



# SMART TECHNOLOGY SYSTEMS – STS

## ETA **Audio-Video** endorsement to the STS

### Competency Requirements

There are **two** levels of expertise for those who install and integrate smart electronics technology into structural systems which are residential and light commercial properties. **STS** installation technicians are responsible for interconnecting electronics communications, data, computer, control or entertainment equipment and converging signals into one faultless system. The two levels for those installation technicians are the **Basic STS**, Basic Smart Technology Systems and the **Master STS**, Smart Technology Systems Master (STSma).

The **BASIC STS** installation technician is proficient in the design of pre-wiring and wireless architectures in residential/light commercial for entertainment, internet of things, and telecommunications equipment interconnections. This will include installation of network wiring for TV, satellite and antenna outlets, voice equipment outlets, audio and video, media streaming, and computer equipment in such a manner that all control and communication signals can be integrated at the home or business system controller and converged into one cogent local network bit stream, to either be used within the system or to be passed back and forth through the system gateway. He/she will be proficient in the many protocols used over diverse media to communicate with and control an array of electronics systems, in addition to the skills required for low voltage wiring installation. Prior CAT, DCI, DVE, FOI, FOT, FOT-OSP, TTT certification is highly recommended to be proficient in STS skills. The Basic STS installation technician will work from telecommunications wireless and wiring plans, installing cable fittings and selecting the specified cabling for each technology and identifying wireless equipment requirements. He/she will test, mark and document all cabling and will have the ability to troubleshoot and restore pre-existing cabling and wireless systems. A Basic STS installation technician typically will also be qualified in one or more of four (4) endorsement specialty areas listed below.

The **MASTER STS** (STSma) will be proficient in **all** of the core STS skills and knowledge including planning and designing the layout for electronics and communications equipment systems for new construction and retro-fit/remodeling. The MASTER STS is capable of designing the entire system and network for audio, video, data and control of security and environment to function in one local network bit stream converged at the system controller. He/she is also capable of troubleshooting, debugging and optimizing the system of planned installations or modifications. The MASTER STS has extensive knowledge of the operation and technology and is proficient in each of the basic and four endorsements of STS electronics.

#### **STS CERTIFICATION PROGRAM overview:**

- **Basic STS:**

The Basic **STS** installation technician can become certified with ETA<sup>®</sup> International by passing the knowledge examination assessments, based on the following **STS BASIC Skills & Knowledge Competency**.

In addition, **STS** certification holders can also acquire one or more of the four (4) endorsement certifications, as listed below:

1. **Audio-Video**
2. **Computer Networking**
3. **Environmental Controls**
4. **Security-Surveillance**

- **MASTER STS:**

The **MASTER STS** certification prerequisites include successfully completing the Basic STS certification requirements, plus earning **each** of the four (4) STS endorsements.

To qualify for the ETA **MASTER STS**, Smart Technology Systems Master, a technician must:

- Hold the STS Basic certification
- Hold each of the four (4) specialty endorsements
- Pass the separate Master STS examination

## ETA **STS Audio-Video Endorsement** Skills and Knowledge Competencies

Refer to the **BASIC STS** Competencies as the foundation for these A-V endorsement competencies

### 1.0 Signals

- 1.1 Describe telephone system signal types
  - 1.1.1 Identify wireless signal types
  - 1.1.2 Identify landline (wired) signal types
- 1.2 List audio signal sources and types
- 1.3 Differentiate between audio, video, and data signals
  - 1.3.1 Compare video signals with radio frequencies and voice
  - 1.3.2 Differentiate between HDBaseT™ and IP-based video

### 2.0 Amplifiers

- 2.1 Compare power amplifiers used in residential systems with other types of audio amplifier circuits used for larger commercial applications
- 2.2 Interpret an amplifier's specifications sheet
- 2.3 Explain the Dolby® sound system, Dolby Digital Ex™, DTC 9.8 and DTS®
  - 2.3.1 List the advantageous features of each
- 2.4 Explain the features and operation of Dolby Pro Logic® (and DPL II®) and compare with basic audio amplifier sound processing

### 3.0 Speakers

- 3.1 Compare various freestanding speakers commonly utilized in home and commercial theater systems
- 3.2 Differentiate between ordinary 2-channel audio, 5.1-channel, 7.1-channel, and 7.2-channel audio systems
- 3.3 Explain the purpose of subwoofers, their frequency range and styles
- 3.4 Explain the advantages of bookshelf speaker units
- 3.5 Describe the pre-wiring of In-Wall speakers, mounting and connections
- 3.6 Identify the different radio frequencies used for wireless speaker technology
  - 3.6.1 Explain the various ways wireless speakers can be connected to sound systems
- 3.7 Define impedance and explain its importance in matching amplifiers to speakers
  - 3.7.1 Identify the formula used to calculate total ohms for a series speaker connection
  - 3.7.2 Identify the formula used to calculate total ohms for a parallel speaker connection
- 3.8 Explain speaker stiffness and its effect on audio balance
- 3.9 Explain speaker mass and its effect on audio frequencies
- 3.10 Explain damping factor in speakers

### 4.0 Speaker Cabling

- 4.1 Explain ways that wrong wire gauge can adversely affect the sound system
- 4.2 Describe connector requirements for multi-room In-Wall speakers
- 4.3 Compare speaker terminal connections including spring clips, optic fiber, binding posts, etc.
- 4.4 Explain the value and differences between audio cable systems including:
  - 4.4.1 Oxygen-free copper wire
  - 4.4.2 Optical digital audio cables
  - 4.4.3 HDMI and HDMI 2.1 cables
- 4.5 Define the following speaker terms:
  - 4.5.1 Transient Distortion
  - 4.5.2 Wow
  - 4.5.3 Flutter
- 4.6 Describe advantages of quality wired speakers including cost comparison
- 4.7 Explain the purpose and components used in cross-over networks
- 4.8 Describe wiring used on wall surfaces, hardware and esthetics

### 5.0 Audio Systems Basics

- 5.1 Explain why audio systems require greater bandwidth than telephone or AM radio
- 5.2 Explain the frequency response of each type of speaker
- 5.3 Explain total harmonic distortion (THD) including causes and cures

- 5.4 Define audio equalization
  - 5.4.1 Compare an equalizer to common tone controls in amplifiers
- 5.5 Explain digital audio sampling rates including various optimum sampling rates
- 5.6 Explain the advantages of compression technology
  - 5.6.1 Explain how and where it is used in audio products
- 5.7 Compare quality of CDs and user functionality with streaming audio or other sources
- 5.8 Compare radio reception quality with CDs and internet/media streaming
  - 5.8.1 Explain radio function of the stereo receiver
  - 5.8.2 Describe satellite radio services

## 6.0 Surround Sound

- 6.1 Explain surround sound basics
- 6.2 Describe how to plan the placement of surround sound speaker units
- 6.3 Describe how to rewire to allow room areas use of surround equipment
- 6.4 Explain digital theatre systems (DTS) and their advantages/disadvantages
  - 6.4.1 Describe Dolby Digital®, Dolby 5.1-channel® surround sound systems
  - 6.4.2 Describe 7.1-channel® surround sound systems
  - 6.4.3 Describe 7.2-channel® surround sound systems
  - 6.4.3 Describe Dolby Atmos® surround sound systems

## 7.0 Acoustics

- 7.1 Define and present examples of good and bad acoustics
- 7.2 Explain acoustic resistance and resonance
- 7.2 Explain causes of detrimental sound reflection
- 7.3 Explain sound refraction and discuss causes
- 7.4 Explain sound diffraction aspects
- 7.5 Describe low frequency effects an area may exhibit
- 7.6 Explain the reasons for audio “holes and nodes” and how to mitigate them

## 8.0 Video

- 8.1 Describe TV “Off-Air” broadcast signals including HDTV (High Definition TV) multicasting
- 8.2 Differentiate between video streaming using cable, satellite or Video Over Cellular (VOC) 4G/5G video programming
  - 8.2.1 Compare DVD, cable, satellite, VOC and off-air High Definition sources and sampling rates
- 8.3 Describe Blu-ray™ and 4K Blu-ray™ technology and audio-video quality
- 8.4 Describe HDVD – DVR (High Definition video disc-digital video recorder) audio and video quality
- 8.5 Explain the purpose of MPEG-4 (Moving Picture Experts Group-4, .M4V, MP4)
- 8.6 Describe how PVRs (personal video recorders) operate and interconnect in the sound system
- 8.7 Define S-Video (separate video or Y/C) and explain its advantages
- 8.8 Define HDMI (High Definition Multimedia Interface) and explain its advantages
  - 8.8.1 Explain Aspect Ratios and how they affect the screen viewing size
  - 8.8.2 Match viewing distance – aspect ratios with various size displays
  - 8.8.3 Differentiate between HD 1080P, 4K Ultra HD and 10K including 8K-60Hz and 4K-120Hz
- 8.9 Explain various digital sampling rates with optimized video quality
- 8.10 Describe display maximization including color temperature/balance
- 8.11 Describe various types of wireless control of audio and video equipment using remote hand units, LED (light-emitting diode) and RF (radio frequency) sending/receiving devices

## 9.0 Display Devices

- 9.1 Describe the operation and handling precautions for liquid-crystal displays (LCD)
- 9.2 Describe LED, LCD plasma, OLED (organic LED) and other projection TV technologies
- 9.3 Compare monitors with TV receivers and list advantages
- 9.4 Compare the following display technologies and list advantages of each:
  - 9.4.1 Digital light processing (DLP)
  - 9.4.2 Liquid crystal on silicon (LCoS)
  - 9.4.3 Cells of electrically charged ionized gases (Plasma)
  - 9.4.4 Quantum dot display (QLED)
- 9.5 Describe projectors/screens used in home theater applications

- 9.6 Describe actuators and remote control for motorized screens
- 9.7 Discuss Scanning and the features of both:
  - 9.7.1 Progressive scanning
  - 9.7.2 Interlaced scanning
- 9.8 Explain the purpose and technology of De-Interlacing and Line Doubling

## 10.0 Home Theater Systems

- 10.1 Describe audio channel selection on a receiver/amplifier
- 10.2 List advantages of remote wireless control of whole-house electronics from the home theater primary viewing area
- 10.3 Summarize modern displays and speaker esthetics for residential function
- 10.4 Discuss home theater seating concepts
- 10.5 Explain importance of seeking customer choices for products and in-home positioning
- 10.6 Explain requirements of cabling, speakers and display units when retrofitting a residence
- 10.7 List the components for a motorized projection screen
- 10.8 Describe the inclusion of CDs (compact discs), DVD (digital video disc), internet streaming, Blu-ray™, 4K Blu-ray™, 8K and 10K in the audio-video system

## 11.0 Off-Air Antennas

- 11.1 Explain off-air antenna installation basics
- 11.2 Identify types of large antenna-dish components and mounts
- 11.3 Discuss logical methods of troubleshooting dish and antenna problems
- 11.4 Compare 4K UltraHD, digital, and HDTV broadcast signals
- 11.5 Describe the required small dish system installation/programming procedures that must be followed and the configuration required prior to customer subscription access

## 12.0 Cable TV

- 12.1 Describe cable TV (CATV) connections, ground blocks and wiring from street drop to home/entry interconnection
- 12.2 List minimum signal levels common for CATV systems and the use of line amplifiers where weak signals exist
- 12.3 Define and list major advantages of each:
  - 12.3.1 DSL (digital subscriber line)
  - 12.3.2 VoIP (voice over internet protocol)
  - 12.3.3 PPV (pay-per-view)
  - 12.3.4 POTS (Plain Old Telephone Services)

## 13.0 Distribution Systems

- 13.1 Describe home run and daisy chain wired signal distribution systems
- 13.2 Describe and compare wireless distribution systems with wired distribution systems
- 13.3 List common usages for cabling and the advantages of each:
  - 13.3.1 RG-59
  - 13.3.2 RG-62
  - 13.3.3 RG6
  - 13.3.4 CAT 5e/6/6A/8 etc
  - 13.3.5 Optical fiber
- 13.4 Describe residential signal distribution equipment interconnection
- 13.5 Describe how a home computer network can be used to remotely control home electronics
- 13.6 Explain how individual areas can be controlled from multiple remote locations
- 13.7 Describe pre-wiring and retro wiring methods including:
  - 13.7.1 wall fish
  - 13.7.2 attics
  - 13.7.3 crawl spaces
  - 13.7.4 other spaces
- 13.8 Describe 70-volt sound distribution technology and indicate applications where it is desirable
  - 13.8.1 Identify wireless sound systems and how they are configured
- 13.9 List online and cloud resources that may be included in home networks
- 13.10 Explain the use of distribution components including splitters, diplexers, taps, fittings and outlets
- 13.11 Explain how plastic optical fiber can be utilized in the home systems

## 14.0 Troubleshooting

- 14.1 Describe common technical problems in home theater systems
- 14.2 Describe methods and equipment used to troubleshoot signal systems or to substitute or detect system signals
- 14.3 Explain the usage of signal generators including:
  - 14.3.1 TDR (time domain reflectometer)
  - 14.3.2 DMM (digital multimeter)
  - 14.3.3 RF (Communication Service Monitor – CSM)
  - 14.3.4 Microwave
- 14.4 List signal problems from external sources or those caused by the A-V system components
- 14.5 List tools and test equipment used for installation work in homes
- 14.6 Describe methods and equipment used to maximize A-V equipment capabilities
- 14.7 Describe procedures for accessing and resolving In-Wall equipment/cabling problems
- 14.8 Present an example of customer equipment faults leading to dissatisfaction of the electronics work and potential loss of income for the installing dealer
- 14.9 Explain the grounding process and its importance in reducing ground loops as well as customer lighting/surge concerns

## End of SMART TECHNOLOGY SYSTEMS **AUDIO-VIDEO** Competency

### Certified Basic Smart Technology Systems Endorsement Advisory Board:

John Baldwin, CETsr, CAT  
 Clifton Beck  
 John Bosnack  
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## **Suggested Additional AUDIO-VIDEO Resource and Study Material:**

**National Electrical Code®**, 2017; National Fire Protection Assn., Sept.,2016; [www.nfpa.org](http://www.nfpa.org)  
**Commercial Low-Voltage Wiring, 1<sup>st</sup> Ed**; Charles J. Brooks, Ray Stroud; ISBN 978-1581220858; Marcraft, an ETG Brand; 2012;  
**Cabling: The Complete Guide to Copper and Fiber-Optic Networking, 5E**; Andrew Oliviero, Bill Woodward; ISBN 978-1-118-80732-3; Sybex, Inc.; March 2014; softcover; 1284 ppg. Available through ETA 800-288-3824, [www.eta-i.org](http://www.eta-i.org)  
**Cybersecurity Essentials, 1<sup>st</sup> Ed**; Charles J. Brooks, Christopher Grow, Philip Craig, Donald Short; ISBN 978-1119362395; Sybex; Oct.2018; 784 pgs  
**Telecommunications and Data Communications Handbook**; Ray Horak; ISBN 978-0470041413; Wiley-Interscience; September 2007; Paperback; 791 ppg.  
**Sound Systems: Design and Optimization: Modern Techniques and Tools for Sound System Design and Alignment, 3E**; Bob McCarthy; ISBN 978-0415731010; Routledge; 2016; 600 ppg.  
**Practical Home Theater: A Guide to Video and Audio Systems (2018 Edition)**; Mark Fleischmann; ISBN 978-1932732191; Quiet River Press, LLC; October 2017; 284(Xperi owned) ppg.  
**RESI Basic Skills & Knowledge**; Charles J. Brooks; ISBN 978-1581220841; eITPrep LLP; 2007; 442 pgs  
**RESI Computer Networking Endorsement**; Charles J. Brooks; ISBN 978-1581221022; eITPrep LLP; 2007;  
**RESI Audio and Video Systems Endorsement**; Max Main, Charles J. Brooks; ISBN 978-1581221039; eITPrep LLP; 2009; 208 pgs  
**RESI Home Security and Surveillance Systems Endorsements**; Max Main, Charles J. Brooks; ISBN 978-1581221046; eITPrep LLP; 2009; 262 pgs  
**RESI Environmental Control Endorsement**; Max Main, Charles J. Brooks; ISBN 978-1581221053; eITPrep LLP; 2009; 268 pgs

Many webpages and links are available searching online, some examples are:

[http://www.eta-i.org/smart\\_home.html](http://www.eta-i.org/smart_home.html)  
<https://hdbaset.org/what-is-hdbaset/hdbaset-solution-for-audiovisual/>  
<https://www.dolby.com/us/en/home/index.html>  
[https://www.xperi.com/markets/home-solutions/?utm\\_source=top\\_nav](https://www.xperi.com/markets/home-solutions/?utm_source=top_nav)  
<http://www.integrahometheater.com/index.php>  
<https://hometheaterreview.com/integra-dtc-98-home-theater-processor-reviewed/>  
<https://hometheaterreview.com/home-theater/>  
<https://hometheaterhifi.com/>  
<https://www.digitaltrends.com/home-theater/ultimate-surround-sound-guide-different-formats-explained/>  
<https://www.z-wave.com/>  
<https://www.zigbee.org/>  
<https://www.bluetooth.com/>  
<https://www.nfpa.org/>  
<http://www.marcraft.com/RESI.html>  
<https://www.tiaonline.org/>  
<http://www.iec.ch/>  
<https://www.nema.org/pages/default.aspx>  
<https://www.iccsafe.org/>  
<https://www.electronicdesign.com>  
<http://resources.rohde-schwarz-usa.com/c/white-paper-testing-?x=zQSHFI>  
<http://www.bcae1.com/spkrmlti.htm>

Call (1-800-288-3824) or contact ETA ([eta@eta-i.org](mailto:eta@eta-i.org)) for numerous white papers, pdfs, power points, etc...

ETA certification programs are accredited through the ICAC, complying with the ISO/IEC 17024 standard.

