DALE2000

LIM/GFI Tester

DALE TECHNOLOGY

Operating Manual

D A L E T E C H N O L O G Y

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To order this manual, use part number 9508-0332

Revision History			
Revision	**Change #**	**Description**	**Date**
A		*Initial Release*	*August 2003*

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Unpacking and Inspection

Follow standard receiving practices upon receipt of the instrument. Check the shipping carton for damage. If damage is found, stop unpacking the instrument. Notify the carrier and ask for an agent to be present while the instrument is unpacked. There are no special unpacking instructions, but be careful not to damage the instrument when unpacking it. Inspect the instrument for physical damage such as bent or broken parts, dents, or scratches.

Claims

Our routine method of shipment is via common carrier, FOB origin. Upon delivery, if physical damage is found, retain all packing materials in their original condition and contact the carrier immediately to file a claim.

If the instrument is delivered in good physical condition but does not operate within specifications, or if there are any other problems not caused by shipping damage, please contact Dale Technology or your local distributor.

Standard Terms and Conditions

Refunds & Credits

Please note that only serialized products (products labeled with a distinct serial number) and accessories are eligible for partial refund and/or credit. Nonserialized parts and accessory items (cables, carrying cases, auxiliary modules, etc.) are not eligible for return or refund. In order to receive a partial refund/credit of a product purchase price on a serialized product, the product must not have been damaged by the customer or by the common carrier chosen by the customer to return the goods, and the product must be returned complete (meaning all manuals, cables, accessories, etc.) within 90 days of original purchase and in "as new" and resellable condition. The Return Procedure must be followed to assure prompt refund/credit.

Restocking Charges

Only products returned within 90 days from the date of original purchase are eligible for refund/credit. Products returned within 30 days of original purchase are subject to a minimum restocking fee of 15%. Products returned in excess of 30 days after purchase, but prior to 90 days, are subject to a minimum restocking fee of 20%. Additional charges for damage and/or missing parts and accessories will be applied to all returns. Products not returned within 90 days of purchase, or products which are not in "as new" and resellable condition, are not eligible for credit return and will be returned to the customer.

Return Procedure

Products sent to Dale Technology for repair must be sent via UPS or FedEx® fully insured to:

Service and Repair
1420 75th Street SW
Everett, WA 98203
888-99FLUKE (888-993-5853) • 425-446-5560
http://www.daletech.com/ • sales@daletech.com

The unit should be wrapped in at least 2 inches of Styrofoam filler or similar packing material. Unit should be accompanied by a written explanation detailing the problem with the unit.

Certification

This instrument was thoroughly tested and inspected and found to meet Dale Technology's manufacturing specifications when it was shipped from the factory. Calibration measurements are traceable to the National Institute of Standards and Technology (NIST). Devices for which there are no NIST calibration standards are measured against in-house performance standards using accepted test procedures.

Warranty

Dale Technology warrants this instrument against defects in materials and workmanship for one full year from the date of original purchase. During the warranty period, we will repair or, at our option, replace at no charge a product that proves to be defective, provided you return the product, shipping prepaid, to Dale Technology. This warranty does not apply if the product has been damaged by accident or misuse or as the result of service or modification by other than Dale Technology. IN NO EVENT SHALL DALE TECHNOLOGY BE LIABLE FOR CONSEQUENTIAL DAMAGES.

Only serialized products and their accessory items (those items bearing a distinct serial number tag) are covered under this one–year warranty. PHYSICAL DAMAGE CAUSED BY MISUSE OR PHYSICAL ABUSE IS NOT COVERED UNDER THE WARRANTY. Items such as cables and nonserialized modules are not covered under this warranty.

This warranty gives you specific legal rights, and you may also have other rights that vary from state to state, province to province, or country to country. This warranty is limited to repairing the instrument to Dale Technology's specifications.

When you return an instrument to Dale Technology, for service, repair, or calibration, we recommend using United Parcel Service, Federal Express, or Air Parcel Post. We also recommend that you insure your shipment for its actual replacement cost. Dale Technology will not be responsible for lost shipments or instruments that are received in damaged condition due to improper packaging or handling. All warranty claim shipments must be made on a freight prepaid basis. Also, in order to expedite your claim, please include a properly completed copy of the Service Return Form. Recalibration of instruments, which have a recommended semiannual calibration frequency, is not covered under the warranty.

Use the original carton and packaging material for shipment. If they are not available, we recommend the following guide for repackaging:

- Use a double–walled carton of sufficient strength for the weight being shipped.
- Use heavy paper or cardboard to protect all instrument surfaces. Use nonabrasive material around all projecting parts.

- Use at least four inches of tightly packed, industrial-approved shock-absorbent material around the instrument.

Warranty Disclaimer

Should you elect to have your instrument serviced and/or calibrated by someone other than Dale Technology, please be advised that the original warranty covering your product becomes void when the tamper-resistant Quality Seal is removed or broken without proper factory authorization. We strongly recommend, therefore, that you send your instrument to Dale Technology for factory service and calibration, especially during the original warranty period.

In all cases, breaking the tamper-resistant Quality Seal should be avoided at all cost, as this seal is the key to your original instrument warranty. In the event that the seal must be broken to gain internal access to the instrument (e.g., in the case of a customer-installed firmware upgrade), you must first contact Dale Technology's technical support department at 800-265-7586. You will be required to provide us with the serial number for your instrument as well as a valid reason for breaking the Quality Seal. You should break this seal only after you have received factory authorization. Do not break the Quality Seal before you have contacted us! Following these steps will help ensure that you will retain the original warranty on your instrument without interruption.

Warning

Unauthorized user modifications or application beyond the published specifications may result in electrical shock hazards or improper operation. Dale Technology will not be responsible for any injuries sustained due to unauthorized equipment modifications.

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SAFETY CONSIDERATIONS

General

This instrument and related documentation must be reviewed for familiarization with safety markings and instructions before you operate the instrument.

Safety Symbols

The symbol to the left is the operating manual symbol. When you see this symbol on the instrument, refer to the operating manual.

WARNING! The **WARNING!** sign denotes a hazard. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a **WARNING!** sign until the indicated conditions are fully understood and met.

CAUTION: The **CAUTION** sign denotes a hazard. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the instrument. Do not proceed beyond a **CAUTION** sign until the indicated conditions are fully understood and met.

General Information

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Inside This Chapter

- ❑ Introduction
- ❑ Key Features
- ❑ Controls and Indicators
- ❑ Specifications
- ❑ Maintenance and Calibration
- ❑ Accessories

Introduction

The DALE2000 LIM/GFI Tester is a stand alone hand held instrument that checks the safety performance of power systems used in hazardous locations. This includes both isolated power systems and ground fault interrupted systems as specified by the National Fire Protection Association (NFPA 99 Standard for Health Care Facilities) for these locations.

Measurements include Line Voltage, Isolation Current to calculate Isolation Impedance of each line, Line Isolation Monitor (LIM) trip point for each line and the Ground Fault Interrupter (GFI) trip point.

Measurement is made by plugging the DALE2000 into a typical output of the system being tested, selecting the desired test via ganged push-buttons and reading the results on a digital display. The instrument's low power electronics is supplied from a 9 volt battery with automatic shut down for extended life of up to 4,000 tests.

Key Features

- ❑ Hand held instrument
- ❑ Stand-alone operation
- ❑ Direct measurement of
  - Line Voltage
  - Line Isolation Current
  - LIM Trip Current
  - GFI Trip Current
- ❑ Memory to hold reading
- ❑ Auto shut off to conserve battery

Controls and Indicators

1. **POWER SYSTEM CONNECTOR**, conventional 3 wire Hospital Grade connector for inputting the power system under test to the DALE2000 for the desired analysis.

2. **FUNCTION SELECTOR** consists of a multi-station push button switch to select and read the parameter to be tested. The parameters include **LINE** voltage, **ISO**lation current, **LIM** and **GFI** trip point for simulating system fault currents which can then be read on the digital display.
3. **TRIP POINT** control simulates a fault to test the LIM and GFI systems trip level. The LIM trip level is read on the meter when the **READ** button is pressed while the GFI trip point is read directly.

4. **METER** is a large, ½ inch, high contrast 3½ digit LCD display. The display will read Volts for line measurement, milliamperes (mA) to 1.999 mA for line isolation current and mA to 19.99 mA for LIM and GFI trip currents depending on the parameter selected.

5. **BATTERY COMPARTMENT** (not shown) holds the 9 volt alkaline battery recommended for use. Battery is only energized when the analyzer is connected to an active power line and for 5 to 10 seconds after loss of power to permit making final readings.

CAUTION

DISCONNECT THE DALE2000 FROM THE POWER SYSTEM AFTER COMPLETING THE TEST. THIS WILL TURN OFF THE DALE2000 AFTER THE 7 SECOND DELAY AND CONSERVE BATTERY LIFE.

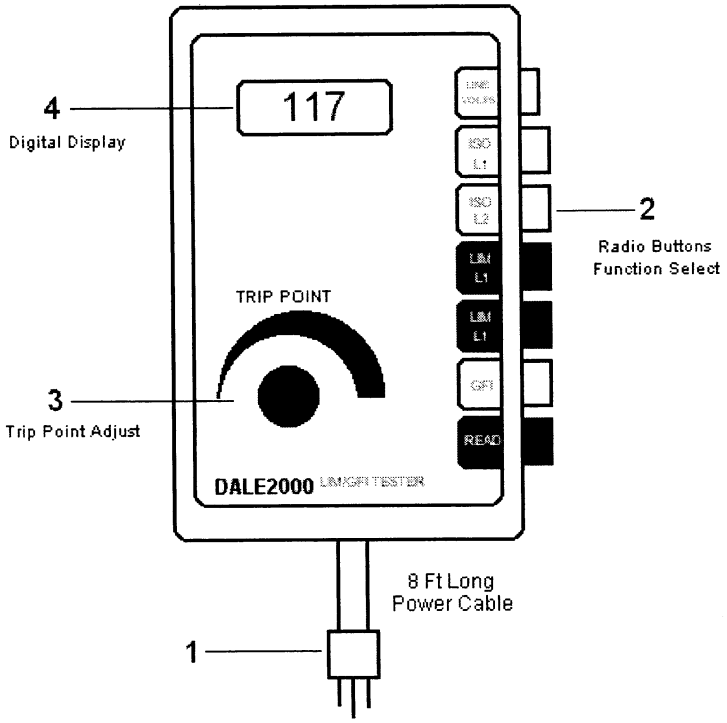

Figure 1. DALE2000 Top View

Specifications

LINE VOLTAGE

Range (Labeled)	100 - 130 VAC 200 - 260 VAC
Accuracy	± 2 % R, ± 1 LSD
Resolution	1 Volt

ISOLATION CURRENT

Range	0-1.999 mA
Accuracy	± 1 % R, ± 1 LSD
Resolution	1 µA
Input Impedance	< 1.5 KΩ

LIM / GFI TRIP CURRENT

Range	
LIM	1-7.5 mA @ 120 V 2-14 mA @ 220 V
GFI	1-11 mA @ 120 V 2-20 mA @ 220 V
Accuracy	± 2 % R, ± 1 LSD
Resolution	.01 mA

BATTERY

Type	9 Volt Alkaline
Measurements	> 4,000
Indicator	Low battery, approximately 100 tests remaining

ENVIRONMENTAL

Operating temperature	15-40 °C
Storage temperature	20-65 °C
Relative humidity	90 % max.

MECHANICAL

Dimensions	3.5" X 6.21" X 1.75" (89mm X 157mm X 44.5mm)
Weight	1 lbs (0.5kg)

Maintenance and Calibration

Your DALE2000 needs little maintenance or special care. However it is a calibrated measuring instrument and should be treated as such. Avoid dropping or other mechanical abuse that could cause a shift in the calibrated settings.

CLEANING the DALE2000 should be done occasionally utilizing a damp cloth and a mild detergent. Care should be taken to avoid the entrance of liquids.

VERIFICATION can best be done by checking line voltage reading against expected values at 115 -125 Volts. Further checks can be made by checking LIM and GFI TRIP CURRENT adjust at it's limits, approximately 1 to 7.5 mA for the LIM and 1 to 11 for GFI.

CALIBRATION of the DALE2000 is best done at the factory on a yearly schedule as we are equipped with the appropriate tools and reference instruments traceable to the National Institute of Standards and Technology (NIST).

Accessories

Item	Dale Part #
Soft carry case	100-030
Operating Manual	9508-0332

Using the DALE2000

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Inside This Chapter

- ❑ Preparing the DALE2000 for use
- ❑ What is being measured
- ❑ Measurement of Line Voltage
- ❑ Measurement of Isolation Current
- ❑ Testing Line Isolation Monitors
- ❑ Testing the Ground Fault Interrupter
- ❑ Ground Fault Interrupters

WARNING

DISCONNECT ALL DEVICES FROM THE POWER SYSTEM BEING TESTED BEFORE STARTING TO ASSURE THE SAFETY OF PATIENTS AND PERSONNEL.AS WELL AS TO AVOID POSSIBLE INTRODUCTION OF ERRORS FROM THE DEVICES OWN LEAKAGE CURRENT.

Preparing the DALE2000 for Use

As it is best to start from the same position each time, place the LIM/GFI tester in the voltage mode by latching in the **LINE VOLTS** button and set the **TRIP POINT** control in the fully counter clockwise position.

Measurement of Line Voltage

The tester can now be connected to the power system under test. The tester will automatically turn on and the **METER** will be reading the power line voltage independent of the type of power system it is connected to. If the reading is not in the proper range, check the system for proper connection, polarity or if the system's protection mechanism has been tripped.

Measurement of Isolation Current

The degree of isolation of an isolated power system is measured by the impedance of each power line to ground. This is determined by measuring the isolation current and calculating the impedance knowing the line voltage measured above. The isolation current is that measured through a low impedance current meter connected between the opposite line and ground.

The measurement is made by first disconnecting the ground connection for the Line Isolation Monitor (LIM). This avoids errors which may be introduced by the LIM. The operation of **ISO L1** and **ISO L2** in turn will connect the low impedance meter between the opposite line and ground. The meter will now display the isolation current for the selected line in milliamperes (mA) to 1.999 mA.

To determine the isolation impedance, divide the line voltage V by the isolation current reading in mA. The result is the isolation impedance in kilohms (KΩ). The National Fire Protection Association (NFPA) established a limit of 200 KΩ minimum for this value. Working backwards, this sets a maximum current of 0.500 to 0.650 mA with line voltage variation from 100 to 130 volts. Thus, setting a limit of 0.500 mA on this reading itself assures compliance with NFPA's requirements for any line voltage.

After completing the line isolation test, ***be sure to reconnect the LIM's grounding conductor to the reference ground.*** The LIM's internal impedance should be high enough to limit the LIM's added leakage current to 1.0 mA when any point in the system is grounded. NFPA recommends that the ground current being displayed on the LIM's meter should be noted as a reference for changes.

Testing the Line Isolation Monitors (LIM)

NFPA requires that each isolated power system be provided with a LIM that indicates possible leakage or fault currents from either isolated conductor to ground. In addition, provide visual and audible alarms when the total hazard current exceeds 5.0 mA under normal line voltage. Further, the LIM should not alarm for currents less than 3.7 mA.

The DALE2000 tests these thresholds for each line by providing an adjustable impedance to ground in order to simulate the fault and then reading the equivalent current on the display. Starting with the **TRIP POINT** control fully counter clockwise, select the **LIM L1** button. Ignoring the display's reading, slowly advance the **TRIP POINT** control until the alarm trips. The equivalent trip current can then be read on the **METER** by pressing the **READ** button. The value should fall between 3.7 and 5.0 mA. This should be repeated for **LIM L2** with similar results.

It is critical to advance the control slowly in order to avoid any erroneous high readings. These can be caused by integrating sensing delays of the LIM detection circuit, as well as any built in delays to avoid nuisance alarms from

transients. Advancing the control in steps of 0.1 or 0.2 mA, with a short pause after each step to allow for response, will provide satisfactory resolution and accuracy.

Testing the Ground Fault Interrupter

Ground Fault Interrupters (GFI) are provided where loss of power is not hazardous to the patient. These devices monitor the leakage current flowing in the green grounding conductor (earth current) of the power cable in all line operated devices. If the current exceeds a safe value, the GFI is tripped and power is removed from the power system. NFPA has set an acceptable value of 6.0 mA as a trip point.

To test the GFI, set the current control fully counter clockwise and select **GFI**. Slowly advance the **TRIP POINT** control until the GFI, trips and power is lost. This will be indicated by the current reading being displayed on the **METER** freezing at the trip value. The reading will be held for 5 to 10 seconds to assure enough time for documentation. Before resetting the GFI, return the **TRIP POINT** control fully counter clockwise.

Like the testing of the LIM, advancing the **TRIP POINT** control slowly is just as important to avoid all time delay errors. Step techniques as described above should also help here.

What is Being Measured

National Fire Protection Association (NFPA) standard for Health Care Facilities (NFPA 99) requires that hazardous locations such as wet locations or anesthetizing locations where flammable inhalation anesthetizing agents may be used shall be provided with special protection against electrical shock. This special protection is to be provided by either:

An electrical power distribution system that limits the possible ground fault current due to a first fault to an acceptable low value without interrupting the power and equipped with an alarm indicating that it has occurred.

Where acceptable, a power distribution system that interrupts the power if the fault current exceeds a specified safe value.

Isolated Power Systems

The uninterrupted power source is provided by an isolated power system which consist of an isolation transformer with it's primary connected to the grounded power system, a grounded electrostatic shield between primary and secondary, and the secondary left floating with respect to ground. However, the secondary designated L1 and L2 while having no physical connection to ground, each does have leakage impedance to ground. These are represented by Z1 and Z2 in Figure 1 and thus does not provide perfect isolation.

The leakage impedance as shown contains both resistive and capacitive components derived from proximity of the isolated components to grounded components, poor insulation, dirt etc.

While these leakage impedance values (actually "isolation" impedance since it measures the degree of isolation) are for the power system alone, the line isolation monitor (LIM) and the devices connected provide additional leakage currents to ground. It is these leakage components that the LIM

monitors once installation is completed. However the basic power system must provide a low enough platform to start from.

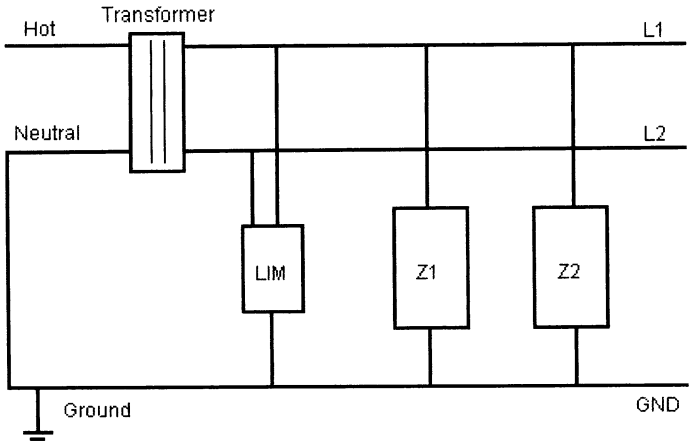

Figure 2. An isolated power system

Protection is provided for the first fault (short of either L1 or L2 to ground) by limiting the current to that set by the isolation impedance to ground of the other line and being related as:

$$IF = \frac{EL}{Z2}$$

NFPA standard sets a minimum isolation impedance of 200,000 ohms which calculates for IF to range between 0.500 mA and 0.650 mA dependent on line voltage (100 to 130V).

This is of course the first fault with the limited low current but if left in place, it sets the stage for a real hazard. A second fault which brings a patient into contact with L2 and ground will after having lost it's protection, produce a macro shock of current limited only by the patient's impedance, generally

assumed to be 1000 ohms or a current of 120mA. The requirement then is for an alarm so as to be made aware immediately if the first level of protection is violated so that corrective action can be taken.

Warning of isolation failure is provided by a Line Isolation Monitor (LIM). As required by NFPA, these devices provide a visual and audible alarm if the isolation impedance drops to a level such as to produce an equivalent ground wire current greater than 5mA. However, they should not alarm for currents less than 3.7 mA. These devices do not measure this current directly but rather by determining the differential current in the two lines, L1 and L2. This differential current returns back to the transformer secondary via ground.

The measurement of the isolation impedance, Z1 and Z2 is made by measuring the current that flows through a low impedance milliammeter connected from the other line to ground. The LIM can be left connected for this test but the connection between the LIM and the reference ground should be opened. The impedance can then be calculated from knowing the line voltage as:

$$Z2 = \frac{EL}{I2}$$

The DALE2000 makes this measurement by operation of the **ISO L1** and **ISO L2** buttons which shorts the opposite line to ground through approximately 1,000 Ω and measuring the current by the voltage drop across a known resistor. The display will read the current to 1.999 mA. While for purity, one can calculate the impedance as described, acceptance can be established for currents less than 500µA (0.500 mA) equivalent to a worst case line voltage of 100V.

The LIM trip point is determined by introducing a variable impedance between either line, L1 or L2 and ground, and by decreasing it until the alarm is triggered. The trip current is then determined by calculating the current that would flow if the resistance is placed directly across the power line, L1- L2.

This is the case that would exist if either line, L1 or L2, was grounded through a low impedance.

The DALE2000 make this measurement by selecting **LIM L1** or **LIM L2.** Starting with the **TRIP POINT** control fully counterclockwise, advance it slowly clockwise. The reading on the display should be ignored during this time. As soon as the alarm sounds, stop advancing the **TRIP POINT** control. Press and hold the **READ** button in order to read the current directly in milliamperes. This should fall between 3.7 mA and 5 mA. No calculation is necessary.

Ground Fault Interrupters

For those areas that can accept loss of power for short periods without jeopardizing the patient, a Ground fault Interrupter (GFI) can be installed. Since the power system is not isolated and ground referenced, contact with the hot wire and any grounded surface will cause current to flow between them.

In addition loss of the grounding third wire will cause all the leakage current, which was safely conducted back to ground (earth) through the green wire to find other paths to ground. This may be in casual contact between a conductive enclosure and a separately grounded bed or a cold water pipe etc. If this ground current is low enough, no hazard exist. If the current becomes excessive, a hazard will exist. Monitoring the ground current to assure a safe value is the acceptable solution.

The GFI performs this function also by sensing the current in the ground conductor by the differential current between the hot and neutral conductors. If the preset limit is exceeded, then the hot and neutral wires are opened by a circuit breaker. NFPA has set an acceptable value of 6 mA. The DALE2000 checks this value by inserting an adjustable current into the ground wire to determine where this takes place. The TRIP CURRENT control should be set fully counterclockwise and the GFI switch actuated.

The control is then advanced slowly clockwise until the GFI is tripped which is indicated by the meter display freezing at this value. The fault current can then be read on the display. Although power is lost, the battery-operated display will hold the reading for approximately 7 seconds so that it can be recorded. At that time the display will go off until power is restored by resetting the GFI.