

**TRANSFORMER TEST SYSTEM**

**MODEL NUMBER TTS2.5**

**VERSION 1.1**

LO/bjf  
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## SPECIFICATIONS

### TTS2.5

**INPUT:** 120 VAC, 30 AAC, single-phase, 60 Hz

**OUTPUT:** Single Phase

Tap	Voltage	Current	
		Continuous	15 min ON/15 min OFF
1	0-125 VAC	20 AAC	30AAC
2	0-250	10	15
3	0-500	5	7.5

#### INSTRUMENTATION:

**Voltmeter:** 3 1/2 digit with LCD display, selectable True RMS or Average responding  
 Ranges: 0-125/250/500 VAC  
 System Accuracy: +/- .5% FS

**Currentmeter:** 3 1/2 digit with LCD display, True RMS responding  
 Ranges: 0-1.999/19.99/199.9 AAC  
 System Accuracy: +/- .5% FS

**Wattmeter:** 3 1/2 digit with LCD display  
 Ranges: 0-199.9 W/1999 W/19.99 kW  
 System Accuracy: +/- .5% FS

**Thermometer:** 3 1/2 digit with LCD display  
 Range: 0-100 degrees Celsius  
 Accuracy: +/- 1 degree Celsius

#### DIMENSIONS:

22.5" W x 21" D x 16" H; 148 lbs.  
 (572mm W x 533mm D x 406mm H; 67kg)

## INTRODUCTION

The PHENIX TECHNOLOGIES TTS2.5 Portable Transformer Loss System is designed to provide voltages and currents to test single-phase distribution transformers. Transformers which can be tested will vary with impedance, approximately as follows:

Impedance	Max. kVA	Max. Secondary Voltage	Max. Primary Voltage
2%	185	500V	25kV
3%	125	500V	16.6kV
4%	94	500V	12.5kV

The TTS2.5 will, of course, test transformers with other impedances; these are examples only. Consult the factory if you are not sure how to determine if a particular transformer can be tested. The tests are made to insure that the transformer meets purchase specifications and will perform adequately after installation. The test set consists of:

- A. Single-phase variable transformer for voltage and current control.
- B. Multi-tapped transformer.
- C. Digital meters to measure the output voltage, current, and power supplied by the test set.
- D. Digital temperature meter to measure the temperature of the transformer being tested for correction of load loss readings.
- E. Overload protection.
- F. Safety interlocks.

## SAFETY

Because the TTS2.5 is designed to supply high voltages, safeguards have been built into it. These safeguards are only effective if safe work practices are also used. The test set and these procedures have been designed for use by knowledgeable electrical workers who have been properly trained in its use.

Please note the following:

1. The test set must be grounded before input power is connected.
2. All power must be disconnected before the test set is ungrounded.
3. The tests described here are to be used **ONLY** on **DE-ENERGIZED** and isolated transformers.
4. **HIGH VOLTAGES (LETHAL IN VALUE) ARE GENERATED DURING THE TESTS AND EXTREME CAUTION MUST BE USED. FOLLOW ALL SAFETY PROCEDURES.**
5. Maintain safe working distance when the test set is energized.

## CONTROLS AND INSTRUMENTATION

The following is a brief description of the various controls and instrumentation found on the TTS2.5. Refer to Figure 1.

1. **Main Power Breaker**

This serves as a master ON/OFF switch and overload protection device.

2. **Main Power Indicator**

This indicator light shows when main power is on.

3-5. **High Voltage On/Off and Indicator**

These buttons activate/deactivate the output of the test set. The light indicates that the output is energized. External interlock and foot switch circuit must be closed and voltage adjust knob must be at zero start (0) for high voltage to turn on. Overload lamp must be off also.

6-7. **Overload Indicator/Reset**

This indicator light shows if set overload condition has occurred. Output will have shut off if light is on. Reset must be pressed and voltage knob reset to zero to re-energize output.

8. **Intlk. Open Indicator**

Light will illuminate if external interlock circuit or foot switch circuit are open. Output will not turn on if lamp is on.

9. **Voltage Adjust**

This controls the output voltage of the test set. Knob must be fully counter-clockwise to energize the test set.

10. **Temperature Meter**

This digital display shows the temperature of the thermocouple.

11. **LOW/HIGH**

This switch allows the operator to change the wattmeter scale.

12. **Currentmeter Range Switch**

Triple range selector switch selects output currentmeter scale.

13. **Meter Hold**

This allows the operator to freeze all meter displays so the readings can be recorded after the test set is de-energized.

## CONTROLS AND INSTRUMENTATION

### 14. **Currentmeter**

This digital currentmeter displays output current.

### 15–16. **Wattmeter and Range Indicators**

This digital wattmeter displays output watts in either watts or kilowatts, depending on which LED is illuminated. The range is determined by the low/high switch and the current meter range switch.

### 17. **Voltmeter**

This digital voltmeter displays output voltage of the test set; the range is determined by the tap selector switch.

### 18. **RMS/AVG**

This switch allows the operator to display the output voltage in either True RMS or average responding, calibrated in RMS.

### 19. **Input Power Receptacle**

Input power cord attached here.

### 20. **Footswitch**

This connector accepts the cable to the foot-operated interlock switch which must be closed before the test can be energized.

### 21. **Output Voltage Tap Selector**

This allows the operator to select one of three output voltage ranges. Push in before turning. Do not change taps during operation.

NOTE: Changing taps when the test set is energized causes High Voltage to shut off.

### 22. **External Interlock**

An external interlock circuit can be installed for added safety using this connector. NOTE: This connector is shipped from the factory with a jumper installed. This circuit must be complete to turn high voltage on.

### 23. **TCI**

The thermocouple is connected here.

### 24. **Primary Voltmeter (Optional)**

This digital voltmeter displays primary or output voltage of the transformer under test.

## CONTROLS AND INSTRUMENTATION

### 25. **Protective Fuses**

F1. – Provides output overload protection. Buss MDA 30 Amp or Little Fuse 326030.

F2. – Protects control circuitry. 5 Amp Type 3AG.

F3. – Protects low current winding of CT2 and low range of current meter. 3 Amp Type 3AG.

### 26. **Power Output Jacks**

The output power leads are connected here.

### 27. **Control Power Indicator**

The indicator lights when the main power breaker is on and fuse F2 is good.

### 28. **Voltmeter Jacks**

The voltage measuring leads are connected here.

### 29. **Ground Terminal**

Connect ground lead here and to facility ground.

## DESCRIPTION OF TESTS

Five tests are typically performed on Distribution Transformers. Their significance is listed below.

1. **Excitation Test**

An AC voltage of 100% rating is applied to the low voltage winding. This test can be combined with the ratio test to identify shorted turns or transformers with incorrect number of turns.

2. **Core Loss Test**

This test measures the core or no-load losses of a transformer. This is especially important when low loss transformers are purchased. This test verifies the manufacturer's guarantee of low losses, an option for which the buyer pays extra. This test also provides important input to the decision of whether an older transformer should be put back into service.

3. **Ratio Test**

This test is used to determine the ratio of the high voltage winding to the low voltage winding and verifies that the proper output (secondary) voltage will be obtained when the rated input (primary) voltage is applied.

4. **Conductor Loss Test**

This test measures the winding losses of the transformer. Also known as the Load Loss Test, this test measures the losses when the transformer is carrying full load and includes all conductor losses due to load current and the stray losses due to stray flux in windings, core clamps, tank walls, and so on. When winding resistances are known, losses due to conductors and strays can be separated and converted to transformer operating temperature.

5. **Impedance Test**

The impedance of a transformer is a measure of the magnetic flux leakage around the windings of a transformer. Movement of the windings or changes in the magnetic circuit of a transformer can be detected by a change in the impedance.

## TEST SET-UP

The test set must be located close to the transformer being tested and in a position where its high voltage output does not put any person in danger. The transformer being tested must be isolated and de-energized.

1. Position the test set at the desired location.
2. Ground the test set using the ground stud provided.
3. Connect the power cable between the test set and 120 VAC, 25A, single-phase, 60 Hz power source.
4. Connect footswitch to its outlet.
5. If an external interlock circuit is to be used, connect the circuit to its connector. All interlock switches should be rated 115 VAC, 5 A, with the normally open contacts wired in series with the External Interlock terminals on the test set. **NOTE: The connector for the external interlock circuit is shipped from the factory with a jumper installed. If there is no external interlock circuit, this connector with its jumper must be connected before the test set can be energized.**
6. Connect the thermocouple cable to its connector.
7. Verify that the transformer to be tested has been tested for PCB's. If the PCB content is unknown, use standard procedures for sampling and testing the oil. If the PCB content is above acceptable limits, follow standard procedures for further handling. **DO NOT PROCEED** with any electrical tests until the PCB content is known.

## CORE LOSS/EXCITATION TEST

1. Ground frame of transformer under test. Connect output and voltmeter leads of test set to secondary (low voltage) terminals of transformer. If the transformer is tapped, utilize the taps that include the full secondary winding. Note that the VM (voltmeter) and output power leads are color-coded. For proper wattmeter readings, red VM lead must go to red power lead and black VM lead must go to black power lead. The black terminals and leads are to be considered the low potential connections, the red are the high potential connections.
2. Turn on Main Power breaker. Place Meter Hold switch in the OFF position and RMS/AVG switch to AVG.
3. **BE SURE THAT THE TRANSFORMER UNDER TEST IS DE-ENERGIZED AND THAT THE TEST SET IS NOT ACTIVATED BEFORE PROCEEDING WITH THIS STEP.** (Temperature correction is not required for Core Loss; if it is considered useful to record transformer temperature during this test, continue with this section.) Insert thermocouple probe into top oil of transformer under test and record this temperature. Remove the probe from the transformer.

NOTE: Oil temperature of transformers that have been stored in one area at a relatively constant temperature can be measured in the following manner: Place open can of transformer oil near transformer to be tested at least 12-24 hours prior to testing. It can be assumed that the temperature of the oil in the can will stabilize at transformer oil temperature.

4. Close the external interlock circuit if it is being used.
5. Set the Current Meter Range Switch to the lowest range which is greater than estimated no-load excitation current of the transformer under test. To determine no-load excitation current, use the Table on the Data Sheet or estimate by taking 2 percent of secondary nameplate current.
6. Set the Tap Selector Switch to the lowest voltage which is greater than the secondary nameplate voltage of the transformer under test.
7. Operate the footswitch and push the Voltage On button.
8. Slowly raise the output to the rated secondary voltage. NOTE: If a 120/240 volt transformer is being tested and the leads are connected to the 120V bushing, test at 120V not at 240.
9. When rated voltage is reached, record the AVG voltage and then put the RMS/AVG switch in the RMS position. Put the Meter Hold switch in the ON position, push the Voltage Off switch, and return the Voltage Adjust knob to the zero position. Record:
  - a. Output (exciting) voltage, AVG and RMS
  - b. Output (exciting) current
  - c. Output (core loss) watts

NOTE: Both RMS and AVG voltages are recorded so the k-factor can be determined for use in correcting wattmeter readings. In most cases, both readings will be the same, giving  $k = 1$ .

10. **BE SURE THE TRANSFORMER UNDER TEST IS DE-ENERGIZED.** Remove power and VM leads. Separate and insulate the power leads. Connect VM leads to the corresponding power leads.
11. Re-energize the test set and raise the output voltage to the exact level recorded in step 9 above. Record current and wattmeter readings; this is the burden of the voltmeter and wattmeter.

**CORE LOSS/EXCITATION TEST**

12. Turn Off the Main Power circuit breaker. Return the Voltage Adjust knob to the zero position.
13. Record the temperature of the transformer per step 3 above.
14. Subtract current and wattmeter readings obtained in step 11 above from those readings obtained in step 9 to find approximate core loss and excitation current. Exact core losses may be calculated using the procedure in ANSI/IEEE C57.12.90, Section 8.2.

## IMPEDANCE/LOAD LOSS TEST

1. Connect the power and VM leads of the test set to the primary terminals of the transformer under test.
2. Short the secondary terminals of the transformer under test. In case of a tapped winding (i.e. pole mount transformer), short the full winding. The shorting jumper should be as short as possible and have a cross-sectional area at least as great as the corresponding transformer leads. In instances where the transformer winding resistances are known, it is advisable to use a jumper of known resistance so that jumper losses can be subtracted from the watt measurements.
3. Close the external interlock circuit if it is being used.
4. Turn on the Main Power circuit breaker.
5. Set the Current Meter Range Switch to accommodate rated primary current. The value of primary current can be found in the Table on the Data Sheet or calculated by dividing kVA rating by the primary voltage (kVA/kV primary). Put the RMS/AVG switch to RMS.
6. Select the output voltage tap by multiplying primary voltage times rated impedance (V primary X % impedance).
7. Operate the footswitch and push the Voltage On button.
8. Slowly raise the output current to the rated nameplate primary current determined in step 5 above.
9. Put the Meter Hold Switch in the ON position, return the Voltage Adjust knob to the zero position, push the Voltage Off button. Record:
  - a. Output (short circuit) current
  - b. Output (short circuit) voltage, RMS
  - c. Output (Impedance/Copper Loss) watts
10. **BE SURE THE TRANSFORMER UNDER TEST IS DE-ENERGIZED.** Remove the power and VM leads. Separate and insulate the power leads. Connect the VM leads to the corresponding power leads.
11. Re-energize the test set and raise the output voltage to the exact level determined in step 9 above. Record current and wattmeter readings; this is the burden of the voltmeter and wattmeter.
12. Subtract current and wattmeter readings obtained in step 11 above from those readings obtained in step 9. If resistance of the shorting lead is known, the watts loss in this lead can be calculated and also subtracted from the readings of step 9. When winding resistances are known, the losses due to the conductors can be calculated and subtracted from the corrected readings, leaving stray losses. The stray and conductor losses measured here can be temperature corrected using the procedures in ANSI/IEEE C57.12.90, Section 9.4.
13. Transformer impedance can be calculated according to the formula on the Data Sheet.

## RECALIBRATION

All calibration potentiometers are accessible by temporarily removing and supporting the front panel. Do not disconnect any wiring.

### **Voltmeter - RMS**

1. Connect a standard True RMS responding AC voltmeter (0-500 VAC) between output terminals. Connect voltmeter terminals to output terminals.
2. Select 125V tap.
3. Select RMS metering.
4. Energize set and raise output until 125V is read on standard. Compare standard and panel meter. If re-calibration is necessary, adjust R3.
5. Vary output and check calibration at various points (25%, 50%, 75%).
6. De-energize set.
7. Select 250V tap.
8. Energize set and raise output until 250V is read on standard. Compare standard and panel meter. If re-calibration is necessary, adjust R7.
9. Vary output and check calibration at various points (25%, 50%, 75%).
10. De-energize set.
11. Select 500V tap.
12. Energize set and raise output until 500V is read on standard. Compare standard and panel meter. If re-calibration is necessary, adjust R5.
13. Vary output and check calibration at various points (25%, 50%, 75%).
14. De-energize set.

### **Voltmeter – Average**

1. Connect a standard AVG responding AC voltmeter (0-500 VAC ) between output terminals. Connect voltmeter terminals to output terminals.
2. Select 125V tap.
3. Select AVG metering.
4. Energize set and raise output until 125V is read on standard. Compare standard and panel meter. If re-calibration is necessary, adjust R11.
5. Vary output and check calibration at various points (25%, 50%, 75%).

## **RECALIBRATION**

6. De-energize set.
7. Select 250V tap.
8. Energize set and raise output until 250V is read on standard. Compare standard and panel meter. If re-calibration is necessary, adjust R15.
9. Vary output and check calibration at various points (25%, 50%, 75%).
10. De-energize set.
11. Select 500V tap.
12. Energize set and raise output until 500V is read on standard. Compare standard and panel meter. If re-calibration is necessary, adjust R13.
13. De-energize set.

### **Currentmeter**

1. Short output leads together through a standard True RMS current meter (0-2A range).
2. Select 125V tap.
3. Energize set and slowly raise output until 1.9A is read on standard. Compare standard and panel meter. If calibration is necessary, adjust R29.
4. Vary output and check calibration at various points (25%, 50%, 75%).
5. De-energize set.

### **Primary Voltmeter (Optional)**

1. Ground case of potential transformer.
2. Connect metering cable from potential transformer to control case.
3. Ground frame of standard transformer of known ration (240:19990 or 480:19990).
4. Connect output of test set to low voltage winding on standard transformer.
5. Connect high voltage winding on standard transformer to potential transformer.
6. Energize test set and raise output until output voltmeter reads the same as rated low voltage of standard transformer.
7. Compare primary voltmeter to rated high voltage of standard transformer. If calibration is necessary, adjust R31.
8. De-energize set.

## RECALIBRATION

9. If standard transformer is not available or if greater accuracy is desired, use a standard True RMS voltmeter (0-20 kV AC range) connected across the high voltage winding of a normal transformer as the standard for comparison.

### Wattmeter

1. Connect output of set to a 125V, 200W load (light bulb).
2. Connect a standard wattmeter.
3. Select 125V tap.
4. Select 2A current range.
5. Select low range on wattmeter.
6. Energize set and raise output until 195 watts is read on standard. Compare standard with panel meter. If re-calibration is necessary, adjust R23.
7. De-energize test set.
8. Select 250V tap.
9. Connect output of set to a 250V, 2000 watt load (heater).
10. Select 250V tap.
11. Select 20A current range.
12. Energize set and raise output until 1950 watts is read on standard. Compare standard with panel meter. If re-calibration is necessary, adjust R21.
13. Select high range on wattmeter. Compare standard with panel meter. If re-calibration is necessary, adjust R26.
14. De-energize test set.
15. Connect load of set to a 500V, 2000 watt load.
16. Select 500V tap.
17. Select 20A current range.
18. Select low range on wattmeter.

## RECALIBRATION

19. Energize set and raise output until 1950 watts is read on standard. Compare standard with panel meter. If re-calibration is necessary, adjust R19.
20. De-energize test Set.

### Temperature Meter

No calibration necessary.

### Overload

1. Open and support front panel of set to gain access to overload board PC 1020.
2. Attach a heavy load that will allow full current to be drawn on any one of the three taps.
3. Select the 200A current range.
4. Energize set and slowly raise output until 150% of rated current for tap is read on current meter.
5. Adjust calibration potentiometer R3 on PC 1020 Board until unit trips off.
6. Press reset and repeat steps 4 above to verify trip point.
7. De-energize set and replace front panel.

**ELECTRICAL SCHEMATICS**

	<u>Drawing Number</u>	<u>Description</u>
1.	31113700	TTS2.5 Metering
2.	950002500-02	TTS2.5 Controls and Regulator
3.	31102002	Overload Circuit

## TTS2.5 PARTS LIST

Reference	Description	Part Number
A1	PCB 1137 Meter Interface	31113700
A2	PCB 1138 Scaling Board	31113800
A3	PCB 1020 Overload Board	31102002
C1	Capacitor, 1 $\mu$ f, 400V	1094150
CB1	Circuit Breaker, 30A	1601330
CT1	Current Transformer, 200:5	1892205
CT2	Current Transformer, Magnetic Specialties	1892207
F1	Fuse, Delay, 30A, 3AG, Buss MDA30, Little Fuse 326030	1603624
F2	Fuse, 5A, 3AG	1603605
F3	Fuse, 3A, 3AG	1603603
F1-3	Fuseholder	1603920
K1	Contactora, 5x465, 120VAC Coil	1705465
LED1,2	LED, Green, 35CA008	1420117
LP1-5	Lamp Socket	1423150
	Lamp Bulb, 6S6	1420250
	Lens, White	1422310
	Lens, Red	1422300
	Lens, Amber	1422305
M1-5	Meter, Acculex DP652	1506400
P1	Receptacle, 115V	1153320
	Plug, 115V	1153325
P2	Output Jack, Red	1153016
	Output Jack, Black	1153015
	Output Plug, Red	1153018
	Output Plug, Black	1153017
P3	Binding Post, Red	1351102
	Binding Post, Black	1351100
	Banana Plug, Red	1356200
	Banana Plug, Black	1356205
P4,5	Receptacle 3102A-125-3S; Foot SW, Ext. Intlk.	1150105
	Plug 3106A-125-3P	1150101
	Cable Clamp	1150922
R1	Resistor, 8 $\Omega$ , 10W	1740140
R2	Resistor, 2 k $\Omega$ , 10W	1742100
R37	Resistor, 39 $\Omega$ , 1/2 W, 10%	1710189
SW1	Switch, Rotary, Voltage Range, Kraus & Naimer	1863320
SW2	Switch, Rotary, Current Range, Kraus & Naimer	1863325
SW3,10	Switch, Pushbutton, H.V. Off, Reset, N.C. 80-541-R	1864010
SW4	Switch, Pushbutton, H.V. On, N.O. 80-541-E	1864005
SW5	Switch, Microswitch, Zero Start, N.O.	1866005
SW6	Switch, Foot Pedal	1868200
SW7	Switch, Toggle, 4PDT, Low/High (Watts)	1865015
SW8,9	Switch, Toggle, 1PDT, RMS/AVG, Meter Hold	1865020
T1	Transformer, Variable, Staco 2510	1862510
T2	Transformer, Power	3832926
T3	Transformer, Potential	3870925
TC1	Thermocouple Jack	1482526

**TTS2.5 PARTS LIST**

<b>Reference</b>	<b>Description</b>	<b>Part Number</b>
	Thermocouple ,15'	1482105
	5V Power Supply	1590100
TD1	Transducer, RMS Voltage	1882060
TD2	Transducer, Average Voltage	1882062
TD3	Transducer, RMS Current	1882064
TD4	Transducer, Watt	1883056
CASE	Case, Skydyne, 92800	2100515
	Glides	2109525
ALLIGATOR CLIP	Cable, Output	1353022
RED BOOT	Cable, Output	1353020
BLACK BOOT	Cable, Output	1353021
ALLIGATOR CLIP	Cable, Voltmeter	1353042
RED BOOT	Cable, Voltmeter	1353040
BLACK BOOT	Cable, Voltmeter	1353041
Individual Circuit Board parts to be ordered by board number and board or schematic part identifier.		

## **MAINTENANCE**

No solution or chemical any stronger than ordinary mild soap and water solution should be applied to the cabinet area of this unit. Care must be used when cleaning the meter faces and console panel. Abrasives may remove printing and descriptive titles and scratch meter faces. When cleaning, always have unit disconnected from power source. Never attempt to clean inside the unit, as the cleaning solution may cause damage to the electronic components.

In the event it becomes necessary to replace any parts, a complete description can be found with the supplied parts list.

## RECOMMENDED SPARE PARTS

Phenix Technologies recommends that the customer purchase and stock the following parts for normal maintenance of the unit. The recommended quantity should be sufficient to support the unit during normal operation.

If the unit will be operated at an isolated site for an extended period or will be subjected to unusual stresses, a larger quantity of parts should be stocked as spares. In such a case, contact Phenix Technologies for a recommendation.

Current prices may be obtained by contacting the Parts Ordering Department at Phenix Technologies.

<u>Part Name</u>	<u>Phenix Part Number</u>	<u>Recommended Quantity</u>
Fuse, 30A	1603624	5
Fuse, 5A	1603605	2
Fuse, 3A	1603603	5
Meter, Acculex	1506400	2
Lamp, Bulb, 6S6	1420250	5

## **PARTS ORDERING INFORMATION**

Replacement parts are available from Phenix Technologies, Inc.

Changes to Phenix Technologies' products are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest technical improvements developed in our Engineering Department. It is, therefore, important when ordering parts to include the serial number of the unit as well as the part number of the replacement part.

When your purchase order is received at our office, a representative of Phenix Technologies will contact you to confirm the current price of the part being ordered. If a part you order has been replaced with a new or improved part, an Applications Engineer will contact you concerning any change in part number.

Your order for replacement parts should be sent to:

Replacement Parts Department  
Phenix Technologies, Inc.  
Industrial Drive  
Accident, Maryland 21520

## **RETURNED MATERIAL**

If for any reason it should become necessary to return this equipment to the factory, the Service Department of Phenix Technologies, Inc. must be given the following information:

Name Plate Information  
Model Number  
Serial Number  
Reason for Return  
Cause of Defect

If Phenix Technologies, Inc. deems return of the part appropriate, it will then issue a "Authorization for Return".

If return is not deemed advisable, other inspection arrangements will be made.

NOTE: Material received at this plant without the proper authorization shall be held as "Customer's Property" with no service until such time as the proper steps have been taken.

Your cooperation is requested in order to ensure prompt service.

## WARRANTY

Phenix Technologies, Inc. warrants to the original purchaser of any new merchandise that the merchandise is free from defects in material and workmanship under normal use and service for a period of 12 months from the date of shipment. The obligation of Phenix Technologies, Inc. under this warranty is limited, in its exclusive option, to repair, replace, or issue credit for parts or materials which prove to be defective, and is subject to purchaser's compliance with the Phenix Technologies, Inc. warranty claim procedure as set forth below. The happening of any one or more of the following events will serve to void this warranty and defect or damage resulting therefrom is specifically excluded from warranty coverage:

- A. Defects due to accident, negligence, alteration, modification, faulty installation by purchaser or purchaser's agents or employees, abuse, or misuse.
- B. Attempted or actual dismantling, disassembling, service or repair by any person, firm, or corporation not specifically authorized in writing by Phenix Technologies, Inc.
- C. Defects caused by or due to handling by carrier, or incurred during shipment, transshipment, or other move.

This warranty covers only those parts and/or materials deemed by Phenix Technologies, Inc. to be defective within the meaning of this warranty. The liability of Phenix Technologies, Inc. shall be limited to the repair, replacement, or issuance of credit for parts deemed defective within the meaning of this warranty. Costs incurred by purchaser for labor or other expenses incidental to the inspection, repair, replacement, or issuance of credit for such parts and/or material shall be the sole responsibility of purchaser. This warranty shall not apply to any accessories, parts, or materials not manufactured or supplied by Phenix Technologies, Inc. and if, in the sole discretion of Phenix Technologies, Inc., purchaser's claim relates to any materials or workmanship manufactured or performed by the supplier of a component part, or of the manufacturer of a device of which the defective part is a component, Phenix Technologies, Inc. reserves the right to disclaim liability under this warranty and to direct that the purchaser deal directly with such supplier or manufacturer. Phenix Technologies, Inc. agrees to assist the purchaser in processing or settling any such claims without prejudicing its position as to liability.

### Warranty Claim Procedure

Compliance with the following warranty claim procedure is a condition precedent to the obligation of Phenix Technologies, Inc. under this warranty.

- A. Purchaser must notify Phenix Technologies, Inc. in writing by certified or registered mail, of the defect claimed within 12 months after date of original shipment. Said notice shall describe in detail the defect, the defective parts and/or part, and the alleged cause of defect.
- B. At the exclusive option of Phenix Technologies, Inc., purchaser shall dismantle or disassemble at purchaser's cost and expense and shall ship the defective part or material prepaid to and from Phenix Technologies, Inc., Accident, Maryland 21520, for inspection, or permit an authorized service representative of Phenix Technologies, Inc. to inspect the defective part or material at purchaser's premises. If Phenix Technologies, Inc. shall inspect the part or material at the purchaser's premises, purchaser shall provide facilities for, and at purchaser's cost and expense, dismantle, disassemble, or otherwise make accessible the subject part of material whether or not same is a component of or installed in a device other than that manufactured or supplied by Phenix Technologies, Inc. If disclosure shows that the defect is not one for which Phenix Technologies, Inc. is liable, the purchaser agrees to reimburse Phenix Technologies, Inc. for all expense incurred.

- C. Upon receipt of the defective part or material, or after access to same, Phenix Technologies, Inc. shall inspect the part or material to determine the validity of purchaser's claim.

The validity of any warranty claim, purchaser's compliance with Phenix Technologies, Inc. warranty claim procedure, the obligation to either repair, replace, or issue credit, or direct the purchaser to deal directly with a manufacturer or supplier are to be determined solely and exclusively by Phenix Technologies, Inc. and any determination so made shall be final and binding.

This warranty is expressly in lieu of all other warranties expressed or implied on the part of Phenix Technologies, Inc., including the warranties of merchantability and fitness for use, and consequential damages arising from any breach thereof and Phenix Technologies, Inc. neither assumes nor authorizes any other person, firm, or corporation to assume any liability or obligation in connection with this sale on its behalf and purchaser acknowledges that no representations except those made herein have been made to purchaser.