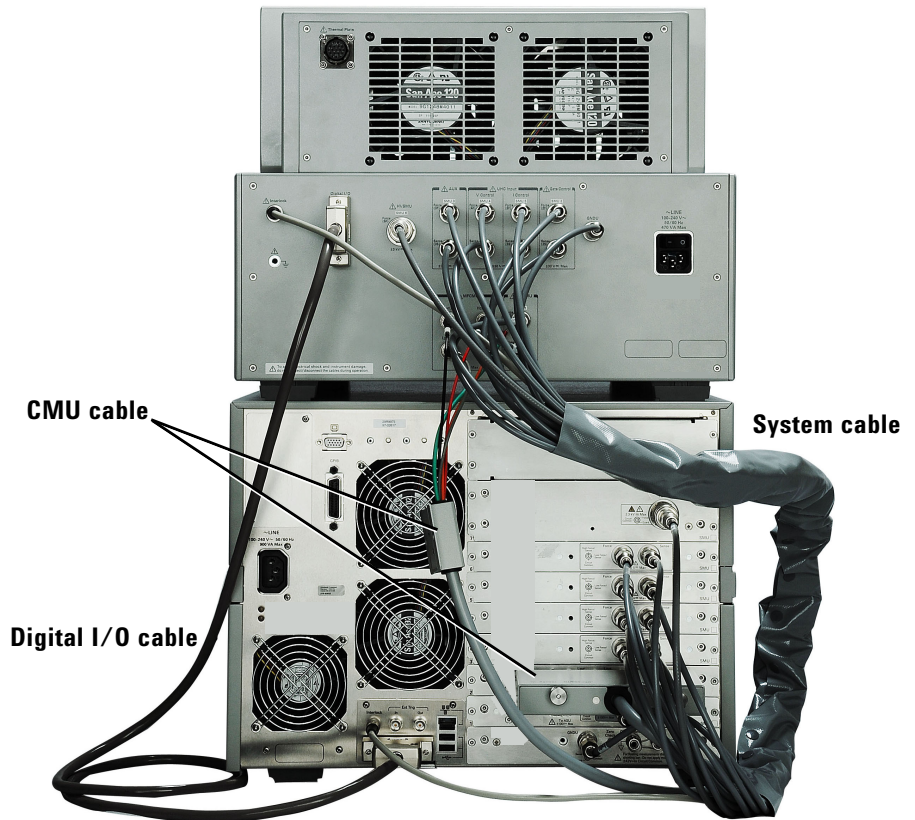


To avoid electrical shock and instrument damage, turn the all instruments off before connecting or disconnecting measurement cable.

Mettez la machine hors tension pour fixer le connecteur ou pour retirer le connecteur de l'unité centrale.

Figure 2-1

B1506A Rear View



Connect the system cables between the mainframe and the test fixture as shown in Figure 2-1.

See Table 2-2 for B1506A-H21.

See Table 2-3 for B1506A-H51 or B1506A-H71.

Installation
 Inspection and Installation

1. Connect the Digital I/O cable.
2. Connect the CMU cable.
3. Connect the System cable in order of the label number.

Table 2-2 B1506A-H21 System Cable Connections

Test Fixture		Label of Cable		Mainframe	
Digital I/O Cable					
Digital I/O		none	none	Digital I/O	
CMU Cable					
MFCMU	Lcur (LC)	LC	Lcur	MFCMU	
	Lpot (LP)	LP	Lpot		
	Hcur (HC)	HC	Hcur		
	Hpot (HP)	HP	Hpot		
System Cable					
MPSMU SMU1	Force (1F)	1F	1F	Force	SMU1
	Sense (1S)	1S	1S	Sense	
Gate Control SMU2	Force (2F)	2F	2F	Force	SMU2
	Sense (2S)	2S	2S	Sense	
AUX SMU3	Force (3F)	3F	3F	Force	SMU3
	Sense (3S)	3S	3S	Sense	
HCSMU SMU4	Force (4F)	4F	4F	Force	SMU4
	Sense (4S)	4S	4S	Sense	
HVSMU SMU5	Force (5F)	5F	5F	Force	SMU5
GNDU		GNDU	GNDU	GNDU	
Interlock		none	none	Interlock	

Table 2-3

B1506A-H51/H71 System Cable Connections

Test Fixture		Label of Cable		Mainframe	
Digital I/O Cable					
Digital I/O		none	none	Digital I/O	
CMU Cable					
MFCMU	Lcur (LC)	LC	Lcur	MFCMU	
	Lpot (LP)	LP	Lpot		
	Hcur (HC)	HC	Hcur		
	Hpot (HP)	HP	Hpot		
System Cable					
MPSMU SMU1	Force (1F)	1F	1F	Force	SMU1
	Sense (1S)	1S	1S	Sense	
Gate Control SMU2	Force (2F)	2F	2F	Force	SMU2
	Sense (2S)	2S	2S	Sense	
AUX SMU3	Force (3F)	3F	3F	Force	SMU3
	Sense (3S)	3S	3S	Sense	
V Control SMU4	Force (4F)	4F	4F	Force	SMU4
	Sense (4S)	4S	4S	Sense	
I Control SMU5	Force (5F)	5F	5F	Force	SMU5
	Sense (5S)	5S	5S	Sense	
HVSMU SMU6	Force (6F)	6F	6F	Force	SMU6
GNDU		GNDU	GNDU	GNDU	
Interlock		none	none	Interlock	

To Check Operation of Test Fixture

After completing the cable connections described in “To Connect Test Fixture” on page 2-11, perform the following procedure.

1. Open the measurement terminals of the test fixture and close the fixture cover.
2. Connect the power cable from the test fixture to an AC power outlet.
3. Connect the power cable from the mainframe to an AC power outlet.
4. Set the test fixture power switch to the ON position to turn on the test fixture.
5. Press the mainframe Standby switch to turn on the mainframe.
6. After boot up, launch the Capacitance Measurement software.
7. Click the Configuration > Module menu to display the Module Configuration dialog box.
8. Use the Module Configuration dialog box and perform diagnosis of the selector installed in the test fixture. If problems arise, contact Keysight Technologies.

To Change Windows Logon Setting

Windows automatic logon has been enabled initially. If you want to change this setting, select *All Programs > Control Auto Logon* from the Start menu. Control Auto Logon is displayed on the browser. Then click one of the following buttons on the browser and follow the setup script.

- Enable Auto Logon
- Disable Auto Logon

NOTE

If you set a password for the user account *Keysight B1500 User*, disable the automatic logon.

To Change GPIB Address

When this instrument is shipped from the factory, the GPIB address is set to 17. To change the GPIB address, perform the following procedure.

1. If the EasyEXPERT software is running, terminate it as shown below:
 - a. Select the menu function *File > Exit* on the EasyEXPERT main screen.
 - b. Click [x] at the upper right corner of the Start EasyEXPERT button.
2. Select *All Programs > Keysight IO Libraries Suite > Keysight Connection Expert* from the Start menu. Keysight Connection Expert window appears.
3. At the *Instrument I/O on this PC* area, select GPIB0, and click the Change Properties... button. Keysight 82350 PCI GPIB Interface - GPIB0 window appears.
4. Change the GPIB Address value.
5. Remove the check from the *Auto-discover instruments connected to this interface* box.
6. Click the OK button on Keysight 82350 PCI GPIB Interface - GPIB0 window.
7. On the Reboot Required dialog box, click the Reboot Now button, and reboot the mainframe.

To Enable System Controller

To allow this instrument to control external GPIB devices, perform the following procedure. After the procedure, you cannot control the instrument from an external computer.

1. If the EasyEXPERT software is running, terminate it as shown below:
 - a. Select the menu function *File > Exit* on the EasyEXPERT main screen.
 - b. Click [x] at the upper right corner of the Start EasyEXPERT button.
2. Select *All Programs > Keysight IO Libraries Suite > Keysight Connection Expert* from the Start menu. Keysight Connection Expert window appears.
3. At the *Instrument I/O on this PC* area, select GPIB0, and click the Change Properties... button. Keysight 82350 PCI GPIB Interface - GPIB0 window appears.
4. Set the GPIB Address value to 21 that is the typical address number for the system controller.
5. Check the *System Controller* box.
6. Remove the check from the *Auto-discover instruments connected to this interface* box.

This disables the automatic device detection. So the Connection Expert cannot detect the instruments connected to the GPIB interface by itself.
7. Click the OK button on Keysight 82350 PCI GPIB Interface - GPIB0 window.
8. On the Reboot Required dialog box, click the Reboot Now button, and reboot the mainframe.

NOTE

To Disable System Controller

To disable the system controller, change the steps 4 and 5 for setting the GPIB Address value to *not* 21 and removing the check from the *System Controller* box, and perform the procedure to the step 8.

Connecting Accessories

The test fixture is used to connect your device under test (DUT). The B1506A is furnished with the following accessories.

- “3-pin Inline Package Socket Module”
- “Gate Charge Socket Adapter”
- “Accessories for Connecting a DUT”
- “Thermocouple”

Also, the following equipment can be used with the B1506A for controlling temperature of DUT. Contact inTEST Corporation for the equipment.

- “Thermal Plate”
- “Thermostream”

WARNING

Set the instrument output off before connecting or disconnecting connection wire.

Press the mainframe front panel Stop key to set the source output off. And confirm that the mainframe front panel High Voltage indicator is not lit.

WARNING



To prevent electrical shock and DUT damage, do not connect or disconnect the DUT while the instrument is applying voltage or current.

When you touch the DUT after measurement, devise a countermeasure of residual charge and heat to prevent electrical shock and burn. Use glove and any tool. Also have enough time for discharge and radiation.

Pour éviter toute électrocution et tout risque d'endommagement de l'appareil, ne retirez pas les câbles pendant le fonctionnement.

Lorsque vous touchez le MST après la mesure, élaborer une contre-mesure de la charge résiduelle et du chauffage afin d'éviter tout choc électrique et toute brûlure. Utilisez des gants et des outils. Prévoyez également du temps pour la décharge et la radiation.

3-pin Inline Package Socket Module

Use the socket module to connect a three-terminal inline packaged device. See the following simple instruction.

Requirements

- 3-pin inline package socket module
- DUT

Procedure

1. Attach the socket module directly to the Base/Gate, Collector/Drain, and Emitter/Source terminals of the test fixture.
2. Set your DUT on the socket.
3. Close the fixture cover and perform measurement.



WARNING

Hazardous voltage, instrument maximum output voltage may appear at the measurement terminals if the fixture cover is closed.

WARNING

Open the Guard terminal of the test fixture. Do not connect anything to it.

CAUTION

Use the socket module within the temperature range of 0 °C to +100 °C.

NOTE

Short plate is furnished with the socket module. It is used for performing the short correction before the capacitance measurement. Set it on the socket before the short correction and remove it after the correction.

Gate Charge Socket Adapter

This socket adapter is designed for performing the gate charge measurement. The adapter supports 3-pin inline package device and other type of device.

- “Connecting 3-pin Inline Package Device”
- “Connecting Other Type of Device”

Connecting 3-pin Inline Package Device

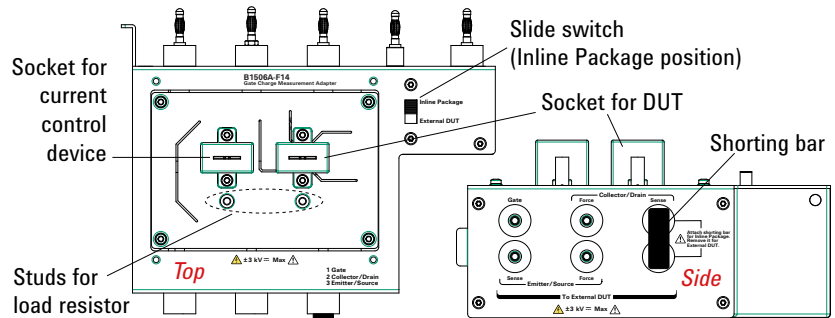
Requirements

- Gate charge socket adapter and Shorting bar (furnished with the adapter)
- DUT (3-pin inline package device)
- Current control device or Load resistor

The current control device must be an extra 3-pin inline package device which is expected to have the same characteristics as DUT. If the device is not available, use a load resistor. The resistor must satisfy the following specifications.

Resistance = V_r/I_r (V_r : rated voltage, I_r : rated current)

Peak power $\geq V_r \times I_r \times 1 \text{ ms}$



Procedure

1. Attach the socket adapter directly to the Base/Gate, Collector/Drain, Emitter/Source, and AUX Force terminals of the test fixture.
2. Attach the shorting bar to the Sense terminals on the side panel.
3. Set the slide switch to the Inline Package position.
4. Set the current control device on the left socket or connect the load resistor between the studs for the resistor.
5. Set your DUT on the right socket.
6. Close the fixture cover and perform measurement.

Installation

Connecting Accessories

WARNING

Hazardous voltage, instrument maximum output voltage may appear at the measurement terminals if the fixture cover is closed.

NOTE

Open the AUX Sense terminals of the test fixture. Do not connect anything to them.

NOTE

Short plate is furnished with the adapter. It is used for performing the short correction before the gate charge measurement. Set it on “Socket for DUT” before the short correction and remove it after the correction.

Connecting Other Type of Device

Requirements

- Gate charge socket adapter
- Blank silicon plate
- Connection wire, clip, adapter, and so on. Use the furnished accessories.

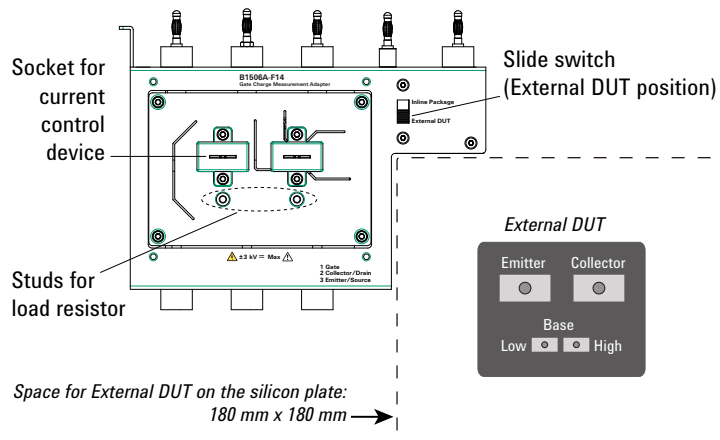
Banana pin to Large alligator clip wire can be assembled by fixing a banana pin adapter and a clip to a connection wire using a screw and a nut.

- DUT (other than 3-pin inline package device)
- Current control device or Load resistor

The current control device must be an extra 3-pin inline package device which is expected to have the same characteristics as DUT. If the device is not available, use a load resistor. The resistor must satisfy the following specifications.

Resistance = V_r/I_r (V_r : rated voltage, I_r : rated current)

Peak power $\geq V_r \times I_r \times 1 \text{ ms}$

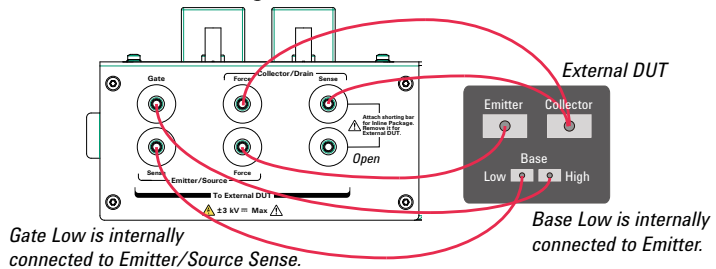


Procedure

1. Set the blank silicon plate on the DUT stage of the test fixture.
2. Attach the socket adapter directly to the Base/Gate, Collector/Drain, Emitter/Source, and AUX Force terminals of the test fixture.
3. Remove the shorting bar from the Sense terminals if it is attached.
4. Set the slide switch to the External DUT position.
5. Set the current control device on the left socket or connect the load resistor between the studs for the resistor.
6. Put your DUT on the space for the external DUT. The device size should be smaller than approximately 170 mm (W) × 170 mm (D) × 130 mm (H).
7. Connect your DUT to the side panel terminals by using connection wire, clip, adapter, and so on.

Force and Sense must be connected together at the terminal of DUT for making the Kelvin connection.

8. Close the fixture cover and perform measurement.



WARNING

Hazardous voltage, instrument maximum output voltage may appear at the measurement terminals if the fixture cover is closed.

WARNING



Make sure that the cover is closed properly before starting measurement. Do not perform the measurement when a wire is protruding from the fixture cover.

Assurez-vous que le couvercle est fermé correctement avant de commencer la mesure. Ne pas effectuer la mesure lorsqu'un câble dépasse du couvercle de l'appareil.

NOTE

Open the AUX Sense terminals of the test fixture. Do not connect anything to them.

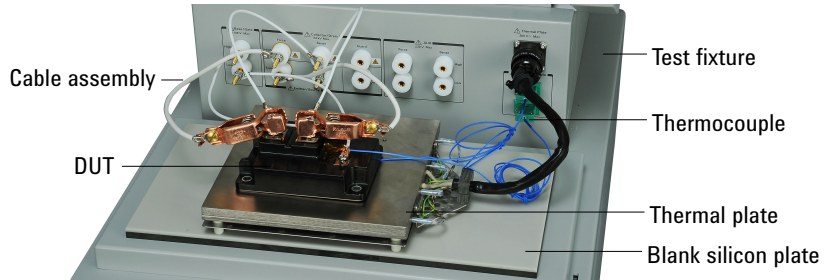
NOTE

Open/short correction should be performed before the gate charge measurement. Open between the Gate/Base terminal and the Emitter/Source terminal for the open correction and short them for the short correction at the end of the extension cables.

Installation
Connecting Accessories

Accessories for Connecting a DUT

Use the connection wire, clip, adapter, and so on to connect a device other than 3-pin inline package.



In the above picture, the blank silicon plate is set on the DUT stage, and the Thermal Plate is placed on the plate and connected to the Thermal Plate connector. Also, the thermocouples are connected to the K Thermocouple terminals and put on the places to monitor temperature. For the Thermal Plate, contact inTEST Corporation.

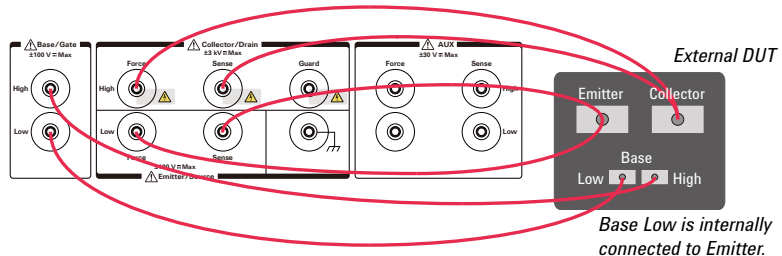
Requirements

- Blank silicon plate
- Connection wire, clip, adapter, and so on. Use the furnished accessories.
Banana pin to Large alligator clip wire can be assembled by fixing a banana pin adapter and a clip to a connection wire using a screw and a nut.
- DUT (other than 3-pin inline package device)

Procedure

1. Set the blank silicon plate on the DUT stage of the test fixture.
2. Put your DUT on the blank silicon plate. The device size should be smaller than approximately 330 mm (W) × 170 mm (D) × 130 mm (H).
3. Connect your DUT to the measurement terminals of the test fixture by using connection wire, clip, adapter, and so on.

Force and Sense must be connected together at the terminal of DUT for making the Kelvin connection.



4. Close the fixture cover and perform measurement.

WARNING

Hazardous voltage, instrument maximum output voltage may appear at the measurement terminals if the fixture cover is closed.

WARNING

To reduce the leakage current of the extension cable, the Guard terminal may be extended as close as possible to the drain or collector terminal of DUT.

Then, open the Guard terminal at the end of the extension cable to avoid electrical shock, instrument damage, or DUT damage. Do not connect anything to this terminal which has the same potential as the High Force and High Sense.

WARNING



Make sure that the cover is closed properly before starting measurement. Do not perform the measurement when a wire is protruding from the fixture cover.

Assurez-vous que le couvercle est fermé correctement avant de commencer la mesure. Ne pas effectuer la mesure lorsqu'un câble dépasse du couvercle de l'appareil.

CAUTION

Never connect the High, High Force, High Sense, or Guard terminal to any output, including circuit common and chassis ground. Connecting other output may damage the connected one.

Thermocouple

Use thermocouple to monitor temperature. The B1506A is furnished with two thermocouples. For the setup image, see the previous page.

1. Connect the thermocouple to the K Thermocouple terminal.
2. Fix the end of the thermocouple to the place to monitor temperature.

Thermal Plate

The test fixture can be equipped with the Thermal Plate for controlling temperature of DUT. For the setup image, see the previous page.

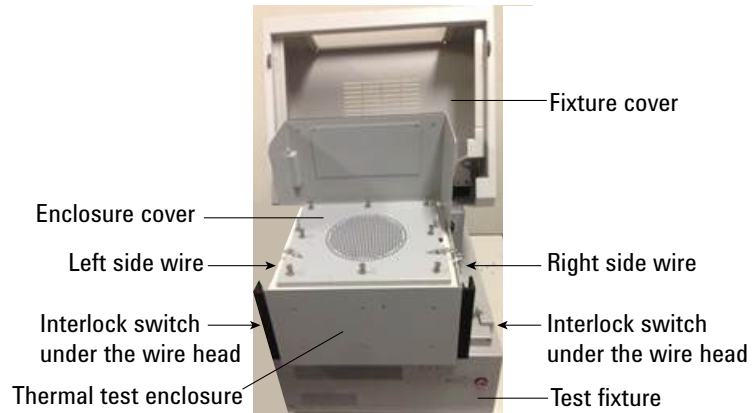
1. Set the blank silicon plate on the DUT stage of the test fixture.
2. Place the Thermal Plate on the silicon plate.
3. Connect the cable from the Thermal Plate to the Thermal Plate connector on the test fixture.
4. Put your DUT on the Thermal Plate. The device size should be smaller than approximately 160 mm (W) × 160 mm (D) × 100 mm (H).
5. Connect your DUT as described in “Accessories for Connecting a DUT” on page 2-22. Or see “Connecting Other Type of Device” on page 2-20 for performing the gate charge measurement.
6. Set the thermocouple if it is used. See “Thermocouple” on page 2-24.
7. Connect the cable from the temperature controller to the Thermal Plate connector on the test fixture rear panel.
8. Close the fixture cover and perform measurement.

For the Thermal Plate, contact inTEST Corporation.

Thermostream

The test fixture can be equipped with the Thermostream for controlling temperature of DUT. For the setup image, see the following figure.

The B1506A-T01 thermal test enclosure is needed to set the Thermostream on the test fixture.



1. Attach the thermal test enclosure directly to the Base/Gate, Collector/Drain, Emitter/Source, and AUX Force terminals of the test fixture.
2. Unscrew and remove the enclosure cover.
3. Put your DUT in the enclosure. The device size should be smaller than approximately 220 mm (W) × 180 mm (D) × 120 mm (H).

If you use the 3-pin inline package socket module, attach it directly to the Base/Gate, Collector/Drain, and Emitter/Source terminals in the enclosure.

4. Connect your DUT as described in “Accessories for Connecting a DUT” on page 2-22. Then use the measurement terminals in the enclosure.

If you use the 3-pin inline package socket module, set your DUT on the socket.

5. Set the thermocouple if it is used. See “Thermocouple” on page 2-24.
6. Set and fix the enclosure cover by screws so that the openings are not made between the enclosure body and the cover especially around the slit labeled “Thermocouple”.

If you use the thermocouple, pass it through the slit. If two thermocouples are used, adjust them so that they do not overlap together.

Installation

Connecting Accessories

7. Set the Thermostream on the enclosure cover.
Adjust the nozzle of the Thermostream so that it fits the cover horizontally and so that the openings are not made between them.
Connect the purge air tube from the Thermostream to the Purge air inlet at the enclosure side back. This is effective for preventing the connectors from the condensation.
8. Set the left side wire head in the slit of the test fixture interlock switch and ram it down.
9. Set the right side wire head in the slit of the test fixture interlock switch and ram it down.
10. Leave the fixture cover open and perform measurement.

For the Thermostream, contact inTEST Corporation.

WARNING

Activating the Thermostream may cause low or high temperature of $-50\text{ }^{\circ}\text{C}$ to $+250\text{ }^{\circ}\text{C}$ on the enclosure front panel, the cover, and the left and right protection panels. To prevent yourself from getting injury, confirm that they are in the safe temperature range before touching the enclosure.

L'activation du flux thermique peut entraîner une basse ou haute température de $-50\text{ }^{\circ}\text{C}$ à $+250\text{ }^{\circ}\text{C}$ sur le panneau de protection avant, le couvercle et les panneaux de protection à gauche et à droite. Pour éviter de vous blesser, confirmez qu'ils sont dans la plage de température de sécurité avant de toucher le boîtier.

WARNING

While the enclosure wire heads are rammed down into the slits of the test fixture interlock switches, hazardous voltage, instrument maximum output voltage may appear at the measurement terminals.

WARNING

Open the Guard terminal of the test fixture. Do not connect anything to it.

CAUTION

Do not expose the back of the enclosure to the condensation. Wetting the connection cables or connectors may cause the instrument damage.

CAUTION

If you use the 3-pin inline package socket module, do not set the Thermostream temperature below $0\text{ }^{\circ}\text{C}$ or over $+100\text{ }^{\circ}\text{C}$. Or else, the socket module may be damaged.

Maintenance

Maintenance should be performed periodically to keep the instrument in good condition.

Cleaning

Before performing cleaning, turn off the instrument, and disconnect power cable from the rear panel. Use a dry cloth to clean the external case parts.

To prevent electrical shock, do not perform cleaning when the instrument is turned on, and do not use a wet cloth.

Self-test and Diagnosis

This instrument provides the following functions to check the operation. Perform the following functions as necessary. Open the measurement terminals to perform self-test, self-calibration, or diagnosis.

- Self-test
- Self-calibration
- Diagnosis

If problems arise, contact Keysight Technologies.

NOTE



Interlock Open/Close test and High Voltage LED test

Interlock function limits the maximum output voltage to ± 42 V when the measurement terminal is touchable. For safety, this function must be checked before using the instrument after power on at least once a day by performing the diagnosis.

Calibration

Calibration and adjustments must be performed periodically so that the instruments satisfy the specifications, and keep a good condition. It is recommended to perform the calibration once a year at least. For the calibration and adjustments, contact Keysight Technologies. Trained service personnel will perform the calibration and adjustments.

Before Shipping to Service Center

Before shipping this instrument to service center, you have to do following:

- “To Make Backup”
- “To Check Module Slots”
- “To Collect Equipment and Accessories”

To Make Backup

If the internal hard disk drive (HDD) is failed, you will lose all data stored in the HDD. So it is important to make backup constantly.

Before shipping the instrument to the service center, make backup of data in the HDD. And keep the backup media in trust. You may need to perform data recovery of the instrument returned from the service center.

If the HDD is replaced, the instrument will be returned with the latest revision of the software.

To Check Module Slots

Do not remove the plug-in module from the mainframe. The instrument must be shipped with all modules. The module cannot be repaired or calibrated without the mainframe.

If a module is removed and installed, the specifications are not guaranteed. The specifications are guaranteed after the calibration is performed at Keysight Technologies service center.

To Collect Equipment and Accessories

The mainframe, test fixture, and all connection cables are required for servicing and must be shipped to the service center. For details, contact the service center.

WARNING

To prevent electrical shock, turn off the instrument and remove the power cable before removing the connection cables.

Mettez la machine hors tension pour fixer le connecteur ou pour retirer le connecteur de l'unité centrale.

3

How To Perform Measurement

How To Perform Measurement

This chapter describes how to measure the power devices by using Keysight B1506A and Keysight Easy Test Navigator Software, and consists of the following sections:

- **How To Perform Datasheet Characterization**
This section describes how to perform the measurement using datasheet characterization software.
- **How To Perform I/V Measurement**
This section describes how to perform the measurement using the I/V measurement software.
- **How To Perform Capacitance Measurement**
This section describes how to perform the measurement using the capacitance measurement software.
- **How To Perform Gate Charge Measurement**
This section describes how to perform the measurement using the gate charge measurement software.
- **How To Calculate Power Loss**
This section describes how to calculate the power loss using the power loss calculation software.
- **How To Monitor/Control Temperature Under Measurement**
This section describes how to monitor/control the temperature using the thermal monitor/control software.

How To Perform Datasheet Characterization

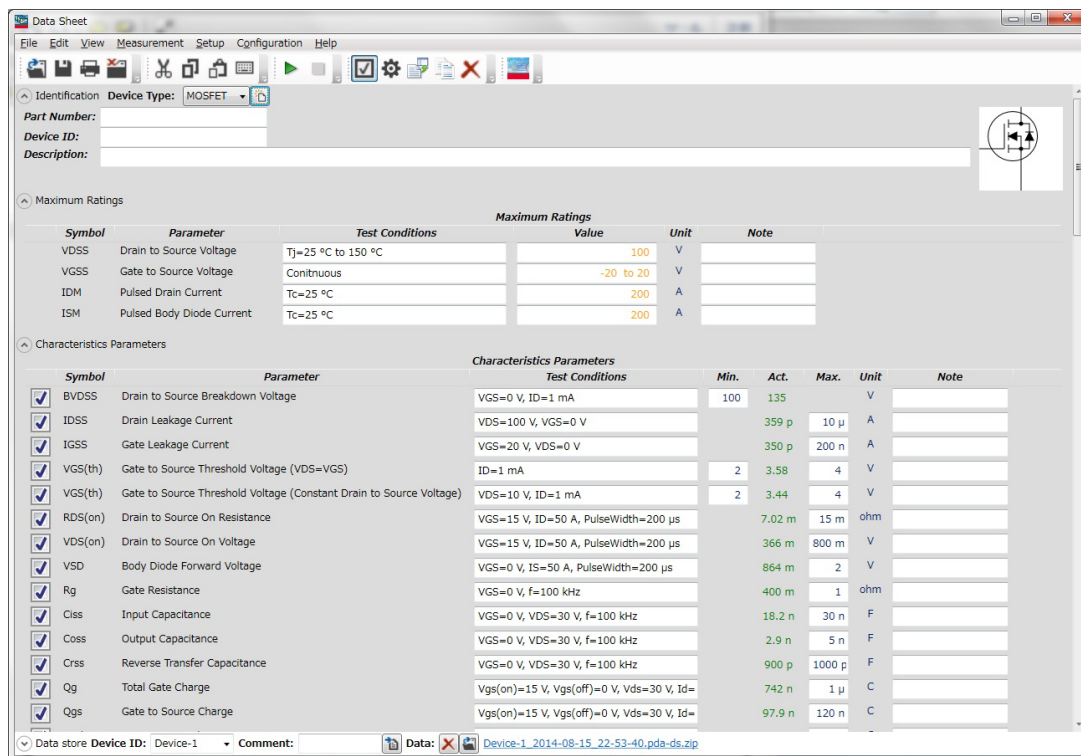
This section describes how to perform measurement on device parameters and characteristics using the datasheet characterization software.

The datasheet characterization software provides a simple operation environment in a familiar datasheet-like format that can specify measurement items and measurement conditions, perform measurement, and displays measurement results.

This section consists of the following sections:

- Preparing Measurement
- Executing Measurement

Figure 3-1 Datasheet Characterization Software



Preparing Measurement

WARNING

Set the instrument output off before connecting or disconnecting connection wire.

Press the mainframe front panel Stop key to set the source output off. And confirm that the mainframe front panel High Voltage indicator is not lit.

WARNING

To prevent electrical shock and DUT damage, do not connect or disconnect the DUT while the instrument is applying voltage or current.

When you touch the DUT after measurement, devise a countermeasure of residual charge and heat to prevent electrical shock and burn. Use glove and any tool. Also have enough time for discharge and radiation.

Step 1. Prepare the test fixture and other accessories to connect your device under test (DUT).

For more information on the test fixture and its accessories, see the following sections:

- “3-pin Inline Package Socket Module” on page 2-18
- “Gate Charge Socket Adapter” on page 2-19
- “Accessories for Connecting a DUT” on page 2-22

Step 2. Connect the test fixture and other accessories.

For more information, see “To Connect Test Fixture” on page 2-11

NOTE

If you would like to monitor/control temperature during measurement, perform the required connection and operation. See “How To Monitor/Control Temperature Under Measurement” on page 45.


Step 3. Turn the instrument on.

Step 4. Measure the calibration data for capacitance measurement.

NOTE

The capacitance measurement software keeps the last measured calibration data. If the connection for the capacitance measurement is same as when the last calibration data was measured, this step can be skipped.

1. Connect the 3-pin inline package socket module or other accessories to the test fixture. Don't connect DUT at this time.


2. On the software palette, click Capacitance Measurement icon . The Capacitance Measurement software (Figure 3-3) opens.
3. Click Start Calibration... button on the toolbar to measure the calibration data.

Follow the instruction on the dialog and measure the open and short calibration data.

Step 5. Measure the calibration data for gate charge measurement.

NOTE

The gate charge measurement software keeps the last measured calibration data. If the connection for the gate charge measurement is same as when the last calibration data was measured, this step can be skipped.

1. Connect the gate charge socket adapter or other accessories to the test fixture. Don't connect DUT at this time.
2. On the software palette, click Gate Charge Measurement icon . The Gate Charge Measurement software (Figure 3-4) opens.
3. Click Start Calibration... button on the toolbar to measure the calibration data.


Follow the instruction on the dialog and measure the open and short calibration data.

Executing Measurement

Perform the measurement as the following steps:

NOTE

The following steps show the measurement example that uses the MOSFET as DUT.

Step 1. On the software palette, click Datasheet Characterization icon . The Datasheet Characterization software (Figure 3-1) opens.

Step 2. Select the device type of DUT to load the corresponding template.



How To Perform Measurement

How To Perform Datasheet Characterization

1. From the Device Type drop-down list on the upper work area, select the device type of DUT.

The following types can be selected:

- MOSFET
- IGBT
- Diode

This example selects MOSFET.

2. Click New Datasheet button .

The template that corresponds to the selected device type (MOSFET in this example) is loaded and new datasheet folder is created.

And, Maximum Ratings, Characteristics Parameters, and Characteristics Graphs shows the template-defined settings and characteristics measurement items and so on.

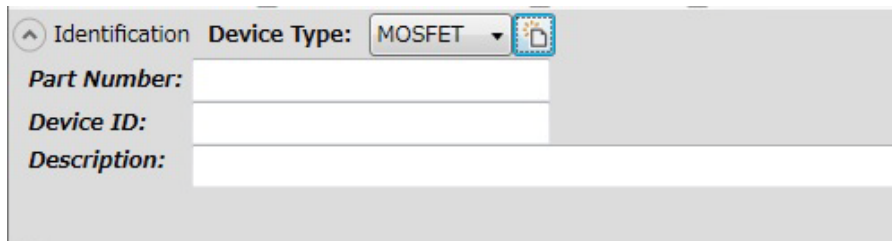
See the followings for the characteristics measurement items defined in template of each device type:

MOSFET “MOSFET Template” on page 4-26

IGBT “IGBT Template” on page 4-31

Diode “Diode Template” on page 4-35

Step 3. Enter the information for device identification.



You can enter the following information for device identification of DUT at Identification area on upper work area:

Part Number Part number of DUT

Device ID Device ID of DUT

Description Device description or any additional information.

Step 4. Specify the maximum ratings of DUT

Maximum Ratings					
Symbol	Parameter	Test Conditions	Value	Unit	Note
VDSS	Drain to Source Voltage	Tj=25 °C to 150 °C	100	V	
VGSS	Gate to Source Voltage	Conitnuous	-20 to 20	V	
IDM	Pulsed Drain Current	Tc=25 °C	200	A	
ISM	Pulsed Body Diode Current	Tc=25 °C	200	A	

Maximum Ratings area shows the maximum rating parameters that defined in the loaded template. So, confirm the parameter values and edit them if needed.

The specified maximum rating values are used to limit the values of measurement conditions for characteristics measurement items..


Symbol Symbol of rating parameter

You can edit this by clicking on the text and determined by pressing the Enter key.


Parameter Rating parameter name

You can edit the name by clicking on the text and determined by pressing the Enter key.

Test Condition Conditions for rating parameter

You can edit the condition by clicking on the text and determined by pressing the Enter key. To close the expanded editing fields, click the Close button  .

Value Maximum rating value

You can edit the maximum rating value by clicking on the value and determined by pressing the Enter key. To close the expanded editing fields, click the Close button  .

Note Note

You can add any text for remarks by clicking the field and determined by pressing the Enter key.

How To Perform Measurement

How To Perform Datasheet Characterization

Step 5. Select characteristics measurement items to be measured and enter measurement conditions

Characteristics Parameters		Characteristics Parameters						
Symbol	Parameter	Test Conditions	Min.	Act.	Max.	Unit	Note	
<input checked="" type="checkbox"/>	BVDSS Drain to Source Breakdown Voltage	VGS=0 V, ID=1 mA	100	135		V		
<input checked="" type="checkbox"/>	IDSS Drain Leakage Current	VDS=100 V, VGS=0 V		359 p	10 μ	A		
<input checked="" type="checkbox"/>	IGSS Gate Leakage Current	VGS=20 V, VDS=0 V		350 p	200 n	A		
<input checked="" type="checkbox"/>	VGS(th) Gate to Source Threshold Voltage (VDS=VGS)	ID=1 mA	2	3.58	4	V		
<input checked="" type="checkbox"/>	VGS(th) Gate to Source Threshold Voltage (Constant Drain to Source Voltage)	VDS=10 V, ID=1 mA	2	3.44	4	V		
<input checked="" type="checkbox"/>	RDS(on) Drain to Source On Resistance	VGS=15 V, ID=50 A, PulseWidth=200 μs		7.02 m	15 m	ohm		
<input checked="" type="checkbox"/>	VDS(on) Drain to Source On Voltage	VGS=15 V, ID=50 A, PulseWidth=200 μs		366 m	800 m	V		
<input checked="" type="checkbox"/>	VSD Body Diode Forward Voltage	VGS=0 V, IS=50 A, PulseWidth=200 μs		864 m	2	V		
<input checked="" type="checkbox"/>	Rg Gate Resistance	VGS=0 V, f=100 kHz		400 m	1	ohm		
<input checked="" type="checkbox"/>	Ciss Input Capacitance	VGS=0 V, VDS=30 V, f=100 kHz		18.2 n	30 n	F		
<input checked="" type="checkbox"/>	Coss Output Capacitance	VGS=0 V, VDS=30 V, f=100 kHz		2.9 n	5 n	F		
<input checked="" type="checkbox"/>	Crss Reverse Transfer Capacitance	VGS=0 V, VDS=30 V, f=100 kHz		900 p	1000 p	F		
<input checked="" type="checkbox"/>	Qg Total Gate Charge	Vgs(on)=15 V, Vgs(off)=0 V, Vds=30 V, Id=		742 n	1 μ	C		
<input checked="" type="checkbox"/>	Qgs Gate to Source Charge	Vgs(on)=15 V, Vgs(off)=0 V, Vds=30 V, Id=		77 n	100 n	C		

Characteristics Parameters area shows the characteristics parameters defined in the template (MOSFET in this example). Each parameter corresponds to a measurement item.

1. Mark the check box at left side of row to select the characteristics parameter to be measured.
2. The following column of each characteristics parameter line shows the following conditions. Confirm the conditions and enter the conditions.

Symbol

Symbol of characteristics parameter.

You can edit this by clicking on the text and determined by pressing the Enter key.


Parameter

Name of characteristics parameter.

You can edit the name by clicking on the text and determined by pressing the Enter key.

Test Conditions

Conditions for characteristics parameter.

You can edit the condition by clicking on the text and determined by pressing the Enter key. To close the expanded editing fields, click the Close button .


Min.

Lower limit of expected range of characteristics parameter.

	<p>You can enter the value by clicking on the value.</p> <p>If lower limit is unavailable, the field is not effective.</p>
Act.	<p>Measured value of characteristics parameter.</p> <p>If a measured value is out of expected range, which is from Min. to Max., a measured value is displayed in red italics.</p>
Max.	<p>Upper limit of expected range of characteristics parameter.</p> <p>You can enter the value by clicking on the value.</p> <p>If upper limit is unavailable, the field is not effective.</p>
Note	<p>Remarks.</p> <p>You can enter the value by clicking on the field and determined by pressing the Enter key.</p>

NOTE**To measure same measurement item under the different conditions**

If you would like to measure same measurement item under the different conditions, do as following instruction:

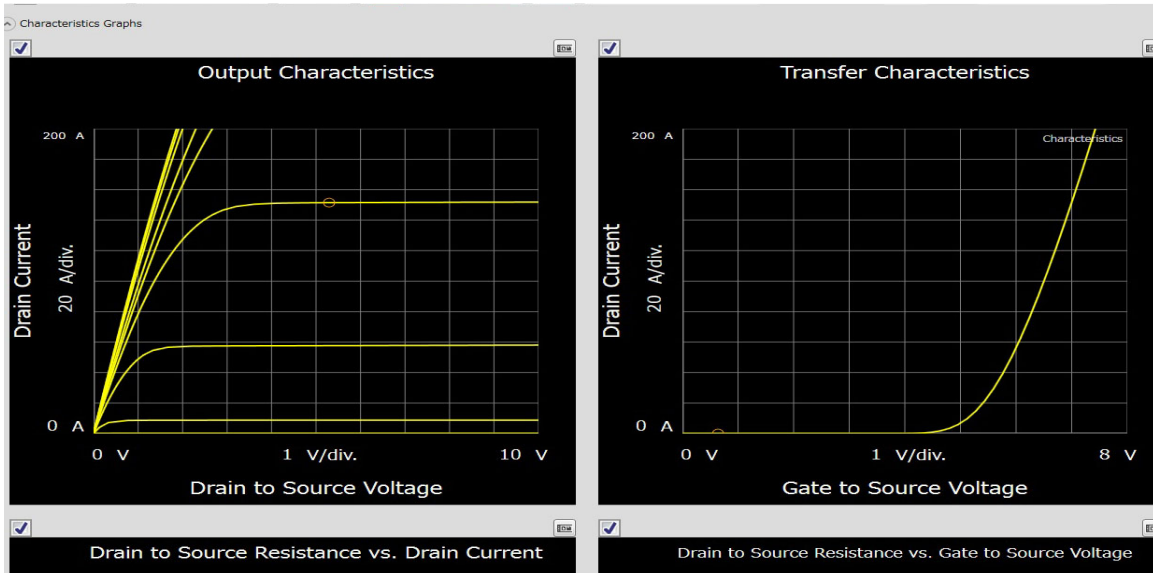
1. To select a characteristics parameter to be measured, Click on the corresponding line.
2. Click Duplicate button  on the toolbar.

The a duplicate line of selected characteristics parameter is added under the selected line.
3. Change the conditions on a duplicate line.

How To Perform Measurement

How To Perform Datasheet Characterization

Step 6. Select characteristics graph to be measured





Characteristics Graphs area shows the characteristics graphs defined in the template (MOSFET in this example). Each characteristics graph corresponds to a measurement item.

1. Mark the check box at upper left of graph to select the characteristics graph to be measured.
2. To change the maximum or minimum value of the X and Y-axis, click on the value.

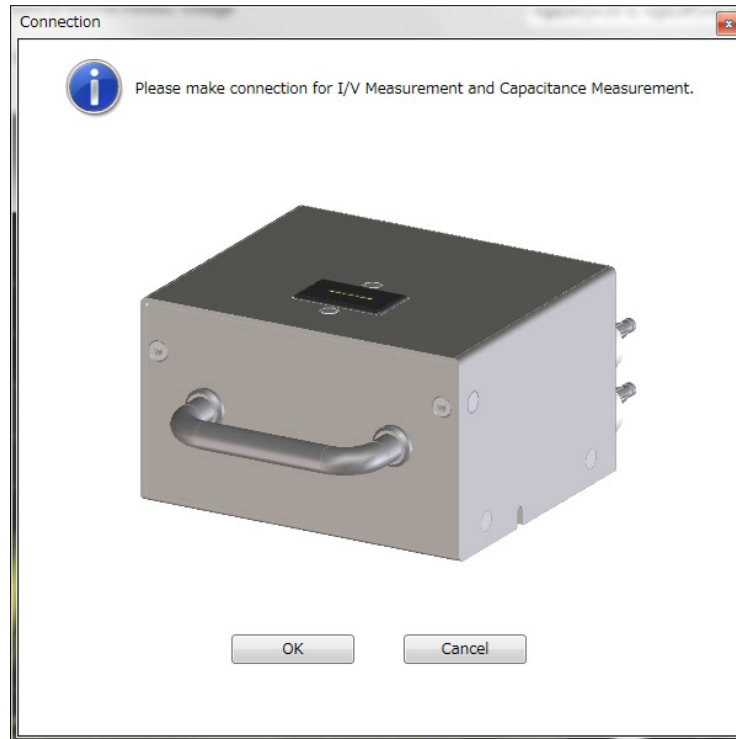
If an X or Y-axis corresponds to voltage or current output value, the minimum and maximum values also specify the output range on measurement.

3. You can change the title of characteristics graph, the labels of X and Y-axis by clicking on them.

Step 7. Click the Start Measurement tool button  to start measurement.

During measurement, you can stop the measurement by clicking the Stop Measurement tool button .

Step 8. The Connection dialog opens. Then, sets up and connect the DUT for capacitance measurement.



1. Set the 3-pin inline package socket module or other accessories corresponding to the DUT and then set the DUT.
2. Click the OK button.

Step 9. I/V measurement software opens and starts the measurement for the selected measurement items.

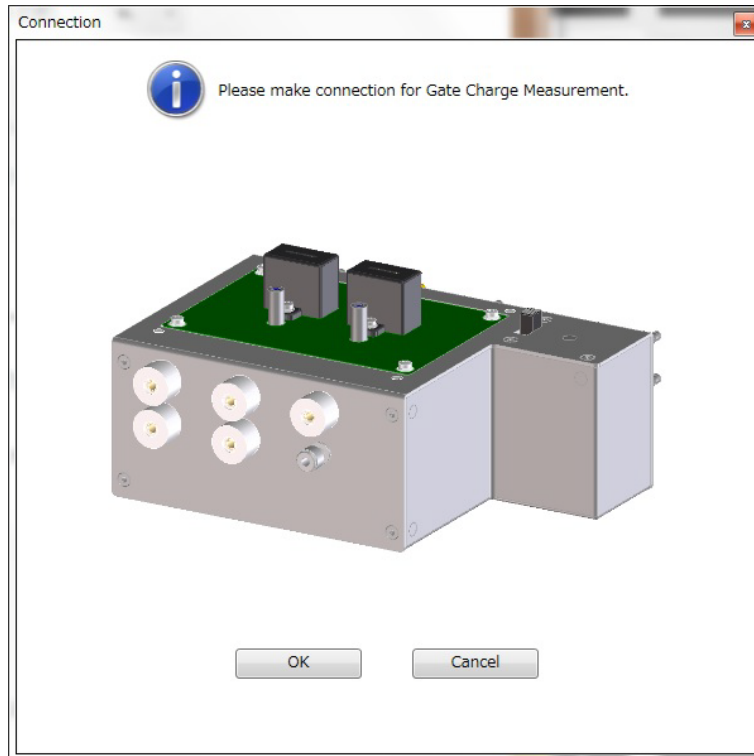
After all measurement items by the I/V measurement software are finished, the capacitance measurement software opens and starts the measurement for the selected measurement items.

During the measurement execution, the measured values of each measurement item are updated on Act. column of corresponding line at Characteristics Parameters or on the corresponding characteristics graph at Characteristics Graphs.

How To Perform Measurement

How To Perform Datasheet Characterization

- Step 10.** After all measurement items by the I/V measurement software and the capacitance measurement software are finished, the Connection dialog opens. Then, change the DUT connection setup to that for the gate charge measurement.



1. Disconnect the DUT and the socket module and other accessories from the test fixture.
2. Attach the gate charge socket adapter and set the DUT.
3. Click the OK button.

- Step 11.** The gate charge measurement software opens and measures the selected measurement items.

During the measurement execution, the measured values of each measurement item are updated on Act. column of corresponding line at Characteristics Parameters or on the corresponding characteristics graph at Characteristics Graphs.

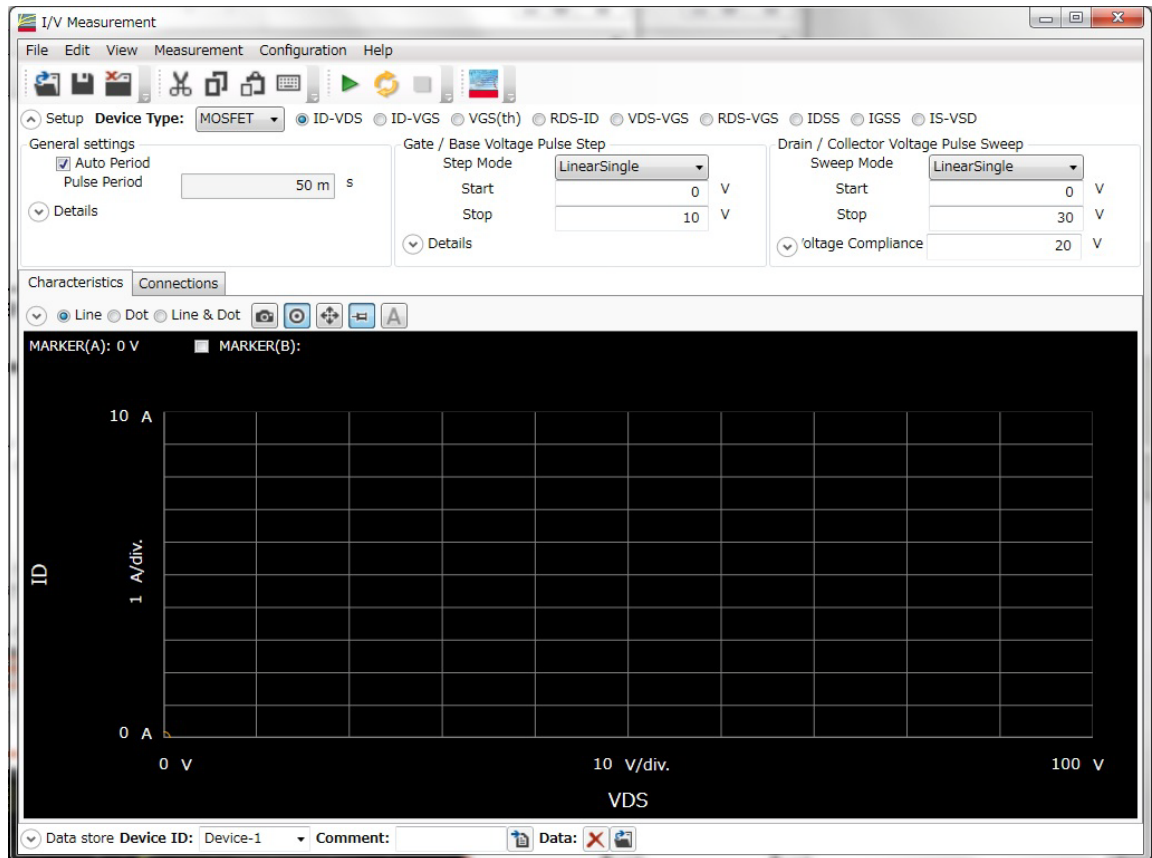
- Step 12.** After all measurement items are finished, the setup data and the measurement data are stored in the datasheet folder.

How To Perform I/V Measurement

This section describes how to perform a measurement using the I/V measurement software and consists of the following sub-sections:

- Preparing Measurement
- Executing Measurement
- Setting Parameter

Figure 3-2 I/V Measurement Software



Preparing Measurement

WARNING

Set the instrument output off before connecting or disconnecting connection wire.

Press the mainframe front panel Stop key to set the source output off. And confirm that the mainframe front panel High Voltage indicator is not lit.

WARNING

To prevent electrical shock and DUT damage, do not connect or disconnect the DUT while the instrument is applying voltage or current.

When you touch the DUT after measurement, devise a countermeasure of residual charge and heat to prevent electrical shock and burn. Use glove and any tool. Also have enough time for discharge and radiation.

Step 1. Prepare the test fixture and other accessories to connect your device under test (DUT).

For more information on the test fixture and its accessories, see the following sections:

- “To Connect Test Fixture” on page 2-11
- “3-pin Inline Package Socket Module” on page 2-18
- “Accessories for Connecting a DUT” on page 2-22

Step 2. Connect the test fixture and, 3-pin inline package socket module or other accessories that is adequate for your DUT.

For more information, see the following sections:

- “To Connect Test Fixture” on page 2-11
- “3-pin Inline Package Socket Module” on page 2-18
- “Accessories for Connecting a DUT” on page 2-22

Step 3. Turn the instrument on and then connect your DUT to the test fixture.

If your DUT is diode, connect a cathode terminal of your DUT to the Collector/Drain terminal of test fixture and a anode terminal of your DUT to the Emitter/Source terminal of test fixture.

NOTE


If you would like to monitor/control temperature during measurement, perform the required connection and operation. See “How To Monitor/Control Temperature Under Measurement” on page 3-45.

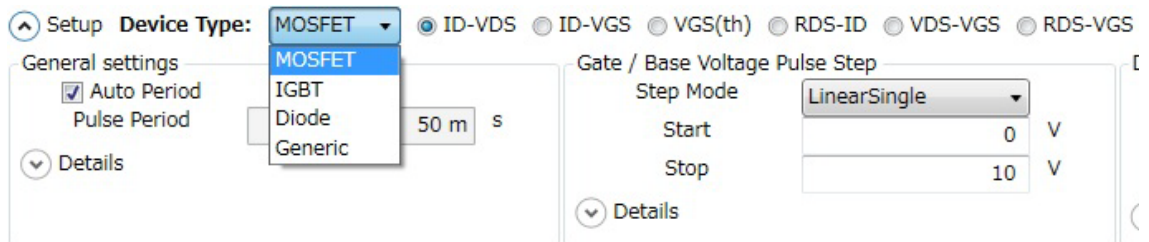
Executing Measurement

NOTE

This section explains the procedure using an example that selects MOSFET as a device type of DUT and ID-VDS as a measurement item.

Execute a measurement as follows:

- Step 1.** On the software palette, click the I/V Measurement icon . The I/V Measurement Software (Figure 3-2) opens.
- Step 2.** At the Setup area in work area, select a device type and measurement item to be measured.



- Device Type

From the Device Type drop-down list, select a device type.

NOTE

This example selects MOSFET.

- Measurement Item

From the radio buttons located on the right of a Device Type selection, which is MOSFET in this example, select a measurement item to be measured.

NOTE

This example selects ID-VDS.

NOTE

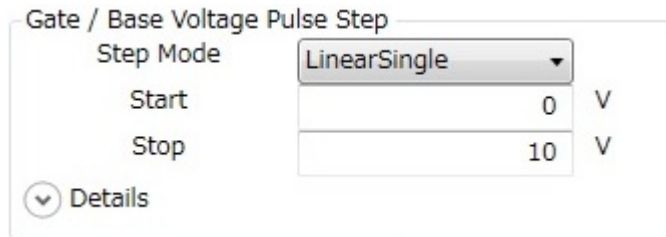
For information on the available device types and measurement items, see Table 3-1 on page 3-21

How To Perform Measurement

How To Perform I/V Measurement

By selecting a device type and measurement item, the setup items displayed in the Setup area are automatically switched.

- Step 3.** Enter or select the setup conditions for the gate of MOSFET in Gate/Base Voltage Pulse Step at the center of Setup area.



Gate / Base Voltage Pulse Step

Step Mode	LinearSingle
Start	0 V
Stop	10 V

Details

- Selecting Step Mode

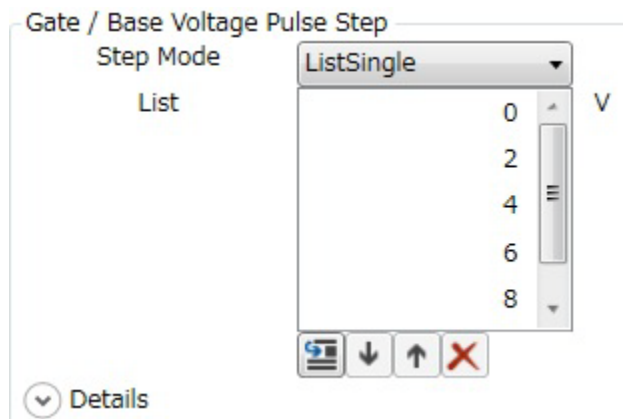
From the Step Mode drop-down list, select a step mode of pulse voltage output.

LinearSingle Outputs voltage level changes from the Start value to the Stop value at equal intervals.

ListSingle Specify the output voltages of each step in the List. Each step voltage in the List will be output in order from top to bottom.

NOTE

This example selects the ListSingle.



Gate / Base Voltage Pulse Step


Step Mode	ListSingle
List	0 V 2 4 6 8

Details



- To change step values

Click the value in the List and you can change it to new value.


- To insert new step value

Select the step value immediately after where you want to insert new step value and click the Insert button .

- To change an output order of step values

Click the Move Down and the Move Up buttons   to move down or up an order of the selected step value.

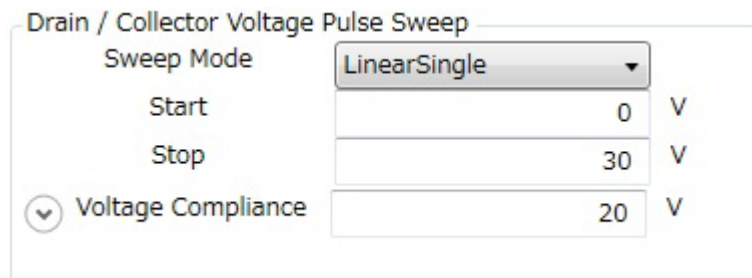
- To delete a step value

Click the Delete button  to delete the selected step value.

By clicking the **Details** chevron, the area expands to set more detail conditions.

For more information on setting items, see “Setup” on page 4-45.

- Step 4.** Enter or select the setup conditions for the drain of MOSFET in Drain/Collector Voltage Pulse Sweep at the right side of Setup area.



Select or specify a sweep mode, a sweep start value, a sweep stop value, and a voltage compliance.

- Sweep Mode

Select a sweep mode from the Sweep Mode drop-down list.

LinearSingle One-way linear sweep from the Start (sweep start value) to the Stop (sweep stop value).

LogSingle One-way logarithmic sweep from the Start (sweep start value) to the Stop (sweep stop value).

LinearDouble Linear-sweep from the Start (sweep start value) to the Stop (sweep stop value) and then return linear-sweep from the Stop to the Start.

How To Perform Measurement

How To Perform I/V Measurement

LogDouble Logarithmic-sweep from the Start (sweep start value) to the Stop (sweep stop value) and then return logarithmic-sweep from the Stop to the Start.

- Start, Stop

Enter the sweep start value in the Start and the sweep stop value in the Stop.

- Voltage Compliance

Enter the voltage compliance value in the Voltage Compliance.

If the output voltage of measurement unit connected to a drain terminal is more than this value, a measurement unit stops the output.

By clicking the **Details** chevron, the area expands to set more detail conditions.

For more information on setting items, see “Setup” on page 4-45.

- Step 5.** Enter the setup conditions for the pulse output in General settings at the left side of Setup area.

General settings

Auto Period

Pulse Period 50 m s

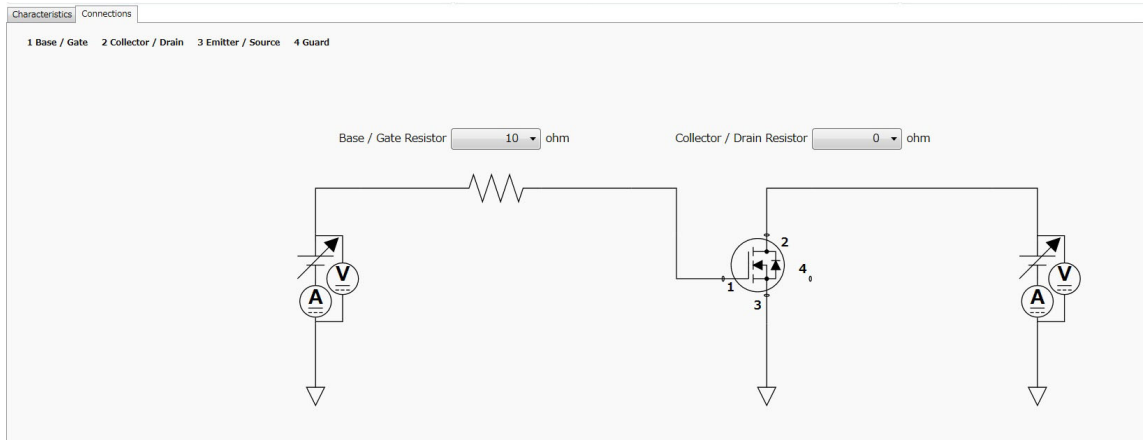
Details

Auto Period Automatic adjustment for the pulse period.
To enable this function, mark the check box.

Pulse Period Pulse period.

However, if the Auto Period function is enabled, the pulse period is automatically adjusted to a minimum period corresponding to the pulse width.

Step 6. Click the Connections tab to display Connections area.



At Connections area, you can confirm a measurement circuit.

Also, you can select a gate resistor/drain resistor that may be effective to suppress a device oscillation during measurement.

- Base/Gate Resistor

You can select a gate resistor from this drop-down list.

A gate resistor may be effective to suppress a device oscillation during large current measurement.

NOTE

You can select a gate resistor only if a measurement resource is MCSMU.

In this example, which selects MOSFET as a device type and ID-VDS as a measurement item, the default measurement resource is MCSMU and you can select a gate resistor.

- Collector/Drain Resistor

You can select a drain resistor from this drop-down list.

A drain resistor may be effective to suppress a over current during a break-down measurement.


NOTE


You can select a drain resistor only if a measurement resource is HVSMU.


How To Perform Measurement

How To Perform I/V Measurement

In this example, which selects MOSFET as a device type and ID-VDS as a measurement item, the default measurement resource is UHCU and a drain resistor is fixed to $0\ \Omega$.

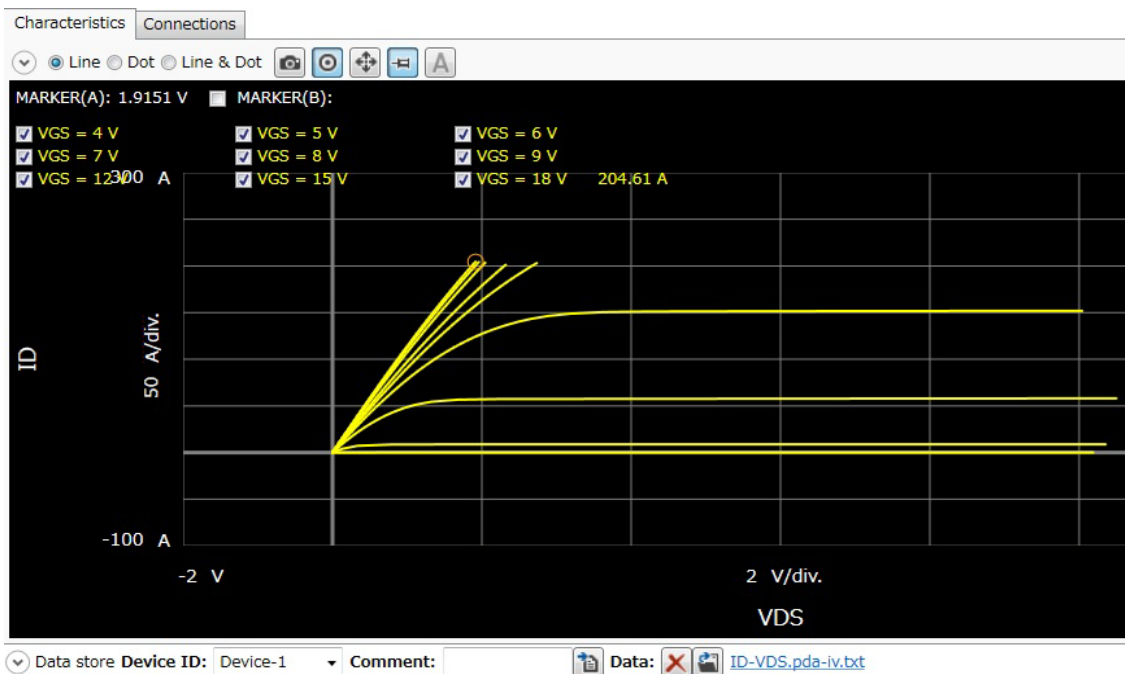
Step 7. Click the Start Measurement tool button  to start a measurement.

Or, click the Repeat Measurement tool button  to repeat a measurement.

After starting a measurement, you can stop a measurement by clicking the Stop Measurement tool button .

Step 8. Click the Characteristics tab to display the Characteristics area.

After a measurement is finished, a measured I/V characteristics curve is displayed on the Characteristics area. This example shows an ID-VDS characteristics curve.



For the operation on the graph display, see “Displaying and Operating Graph” on page 3-51.

Setting Parameter

Table 3-1 Available Device Types and Measurement Items

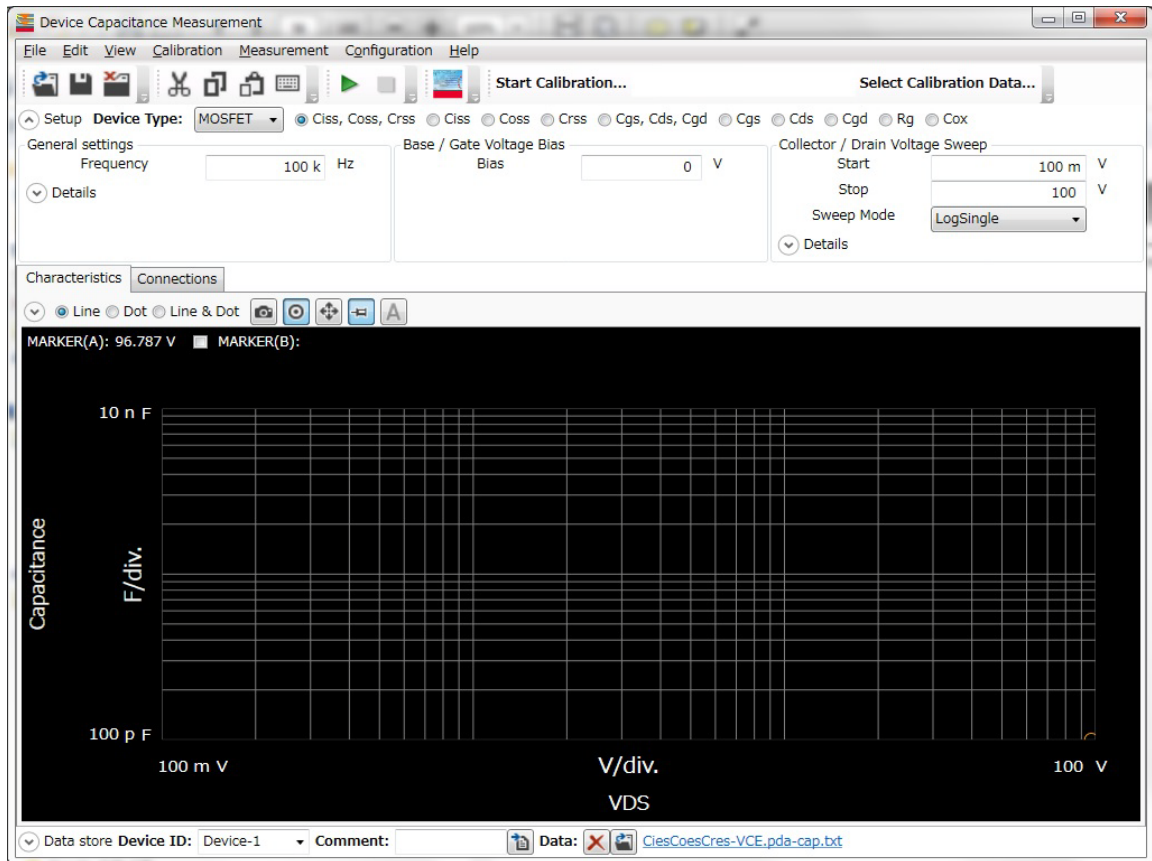
Device Type	Measurement Item	Description
MOSFET	ID-VDS	ID-VDS output characteristics
	ID-VGS	ID-VGS transmission characteristics
	RDS-ID	RDS (Drain to Source resistance) - ID characteristics
	VDS-VGS	VDS-VGS characteristics
	RDS-VGS	RDS (Drain to Source resistance) - VGS characteristics
	IDSS	Drain leak current - VDS characteristics
	IGSS	Gate leak current - VGS characteristics
	IS-VSD	Forward current of body diode - VSD characteristics
IGBT	IC-VCE	IC-VCE output characteristics
	IC-VGE	IC-VGE transmission characteristics
	VCE-VGE	VCE-VGE characteristics
	VCE(sat)	VCE(sat) (Collector to Emitter saturation voltage) - IC characteristics
	ICES	Collector leak current - VCE characteristics
	IGES	Gate leak current - VGE characteristics
Diode	IF-VF	Forward bias current - voltage characteristics
	IR-VR	Reverse bias current - voltage characteristics
Generic		Free setup on the measurement units connection and measurement conditions.

How To Perform Capacitance Measurement

This section describes how to perform a measurement using the capacitance measurement software and consists of the following sub-sections:

- Preparing Measurement
- Executing Measurement
- Setting Parameter

Figure 3-3 Capacitance Measurement Software



Preparing Measurement

WARNING

Set the instrument output off before connecting or disconnecting connection wire.

Press the mainframe front panel Stop key to set the source output off. And confirm that the mainframe front panel High Voltage indicator is not lit.

WARNING

To prevent electrical shock and DUT damage, do not connect or disconnect the DUT while the instrument is applying voltage or current.

When you touch the DUT after measurement, devise a countermeasure of residual charge and heat to prevent electrical shock and burn. Use glove and any tool. Also have enough time for discharge and radiation.

Step 1. Prepare the test fixture and other accessories to connect your device under test (DUT).

For more information on the test fixture and its accessories, see the following sections:

- “To Connect Test Fixture” on page 2-11
- “3-pin Inline Package Socket Module” on page 2-18
- “Accessories for Connecting a DUT” on page 2-22

Step 2. Connect the test fixture and, 3-pin inline package socket module or other accessories that is adequate for your DUT.

For more information, see the following sections:

- “To Connect Test Fixture” on page 2-11
- “3-pin Inline Package Socket Module” on page 2-18
- “Accessories for Connecting a DUT” on page 2-22

Step 3. Turn the instrument on.
Don't connect your DUT to the test fixture at this time.

NOTE


If you would like to monitor/control temperature during measurement, perform the required connection and operation. For more information, see “How To Monitor/Control Temperature Under Measurement” on page 3-45.

Executing Measurement

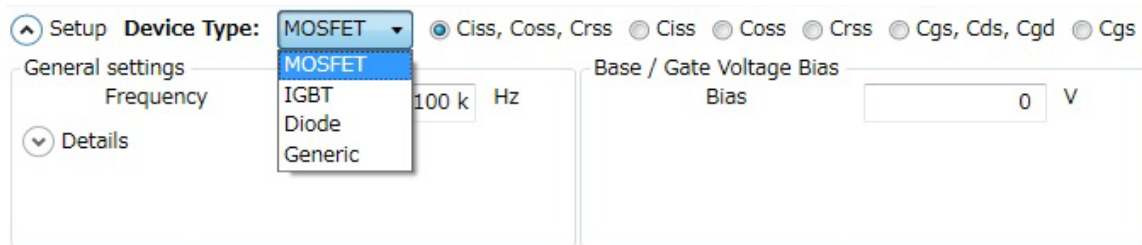
NOTE

This section explains the procedure using an example that selects MOSFET as a device type of DUT and Ciss, Coss, Crss as a measurement item.

Execute a measurement as follows:

Step 1. On the software palette, click the Capacitance Measurement icon . The Capacitance Measurement software (Figure 3-3) opens.

Step 2. At the Setup area in work area, select a device type of your DUT and a measurement item to be measured.



- Device Type

Select a device type from the Device Type drop-down list.

NOTE

This example selects MOSFET.

- Measurement Item

From the radio buttons located on the right of a Device Type selection, which is MOSFET in this example, select a measurement item to be measured.

NOTE

This example selects Ciss, Coss, Crss.

NOTE

For information on the available device types and measurement items, see Table 3-2 on page 3-27

By selecting a device type and measurement item, the setup items displayed in the Setup area are automatically switched.

Step 3. Enter the measurement frequency in the Frequency of General settings located at the left part of Setup area.



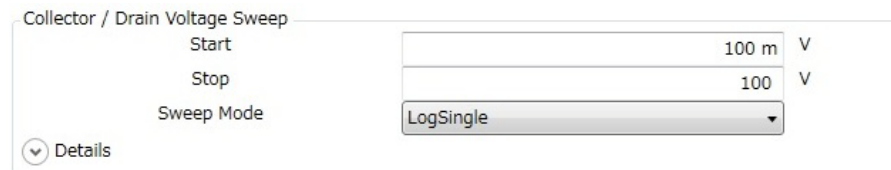
By clicking the **Details** chevron, the area expands to set more detail conditions.

For more information on setting items, see “Setup” on page 4-77.

Step 4. Enter the bias voltage value in the Bias of Base/Gate Voltage Bias at the center of Setup area.



Step 5. Enter or select the voltage sweep conditions in the Collector/Drain Voltage Sweep at the right of Setup area.



Start Enter a start voltage value of sweep.

Stop Enter a stop voltage value of sweep.

Sweep Mode Select a sweep mode.

LinearSingle One-way linear sweep from the Start to the Stop.

LogSingle One-way logarithmic sweep from the Start to the Stop.

LinearDouble Linear-sweep from the Start to the Stop and then return linear-sweep from the Stop to the Start.

LogDouble Logarithmic-sweep from the Start to the Stop and then return logarithmic-sweep from the Stop to the Start.

By clicking the **Details** chevron, the area expands to set more detail conditions.

How To Perform Measurement


How To Perform Capacitance Measurement


For more information on setting items, see “Setup” on page 4-77.

- Step 6.** Click the Start Calibration... button in the toolbar to measure the calibration data of measurement path.

Follow the instruction displayed on the dialog to measure the open and short calibration data.

If you have measured and saved the calibration data of measurement path, click the Select Calibration Data... button in the toolbar to select and load the stored calibration data.

- Step 7.** Set your DUT on the test fixture and click the Start Measurement button  to start a measurement.

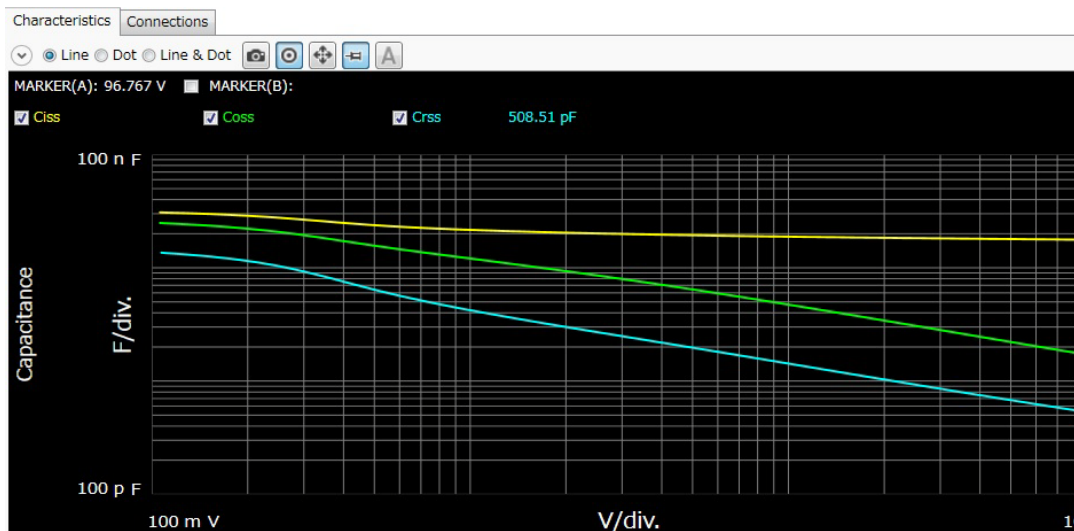
You can stop the measurement by clicking the Stop Measurement button  during a measurement execution.

NOTE

If your DUT is diode, connect the cathode of your DUT to the Collector/Drain terminal of the test fixture and the anode of your DUT to the Emitter/Source terminal of the test fixture.

- Step 8.** Click the Characteristics tab to display the Characteristics area.

After a measurement is finished, a measured capacitance characteristics curve is displayed on the Characteristics area. This example shows the Ciss, Coss, and Crss, characteristics curves.



For the operation on the graph display, see “Displaying and Operating Graph” on page 3-51.

Setting Parameters

Table 3-2 Available Device Types and Measurement Items

Device Type	Measurement Item	Description
MOSFET	Ciss	Ciss (Input capacitance) - Vds characteristics
	Coss	Coss (Output capacitance) - Vds characteristics
	Crss	Crss (Feedback capacitance) - Vds characteristics
	Ciss, Coss, Crss	Ciss, Coss, and Crss characteristics
	Cgs	Cgs (Gate to Source capacitance) - Vds characteristics
	Cds	Cds (Drain to Source capacitance) - Vds characteristics
	Cgd	Cgd (Gate to Drain capacitance) - Vds characteristics
	Cgs, Cds, Cgd	Cgs, Cds, and Cgd characteristics
	Rg	Rg (Gate resistance) - Vgs characteristics
	Cox	Cox (Gate oxide film capacitance) - Vgs characteristics
IGBT	Cies	Cies (Input capacitance) - Vce characteristics
	Coēs	Coēs (Output capacitance) - Vce characteristics
	Cres	Cres (Feedback capacitance) - Vce characteristics
	Cies, Coēs, Cres	Cies, Coēs, and Cres characteristics
	Cge	Cge (Gate to Emitter capacitance) - Vce characteristics
	Cce	Cce (Collector to Emitter capacitance) - Vce characteristics
	Cgc	Cgc (Gate to Collector capacitance) - Vce characteristics
	Cge, Cce, Cgc	Cge, Cce, and Cgc characteristics
	Rg	Rg (Gate resistance) - Vge characteristics

How To Perform Measurement
How To Perform Capacitance Measurement

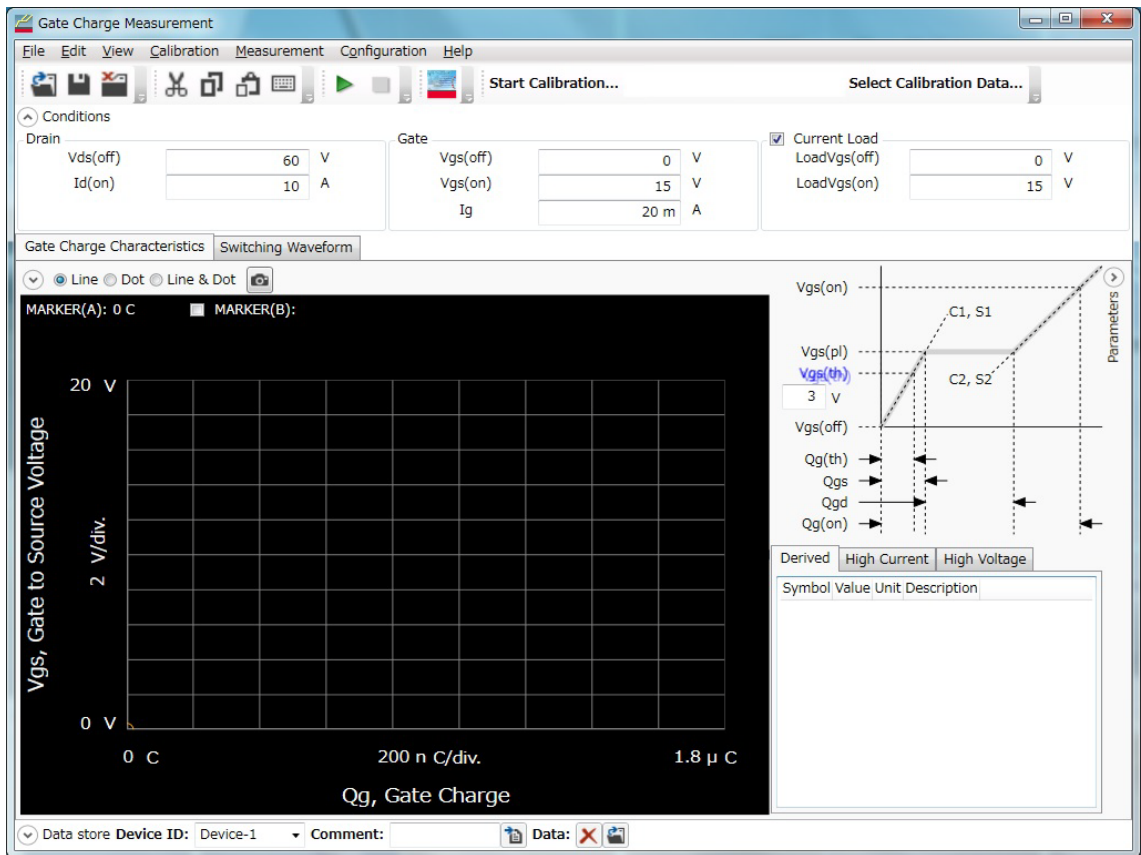
Device Type	Measurement Item	Description
Diode	CT	Total capacitance at reverse bias to bias voltage characteristics
Generic	Collector/Drain Voltage Sweep	Cp-G model capacitance between Collector/Drain terminal and Emitter/Source terminal to Vce/Vds characteristics
	Base/Gate Voltage Sweep	Cs-Rs model capacitance between Base/Gate terminal and Emitter/Source terminal to Vbe/Vgs characteristics

How To Perform Gate Charge Measurement

This section describes how to perform a measurement using the gate charge measurement software and consists of the following sub-sections:

- Preparing Measurement
- Executing Measurement

Figure 3-4 Gate Charge Measurement Software



Preparing Measurement

WARNING

Set the instrument output off before connecting or disconnecting connection wire.

Press the mainframe front panel Stop key to set the source output off. And confirm that the mainframe front panel High Voltage indicator is not lit.

WARNING

To prevent electrical shock and DUT damage, do not connect or disconnect the DUT while the instrument is applying voltage or current.

When you touch the DUT after measurement, devise a countermeasure of residual charge and heat to prevent electrical shock and burn. Use glove and any tool. Also have enough time for discharge and radiation.

Step 1. Connect the test fixture and the gate charge socket adapter.

For more information, see the following sections:

- “To Connect Test Fixture” on page 2-11
- “Gate Charge Socket Adapter” on page 2-19

Step 2. Turn the instrument on.
Don’t connect your DUT to the test fixture at this time.

NOTE


If you would like to monitor/control temperature during measurement, perform the required connection and operation. For more information, see “How To Monitor/Control Temperature Under Measurement” on page 3-45.

Executing Measurement

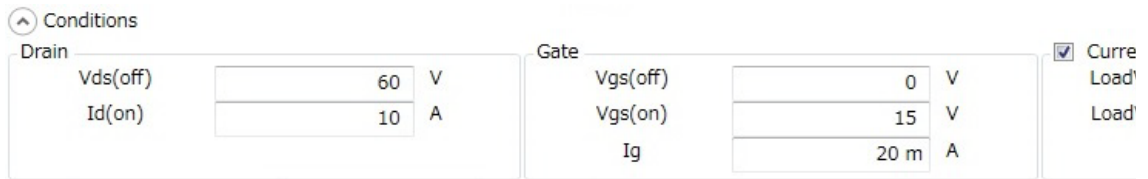
NOTE

This section explains the procedure using an example that selects MOSFET as a device type of DUT and Ciss, Coss, Crss as a measurement item.

Execute a measurement as follows:

Step 1. On the software palette, click the Gate Charge Measurement icon . The Gate Charge Measurement software (Figure 3-4) opens.

Step 2. Enter the measurement conditions at the Condition area.



Drain		Gate		Current Load
Vds(off)	60 V	Vgs(off)	0 V	<input checked="" type="checkbox"/>
Id(on)	10 A	Vgs(on)	15 V	<input type="checkbox"/>
		Ig	20 m A	<input type="checkbox"/>

Drain

Specify the drive conditions for the drain of DUT.

- Vds(off)

Enter the voltage to force between drain and source of DUT at the off-state.

- Id(on)

Enter the drain current to force to DUT at the on-state if the constant current load (Current Load) is used.

If the constant current load is not used, the drain current at the on-state is determined by the Vds(off), the resistance of resistive load, and the on-state resistance/saturation voltage. For the current output range of measurement resource, the minimum range that includes Id(on) is automatically selected.

Gate

Specify the gate drive conditions of DUT.

- Vgs(off)

Enter the gate-source voltage that turns the DUT to the off-state.

- Vgs(on)

How To Perform Measurement

How To Perform Gate Charge Measurement

Enter the gate-source voltage that turns the DUT to the complete on-state.

- I_g

Enter the limit value of gate current.

This setting effects the switching time. The larger limit causes the shorter switching time and the smaller limit causes the longer switching time.

Current Load Mark the check box if the constant current load is used.

0	V	<input checked="" type="checkbox"/> Current Load		
15	V	LoadVgs(off)	0	V
20 m	A	LoadVgs(on)	15	V

Specify the gate drive conditions of the constant current load transistor so that the constant current load transistor forces the current as same as $I_d(\text{on})$ specified in the Drain.

If you don't use the constant current load but use the resistive load, unmark the Current Load check box.

- LoadVgs(off)

Enter the gate-source voltage that turns the constant current load transistor to the off-state.


- LoadVgs(on)


Enter the gate-source voltage that turns the constant current load transistor to the complete on-state.

Step 3. Click the Start Calibration... button in the toolbar to measure the calibration data of measurement path.

Follow the instruction displayed on the dialog to measure the open and short calibration data.

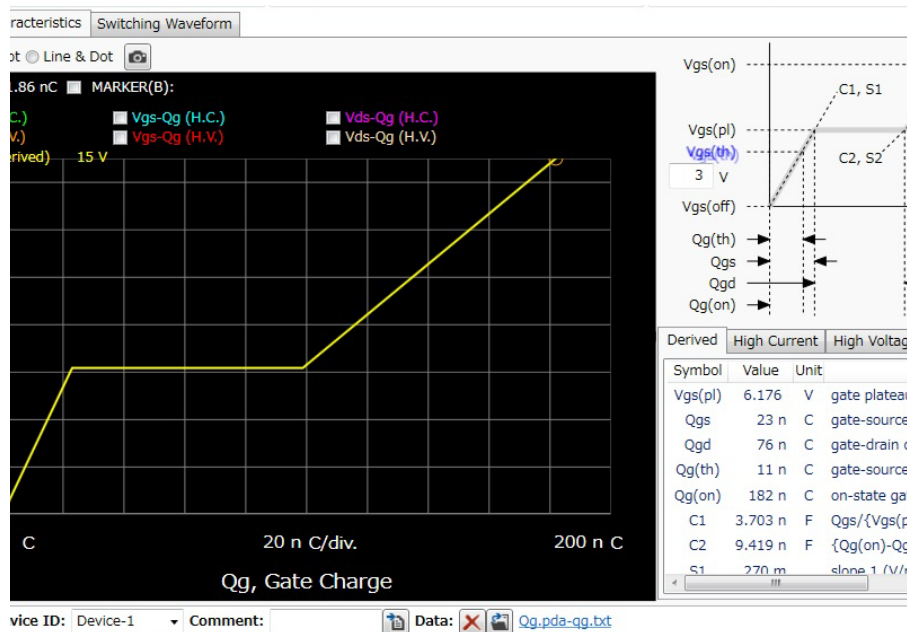
If you have measured and saved the calibration data of measurement path, click the Select Calibration Data... button in the toolbar to select and load the stored calibration data.

Step 4. Set your DUT on the test fixture and click the Start Measurement button  to start a measurement.

You can stop the measurement by clicking the Stop Measurement button  during a measurement execution.

Step 5. Click the Gate Charge Characteristics tab to display the Gate Charge Characteristics area.

After a measurement is finished, a measured gate charge characteristics curve and extracted parameters are displayed on the Gate Charge Characteristics area.



The left side shows the measured gate charge characteristics curve and the right side shows the extracted parameters.

Step 6. Displaying the gate charge characteristics curve

- To select the gate charge characteristics curve to be displayed

Mark the check box corresponding to the gate charge characteristics to display the characteristics curve.

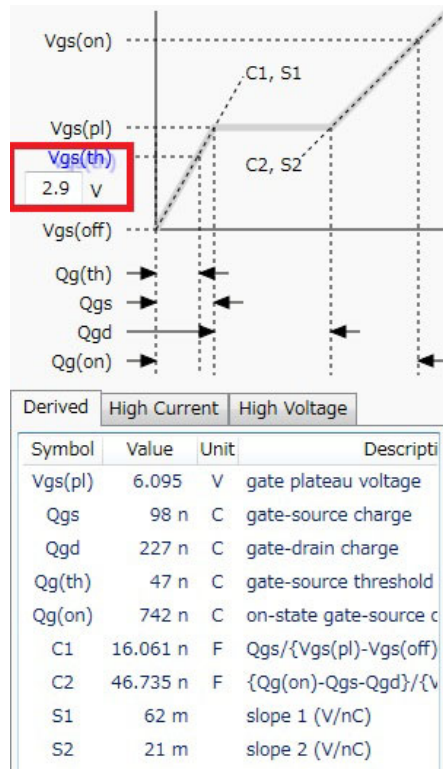
You can select the multiple gate charge characteristics.

How To Perform Measurement
 How To Perform Gate Charge Measurement

JESD24-2 (Derived)	Shows the approximation straight line of gate charge characteristics that measured under conditions of $V_{ds(off)}$ and $I_{g(on)}$ specified in “Drain”.
V_{gs}-Q_g (H.C.)	Shows the gate charge characteristics that measured under the condition of $I_{d(on)}$ specified in “Drain”.
V_{gs}-Q_g (H.V.)	Shows the gate charge characteristics that measured under the condition of $V_{ds(off)}$ specified in “Drain”.
JESD24-2 (H.C.)	Shows the approximation straight line of V _{gs} -Q _g (H.C.) gate charge characteristics. The approximation is calculated on sloops (S_1 , S_2 , and S_3) defined in JEDEC Standard JESD24-2.
JESD24-2 (H.V.)	Shows the approximation straight line of V _{gs} -Q _g (H.V.) gate charge characteristics. The approximation is calculated on sloops (S_1 , S_2 , and S_3) defined in JEDEC Standard JESD24-2.
V_{ds}-Q_g (H.C.)	Shows the relationship between the drain-source voltage and gate charge when the V _{gs} -Q _g (H.C.) is measured.
V_{ds}-Q_g (H.V.)	Shows the relationship between the drain-source voltage and gate charge when the V _{gs} -Q _g (H.V.) is measured.

By the radio buttons at the bottom of graph, you can select the line type of characteristics curve from Line, Dot, or (Line & Dot).

- Extracted Parameter Display



Enter the threshold voltage of DUT in the Vgs(th) at the upper of parameter display area.

The gate charge parameter values that extracted from the specified threshold voltage Vgs(th), and JESD24-2(Derived), JESD24-2(H.C.), and JESD24-2(H.V) are displayed in this area.

To show the gate charge parameters from JESD24-2(Derived), click the Derived tab.

To show the gate charge parameters from JESD24-2(H.C.), click the High Current tab.

To show the gate charge parameters from JESD24-2(H.V.), click the High Voltage tab.

The following gate charge parameters are displayed:

Vgs(pl) Gate plateau voltage

How To Perform Measurement

How To Perform Gate Charge Measurement

Qgs	Gate - source charge Gate charge for slope S_1 defined in JEDEC Standard JESD24-2.
Qgd	Gate - drain charge Gate charge for slope S_3 defined in JEDEC Standard JESD24-2.
Qg(th)	Gate-source charge at threshold Gate charge from $V_{gs(off)}$ to $V_{gs(th)}$.
Qg(on)	Gate-source charge in on-state Gate charge from $V_{gs(off)}$ to $V_{gs(on)}$.
C1	$Q_{gs} / \{V_{gs(pl)} - V_{gs(off)}\}$. Equivalent capacitance for slope S_1 defined in JEDEC Standard JESD24-2
C2	$\{Q_{gs(on)} - Q_{gs} - Q_{gd}\} / \{V_{gs(on)} - V_{gs(pl)}\}$. Equivalent capacitance for slope S_2 defined in JEDEC Standard JESD24-2.
S1	Slope S_1 defined in JEDEC Standard JESD24-2
S2	Slope S_2 defined in JEDEC Standard JESD24-2

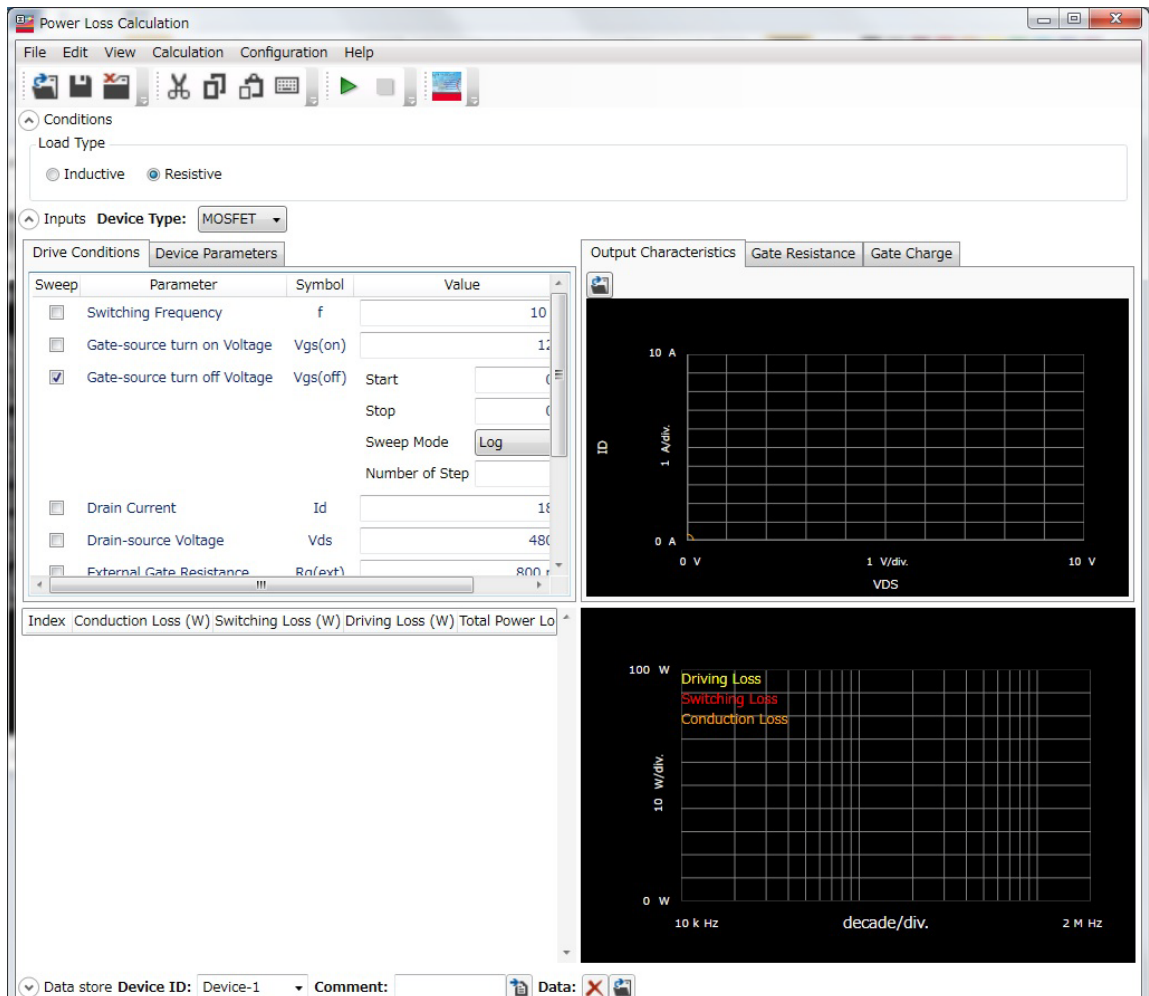
For more information on the operation for graph display, see “Displaying and Operating Graph” on page 3-51.

How To Calculate Power Loss

This section describes how to calculate the power loss at a switching device using the power loss calculation software and consists of the following sub-sections:

- Calculating Power Loss
- Extracted Parameters By Power Loss Calculation

Figure 3-5 Power Loss Calculation Software



How To Perform Measurement

How To Calculate Power Loss

The power loss calculation software calculates the power loss from the drive conditions and the device characteristics parameters of DUT.

There are the following two ways to specify the parameters for calculation:

- Specify the parameter values from the datasheet of DUT.
If you want to calculate the power loss of DUT at the different drive conditions or there are the parameters that are not specified in the datasheet, you may specify the predicted values.
- Measure the switching device by the I/V measurement software, capacitance measurement software, and gate charge measurement software at your desired drive conditions and store the measurement data. Then, the power loss calculation software read the stored measurement data and extract the required drive conditions and characteristics parameters for power loss calculation.

This section explains the procedure that specify the measurement data file of DUT.

Calculating Power Loss


Step 1. Prepare the measurement data

The power loss calculation software uses the following measurement data files to calculate the power loss. So, measure the DUT at your desired drive conditions and save the measured data.

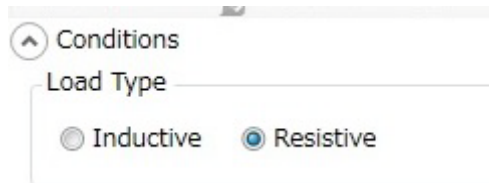
- Measurement data file of I/V measurement software
Prepare a measurement data file that measured either one of the following measurement item.
 - ID-VDS
 - RDS-ID
 - VDS-VGS
 - RDS-VGS
- Measurement data file of capacitance measurement software
Prepare the measurement data files that measured the following measurement items.
 - Rg
 - Crss

- Measurement data file of gate charge measurement software

Prepare a measurement data file that measured any measurement item.

Step 2. On the software palette, click the Power Loss Calculation icon . The Power Loss Calculation software (Figure 3-5) opens.

Step 3. Select the assumed load type to calculate the power loss in the Conditions area on the work area.



Inductive Inductive load

Resistive Resistive load


Step 4. Specify the measurement data files to be used for power loss calculation and load them.



1. Specify the measurement data file of the I/V measurement software to load.
 - a. Click the Output Characteristics tab at the right of work area to display the Output Characteristics area.

How To Perform Measurement

How To Calculate Power Loss


- b. Click the Load Measurement Data button  at the upper-left corner of the Output Characteristics area.

After the dialog box opens, specify the measurement data of I/V measurement software.

The characteristics graph of the loaded measurement item is displayed.

2. Specify the Rg measurement data file of the capacitance measurement software to load.

- a. Click the Gate Resistance tab to display the Gate Resistance area.


- b. Click the Load Measurement Data button  at the upper-left corner of the Gate Resistance area.

After the dialog box opens, specify the Rg measurement data of capacitance measurement software.

The loaded Rg characteristics graph is displayed.

3. Specify the Crss measurement data file of the capacitance measurement software to load.

- a. Click the Reverse Transfer Capacitance tab to display the Revers Transfer Capacitance area.


- b. Click the Load Measurement Data button  at the upper-left corner of the Reverse Transfer Capacitance area.

After the dialog box opens, specify the Crss measurement data of capacitance measurement software.

The loaded Crss characteristics graph is displayed.

4. Specify the measurement data file of the gate charge measurement software to load.

- a. Click the Gate Charge tab to display the Gate Charge area.

- b. Click the Load Measurement Data button  at the upper-left corner of the Gate Charge area.

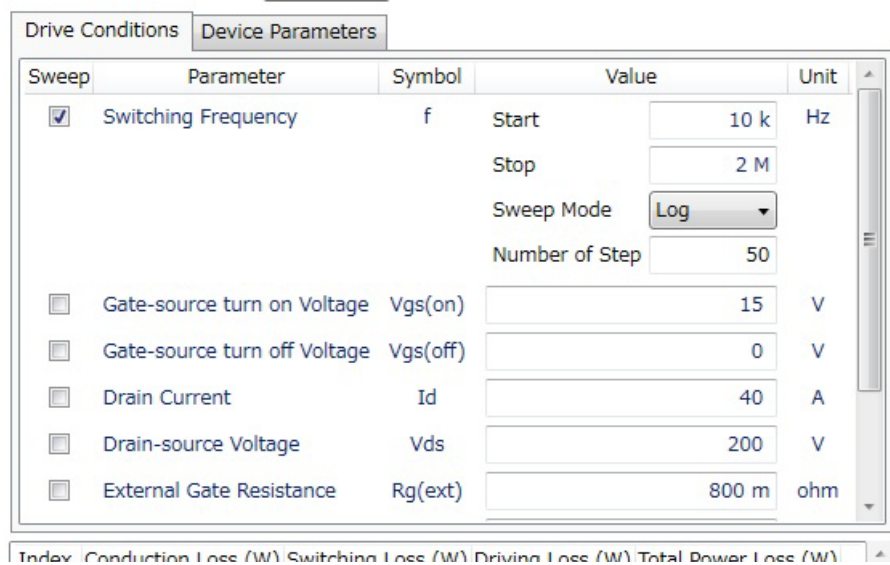
After the dialog box opens, specify the measurement data of gate charge measurement software.

The gate charge characteristics graph of the loaded measurement item is displayed.

For the drive conditions and the device parameters for power loss calculation that extracted from the loaded measurement data, see “Measurement Data and Extracted Drive Conditions and Device Parameters for Power Loss Calculation” on page 44”.

You can confirm or change the drive conditions for power loss calculation by clicking the Drive Conditions tab at the left of work area.

Also, you can confirm or change the device parameters for power loss calculation by clicking the Device Parameters tab.



Step 5. Select a drive condition or device parameter to be swept and specify the sweep condition.

If you select a drive condition parameter to be swept, click the Drive Condition tab and mark the check box of the desired drive parameter.

If you select a device parameter to be swept, click the Device Parameters tab and mark the check box of the desired device parameter.

This example select a switching frequency to be swept.

1. Click the Drive Conditions tab and mark the check box of the Switching Frequency parameter to select.
2. Specify the sweep condition in the Value column.

Start Sweep start value

How To Perform Measurement
How To Calculate Power Loss

Stop	Sweep stop value
Sweep Mode	Sweep mode Log (logarithmic sweep) or Linear (linear sweep)
Number of Step	Number of sweep steps

Step 6. Specify the drive conditions that are not extracted from the loaded measurement data.

1. Click the Drive Conditions tab at the left of work area to display the Drive Conditions area.
2. Specify the following drive conditions that are not extracted from the measurement data.


Switching Frequency Switching frequency
In this example, this parameter already specified by Step.4.

Rg(ext) Gate input resistance in the external drive circuit

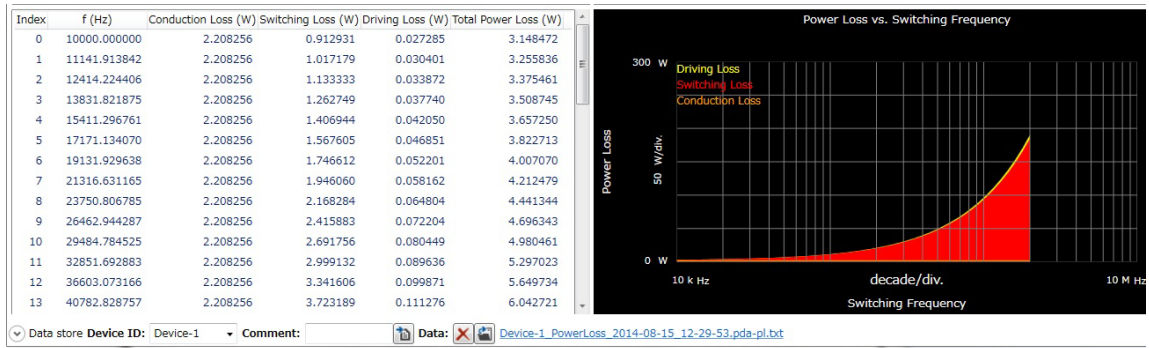
Irms, D Irms: Effective drain current (the root mean square of the load current)
D: Duty cycle.

Specify Irms or D.

The relation between Irms and D is $I_{rms} = I_d \times D$.

Step 7. Click the Start button  of toolbar to start the power loss calculation.

Step 8. After the calculation is completed, the list of calculated values are displayed at the left of the Results area and the trend chart of swept parameter and calculated values are displayed at the right of the Results area.



- List

The following calculated data are displayed in list format.

Index	Index number of sweep step.
Sweep Parameter	Sweep parameter and its step values.
Conduction Loss	Calculated conduction loss
Switching Loss	Calculated switching loss
Driving Loss	Calculated driving loss
Total Power Loss	Sum total of the conduction loss, switching loss, and driving loss.

For the calculation formula for each power loss, see “Results” on page 4-132.

- Trend Chart

The sweep parameter is assigned to X-axis, and the conduction loss, switching loss, and driving loss are assigned to Y-axis and accumulated in this order.

You can change the minimum and maximum values on the X and Y-axes by clicking the value.

Extracted Parameters By Power Loss Calculation

Table 3-3

Measurement Data and Extracted Drive Conditions and Device Parameters for Power Loss Calculation

Measurement Data		Extracted Drive Conditions	Extracted Device Parameters
Measurement Software	Measurement Item		
I/V Measurement	ID-VDS, RDS-ID, RDS-VGS, or VDS-VGS		Rds(on) ^a
Capacitance Measurement	Rg		Rg ^b
	Crss		Qsw ^c
Gate Charge Measurement	Any measurement items	Vgs(on), Vgs(off), Id, Vds	Qg(on), Qg(off), Qsw, Vgs(pl)

- a. Extracted from Vgs(on)
- b. Extracted from Vgs(off)
- c. Extracted from Vgs(off) and Vds(off)

How To Monitor/Control Temperature Under Measurement

The thermal monitor/control software provides the following functions:

- Thermal monitor using the thermocouple
- Thermal control using the inTEST ThermoStream
- Synchronized measurement execution with the thermal conditions

These functions enable the automated measurement execution under the multiple temperature conditions.

This section describes how to monitor the temperature and execute the measurement synchronized with the specified thermal conditions using the thermal monitor/control software and consists of the following sub-sections:

- Preparing the Measurement
- Thermal Monitor/Control During Measurement

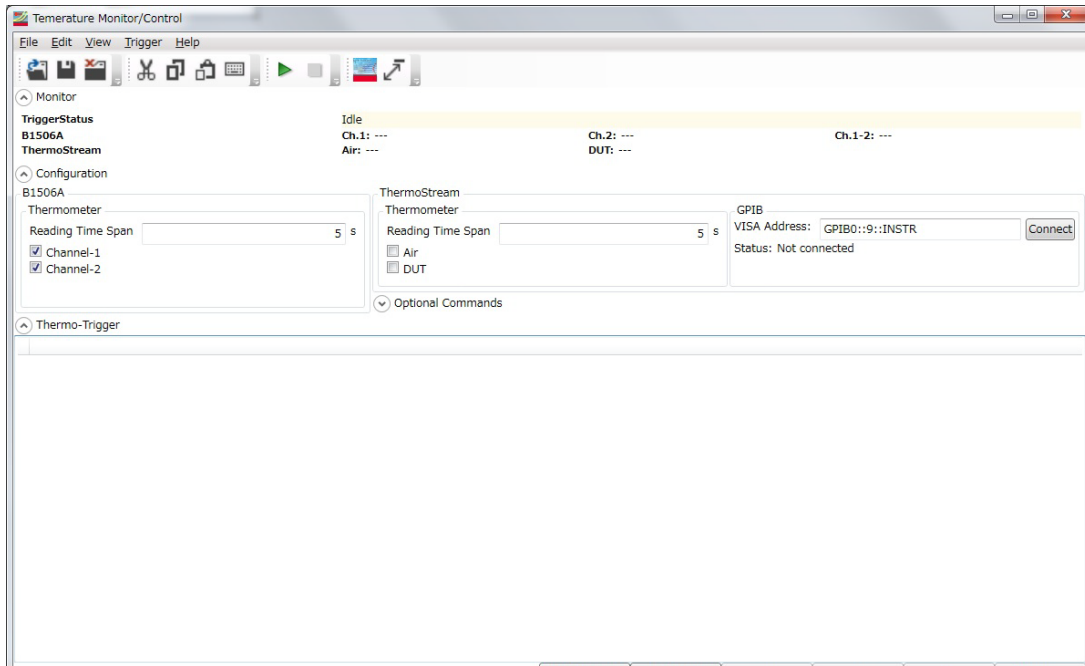
NOTE

This section uses the example that monitors the temperature of DUT controlled by thermal plate and executes the measurement synchronized with the thermal conditions.

How To Perform Measurement

How To Monitor/Control Temperature Under Measurement

Figure 3-6 Thermal Monitor/Control Software



Preparing the Measurement

Step 1. Setup the connections of test fixture, thermal plate, thermocouple, DUT.


For the detail information on connection, see:

- “Accessories for Connecting a DUT” on page 2-22
- “Thermocouple” on page 2-24
- “Thermal Plate” on page 2-24

Step 2. Turn the instrument on.

Thermal Monitor/Control During Measurement

Step 1. Datasheet Characterization icon . The Datasheet Characteristics software (Figure 3-1) opens.

On the software palette, click the Thermal Monitor/Control icon . The Thermal Monitor/Control software (Figure 3-6) opens.

- Step 2.** Specify the conditions of thermal monitor at the Thermometer of Configuration area in the work area.

This example uses the thermocouple connected to the B1506A to monitor the temperature, so specify at the Thermometer of B1506A.

Reading Time Span	Thermal reading interval
Channel 1	Mark the check box if you would like to enable the thermal monitor for the thermocouple connected to the channel 1 of K Thermocouple terminal on the test fixture.
Channel 2	Mark the check box if you would like to enable the thermal monitor for the thermocouple connected to the channel 2 of K Thermocouple terminal on the test fixture is enabled.

- Step 3.** Specify the conditions of thermo-trigger function

The thermo-trigger function executes the thermo-trigger list, which consists of the steps for watching on establishment of thermal condition and the steps for thermal control, sequentially.

If the thermo-trigger function is under execution, the measurement application waits the establishment of thermal condition and then executes the measurement.

This example set the following thermo-trigger steps:

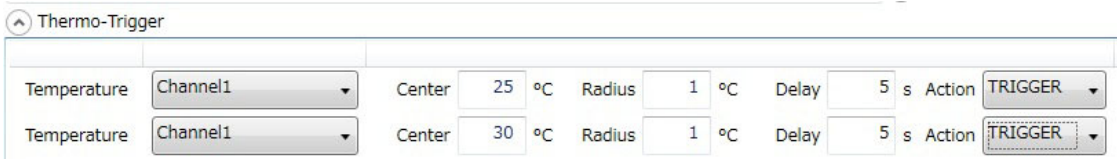
- a. Wait until the temperature of the B1506A thermometer channel 1 is (25 ± 1) °C.
If the thermal condition is established, wait for 5 seconds and then output the measurement trigger to the measurement software.

Wait for the measurement completion by the measurement software.
If the measurement is completed, proceed to the next thermo-trigger step.
- b. Wait until the temperature of the B1506A thermometer channel 1 is (30 ± 1) °C.
If the thermal condition is established, wait for 5 seconds and then output the measurement trigger to the measurement software.

Wait for the measurement completion by the measurement software.
If the measurement is completed, proceed to the next thermo-trigger step.
- c. End of the thermo-trigger step.

How To Perform Measurement
How To Monitor/Control Temperature Under Measurement

Example of Thermo-trigger Steps



1. Click the Insert Control button at the bottom of the window.
2. The line for a thermo-trigger step is inserted in the Thermo-Trigger. Specify the condition.



- a. Select the target temperature by the drop-down list of second column.

This example selects the Channel1.

You can select the followings by this drop-down list:

Channel1	The temperature monitored by B1506A thermometer channel 1
Channel2	The temperature monitored by B1506A thermometer channel 2
Channel1_2	Differences between the temperature monitored by B1506A thermometer channel 1 and channel 2 (Channel 1 - Channel 2)
ThermoStream Air	The temperature of air blowing from the ThermoStream (When using the ThermoStream)
ThermoStream DUT	The temperature monitored by the DUT thermometer of ThermoStream (When using the ThermoStream)

- b. Specify the thermal condition.

Center	Center value of thermal condition. This example specified as 25.
Radius	Allowable range from the center value for the thermal condition. This example specifies as 1.
Delay	Delay time after establishment of thermal condition to execute the specified action. This example specifies as 5 (s).

- c. Selects the action after establishment of thermal condition from the Action drop-down list.

This example selects the TRIGGER, which outputs the measurement trigger.


You can select the following actions by this drop-down list:

TRIGGER	Outputs the measurement trigger.
NOP	Does nothing and proceed to the next step.
END	Terminates the thermo-trigger list execution.


3. Click the Duplicate button at the bottom of the window to copy the line of thermo-trigger step and add the copied line to the Thermo-Trigger.
4. Specify the thermal condition of the copied thermo-trigger line.
This example changes the condition of Center to 30 °C.

- Step 4.** Opens the measurement software that will synchronized with the thermo-trigger function and setup the measurement condition on it.

After the measurement setup is completed, leave the software to be opened.

- Step 5.** Click the Start button  of the menu bar on the thermal monitor/control software to start the thermo-trigger function.

The thermal monitor/control software execute the first thermo-trigger step and waits for the establishment of thermal condition.

- Step 6.** Click the Start button  of the menu bar on the measurement software to start the measurement.

The measurement software waits for the measurement trigger from the thermal monitor/control software.

How To Perform Measurement

How To Monitor/Control Temperature Under Measurement

Step 7. Control the thermal plate so that the temperature is (25 ± 1) °C, which is the first thermal condition.

If the thermal condition is established, the thermal monitor/control software outputs the measurement trigger to the measurement software.

After receiving the measurement trigger, the measurement software starts the measurement.

Step 8. When the measurement is finished, the measurement software outputs the signal of the measurement completion to the thermal monitor/control software.
And then, the measurement software waits for the next measurement trigger from the thermal monitor/control software.

When the thermal monitor/control software receives the signals of measurement completion, the thermal monitor/control software executes the next thermo-trigger step and waits for the establishment of thermal condition.

Step 9. Control the thermal plate so that the temperature is (30 ± 1) °C, which is the next thermal condition.

If the thermal condition is established, the thermal monitor/control software outputs the measurement trigger to the measurement software.

After receiving the measurement trigger, the measurement software starts the measurement under the different thermal condition.

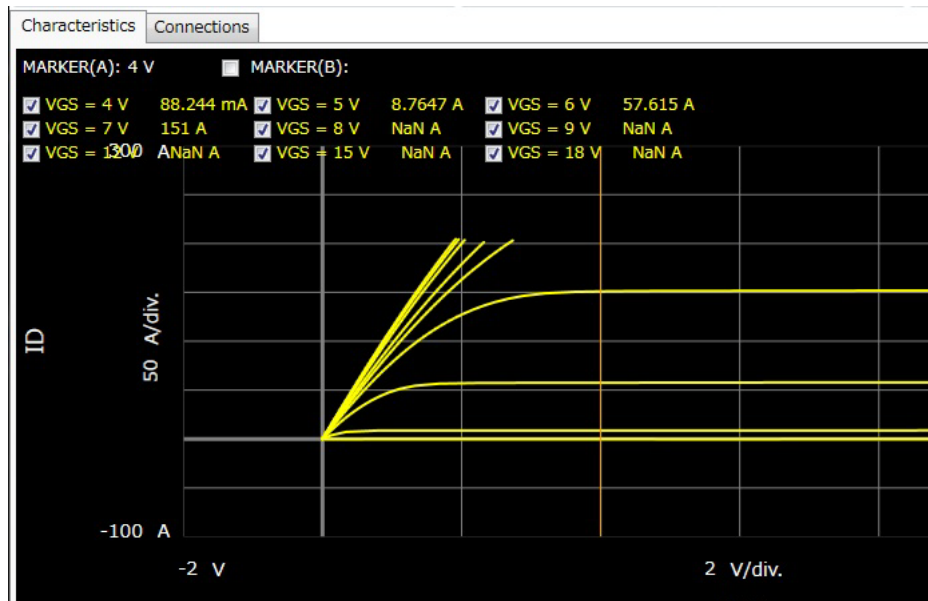
Displaying and Operating Graph

This section describes the common graph operation within the measurement softwares and consists of the followings:

- How To Select and Display Characteristics Curve
- How To Use the Marker

How To Select and Display Characteristics Curve

Step 1. Select the characteristics curves to display.

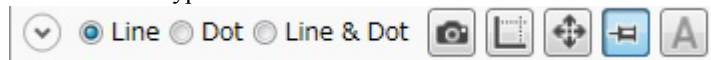


The check boxes for the available characteristics are displayed at the upper left on the graph area.

Mark the check boxes for the desired characteristics to display.

You can select the multiple characteristics to display.


Step 2. Select the line type of curve.





How To Perform Measurement Displaying and Operating Graph

By the radio buttons at the top of graph area, you can select the line type of curve from the Line, Dot, or Line&Dot.

Step 3. Change the minimum and maximum values of X and Y-axes

If the auto scale mode button  is selected, the X and Y-axes of the graph are automatically changing to fit the measured data during measurement execution.

If the fixed scale mode button  is selected and the auto-scale button  is clicked, the X and Y-axes of the graph are changed to fit the measured data.

Or, you can change the minimum and maximum values of X and Y-axes by clicking the value.



How To Use the Marker

You can use the domain marker and/or trace marker to read the value on the curve.

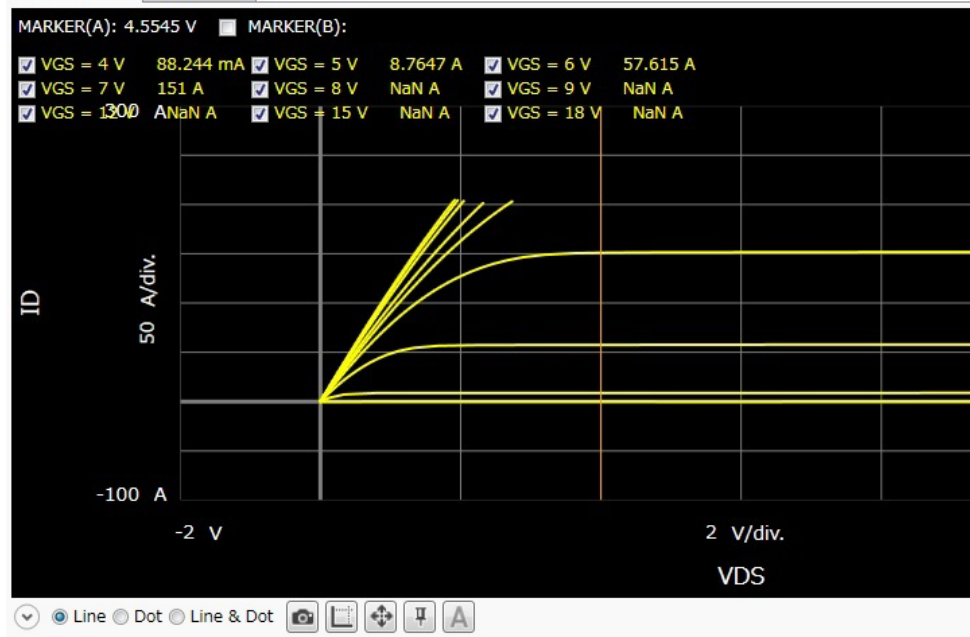
The following table shows the measurement softwares and their furnished marker function.

Marker	Description	Applied Software
Domain Marker	Vertical line marker. The marker moves in the direction of X and you can read the X-axis value of the marker and Y-axis values of the intersections of marker and characteristics curves.	I/V measurement, Capacitance measurement, Gate charge measurement
Trace Marker	Circle marker. The marker moves on a characteristics curve and you can read the X and Y-axis values of the marker.	I/V measurement, Capacitance measurement,

Using the domain marker

Step 1. If the trace marker is displayed, click the trace marker mode button  to change to the domain marker mode .

Step 2. Marker A (Vertical line) is displayed.

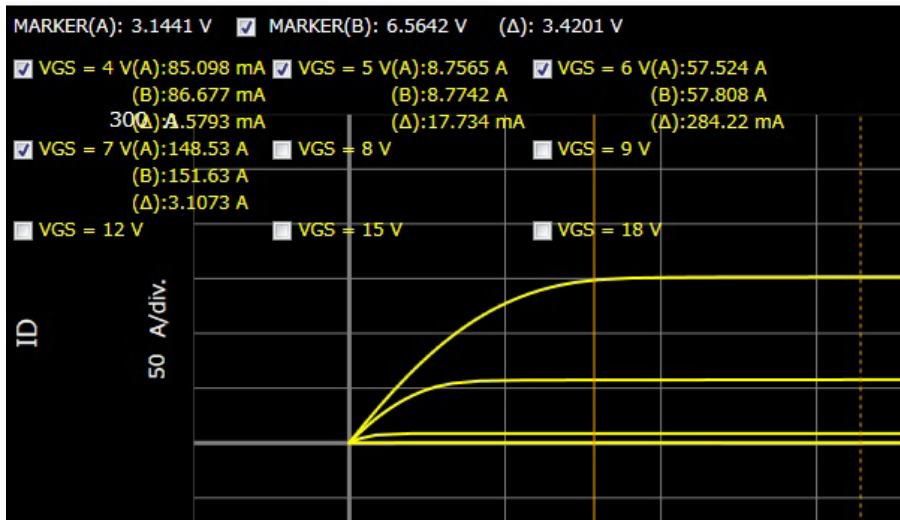


To move the marker, use the rotary knob or mouse.

The **MARKER(A)**: at the upper left of graph area shows the X-axis value of marker A and the Y-axis value of the intersection of the marker and each characteristics curve is displayed at the right of characteristics curve name.

How To Perform Measurement Displaying and Operating Graph

- Step 3.** If the check box at the left of the **MARKER(B)**: is marked, the marker B (vertical dot line) is displayed.





The following information is displayed at the top of graph area:

MARKER(B): X-axis value of marker B

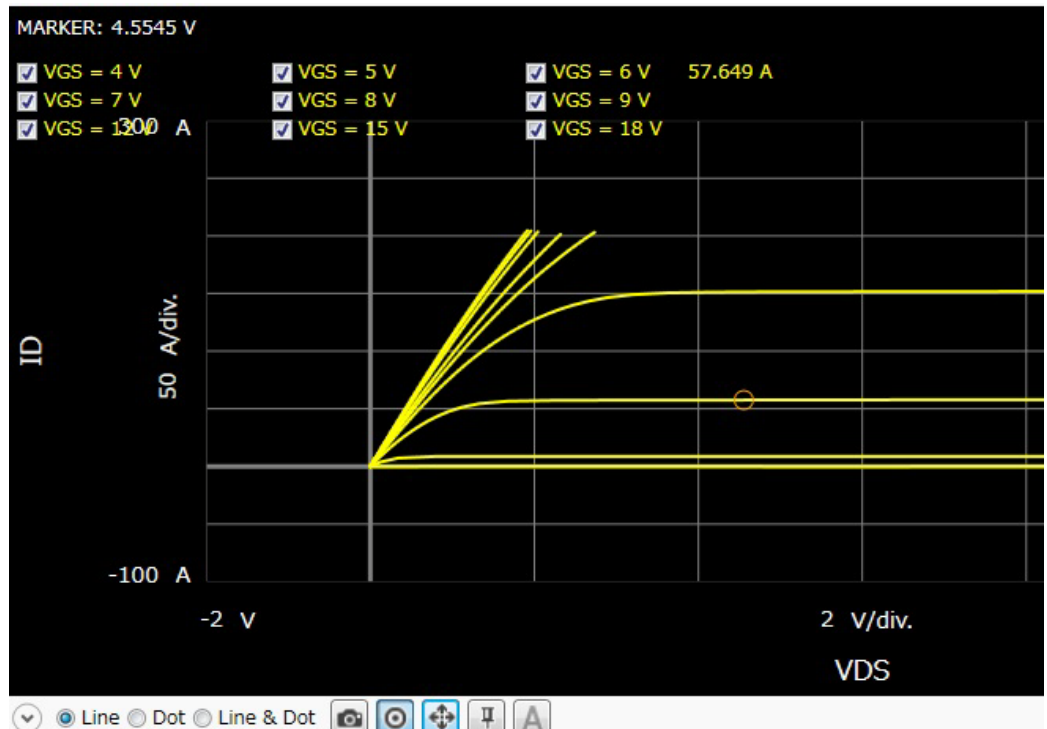
(Δ) X-axis value of marker B - X-axis value of marker A

The Y-axis values of the intersection of the markers and each characteristics curve, and the differences of Y-axis values between the mark A interaction and the mark B interaction (B-A) are displayed at the right of characteristics curve name.

Using the trace marker

- Step 1.** If the domain marker is displayed, click the domain marker mode button  to change to the trace marker mode .

Step 2. The trace marker (circle) is displayed.



You can move the trace marker on the characteristics curve using the rotary knob or mouse.

The **MARKER**: at the upper left of graph shows the X-axis value of the marker and the Y-axis value is displayed at the right of the characteristics curve name.

How To Perform Measurement
Displaying and Operating Graph

4

GUI Reference

GUI Reference

Keysight Easy Test Navigator software provides dedicated measurement software for power device characterization. It supports various types of measurement tasks with ease-of-use and simple operation.

This chapter describes reference information of the Keysight Easy Test Navigator software, and covers the following topics.

- “Software Palette”
- “Datasheet Characterization Software”
- “I/V Measurement Software”
- “Capacitance Measurement Software”
- “Gate Charge Measurement Software”
- “Power Loss Calculation Software”
- “Thermal Monitor/Control Software”

For how to perform the measurements, see Chapter 3.

For the EasyEXPERT software, see *EasyEXPERT User’s Guide*.

Software Palette

The Software Palette provides a complete list of the B1506A's measurement software and also allows this software to be launched. The Software Palette lists icons with the measurement software names. You can start the measurement software by clicking the icons or software names. And, you can also start it by pressing the softkeys on the front panel, shown the correspondence by lines on the Software Palette.

The Software Palette is displayed in fullscreen mode after powering up the B1506A. The Software Palette can be minimized to access the Windows desktop.

The following shows the icons and texts displayed on the Software Palette, and actions by clicking them.



**Datasheet
Characterization**

Starts the datasheet characterization software. See “Datasheet Characterization Software” on page 4-4.



I/V Measurement

Starts the I/V measurement software. See “I/V Measurement Software” on page 4-39.



**Capacitance
Measurement**

Starts the capacitance measurement software. See “Capacitance Measurement Software” on page 4-70.



**Gate Charge
Measurement**

Starts the gate charge measurement Software. See “Gate Charge Measurement Software” on page 4-99.



**Power Loss
Calculation**

Starts the power loss calculation software. See “Power Loss Calculation Software” on page 4-121.



**Thermal
Monitor/Control**

Starts the thermal monitor/control software. See “Thermal Monitor/Control Software” on page 4-138.



Minimize

Minimizes the Software Palette. This is useful when you access the Windows desktop. When you click the icon on the taskbar, the Software Palette appears again.

Datasheet Characterization Software

The datasheet characterization software provides:

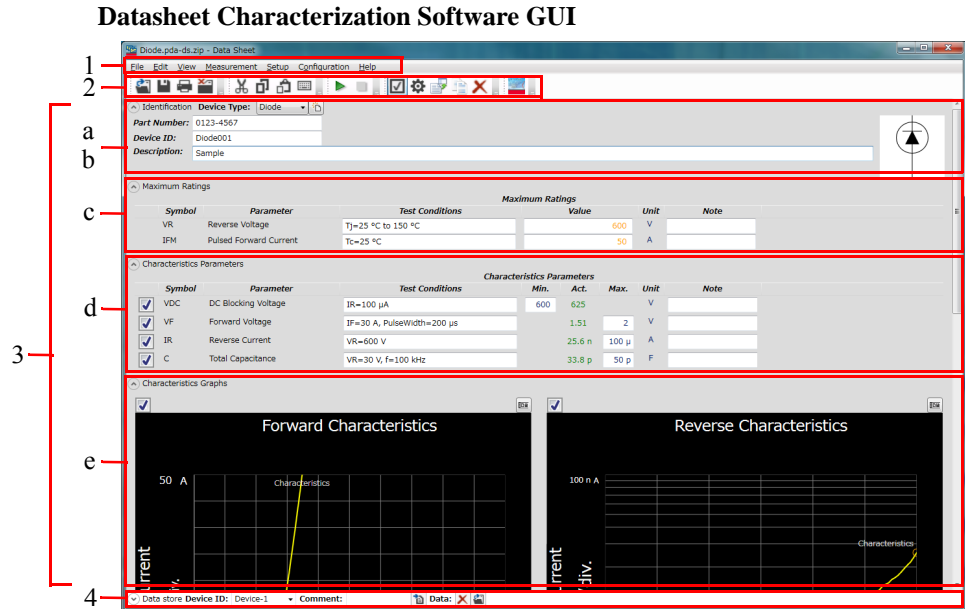
- A simple operating environment that can measure a range of device parameters and characteristics using a familiar datasheet-like format
 - The ability to input measurement conditions in a datasheet-like format
 - The ability to specify graphical limits on sweep measurements
 - Display measured parameters and characteristics in a datasheet-like format
 - The ability to compare measurement results with expected values
- Minimal software learning curve for device characterization using the predefined measurement templates
 - Furnished measurement templates are user-customizable
- The ability to effectively generate new datasheet contents for operating conditions not covered on the manufacturer's datasheet

This software measures various characteristics parameters and graphs of the I/V characteristics, capacitance characteristics, and gate charge characteristics described on a device datasheet.

GUI Overview

The GUI (Graphical User Interface) of the datasheet characterization software is comprised of the following areas.

Figure 4-1



1. “Main Menu” on page 4-6
 This provides the functions needed for various operations in the menu format.
2. “Toolbar” on page 4-10
 This provides the functions that are very frequently used in the button format.
3. “Work Area” on page 4-13
 This area provides the functions to set the measurement conditions and observe the measurement results. This is separated to the following areas.
 - a. “Templates” on page 4-13
 - b. “Identification” on page 4-14
 - c. “Maximum Ratings” on page 4-14
 - d. “Characteristics Parameters” on page 4-16
 - e. “Characteristics Graphs” on page 4-18

4. “Data List” on page 4-20

This area provides the functions regarding the saving of the measurement data files.

For the dialog boxes displayed during this software operation, see “Dialog Boxes” on page 4-22.

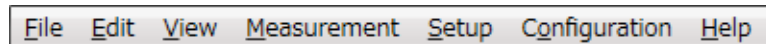
For the files handled by this software, see “Summary of Files” on page 4-23.

For details of the templates supplied by this software, see “Templates” on page 4-26. And, for how to prepare a custom datasheet folder using the templates, “Preparing Custom Datasheet Folder for Specific Device Model” on page 4-37.

Main Menu

Figure 4-2

Main Menu



The following shows the structure of the main menu.

File Menu

Displays the following menu items to operate the setup file and measurement data file. For the kinds of the files and file extensions, see “Summary of Files” on page 4-23.

New	Creates a new datasheet folder. A datasheet folder is an archive file for this software, that has many measurement data files and so on. This destroys the setup that you are editing, and creates a new datasheet folder.
Open...	Opens an existing datasheet folder. This opens the file selection dialog box, destroys the setup that you are editing, and then opens the datasheet folder selected in the dialog box.
Save	Saves the present setup data and measurement data to the original datasheet folder.
Save As...	Saves the present setup data and measurement data to the specified datasheet folder. This opens the file selection dialog box, and saves the present setup data and measurement data to the specified datasheet folder.

Print... Prints the present setup data and measurement data to the specified printer in the datasheet format, or to a document file in the XPS (XML Paper Specification) format.

To print to an XPS file, select the Microsoft XPS Document Writer as a printer in the Print dialog box.

If the PDF Writer/Printer is available, you can also print the present setup data and measurement data to a document file in the PDF format.

Change Device ID...

Changes the device ID recorded in the datasheet folder.

This opens the Change Device ID dialog box, and changes the device ID recorded in the selected datasheet folder(s). See “Change Device ID Dialog Box” on page 4-22.

Recent Setup Files

Lists a maximum of 10 names of the datasheet folders that were recently edited, as menu items. You can easily open a datasheet folder by using them.

Exit Exits the datasheet characterization software. Unsaved data is destroyed.

Edit Menu

Displays the following menu items to edit the setup.

Cut Moves the selected text to the clipboard.

Copy Copies the selected text to the clipboard.

Paste Pastes the text from the clipboard to the insertion point.

On-screen keyboard... Displays the on-screen keyboard.

View Menu

Displays the following menu items for the display setting.

Go to Palette Displays the Software Palette in fullscreen mode.

Main Window Displays the following menu item.

Fullscreen Changes the display style of the main window.

If this is marked, the main window does not have the titlebar and is displayed in fullscreen mode.

If this is unmarked, the main window has the titlebar and is displayed in the regular window style.


This is initially marked.

Color Settings... Opens the Color Setting dialog box to set the color for parts in this software. See “Color Setting Dialog Box” on page 4-22.

Measurement Menu

Displays the following menu items for controlling the measurement.

Start Starts to measure the marked measurement items in sequence. During the measurement, the measurement status indicator on the front panel lights up.

To stop the measurement, select the Measurement > Stop menu, click the Stop Measurement button  on the toolbar, or press the Stop key on the front panel.

Stop Stops the measurement.

Setup Menu

Displays the following menu items for setting up the measurement items.

Check All Marks the check boxes of all characteristics parameters and graphs to measure all of them.

Uncheck All Unmarks the check boxes of all characteristics parameters and graphs to not measure all of them.

Setup Sets up the measurement of the selected measurement item in detail.

Launches one of the following software corresponding to the selected measurement item.

- “I/V Measurement Software”
- “Capacitance Measurement Software”
- “Gate Charge Measurement Software”

You can do the following tasks on the launched software.

- Adjusting and changing the measurement conditions that are not included in the datasheet.
- Trying to measure the measurement item.
(The measurement result is automatically reflected onto the datasheet characterization software GUI.)

If you adjusted some measurement conditions without the measurement execution, save the setup data on the launched software. This will reflect this change to the datasheet folder when saving the datasheet folder on the datasheet characterization software.

Import

Imports the measurement data file (setup and measurement data) corresponding to the selected measurement item.

This opens the file selection dialog box, and then opens the measurement data file selected in the dialog box.

It is useful when you need to replace the setup and measurement data with ones in the existing measurement data file.

Duplicate

Makes a duplicate of the selected measurement item. The duplicated item is placed after the selected item.

It is useful when you need to measure the same characteristics parameter with multiple conditions.

Delete

Deletes the selected measurement item.

Configuration Menu Displays the following menu item to administrate the configuration of the built-in modules in the mainframe and test fixture.

Module... Opens the Module Configuration dialog box. See “Module Configuration Dialog Box” on page 4-158.

Help Menu Displays the following menu item.

About... Opens the About Box dialog box. See “About Box Dialog Box” on page 4-22.

Toolbar


Figure 4-3




Toolbar







The toolbar has five tool button groups. The following shows the tool buttons in the tool button groups.

File tool button group

- | | | |
|--|--------------|---|
|  | Open | Opens an existing datasheet folder.

This opens the file selection dialog box, destroys the setup that you are editing, and then opens the datasheet folder selected in the dialog box. |
|  | Save | Saves the present setup data and measurement data to the original datasheet folder. |
|  | Print | Prints the present setup data and measurement data to the specified printer in the datasheet format, or to a document file in the XPS or PDF format. |
|  | Exit | Exits the datasheet characterization software. Unsaved data is destroyed. |


Edit tool button group

- | | | |
|---|---------------------------|--|
|  | Cut | Moves the selected text to the clipboard. |
|  | Copy | Copies the selected text to the clipboard. |
|  | Paste | Pastes the text from the clipboard to the insertion point. |
|  | On-screen keyboard | Displays the on-screen keyboard. |

Measurement tool button group

 **Start Measurement**

Starts to measure the marked measurement items in sequence. During the measurement, the measurement status indicator on the front panel lights up.

To stop the measurement, select the Measurement > Stop menu, click the Stop Measurement button  on the toolbar, or press the Stop key on the front panel.

 **Stop Measurement**

Stops the measurement.

Setup tool button group

 **All Check/Uncheck**

This button indicates three statuses whether all of the measurement items (characteristics parameters and graphs) are objects to be measured.

This status shows that all measurement items are not objects to be measured. If clicking this button under this status, the check boxes of all measurement items are marked to set to objects to be measured.



This status shows that some measurement items are objects to be measured. If clicking this button under this status, the check boxes of all measurement items are marked to set to objects to be measured.



This status shows that all measurement items are objects to be measured. If clicking this button under this status, the check boxes of all measurement items are unmarked to set to no objects to be measured.

GUI Reference

Datasheet Characterization Software



Setup

Sets up the measurement of the selected measurement item in detail.

Launches one of the following software corresponding to the selected measurement item.

- “I/V Measurement Software”
- “Capacitance Measurement Software”
- “Gate Charge Measurement Software”

You can adjust and change the measurement conditions that are not included in the datasheet on the launched software.



Import

Imports the measurement data file (setup and measurement data) corresponding to the selected measurement item.

This opens the file selection dialog box, and then opens the measurement data file selected in the dialog box.



Duplicate

Makes a duplicate of the selected measurement item. The duplicated item is placed after the selected item.



Delete

Deletes the selected measurement item.

View tool button group



Go to Palette

Displays the Software Palette in fullscreen mode.

Work Area

In this area, set the measurement conditions and observe the measurement results. This is separated to the following areas.


- “Templates” on page 4-13
- “Identification” on page 4-14
- “Maximum Ratings” on page 4-14
- “Characteristics Parameters” on page 4-16
- “Characteristics Graphs” on page 4-18

Templates

Figure 4-4 **Templates and Identification**



This is an area to select a datasheet template corresponding to the device type of your DUT. The datasheet template is comprised of typical rating items and characteristics measurement items.

To create a new datasheet folder, select a template from the Device Type combo box and click the New Datasheet button . At this time, a new datasheet is opened, and various setup and measurement items defined in the template are displayed in the Maximum Ratings, Characteristics Parameters, and Characteristics Graphs areas.

a. Device Type Combo Box

Select a template corresponding to the device type of your DUT.

You can select one from the following templates supplied by this software.

- MOSFET

For the characteristics measurement items defined in this template, see “MOSFET Template” on page 4-26.

- IGBT


For the characteristics measurement items defined in this template, see “IGBT Template” on page 4-31.

GUI Reference

Datasheet Characterization Software

- Diode

For the characteristics measurement items defined in this template, see “Diode Template” on page 4-35.

- b. New Datasheet button 

Creates a new datasheet folder using the selected template.

Identification

This is an area to record the following information for identifying your DUT. See Figure 4-4.

- c. Part Number


You can enter a part number of your DUT.

- d. Device ID

You can enter a Device ID to identify your DUT.

- e. Description

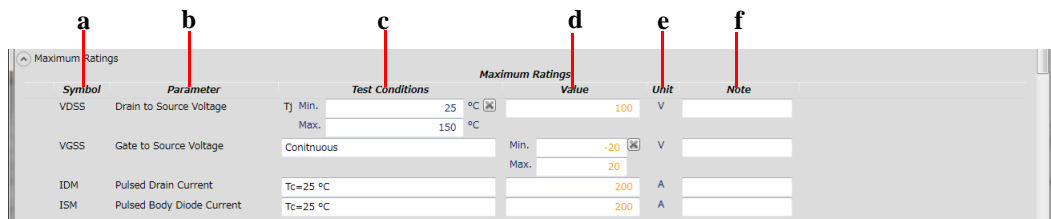
You can enter a device description and so on.

This area can be hidden or shown by clicking the chevron  of the Identification.

Maximum Ratings

Figure 4-5

Maximum Ratings



Symbol	Parameter	Test Conditions	Value	Unit	Note
VDSS	Drain to Source Voltage	Tj Min. 25 °C [X] Max. 150 °C	100	V	
VGSS	Gate to Source Voltage	Continuous	Min. -20 [X] Max. 20	V	
IDM	Pulsed Drain Current	Tc=25 °C	200	A	
ISM	Pulsed Body Diode Current	Tc=25 °C	200	A	

This is an area to set up the maximum ratings of your DUT. The entered maximum rating values are used as the limits for the measurement conditions of the characteristics measurement items.

The maximum rating parameters are displayed in the table format that has the following columns.

- a. Symbol

Shows a symbol of a rating parameter.

You can edit this by clicking on the text, and fix it by pressing the Enter key.


b. Parameter

Shows a name of a rating parameter.

You can edit this by clicking on the text, and fix it by pressing the Enter key.


c. Test Condition

Enter condition values for a rating parameter.

You can edit this by clicking on the text, and fix it by pressing the Enter key. To close the expanded edition fields, click the Close button .

d. Value

Enter a rating value.

You can edit this by clicking on the text, and fix it by pressing the Enter key. To close the expanded edition fields, click the Close button .


e. Unit

Shows a unit for the rating value.

f. Note

You can enter a remark for the rating value.

You can change the column order in this table by dragging and moving a column header.

This area can be hidden or shown by clicking the chevron  of the Maximum Ratings.

Characteristics Parameters

Figure 4-6

Characteristics Parameters

Symbol	Parameter	Test Conditions	Min.	Act.	Max.	Unit	Note
<input checked="" type="checkbox"/>	BVDS	Drain to Source Breakdown Volta	VGS 0 V	100	135	V	
		ID 1 m A					
<input checked="" type="checkbox"/>	IDSS	Drain Leakage Current	VDS=100 V, VGS=0 V	359 p	10 μ	A	
<input checked="" type="checkbox"/>	IGSS	Gate Leakage Current	VGS=20 V, VDS=0 V	350 p	200 n	A	
<input checked="" type="checkbox"/>	VGS(th)	Gate to Source Threshold Voltage	ID=1 mA	2	3.6	4	V
<input checked="" type="checkbox"/>	VGS(th)	Gate to Source Threshold Voltage	VDS=10 V, ID=1 mA	2	3.44	4	V
<input checked="" type="checkbox"/>	RDS(on)	Drain to Source On Resistance	VGS=15 V, ID=50 A, PulseWidth=200 μs		7.02 m	15 m	ohm
<input checked="" type="checkbox"/>	VDS(on)	Drain to Source On Voltage	VGS=15 V, ID=50 A, PulseWidth=200 μs		366 m	800 m	V

A characteristics parameter corresponds to a measurement item. This is an area to set up the characteristics parameter measurements.

The characteristics parameters are displayed in the table format that has the following columns.

a. Check box

Mark this for a characteristics parameter to be measured.

b. Symbol

Shows a symbol of a characteristics parameter.

You can edit this by clicking on the text, and fix it by pressing the Enter key.


c. Parameter

Shows a name of a characteristics parameter.

You can edit this by clicking on the text, and fix it by pressing the Enter key.

d. Test Conditions

Enter measurement condition values to measure a characteristics parameter.

You can edit this by clicking on the text, and fix it by pressing the Enter key. To close the expanded edition fields, click the Close button .

e. Min.

Enter a lower limit value of the expected range for the measured characteristics parameter value.

Leave a blank if there is no lower limit.

f. Act.

Shows an actual measured value of a characteristics parameter.

The measured value is displayed in red italic type if it is out of the expected range from “Min.” to “Max.”.

g. Max.

Enter an upper limit value of the expected range for the measured characteristics parameter value.

Leave a blank if there is no upper limit.

h. Unit


Shows a unit for a characteristics parameter.

i. Note

You can enter a remark for the characteristics parameter value.

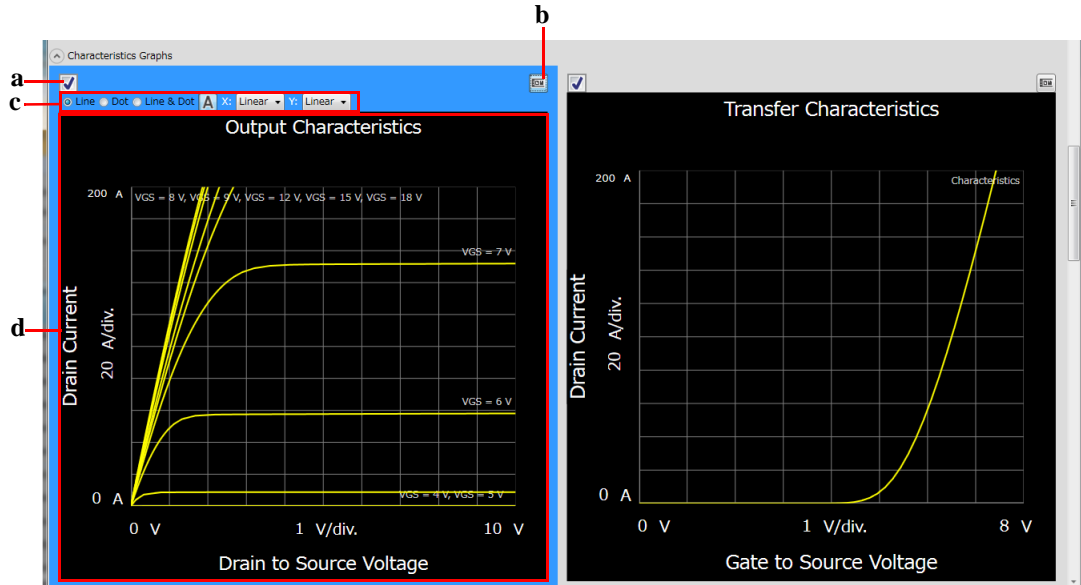
You can change the column order in this table by dragging and moving a column header.

To select a characteristics parameter, click on the blank space (excepting edition fields) of its row. The selected row is highlighted.

This area can be hidden or shown by clicking the chevron  of the Characteristics Parameter.

Characteristics Graphs

Figure 4-7 Characteristics Graphs



A characteristics graph corresponds to a measurement item. This is an area to set up the measurements for obtaining the characteristics graphs.

A characteristics graph is comprised of the following items.

- a. Check box

Mark this for a characteristics graph to be measured.

- b. Graph tool button

Shows or hides the graph tools under the graph.

- c. Graph tools


You can do below using the graph tools.

- Curve Representation

You can select one from the following curve representations.

The curves can be represented as Line, Dot, or combination (Line & Dot).

Select any curve representation using the radio buttons shown in the bottom part of the graph.

- Line
Plots a line between two measurement points.
- Dot
Represents the measurement points by dots.
- Line & Dot
Represents the measurement points by dots and plots a line between two measurement points.
- Trace label button 
Shows or hides labels to distinguish multiple traces on the graph.
- X/Y-axes scales
You can select scales for the X and Y-axes from the following.
 - Linear
Linear scale
 - PositiveLog
Logarithm scale for positive data
 - NegativeLog
Logarithm scale for negative data


d. Graph

Shows the measured characteristics graph.

You can change the minimum and maximum values on the X and Y-axes by clicking on the values.

For X and Y-axes of the voltage or current output values, enter the minimum and maximum values on X and Y-axes to specify the measurement range.

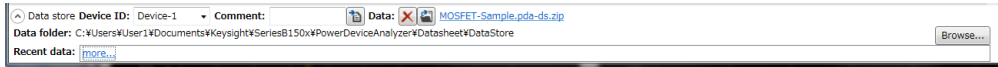
To select a characteristics graph, click on the graph. The outer frame of the selected graph is highlighted.

This area can be hidden or shown by clicking the chevron  of the Characteristics Graphs.

Data List

Figure 4-8

Data List



The data list area provides the following functions regarding the saving of the datasheet folders.


- Set the device ID to be recorded to the datasheet folder
See “Device ID” on page 4-20.
- Enter a comment to be recorded to the datasheet folder
See “Comment” on page 4-20.
- Operations for the latest datasheet folder
See “Data” on page 4-21.
- Access to the datasheet folders that were automatically saved
See “Data store” on page 4-21.

The setup data and measurement data are automatically saved to a new datasheet folder (archive file) at the end of the measurement. At this time, you can also record a device ID to identify your DUT and a comment. And, the destination folder of the datasheet folder for auto-saving is predefined. You can set the device ID and comment, and change the destination folder using this area.

Device ID

Enter device ID string to the Device ID field. The maximum 10 recently-entered device IDs can be kept as history, and you can also select one from the history list.


The entered device ID is automatically saved to the datasheet folder at the end of the measurement.

You can also change the device ID in the latest datasheet folder after the measurement here. To change it, change the device ID in the Device ID field, and then click the Apply button .

Comment



Enter a comment string to the Comment field.

The entered comment is automatically saved to the datasheet folder at the end of the measurement.

You can also change the comment in the latest datasheet folder after the measurement here. To change it, change the comment in the Comment field, and then click the Apply button .


Data

The Data field shows the latest auto-saved or last-opened datasheet folder name. You can do the following operations.

- Open the datasheet folder by clicking the Open button .
- Rename the datasheet folder by clicking the datasheet folder name.
- Delete the datasheet folder by clicking the Delete button .

Data store

Using the following fields, you can change the destination folder of the auto-saved datasheet folder, and access the auto-saved datasheet folders.

The following fields can be shown or hidden by clicking the chevron  next to “Data store”.

Data folder Shows the absolute path of the auto-saved datasheet folder. To change this, click the Browse button to open the folder selection dialog box. Select your desired folder in the dialog box.

For the initial setting of the data folder, see “Summary of Files” on page 4-68.

Recent data Shows up to 10 auto-saved datasheet folders that were automatically saved recently, in the hyper-link format. Clicking the hyper-link opens the selected datasheet folder. This destroys the presently-editing data.

If the number of the auto-saved datasheet folders is over ten, this field shows “more...”. Clicking this opens the file selection dialog box. Select a datasheet folder to open.

Dialog Boxes

Change Device ID Dialog Box

The Change Device ID dialog box is used to change the device ID in all selected datasheet folders at once.

- | | |
|------------------------|--|
| Device ID field | Enter a new device ID. You can also select it from the history. |
| Add... button | Opens the file selection dialog box to select the datasheet folder(s) that you want to change the device ID. The selected datasheet folders are displayed into the list. |
| Remove button | Excludes the selected datasheet folder from the list. |
| Execute button | Changes the device ID. |
| Close button | Closes this dialog box. |

This dialog box is opened by selecting the main menu File > Change Device ID....

Color Setting Dialog Box

The Color Setting dialog box is used to set colors of parts in this software.

The elements supported by this dialog box are window background, graph background, X and Y-axes, graph grid, graph text, and trace. Clicking the color pattern opens the dialog box for selecting a color.

The setting in the Color Setting dialog box is saved as a user setting.

- | | |
|----------------------|---|
| Apply button | Applies the present setting to the graph. |
| Reset button | Resets to the default setting. |
| OK button | Applies the present setting to the graph, and closes this dialog box. |
| Cancel button | Closes this dialog box without applying the present setting. |

This dialog box is opened by selecting the main menu View > Color Settings....

About Box Dialog Box

The About Box dialog box displays the model number, the software revision number, download URL for software updating, and so on.

This dialog box is opened by selecting the main menu Help > About....

Summary of Files

The following shows the summary of the files handled by the datasheet characterization software.

Table 4-1 Summary of Files

File Type	Description	Extension	Folder as Initial Setting
Datasheet folder	<p>This archive file is comprised of the following files that have setup data and measurement data.</p> <ul style="list-style-type: none"> • Datasheet characterization recipe file • Various measurement data files <p>This is automatically saved after the measurement. You can optionally save this.</p>	*.pda-ds.zip	C:\Users\<user name>\Documents\Keysight\SeriesB150x\PowerDeviceAnalyzer\Datasheet\DataStore (You can change this)
Datasheet characterization recipe file	<p>All setup data specified on this software GUI</p> <p>This is saved in the datasheet folder.</p>	*.pda-ds	Datasheet folder
I/V measurement data file	<p>Setup data and measurement data for a measurement item (characteristics parameter or graph) regarding the I/V measurement, including the device ID and comment</p> <p>This is saved in the datasheet folder.</p>	*.pda-iv.txt	Datasheet folder

File Type	Description	Extension	Folder as Initial Setting
Capacitance measurement data file	Setup data and measurement data for a measurement item (characteristics parameter or graph) regarding the capacitance measurement, including the device ID and comment This is saved in the datasheet folder.	*.pda-cap.txt	Datasheet folder
Gate charge measurement data file	Setup data and measurement data for a measurement item (characteristics parameter or graph) regarding the gate charge measurement, including the device ID and comment This is saved in the datasheet folder.	*.pda-qg.txt	Datasheet folder
XPS output file	Output file in XPS ^a format	*.xps	(You can specify the folder when printing this file)

a. XPS (XML Paper Specification) is the standard document format on Windows.

File name of Datasheet Folder on Auto-saving

An auto-saved datasheet folder is named as the following rule.

1. Concatenates the device ID, available thermometer readings, and date and time on save by an underscore (_).

The available thermometer readings are characters of the available thermometer identifiers set in the “Thermal Monitor/Control Software” on page 4-138, and their readings as shown in the following syntax.

@<thermometer>=<reading>degC[_<thermometer>=<reading>degC[...]]

- <thermometer>

An identifier of the available thermometer

Ch1 Channel 1 thermometer of B1506A

Ch2 Channel 2 thermometer of B1506A

Air Thermometer on the air outlet port of the ThermoStream

DUT Thermometer on the DUT port of the ThermoStream

- <reading>

A reading value of the thermometer in degrees centigrade

Example) @Ch1=25degC_Ch2=75degC_Air=100degC

2. Concatenates the file extension (.pda-ds.zip) to the end of the “step 1” string.
3. If the “step 2” file name duplicates the existing file name, concatenates the serial number from 2 enclosed by brackets and the file extension to the end of the “step 1” string.

Templates

This section provides the maximum ratings and characteristics measurement items defined in the templates supplied by this software.

MOSFET Template

The section shows the maximum ratings and characteristics measurement items defined in the template for the MOSFET devices using some tables.

The following table shows the maximum rating parameters defined in this template.

Table 4-2

Maximum Ratings

Parameter	Symbol
Drain to Source Voltage	VDSS
Gate to Source Voltage	VGSS
Pulsed Drain Current	IDM
Pulsed Body Diode Current	ISM

The following table shows the characteristics parameters that are defined in this template.

You can specify values to the parameters described in the Conditions column of the following table, as the measurement conditions. And, the rating parameter described in the Ratings column is used as the limit for the measurement conditions.

Table 4-3

Characteristics Parameters

Parameter	Symbol	Conditions	Ratings
Drain to Source Breakdown Voltage	BVDSS	ID	IDM
		VGS	VGSS
Drain Leakage Current	IDSS	VDS	VDSS
		VGS	VGSS
Gate Leakage Current	IGSS	VGS	VGSS
		VDS	VDSS

Parameter	Symbol	Conditions	Ratings
Gate to Source Threshold Voltage ^a	VGS(th)	ID	IDM
Gate to Source Threshold Voltage (Constant Drain to Source Voltage)	VGS(th)	VDS	VDSS
		ID	IDM
Drain to Source On Resistance	RDS(on)	VGS	VGSS
		ID	IDM
		PulseWidth	
Drain to Source On Voltage	VDS(on)	VGS	VGSS
		ID	IDM
		PulseWidth	
Body Diode Forward Voltage	VSD	IS	ISM
		VGS	VGSS
Gate Resistance	Rg	VGS	VGSS
		f	
Input Capacitance	Ciss	VDS	VDSS
		VGS	VGSS
		f	
Output Capacitance	Coss	VDS	VDSS
		VGS	VGSS
		f	
Reverse Transfer Capacitance	Crss	VDS	VDSS
		VGS	VGSS
		f	

GUI Reference
 Datasheet Characterization Software

Parameter	Symbol	Conditions	Ratings
Total Gate Charge	Qg	Vds	VDSS
		Vgs(on)	VGSS
		Vgs(off)	VGSS
		Id	IDM
Gate to Source Charge	Qgs	Vds	VDSS
		Vgs(on)	VGSS
		Vgs(off)	VGSS
		Id	IDM
Gate to Drain Charge	Qgd	Vds	VDSS
		Vgs(on)	VGSS
		Vgs(off)	VGSS
		Id	IDM
Gate to Source Plateau Voltage	Vgs(pl)	Vds	VDSS
		Vgs(on)	VGSS
		Vgs(off)	VGSS
		Id	IDM

- a. The same voltage is forced to between the drain-source terminals and the gate-source terminals at the measurement.

The following table shows the characteristics graphs that are defined in this template.

The X and Y in the Symbol column show the measurement data specified as the X and Y-axes data on the graph. And, the rating parameters in the X and Y of the Ratings column are used as the limit for the measurement conditions.

Table 4-4 **Characteristics Graphs**

Characteristics	Symbols		Ratings	
	X	Y	X	Y
Output Characteristics	VDS	ID	VDSS	IDM
Transfer Characteristics	VGS	ID	VGSS	IDM
Drain to Source Resistance vs. Drain Current	ID	RDS	IDM	
Drain to Source Resistance vs. Gate to Source Voltage	VGS	RDS	VGSS	
Drain to Source Voltage vs. Gate to Source Voltage	VGS	VDS	VGSS	VDSS
Body Diode Forward Characteristics	VSD	IS	VDSS	ISM
Capacitances vs. Drain to Source Voltage	VDS	Ciss, Coss, Crss	VDSS	
Gate Charge Characteristics	Qg	Vgs		VGSS

The following describes about the symbols in the Conditions column of Table 4-3 on page 4-26 and in the Symbols column of Table 4-4 on page 4-29.

Table 4-5 **Glossary of MOSFET Template**

Symbol	Description
VGS	Gate-source voltage
VDS	Drain-source voltage
ID	Drain current
PulseWidth	Pulse width of drain current/voltage
f	AC signal frequency
IS	Body diode forward current (source current)
VSD	Body diode forward voltage (source-drain voltage)

GUI Reference
Datasheet Characterization Software

Symbol	Description
RDS	Drain-source resistance
Ciss	Input capacitance
Coss	Output capacitance
Crss	Reverse transfer capacitance
Qg	Gate charge
Vgs	Gate-source voltage (gate charge measurement)
Vgs(on)	Gate-source “On-state” voltage (gate charge measurement)
Vgs(off)	Gate-source “Off-state” voltage (gate charge measurement)
Vds	Drain-source “Off-state” voltage (gate charge measurement)
Id	Drain “On-state” current (gate charge measurement)

IGBT Template

The section shows the maximum ratings and characteristics measurement items defined in the template for the IGBT devices using some tables.

The following table shows the maximum rating parameters defined in this template.

Table 4-6

Maximum Ratings

Parameter	Symbol
Collector to Emitter Voltage	VCES
Gate to Emitter Voltage	VGES
Pulsed Collector Current	ICM
Pulsed Freewheeling Diode Current	IFM

The following table shows the characteristics parameters that are defined in this template.

You can specify values to the parameters described in the Conditions column of the following table, as the measurement conditions. And, the rating parameter described in the Ratings column is used as the limit for the measurement conditions.

Table 4-7

Characteristics Parameters

Parameter	Symbol	Conditions	Ratings
Collector to Emitter Breakdown Voltage	BVCES	IC	ICM
		VGE	VGES
Collector Leakage Current	ICES	VCE	VCES
		VGE	VGES
Gate Leakage Current	IGES	VGE	VGES
		VCE	VCES
Gate to Emitter Threshold Voltage ^a	VGE(th)	IC	ICM
Gate to Emitter Threshold Voltage (Constant Collector to Emitter Voltage)	VGE(th)	VCE	VCES
		IC	ICM

GUI Reference
 Datasheet Characterization Software

Parameter	Symbol	Conditions	Ratings
Collector to Emitter Saturation Voltage	VCE(sat)	VGE	VGES
		IC	ICM
		PulseWidth	
Freewheeling Diode Forward Voltage	VF	IF	IFM
		VF	VCES
Gate Resistance	Rg	VGE	VGES
		f	
Input Capacitance	Cies	VCE	VCES
		VGE	VGES
		f	
Output Capacitance	Coes	VCE	VCES
		VGE	VGES
		f	
Reverse Transfer Capacitance	Cres	VCE	VCES
		VGE	VGES
		f	
Total Gate Charge	Qg	Vce	VCES
		Vge(on)	VGES
		Vge(off)	VGES
		IC	ICM
Gate to Emitter Charge	Qge	Vce	VCES
		Vge(on)	VGES
		Vge(off)	VGES
		Ic	ICM

Parameter	Symbol	Conditions	Ratings
Gate to Collector Charge	Qgc	Vce	VCES
		Vge(on)	VGES
		Vge(off)	VGES
		Ic	ICM
Gate to Emitter Plateau Voltage	Vge(pl)	Vce	VCES
		Vge(on)	VGES
		Vge(off)	VGES
		Ic	ICM

- a. The same voltage is forced to between the collector-emitter terminals and the gate-emitter terminals at the measurement.

The following table shows the characteristics graphs that are defined in this template.

The X and Y in the Symbol column show the measurement data specified as the X and Y-axes data on the graph. And, the rating parameters in the X and Y of the Ratings column are used as the limit for the measurement conditions.

Table 4-8

Characteristics Graphs

Characteristics	Symbols		Ratings	
	X	Y	X	Y
Output Characteristics	VCE	IC	VCES	ICM
Transfer Characteristics	VGE	IC	VGES	ICM
Collector to Emitter Voltage vs. Gate to Emitter Voltage	VCE	VGE	VCES	VGES

Characteristics	Symbols		Ratings	
	X	Y	X	Y
Freewheeling Diode Forward Characteristics	VF	IF	VCES	IFM
Capacitances vs. Collector to Emitter Voltage	VCE	Cies, Coes, Cres	VCES	
Gate Charge Characteristics	Qg	Vge		VGES

The following describes about the symbols in the Conditions column of Table 4-7 on page 4-31 and in the Symbols column of Table 4-8 on page 4-33.

Table 4-9

Glossary of IGBT Template

Symbol	Description
VGE	Gate-emitter voltage
VCE	Collector-emitter voltage
IC	Collector current
PulseWidth	Pulse width of collector current/voltage
f	AC signal frequency
IF	Free-wheel diode forward current
VF	Free-wheel diode forward voltage
Cies	Input capacitance
Coes	Output capacitance
Cres	Reverse transfer capacitance
Qg	Gate charge
Vge	Gate-emitter voltage (gate charge measurement)
Vge(on)	Gate-emitter “On-state” voltage (gate charge measurement)

Symbol	Description
V _{ge(off)}	Gate-emitter “Off-state” voltage (gate charge measurement)
V _{ce}	Collector-emitter “Off-state” voltage (gate charge measurement)
I _c	Collector “On-state” current (gate charge measurement)

Diode Template

The section shows the maximum ratings and characteristics measurement items defined in the template for the diodes using some tables.

The following table shows the maximum rating parameters defined in this template.

Table 4-10

Maximum Ratings

Parameter	Symbol
Reverse Voltage	VR
Pulsed Forward Current	IFM

The following table shows the characteristics parameters that are defined in this template.

You can specify values to the parameters described in the Conditions column of the following table, as the measurement conditions. And, the rating parameter described in the Ratings column is used as the limit for the measurement conditions.

Table 4-11

Characteristics Parameters

Parameter	Symbol	Conditions	Ratings
DC Blocking Voltage	VDC	IR	
Forward Voltage	VF	IF	IFM
Reverse Current	IR	VR	VR
Total Capacitance	CT	VR	VR
		f	

The following table shows the characteristics graphs that are defined in this template.

The X and Y in the Symbol column show the measurement data specified as the X and Y-axes data on the graph. And, the rating parameters in the X and Y of the Ratings column are used as the limit for the measurement conditions.

Table 4-12 **Characteristics Graphs**

Characteristics	Symbols		Ratings	
	X	Y	X	Y
Forward Characteristics	VF	IF		IFM
Reverse Characteristics	VR	IR	VR	
Capacitance	VR	CT	VR	

The following describes about the symbols in the Conditions column of Table 4-11 on page 4-35 and in the Symbols column of Table 4-12 on page 4-36.

Table 4-13 **Glossary of Diode Template**

Symbol	Description
IR	Reverse current
IF	Forward current
VR	Reverse voltage
f	AC signal frequency
VF	Forward voltage
CT	Total capacitance

Preparing Custom Datasheet Folder for Specific Device Model


This section introduces essentials to prepare your custom datasheet folder that can be used as a new template for specific device model.

It starts from making a new datasheet folder using any template supplied in this software. And then, customize the settings as described below.

After finishing all customization, save and manage the datasheet folder as a new template for evaluating your device model. When evaluating each individual device, use a copy of the datasheet folder.

- Customizing in the Identification area
 - Select a template corresponding to the type of your device, and then create a new datasheet folder.
 - Enter a part number of your device.
- Customizing in the Maximum Ratings area
 - Review the maximum rating values, and change them to values appropriate for your device.
- Customizing in the Characteristics Parameters and Characteristics Graphs areas
 - Review the measurement items, and delete unnecessary items.
 - Review the measurement items, and make duplicates of the measurement item if you need to measure the same characteristics parameter/graph with multiple conditions.
 - For the characteristics parameters, change the parameter values of the Test Conditions to new preset values appropriate for your device.

For the characteristics graphs, change the minimum and maximum values on the voltage/current axes to new preset output values appropriate for your device.

- Select a measurement item in the Characteristics Parameters and Characteristics Graphs areas, and then click the Setup button  on the toolbar (or select Setup from the Setup menu).

Review the detailed settings on the launched measurement software, adjust them with executing the measurement. The measurement result is automatically reflected onto the datasheet characterization software GUI.

GUI Reference

Datasheet Characterization Software

If you change the settings without executing the measurement on the launched measurement software, save new settings to the present measurement data file. The new settings saved into the measurement data file are reflected to the datasheet folder when saving the datasheet folder.

- Conveniently save the datasheet folder.

Save your setup data to the datasheet folder with an appropriate name.

By saving the datasheet folder, the changes on the launched measurement software are reflected to the datasheet folder.

- After finishing to adjust the settings of all measurement items, mark the check boxes of all measurement items, start the datasheet characterization measurement for all items, and then check all results.

I/V Measurement Software

I/V Measurement Software provides:

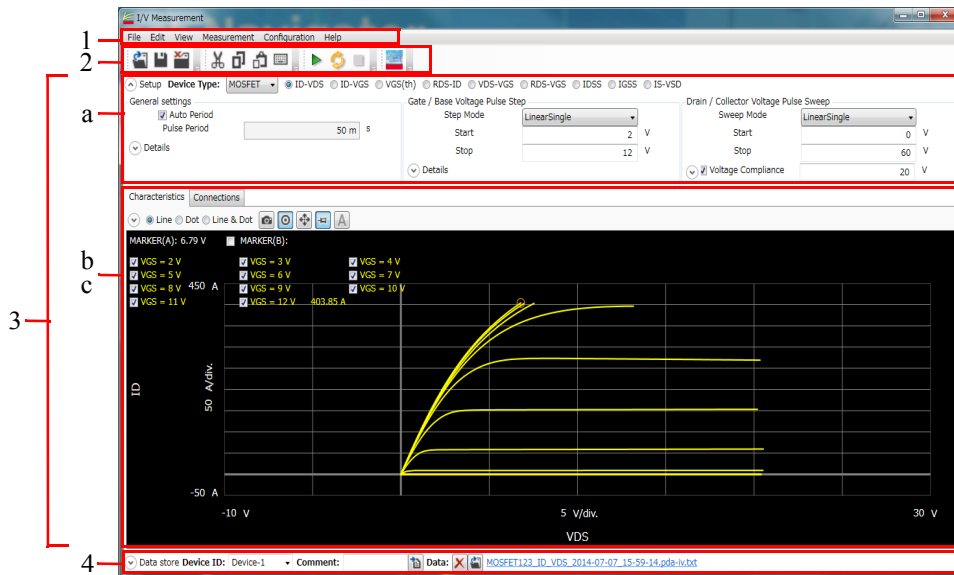
- Voltage/current sweep/spot measurements
- DC/pulse outputs
- Linear/log sweep with both single (one-way) and double (round-trip) capability for the primary sweep source (similar to the collector supply of a conventional curve tracer)
- Linear/list sweep capability for the secondary sweep source (corresponding to the step generator of a conventional curve tracer)
- The ability to assign the primary sweep source or the secondary sweep source to either the collector/drain terminal or to the base/gate terminal.
- Intuitive and interactive sweep/spot measurement operation using rotary knob.
- Predefined templates for typical MOSFET, IGBT and Diode I/V measurements.

GUI Overview

The GUI (Graphical User Interface) of the I/V measurement software is comprised of the following areas.

Figure 4-9

I/V Measurement Software GUI



1. “Main Menu” on page 4-41

This provides the functions needed for various operations in the menu format.

2. “Toolbar” on page 4-43

This provides the functions that are very frequently used in the button format.

3. “Work Area” on page 4-45

This area provides the functions to set the measurement conditions and observe the measurement results. This is separated to the following areas.

a. “Setup” on page 4-45

b. “Characteristics” on page 4-60

c. “Connections” on page 4-63

4. “Data List” on page 4-65

This area provides the functions regarding the saving of the measurement data files.

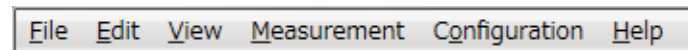
For the dialog boxes displayed during this software operation, see “Dialog Boxes” on page 4-67.

For the files handled by this software, see “Summary of Files” on page 4-68.

Main Menu

Figure 4-10

Main Menu



The following shows the structure of the main menu.

File Menu

Displays the following menu items to operate the setup file and measurement data file. For the kinds of the files and file extensions, see “Summary of Files” on page 4-68.

New	Creates a new setup. This destroys the setup that you are editing, and creates a new setup.
Open...	Opens an existing setup file or measurement data file. This opens the file selection dialog box, destroys the setup that you are editing, and then opens the file selected in the dialog box.
Save	Saves the setup that you are editing to the original setup file.
Save Setup As...	Saves the setup that you are editing to the specified setup file. This opens the file selection dialog box, and saves the present setup to the specified setup file.
Save Data As...	Saves the present setup data and measurement data to the specified measurement data file. This opens the file selection dialog box, and saves the present setup data and measurement data to the specified measurement data file.
Change Device ID...	Changes the device ID recorded in the measurement data file.

This opens the Change Device ID dialog box, and changes the device ID recorded in the selected measurement data file(s). See “Change Device ID Dialog Box” on page 4-67.

Recent Setup Files

Lists a maximum of 10 names of the setup files that were recently edited, as menu items. You can easily open a setup file by using them.

Exit Exits the I/V measurement software. Unsaved data is destroyed.

Edit Menu

Displays the following menu items to edit the setup.

Cut Moves the selected text to the clipboard.

Copy Copies the selected text to the clipboard.

Paste Pastes the text from the clipboard to the insertion point.

**On-screen
keyboard...**

Displays the on-screen keyboard.

View Menu

Displays the following menu items for the display setting.

Go to Palette Displays the Software Palette in fullscreen mode.

Main Window Displays the following menu item.

Fullscreen Changes the display style of the main window.

If this is marked, the main window does not have the titlebar and is displayed in fullscreen mode.

If this is unmarked, the main window has the titlebar and is displayed in the regular window style.


This is initially marked.

Color Settings... Opens the Color Setting dialog box to set the color for parts in this software. See “Color Setting Dialog Box” on page 4-67.

**Measurement
Menu**

Displays the following menu items for controlling the measurement.

Start Starts a measurement. During the measurement, the measurement status indicator on the front panel lights up.

- Repeat** Starts a repeat measurement. During the measurement, the measurement status indicator on the front panel lights up. This allows you to observe the measurement result with changing the setup.
- To stop the measurement, select the Measurement > Stop menu, click the Stop Measurement button  on the toolbar, or press the Stop key on the front panel.
- Stop** Stops the measurement.

Configuration Menu

Displays the following menu item to administrate the configuration of the built-in modules in the mainframe and test fixture.

- Module...** Opens the Module Configuration dialog box. See “Module Configuration Dialog Box” on page 4-158.

Help Menu

Displays the following menu item.

- About...** Opens the About Box dialog box. See “About Box Dialog Box” on page 4-67.

Toolbar




Figure 4-11

Toolbar



The toolbar has four tool button groups. The following shows the tool buttons in the tool button groups.





File tool button group

-  **Open** Opens an existing setup file or measurement data file. This opens the file selection dialog box, destroys the setup that you are editing, and then opens the file selected in the dialog box.
-  **Save** Saves the setup that you are editing to the original setup file.
-  **Exit** Exits the I/V measurement software. Unsaved data is destroyed.



GUI Reference



I/V Measurement Software

Edit tool button group

- | | | |
|---|---------------------------|--|
|  | Cut | Moves the selected text to the clipboard. |
|  | Copy | Copies the selected text to the clipboard. |
|  | Paste | Pastes the text from the clipboard to the insertion point. |
|  | On-screen keyboard | Displays the on-screen keyboard. |

Measurement tool button group

- | | | |
|---|---------------------------|---|
|  | Start Measurement | Starts a measurement. During the measurement, the measurement status indicator on the front panel lights up. |
|  | Repeat Measurement | Starts a repeat measurement. During the measurement, the measurement status indicator on the front panel lights up.
This allows you to observe the measurement result with changing the setup.

To stop the measurement, select the Measurement > Stop menu, click the Stop Measurement button  on the toolbar, or press the Stop key on the front panel. |
|  | Stop Measurement | Stops the measurement. |

View tool button group

- | | | |
|---|----------------------|---|
|  | Go to Palette | Displays the Software Palette in fullscreen mode. |
|---|----------------------|---|

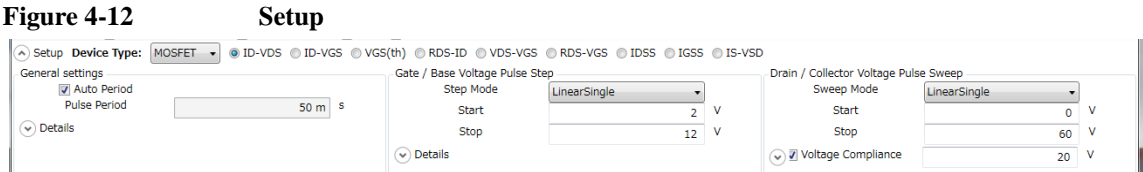
Work Area

In this area, set the measurement conditions and observe the measurement results. This is separated to the following areas.

- “Setup” on page 4-45
- “Characteristics” on page 4-60
- “Connections” on page 4-63

Setup

Figure 4-12



This is an area to select the device type and its measured I/V characteristics, and enter your measurement conditions.

Device Type

Select the device type of your DUT from below.

- MOSFET
- IGBT
- Diode
- Generic

Select the Generic to execute more general measurements for device other than above types.

MOSFET

You can select one of the following I/V characteristics measurements for “MOSFET” device type.

- ID-VDS
Creates new settings to measure the output characteristics.
- ID-VGS
Creates new settings to measure the transfer characteristics.
- VGS(th)

GUI Reference

I/V Measurement Software

Creates new settings to measure the threshold voltage.

- RDS-ID

Creates new settings to measure the drain-source resistance characteristics for the drain current.

- VDS-VGS

Creates new settings to measure the drain-source voltage characteristics for the gate-source voltage.

- RDS-VGS

Creates new settings to measure the drain-source resistance characteristics for the gate-source voltage.

- IDSS

Creates new settings to measure the drain leak current characteristics for the drain-source voltage.

- IGSS

Creates new settings to measure the gate leak current characteristics for the gate-source voltage.

- IS-VSD

Creates new settings to measure the forward characteristics of the body diode for the source-drain voltage.

IGBT

You can select one of the following I/V characteristics measurements for “IGBT” device type.

- IC-VCE

Creates new settings to measure the output characteristics.

- IC-VGE

Creates new settings to measure the transfer characteristics.

- VGE(th)

Creates new settings to measure the threshold voltage.

- VCE-VGE

Creates new settings to measure the collector-emitter voltage characteristics for the gate-emitter voltage.

- VCE(sat)

Creates new settings to measure the collector-emitter saturation voltage characteristics for the collector current.

- ICES

Creates new settings to measure the collector leak current characteristics for the collector-emitter voltage.

- IGES

Creates new settings to measure the gate leak current characteristics for the gate-emitter voltage.

- IF-VF

Creates new settings to measure the free-wheel diode forward characteristics.

Diode

You can select one of the following I/V characteristics measurements for “Diode” device type.

- IF-VF

Creates new settings to measure the forward bias characteristics.

- IR-VR

Creates new settings to measure the reverse bias characteristics.

Generic

Set your measurement conditions in “General settings” on page 4-47, “Gate/Base drive settings” on page 4-49, and “Drain/Collector drive settings” on page 4-49 for “Generic” device type.

General settings

In this area, you can set the following measurement conditions for DC output measurement or pulse output measurement.

For DC output measurement:

- Step Time

Specify the period between steps for the staircase sweep.
Setting range: 500 μ s to 5 s

- Aperture

Specify the measurement time at each step for the staircase sweep.
Setting range: 2 μ s to 20 ms

- Hold Time

GUI Reference

I/V Measurement Software

Specify the hold time of the sweep start voltage. At the sweep start point, the start voltage is forced for more than the specified time.

Setting range: 0 to 655.35 s

For pulse output measurement:

- Auto Period

Enable or disable the automatic adjustment for the pulse period. To enable this, mark the check box.

- Pulse Period

Specify the pulse period.

Setting range: 5 ms to 5 s

If the Auto Period is enabled, this is automatically adjusted to minimum period corresponding to the pulse width.

- Aperture


Specify the measurement time at each pulse.

Setting range: 2 μ s to 20 ms

- Hold Time

Specify the hold time of the sweep start voltage. At the sweep start point, the start voltage is forced for more than the specified time.

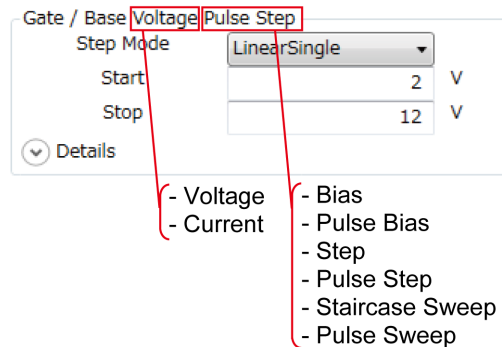
Setting range: 0 to 655.35 s

The following parameter can be shown or hidden by clicking the chevron  of the Details.

- Aperture
- Hold Time

Gate/Base drive settings

Set the output voltage/current to the gate/base terminal. One of the following types is automatically selected depending on the selected characteristics measurement. The selected type is displayed on the title of this terminal setting area as shown in the following figure.



For the setting items of the types, see below.

- “Bias” on page 4-50
Outputs the constant bias voltage/current.
- “Pulse Bias” on page 4-50
Outputs the voltage or current pulse that the peak output is constant.
- “Step” on page 4-51
Outputs the constant voltage/current that the level is changed every time a sweep measurement is finished.
- “Pulse Step” on page 4-52
Outputs the voltage/current pulse that the peak level is changed every time a sweep measurement is finished.
- “Staircase Sweep” on page 4-54
Outputs the staircase-swept voltage/current.
- “Pulse Sweep” on page 4-55
Outputs the staircase-swept pulse voltage/current.

Drain/Collector drive settings

Set the output voltage/current to the drain/collector terminal. One of the following types is automatically selected depending on the selected characteristics measurement. The selected type is displayed on the title of this terminal setting area.

For the setting items of the types, see below.

- “Bias” on page 4-50
Outputs the constant bias voltage/current.

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- “Pulse Bias” on page 4-50
Outputs the voltage or current pulse that the peak output is constant.
- “Step” on page 4-51
Outputs the constant voltage/current that the level is changed every time a sweep measurement is finished.
- “Pulse Step” on page 4-52
Outputs the voltage/current pulse that the peak level is changed every time a sweep measurement is finished.
- “Staircase Sweep” on page 4-54
Outputs the staircase-swept voltage/current.
- “Pulse Sweep” on page 4-55
Outputs the staircase-swept pulse voltage/current.

Bias

The terminal outputs the constant voltage or current.

Set the following parameters.

- Source
Specify an output voltage/current value.

The following parameters can be shown or hidden by clicking the chevron  of the Details.

- Resource/Output Mode/Output Sequence
You can change the settings of this terminal using the pull-down menu. For details, see “Resource/Output Mode/Output Sequence” on page 4-57.
- Compliance
Specify a current/voltage compliance value.
If the output exceeds this, the sweep measurement is terminated.
- Voltage Compliance
Specify a voltage compliance value for UHCU.
To enable this, mark the check box.
If the output exceeds this, the sweep measurement is terminated.
Available for UHCU.


Pulse Bias

The terminal outputs the voltage or current pulse that the peak output is constant.

Set the following parameters.

- Source

Specify a pulse peak voltage/current value.

The following parameters can be shown or hidden by clicking the chevron  of the Details.

- Resource/Output Mode/Output Sequence

You can change the settings of this terminal using the pull-down menu. For details, see “Resource/Output Mode/Output Sequence” on page 4-57.

- Base

Specify a pulse base voltage/current value.

- Compliance

Specify a current/voltage compliance value.

If the output exceeds this, the sweep measurement is terminated.

- Voltage Compliance

Specify a voltage compliance value for UHCU.

To enable this, mark the check box.

If the output exceeds this, the sweep measurement is terminated.

Available for UHCU.

- Peak Delay

Specify a delay time from the beginning point of the pulse period to the raising point.

- Peak Width

Specify a period of the pulse peak.

Step

The terminal outputs the constant voltage or current that the level is changed every time a sweep measurement is finished.

Set the following parameters.

- Step Mode

Select one from the following level change operation.

- LinearSingle: Constant level is changed by a constant step value.
- ListSingle: Constant level is changed according to the listed levels.

- Start

Specify the first step value.

Available for the “LinearSingle” Step Mode.


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- Stop

Specify the last step value.

Available for the “LinearSingle” Step Mode.

The following parameters can be shown or hidden by clicking the chevron  of the Details.

- Resource/Output Mode/Output Sequence

You can change the settings of this terminal using the pull-down menu. For details, see “Resource/Output Mode/Output Sequence” on page 4-57.

- Number of Step


Specify the number of steps.



Available for the “LinearSingle” Step Mode.


- List

Create the list of the output levels.

Available for the “ListSingle” Step Mode.

To insert a new step entry before the selected step value, click the Insert button .

To move the selected step value up/down, click the Move button  .

To delete the selected step value, click the Delete button .

- Compliance

Specify a current/voltage compliance value.

If the output exceeds this, the sweep measurement is terminated.

- Power Compliance

Specify the power compliance value.

To enable this, mark the check box.

If the output exceeds this, the sweep measurement is terminated.

Not available for HVSMU.

- Voltage Compliance

Specify a voltage compliance value for UHCU.

To enable this, mark the check box.

If the output exceeds this, the sweep measurement is terminated.

Available for UHCU.

Pulse Step

The terminal outputs the voltage or current pulse that the peak level is changed every time a sweep measurement is finished.

Set the following parameters.

- Step Mode

Select one from the following level change operations.

- LinearSingle: Peak level is changed by a constant step value.
- ListSingle: Peak level is changed according to the listed levels.

- Start


Specify the first pulse peak value.
Available for the “LinearSingle” Step Mode.



- Stop


Specify the last pulse peak value.
Available for the “LinearSingle” Step Mode.


- List

Create the list of the output levels.
Available for the “ListSingle” Step Mode.

To insert a new step entry before the selected step value, click the Insert button .

To move the selected step value up/down, click the Move button  .

To delete the selected step value, click the Delete button .

The following parameters can be shown or hidden by clicking the chevron  of the Details.

- Resource/Output Mode/Output Sequence

You can change the settings of this terminal using the pull-down menu. For details, see “Resource/Output Mode/Output Sequence” on page 4-57.

- Base

Specify a pulse base voltage/current value.

- Number of Step

Specify the number of steps.
Available for the “LinearSingle” Step Mode.

- Compliance

Specify a current/voltage compliance value.
If the output exceeds this, the sweep measurement is terminated.


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- Power Compliance
Specify the power compliance value.
To enable this, mark the check box.
If the output exceeds this, the sweep measurement is terminated.
Not available for HVSMU.
- Voltage Compliance
Specify a voltage compliance value for UHCU.
To enable this, mark the check box.
If the output exceeds this, the sweep measurement is terminated.
Available for UHCU.
- Peak Delay
Specify a delay time from the beginning point of the pulse period to the raising point.
- Peak Width
Specify a period of the pulse peak.

Staircase Sweep The terminal outputs the staircase-swept voltage/current.
Set the following parameters.

- Sweep Mode
Select one from the following sweep modes.
 - LinearSingle (Sweep from start to stop in a linear incremental step)
 - LogSingle (Sweep from start to stop in a logarithmic incremental step)
 - LinearDouble (Sweep from start to stop to start in a linear incremental step)
 - LogDouble (Sweep from start to stop to start in a logarithmic incremental step)
- Start
Specify the sweep start value.
- Stop
Specify the sweep stop value.

The following parameters can be shown or hidden by clicking the chevron  of the Details.

- Resource/Output Mode/Output Sequence

You can change the settings of this terminal using the pull-down menu. For details, see “Resource/Output Mode/Output Sequence” on page 4-57.

- Number of Step
Specify the number of sweep steps from start to stop.
- Compliance
Specify a current/voltage compliance value.
If the output exceeds this, the sweep measurement is terminated.
- Power Compliance
Specify the power compliance value.
To enable this, mark the check box.
If the output exceeds this, the sweep measurement is terminated.
Not available for HVSMU.
- Voltage Compliance
Specify a voltage compliance value for UHCU.
To enable this, mark the check box.
If the output exceeds this, the sweep measurement is terminated.
Available for UHCU.

Pulse Sweep


The terminal outputs the staircase-swept pulse voltage/current.

Set the following parameters.

- Sweep Mode
Select one from the following sweep modes.
 - LinearSingle (Sweep from start to stop in a linear incremental step)
 - LogSingle (Sweep from start to stop in a logarithmic incremental step)
 - LinearDouble (Sweep from start to stop to start in a linear incremental step)
 - LogDouble (Sweep from start to stop to start in a logarithmic incremental step)
- Start
Specify the sweep start value.
- Stop
Specify the sweep stop value.

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The following parameters can be shown or hidden by clicking the chevron  of the Details.

- Resource/Output Mode/Output Sequence
You can change the settings of this terminal using the pull-down menu. For details, see “Resource/Output Mode/Output Sequence” on page 4-57.
- Base
Specify a pulse base voltage/current value.
- Number of Step
Specify the number of sweep steps from start to stop.
- Compliance
Specify a current/voltage compliance value.
If the output exceeds this, the sweep measurement is terminated.
- Power Compliance
Specify the power compliance value.
To enable this, mark the check box.
If the output exceeds this, the sweep measurement is terminated.
Not available for HVSMU.
- Voltage Compliance
Specify a voltage compliance value for UHCU.
To enable this, mark the check box.
If the output exceeds this, the sweep measurement is terminated.
Available for UHCU.
- Peak Delay
Specify a delay time from the beginning point of the pulse period to the raising point.
- Peak Width
Specify a period of the pulse peak.

Resource/Output Mode/Output Sequence

Depending on the selected characteristics measurement, the pre-defined output mode and sequence are automatically selected. If necessary, you can change the measurement resource, the output mode, and the output sequence. Table 4-14 shows the available alternatives for the gate/base terminal, and Table 4-15 shows the available alternatives for the drain/collector terminal.

Table 4-14 Available Resource/Output Mode/Output Sequence for Gate/Base Terminal

Measurement Resource	Output Mode	Output Sequence
<ul style="list-style-type: none"> • MCSMU MCSMU is connected to this terminal. • MPSMU MPSMU is connected to this terminal. 	<ul style="list-style-type: none"> • V Specifies the DC voltage output. • VPulse Specifies the pulse voltage output. • I Specifies the DC current output. • IPulse Specifies the pulse current output. 	<ul style="list-style-type: none"> • Constant Specifies the constant bias output sequence. • Step Specifies the step bias output sequence. • Sweep Specifies the sweep output sequence.

Table 4-15

Available Resource/Output Mode/Output Sequence for Drain/Collector Terminal

Measurement Resource	Output Mode	Output Sequence
<ul style="list-style-type: none"> • Open No connection. This terminal is opened. • UHCU^a UHCU is connected to this terminal. • HCSMU^b HCSMU is connected to this terminal. • HVSMU HVSMU is connected to this terminal. • MPSMU MPSMU is connected to this terminal. 	<ul style="list-style-type: none"> • V^c Specifies the DC voltage output. • VPulse Specifies the pulse voltage output. • I^c Specifies the DC current output. • IPulse Specifies the pulse current output. 	<ul style="list-style-type: none"> • Constant Specifies the constant bias output sequence. • Step Specifies the step bias output sequence. • Sweep Specifies the sweep output sequence.

a. Available for B1506A-H71/H51.

b. Available for B1506A-H21.

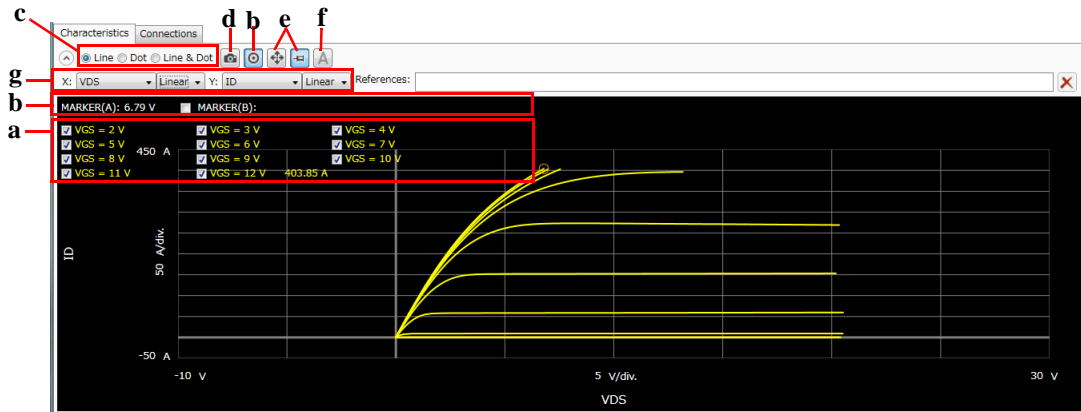
c. Not available for UHCU.

The combinations of the Output Mode and Output Sequence decide the types as shown in the following table.

Type	Output Mode	Output Sequence
Bias	V or I	Constant
Pulse Bias	VPulse or IPulse	Constant
Step	V or I	Step
Pulse Step	VPulse or IPulse	Step
Staircase Sweep	V or I	Sweep
Pulse Sweep	VPulse or IPulse	Sweep

Characteristics

Figure 4-13 Characteristics



This page shows the graph of the specified I/V characteristics as the measurement result. To display this page, click the Characteristics tab.

a. Displaying Characteristic Curves

The data for the X and Y-axes are assigned according to the I/V characteristics specified in the Setup.

If the graph has multiple characteristic curves for different measurement conditions, the measurement conditions are displayed on the graph with the check boxes. Marking the check box displays the characteristic curve for the measurement condition. You can mark multiple check boxes for the measurement conditions.

You can change the minimum and maximum values on the X and Y-axes by clicking the value.

b. Markers

This graph supports two kinds of markers: Domain marker and Trace marker. You can switch these markers by clicking the Marker button shown in the bottom part of the graph.



: Marker button when the Domain marker is used.



: Marker button when the Trace marker is used.

The Domain marker can read multiple characteristic values for the X-axis position.

The Domain marker supports two markers (A and B). Marker A is always available. To use the Marker B, mark the check box for the Marker B. The Marker B is a break line. To move the marker position, use the rotary knob or mouse.

The marker annotation on the graph has X-axis values for markers, and a difference value (Δ) between the Marker B and A (B–A). And, each curve annotation has Y-axis values and difference values (Δ) between the Marker B and A (B–A).


The Trace marker can read the characteristic value with tracing each characteristic curve. It is useful when you want to read the characteristic value on double sweep result.



The marker annotation on the graph has X-axis value for the marker. And, the traced curve annotation has Y-axis value.


c. Curve Representation

The curves can be represented as Line, Dot, or combination (Line & Dot). Select any curve representation using the radio buttons shown in the bottom part of the graph.

d. Reference Traces


You can register the presently-displayed curves as reference traces to compare with other measurement results on the graph. If you register them as reference traces, the reference traces are displayed as break lines on the graph when you open other measurement data files or execute the next measurement. To register as the reference traces, click the Capture button  shown in the bottom part of the graph.

You can register a maximum of 10 reference traces. The measurement data files registered as the reference traces are listed in the References field under the Capture button . You can show or hide the reference traces using the check boxes at the head of the measurement data file names. The References field can be shown or hidden by clicking the chevron  under the graph.

To remove unnecessary reference traces, select the measurement data file in the References field, and then click the Remove button .


The registration of the reference traces is cleared when you exit the I/V measurement software.


e. Auto Scale

Clicking the Auto Scale button  fits the measurement data at that time in the graph scale.


If the auto scale mode is selected by using the Scale mode button, the measurement data is automatically fit according to the progress of the measurement.

If the fixed scale mode is selected by using the Scale mode button, the scale is fixed until changing the scale manually or clicking the Auto Scale button.

 : Scale mode button during selecting the auto scale mode.

 : Scale mode button during selecting the fixed scale mode.


f. Trace Labels

The step values for the characteristic curves can be shown or hidden by clicking the Trace Label button .

In the case that multiple curves are displayed on the IV-VDS characteristic graph of MOSFET, IC-VCE characteristic graph of IGBT, and so on, the step value display is useful to identify which curve is for which step value.

g. X/Y Data

You can select the data and scale for the X and Y-axes. As default, the data for the X and Y-axes are assigned according to the I/V characteristics specified in the Setup.

The X/Y data field can be shown or hidden by clicking the chevron  under the graph.

Select one from the following scales.

- Linear
Linear scale
- PositiveLog
Logarithm scale for positive data
- NegativeLog
Logarithm scale for negative data

Select data for X and Y-axes corresponding to the specified device type. The following shows data corresponding to the device type.

For MOSFET:

- VDS: Drain-source voltage
- ID: Drain current
- RDS: Drain-source resistance
- VGS: Gate-source voltage
- IG: Gate current
- IS: Forward direction current of body diode (source current)
- VSD: Forward direction voltage of body diode (source-drain voltage)

For IGBT:

- VCE: Collector-emitter voltage
- IC: Collector current
- VGE: Gate-emitter voltage

- IG: Gate current

For Diode:

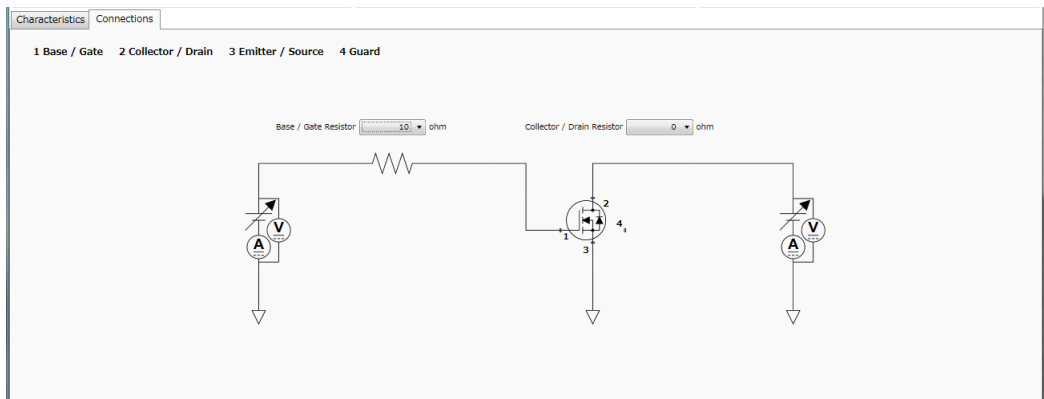
- VF: Forward direction voltage
- IF: Forward direction current
- VR: Reverse direction voltage
- IR: Reverse direction current

For Generic: same as data for MOSFET

Connections

Figure 4-14

Connections



This page shows the measurement circuit that is automatically connected according to your specified measurement conditions. To display this page, click the Connections tab.

On the measurement circuit, the measurement terminals, the measurement resources, and the built-in capacitance and resistance are displayed. The following shows the relationship between the terminal numbers and the measurement terminals.

- 1: Base/Gate terminal
- 2: Collector/Drain terminal
- 3: Emitter/Source terminal
- 4: Guard terminal

NOTE

If DUT is a diode, connect the cathode terminal to 2. Collector/Drain terminal, and the anode terminal to 3. Emitter/Source terminal.

Base/Gate Resistor

If the MCSMU is specified to the Base/Gate terminal as the measurement resource, you can select one from the following base/gate resistances.

- 0 Ω
- 10 Ω
- 100 Ω
- 1 k Ω

The base/gate resistance is effective to restrain the oscillation of DUT that occurs during the ultra high current measurement and so on.

Collector/Drain Resistor

If the MVSMU is specified to the Collector/Drain terminal as the measurement resource, you can select one from the following collector/drain resistances.

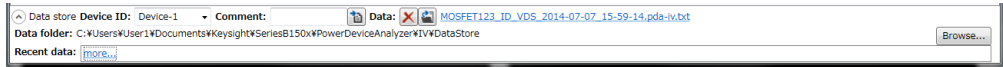
- 0 Ω
- 100 k Ω

The collector/drain resistance is effective to restrain the over current that occurs during the breakdown measurement and so on.

Data List

Figure 4-15

Data List



The data list area provides the following functions regarding the saving of the measurement data files.


- Set the device ID to be recorded to the measurement data file
See “Device ID” on page 4-65.
- Enter a comment to be recorded to the measurement data file
See “Comment” on page 4-65.
- Operations for the latest measurement data file
See “Data” on page 4-66.
- Access to the measurement data files that were automatically saved
See “Data store” on page 4-66.

The setup data and measurement data are automatically saved to a new measurement data file at the end of the measurement. At this time, you can also record a device ID to identify your DUT and a comment. And, the destination folder of the measurement data file for auto-saving is predefined. You can set the device ID and comment, and change the destination folder using this area.

Device ID

Enter device ID string to the Device ID field. The maximum 10 recently-entered device IDs can be kept as history, and you can also select one from the history list.


The entered device ID is automatically saved to the measurement data file at the end of the measurement.

You can also change the device ID in the latest measurement data file after the measurement here. To change it, change the device ID in the Device ID field, and then click the Apply button .

Comment



Enter a comment string to the Comment field.

The entered comment is automatically saved to the measurement data file at the end of the measurement.

You can also change the comment in the latest measurement data file after the measurement here. To change it, change the comment in the Comment field, and then click the Apply button .


Data

The Data field shows the latest auto-saved or last-opened measurement data file name. You can do the following operations.

- Open the measurement data file by clicking the Open button .
- Rename the measurement data file by clicking the measurement data file name.
- Delete the measurement data file by clicking the Delete button .

Data store

Using the following fields, you can change the destination folder of the auto-saved measurement data file, and access the auto-saved measurement data files.

The following fields can be shown or hidden by clicking the chevron  next to “Data store”.

Data folder Shows the absolute path of the auto-saved measurement data file. To change this, click the Browse button to open the folder selection dialog box. Select your desired folder in the dialog box.

For the initial setting of the data folder, see “Summary of Files” on page 4-68.

Recent data Shows up to 10 auto-saved measurement data files that were automatically saved recently, in the hyper-link format. Clicking the hyper-link opens the selected measurement data file. This destroys the presently-editing data.

If the number of the auto-saved measurement data files is over ten, this field shows “more...”. Clicking this opens the file selection dialog box. Select a measurement data file to open.

Dialog Boxes

Change Device ID Dialog Box

The Change Device ID dialog box is used to change the device ID in all selected measurement data files at once.

- Device ID field** Enter a new device ID. You can also select it from the history.
- Add... button** Opens the file selection dialog box to select the measurement data file(s) that you want to change the device ID. The selected files are displayed into the list.
- Remove button** Excludes the selected measurement data file from the list.
- Execute button** Changes the device ID.
- Close button** Closes this dialog box.

This dialog box is opened by selecting the main menu File > Change Device ID....

Color Setting Dialog Box

The Color Setting dialog box is used to set colors of parts in this software.

The graph elements supported by this dialog box are graph background, X and Y-axes, graph grid, graph text, marker, and trace. Clicking the color pattern opens the dialog box for selecting a color.

The setting in the Color Setting dialog box is saved as a user setting.

- Apply button** Applies the present setting to the graph.
- Reset button** Resets to the default setting.
- OK button** Applies the present setting to the graph, and closes this dialog box.
- Cancel button** Closes this dialog box without applying the present setting.

This dialog box is opened by selecting the main menu View > Color Settings....

About Box Dialog Box

The About Box dialog box displays the model number, the software revision number, download URL for software updating, and so on.

This dialog box is opened by selecting the main menu Help > About....

Summary of Files

The following shows the summary of the files handled by the I/V measurement software.

Table 4-16 Summary of Files

File Type	Description	Extension	Folder as Initial Setting
Setup File	Setup data You can save this if needed.	*.pda-iv	(You can specify the folder when saving the data)
Measurement Data File	Setup data and measurement data including the device ID and comment This is automatically saved after the measurement. You can optionally save this.	*.pda-iv.txt	C:\Users\ <user name="">\Documents\Keysight\SeriesB150x\PowerDeviceAnalyzer\IV\DataStore (You can change this)</user>

File name of Measurement Data File on Auto-saving

An auto-saved measurement data file is named as the following rule.

1. Concatenates the device ID, available thermometer readings, and date and time on save by an underscore (_).

The available thermometer readings are characters of the available thermometer identifiers set in the “Thermal Monitor/Control Software” on page 4-138, and their readings as shown in the following syntax.

@<thermometer>=<reading>degC[_<thermometer>=<reading>degC[...]]

- <thermometer>

An identifier of the available thermometer

Ch1 Channel 1 thermometer of B1506A

Ch2 Channel 2 thermometer of B1506A

Air Thermometer on the air outlet port of the ThermoStream

DUT Thermometer on the DUT port of the ThermoStream

- <reading>

A reading value of the thermometer in degrees centigrade

Example) @Ch1=25degC_Ch2=75degC_Air=100degC

2. Concatenates the file extension (.pda-iv.txt) to the end of the “step 1” string.
3. If the “step 2” file name duplicates the existing file name, concatenates the serial number from 2 enclosed by brackets and the file extension to the end of the “step 1” string.

Capacitance Measurement Software

Capacitance measurement software provides:

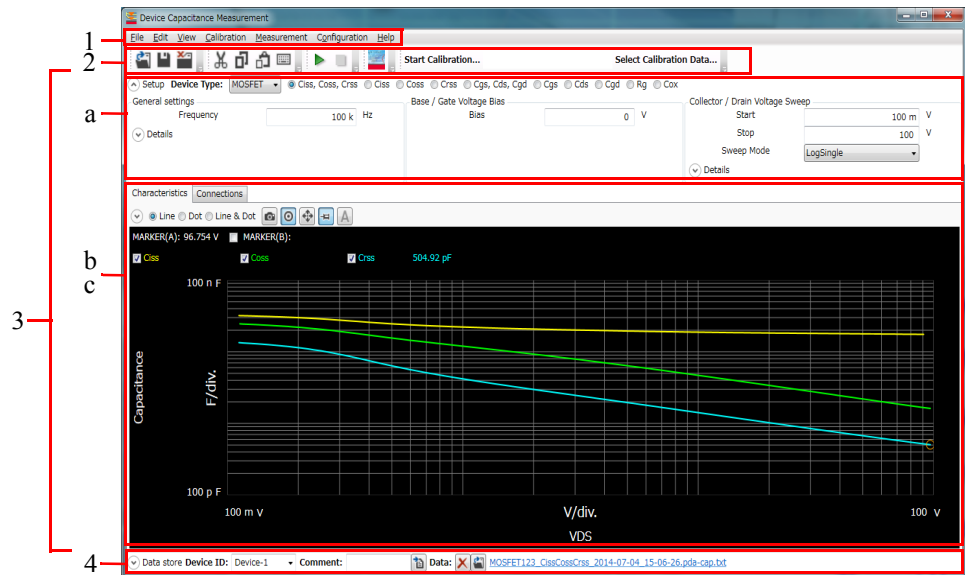
- Automated measurement circuit configuration for three-terminal device capacitance measurement (e.g. Ciss, Coss and Crss), with no need to manually modify any device connections
 - With DC bias (sweep) control up to 3 kV for Collector/Drain terminal
 - With DC bias (sweep) control up to 100 V for Base/Collector terminal
- Automated correction for every measurement path
- Stable measurements even if the low-side load capacitance changes due to a bias change (load adaptive gain-phase compensation)
- Predefined templates for typical capacitance measurements of both enhancement and depletion type MOSFETs, IGBTs and Diodes

GUI Overview

The GUI (Graphical User Interface) of the capacitance measurement software is comprised of the following areas.

Figure 4-16

Capacitance Measurement Software GUI



1. “Main Menu” on page 4-72
This provides the functions needed for various operations in the menu format.
2. “Toolbar” on page 4-75
This provides the functions that are very frequently used in the button format.
3. “Work Area” on page 4-77
This area provides the functions to set the measurement conditions and observe the measurement results. This is separated to the following areas.
 - a. “Setup” on page 4-77
 - b. “Characteristics” on page 4-86
 - c. “Connections” on page 4-90
4. “Data List” on page 4-94

GUI Reference

Capacitance Measurement Software

This area provides the functions regarding the saving of the measurement data files.

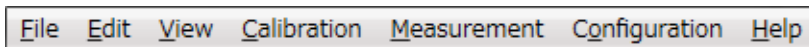
For the dialog boxes displayed during this software operation, see “Dialog Boxes” on page 4-96.

For the files handled by this software, see “Summary of Files” on page 4-97.

Main Menu

Figure 4-17

Main Menu



The following shows the structure of the main menu.

File Menu

Displays the following menu items to operate the setup file and measurement data file. For the kinds of the files and file extensions, see “Summary of Files” on page 4-97.

New	Creates a new setup. This destroys the setup that you are editing, and creates a new setup.
Open...	Opens an existing setup file or measurement data file. This opens the file selection dialog box, destroys the setup that you are editing, and then opens the file selected in the dialog box.
Save	Saves the setup that you are editing to the original setup file.
Save Setup As...	Saves the setup that you are editing to the specified setup file. This opens the file selection dialog box, and saves the present setup to the specified setup file.
Save Data As...	Saves the present setup data and measurement data to the specified measurement data file. This opens the file selection dialog box, and saves the present setup data and measurement data to the specified measurement data file.
Change Device ID...	Changes the device ID recorded in the measurement data file.

This opens the Change Device ID dialog box, and changes the device ID recorded in the selected measurement data file(s). See “Change Device ID Dialog Box” on page 4-96.

Recent Setup Files

Lists a maximum of 10 names of the setup files that were recently edited, as menu items. You can easily open a setup file by using them.

Exit

Exits the capacitance measurement software. Unsaved data is destroyed.

Edit Menu

Displays the following menu items to edit the setup.

Cut

Moves the selected text to the clipboard.

Copy

Copies the selected text to the clipboard.

Paste

Pastes the text from the clipboard to the insertion point.

**On-screen
keyboard...**

Displays the on-screen keyboard.

View Menu

Displays the following menu items for the display setting.

Go to Palette

Displays the Software Palette in fullscreen mode.

Main Window

Displays the following menu item.

Fullscreen

Changes the display style of the main window.

If this is marked, the main window does not have the titlebar and is displayed in fullscreen mode.

If this is unmarked, the main window has the titlebar and is displayed in the regular window style.

This is initially marked.

Color Settings...

Opens the Color Setting dialog box to set the color for parts in this software. See “Color Setting Dialog Box” on page 4-96.

Calibration Menu

Displays the following menu items for the calibration.

Start

Starts to get the calibration data.

GUI Reference

Capacitance Measurement Software


Open or short the measurement circuit according to instructions of the wizard.

Select Data Opens the file selection dialog box, and then applies the selected calibration data file to the measurement.

Measurement Menu

Displays the following menu items for controlling the measurement.

Start Starts a measurement. During the measurement, the measurement status indicator on the front panel lights up.

To stop the measurement, select the Measurement > Stop menu, click the Stop Measurement button  on the toolbar, or press the Stop key on the front panel.

Stop Stops the measurement.

Configuration Menu

Displays the following menu item to administrate the configuration of the built-in modules in the mainframe and test fixture.

Module... Opens the Module Configuration dialog box. See “Module Configuration Dialog Box” on page 4-158.

Help Menu

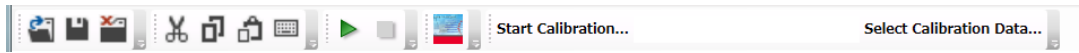
Displays the following menu item.

About... Opens the About Box dialog box. See “About Box Dialog Box” on page 4-96.

Toolbar

Figure 4-18

Toolbar



The toolbar has five tool button groups. The following shows the tool buttons in the tool button groups.

File tool button group



Open

Opens an existing setup file or measurement data file.

This opens the file selection dialog box, destroys the setup that you are editing, and then opens the file selected in the dialog box.



Save

Saves the setup that you are editing to the original setup file.



Exit

Exits the capacitance measurement software. Unsaved data is destroyed.

Edit tool button group



Cut

Moves the selected text to the clipboard.



Copy

Copies the selected text to the clipboard.



Paste

Pastes the text from the clipboard to the insertion point.



On-screen keyboard

Displays the on-screen keyboard.

Measurement tool button group


GUI Reference

Capacitance Measurement Software



Start Measurement

Starts a measurement. During the measurement, the measurement status indicator on the front panel lights up.

To stop the measurement, select the Measurement > Stop menu, click the Stop Measurement button  on the toolbar, or press the Stop key on the front panel.



Stop Measurement

Stops the measurement.

View tool button group



Go to Palette

Displays the Software Palette in fullscreen mode.

Calibration tool button group

Start Calibration...

Starts to get the calibration data.

Open or short the measurement circuit according to instructions of the wizard.

Select Calibration Data...

Opens the file selection dialog box, and then applies the selected calibration data file to the measurement.

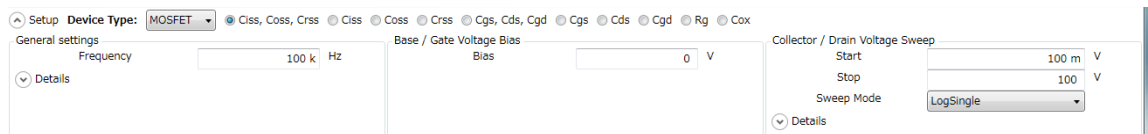
Work Area

In this area, set the measurement conditions and observe the measurement results. This is separated to the following areas.

- “Setup” on page 4-77
- “Characteristics” on page 4-86
- “Connections” on page 4-90

Setup

Figure 4-19



This is an area to select the device type and its measured parameters, and enter your measurement conditions.

Device Type

Select the device type of your DUT from below.

- “MOSFET”
- “IGBT”
- “Diode”
- “Generic”

Select Generic to execute more general measurements for device other than above types.

MOSFET

You can select one of the following capacitance and resistance parameter measurements for “MOSFET” device type.

- Ciss, Coss, Crss

Creates new settings to measure the characteristics of the input capacitance, output capacitance, and reverse transfer capacitance for the drain-source voltage in order.

- Ciss

Creates new settings to measure the characteristics of the input capacitance for the drain-source voltage.

GUI Reference

Capacitance Measurement Software

- Coss
Creates new settings to measure the characteristics of the output capacitance for the drain-source voltage.
- Crss
Creates new settings to measure the characteristics of the reverse transfer capacitance for the drain-source voltage.
- Cgs, Cds, Cgd
Creates new settings to measure the characteristics of the gate-source capacitance, drain-source capacitance, and gate-drain capacitance for the drain-source voltage in order.
- Cgs
Creates new settings to measure the characteristics of the gate-source capacitance for the drain-source voltage.
- Cds
Creates new settings to measure the characteristics of the drain-source capacitance for the drain-source voltage.
- Cgd
Creates new settings to measure the characteristics of the gate-drain capacitance for the drain-source voltage.
- Rg
Creates new settings to measure the characteristics of the gate resistance for the gate-source voltage.
- Cox
Creates new settings to measure the characteristics of the gate oxide capacitance for the gate-source voltage.

IGBT

You can select one of the following capacitance and resistance parameter measurements for “IGBT” device type.

- Cies, Coes, Cres
Creates new settings to measure the characteristics of the input capacitance, output capacitance, and reverse transfer capacitance for the collector-emitter voltage in order.
- Cies

Creates new settings to measure the characteristics of the input capacitance for the collector-emitter voltage.

- Coes

Creates new settings to measure the characteristics of the output capacitance for the collector-emitter voltage.

- Cres

Creates new settings to measure the characteristics of the reverse transfer capacitance for the collector-emitter voltage.

- Cge, Cce, Cgc

Creates new settings to measure the characteristics of the gate-emitter capacitance, collector-emitter capacitance, and gate-collector capacitance for the collector-emitter voltage in order.

- Cge

Creates new settings to measure the characteristics of the gate-emitter capacitance for the collector-emitter voltage.

- Cce

Creates new settings to measure the characteristics of the collector-emitter capacitance for the collector-emitter voltage.

- Cgc

Creates new settings to measure the characteristics of the gate-collector capacitance for the collector-emitter voltage.

- Rg

Creates new settings to measure the characteristics of the gate resistance for the gate-emitter voltage.

Diode

You can select the following capacitance parameter measurements for “Diode” device type.

- CT

Creates new settings to measure the characteristics of the total anode-cathode capacitance for the reverse bias voltage.

Generic

You can select one of the following measurements for “Generic” device type.

- Collector/Drain Voltage Sweep

GUI Reference

Capacitance Measurement Software

Creates new settings to measure the Cp-G model capacitance between the collector/drain and the emitter/source terminals for the swept collector-emitter or drain-source voltage.

- Base/Gate Voltage Sweep

Creates new settings to measure the Cs-Rs model capacitance between the base/gate and the emitter/source terminals for the swept base-emitter or gate-source voltage.

General settings

In this area, you can set the following measurement conditions.

- Frequency

Specify the output frequency of the AC signal from MFCMU.
Setting range: 1 kHz to 1 MHz

- AC Level

Specify the output level of the AC signal from MFCMU.
Setting range: 0 to 250 mV

- N PLC

Specify the measurement time (integral time) in the number of power line cycle.
Setting range: 1 to 100

- Phase Compensation

Specify one from the following phase compensation modes.


- Auto

Uses the predefined phase compensation data.

- Adaptive

Compensates the phase at each measurement point before the measurement.

It is useful when you cannot measure in the Auto compensation mode by MFCMU oscillation.

The following parameter can be shown or hidden by clicking the chevron  of the Details.

- AC Level
- N PLC
- Phase Compensation

Base/Gate drive settings

Specify the output settings for the base-collector or gate-source voltage. You can set them up depending on the types of the selected measurement: forcing the constant bias voltage or sweeping the bias voltage.

Base/Gate Voltage Bias:

You can specify the following parameters to force the constant bias voltage.

- Bias
Specify the bias voltage.
Setting range: -100 V to +100 V

Base/Gate Voltage Sweep:

You can specify the following parameters to sweep the bias voltage.

- Start
Specify the sweep start value.
Setting range: -100 V to +100 V
- Stop
Specify the sweep stop value.
Setting range: -100 V to +100 V
- Sweep Mode
Select one from the following sweep modes.
 - LinearSingle (Sweep from start to stop in a linear incremental step)
 - LogSingle (Sweep from start to stop in a logarithmic incremental step)
 - LinearDouble (Sweep from start to stop to start in a linear incremental step)
 - LogDouble (Sweep from start to stop to start in a logarithmic incremental step)
- Number of Step
Specify the number of sweep steps from start to stop.
Setting range: 1 to 1001
- Hold Time
Specify the hold time of the sweep start voltage. At the sweep start point, the start voltage is forced for more than the specified time.
Setting range: 0 to 655.35 s
- Delay Time

GUI Reference

Capacitance Measurement Software

Specify the delay time of the measurement at each sweep step. The measurement is executed after waiting for more than the specified time at each sweep step.
Setting range: 0 to 65.535 s


- Zero Bias Time

Keeps 0 V at every terminal for more than the specified time after one sweep measurement.

Setting range: 0 to 99.9 s

In the measurement of the same capacitance parameter as shown in the following table, the characteristics results by the single measurement and the continuous measurement may have the difference depending on the bias voltage condition between the measurements. This parameter is used to cancel the dependence on the bias voltage condition in the continuous measurement.

Device Type	Continuous Measurement	Single Measurement
MOSFET	<ul style="list-style-type: none"> • Ciss, Coss, Crss 	<ul style="list-style-type: none"> • Ciss • Coss • Crss
	<ul style="list-style-type: none"> • Cgs, Cds, Cgd 	<ul style="list-style-type: none"> • Cgs • Cds • Cgd
IGBT	<ul style="list-style-type: none"> • Cies, Coes, Cres 	<ul style="list-style-type: none"> • Cies • Coes • Cres
	<ul style="list-style-type: none"> • Cge, Cce, Cgc 	<ul style="list-style-type: none"> • Cge • Cce • Cgc

The following parameter can be shown or hidden by clicking the chevron  of the Details.

- Number of Step

- Hold Time
- Delay Time
- Zero Bias Time

Collector/Drain drive settings

Specify the output settings for the collector-emitter or drain-source voltage. You can set them up depending on the types of the selected measurement: forcing the constant bias voltage or sweeping the bias voltage.

Collector/Drain Voltage Bias:

You can specify the following parameters to force the constant bias voltage.

- Bias

Specify the bias voltage.

Setting range: -3000 V to +3000 V

Collector/Drain Voltage Sweep:

You can specify the following parameters to sweep the bias voltage.

- Start

Specify the sweep start value.

Setting range: -3000 V to +3000 V

- Stop

Specify the sweep stop value.

Setting range: -3000 V to +3000 V

- Sweep Mode

Select one from the following sweep modes.

- LinearSingle (Sweep from start to stop in a linear incremental step)
- LogSingle (Sweep from start to stop in a logarithmic incremental step)
- LinearDouble (Sweep from start to stop to start in a linear incremental step)
- LogDouble (Sweep from start to stop to start in a logarithmic incremental step)

- Number of Step

Specify the number of sweep steps from start to stop.

Setting range: 1 to 1001

- Hold Time

GUI Reference
 Capacitance Measurement Software

Specify the hold time of the sweep start voltage. At the sweep start point, the start voltage is forced for more than the specified time.

Setting range: 0 to 655.35 s

- Delay Time

Specify the delay time of the measurement at each sweep step. The measurement is executed after waiting for more than the specified time at each sweep step.

Setting range: 0 to 65.535 s


- Zero Bias Time

Keeps 0 V at every terminal for more than the specified time after one sweep measurement.

Setting range: 0 to 99.9 s

In the measurement of the same capacitance parameter as shown in the following table, the characteristics results by the single measurement and the continuous measurement may have the difference depending on the bias voltage condition between the measurements. This parameter is used to cancel the dependence on the bias voltage condition in the continuous measurement.

Device Type	Continuous Measurement	Single Measurement
MOSFET	<ul style="list-style-type: none"> • Ciss, Coss, Crss 	<ul style="list-style-type: none"> • Ciss • Coss • Crss
	<ul style="list-style-type: none"> • Cgs, Cds, Cgd 	<ul style="list-style-type: none"> • Cgs • Cds • Cgd
IGBT	<ul style="list-style-type: none"> • Cies, Coes, Cres 	<ul style="list-style-type: none"> • Cies • Coes • Cres
	<ul style="list-style-type: none"> • Cge, Cce, Cgc 	<ul style="list-style-type: none"> • Cge • Cce • Cgc

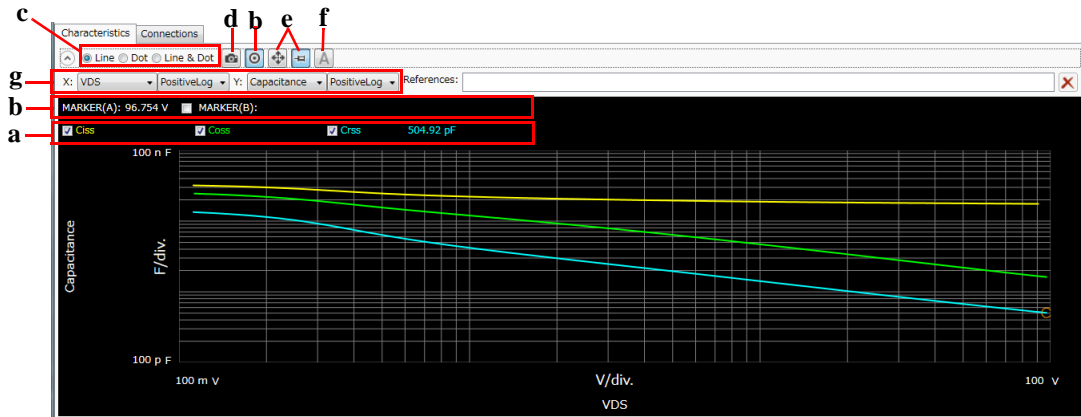
The following parameter can be shown or hidden by clicking the chevron  of the Details.

- Number of Step
- Hold Time
- Delay Time
- Zero Bias Time

Characteristics

Figure 4-20

Characteristics



This page shows the graph of the specified parameter characteristics as the measurement result. To display this page, click the Characteristics tab.

a. Displaying Characteristic Curves



The data for the X and Y-axes are assigned according to the parameter characteristics specified in the Setup.

If the graph has multiple characteristic curves for different measurement conditions, the measurement conditions are displayed on the graph with the check boxes. Marking the check box displays the characteristic curve for the measurement condition. You can mark multiple check boxes for the measurement conditions.

You can change the minimum and maximum values on the X and Y-axes by clicking the value.

b. Markers

This graph supports two kinds of markers: Domain marker and Trace marker. You can switch these markers by clicking the Marker button shown in the bottom part of the graph.

-  : Marker button when the Domain marker is used.
-  : Marker button when the Trace marker is used.

The Domain marker can read multiple characteristic values for the X-axis position.

The Domain marker supports two markers (A and B). Marker A is always available. To use the Marker B, mark the check box for the Marker B. The Marker B is a break line. To move the marker position, use the rotary knob or mouse.

The marker annotation on the graph has X-axis values for markers, and a difference value (Δ) between the Marker B and A (B–A). And, each curve annotation has Y-axis values and difference values (Δ) between the Marker B and A (B–A).


The Trace marker can read the characteristic value with tracing each characteristic curve. It is useful when you want to read the characteristic value on double sweep result.



The marker annotation on the graph has X-axis value for the marker. And, the traced curve annotation has Y-axis value.


c. Curve Representation

The curves can be represented as Line, Dot, or combination (Line & Dot). Select any curve representation using the radio buttons shown in the bottom part of the graph.

d. Reference Traces


You can register the presently-displayed curves as reference traces to compare with other measurement results on the graph. If you register them as reference traces, the reference traces are displayed as break lines on the graph when you open other measurement data files or execute the next measurement. To register as the reference traces, click the Capture button  shown in the bottom part of the graph.

You can register a maximum of 10 reference traces. The measurement data files registered as the reference traces are listed in the References field under the Capture button . You can show or hide the reference traces using the check boxes at the head of the measurement data file names. The References field can be shown or hidden by clicking the chevron  under the graph.

To remove unnecessary reference traces, select the measurement data file in the References field, and then click the Remove button .

The registration of the reference traces is cleared when you exit the capacitance measurement software.

e. Auto Scale

Clicking the Auto Scale button  fits the measurement data at that time in the graph scale.

If the auto scale mode is selected by using the Scale mode button, the measurement data is automatically fit according to the progress of the measurement.

If the fixed scale mode is selected by using the Scale mode button, the scale is fixed until changing the scale manually or clicking the Auto Scale button.



: Scale mode button during selecting the auto scale mode.




: Scale mode button during selecting the fixed scale mode.

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Capacitance Measurement Software


f. Trace Labels

The step values for the characteristic curves can be shown or hidden by clicking the Trace Label button .

In the case that multiple curves (Ciss, Coss, and Crss of MOSFET, and so on) are displayed on the graph, the parameter name display is useful to identify which curve is for which parameter.

g. X/Y Data

You can select the data and scale for the X and Y-axes. As default, the data for the X and Y-axes are assigned according to the parameter characteristics specified in the Setup.

The X/Y data field can be shown or hidden by clicking the chevron  under the graph.

Select one from the following scales.

- Linear
Linear scale
- PositiveLog
Logarithm scale for positive data
- NegativeLog
Logarithm scale for negative data

Select data for X and Y-axes. The data corresponding to the parameter specified in the Setup is represented as Capacitance, Conductance, or Resistance.

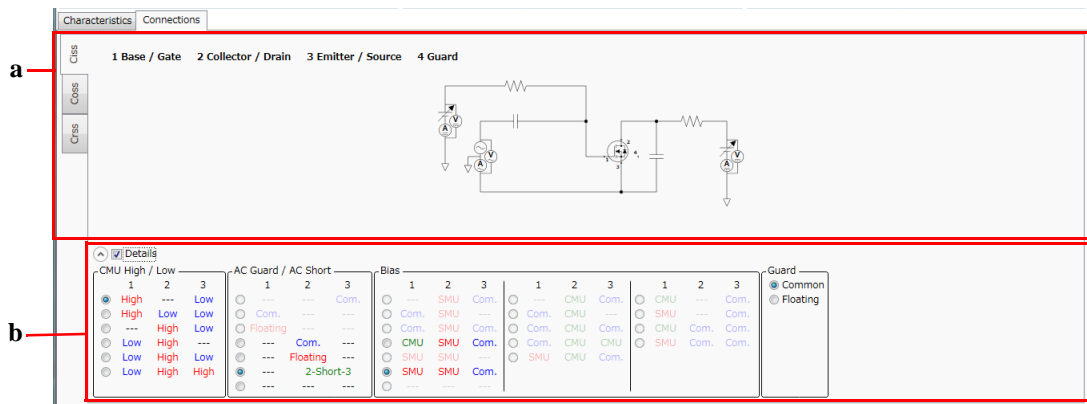
For example, in the case of the Ciss measurement, Cp is represented as Capacitance and G is represented as Conductance. In like manner, in the case of the Rs measurement, Rs is represented as Resistance and Cs is represented as Capacitance.

- Cp
Parallel capacitance on the Cp-G model
- G
Conductance on the Cp-G model
- Cs
Serial capacitance on the Cs-Rs model
- Rs
Serial resistance on the Cs-Rs model
- Ls

- Serial inductance on the Ls-Rs model
- Lp
Parallel inductance on the Lp-G model
- R
Resistance on the R-X (impedance) model
- X
Reactance on the R-X (impedance) model
- G
Conductance on the G-B (admittance) model
- B
Susceptance on the G-B (admittance) model
- VGS (for MOSFET)/VGE (for IGBT)
Gate-source voltage or base-emitter voltage
- IG
Gate or base current
- VDS (for MOSFET)/VCE (for IGBT)
Drain-source voltage or collect-emitter voltage
- ID (for MOSFET)/IC (for IGBT)
Drain or collector current

Connections

Figure 4-21 Connections



This page shows the measurement circuit that is automatically connected according to your specified measurement conditions. To display this page, click the Connections tab.

a. Measurement Circuit

On the measurement circuit, the measurement terminals, the measurement resources, and the built-in capacitance and resistance are displayed. The following shows the relationship between the terminal numbers and the measurement terminals.

- 1: Base/Gate terminal
- 2: Collector/Drain terminal
- 3: Emitter/Source terminal
- 4: Guard terminal

NOTE

If DUT is a diode, connect the cathode terminal to 2. Collector/Drain terminal, and the anode terminal to 3. Emitter/Source terminal.

In the case that the specified parameter characteristics has multiple measurements such as Ciss, Coss, and Crss measurements, the measurement circuits are respectively separated for the measurements by left-side tabs.

b. Details

This area is hidden as default. You can show this area under the measurement circuit by clicking the chevron (⌵) of the Details.

This area shows the connection status for the terminals in the table format. To edit the settings, mark the check box in this area. You can set up the connections by the combination of the following items.

- CMU High/Low

Select a combination of connections between the DUT terminals (1 to 3) and the CMU terminals (High and Low).

- High** Connects the DUT terminal to the High terminal of CMU.
- Low** Connects the DUT terminal to the Low terminal of CMU.
- No connection

- AC Guard/AC Short

Select a combination of connections between the DUT terminals (1 to 3) and AC Guard terminal, or AC short connection between the DUT terminals 2 and 3.

- Com.** Connects the DUT terminal to the circuit common directly.
- Floating** Connects the DUT terminal to the selected bias source or the circuit common via the built-in capacitor.
- 2-Short-3** Shorts between DUT terminals 2 and 3 via the built-in capacitor.
- No connection

- Bias

Select a combination of connections between the DUT terminals (1 to 3) and the DC bias source (SMU, CMU, or Common).

- CMU** Uses the bias source in the CMU that is connected.
- SMU** Connects the DUT terminal to an SMU as the bias source.
- Com.** Connects the DUT terminal to the circuit common.
- No connection

- Guard

Select a connection between the DUT terminal 4 and AC Guard terminal.

- Com.** Connects the DUT terminal 4 to circuit common directly.
- Floating** Connects the DUT terminal 4 to the selected bias source or the circuit common via the built-in capacitor.

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The following table shows applicable connections between the DUT terminals and the measurement resources. The rightmost column shows the potential at the DUT terminal 4 when it is connected to the AC Guard terminal in the built-in capacitor (Floating connection). In the table, the blank cell means “same as above”.

Table 4-17 **Applicable Connections**

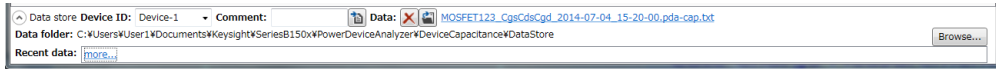
CMU High/Low			AC Guard/AC Short			Bias			Guard
1	2	3	1	2	3	1	2	3	Floating
High	---	Low	---	Com.	---	CMU	Com.	Com.	AC Guard
						SMU	Com.	Com.	AC Guard
			---	Floating	---	CMU	SMU	Com.	Terminal 2
						SMU	SMU	Com.	Terminal 2
						CMU	---	Com.	AC Guard
						SMU	---	Com.	AC Guard
			---	2-Short-3		CMU	SMU	Com.	Terminal 2
						SMU	SMU	Com.	Terminal 2
High	Low	Low	---	---	---	CMU	Com.	Com.	AC Guard
						SMU	Com.	Com.	AC Guard
---	High	Low	Com.	---	---	Com.	SMU	Com.	AC Guard
			Floating	---	---	SMU	SMU	Com.	AC Guard
						---	CMU	Com.	AC Guard
						SMU	CMU	Com.	AC Guard
Low	High	---	---	---	Com.	Com.	SMU	Com.	AC Guard
						SMU	SMU	Com.	AC Guard
						Com.	CMU	Com.	AC Guard
						SMU	CMU	Com.	AC Guard
Low	High	Low	---	---	---	Com.	SMU	Com.	AC Guard

CMU High/Low			AC Guard/AC Short			Bias			Guard
1	2	3	1	2	3	1	2	3	Floating
						SMU	SMU	Com.	AC Guard
						Com.	CMU	Com.	AC Guard
						SMU	CMU	Com.	AC Guard
Low	High	High	---	---	---	Com.	CMU	CMU	AC Guard

Data List

Figure 4-22

Data List



The data list area provides the following functions regarding the saving of the measurement data files.


- Set the device ID to be recorded to the measurement data file
See “Device ID” on page 4-94.
- Enter a comment to be recorded to the measurement data file
See “Comment” on page 4-94.
- Operations for the latest measurement data file
See “Data” on page 4-95.
- Access to the measurement data files that were automatically saved
See “Data store” on page 4-95.

The setup data and measurement data are automatically saved to a new measurement data file at the end of the measurement. At this time, you can also record a device ID to identify your DUT and a comment. And, the destination folder of the measurement data file for auto-saving is predefined. You can set the device ID and comment, and change the destination folder using this area.

Device ID

Enter device ID string to the Device ID field. The maximum 10 recently-entered device IDs can be kept as history, and you can also select one from the history list.


The entered device ID is automatically saved to the measurement data file at the end of the measurement.

You can also change the device ID in the latest measurement data file after the measurement here. To change it, change the device ID in the Device ID field, and then click the Apply button .

Comment



Enter a comment string to the Comment field.

The entered comment is automatically saved to the measurement data file at the end of the measurement.

You can also change the comment in the latest measurement data file after the measurement here. To change it, change the comment in the Comment field, and then click the Apply button .


Data

The Data field shows the latest auto-saved or last-opened measurement data file name. You can do the following operations.

- Open the measurement data file by clicking the Open button .
- Rename the measurement data file by clicking the measurement data file name.
- Delete the measurement data file by clicking the Delete button .

Data store

Using the following fields, you can change the destination folder of the auto-saved measurement data file, and access the auto-saved measurement data files.

The following fields can be shown or hidden by clicking the chevron  next to “Data store”.

Data folder Shows the absolute path of the auto-saved measurement data file. To change this, click the Browse button to open the folder selection dialog box. Select your desired folder in the dialog box.

For the initial setting of the data folder, see “Summary of Files” on page 4-97.

Recent data Shows up to 10 auto-saved measurement data files that were automatically saved recently, in the hyper-link format. Clicking the hyper-link opens the selected measurement data file. This destroys the presently-editing data.

If the number of the auto-saved measurement data files is over ten, this field shows “more...”. Clicking this opens the file selection dialog box. Select a measurement data file to open.

Dialog Boxes

Change Device ID Dialog Box

The Change Device ID dialog box is used to change the device ID in all selected measurement data files at once.

- | | |
|------------------------|---|
| Device ID field | Enter a new device ID. You can also select it from the history. |
| Add... button | Opens the file selection dialog box to select the measurement data file(s) that you want to change the device ID. The selected files are displayed into the list. |
| Remove button | Excludes the selected measurement data file from the list. |
| Execute button | Changes the device ID. |
| Close button | Closes this dialog box. |

This dialog box is opened by selecting the main menu File > Change Device ID....

Color Setting Dialog Box

The Color Setting dialog box is used to set colors of parts in this software.

The graph elements supported by this dialog box are graph background, X and Y-axes, graph grid, graph text, marker, and three traces. Clicking the color pattern opens the dialog box for selecting a color.

The setting in the Color Setting dialog box is saved as a user setting.

- | | |
|----------------------|---|
| Apply button | Applies the present setting to the graph. |
| Reset button | Resets to the default setting. |
| OK button | Applies the present setting to the graph, and closes this dialog box. |
| Cancel button | Closes this dialog box without applying the present setting. |

This dialog box is opened by selecting the main menu View > Color Settings....

About Box Dialog Box

The About Box dialog box displays the model number, the software revision number, download URL for software updating, and so on.

This dialog box is opened by selecting the main menu Help > About....

Summary of Files

The following shows the summary of the files handled by the capacitance measurement software.

Table 4-18 Summary of Files

File Type	Description	Extension	Folder as Initial Setting
Setup File	Setup data You can save this if needed.	*.pda-cap	(You can specify the folder when saving the data)
Measurement Data File	Setup data and measurement data including the device ID and comment This is automatically saved after the measurement. You can optionally save this.	*.pda-cap.txt	C:\Users\<<user name>\Documents\Keysight\SeriesB150x\PowerDevice Analyzer\DeviceCapacitance\DataStore (You can change this)
Calibration Data File	Calibration data This is automatically saved after the calibration execution.	*.pda-cap.cal	C:\ProgramData\Keysight\SeriesB150x\PowerDevice Analyzer\DeviceCapacitance\UserCalibrationData
	Factory Default Calibration data This is used when there is no user calibration data.		C:\ProgramData\Keysight\SeriesB150x\PowerDevice Analyzer\DeviceCapacitance\CalibrationData

File name of Measurement Data File on Auto-saving

An auto-saved measurement data file is named as the following rule.

1. Concatenates the device ID, available thermometer readings, and date and time on save by an underscore (_).

The available thermometer readings are characters of the available thermometer identifiers set in the “Thermal Monitor/Control Software” on page 4-138, and their readings as shown in the following syntax.

@<thermometer>=<reading>degC[_<thermometer>=<reading>degC[...]]

- <thermometer>

An identifier of the available thermometer

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Capacitance Measurement Software

Ch1	Channel 1 thermometer of B1506A
Ch2	Channel 2 thermometer of B1506A
Air	Thermometer on the air outlet port of the ThermoStream
DUT	Thermometer on the DUT port of the ThermoStream

- <reading>

A reading value of the thermometer in degrees centigrade

Example) @Ch1=25degC_Ch2=75degC_Air=100degC

2. Concatenates the file extension (.pda-cap.txt) to the end of the “step 1” string.
3. If the “step 2” file name duplicates the existing file name, concatenates the serial number from 2 enclosed by brackets and the file extension to the end of the “step 1” string.

Gate Charge Measurement Software

Gate charge measurement Software provides;

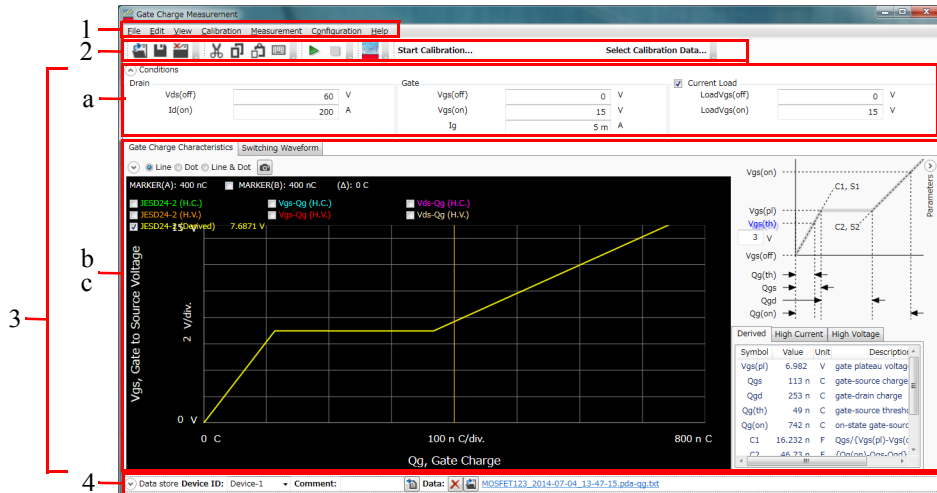
- Support for both constant current load mode and resistive load mode
- Correction of parasitic capacitance and residual resistance in the gate path
- Monitoring of gate and drain/collector voltage/ and current waveforms during the DUT turn-on period phase
- JESD24-2 compliant Qg curve, line fitting and parameter extraction

GUI Overview

The GUI (Graphical User Interface) of the gate charge measurement software is comprised of the following areas.

Figure 4-23

Gate Charge Measurement Software GUI



1. “Main Menu” on page 4-101
This provides the functions needed for various operations in the menu format.
2. “Toolbar” on page 4-104
This provides the functions that are very frequently used in the button format.
3. “Work Area” on page 4-106
This area provides the functions to set the measurement conditions and observe the measurement results. This is separated to the following areas.
 - a. “Conditions” on page 4-106
 - b. “Gate Charge Characteristics” on page 4-108
 - c. “Switching Waveform” on page 4-111
4. “Data List” on page 4-116
This area provides the functions regarding the saving of the measurement data files.

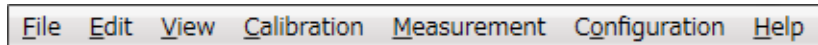
For the dialog boxes displayed during this software operation, see “Dialog Boxes” on page 4-118.

For the files handled by this software, see “Summary of Files” on page 4-119.

Main Menu

Figure 4-24

Main Menu



The following shows the structure of the main menu.

File Menu

Displays the following menu items to operate the setup file and measurement data file. For the kinds of the files and file extensions, see “Summary of Files” on page 4-119.

- | | |
|----------------------------|---|
| New | Creates a new setup.

This destroys the setup that you are editing, and creates a new setup. |
| Open... | Opens an existing setup file or measurement data file.

This opens the file selection dialog box, destroys the setup that you are editing, and then opens the file selected in the dialog box. |
| Save | Saves the setup that you are editing to the original setup file. |
| Save Setup As... | Saves the setup that you are editing to the specified setup file.

This opens the file selection dialog box, and saves the present setup to the specified setup file. |
| Save Data As... | Saves the present setup data and measurement data to the specified measurement data file.

This opens the file selection dialog box, and saves the present setup data and measurement data to the specified measurement data file. |
| Change Device ID... | Changes the device ID recorded in the measurement data file.

This opens the Change Device ID dialog box, and changes the device ID recorded in the selected measurement data file(s). See “Change Device ID Dialog Box” on page 4-118. |

GUI Reference
Gate Charge Measurement Software

Recent Setup Files

Lists a maximum of 10 names of the setup files that were recently edited, as menu items. You can easily open a setup file by using them.

Exit Exits the gate charge measurement software. Unsaved data is destroyed.

Edit Menu

Displays the following menu items to edit the setup.

Cut Moves the selected text to the clipboard.

Copy Copies the selected text to the clipboard.

Paste Pastes the text from the clipboard to the insertion point.

On-screen keyboard... Displays the on-screen keyboard.

View Menu

Displays the following menu items for the display setting.

Go to Palette Displays the Software Palette in fullscreen mode.

Main Window Displays the following menu item.

Fullscreen Changes the display style of the main window.

If this is marked, the main window does not have the titlebar and is displayed in fullscreen mode.

If this is unmarked, the main window has the titlebar and is displayed in the regular window style.

This is initially marked.

Color Settings... Opens the Color Setting dialog box to set the color for parts in this software. See “Color Setting Dialog Box” on page 4-118.

Calibration Menu

Displays the following menu items for the calibration.

Start Starts to get the calibration data.

Open or short the gate charge measurement circuit according to instructions of the wizard.


Select Data Opens the file selection dialog box, and then applies the selected calibration data file to the measurement.

Measurement Menu

Displays the following menu items for controlling the measurement.

Start

Starts a measurement. During the measurement, the measurement status indicator on the front panel lights up.

To stop the repeat measurement, select the Measurement > Stop menu, click the Stop Measurement button  on the toolbar, or press the Stop key on the front panel.

Stop

Stops the measurement.

Configuration Menu

Displays the following menu item to administrate the configuration of the built-in modules in the mainframe and test fixture.

Module...

Opens the Module Configuration dialog box. See “Module Configuration Dialog Box” on page 4-158.

Help Menu

Displays the following menu item.

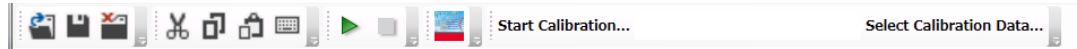
About...

Opens the About Box dialog box. See “About Box Dialog Box” on page 4-118.

Toolbar


Figure 4-25



Toolbar







The toolbar has five tool button groups. The following shows the tool buttons in the tool button groups.

File tool button group

- | | | |
|---|-------------|--|
|  | Open | Opens an existing setup file or measurement data file.

This opens the file selection dialog box, destroys the setup that you are editing, and then opens the file selected in the dialog box. |
|  | Save | Saves the setup that you are editing to the original setup file. |
|  | Exit | Exits the gate charge measurement software. Unsaved data is destroyed. |


Edit tool button group

- | | | |
|---|---------------------------|--|
|  | Cut | Moves the selected text to the clipboard. |
|  | Copy | Copies the selected text to the clipboard. |
|  | Paste | Pastes the text from the clipboard to the insertion point. |
|  | On-screen keyboard | Displays the on-screen keyboard. |

Measurement tool button group

 **Start Measurement**


Starts a measurement. During the measurement, the measurement status indicator on the front panel lights up.

To stop the repeat measurement, select the Measurement > Stop menu, click the Stop Measurement button  on the toolbar, or press the Stop key on the front panel.

 **Stop Measurement**

Stops the measurement.

View tool button group

 **Go to Palette** Displays the Software Palette in fullscreen mode.

Calibration tool button group

Start Calibration... Starts to get the calibration data.

Open or short the gate charge measurement circuit according to instructions of the wizard.

Select Calibration Data... Opens the file selection dialog box, and then applies the selected calibration data file to the measurement.

Work Area

In this area, set the measurement conditions and observe the measurement results. This is separated to the following areas.

- “Conditions” on page 4-106
- “Gate Charge Characteristics” on page 4-108
- “Switching Waveform” on page 4-111


Conditions

Figure 4-26

Conditions

Section	Parameter	Value	Unit
Drain	Vds(off)	60	V
	Id(on)	200	A
Gate	Vgs(off)	0	V
	Vgs(on)	15	V
	Ig	5 m	A
Current Load	LoadVgs(off)	0	V
	LoadVgs(on)	15	V

This is an area to enter your measurement conditions. You can set the following condition parameters. For the setting range of the condition parameters, see Table 4-19 on page 4-107.

This area can be hidden or shown by clicking the chevron  at the left top corner of the window.

Drain

Set the conditions for driving the drain of DUT.

Vds(off) Enter a value of the drain-source voltage at the off-state.

Id(on) Enter a value of the drain current at the on-state when the constant current load is used.

When the constant current load is not used, the on-state current is decided by the off-state voltage, resistance of the resistive load, and the on-state resistance/saturation voltage. For the current output range of the power supply, the minimum range including Id(on) is automatically selected.

Gate

Set the conditions for driving the gate of DUT.

Vgs(off) Enter a value of the gate-source voltage to change the DUT to the off-state.

Vgs(on) Enter a value of the gate-source voltage to completely change the DUT to the on-state.

I_g Enter a limit value of the gate current. This value impacts on the switching time. Large I_g shortens the switching time, and small I_g elongates it.

Current Load

Mark the check box when you want to use the constant current load.

Set the conditions for driving the gate of the transistor for the constant current load, that is the source of the on-state current described in “Drain” on page 4-106.

When you use the resistive load (not use the constant current load), unmark the check box to disable the constant current load.

LoadV_{gs(off)} Enter a value of the gate-source voltage to change the transistor for the constant current load to the off-state.

LoadV_{gs(on)} Enter a value of the gate-source voltage to completely change the transistor for the constant current load to the on-state.

Before the gate charge measurement, DUT is completely changed to the on-state. During this situation, the gate-drain voltage of the transistor is searched from V_{gs(off)} to V_{gs(on)} so that the specified on-state current I_d (on) flows. The transistor is driven by the searched gate-source voltage, and then the gate charge measurement is executed. Where, “DUT is completely changed to the on-state” means the state that the gate-source voltage of the DUT is set to the V_{gs(on)} entered for the gate drive condition.

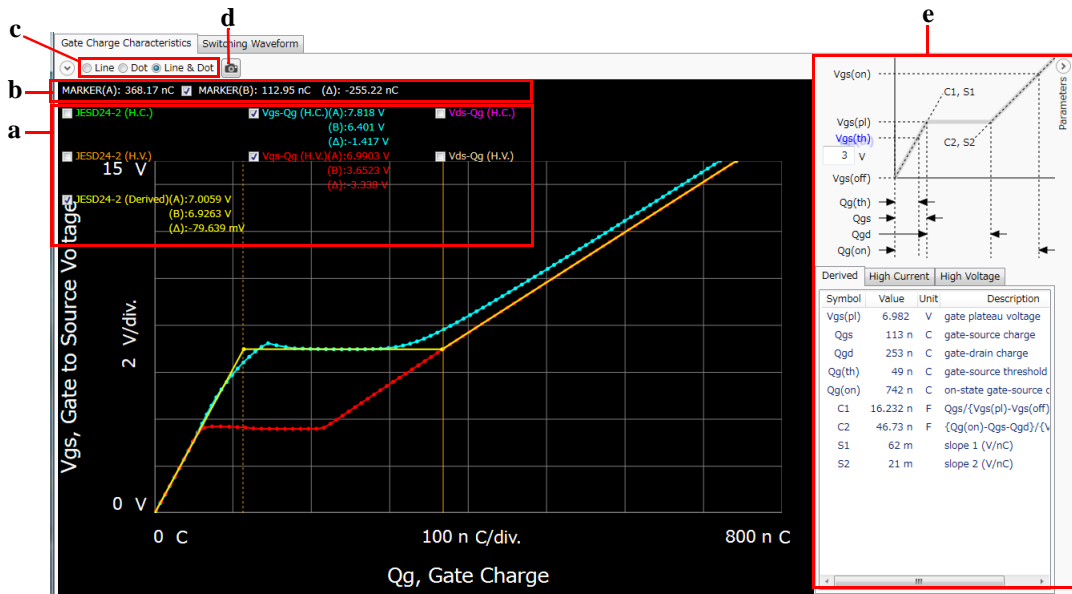
Table 4-19

Setting Range for Parameters

Setting Parameter	Setting Range		
	B1506A-H21	B1506A-H51	B1506A-H71
V _{ds(off)} @High Voltage	0 V to +3000 V		
V _{ds(off)} @High Current	-40 V to +40 V	-60 V to +60 V	
I _{d(on)} max.	20 A	450 A	1100 A
V _{gs(off)}	-30 V to +30 V		
V _{gs(on)}	-30 V to +30 V		
I _g	1 μA to 1 A		
LoadV _{gs(off)}	-30 V to +30 V		
LoadV _{gs(on)}	-30 V to +30 V		

Gate Charge Characteristics

Figure 4-27 Gate Charge Characteristics



This page shows the graph and extracted parameters of the gate charge characteristics as the measurement results. To display this page, click the Gate Charge Characteristics tab.

a. Displaying Characteristic Curves

This area can display multiple characteristics curves as shown in the following list. To display curves, mark the check boxes for the characteristics curves you want to display.

- JESD24-2 (Derived)
Shows the gate charge characteristics when the off-state voltage and the on-state current specified in “Drain” are applied.
- Vgs-Qg (H.C.)
Shows the gate charge characteristics when the on-state current specified in “Drain” is applied.
When the constant current load is not used, the on-state current is decided by the off-state voltage, resistance of the resistive load, on-state resistance, and the output voltage of UHCU/HCSMU.
- Vgs-Qg (H.V.)

Shows the gate charge characteristics when the off-state voltage specified in “Drain” is applied.

- JESD24-2 (H.C.)

Shows an approximation straight line of Vgs-Qg (H.C.) gate charge characteristics. The approximation is calculated on sloops (S₁, S₂, and S₃) defined in JEDEC Standard JESD24-2.

- JESD24-2 (H.V.)

Shows an approximation straight line of Vgs-Qg (H.V.) gate charge characteristics. The approximation is calculated on sloops (S₁, S₂, and S₃) defined in JEDEC Standard JESD24-2.

- Vds-Qg (H.C.)

Shows the relationship between the drain-source voltage and gate charge when the Vgs-Qg (H.C.) is measured.

For HCSMU, the drain-source voltage is a voltage between the drain of the constant current load transistor and the source of DUT.

- Vds-Qg (H.V.)

Shows the relationship between the drain-source voltage and gate charge when the Vgs-Qg (H.V.) is measured.

You can change the minimum and maximum values on the X and Y-axes by clicking the value.

b. Markers


This graph supports two markers (A and B). Marker A is always available. To use the Marker B, mark the check box for the Marker B. The Marker B is a break line. To move the marker position, use the rotary knob or mouse.

The marker annotation on the graph has X-axis values for markers, and a difference value (Δ) between the Marker B and A (B–A). And, each curve annotation has Y-axis values and difference values (Δ) between the Marker B and A (B–A).

c. Curve Representation



The curves can be represented as Line, Dot, or combination (Line & Dot). Select any curve representation using the radio buttons shown in the bottom part of the graph.


d. Reference Traces

You can register the presently-displayed curves as reference traces to compare with other measurement results on the graph. If you register them as reference traces, the reference traces are displayed as break lines on the graph when you open other measurement data files or execute the next measurement. To register as the reference traces, click the Capture button  shown in the bottom part of the graph.

GUI Reference

Gate Charge Measurement Software

You can register a maximum of 10 reference traces. The measurement data files registered as the reference traces are listed in the References field under the Capture button . You can show or hide the reference traces using the check boxes at the head of the measurement data file names. The References field can be hidden or shown by clicking the chevron  under the graph.


To remove unnecessary reference traces, select the measurement data file in the References field, and then click the Remove button .

The registration of the reference traces is cleared when you exit the gate charge measurement software.

e. Parameter

To extract and show the gate charge parameter values according to JESD24-2 (Derived), JESD24-2 (H.C.), and JESD24-2 (H.V.) in this area, enter the threshold voltage $V_{gs(th)}$ of the DUT. You can change the display contents by clicking the tabs.

$V_{gs(pl)}$	Gate plateau voltage
Q_{gs}	Gate-source charge Gate charge for slope S_1 according to JEDEC Standard JESD24-2
Q_{gd}	Gate-drain charge Gate charge for slope S_3 according to JEDEC Standard JESD24-2
$Q_{g(th)}$	Gate-source threshold charge Gate charge from $V_{gs(off)}$ to $V_{gs(th)}$
$Q_{g(on)}$	On-state gate-source charge Gate charge from $V_{gs(off)}$ to $V_{gs(on)}$
C_1	$Q_{gs}/\{V_{gs(pl)}-V_{gs(off)}\}$ Equivalent capacitance for S_1 in JESD24-2
C_2	$\{Q_{g(on)}-Q_{gs}-Q_{gd}\}/\{V_{gs(on)}-V_{gs(pl)}\}$ Equivalent capacitance for S_2 in JESD24-2
S_1	S_1 in JESD24-2
S_2	S_2 in JESD24-2

This area can be hidden or shown by clicking the chevron  at the right top corner of the window.

Switching Waveform

This page shows the switching waveforms of DUT to observe the switching behavior. And, you can also set detailed parameters before the measurement. To display this page, click the Switching Waveform tab.

The gate charge characteristics is calculated from the gate current and waveform data of the gate-source voltage obtained from the switching, and the calibration data.

There are the following switching modes.

- “High Current Switching Mode”

UHCU or HCSMU is used as a power supply to force the on-state current specified in “Drain” to DUT via the constant current load specified in “Current Load”.

And, the applied voltage is determined as follows, depending on the off-state voltage specified in “Drain”.

- If the off-state voltage is within the output voltage range of UHCU/HCSMU, they force the specified voltage. The maximum output voltage of UHCU is 60 V and it of HCSMU is 20 V at 20 A range.
- If the off-state voltage exceeds the output voltage range of UHCU/HCSMU, UHCU forces 60 V and HCSMU forces 20 V.

If you don't use the constant current load, the applied current is determined from the load resistance, on-state resistance of DUT, and the output voltage of the power supply.

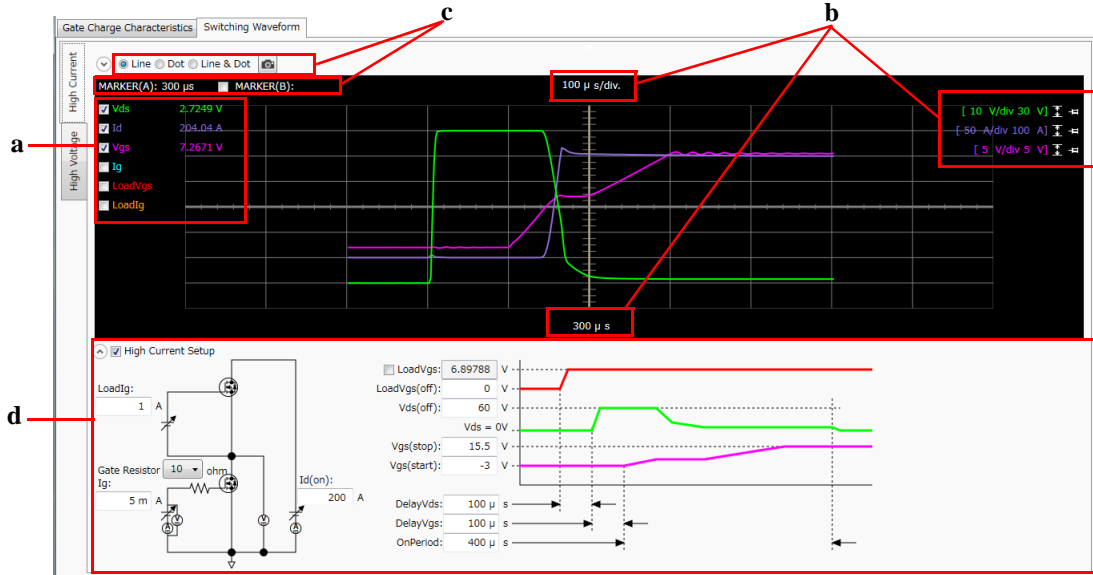
- “High Voltage Switching Mode”

HVSMU is used as a power supply to force the off-state voltage specified in “Drain” to DUT.

This page has the graph area to display the time-domain switching waveforms and the advanced setup area to set the detailed parameters for the measurement in the above modes. To switch the mode, click the tab (High Current or High Voltage) on the left side.

High Current Switching Mode

Figure 4-28 Switching Waveform (High Current Switching Mode)



a. Displaying Characteristic Curves

This area can display the following switching waveforms in the high current switching mode. To display switching waveform(s), mark the check boxes for the waveforms.

- Vds: Drain-source voltage waveform
- Id: Drain current waveform
- Vgs: Gate-source voltage waveform
- Ig: Gate current waveform
- LoadVgs: Gate-source voltage waveform of the current load
- LoadIg: Gate current waveform of the current load

b. Adjusting Scale


The scale and offset values on the Y-axis for each displayed curve are displayed on the right upper portion.

You can change the following values on the X and Y-axes by clicking the value.

- Scale and origin values on X-axis


- Scale and offset values on Y-axis


There are the Auto Scale button and Scale mode button next to the scale and offset values on the Y-axis.

Clicking the Auto Scale button  fits the measurement data at that time in the graph scale.

If the auto scale mode is selected by using the Scale mode button, the measurement data is automatically fit according to the progress of the measurement.

If the fixed scale mode is selected by using the Scale mode button, the scale is fixed until changing the scale manually or clicking the Auto Scale button.


 : Scale mode button during selecting the auto scale mode.

 : Scale mode button during selecting the fixed scale mode.

c. Other Graph Functions

On the graph, you can read values using the markers, change the curve representation, and use the reference traces. For details, see “b. Markers” on page 4-109, “c. Curve Representation” on page 4-109, and “d. Reference Traces” on page 4-109.

d. Advanced Setup

This area is hidden as default. You can show this area under the graph area by clicking the chevron  at the head of the High Current Setup.

This area shows the setup items on the measurement circuit and timing chart. To edit the setting values, mark the check box of the High Current Setup.

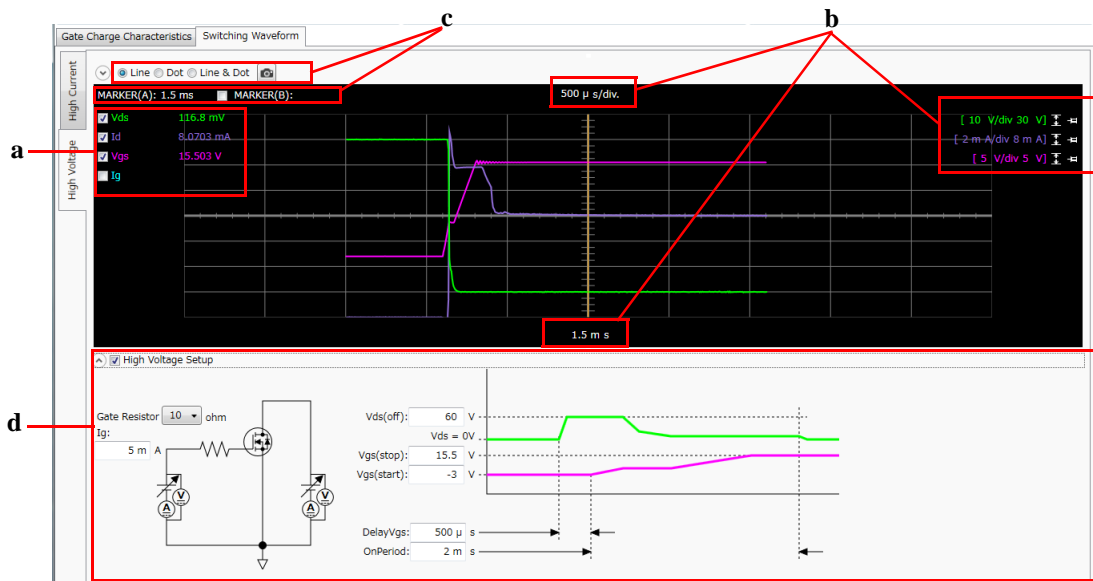
LoadIg	Gate current limit for Current Load
Ig	Gate current limit for DUT
Gate Resistor	Gate resistance for DUT (Same value is used between the both switching modes.)
Id(on)	On-state drain current
LoadVgs	Gate to-source voltage for Current Load adjusted to Id(on) By marking the check box, you can overwrite the gate-source voltage of the current load that was adjusted according to the Id(on).
LoadVgs(off)	Off-state gate-source voltage for Current Load
Vds(off)	Off-state drain-source voltage
Vgs(stop)	Stop value for Vgs
Vgs(start)	Start value for Vgs

GUI Reference
Gate Charge Measurement Software

- DelayVds** Delay time from Current Load gating to off-state drain-source voltage application
- DelayVgs** Delay time from off-state drain-source voltage application to start of Vgs swing
- OnPeriod** Period from start of Vgs swing to Vds zero

High Voltage Switching Mode

Figure 4-29 Switching Waveform (High Voltage Switching Mode)



a. Displaying Characteristic Curves

This area can display the following switching waveforms in the high voltage switching mode. To display switching waveform(s), mark the check boxes for the waveforms.

- Vds: Drain-source voltage waveform
- Id: Drain current waveform
- Vgs: Gate-source voltage waveform
- Ig: Gate current waveform


b. Adjusting Scale

The scale and offset values on the Y-axis for each displayed curve are displayed on the right upper portion.

You can change the following values on the X and Y-axes by clicking the value.



- Scale and origin values on X-axis
- Scale and offset values on Y-axis

There are the Auto Scale button and Scale mode button next to the scale and offset values on the Y-axis.

Clicking the Auto Scale button  fits the measurement data at that time in the graph scale.

If the auto scale mode is selected by using the Scale mode button, the measurement data is automatically fit according to the progress of the measurement.


If the fixed scale mode is selected by using the Scale mode button, the scale is fixed until changing the scale manually or clicking the Auto Scale button.

-  : Scale mode button during selecting the auto scale mode.
-  : Scale mode button during selecting the fixed scale mode.

c. Other Graph Functions

On the graph, you can read values using the markers, change the curve representation, and use the reference traces. For details, see “b. Markers” on page 4-109, “c. Curve Representation” on page 4-109, and “d. Reference Traces” on page 4-109.

d. Advanced Setup

This area is hidden as default. You can show this area under the graph area by clicking the chevron  at the head of the High Voltage Setup.

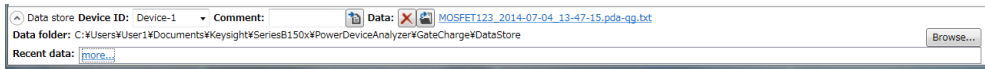
This area shows the setup items on the measurement circuit and timing chart. To edit the setting values, mark the check box of the High Voltage Setup.

Ig	Gate current limit for DUT
Gate Resistor	Gate resistance for DUT (Same value is used between both switching modes.)
Vds(off)	Off-state drain-source voltage
Vgs(stop)	Stop value for Vgs
Vgs(start)	Start value for Vgs
DelayVgs	Delay time from off-state drain-source voltage application to start of Vgs swing
OnPeriod	Period from start of Vgs swing to Vds zero

Data List

Figure 4-30

Data List



The data list area provides the following functions regarding the saving of the measurement data files.


- Set the device ID to be recorded to the measurement data file
See “Device ID” on page 4-116.
- Enter a comment to be recorded to the measurement data file
See “Comment” on page 4-116.
- Operations for the latest measurement data file
See “Data” on page 4-117.
- Access to the measurement data files that were automatically saved
See “Data store” on page 4-117.

The setup data and measurement data are automatically saved to a new measurement data file at the end of the measurement. At this time, you can also record a device ID to identify your DUT and a comment. And, the destination folder of the measurement data file for auto-saving is predefined. You can set the device ID and comment, and change the destination folder using this area.

Device ID

Enter device ID string to the Device ID field. The maximum 10 recently-entered device IDs can be kept as history, and you can also select one from the history list.


The entered device ID is automatically saved to the measurement data file at the end of the measurement.

You can also change the device ID in the latest measurement data file after the measurement here. To change it, change the device ID in the Device ID field, and then click the Apply button .

Comment



Enter a comment string to the Comment field.

The entered comment is automatically saved to the measurement data file at the end of the measurement.

You can also change the comment in the latest measurement data file after the measurement here. To change it, change the comment in the Comment field, and then click the Apply button .


Data

The Data field shows the latest auto-saved or last-opened measurement data file name. You can do the following operations.

- Open the measurement data file by clicking the Open button .
- Rename the measurement data file by clicking the measurement data file name.
- Delete the measurement data file by clicking the Delete button .

Data store

Using the following fields, you can change the destination folder of the auto-saved measurement data file, and access the auto-saved measurement data files.

The following fields can be shown or hidden by clicking the chevron  next to “Data store”.

Data folder Shows the absolute path of the auto-saved measurement data file. To change this, click the Browse button to open the folder selection dialog box. Select your desired folder in the dialog box.

For the initial setting of the data folder, see “Summary of Files” on page 4-119.

Recent data Shows up to 10 auto-saved measurement data files that were automatically saved recently, in the hyper-link format. Clicking the hyper-link opens the selected measurement data file. This destroys the presently-editing data.

If the number of the auto-saved measurement data files is over ten, this field shows “more...”. Clicking this opens the file selection dialog box. Select a measurement data file to open.

Dialog Boxes

Change Device ID Dialog Box

The Change Device ID dialog box is used to change the device ID in all selected measurement data files at once.

- | | |
|------------------------|---|
| Device ID field | Enter a new device ID. You can also select it from the history. |
| Add... button | Opens the file selection dialog box to select the measurement data file(s) that you want to change the device ID. The selected files are displayed into the list. |
| Remove button | Excludes the selected measurement data file from the list. |
| Execute button | Changes the device ID. |
| Close button | Closes this dialog box. |

This dialog box is opened by selecting the main menu File > Change Device ID....

Color Setting Dialog Box

The Color Setting dialog box is used to set colors of parts in this software.

The graph elements supported by this dialog box are graph background, X and Y-axes, graph grid, graph text, marker, seven traces on the gate charge characteristic graph, and six traces on the switching waveform graph. Clicking the color pattern opens the dialog box for selecting a color.

The setting in the Color Setting dialog box is saved as a user setting.

- | | |
|----------------------|---|
| Apply button | Applies the present setting to the graph. |
| Reset button | Resets to the default setting. |
| OK button | Applies the present setting to the graph, and closes this dialog box. |
| Cancel button | Closes this dialog box without applying the present setting. |

This dialog box is opened by selecting the main menu View > Color Settings....

About Box Dialog Box

The About Box dialog box displays the model number, the software revision number, download URL for software updating, and so on.

This dialog box is opened by selecting the main menu Help > About....

Summary of Files

The following shows the summary of the files handled by the gate charge measurement software.

Table 4-20 Summary of Files

File Type	Description	Extension	Folder as Initial Setting
Setup File	Setup data You can save this if needed.	*.pda-qg	(You can specify the folder when saving the data)
Measurement Data File	Setup data and measurement data including the device ID and comment This is automatically saved after the measurement. You can optionally save this.	*.pda-qg.txt	C:\Users\<<user name>\Documents\Keysight\SeriesB150x\PowerDevice Analyzer\GateCharge\Data Store (You can change this)
Calibration Data File	Calibration data This is automatically saved after the calibration execution.	*.pda-qg.cal	C:\ProgramData\Keysight\SeriesB150x\PowerDevice Analyzer\GateCharge\CalibrationDataStore

File name of Measurement Data File on Auto-saving

An auto-saved measurement data file is named as the following rule.

- Concatenates the device ID, available thermometer readings, and date and time on save by an underscore (_).

The available thermometer readings are characters of the available thermometer identifiers set in the “Thermal Monitor/Control Software” on page 4-138, and their readings as shown in the following syntax.

@<thermometer>=<reading>degC[_<thermometer>=<reading>degC[...]]

- <thermometer>

An identifier of the available thermometer

Ch1 Channel 1 thermometer of B1506A

Ch2 Channel 2 thermometer of B1506A

Air Thermometer on the air outlet port of the ThermoStream

DUT Thermometer on the DUT port of the ThermoStream

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Gate Charge Measurement Software

- <reading>

A reading value of the thermometer in degrees centigrade

Example) @Ch1=25degC_Ch2=75degC_Air=100degC

2. Concatenates the file extension (.pda-qg.txt) to the end of the “step 1” string.
3. If the “step 2” file name duplicates the existing file name, concatenates the serial number from 2 enclosed by brackets and the file extension to the end of the “step 1” string.

Power Loss Calculation Software

Power loss calculation software provides:

- Calculation of switching device power loss for:
 - Hard switching mode
 - Soft switching mode
- Inputs to characterize the following parameters:
 - Gate resistance
 - On resistance
 - Gate charge
 - Gate switching charge
 - Equivalent output capacitance (energy related)
 - Equivalent output capacitance (time related)
 - Input parameter assistance using related measurement data including:
 - Display of source measurement data
- Switching condition parameter input
 - Support of parameter sweep for one parameter
- Power loss calculation results of:
 - Total power loss
 - Conductive power loss
 - Driving power loss
 - Switching power loss (inductive load)
 - Graph representation of loss components for optional parameter sweep

GUI Reference

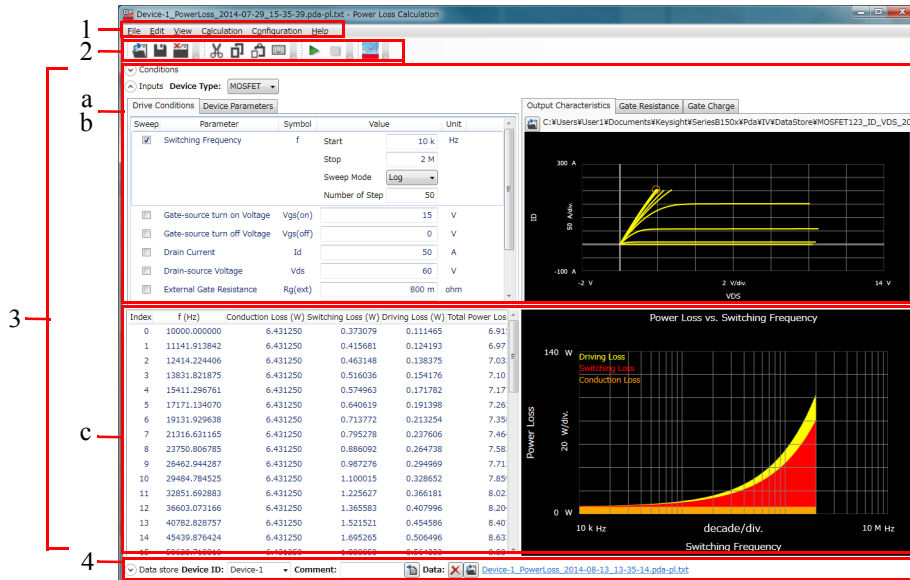
Power Loss Calculation Software

GUI Overview

The GUI (Graphical User Interface) of the Power loss calculation software is comprised of the following areas.

Figure 4-31

Power Loss Calculation Software GUI



1. “Main Menu” on page 4-123
This provides the functions needed for various operations in the menu format.
2. “Toolbar” on page 4-125
This provides the functions that are very frequently used in the button format.
3. “Work Area” on page 4-127
This area provides the functions to set the calculation conditions and observe the calculation results. This is separated to the following areas.
 - a. “Conditions” on page 4-127
 - b. “Inputs” on page 4-127
 - c. “Results” on page 4-132
4. “Data List” on page 4-134

This area provides the functions regarding the saving of the calculation data files.

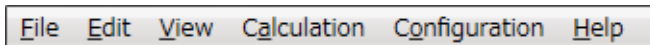
For the dialog boxes displayed during this software operation, see “Dialog Boxes” on page 4-136.

For the files handled by this software, see “Summary of Files” on page 4-137.

Main Menu

Figure 4-32

Main Menu



The following shows the structure of the main menu.

File Menu

Displays the following menu items to operate the setup file and calculation data file. For the kinds of the files and file extensions, see “Summary of Files” on page 4-137.

- | | |
|----------------------------|--|
| New | Creates a new setup.

This destroys the setup that you are editing, and creates a new setup. |
| Open... | Opens an existing setup file or calculation data file.

This opens the file selection dialog box, destroys the setup that you are editing, and then opens the file selected in the dialog box. |
| Save | Saves the setup that you are editing to the original setup file. |
| Save Setup As... | Saves the setup that you are editing to the specified setup file.

This opens the file selection dialog box, and saves the present setup to the specified setup file. |
| Save Data As... | Saves the present setup data and calculation data to the specified calculation data file.

This opens the file selection dialog box, and saves the present setup data and calculation data to the specified calculation data file. |
| Change Device ID... | Changes the device ID recorded in the calculation data file. |

This opens the Change Device ID dialog box, and changes the device ID recorded in the selected calculation data file(s). See “Change Device ID Dialog Box” on page 4-136.

Recent Setup Files

Lists a maximum of 10 names of the setup files that were recently edited, as menu items. You can easily open a setup file by using them.

Exit Exits the power loss calculation software. Unsaved data is destroyed.

Edit Menu

Displays the following menu items to edit the setup.

Cut Moves the selected text to the clipboard.

Copy Copies the selected text to the clipboard.

Paste Pastes the text from the clipboard to the insertion point.

On-screen keyboard... Displays the on-screen keyboard.

View Menu

Displays the following menu items for the display setting.

Go to Palette Displays the Software Palette in fullscreen mode.

Main Window Displays the following menu item.

Fullscreen Changes the display style of the main window.

If this is marked, the main window does not have the titlebar and is displayed in fullscreen mode.

If this is unmarked, the main window has the titlebar and is displayed in the regular window style.


This is initially marked.

Color Settings... Opens the Color Setting dialog box to set the color for parts in this software. See “Color Setting Dialog Box” on page 4-136.

Calculation Menu

Displays the following menu items for controlling the calculation.

Start Starts a calculation.

To stop the present calculation, select the Calculation > Stop menu, click the Stop Calculation button  on the toolbar, or press the Stop key on the front panel.

Stop Stops the measurement.

Help Menu

Displays the following menu item.

About... Opens the About Box dialog box. See “About Box Dialog Box” on page 4-136.

Toolbar

Figure 4-33

Toolbar



The toolbar has four tool button groups. The following shows the tool buttons in the tool button groups.

File tool button group



Open

Opens an existing setup file or calculation data file.

This opens the file selection dialog box, destroys the setup that you are editing, and then opens the file selected in the dialog box.



Save

Saves the setup that you are editing to the original setup file.



Exit

Exits the power loss calculation software. Unsaved data is destroyed.

Edit tool button group



Cut

Moves the selected text to the clipboard.



Copy

Copies the selected text to the clipboard.



Paste

Pastes the text from the clipboard to the insertion point.

GUI Reference
Power Loss Calculation Software



**On-screen
keyboard**


Displays the on-screen keyboard.

Calculation tool button group



**Start
Calculation**

Starts a measurement. During the measurement, the measurement status indicator on the front panel lights up.

To stop the calculation, select the Calculation > Stop menu, click the Stop Calculation button  on the toolbar, or press the Stop key on the front panel.



**Stop
Calculation**

Stops the calculation.

View tool button group



Go to Palette

Displays the Software Palette in fullscreen mode.

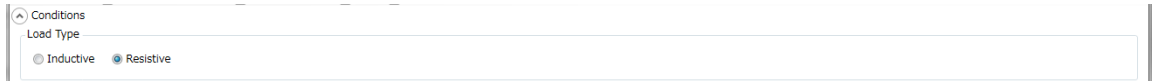
Work Area

In this area, set the calculation conditions and observe the calculation results. This is separated to the following areas.


- “Conditions” on page 4-127
- “Inputs” on page 4-127
- “Results” on page 4-132

Conditions

Figure 4-34 Conditions



This is an area to specify your assumption to calculate the power loss on your switching device.

This area can be shown or hidden by clicking the chevron  of the Conditions.

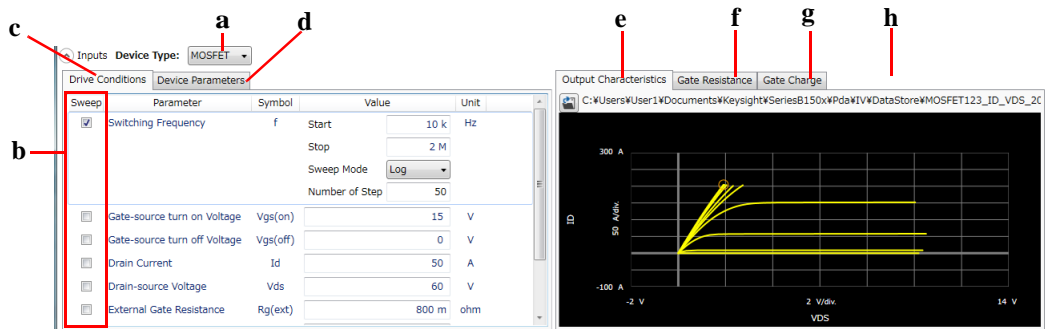
Load Type

Select the assumed load type to calculate the power loss. You can select one from the following load types.

- Inductive: Inductive load
- Resistive: Resistive load

Inputs

Figure 4-35 Inputs



GUI Reference


Power Loss Calculation Software

This is an area to specify the device type of your DUT, and driving condition and device characteristic parameters that are used as the input data for calculation. The driving condition parameters and device characteristic parameters are separated by tabs.

Other than manually entering the parameter values with referring the device data sheet, you can also enter them using existing measurement data files. This area is equipped with the functions to read existing measurement data files, display the characteristic curve graphs, and extract some parameter values from them. The following measurement data files are readable.

- I/V measurement data file
- Capacitance measurement data file
- Gate charge measurement data file

They are separated by tabs.

This area can be hidden or shown by clicking the chevron  of the Inputs.

a. Device Type

Select the device type of your DUT from below.

- MOSFET

b. Sweep Parameter

Select one parameter that is swept to observe the loss changes for the changes of this parameter, from the driving condition parameters and device characteristic parameters. To select it, mark the check box of the parameter. As the default, the Switching Frequency parameter in the Driving parameters is selected.

Specify the following items for the selected parameter as the sweep parameter.

- Start
Specify the sweep start value.
- Stop
Specify the sweep stop value.
- Sweep Mode
Select one from the following sweep modes.
 - Linear (Sweep from start to stop in a linear incremental step)
 - Log (Sweep from start to stop in a logarithmic incremental step)
- Number of Step
Specify the number of sweep steps from start to stop.

c. Drive Conditions

Specify the driving condition parameter values.

- **f**: Switching Frequency
Specify the switching frequency.
- **V_{gs(on)}**: Gate-source turn on Voltage
Specify the gate-source voltage required to turn the device on.
- **V_{gs(off)}**: Gate-source turn off Voltage
Specify the gate-source voltage required to turn the device off.
- **I_d**: Drain Current
Specify the On-state drain current.
- **V_{ds}**: Drain-source Voltage
Specify the Off-state drain-source voltage.
- **R_{g(ext)}**: External Gate Resistance
Specify the gate resistance included in the external driving circuit.
- **I_{rms}**: Effective Drain Current
Specify the effective drain current (the root mean square of the load current).
The effective drain current (**I_{rms}**) is the product of the drain current (**I_d**) and the duty cycle (**D**).
- **D**: Duty Cycle
Specify the duty cycle within the range from 0 to 1.

d. Device Parameters

Specify the device characteristic parameter values.

- **Q_{g(on)}**: Gate Charge at on
Specify the On-state gate charge.
Q_{g(on)} – Q_{g(off)} is regarded as the gate charge required to turn the device on.
- **Q_{g(off)}**: Gate Charge at off
Specify the Off-state gate charge.
Q_{g(on)} – Q_{g(off)} is regarded as the gate charge required to turn the device on.
- **R_g**: Gate Resistance
Specify the gate resistance.
- **Q_{sw}**: Gate Switching Charge (**C_{rss}**)


GUI Reference

Power Loss Calculation Software

Specify the required gate charge (Mirror Charge) so that the drain-source voltage is same as the gate-source voltage when the device state changes from Off to On.

- **Vgs(pl): Gate Plateau Voltage**
Specify the gate plateau voltage.
- **Rds(on): On Resistance**
Specify the On-state resistance.

e. Output Characteristics

Specify the measurement data file taken by the I/V measurement software. To read the file, click the Load Measurement Data button  in the top left corner. The file selection dialog box opens to read the file. The file name to be read is displayed next to the Load Measurement Data button. And, the output characteristic data is displayed on the graph.

The measurement data file that has any of the following output characteristics is readable.


- ID-VDS
- RDS-ID
- VDS-VGS
- RDS-VGS

The following parameter value is extracted from the Vgs(on) parameter value specified in the Drive Conditions and the output characteristic data to be read.

- Device Parameters
 - Rds(on): On Resistance

You can change the minimum and maximum values on the X and Y-axes by clicking the value.

f. Gate Resistance

Specify the Rg characteristic measurement data file taken by the capacitance measurement software. To read the file, click the Load Measurement Data button  in the top left corner. The file selection dialog box opens to read the file. The file name to be read is displayed next to the Load Measurement Data button. And, the Rg characteristic data is displayed on the graph.


The following parameter value is extracted from the Vgs(off) parameter value specified in the Drive Conditions and the Rg characteristic data to be read.

- Device Parameters

- Rg: Gate Resistance

You can change the minimum and maximum values on the X and Y-axes by clicking the value.

g. Reverse Transfer Capacitance


Specify the Crss characteristic measurement data file taken by the capacitance measurement software. To read the file, click the Load Measurement Data button  in the top left corner. The file selection dialog box opens to read the file. The file name to be read is displayed next to the Load Measurement Data button. And, the Crss characteristic data is displayed on the graph.

The following parameter value is extracted from the Vgs(off) and Vds(off) parameter values specified in the Drive Conditions and the Crss characteristic data to be read.

- Device Parameters
 - Qsw: Gate Switching Charge

You can change the minimum and maximum values on the X and Y-axes by clicking the value.

h. Gate Charge

Specify the measurement data file taken by the gate charge measurement software. To read the file, click the Load Measurement Data button  in the top left corner. The file selection dialog box opens to read the file. The file name to be read is displayed next to the Load Measurement Data button. And, the gate charge characteristic data is displayed on the graph.

The following parameter values are extracted from the gate charge characteristic data to be read.

- Drive Conditions
 - Vgs(on): Gate-source turn on Voltage
 - Vgs(off): Gate-source turn off Voltage
 - Id: Drain Current
 - Vds: Drain-source Voltage
- Device Parameters
 - Qg(on): Gate Charge at on
 - Qg(off): Gate Charge at off
 - Qsw: Gate Switching Charge (Crss)

GUI Reference

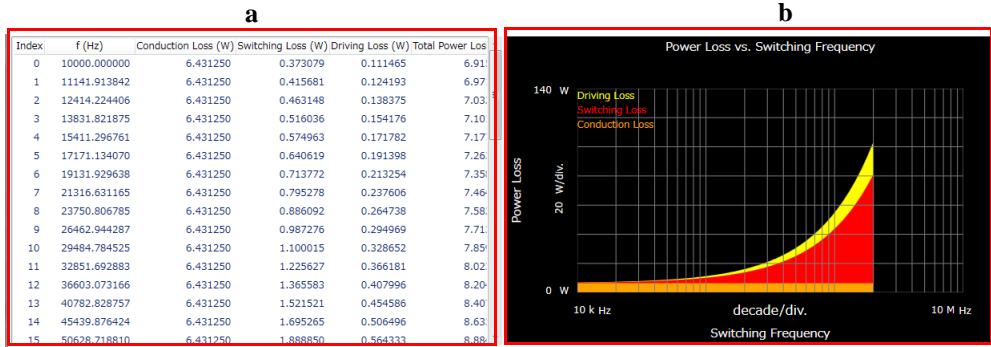
Power Loss Calculation Software

- Vgs(pl): Gate Plateau Voltage

You can change the minimum and maximum values on the X and Y-axes by clicking the value.

Results

Figure 4-36



This area shows the power loss data in the list and the trend chart formats, that was calculated along your parameter settings specified in the Inputs.

a. List

Shows the loss data for the swept parameter values as the calculation result in the list format.

- Index

Shows the index number of the sweep step.

- Sweep parameter

Shows the sweep parameter value specified in the Inputs.

- Conduction Loss

Shows the conduction loss as the calculation result.

This is calculated from the following expression.

$$R_{ds(on)} \times I_{rms}^2$$

- Switching Loss

Shows the switching loss as the calculation result.

This is calculated from either of the following expressions.

When the Load Type specified in the Conditions is “Inductive”:

$$\frac{1}{2} \times f \times Vds \times Id \times \{Rg + Rg(ext)\} \times Qsw \times \left\{ \frac{1}{Vgs(on) - Vgs(pl)} + \frac{1}{Vgs(pl) - Vgs(off)} \right\}$$

When the Load Type is “Resistive”:

$$\frac{1}{6} \times f \times Vds \times Id \times \{Rg + Rg(ext)\} \times Qsw \times \left\{ \frac{1}{Vgs(on) - Vgs(pl)} + \frac{1}{Vgs(pl) - Vgs(off)} \right\}$$

- **Driving Loss**

Shows the driving loss as the calculation result.

This is calculated from the following expression.

$$f \times \{Qg(on) - Qg(off)\} \times \{Vgs(on) - Vgs(off)\}$$

- **Total Power Loss**

Shows the total sum of the conduction loss, switching loss, and driving loss.

b. Trend Chart

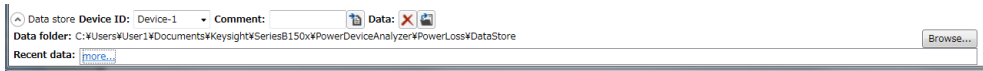
Shows the loss data for the swept parameter values as the calculation result in the trend chart format. Where, the sweep parameter is assigned to the data for the X-axis, and the conduction loss, switching loss, and driving loss are assigned to the data for the Y-axis and are accumulated in this order.

You can change the minimum and maximum values on the X and Y-axes by clicking the value.

Data List

Figure 4-37

Data List



The data list area provides the following functions regarding the saving of the calculation data files.


- Set the device ID to be recorded to the calculation data file
See “Device ID” on page 4-134.
- Enter a comment to be recorded to the calculation data file
See “Comment” on page 4-134.
- Operations for the latest calculation data files
See “Data” on page 4-135.
- Access to the calculation data files that were automatically saved
See “Data store” on page 4-135.

The setup data and calculation data are automatically saved to a new calculation data file at the end of the calculation. At this time, you can also record a device ID to identify your DUT and a comment. And, the destination folder of the calculation data file for auto-saving is predefined. You can set the device ID and comment, and change the destination folder using this area.

Device ID

Enter device ID string to the Device ID field. The maximum 10 recently-entered device IDs can be kept as history, and you can also select one from the history list.


The entered device ID is automatically saved to the calculation data file at the end of the calculation.

You can also change the device ID in the latest calculation data file after the calculation here. To change it, change the device ID in the Device ID field, and then click the Apply button .

Comment


Enter a comment string to the Comment field.

The entered comment is automatically saved to the calculation data file at the end of the calculation.

You can also change the comment in the latest calculation data file after the calculation here. To change it, change the comment in the Comment field, and then click the Apply button .


Data

The Data field shows the latest auto-saved or last-opened calculation data file name. You can do the following operations.

- Open the calculation data file by clicking the Open button .
- Rename the calculation data file by clicking the calculation data file name.
- Delete the calculation data file by clicking the Delete button .

Data store

Using the following fields, you can change the destination folder of the auto-saved calculation data file, and access the auto-saved calculation data files.

The following fields can be shown or hidden by clicking the chevron  next to “Data store”.

Data folder Shows the absolute path of the auto-saved calculation data file. To change this, click the Browse button to open the folder selection dialog box. Select your desired folder in the dialog box.

For the initial setting of the data folder, see “Summary of Files” on page 4-137.

Recent data Shows up to 10 auto-saved calculation data files that were automatically saved recently, in the hyper-link format. Clicking the hyper-link opens the selected calculation data file. This destroys the presently-editing data.

If the number of the auto-saved calculation data files is over ten, this field shows “more...”. Clicking this opens the file selection dialog box. Select a calculation data file to open.

Dialog Boxes

Change Device ID Dialog Box

The Change Device ID dialog box is used to change the device ID in all selected calculation data files at once.

- Device ID field** Enter a new device ID. You can also select it from the history.
- Add... button** Opens the file selection dialog box to select the calculation data file(s) that you want to change the device ID. The selected files are displayed into the list.
- Remove button** Excludes the selected calculation data file from the list.
- Execute button** Changes the device ID.
- Close button** Closes this dialog box.

This dialog box is opened by selecting the main menu File > Change Device ID....

Color Setting Dialog Box

The Color Setting dialog box is used to set colors of parts in this software.

The graph elements supported by this dialog box are graph background, X and Y-axes, graph grid, graph text, three trends on the trend charge, and traces on the characteristic graphs. Clicking the color pattern opens the dialog box for selecting a color.

The setting in the Color Setting dialog box is saved as a user setting.

- Apply button** Applies the present setting to the graph.
- Reset button** Resets to the default setting.
- OK button** Applies the present setting to the graph, and closes this dialog box.
- Cancel button** Closes this dialog box without applying the present setting.

This dialog box is opened by selecting the main menu View > Color Settings....

About Box Dialog Box

The About Box dialog box displays the model number, the software revision number, download URL for software updating, and so on.

This dialog box is opened by selecting the main menu Help > About....

Summary of Files

The following shows the summary of the files handled by the power loss calculation software.

Table 4-21 **Summary of Files**

File Type	Description	Extension	Folder as Initial Setting
Setup File	Setup data You can save this if needed.	*.pda-pl	(You can specify the folder when saving the data)
Calculation data File	Setup data and calculation data including the device ID and comment This is automatically saved after the calculation. You can optionally save this.	*.pda-pl.txt	C:\Users\<<user name>\Documents\Keysight\SeriesB150x\PowerDeviceAnalyzer\PowerLoss\DataStore (You can change this)

File name of calculation data File on Auto-saving

An auto-saved calculation data file is named as the following rule.

1. Concatenates the device ID and date and time on save by an underscore (_).
2. Concatenates the file extension (.pda-pl.txt) to the end of the “step 1” string.
3. If the “step 2” file name duplicates the existing file name, concatenates the serial number from 2 enclosed by brackets and the file extension to the end of the “step 1” string.

Thermal Monitor/Control Software

Thermal monitor/control software provides;

- Thermometer indication
- Thermal profile with measurement triggers
- Control of inTEST ThermoStream

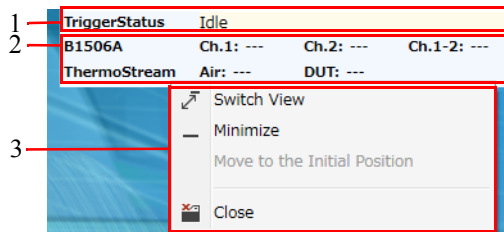
The thermal monitor/control software has two view modes: Monitor mode and Control mode. Just after starting this software, the control mode GUI is displayed.

The following sections describes about GUI (Graphical User Interface) in two view modes.

Monitor Mode GUI

Figure 4-38

Thermal Monitor/Control Software GUI (Monitor Mode)



The monitor mode GUI is a panel without a frame, and is displayed at the upper-right corner of the screen. It always stays on top of other windows. You can move this panel by dragging and releasing it.

The monitor mode GUI is comprised of the following areas.

1. “Trigger Status” on page 4-139
This displays the thermal condition for the idled DUT characteristics measurement and the target temperature controlled by ThermoStream.
2. “Thermometer Readings” on page 4-139
This displays the readings on the thermometers.
3. “Context Menu” on page 4-140
This provides the functions needed for various operations in the menu format.

Trigger Status

This displays the thermal condition for the idled DUT characteristics measurement and the target temperature controlled by ThermoStream. When no thermo-trigger list is executing, this displays “Idle”.

- During the DUT characteristics measurement is waiting until the thermal condition is true, this displays the thermal condition for the idled measurement.
- During controlling the temperature of the ThermoStream, this displays the target temperature controlled by ThermoStream and the thermometer position.

For details, see “Thermo-Trigger” on page 4-150.

Thermometer Readings

This displays the readings of the following thermometers. It displays invalid value for invalid thermometers.

B1506A Displays temperatures measured by thermocouples connected to the test fixture.

- Ch.1

Displays a temperature measured by a thermocouple connected to the thermocouple connector 1.

- Ch.2

Displays a temperature measured by a thermocouple connected to the thermocouple connector 2.

- Ch.1 - 2

Displays a gap between the above Ch.1 and 2 values.

ThermoStream Displays temperatures measured by thermometers on the ThermoStream.

- Air

Displays a temperature at the air outlet.

- DUT

Displays a temperature measured by the DUT thermometer.

Context Menu

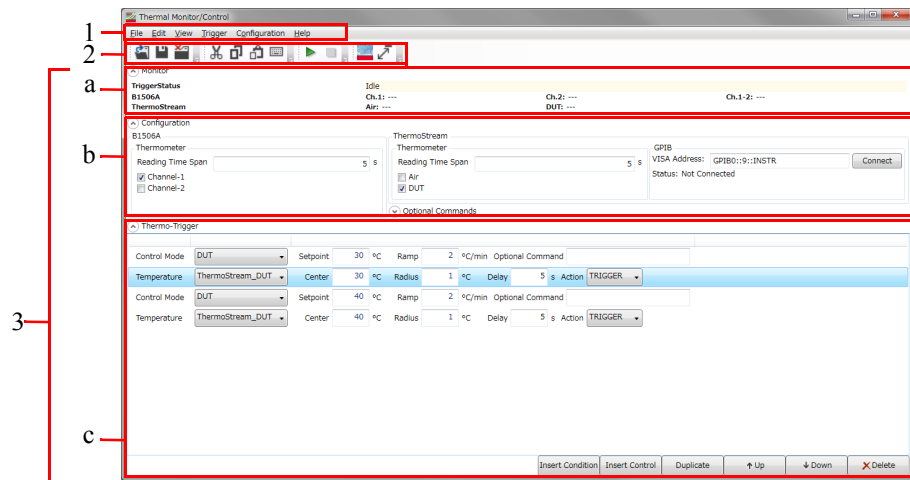
The following context menu is displayed by right-clicking on the panel.

- | | |
|-------------------------------------|---|
| Switch View | Switches the view mode to the Control mode.
You can also switch to the Control mode by double-clicking on the panel. |
| Minimize | Minimizes the panel. |
| Move to the Initial Position | Moves the panel to the initial position. |
| Close | Closes the panel and exits the thermal monitor/control software. |

Control Mode GUI

Figure 4-39

Thermal Monitor/Control Software GUI (Control Mode)



The control mode GUI is comprised of the following areas.

1. “Main Menu” on page 4-142

This provides the functions needed for various operations in the menu format.

2. “Toolbar” on page 4-144

This provides the functions that are very frequently used in the button format.

3. “Work Area” on page 4-146

This area provides the functions to set the thermometers and ThermoStream, and create the thermo-trigger list, in addition to all the functions on the monitor mode panel. This is separated to the following areas.

- a. “Monitor” on page 4-146
- b. “Configuration” on page 4-147
- c. “Thermo-Trigger” on page 4-150

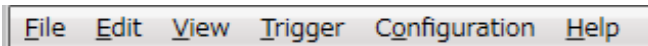
For the dialog box displayed during this software operation, see “Dialog Boxes” on page 4-156.

For the files handled by this software, see “Summary of Files” on page 4-157.

Main Menu

Figure 4-40

Main Menu



The following shows the structure of the main menu.

File Menu

Displays the following menu items to operate the setup file. For the kinds of the files and file extensions, see “Summary of Files” on page 4-157.

- New** Creates a new setup.

 This destroys the setup that you are editing, and creates a new setup.
- Open...** Opens an existing setup file.

 This opens the file selection dialog box, destroys the setup that you are editing, and then opens the file selected in the dialog box.
- Save** Saves the setup that you are editing to the original setup file.
- Save Setup As...** Saves the setup that you are editing to the specified setup file.

 This opens the file selection dialog box, and saves the present setup to the specified setup file.
- Recent Setup Files** Lists a maximum of 10 names of the setup files that were recently edited, as menu items. You can easily open a setup file by using them.
- Exit** Exits the thermal monitor/control software. Unsaved data is destroyed.

Edit Menu

Displays the following menu items to edit the setup.

- Cut** Moves the selected text to the clipboard.
- Copy** Copies the selected text to the clipboard.
- Paste** Pastes the text from the clipboard to the insertion point.
- On-screen
keyboard...** Displays the on-screen keyboard.

View Menu

Displays the following menu items for the display setting.

Go to Palette	Displays the Software Palette in fullscreen mode.
Switch View	Switches the view mode to the Monitor mode.
Main Window	Displays the following menu item. Fullscreen Changes the display style of the main window. If this is marked, the main window does not have the titlebar and is displayed in fullscreen mode. If this is unmarked, the main window has the titlebar and is displayed in the regular window style. This is initially marked.

Trigger Menu

Displays the following menu items for controlling the thermo-trigger list execution.

Start	Starts to execute the thermo-trigger list, and then switches the view mode to the monitor mode. The thermo-trigger list is a sequence comprised of thermal condition steps and thermal control steps. For details, see “Thermo-Trigger” on page 4-150. During executing one thermo-trigger list, you can execute a measurement on one of the following software in synchronization if the thermal conditions are respectively true. <ul style="list-style-type: none">• “Datasheet Characterization Software” on page 4-4• “I/V Measurement Software” on page 4-39• “Capacitance Measurement Software” on page 4-70• “Gate Charge Measurement Software” on page 4-99 During executing one thermo-trigger list, a measurement on the measurement software waits until the thermal condition is true. Then, when it is true, the measurement is executed. For the measurement execution in synchronization with the thermo-trigger list, see “Executing Measurement in Synchronization with Thermo-trigger List” on page 4-154.
Stop	Stops the thermo-trigger list execution.

The measurement software cancels the idled measurement. Hence, the measurement is not executed.

Configuration Menu

Displays the following menu item for the ThermoStream parameter setting.

Define ThermoStream Parameters...

Opens the ThermoStream Parameters dialog box. See “ThermoStream Parameters Dialog Box” on page 4-156.

Help Menu

Displays the following menu item.

About...

Opens the About Box dialog box. See “About Box Dialog Box” on page 4-157.

Toolbar

Figure 4-41

Toolbar



The toolbar has four tool button groups. The following shows the tool buttons in the tool button groups.

File tool button group



Open

Opens an existing setup file.

This opens the file selection dialog box, destroys the setup that you are editing, and then opens the file selected in the dialog box.



Save

Saves the setup that you are editing to the original setup file.



Exit




Exits the thermal monitor/control software. Unsaved data is destroyed.

Edit tool button group






Cut

Moves the selected text to the clipboard.



-  **Copy** Copies the selected text to the clipboard.
-  **Paste** Pastes the text from the clipboard to the insertion point.
-  **On-screen keyboard** Displays the on-screen keyboard.

Trigger tool button group

-  **Start** Starts to execute the thermo-trigger list, and then switches the view mode to the monitor mode.

To stop the thermo-trigger list execution, select the Trigger > Stop menu, or click the Stop button  on the toolbar.
-  **Stop** Stops the thermo-trigger list execution.

View tool button group

-  **Go to Palette** Displays the Software Palette in fullscreen mode.
-  **Switch View** Switches the view mode to the Monitor mode.

Work Area

In this area, set the thermometers and ThermoStream, and create the thermo-trigger list. This is separated to the following areas.

- “Monitor” on page 4-146
- “Configuration” on page 4-147
- “Thermo-Trigger” on page 4-150


Monitor

Figure 4-42

Monitor



This is an area to display the following items that are common information on the monitor mode panel.

The following fields can be hidden or shown by clicking the chevron  next to “Monitor”.

- Trigger Status** This displays the thermal condition for the idled DUT characteristics measurement and the target temperature controlled by ThermoStream. When no thermo-trigger list is executing, this displays “Idle”.
- During the DUT characteristics measurement is waiting until the thermal condition is true, this displays the thermal condition for the idled measurement.
 - During controlling the temperature of the ThermoStream, this displays the target temperature controlled by ThermoStream and the thermometer position.

For details, see “Thermo-Trigger” on page 4-150.

- B1506A** Displays temperatures measured by thermocouples connected to the test fixture.
- Ch.1
Displays a temperature measured by a thermocouple connected to the thermocouple connector 1.
 - Ch.2

Displays a temperature measured by a thermocouple connected to the thermocouple connector 2.

- Ch.1 - 2

Displays a gap between the above Ch.1 and 2 values.

ThermoStream Displays temperatures measured by thermometers on the ThermoStream.

- Air

Displays a temperature at the air outlet.

- DUT


Displays a temperature measured by the DUT thermometer.

Configuration

Figure 4-43



This is an area to set the following items regarding the B1506A’s thermometers and ThermoStream’s thermometers and control.

The following fields can be hidden or shown by clicking the chevron  next to “Configuration”.

- a. B1506A Thermometer

This is an area to set the following items regarding the B1506A’s thermometers.

Reading Time Span

Specify the reading time span for the B1506A’s thermometers.

Setting range: 2 s to 3600 s (resolution: 1 s). The default

GUI Reference
Thermal Monitor/Control Software

setting is 5 s.
While executing a measurement by any measurement software, the reading is delayed.

**Channel 1
check box**

Enable (On) or disable (Off) a thermocouple connected to the thermocouple connector 1 on the test fixture.

**Channel 2
check box**

Enable (On) or disable (Off) a thermocouple connected to the thermocouple connector 2 on the test fixture.

b. ThermoStream

This is an area to set the following items regarding the ThermoStream.

Thermometer

Set up the thermometers of the ThermoStream.

- Reading Time Span

Specify the reading time span for the ThermoStream's thermometers.
Setting range: 2 s to 3600 s (resolution: 1 s). The default setting is 5 s.

- Air check box

Enable (On) or disable (Off) the thermometer at the air outlet of ThermoStream.

- DUT check box

Enable (On) or disable (Off) the DUT thermometer of ThermoStream.

GPIB

Set up the communication with ThermoStream using the GPIB.

NOTE

To control the ThermoStream from B1506A, set B1506A to the system controller.

- VISA Address

Specify the VISA address string of the ThermoStream.
The default value is "GPIB0::9::INSTR".

- Connect/Disconnect button

Tries to connect with the ThermoStream using the specified VISA Address, or to disconnect from it.

- Connection Status

Displays the result of the connection trial.

- Connected


Means that the ThermoStream is successfully connected.

- Disconnected

Means that the ThermoStream is NOT connected or is disconnected.

c. Optional Commands

You can specify additional ThermoStream command string that is sent to ThermoStream when executing the thermo-trigger list. For the ThermoStream commands, see InTest ThermoStream's manual.

This field can be shown or hidden by clicking the chevron  next to "Optional Commands".

- Initialization

Specify command string that is sent at the beginning of the thermo-trigger list execution.

You can also specify multiple commands in list format.

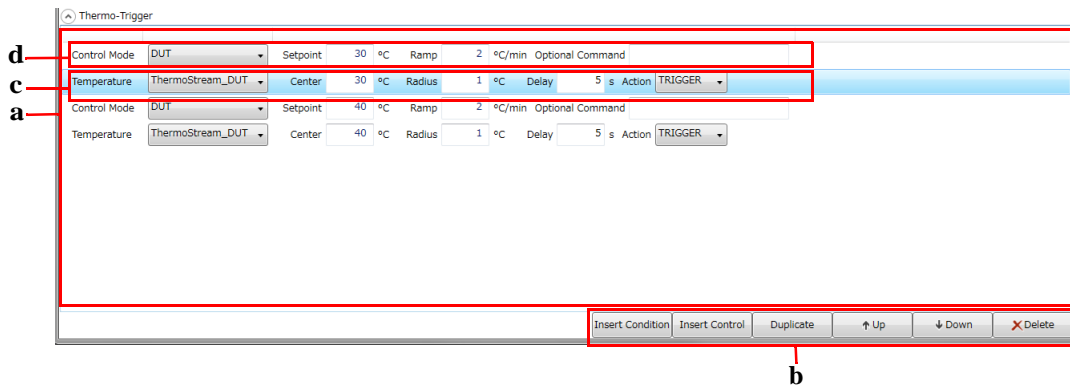
- Finalization

Specify command string that is sent at the end of the thermo-trigger list execution.

You can also specify multiple commands in list format.

Thermo-Trigger

Figure 4-44 Thermo-Trigger



This is an area to create a thermo-trigger list.

Insert thermal condition steps and thermal control steps using the edition buttons on the bottom of the thermo-trigger list area, and set up the parameters of their steps to create a thermo-trigger list.

The following fields can be hidden or shown by clicking the chevron (▲) next to “Thermo-Trigger”.

a. Thermo-Trigger List

The thermo-trigger list is a sequence comprised of thermal condition steps and thermal control steps.

The thermo-trigger list is executed from the top to the bottom of the list. If the ThermoStream is not connected, all thermal control steps in the list are skipped.

During executing one thermo-trigger list, a measurement on the measurement software waits until the thermal condition is true. Then, when it is true, the measurement is executed.

A thermo-trigger list can have maximum 100 steps.

Create a thermo-trigger list using the following edition buttons.

b. Edition Buttons

- Insert Condition

Inserts a new thermal condition step just before the selected step.

A new thermal condition step is added if the list is empty.

- **Insert Control**
Inserts a new thermal control step just before the selected step.
A new thermal control step is added if the list is empty.
 - **Duplicate**
Makes a duplicate of the selected step and insert it just before the selected step.
 - **Up**
Move the selected step up one line.
 - **Down**
Moves the selected step down one line.
 - **Delete**
Deletes the selected step.
- c. **Parameters of Thermal Condition Step**
- The thermal condition step compares the specified temperature reading with the specified temperature window, and do the specified action such as triggering the DUT characteristics measurement if the temperature is within the window.
- Specify a thermal condition (used thermometer and temperature window) and an action if the condition is true, in a thermal condition step.

Temperature Select a temperature that is used for the condition judgment.

- **Channel1**
Temperature measured by a thermocouple connected to the thermocouple connector 1 on the test fixture.
- **Channel2**
Temperature measured by a thermocouple connected to the thermocouple connector 2 on the test fixture.
- **Channel1_2**
A gap between the above Channel 1 and 2 values.
- **ThermoStream_Air**
Temperature at the air outlet of ThermoStream.
- **ThermoStream_DUT**

GUI Reference
Thermal Monitor/Control Software

	Temperature measured by the DUT thermometer of ThermoStream.
Center	Specify the center of the temperature window of the thermal condition.
Radius	Specify the range of the temperature window of the thermal condition. If you specify the Center parameter to 30°C and the Radius parameter to 2°C, the range of the thermal condition is from 28°C to 32°C.
Delay	Specify a time after that the condition is true and before the specified action is done.
Action	Select an action if the condition is true. <ul style="list-style-type: none">• TRIGGER Sends the start trigger for DUT characteristics measurement.• NOP No operation, and goes to the next step. This is useful to set multiple thermal conditions for a measurement.• END Finishes the thermo-trigger list execution.

d. Parameters of Thermal Control Step

NOTE

This area is for the thermal control using the ThermoStream. Skip this section if you use the thermal plate for thermal control.

The thermal control step controls the ThermoStream so that the temperature of the specified observation point reaches to the specified target temperature.

If there is a thermal condition step before a thermal control step in the thermo-trigger list, the thermal control step is executed after finishing the measurement triggered from the thermal condition step.

Specify a temperature observation point (control mode) and a target temperature in a thermal control step.

Control Mode	Select the thermal control mode from below. <ul style="list-style-type: none">• Air
---------------------	---

	Controls the temperature with referring to the thermometer at the air outlet of ThermoStream.
	<ul style="list-style-type: none">• DUT
	Controls the temperature with referring to the DUT thermometer of the ThermoStream.
Setpoint	Specify the target temperature.
Ramp	Specify the ramp rate of the temperature.
Optional Command	<p>You can specify additional ThermoStream command string that is sent to ThermoStream when executing the thermal control step. For the ThermoStream commands, see InTest ThermoStream's manual.</p> <p>You can also specify multiple commands in list format.</p>

Executing Measurement in Synchronization with Thermo-trigger List

You can execute a DUT characteristics measurement using one of the following software in synchronization with the thermo-trigger list. Along the progress of the thermo-trigger list, the temperature around DUT is controlled and the measurement is executed if it reaches within the target temperature window.

- Datasheet Characterization Software
- I/V Measurement Software
- Capacitance Measurement Software
- Gate Charge Measurement Software

If you use the ThermoStream to control the temperature around DUT, do the following preparation for the measurement in synchronization with the thermo-trigger list.

- On the measurement software:
Set up the measurement conditions, and confirm the measurement is successfully executed at normal temperature. And then, save the setup data to a setup file or measurement data file.
- On the thermal monitor/control software:
Set up the thermal condition and ThermoStream control, and create a thermo-trigger list in the control mode. And then, save the setup data to a setup file.

After this preparation, follow the step below to execute the measurement in synchronization with the thermo-trigger list.

1. Start the thermal monitor/control software.
2. Switch the view mode to the Control mode.
3. Open the prepared setup file on the thermal monitor/control software.
4. Start the measurement software.
5. Open the prepared setup file or measurement data file on the measurement software.
6. Click Start tool button in the toolbar (or select Trigger > Start menu) on the thermal monitor/control software. The thermo-trigger list is executed.

7. Click Start tool button in the toolbar (or select Measurement > Start menu) on the measurement software.

At this time, the measurement is not executed, and waits until the temperature reaches within the target temperature window. Along the progress of the thermo-trigger list, the temperature around DUT is controlled and the measurement is executed if it reaches within the target temperature window.

If you use the thermal plate to control the temperature around DUT, you need to control the thermal source manually. Even in this case, you can execute the measurement in synchronization with the thermo-trigger list using the similar manner as above. The following shows the differences.

- Preparation on the thermal monitor/control software:
Set up the thermal conditions only, and create a thermo-trigger list that has only thermal condition steps, not thermal control steps.
- With checking the present temperature around DUT and the next target temperature window (thermal condition) using the monitor mode panel of the thermal monitor/control software, control the thermal source manually.
When the present temperature reaches within the target temperature window, the measurement is executed. Wait until finishing the measurement, control the thermal source again so that the temperature goes to the next target temperature window.

Dialog Boxes

ThermoStream Parameters Dialog Box

The ThermoStream Parameters dialog box is used to define the ThermoStream parameters. For details of the parameters, InTest ThermoStream's manual.

DUT sensor	Select the type of the thermocouple used as the DUT thermometer. <ul style="list-style-type: none">• OFF (disable)• K• T
DUT self tuning control	Select OFF or ON to disable or enable the self tuning control regarding the overshoot and speed of the DUT thermal controlling.
DUT thermal constant	Specify a thermal constant for DUT thermal controlling.
Air to DUT max	Specify the maximum acceptable difference between the DUT temperature and the temperature at the air outlet of ThermoStream.
Air temperature max	Specify the maximum temperature at the air outlet of ThermoStream.
Air temperature min	Specify the minimum temperature at the air outlet of ThermoStream.
Apply button	Applies the present setting to the ThermoStream.
OK button	Applies the present setting to the ThermoStream, and closes this dialog box.
Cancel button	Closes this dialog box without applying the present setting.

This dialog box is opened by selecting the main menu Configuration > Define ThermoStream Parameters....

About Box Dialog Box

The About Box dialog box displays the model number, the software revision number, download URL for software updating, and so on.

This dialog box is opened by selecting the main menu Help > About....

Summary of Files

The following shows the summary of the files handled by the thermal monitor/control software.

Table 4-22 **Summary of Files**

File Type	Description	Extension	Folder as Initial Setting
Setup File	Setup data You can save this if needed.	*.pda-th	(You can specify the folder when saving the data)

Common GUI Components

This section describes the following GUI components commonly used in the Keysight Easy Test Navigator software.

- “Module Configuration Dialog Box” on page 4-158

Module Configuration Dialog Box

You can do the following operations in the Module Configuration dialog box.

- Checking the revision of the firmware
- Setting the power line cycle
- Checking the status of the hardware modules
- Resetting the hardware modules
- Executing the self-test
- Executing the self-calibration
- Executing the self-diagnostics

This dialog box is opened by selecting the main menu Configuration > Module....

Firmware Revision Shows the revision of the firmware.

Line Frequency Select the power line frequency from below. This is used as the PLC value for the measurement time setting.

- 50 Hz
- 60 Hz

Module Status Shows the module’s model numbers and the result of the self-test, self-calibration, and self-diagnostics for the modules as the status.

- B1506A-H51/H71

The following tables shows the configuration and status for B1506A-H51 and B1506A-H71.

Table 4-23 B1506A-H51/H71 Configuration and Status

Configuration	Status
GNDU : B1500-66505	<ul style="list-style-type: none"> • Pass It is passed. • Fail It is failed in the self-test or self-calibration. • Unavailable It is not acknowledged.
MPSMU (SMU1) : B1511B	
MFCMU : B1520A	
MCSMU (SMU2) : B1514A	
MCSMU (SMU3) : B1514A	
MCSMU (SMU4) : B1514A	
MCSMU (SMU5) : B1514A	
HVSMU (SMU6) : B1513C	
UHCU	
I/V Selector	<ul style="list-style-type: none"> • Pass It is passed. • Fail It is failed in the self-diagnostics. • Unavailable ^a It is not acknowledged.
Device Capacitance Selector	

a. This also occurs when it is turned off.

- B1506A-H21

The following tables shows the configuration and status for B1506A-H21.

Table 4-24 B1506A-H21 Configuration and Status

Configuration	Status
GNDU : B1500-66505	<ul style="list-style-type: none"> • Pass It is passed. • Fail It is failed in the self-test or self-calibration. • Unavailable It is not acknowledged.
MPSMU (SMU1) : B1511B	
MFCMU : B1520A	
MCSMU (SMU2) : B1514A	
MCSMU (SMU3) : B1514A	
HCSMU (SMU4) : B1512A	
HVSMU (SMU5) : B1513C	
I/V Selector	<ul style="list-style-type: none"> • Pass It is passed. • Fail It is failed in the self-diagnostics. • Unavailable ^a It is not acknowledged.
Device Capacitance Selector	

a. This also occurs when it is turned off.

Operation Buttons You can do the following operations using the buttons below.

- Resetting the hardware modules
- Executing the self-test
- Executing the self-calibration
- Executing the self-diagnostics

Reset button Initializes and re-acknowledges all the modules.

Self Test button Executes the self-test for all the modules.

Self Calibration button Executes the self-calibration for all the modules.

Diagnosis button Executes the self-diagnostics for all the output selectors.

Connect the output terminals according to the displayed instructions during the diagnostics execution.

Error Log

Shows the error messages when errors occur for the above button operations. The error messages are cleared when you do any new operation.

GUI Reference
Common GUI Components

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