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® 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 (STS A-V)
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
      1.1.2.1 POTS Plain Old Telephone services
      1.1.2.2 VoIP (voice over internet protocol)
      1.1.2.2.1 Identify how VOIP connections are made over networks
1.2 List audio signal sources and types
1.3 Differentiate between audio, video, and data signals
   1.3.1 Identify signals associated with A-BUS audio
   1.3.2 Explain signal sample rates
   1.3.3 Identify the difference between NTSC and PAL (STS-Basic Comp.8.7)
   1.3.4 Compare video signals with radio frequencies and voice
   1.3.5 Differentiate between HDBaseT™ and IP-based video
   1.3.6 Identify the difference between the digital HDTV transmission standards and ATSC 3.0 or NextGen TV broadcasting standards
1.4 Explain how different devices within a building can be paired and controlled by smart technology system hubs connected to the wireless network
   1.4.1 Describe how smart technology system hubs can be extended throughout a building using hub repeaters or extender devices
1.5 Explain how entertainment systems can be connected to smart technology systems and how all room speaker systems can be set up wirelessly

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 Audio/Video 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 Define the following speaker terms:
4.4.1 Transient Distortion
4.4.2 Wow
4.4.3 Flutter

4.5 Describe advantages of quality wired speakers including cost comparison

4.6 Explain the purpose and components used in cross-over networks

4.7 Explain the value and differences between audio/video cable systems including:
   4.7.1 Oxygen-free copper wire
   4.7.2 Optical digital audio cables
   4.7.3 HDMI and HDMI 2.1 audio/video cables
   4.7.4 Identify the IEEE 1394 high speed serial bus versions
      4.7.4.1 IEEE 1394 FireWire™ 400, (i.LINK™, Lynx™) - 6 pin
      4.7.4.2 IEEE 1394a - 4 pin
      4.7.4.3 IEEE 1394b, FireWire™ 800 - 8 pin
   4.7.5 Component audio/video cables
   4.7.6 S-Video cables
   4.7.7 RCA cables

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
7.3 Explain causes of detrimental sound reflection
7.4 Explain sound refraction and discuss causes
7.5 Explain sound diffraction aspects
7.6 Describe low frequency effects an area may exhibit
7.7 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 PPV (pay-per-view)
13.0 Distribution Systems
13.1 Describe home run and daisy chain wired signal distribution systems
   13.1.1 Explain how A-BUS systems work
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 Identify causes of cabling crosstalk interference
13.5 Describe residential signal distribution equipment interconnection
13.6 Describe how a home computer network can be used to remotely control home electronics
13.7 Explain how individual areas can be controlled from multiple remote locations
13.8 Describe pre-wiring and retro wiring methods including:
   13.8.1 wall fish
      13.8.1.1 Describe the need for drywall and other penetrations of walls and ceilings in retrofit applications
      13.8.1.2 Describe restoration techniques and list materials used
   13.8.2 attics
   13.8.3 crawl spaces
   13.8.4 other spaces
13.9 Describe 70-volt sound distribution technology and indicate applications where it is desirable
   13.9.1 Identify wireless sound systems and how they are configured
13.10 List online and cloud resources that may be included in home networks
13.11 Explain the use of distribution components including splitters, diplexers, taps, fittings and outlets
13.12 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 Endorsement Competency
Suggested Additional **AUDIO-VIDEO** Resource and Study Material:

- **Commercial Low-Voltage Wiring**: Brooks, Stroud; ISBN 978-1581220858; Marcraft, ETG Brand; 2012
- **Residential Wiring and Smart Home Technology**: Rockis & Rockis; ISBN 978-0826918338; ATP; 2018
- **Cybersecurity Essentials, 1st 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 pgs

**RESI library**: Charles J. Brooks with Max Main, eITPrep LLP, Marcraft:
- **RESI Basic Skills & Knowledge**: ISBN 978-1581220841; 2007; 442 pgs
- **RESI Audio and Video Systems Endorsement**: ISBN 978-1581221039; 2009; 208 pgs
- **RESI Environmental Control Endorsement**: ISBN 978-1581221053; 2009; 268 pgs

**Residential Integration Series Library**: Cengage Learning Delmar:
- **RESI Basics**: ISBN 978-1418014070; 2006; 466 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://hdbaset.org/what-is-hdbaset/hdbaset-solution-for-audiovisual/)
- [https://hometheaterreview.com/home-theater/](https://hometheaterreview.com/home-theater/)
- [https://hometheatherhifi.com/](https://hometheatherhifi.com/)
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- [http://www.bcae1.com/spkrmulti.htm](http://www.bcae1.com/spkrmulti.htm)

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