

**Consumer Electronics Service Technician specialty-C.E.S.T.** Consumer Electronics Service Technicians are expected to have knowledge and abilities to operate, install and service home electronics products. These include television, VCR, CD, DVD, radio, audio and video equipment, not including computers, satellite reception systems or home security/environment components. With minimal training in areas unique to this specialty, the CEST should become proficient in consumer electronics servicing. Consumer Electronics Service Technicians must be knowledgeable and have abilities in the following technical areas:

Pre-requisite for CEST training is an approved BASIC Electronics course.

## **1. Safety**

- 1.1. Characterize First Aid, its proper usage and precautions
- 1.2. List types of protective gear and clothing, and reasons for each
- 1.3. Detail electrical safety practices
- 1.4. List dangers associated with operation of trucks and service vehicles
- 1.5. Enumerate machinery and tools dangers and list proper safety precautions for each
- 1.6. Describe heavy/bulky product-lifting hazards and precautions when using special moving equipment
- 1.7. Outline OSHA's rules, pertaining to climbing and the dangers of working at heights
- 1.8. List chemicals commonly used in consumer electronics service work and precautions for each
- 1.9. Explain handling and disposal procedures of materials classified as hazardous to the environment
- 1.10. Characterize in-home hazards and precautions for service workers
- 1.11. Explain reasons for electrical grounding of appliances and electrical equipment
- 1.12. Explain reasons for electrical line isolation, and elaborate on the methods used to achieve it
- 1.13. Detail special precautions when working with TV high voltage and power supplies circuits
- 1.14. Express TV-CRT handling safety precautions

## **2. Work Practices**

- 2.1. Explain the need to have emergency telephone numbers available in the work environment
- 2.2. Enumerate the electronics shop environment safety and security aspects needed by technicians
- 2.3. Outline work bench and work area safety and efficiency practices, 'good' and 'bad'
- 2.4. Elaborate on preparations and permissions required for using special machinery, such as lifting and digging equipment, power tools, etc.
- 2.5. List concerns that field techs should be aware of in the In-home environment
- 2.6. Detail efficiency, security, and safety aspects of vehicle operation by technicians
- 2.7. Produce an example of good practices, such as 'testing & cleaning' of repaired units after service

- 2.8. Depict the routines, which service technicians require in the parts procurement process
- 2.9. Demonstrate obtaining a part by using a supplier's reference and data books or catalogs
- 2.10. Itemize the pitfalls which can occur in the process of billing customers for service incidents
- 2.11. Characterize both good and bad examples of cash handling procedures by technicians
- 2.12. Prepare a detailed flow chart which explains warranty claims processing requirements
- 2.13. Describe the detrimental and/or beneficial aspects of disseminating privileged industry information to competitors, suppliers, other employees, or product owners

### **3. Hand Tools and Supplies**

- 3.1. Demonstrate skills and safety practices in handling basic tools (pliers, wrenches, screwdrivers, hack saws, hand drills - (wood and masonry), hammers, files, clamps, ratchets and socket sets, levels, vises, pipe cutters, staplers, and side-cutters)
- 3.2. Demonstrate proper and safe use of power drills and other power tools
- 3.3. Enumerate safety and usage practices for electric bench grinders
- 3.4. Perform crimping and stripping of coax, telephone, and network cables, using common prep tools
- 3.5. Depict the purpose of the degauss coil, both built-in and as a service tool
- 3.6. List common wall-fish equipment
- 3.7. Demonstrate proficiency in soldering and desoldering, including the use of equipment, heat shunts, and in soldering surface-mount devices and through-hole connections
- 3.8. List the precautions and proper uses of cleaners & chemicals commonly used in consumer electronic servicing
- 3.9. Describe protective gear and the protections it offers while using tools

### **4. Test Equipment**

- 4.1. Explain how variacs and isolation transformers are used and the differences between them
- 4.2. Compare the specifications of DC power supplies and explain proper usage
- 4.3. Properly connect and operate an Audio and RF signal generator
- 4.4. Properly connect and operate a pattern generator
- 4.5. Explain where RF analyzers (signal level meter, spectrum analyzer) are used
- 4.6. Measure TV or radio frequencies with a frequency counter and explain the limitations
- 4.7. Measure radio, cable, and TV signals using a signal level meter
- 4.8. Explain the proper use of logic pulsers and logic analyzers

- 4.9. Explain the functions and proper usage of video display color temperature analyzers
- 4.10. Explain the uses of each control button of an oscilloscope and explain how oscilloscopes are used
- 4.11. Describe how magnifiers can aid board-level electronics technicians
- 4.12. Demonstrate the use of an IC extractor
- 4.13. Demonstrate the use of VOM and DMM by testing discrete components

## **5. Computer Applications**

- 5.1. Explain how computers may be used as troubleshooting tools
- 5.2. Using a computer, demonstrate accessing technical assistance of a product manufacturer
- 5.3. Detail how to utilize Internet product-parts-service literature sources
- 5.4. Demonstrate database entry of customer and service information
- 5.5. Demonstrate ability to use a word processing computer program
- 5.6. Explain programming concepts required by various CE products
- 5.7. Demonstrate online research for parts, tech info, and reference data
- 5.8. Locate and demonstrate the use of an online training resource
- 5.9. Detail how personal convenience products (PDA's, dictionaries, etc.) may be interconnected with other CE equipment and explain the technology and operation of such units

## **6. Internet**

- 6.1. Demonstrate accessing the Internet and utilizing Worldwide Web resources
- 6.2. Illustrate communications with others via Internet
- 6.3. Access product, parts, literature procurement resources
- 6.4. Access a repair-fix data base and describe its usage
- 6.5. Access industry companies, associations, or information sources, and interact
- 6.6. Demonstrate the use of tutorials and on-line training resources

## **7. Block and Schematic Diagrams**

- 7.1. Identify major sections in block diagrams of TV (Projection, Plasma, LCD, DLP), audio receiver, radio, and DVD and HDD player/recorder
- 7.2. Explain functions of stages in a TV tuner
- 7.3. Compare the circuitry of a complete TV set and that of a video monitor
- 7.4. Compare digital and analog circuitry flow charts
- 7.5. Trace signal path in block and detailed schematic diagrams, and locate faults
- 7.6. Sketch the functional sections of a radio tuner and show signal levels and frequencies

## **8. Components**

- 8.1. List types of fuses, circuit breakers, ground-fault circuit interrupters, and uses of each
- 8.2. Describe and compare common consumer electronics display devices
- 8.3. Explain loudspeaker technology, power, frequency, and usages
- 8.4. List the special purposes of opto-isolators and thyristers: SCRs, triacs, diacs, etc.
- 8.5. Describe Special IC circuits (Integrators, differentiators, and comparators)
- 8.6. Identify the pin connections on common CE chips and modules
- 8.7. Interpret component rating and measurement specifications
- 8.8. Compare component testing, in and out of circuit
- 8.9. Interpret special color coding and identifications used in CE repairs
- 8.10. Explain how audio & video tape record/play heads work and methods of fault finding
- 8.11. Demonstrate special precautions required to prevent static damage to electronic components

## **9. TV Antennas**

- 9.1. Describe TV antenna construction, gain, polar patterns and frequency characteristics, and list antenna types.
- 9.2. Illustrate TV RF wave-propagation - electrostatic and electromagnetic fields
- 9.3. Characterize reflected signals and multi-source interference
- 9.4. List major types of broadcast TV radio signal interference
- 9.5. Outline the differences between satellite and other common terrestrial TV-RF signals
- 9.6. Outline rooftop antenna installation theory and procedures
- 9.7. Define antenna resonant frequency
- 9.8. Enumerate antenna heights safety practices
- 9.9. Describe the purposes of and the installation procedures for towers, rotors, pre-amplifiers, and accessories
- 9.10. Explain signal range and sensitivity, and the differences in antenna requirements for 8-VSB, DVB, and NTSC signals
- 9.11. Detail digital TV signal reception considerations (direct & multi-path effects on digital and analog)
- 9.12. List the reasons for grounding antennas and cables, and the grounding methods

## **10. Cables**

- 10.1. Set forth the common uses for coaxial cable and explain its properties and types
- 10.2. Define twisted pair cabling and compare classifications as they relate to frequency limits

- 10.3. Explain 'Impedance Matching' and its relationship to cable termination and standing waves
- 10.4. Characterize frequency tilt and compensation, and explain its importance in balancing signal levels
- 10.5. Demonstrate proper waterproofing of outdoor cable connections
- 10.6. Measure cable signal levels and explain testing and troubleshooting procedures
- 10.7. Explain methods and precautions for wall-fishing and routing cables in attics and crawl spaces
- 10.8. Explain the reasons for grounding, surge protection, and the effects of lightning
- 10.9. Describe the purposes of splitters, fittings, and diplexers, and indicate their expected signal-losses
- 10.10. Express the reasons for NEC and NFPC standards and list those of major concern to CE technicians
- 10.11. Explain shielding and define RFI ingress and egress, and explain their detrimental effects

## **11. Power Supplies**

- 11.1. Depict the purposes of power interlocks and fusing
- 11.2. Describe the circuit of an external AC power module
- 11.3. Sketch and compare common low voltage regulated power supply circuits
- 11.4. Explain the concept of integrated high voltage power supply circuits and list precautions
- 11.5. Describe switching power supplies and active filters
- 11.6. Outline the different power supply requirements in Projection TV, Plasma TV, LCD TV, and DVD Players
- 11.7. Describe the operation of Boost, Flyback, and Buck (in series with load) switching power regulators
- 11.8. Explain and compare the power supply and regulator circuits in AC and battery operated TVs
- 11.9. List uses for optical coupling in power supplies
- 11.10. Describe shutdown and protection circuits used in TV and other CE products

## **12. Amplifiers**

- 12.1. Describe the purposes of TV radio-signal boosters and common locations for them
- 12.2. Express the differences between phono, CD, Mic, and P.A. amplifiers
- 12.3. Depict the methods used in multistage amplifier coupling circuits (direct, capacitive, transformer, etc.)
- 12.4. Explain the uses for Operational Amplifiers and show how to increase or decrease their gain
- 12.5. List types of amplifier protection circuits
- 12.6. Describe the purposes for degenerative and regenerative feedback in amplifier circuits
- 12.7. Explain amplifier gain and signal to noise (S/N) ratios

- 12.8. Sketch the most common power output circuit configurations
- 12.9. Analyze the need for equalizers and tone controls and the methods of incorporating them in a circuit
- 12.10. Explain the differences between class A, B, AB, and C amplifiers, including efficiencies and distortion

### **13. Circuits and Devices**

- 13.1. Explain how to troubleshoot a faulty TV degauss circuit
- 13.2. Describe the differences between TV amplifiers (RF, IF, Video, Audio)
- 13.3. Describe the switching and control circuitry for multiple tuner and PIP (picture in picture) circuitry
- 13.4. Sketch the major sections of a TV tuner and calculate the frequencies involved
- 13.5. Explain the technology of HDTV systems
- 13.6. Describe the differences between DTV formats
- 13.7. Explain the major segments of Cable TV signals, preferred levels for consumer product, and common faults
- 13.8. Compare analog with DTV and HDTV reception systems
- 13.9. Depict the methods for troubleshooting TV - Satellite – DVD - VCR combination receivers/recorders
- 13.10. Explain DVD and CD technology and list ways to troubleshoot faults in each
- 13.11. Describe the operation of AGC and ALC circuits
- 13.12. Characterize how special monitoring circuits (pressure, temperature, moisture, etc.) may be used in consumer electronics products
- 13.13. Illustrate how an audio module works and show a procedure for troubleshooting a fault in it
- 13.14. Outline the differences between stereo and multi-channel sound systems
- 13.15. Explain the technology of wireless speaker systems

### **14. Digital Circuits and Devices**

- 14.1. Compare the usage of digital circuitry in use today, with historical circuits used for similar purposes
- 14.2. Interpret the symbols used to identify digital circuits and components
- 14.3. List digital integrated circuits commonly found in consumer electronic products
- 14.4. Detail digital gates & truth tables and explain tri-state logic
- 14.5. Explain memory and data storage methods, as used in computerized CE equipment
- 14.6. Compare sinusoidal and non-sinusoidal oscillators
- 14.7. Explain the purpose and locations for registers and counters
- 14.8. Explain the purpose and locations for clock and timing circuits
- 14.9. Compare common digital display methods
- 14.10. Explain the usages of multiplexers and demultiplexers
- 14.11. Detail the operation of DACs, ADCs, and matrix circuits
- 14.12. Describe the need for and usages of decoders and encoders
- 14.13. Sketch a block diagram of a microprocessor and explain its functions

- 14.14. Sketch a block diagram of a microcontroller and list where it might be used in CE products
- 14.15. Compare digital data compression schemes used in MPEG-2, RLC (Run Length Coding), VLC (Variable Length Coding, etc.)
- 14.16. Describe the purposes of programmable logic devices and gate arrays
- 14.17. Compare digital serial and parallel protocols used in CE devices
- 14.18. Define a data communication bus and list its components
- 14.19. Compare the I<sup>2</sup>C bus with other data communication buses used in CE and describe its advantages

## **15. Display Devices**

- 15.1. List common usages for LEDs
- 15.2. List common usages for LCDs
- 15.3. Describe the concept of LCoS (liquid crystal on silicon) and list products which incorporate LCoS
- 15.4. Explain OLED (Organic LEDs) technology and why it is used
- 15.5. Illustrate the use of DMD (Digital Mirror Devices)
- 15.6. Describe the theory of plasma display and precautions for installation and for troubleshooting
- 15.7. Sketch the electron gun of a cathode ray tube and expected voltages on CRT connectors
- 15.8. Demonstrate the proper method of degaussing a TV set
- 15.9. Describe precautions for projection TV servicing
- 15.10. Compare the operation and circuitry of a video projector with a slide or overhead projector
- 15.11. Properly test CRTs for emission levels and shorts

## **16. Formats and Protocols**

- 16.1. Define IEEE1394 and describe its uses in CE products
- 16.2. Enumerate audio compression methods used in digital TV formats
- 16.3. Describe the differences between AC-3 (Audio Coding –3), AAC (Advanced Audio Coding), and MP-3 and indicate their uses
- 16.4. Explain the differences between MPEG-2 and MPEG-4 and their uses
- 16.5. Enumerate the types of memory cards and their uses in CE products

## **17. Interfacing**

- 17.1. Describe problems which may be encountered when interfacing printers, scanners, test fixtures, etc.
- 17.2. State expected signal levels at the input and output ports of CE products
- 17.3. Explain potential sources of signal conflicts
- 17.4. List symptoms of power source and grounding conflicts
- 17.5. Explain photo-optical video and audio sources and conversion methods used to restore original electronic signals
- 17.6. Define DVI and HDMI and their usage in CE products



- 17.7. Describe optical interfaces (coupling between 2 or more units) and list products in which they are used
- 17.8. Depict an example of product incompatibility conflicts
- 17.9. List common types of plugs and connectors common to CE products
- 17.10. Explain where different types of modulation schemes (QAM, VSB, etc.) are used
- 17.11. List reasons for and locations where phone and cable hookups may be needed with CE products

## **18. Optical Electronics**

- 18.1. List locations where laser technology is used in audio or video CE equipment
- 18.2. Explain CD signal recovery techniques and name the components used
- 18.3. Explain DVD signal recovery techniques and name the components used
- 18.4. Describe basic fiber optics cabling theory and components
- 18.5. Compare Infrared uses (CE, auto-focus, intrusion alarms, etc.)
- 18.6. List the major sections of electronic camcorders and cameras
- 18.7. Define CCD (charge coupled devices) and name products in which they are used
- 18.8. Describe the theory of LCD displays and identify components required
- 18.9. Describe the theory of LED displays and unique circuitry used
- 18.10. Explain remote control hand-unit basics of operation and one-unit control of multiple products

## **19. Troubleshooting**

- 19.1. Explain static and safety issues for bench-level troubleshooter technicians
- 19.2. Demonstrate proper use of a DMM (digital multimeter)
- 19.3. Demonstrate making voltage checks
- 19.4. Explain how to verify symptoms and make visual checks as first steps in troubleshooting
- 19.5. Explain the 'divide & conquer' troubleshooting concept
- 19.6. Explain the 'Black Box' troubleshooting concept
- 19.7. Depict the methods of signal injection and tracing
- 19.8. Detail proper parts substitution and cross referencing to exact specifications (where required)
- 19.9. Demonstrate the use of diagnostic programs for troubleshooting assistance
- 19.10. Implement a product maker's help-desk for repair assistance
- 19.11. Enumerate sources which may offer troubleshooting help
- 19.12. Express the use of flow charts in troubleshooting
- 19.13. Detail surface-mount board troubleshooting

## **20. Product Repair and Adjustment**

- 20.1. Demonstrate mechanical assemblies cleaning and adjustment (DVD mech., DVC mech., etc.)



- 20.2. Demonstrate proper CRT convergence procedures
- 20.3. Detail surface-mount board parts replacement procedures
- 20.4. Identify the mechanical control devices used in VCRs, CD and DVD players/recorders
- 20.5. Detail precautions and procedures for replacement of special fire and X-ray circuitry parts
- 20.6. Summarize and compare white-balance adjustment procedures on Plasma and CRT-based TV receivers

## **21. Control Circuits**

- 21.1. Explain where control processes may be used in CE equipment
- 21.2. Explain CD and DVD functions and how their electronic and mechanical actions are sensed and communicated
- 21.3. Explain the electronics technology used in DVC (Digital Video Cassette) and VCR mechanical control circuitry
- 21.4. Describe various TV control circuits, control methods, and control functions
- 21.5. Explain how video control boxes and selectors may be used to connect multiple signal sources and destinations
- 21.6. Sketch a typical remote receiver circuit and a typical remote transmitter (hand-unit) circuit

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*[http://www.ncee-edu.org/ncee\\_standing\\_technical\\_committee.htm](http://www.ncee-edu.org/ncee_standing_technical_committee.htm)*

*C.E.S.T. Competencies - June 16, 2005*