The University of Tennessee

Power Electronics Laboratory

Department of Electrical and Computer Engineering

SAFETY PROCEDURE

in the

UT POWER ELECTRONICS LABORATORY

Science and Engineering Research Facility – Room 538

Revision 0

Effective Date: 02/14/2002

Approved by: ____________________________ Date:____________________
PURPOSE

This procedure addresses the safety requirements for testing and troubleshooting powered electronic equipment within the Power Electronics and Control of Electric Machinery Research Center of the Department of Electrical and Computer Engineering at The University of Tennessee, which is located in Room 538 of the Science and Engineering Research Facility. This procedure also serves as a general guide for performing maintenance work and testing of energized circuits and equipment. Therefore, this procedure applies to circuits energized with voltages from 50 to 600 volts (see references).

APPLIES TO

This procedure applies to all personnel (faculty, staff, graduate students, undergraduate students, and visiting scholars) who are involved in activities associated with energized electronic equipment from 50 to 600 volts undergoing testing, repair, or troubleshooting. It addresses safety concerns for these activities.

OTHER DOCUMENTS NEEDED

6. Schematics pertaining to the electronics unit being worked.
7. Data books or data sheets listing parts for the electronics unit(s) being worked.

RESPONSIBILITIES

Faculty Supervisor

1. Ensure implementation, interpretation, and maintenance of this procedure.
2. Ensure that personnel are properly trained on this procedure and have experience with electronic equipment.
3. Ensure that personnel are not allowed to work in areas containing electrical hazards while their alertness is recognizably impaired due to fatigue, illness, or any other reason.
Personnel

1. Ensure compliance with all requirements set forth in this procedure.

2. Perform a series of mental preplanning before testing or troubleshooting energized electronic equipment. Constant alertness is essential to safe work where electrical hazards may exist.

3. Analyze all tasks to identify possible hazards and safety measures that might be required when working on energized electronic equipment. Prepare a test procedure before energizing the electronic equipment. Follow it step-by-step; at each step testing the voltage and/or current waveforms from the source to the load. If something does not look right, stop testing and determine source of problem.

4. Patience and caution are to be used for all testing in the Power Electronics Laboratory. Take time to be safe. Safety is everyone’s responsibility.

5. Report promptly to your faculty supervisor any unsafe condition or practice that you observe. Make suggestions to improve safety in the laboratory to the faculty supervisors.

6. Good housekeeping means simply a place for everything and everything in its place. Keep work areas clean and aisleways open. Clean up your workplace and return tools to their proper place immediately after finishing a job.

7. Do not block access to panelboards, switchboards, or disconnect switches that have receptacles with equipment plugged into them.

8. Know the location of all emergency exits. Never block aisleways or exit paths with equipment or boxes. Know the location of the room electric power “shut-down” buttons, which de-energize all power in the lab when pressed.

9. Learn the location of the fire extinguishers in your area and how to use them. Notify your faculty supervisor after using an extinguisher so that it can be recharged or replaced immediately.

10. Safety showers and eye-wash fountains are provided for immediate first aid treatment of cases involving chemical contact or clothing fires. Know the location and correct operation of the nearest safety shower.
11. Before use, visually inspect equipment and cords for obvious defects such as cracking or other damage or for missing or loose covers or screws. Check the AC power disconnect boxes, isolation transformers, and power cables for proper mechanical and electrical operation before use. Do not use defective equipment or cords. Do not place cords across sharp objects that may damage the insulation. Always use insulated cables and insulate any exposed part of the conductor with electrical tape.

12. Check connections in the test set-up and tighten loose connections before energizing the equipment.

13. Plug all instruments and power sources into one outlet so that they can be turned on and off at the same time with just one switch.

14. Cardio pulmonary resuscitation training and certification through the American Heart Association or an equivalent is recommended for all personnel who work with energized electronic systems that exceed the 50-volt limit. In an emergency (fire, severe injury, or trauma), make sure all personnel are clear of the area where there is immediate danger and call the 911 operator.

15. Report all electrical shocks to your faculty supervisor regardless of how minor.

16. Two people must be present and working with each other for the protection and safety of each individual when working on energized electronic systems that exceed the 50-volt minimum limit.

17. Use the “one-hand-rule.” Use only one hand when touching any electronic equipment. Put the other hand in your pocket or behind your back.

18. Wear safety glasses when work is being done such as performing tests, running electric machinery, soldering, or cutting wire.

19. Do not wear jewelry or conductive apparel that could come in contact with energized parts while working on equipment that operates above the 50 volt minimum level.

20. Some power electronic sections float with respect to earth ground. Floating power sections of equipment can be tested by using a digital voltmeter and measuring from the normally common side of a power supply to earth ground. If the system is floating, there will be some potential that can be measured on the digital voltmeter.

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21. Troubleshooting of energized electronic equipment that float with respect to earth ground must be done with a differential scope connection or an isolation amplifier or by the use of an isolation transformer.

22. An equipment earth-ground should not be attached to any part of energized electronic equipment that float with respect to earth-ground.

23. Remain clear of unit when energizing or re-energizing electronic equipment that operate above the 50-volt minimum level. Signs will be posted warning when such equipment is energized so that only qualified personnel are allowed near the equipment.

24. Observe all posted signs when energized electronic equipment is being tested and troubleshooting is being done and the low-level limit of approximately 50 volts is exceeded. Only qualified personnel will be allowed near the energized equipment.

25. Maintain adequate illumination at all times when working with energized parts and in cabinets with energized systems.

26. Clothing such as cotton, nomex, or equivalent fabrics is required when working with unprotected circuits where a potential for electrical flashing exists. However, such work is strongly discouraged and is not anticipated in the lab.

Clothing such as polyester, nylon, rayon, acetate, or blends of these materials is prohibited for use by staff who could be exposed to potential electrical flames and or arcs. However, this type of work is not within the normal working conditions of the laboratory.

Do not wear gloves, ties, or loose-fitting clothing or jewelry when working on or around machinery with moving parts. Persons with long hair must wear hair up to prevent hair from catching on moving parts.

27. Use suitably insulated tools and equipment when working around electronic equipment. Use the right tool for the right job; use tools for their intended purpose. Make sure the tool is in good condition; report defective tools to your faculty supervisor for repair or replacement. Use the tool correctly. Keep tools in a safe place; do not allow tools to lie haphazardly around your work area.

28. Maintain a shield between solid state power devices and personnel when equipment is purposely being stressed for long periods of time.
29. Use a voltmeter to verify the energy level of components when power is removed from electronic units prior to handling the equipment (which operate above 50 volts). Some equipment contains capacitors that will maintain a charge even after the power supply has been removed.

30. Bypass of built-in safety systems of the electronic equipment shall not be used unless deemed absolutely necessary by personnel involved in energized electronic testing and approved by the faculty supervisor prior to work being started.

31. Power down must be conducted before disconnecting or connecting probes or leads of instruments when working with energized electronic systems in a "live" test mode and the voltage exceeds the approximate 50-volt level.

32. All output cables shall have female inserts in the connectors so that personnel cannot inadvertently come in contact with an output pin. All input cables shall have male inserts in the connectors and no "live" power shall be available on these pins.

33. At the conclusion of experimental work, make sure all equipment including power supplies, instrumentation, and experimental setup have been turned off.

34. Do not inhale soldering fumes. Use a fan to pull the fumes away from the soldering station. Do not eat or drink at the soldering stations or near equipment test stations.

APPENDICES

A. Definitions
APPENDIX A

DEFINITIONS

Circuit - The complete path of an electric current including the source of electric energy.

Conductive - To have the quality to transmit heat, light, sound, or electricity.

Current - A flow of electric charge which can be either alternating or direct; also, the rate of such flow.

Device - A unit of an electrical system which is intended to carry but not utilize electric energy.

Disconnect - To discontinue a conductive electrical connection.

Energized – Indicates the state of a circuit so as to permit operation. Power has been applied to the system.

Equipment - A general term including material, fittings, devices, appliances, fixtures, apparatus, and the like, used as part of or in connection with an electrical installation.

Ground - A conducting connection, whether intentional or accidental, between an electrical circuit and the earth or to some conducting body that serves in place of the earth.

Insulated - A conductor encased within material of composition or thickness that is recognized by national standards as electrical insulation.

"Live" - In electronics, it means connected to electric power, in an operating state, or functioning.

Multimeter - An instrument used to measure the quantities of voltage, resistance, or current that may be associated to an electric circuit.

Power Device - Usually an electronic device that is used to supply large amounts of energy to a load.

Power Disconnect Box - A means by which equipment is normally connected back to a main power source and can quickly be disconnected.

Power Down - To remove the power input from a device or apparatus. To stop the operation of a system.

Probe - A device used for making contact with a circuit element being checked, so that one might thoroughly explore the aspects of an electronic circuit.

Qualified Personnel - Personnel who have complied with specific requirements or precedent conditions. Personnel whose background or field of study is prevalent to the work in which they are required to do.
APPENDIX A (cont.)

**Safety Glasses** - An impact resistant set of lenses that are fitted in to frames which are used to protect the eyes.

**Soldering** - A metallic alloy, usually tin, lead, or silver, that when melted is used to join two different surfaces together in a firm union.

**Troubleshooting** - The process of discovering and locating the source or reason for problems occurring in an electronic circuit and instituting the repair of such problems.

**Verify** - To confirm or establish the truth, accuracy, or reality.

**Volt** - The potential developed across a resistance of one ohm when one ampere of current is flowing through it. Can be alternating or direct.

**Voltage** - An electric potential or potential difference expressed in volts.