

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, Blu-ray, 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 and Environment

- 1.1. Describe the proper uses of First Aid and indicate precautions
- 1.2. List types of protective gear and clothing, and reasons for each
- 1.3. Detail electrical safety practices
- 1.4. List the environment safety and security aspects needed by technicians in electronics shops
- 1.5. List dangers associated with operation of trucks and service vehicles
- 1.6. List dangers associated with using machinery and tools and indicate the proper safety precautions
- 1.7. State the hazards of lifting heavy or bulky products, and indicate precautions when using special moving equipment
- 1.8. Outline OSHA's rules, pertaining to climbing and the dangers of working at heights
- 1.9. List chemicals commonly used in consumer electronics service work and precautions for each
- 1.10. Explain handling and disposal procedures of materials classified as hazardous to the environment
- 1.11. Describe in-home hazards and precautions for service workers
- 1.12. Explain reasons for grounding electrical appliances and equipment
- 1.13. Explain reasons for electrical line isolation, and elaborate on the methods used to achieve it
- 1.14. Outline safety and efficiency practices for work bench and work area, 'good' and 'bad'
- 1.15. Detail special precautions when working with TV high voltage and power supplies circuits
- 1.16. Express TV-CRT handling safety precautions
- 1.17. Explain reasons for using Lead-free solder and elaborate on proper soldering of circuits containing Lead solder
- 1.18. Detail efficiency, security, and safety aspects of vehicle operation by technicians

2. Work Practices

- 2.1. Explain the need to have emergency telephone numbers available in the work environment
- 2.2. Elaborate on preparations and permissions required for using special machinery, such as lifting and digging equipment, power tools, etc.

- 2.3. List concerns that field techs should be aware of in the in-home environment
- 2.4. Produce an example of good practices, such as 'testing & cleaning' of products after completion of repairs
- 2.5. Itemize the pitfalls which can occur in the process of billing customers for service incidents
- 2.6. Differentiate between good and bad examples of cash handling procedures by technicians
- 2.7. Prepare a detailed flow chart, which explains warranty claims processing requirements
- 2.8. Describe the detrimental and/or beneficial aspects of disseminating privileged industry information to competitors, suppliers, other employees, or product owners
- 2.9. List and describe practices, strategies, and methods used to ensure customer satisfaction

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. Itemize 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. State the purpose of the degauss coil, both built-in and as a service tool
- 3.6. Employing special equipment, demonstrate proficiency in soldering and desoldering electronic components, including surface-mount devices
- 3.7. List the precautions and proper uses of cleaners & chemicals commonly used in consumer electronic servicing
- 3.8. 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 outline the differences between them
- 4.2. Explain how variable and fixed DC power supplies are used in troubleshooting, and list precautions
- 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 use of video display color temperature analyzers
- 4.10. Explain the uses of each control button of an oscilloscope and explain how oscilloscopes are used in troubleshooting
- 4.11. Describe how magnifiers can aid electronics technicians in performing component level repairs
- 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. Explain programming concepts required by various CE products
- 5.4. Demonstrate downloading and extracting zipped firmware files for updating CE products' firmware

6. Block and Schematic Diagrams

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

7. Components

- 7.1. List types of fuses, circuit breakers, ground-fault circuit interrupters, and uses of each
- 7.2. Describe and compare common consumer electronics display devices
- 7.3. Explain loudspeaker technology, power, frequency, and uses
- 7.4. List the special purposes of opto-isolators and thyristers: SCRs, triacs, diacs, etc.
- 7.5. Describe Special IC circuits (Integrators, differentiators, and comparators)
- 7.6. Identify the pin connections on common CE chips and modules
- 7.7. Interpret component rating and measurement specifications
- 7.8. Compare component testing, in and out of circuit
- 7.9. Interpret special color coding and other indications used in CE repairs
- 7.10. Explain how audio & video tape record/play heads work and methods of fault isolation
- 7.11. Demonstrate special precautions required to prevent static damage to electronic components

8. TV Antennas

- 8.1. Describe TV antenna construction, gain, polar patterns and frequency characteristics, and list antenna types.
- 8.2. Illustrate TV RF wave-propagation, electrostatic and electromagnetic fields
- 8.3. Describe reflected signals and multi-source interference
- 8.4. List major types of broadcast TV radio signal interference
- 8.5. Outline the differences between satellite and other common terrestrial TV-RF signals
- 8.6. Outline the differences between satellite radio, AM, and FM RF signals
- 8.7. Outline rooftop antenna installation theory and procedures
- 8.8. Define antenna resonant frequency
- 8.9. Itemize antenna heights safety practices
- 8.10. Describe the purposes of and the installation procedures for towers, rotors, pre-amplifiers, and accessories
- 8.11. Explain signal range and sensitivity, and the differences in antenna requirements for 8-VSB, DVB, and NTSC signals
- 8.12. Detail digital TV signal reception considerations (direct & multi-path effects on digital and analog)
- 8.13. List the reasons for grounding antennas and cables, and indicate the grounding methods

9. Cables

- 9.1. State the common uses for coaxial cable and explain its properties and types
- 9.2. Define twisted pair cabling and compare classifications as they relate to frequency limitations
- 9.3. Explain 'Impedance Matching' and its relationship to cable termination and standing waves
- 9.4. Characterize frequency tilt and compensation, and explain its importance in balancing signal levels
- 9.5. Demonstrate proper waterproofing of outdoor cable connections
- 9.6. Measure cable signal levels and explain testing and troubleshooting procedures
- 9.7. Explain the reasons for grounding, surge protection, and the effects of lightning
- 9.8. Describe the purposes of splitters, fittings, and diplexers, and indicate their expected signal-losses
- 9.9. Express the reasons for NEC and NFPC standards and list those of major concern to CE technicians
- 9.10. Explain shielding and define RFI ingress and egress, and explain their detrimental effects
- 9.11. Explain and detail the precautions required in handling ribbon cables used plasma and LCD panels

10. Power Supplies

- 10.1. State the purposes of power interlocking and fusing
- 10.2. Describe the circuit of an external AC power module
- 10.3. Sketch and compare common low voltage regulated power supply circuits
- 10.4. Explain the concept of integrated high voltage power supply circuits and list precautions
- 10.5. Outline the different power supply requirements in Projection TV, Plasma TV, LCD TV, and DVD Players
- 10.6. Describe the operation of Boost, Flyback, and Buck (in series with load) switching power regulators
- 10.7. Explain and compare the power supply and regulator circuits in AC and battery operated TVs
- 10.8. List uses for optical coupling in power supplies
- 10.9. Describe shutdown and protection circuits used in TV and other CE products

11. Amplifiers

- 11.1. Indicate the purposes of TV radio-signal boosters and common locations for them
- 11.2. Outline the differences between phono, CD, Mic, and P.A. amplifiers
- 11.3. Depict the methods used in multistage amplifier coupling circuits (direct, capacitive, transformer, optical, etc.)
- 11.4. Explain the uses for Operational Amplifiers and show how to increase or decrease their gain
- 11.5. List types of amplifier protection circuits
- 11.6. Describe the purposes for degenerative and regenerative feedback in amplifier circuits
- 11.7. Explain amplifier gain and signal to noise (S/N) ratio
- 11.8. Sketch the most common power output circuit configurations
- 11.9. Indicate the reasons for using equalizers and tone controls and point out the methods of incorporating them in a circuit
- 11.10. Explain the differences between class A, B, AB, and C amplifiers, indicating their efficiencies and distortion levels
- 11.11. Explain the operation of digital audio amplifiers and PWM audio output circuits

12. Circuits and Devices

- 12.1. Explain how to troubleshoot a faulty TV degauss circuit
- 12.2. Describe the differences between TV amplifier circuits (RF, IF, Video, Audio)
- 12.3. Describe the switching and control circuitry for multiple tuner and PIP (picture in picture) circuitry
- 12.4. Sketch the major sections of modern ATSC and DVB TV tuners and elaborate on their signals
- 12.5. Describe the differences between DTV formats and expand on HDTV systems

- 12.6. Explain the major segments of Cable TV signals, preferred levels for consumer product, and common faults
- 12.7. Compare analog with DTV and HDTV reception systems
- 12.8. Demonstrate methods for troubleshooting TV – Satellite – DVD - VCR combination receivers/recorders
- 12.9. Explain Blu-ray, DVD, and CD technologies and list ways to troubleshoot faults in each
- 12.10. Describe the operation of AGC, ALC, and ABL circuits
- 12.11. Explain the operation of AFC circuits and their applications in DTV tuners
- 12.12. Explain the theory of operation of a PLL (Phase Locked Loop) circuit
- 12.13. Indicate the differences between basic Synchronous and basic Asynchronous circuits
- 12.14. Explain the purpose and theory of data interleaving and error correction circuits
- 12.15. Indicate how special monitoring circuits (pressure, temperature, moisture, etc.) may be used in consumer electronics products
- 12.16. Illustrate how an audio module works and show a procedure for troubleshooting a fault in it
- 12.17. Outline the differences between stereo and multi-channel sound systems
- 12.18. Explain the technology of wireless speaker systems
- 12.19. Explain basic ballast circuits principals and list their uses in CE products

13. Digital Circuits and Devices

- 13.1. Interpret the symbols used to identify digital circuits and components
- 13.2. List digital integrated circuits commonly found in consumer electronic products
- 13.3. Draw digital gates symbols and indicate their truth tables
- 13.4. Explain tri-state logic and how it is used
- 13.5. Explain memory and data storage methods, as used in computerized CE equipment
- 13.6. Describe the function of a “shift register” and its uses in consumer electronics
- 13.7. Compare the attributes of sinusoidal and non-sinusoidal oscillators
- 13.8. Explain the purpose and locations for registers and counters
- 13.9. Explain the purpose and locations for clock and timing circuits
- 13.10. Compare common digital display methods
- 13.11. Explain the uses of multiplexers and de-multiplexers
- 13.12. Detail the operation of DACs, ADCs, and matrix circuits
- 13.13. Describe the need for and uses of decoders and encoders
- 13.14. Sketch a block diagram of a basic microprocessor and explain its functions
- 13.15. Compare digital data compression schemes used in MPEG-2, RLC (Run Length Coding), VLC (Variable Length Coding, etc.)
- 13.16. Describe the purposes of programmable logic devices and gate arrays
- 13.17. Compare digital serial and parallel protocols used in CE devices
- 13.18. Define a data communication bus and list its components
- 13.19. Compare the I²C bus with other data communication buses used in CE and describe its advantages
- 13.20. Explain “Serial to Parallel” and “Parallel to Serial” conversions

14. Display Devices

- 14.1. List common uses for LEDs
- 14.2. List common uses for LCDs
- 14.3. Describe the concept of LCoS (Liquid Crystal on Silicon) and list products which incorporate LCoS
- 14.4. Explain OLED (Organic LEDs) technology and why it is used
- 14.5. Illustrate the use of DMD (Digital Mirror Devices)
- 14.6. Describe the function of a color wheel and elaborate on its synchronization requirements
- 14.7. Describe the theory of plasma display and precautions for installation and for troubleshooting
- 14.8. Explain the functions of scan and sustain circuits in plasma monitors
- 14.9. Sketch the electron gun of a cathode ray tube and expected voltages on CRT connectors
- 14.10. Demonstrate the proper method of degaussing a TV set
- 14.11. List precautions for projection TV servicing
- 14.12. Compare the operation and circuitry of a video projector with a slide or overhead projector
- 14.13. Properly test CRTs for emission levels and shorts
- 14.14. Indicate the proper methods of transporting plasma panels
- 14.15. Demonstrate the proper procedures for replacing a plasma and LCD panels

15. Formats and Protocols

- 15.1. Define IEEE1394 and describe its uses in CE products
- 15.2. Define USB computer ports and their use in servicing consumer electronics products
- 15.3. List and elaborate on audio compression methods used in digital TV formats
- 15.4. Describe the differences between AC-3 (Audio Coding –3), AAC (Advanced Audio Coding), and MP-3 and indicate their uses
- 15.5. Explain the differences between MPEG-2 and MPEG-4 and their uses
- 15.6. Explain where different types of modulation schemes (QAM, VSB, etc.) are used
- 15.7. List the types of memory cards and their uses in CE products

16. Interfacing

- 16.1. State expected signal levels at the input and output ports of CE products
- 16.2. Explain potential causes for signal conflicts
- 16.3. List symptoms of power source and grounding conflicts
- 16.4. Explain photo-optical video and audio sources and conversion methods used to restore original electronic signals
- 16.5. Define DVI, HDMI, LVDS (Low Voltage Differential Signaling) and their use in CE products
- 16.6. Describe optical interfaces (coupling between 2 or more units) and list products in which they are used

- 16.7. Depict an example of product incompatibility conflicts
- 16.8. List common types of plugs and connectors common to CE products
- 16.9. List reasons for and locations where phone and cable hookups may be needed with CE products
- 16.10. List types of input signals to CE display products, such as RGB, YUV, etc. and elaborate on the differences.

17. Optical Electronics

- 17.1. List locations where laser technology is used in audio or video CE equipment
- 17.2. Explain CD signal recovery techniques and name the components used
- 17.3. Explain DVD signal recovery techniques and name the components used
- 17.4. Elaborate on the major differences between DVD, and Blu-Ray
- 17.5. Explain the reasons for disc capacity difference between DVD as compared with Blu-Ray
- 17.6. Describe basic fiber optics cabling theory and components
- 17.7. Compare Infrared uses (auto-focus, intrusion alarms, etc.)
- 17.8. List the major sections of electronic camcorders and cameras
- 17.9. Define CCD (charge coupled devices) and name products in which they are used
- 17.10. Describe the theory of LCD displays and identify components required
- 17.11. Describe the theory of LED displays and unique circuitry used
- 17.12. Describe the theory of DLP displays and unique circuitry used
- 17.13. List the different types of light sources used in projection display products
- 17.14. Explain remote control hand-unit basics of operation and one-unit control of multiple products

18. Troubleshooting

- 18.1. Explain static and safety issues for bench-level troubleshooter technicians
- 18.2. Demonstrate proper use of a DMM (digital multimeter)
- 18.3. Demonstrate making voltage checks
- 18.4. Explain how to verify symptoms and make visual checks as first steps in troubleshooting
- 18.5. Explain the 'divide & conquer' troubleshooting concept
- 18.6. Explain the 'Black Box' troubleshooting concept
- 18.7. Depict the methods of signal injection and tracing
- 18.8. Detail proper parts substitution and cross referencing to exact specifications (where required)
- 18.9. Demonstrate the use of diagnostic programs for troubleshooting assistance
- 18.10. Implement a product maker's help-desk for repair assistance
- 18.11. List resources that may offer troubleshooting help
- 18.12. Demonstrate the use of flow charts in troubleshooting
- 18.13. Detail surface-mount board troubleshooting

19. Product Repair and Adjustment

- 19.1. Demonstrate mechanical assemblies cleaning and adjustment (DVD mech., DVC mech., etc.)
- 19.2. Detail surface-mount board parts replacement procedures
- 19.3. Identify the mechanical control devices used in VCRs, CD and DVD players/recorders
- 19.4. Detail precautions and procedures for replacement of special fire and X-ray circuitry parts
- 19.5. Summarize and compare white-balance adjustment procedures on Plasma and CRT-based TV receivers
- 19.6. Demonstrate the ability to follow adjustment and alignment procedures in manufacturers' service manuals
- 19.7. Demonstrate proper hookup and use of test equipment to a CE product on a service bench
- 19.8. Demonstrate the procedure of updating firmware on a DVD recorder and a Digital Still Camera (DSC)

20. Control Circuits

- 20.1. Explain where control processes may be used in CE equipment
- 20.2. Explain CD and DVD functions and how their electronic and mechanical actions are sensed and communicated
- 20.3. Explain how motor speed and phase are controlled in a servo circuit
- 20.4. Explain the electronics technology used in DVC (Digital Video Cassette) and VCR mechanical control circuitry
- 20.5. Describe various TV control circuits, control methods, and control functions
- 20.6. Explain how video control boxes and selectors may be used to connect multiple signal sources and destinations
- 20.7. Sketch a typical remote receiver circuit and a typical remote transmitter (hand-unit) circuit
- 20.8. Explain how custom programs are uploaded to unified CE remotes

For suggestion, additions, deletions, corrections please contact: ShosharaS@US.Panasonic.com

*Project Manager for C.E.S.T. 2008: Sami Shoshara, Panasonic shosharas@us.panasonic.com
C.E.S.T Subject Matter Experts are listed on the NCEE website SME page:
http://www.ncee-edu.org/ncee_standing_technical_committe.htm
C.E.S.T. Competencies – April 11, 2008*