

TELECOMMUNICATIONS CABLING



PURPOSE

To evaluate each contestant's preparation for employment and to recognize outstanding students for excellence and professionalism in the field of telecommunications cabling.

First, download and review the General Regulations at: <http://updates.skillsusa.org>.

ELIGIBILITY

Open to active SkillsUSA students enrolled in a career and technical education program with telecommunications cabling (systems connectivity) as the occupational objective.

CLOTHING REQUIREMENT

Class E: Contest specific — Business Casual

For men: Official SkillsUSA white polo shirt, black dress slacks, black socks, black leather shoes.

For women: Official SkillsUSA white polo shirt with black dress skirt (knee-length) or black slacks; black socks or black or skin-tone seamless hose; black leather dress shoes.

These regulations refer to clothing items that are pictured and described at: www.skillsusastore.org. If you have questions about clothing or other logo items, call 800-401-1560 or 703-956-3723.

Note: Contestants must wear their official contest clothing to the contest orientation meeting.

EQUIPMENT AND MATERIALS

1. Supplied by the technical committee:
 - a. Mock wall, cable ladder, equipment racks, cable, telecommunications outlets, termination blocks, modular plugs and cable labeling device
 - b. Connectors RJ-45 CAT 6, BNC F-Type, coax connectors, 110 blocks with C-4 and C-5 clips

- c. Fiber optic termination connectors, fiber optic cable
2. Supplied by contestant:
 - a. Eye protection
 - b. Hard hat
 - c. IDC and compression tool necessary to terminate 8-pin modular plugs
 - d. Compression tool for use with coaxial F-style snap and seal connectors
 - e. Cable preparation tools such as electrician's scissors, stripping tools, etc.
 - f. Fish tape
 - g. Electrical tape
 - h. Mechanical probe-pic
 - i. Cable labeling device
 - j. Volt ohmmeter or DMM
 - k. Cable wire mapping tester
 - l. Fiber-optic continuity tester (small flashlight)
 - m. All competitors must create a one-page résumé and submit a hard copy to the technical committee chair at orientation. Failure to do so will result in a 10-point penalty.

Note: Your contest may also require a hard copy of your résumé as part of the actual contest. Check the Contest Guidelines and/or the updates page on the SkillsUSA website at <http://updates.skillsusa.org>.

SCOPE OF THE CONTEST

Knowledge Performance

The contest includes a written knowledge exam to assess knowledge of structured cabling. Questions from the written evaluation will be taken from the following general telecommunications cabling topic areas and are verbalized in the attached competencies: cable pulling, copper media (UTP cabling), fiber optic media, fire stopping, grounding and bonding, horizontal cabling, installation of support structures, plans (blueprint and drawing), safety practices, splicing, standards and codes, telecommunications cabling systems, testing UTP cabling, transmission theory and troubleshooting.

Skill Performance

The purpose of the hands-on component of the contest will be to evaluate the ability to install, terminate and manage telecommunications cabling.

Contest Guidelines

1. An installation will be tested to industry standard requirements.
2. The cabling project must be completed within the given time and certified for use.
3. Equipment and tools needed to install the appropriate connectivity for the project will be provided by the committee and the contestant as described above in “Supplied by the Technical Committee.”
4. Skills that are to be evaluated are outlined in the competencies provided by the contest technical committee. Standards are congruent with those established by the ETA Competency Requirements for Certified Data Cabling Installers.
5. Two industry certifications—Customer Service Specialist and Data Cabling Installer—may be earned as part of the contest. The Customer Service Specialist certification requires a passing score of 75 percent on a written evaluation that tests soft skills and work readiness. The Customer Service Specialist written evaluation is five percent of the total contest points. The Data Cabling Installer Certification requires both a passing score of 75 percent on a written evaluation and a score of 85 percent on the performance parts of the contest (Cable Installing, Cable Termination, Cable Construction, Cable Troubleshooting, and Fiber Optic Troubleshooting). The Data Cabling Installer Certification written evaluation is 10 percent of the total contest points. Both written exams will be administered at the orientation meeting.

Standards and Competencies

CAB 1.0 — Show knowledge of telecommunications safety as outlined by the ETA

- 1.1 Demonstrate basic workspace and ladder safety knowledge
- 1.2 Identify personal protective gear/equipment used in telecommunications cabling work
- 1.3 Exercise safety practices for cabling pathways
- 1.4 Identify safety issues specific to working with fiber optics cables
- 1.5 Demonstrate knowledge of OSHA safety regulations applicable to telecommunication installers
- 1.6 Demonstrate safety knowledge for confined spaces
- 1.7 Demonstrate knowledge of telecommunication safety hazards and threats

CAB 2.0 — Apply knowledge of telecommunications and electronics theory

- 2.1 Explain the relationship between voltage, current, resistance and power
- 2.2 Calculate voltage, current and resistance using Ohms Law
- 2.3 Identify passive components and active components in cabling circuits
- 2.4 Identify the electrical properties of inductors and capacitors
- 2.5 Recognize and explain the difference between DC and AC circuits
- 2.6 Identify the periodic units of sinusoidal AC
- 2.7 Explain the frequency response difference between inductive reactance and capacitive reactance
- 2.8 Define impedance and explain its relationship with reactance and resistance
- 2.9 Describe and identify resonant frequency, bandwidth and basic filter types
- 2.10 Explain how noise is generated in communications components
- 2.11 Define signal-to-noise ratio

CAB 3.0 — Apply knowledge of structured cabling components, elements and functional groups as outlined by the posted ETA competencies based on industry standards

- 3.1 Identify Inside Plant (ISP) LAN structured cabling elements
- 3.2 Identify and explain the function of the entrance facility
- 3.3 Identify and explain the function of the equipment room
- 3.4 Identify structured cabling elements
- 3.5 Identify codes and standards applicable to cable types, jackets and applications
- 3.6 Identify ground system components
- 3.7 Identify ground wiring minimum code requirements
- 3.8 Explain the function and importance of grounding/earthing systems to communications
- 3.9 Describe and apply ground codes and standards

CAB 4.0 — Apply knowledge of copper cabling installation including color coding, cable pulling and installation, connector terminations and cable testing as outlined by the contest technical committee

- 4.1 Demonstrate knowledge of the TIA standard color code for 4-pair and 25-pair UTP cabling
- 4.2 Demonstrate proper conduit cable pulling techniques
- 4.3 Demonstrate proper cable ladder cable pulling techniques
- 4.4 Install and terminate a ground conductor
- 4.5 Install and terminate to UTP patch panels
- 4.6 Install and terminate UTP wall outlets
- 4.7 Terminate a 25-pair cable to 66-style connecting blocks
- 4.8 Terminate a 25-pair cable to 110-style connecting block
- 4.9 Install and terminate UTP 4 pair CAT 6 modular outlets. Two modular outlets at faceplate
- 4.10 Install and terminate coaxial “F” style connectors
- 4.11 Install and terminate coaxial BNC style connectors
- 4.12 Test UTP and coaxial cabling continuity

CAB 5.0 — Describe terms related to analog and digital communication systems as outlined by the posted ETA competencies based on industry standards

- 5.1 Define asynchronus communications
- 5.2 Define synchronus communications
- 5.3 Describe the general characteristics of analog communications
- 5.4 Define the general characteristics of digital communications
- 5.5 Describe packet communications

CAB 6.0 — Explain common definitions, symbols and abbreviations relevant to telecommunications systems as outlined by the posted ETA competencies based on industry standards

- 6.1 Define the audio spectrum range
- 6.2 Define radio frequency
- 6.3 Explain channel bandwidth
- 6.4 Explain the difference between frequency, bit rate, baud and symbol rate
- 6.5 Convert signals from voltage levels to their corresponding decibel equivalents and decibel levels to their corresponding voltage or current levels
- 6.6 Convert signal gains or losses to comparative decibel readings

CAB 7.0 — Describe basic cable construction elements and cable types as outlined by the posted ETA competencies based on industry standards

- 7.1 Describe the basic components of:
 - 7.1.1 twisted-pair cables
 - 7.1.2 coaxial cables
- 7.2 Explain the differences between shielded twisted pair (STP) and unshielded twisted pair (UTP) cable
- 7.3 Read cable cordage and calculate cable length
- 7.4 Describe the use for standard cable jacket ratings:
 - 7.4.1 Plenum
 - 7.4.2 Riser
 - 7.4.3 General
- 7.5 Identify the NEC codes covering communication cabling use
- 7.6 Describe a composite cable
- 7.7 Describe a hybrid cable
- 7.8 Describe the performance differences between CAT 5 and 6 telephone-data cables

CAB 8.0 — Describe the copper cabling electrical performance characteristics, standards and terminology as outlined by the posted ETA competencies based on industry standards

- 8.1 Define cabling characteristic impedance
- 8.2 Define cabling attenuation
- 8.3 Define cabling return loss
- 8.4 Define pair cross talk
- 8.5 Describe the difference between near and far-end cross talk
- 8.6 Describe the cable elements:
 - 8.6.1 Jacket
 - 8.6.2 Conductor
 - 8.6.3 Pair
 - 8.6.4 Binder
 - 8.6.5 Shield
- 8.7 Identify electrical units of inductance, capacitance and resistance in relation to cable construction
- 8.8 Identify the terms “self-inductance” and “mutual inductance” and describe their application within cable construction
- 8.9 Describe the difference between balanced and unbalanced communications cabling

CAB 9.0 — Demonstrate knowledge of fiber optic technology and cable construction as outlined by the posted ETA competencies based on industry standards

- 9.1 List the name and function of optical cabling construction components:
 - 9.1.1 Core
 - 9.1.2 Cladding
 - 9.1.3 Buffer
 - 9.1.4 Tubing
- 9.2 Identify loose tube and tight buffered cables
- 9.3 Explain the TIA 598 fiber color code
- 9.4 Describe the difference and function of:
 - 9.4.1 Single-mode fiber
 - 9.4.2 Multi-mode fiber
- 9.5 Describe the operating wavelength bands for:
 - 9.5.1 Single-mode fiber
 - 9.5.2 Multi-mode fiber
- 9.6 Explain the optical terms and units of:
 - 9.6.1 Wavelength
 - 9.6.2 Attenuation
 - 9.6.3 Power
 - 9.6.4 Reflectance

- 9.7 Identify industry standard fiber connector types, including SC, ST, LC, MPO and Array
- 9.8 Evaluate the “end-face” of a fiber optic connector
- 9.9 Test optical fiber continuity
- 9.10 Measure optical power
- 9.11 Terminate fiber optic cables
- 9.12 Splice fiber optic cables

CAB 10.0 — Explain the purpose and basic requirements of the following standards as outlined by the posted ETA competencies based on industry standards

- 10.1 ANSI/TIA/EIA-568 standard
- 10.2 ANSI/TIA/EIA-569 standard
- 10.3 ANSI/TIA/EIA-606 standard
- 10.4 ANSI/TIA/EIA-607 standard
- 10.5 ANSI/TIA/EIA-570 (residential telecom cabling) standard
- 10.6 ISO/IEC-11801 standard

CAB 11.0 — Explain basic computer network physical topologies and explain the advantages of each as outlined by the posted ETA competencies based on industry standards

- 11.1 Draw a diagram of a physical network for each of the following topologies:
 - 11.1.1 STAR topology
 - 11.1.2 BUS topology
 - 11.1.3 RING topology
- 11.2 Explain the advantages of each type of topology:
 - 11.2.1 STAR topology
 - 11.2.2 BUS topology
 - 11.2.3 RING topology

CAB 12.0 — Describe basic Ethernet network equipment as outlined by the posted ETA competencies based on industry standards

- 12.1 Describe Ethernet hub
- 12.2 Describe Ethernet switch
- 12.3 Describe Ethernet router
- 12.4 Describe Ethernet bridge

CAB 13.0 — Display knowledge of the National Electric Code (NEC)

- 13.1 Understand and have knowledge of all chapters in the NEC book
- 13.2 Explain TIA/EIA 606 administration standard for networks

CAB 14.0 — Explain structured cabling system components as outlined by the posted ETA competencies based on industry standards

- 14.1 Describe horizontal and backbone cables
- 14.2 Explain why patch cords are used and describe them
- 14.3 Explain the differences between the various segments of cabling pathways
- 14.4 Describe the purpose, construction and usage of communications wiring closets
- 14.5 Define MDF or ER (Equipment Room) and IDF or TR (Communications Room)
- 14.6 Explain the purpose and use of a punch down block
- 14.7 Compare power sources for telephone-data cabling equipment

CAB 15.0 — Demonstrate the use of Data Cabling Installer installation tools as outlined by the posted ETA competencies based on industry standards

- 15.1 Explain the purpose and proper usage of wire strippers, wire cutters, punch-down tools and other cable prep tools
- 15.2 Demonstrate the use of wire strippers, wire cutters, and other cable prep tools
- 15.3 Demonstrate the proper method of using cable crimpers (TP and coaxial)
- 15.4 Demonstrate the use of a punch-down tool
- 15.5 Demonstrate the use of fish tapes and other pull devices

CAB 16.0 — Discuss proper identification numbers and use of connectors and outlets as outlined by the posted ETA competencies based on industry standards

- 16.1 List the proper identification numbers for twisted pair plugs and jacks
- 16.2 List the proper identification numbers for coaxial cable plugs, splices and jacks
- 16.3 Describe fixed design wall plates and explain where they are used
- 16.4 Describe a modular wall plate, why it is used, and where it is used
- 16.5 Describe a biscuit jack and why it is used
- 16.6 Describe a floor telecom outlet
- 16.7 Describe a cable junction box

CAB 17.0 — Demonstrate the steps, precautions and methods used in cabling installation as outlined by the posted ETA competencies based on industry standards

- 17.1 Describe the steps used in installing communications cabling
- 17.2 Explain cable stress and the precautions that should be taken during aerial, underground, duct and plenum installations
- 17.3 Define pulling tension and bend radius
- 17.4 Describe cabling dressing and methods of securing cabling
- 17.5 Explain proper labeling of cables
- 17.6 Describe a wire map
- 17.7 Explain the concept of cabling management and proper outlet placement and requirements
- 17.8 Demonstrate proper cable stripping, termination and installation techniques
- 17.9 Explain how ducts are used for cabling installations
- 17.10 Describe how the telecommunications closet is wired
- 17.11 Demonstrate the proper selection and use of cable testing tools and equipment

CAB 18.0 — Demonstrate proper installations of connectors, and describe the color code for pin/pair assignments as outlined by the posted ETA competencies based on industry standards

- 18.1 Demonstrate proper installation of twisted pair connectors
- 18.2 Demonstrate proper installation of coaxial cable connectors
- 18.3 Describe the color code for telecom cabling and the pin/pair assignments

CAB 19.0 — Explain and demonstrate methods of cable troubleshooting as outlined by the posted ETA competencies based on industry standards

- 19.1 Explain how to establish a baseline for testing or repairing a cabling system
- 19.2 Demonstrate methods for locating a cabling defect or problem
- 19.3 Describe commonly encountered cable problems and the methods used to resolve them
- 19.4 Explain cross-talk and florescent lighting interference
- 19.5 Explain loop-testing
- 19.6 Describe a radio detector and how it is used to locate interference sources

CAB 20.0 — Explain cable plant testing, certification and documentation as outlined by the posted ETA competencies based on industry standards

- 20.1 Explain the purpose of installation testing
- 20.2 Describe the purpose and methods of certifying the cable plant
- 20.3 Explain the purpose of documenting a cabling installation
- 20.4 Explain the required ingredients of the installation documents
- 20.5 Prepare a sample cable documentation record that meets industry standards

Committee Identified Academic Skills

The technical committee has identified that the following academic skills are embedded in this contest.

Math Skills

- Use fractions to solve practical problems
- Use proportions and ratios to solve practical problems
- Simplify numerical expressions
- Use scientific notation
- Solve practical problems involving percents
- Solve single variable algebraic expressions
- Construct three-dimensional models
- Make predictions using knowledge of probability
- Make comparisons, predictions and inferences using graphs and charts
- Organize and describe data using matrixes
- Solve problems using proportions, formulas and functions

Science Skills

- Use knowledge of mechanical, chemical and electrical energy
- Use knowledge of heat, light and sound energy
- Use knowledge of sound and technological applications of sound waves
- Use knowledge of the nature and technological applications of light
- Use knowledge of work, force, mechanical advantage, efficiency and power
- Use knowledge of principles of electricity and magnetism
- Use knowledge of static electricity, current electricity and circuits

- Use knowledge of magnetic fields and electromagnets

Language Arts Skills

- Provide information in conversations and group discussions
- Provide information in oral presentations
- Demonstrate use of verbal communication skills: word choice, pitch, feeling, tone and voice
- Demonstrate use of nonverbal communication skills: eye contact, posture and gestures using interviewing techniques to gain information
- Demonstrate comprehension of a variety of informational texts
- Identify words and phrases that signal an author's organizational pattern to aid comprehension
- Demonstrate knowledge of appropriate reference materials
- Use print, electronic databases and online resources to access information in books and articles
- Demonstrate informational writing

Connections to National Standards

State-level academic curriculum specialists identified the following connections to national academic standards.

Math Standards

- Numbers and operations
- Algebra
- Geometry
- Measurement
- Problem solving
- Reasoning and proof
- Communication
- Connections
- Representation

Source: NCTM Principles and Standards for School Mathematics. For more information, visit: <http://www.nctm.org>.

Science Standards

- Understands the structure and properties of matter
- Understands the sources and properties of energy
- Understands forces and motion
- Understands the nature of scientific inquiry

Source: McREL compendium of national science standards. To view and search the compendium, visit:
<http://www2.mcrel.org/compendium/browse.asp>

Language Arts Standards

- Students read a wide range of print and nonprint texts to build an understanding of texts, of themselves, and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classic and contemporary works
- Students apply a wide range of strategies to comprehend, interpret, evaluate and appreciate texts. They draw on their prior experience, their interactions with other readers and writers, their knowledge of word meaning and of other texts, their word identification strategies and their understanding of textual features (e.g., sound-letter correspondence, sentence structure, context, graphics)
- Students adjust their use of spoken, written and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes
- Students apply knowledge of language structure, language conventions (e.g., spelling and punctuation), media techniques, figurative language and genre to create, critique and discuss print and nonprint texts
- Students use a variety of technological and information resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge
- Students use spoken, written and visual language to accomplish their own purposes (e.g., for learning, enjoyment, persuasion and the exchange of information)

Source: IRA/NCTE Standards for the English Language Arts.
To view the standards, visit: www.ncte.org/standards.