

# Certified Industrial Electronics Technician – (IND) Competency Requirements—2007



## —CATEGORIES LIST

A listing of the major areas of knowledge and skills required by Industrial Electronics Technicians

- 1.0 Amplifiers
- 2.0 Components
- 3.0 Optical Wiring
- 4.0 Interfacing
- 5.0 Block Diagrams—Schematics
- 6.0 Power Supplies
- 7.0 Test Equipment-Tools
- 8.0 Mathematics
- 9.0 Computers-Digital Concepts
- 10.0 Programmable Logic Controllers
- 11.0 Software
- 12.0 Safety
- 13.0 Satellite-Wireless-Data Communications
- 14.0 Cabling
- 15.0 Troubleshooting
- 16.0 Motors
- 17.0 Workplace Practices

# Certified Industrial Electronics Technician – (IND) Competency Requirements—2007



## —ITEMS LISTING—SYLLABUS

### 1.0 Amplifiers

- 1.1 Electronic amplifiers configuration
- 1.2 Methods of increasing or decreasing amplification
- 1.3 Overdrive
- 1.4 Bandwidth
- 1.5 Amplifier selection
- 1.6 Measuring gain
- 1.7 Biasing
- 1.9 Line amplifiers
- 1.10 Magnetic amplifiers

### 2.0 Components

- 2.1 Schematic symbols
- 2.2 Signal filters
- 2.3 Crystals
- 2.4 Power supply components
- 2.5 Circuit board substitution
- 2.6 CRTs, LEDs and LCDs
- 2.7 Active—passive filters
- 2.8 Magnitude tachometers; transducers; RTDs; SCRs; Triacs; solenoids and synchros
- 2.9 Thermostats; limit switches; fans, pressure and level controls
- 2.10 Op-amps—op amp filters
- 2.11 Lasers
- 2.12 Batteries
- 2.13 Light, electromagnetic waves, gravity

### 3.0 Optical Wiring

- 3.1 Disposal and eye safety
- 3.2 Types of optical cables
- 3.3 Conversion from copper to fiber signals
- 3.4 SONET
- 3.5 DWDM

### 4.0 Interfacing

- 4.1 Interconnecting wiring
- 4.2 Signal types, frequencies and levels
- 4.3 Data transfer busses—RS 232C
- 4.4 Block diagram of an intercom system
- 4.5 Motor circuits
- 4.6 Noise interference
- 4.7 Building wiring standards

### 5.0 Block Diagrams - Schematics

- 5.1 Principles of block diagrams
- 5.2 Expected voltage or signal levels
- 5.3 Sections and test points

- 5.4 Test equipment used

### 6.0 Power Supplies

- 6.1 Resistance
- 6.2 Loss
- 6.3 AC generator
- 6.4 Crowbar circuit
- 6.5 Power factor
- 6.6 Wire size
- 6.7 Ampacity
- 6.8 VAR

### 7.0 Test Equipment - Tools

- 7.1 Certifying wired communications networks
- 7.2 OTDRs and TDRs
- 7.3 SWR
- 7.4 Use of test equipment
- 7.5 Hand tools
- 7.6 Solder
- 7.7 Static control, eye safety, working at heights

### 8.0 Mathematics

- 8.1 Basic math
- 8.2 Scientific calculators
- 8.3 Ohm's law—reactance; capacitance; inductance; circuit calculations; wave-length and frequency; RC and RL
- 8.4 Decibels
- 8.5 Exponential calculations
- 8.6 Decimal, binary, octal and hex
- 8.7 Boolean algebra
- 8.8 Color coding
- 8.9 Service-functions—costs and profitability
- 8.10 Estimates to perform repairs

### 9.0 Computers - Digital Concepts

- 9.1 Basic computer operation
- 9.2 Computer component symbols
- 9.3 Gates and truth tables
- 9.4 Integrated circuits
- 9.5 Chip types
- 9.6 DAC's, ADC's, interface devices
- 9.7 Safety precautions—Digital circuitry
- 9.8 Programming
- 9.9 Storing computer data and programs
- 9.10 Software troubleshooting programs

9.11	Graphics translators, cameras and scanners	9.13	Switch—relay CNC control of machinery
9.12	Keyboards	14.4	Long-run cable-loss characteristics
<b>10.0</b>	<b>Programmable Logic Controllers</b>	14.5	Prepare coax and telephone cable
10.1	Utilizing types of discrete controller modules	<b>15.0</b>	<b>Troubleshooting</b>
10.1.1	DC & AC	15.1	Test equipment
10.1.2	Analog	15.2	Software troubleshooting programs
10.1.3	Specialty (communications; co-processors; encoder; motion and signaling conditioning)	15.3	Non-destructive testing
10.2	Sinking/Sourcing I/O (Input/Output) modules	15.4	Component and subassembly substitution
10.3	PLC connection diagrams	15.5	Service records
10.4	Scan time-Scan cycle	15.6	Parts— literature procurement
10.5	Memory-size and Tracking	15.7	Schematic components and test points
10.6	Data input, output, filing and addressing	15.8	PC board circuit problems
10.7	Processor	15.9	Safety considerations
10.8	Memory capability	15.10	Kinescopes and high voltage
10.9	PLC circuits	<b>16.0</b>	<b>Motors</b>
10.10	Ladder diagram language	16.1	Magnetism
10.11	Shift register	16.2	Definitions
10.12	Sequencer instruction	16.3	Laminated armatures
10.13	Programming device	16.4	Motor and generators
<b>11.0</b>	<b>Software</b>	16.5	Commutators
11.1	Spread-sheet, word processor, graphics	16.6	Motor/generator brushes
11.2	Diagnostic programs	16.7	AC and DC motors
<b>12.0</b>	<b>Safety</b>	16.8	Series and shunt motors
12.1	Static sensitive electronics components	16.9	Speed control
12.2	NEC, (National Electrical Code)	16.10	Combination motors
12.3	Tagging of wiring or equipment	16.11	Single-phase, split-phase and polyphase
12.4	Equipment hazardous when turned off	16.12	Speed control feedback
12.5	Ground faults	16.13	Triac speed-control
12.6	Isolation transformers	16.14	Motor control types
12.7	Ground blocks and rods	16.15	Pulse-width motor control
12.8	Electrical or chemical fire extinguishers	16.16	Phase-locked-loop motor speed control
12.9	Metal chains—ornamentation hazards	16.17	Dynamic braking
12.10	Electrical shock	16.18	Optical motor control
12.11	First aid	<b>17.0</b>	<b>Workplace Practices</b>
12.12	Unsafe clothing	17.1	CSS—Customer Service Specialist
12.13	Leaded solder	17.2	Working cooperatively
12.14	OSHA safety rules for heights	17.3	Defusing customer problems
<b>13.0</b>	<b>Satellite, Wireless and Data Communications</b>	17.4	Telephone techniques
13.1	Concepts of the above three terms	17.5	Personal hygiene and appearance
13.2	BASEBAND in satellite communications	17.6	Teamwork
13.3	Block diagram of the interconnections	17.7	Emotions
<b>14.0</b>	<b>Cabling</b>	17.8	Improper service actions
14.1	Wavelength and frequency	17.9	Respect
14.2	Impedance in coaxial cables	17.10	Work orders
14.3	Fiber optics and telephone communications		

# Certified Industrial Electronics Technician - IND Competency Requirements—2007



*Industrial journeyman-level electronics technicians are expected to obtain knowledge of industrial electronics basic concepts which are then applicable to all the various specialty areas of industry. Once the CET has acquired these skills, abilities and knowledge, he or she will be able to enter employment in any part of the industrial field. With minimal training in areas unique to the specific products, the CET should become a profitable and efficient part of the industrial electronics workforce.*

Industrial Electronics Technicians must be knowledgeable and have abilities in the following technical and human relations areas:

## 1.0 Amplifiers

- 1.1 Describe usage of various types of electronic amplifiers, their configuration and features. These include push-pull; complimentary, Darlington, transformerless and video
- 1.2 List methods in which amplification in a circuit may be decreased or increased
- 1.3 Explain amplifier overdrive and its causes.
- 1.4 Explain the concept of bandwidth and know why a certain bandwidth is necessary for: radio tuners, IF sections, video amplifiers, cable and line amplifiers
- 1.5 Describe reasoning for selecting one amplifier over another
- 1.6 Demonstrate ability to measure amplifier gain
- 1.7 Describe biasing of transistor amplifiers
- 1.9 Show understanding of distribution system line amplifier requirements
- 1.10 Explain the theory of magnetic amplifiers and show historical usage

## 2.0 Components

- 2.1 Identify various industrial electronic and electrical component schematic symbols
- 2.2 Describe the use of signal filters and list several types
- 2.3 Explain the use of crystals and show various circuits they may be used in
- 2.4 Identify the components used in the power supply section of industrial electronics equipment
- 2.5 Compare the practicality of circuit board substitution versus component level parts replacement
- 2.6 Describe the differences between display components such as CRTs, LEDs and LCDs
- 2.7 Contrast active filters used in industrial equipment and passive filters
- 2.8 Identify and describe the uses for: magnitude tachometers; low voltage dielectric transducers; RTDs; SCRs; Triacs; solenoids and synchro-transmitters
- 2.9 Identify and describe the uses for thermostats; limit switches; fans, pressure and level controls
- 2.10 Draw the circuits for op-amps used for amplifiers, lo pass filters, high pass filters and band pass filters
- 2.11 Identify the components and their uses in laser scanning units
- 2.12 Compare the different types of batteries and state their uses
- 2.13 Compare the phenomena of light, electromagnetic waves, gravity, static electricity and magnetism and state an application in industrial electronics where each force is utilized

## 3.0 Optical Wiring

- 3.1 Demonstrate the rules for disposal and eye safety pertaining to fiber
- 3.2 Describe the two basic types of optical cables and show knowledge of different parameters and reasons for choosing each
- 3.3 Describe the conversion process from copper to fiber signals
- 3.4 Define and explain the term SONET
- 3.5 Explain DWDM, Dense Wave Division Multiplexing

## 4.0 Interfacing

- 4.1 Demonstrate ability to install and troubleshoot interconnecting wiring of industrial electronics equipment
- 4.2 List the signal types, frequencies and levels required for interconnecting industrial equipment
- 4.3 Explain how data transfer busses are used, including RS 232C

- 4.4 Draw a block diagram of an intercom system and explain its application in industry
- 4.5 Describe the power system used for motor circuits
- 4.6 Explain common noise interference causes and methods of reduction such as shielding
- 4.7 Describe existing building wiring standards

## **5.0 Block Diagrams and Schematics**

- 5.1 Demonstrate understanding of the principles of block diagrams and their usage in troubleshooting electronics circuitry
- 5.2 Describe expected voltage or signal levels at block diagram or schematic test points. Explain the 'divide and conquer' troubleshooting technique
- 5.3 Locate block diagram sections and test points
- 5.4 Determine what test equipment should be used at various block diagram test points

## **6.0 Power Supplies**

- 6.1 Describe the uses of resistance in power supply filters and voltage source divider networks
- 6.2 Describe power supply loss factors
- 6.3 Draw a basic AC generator and name its components
- 6.4 Explain the purpose of a crowbar circuit and describe its operation
- 6.5 Connect apparent true power and describe power factor
- 6.6 Describe wire loss factors as they relate to AWG wire sizes
- 6.7 Explain the term ampacity and present examples of its uses
- 6.8 Explain the differences between VAR and other power measurements

## **7.0 Test Equipment and Tools**

- 7.1 Define the job of certifying wired communications networks
- 7.2 Describe the use of OTDRs and TDRs
- 7.3 Measure SWR (standing wave ratio) and explain its significance in industrial communications
- 7.4 Demonstrate ability to efficiently use volt, ohm and current meters, oscilloscopes, signal generators, power meters, meggers, frequency counters and specialized industrial electronics test equipment testing instruments
- 7.5 Demonstrate ability to properly use common hand tools
- 7.6 List the different types of solder used in electronics service work. Explain how solder containing lead is in the process of being replaced by countries around the world and for what reasons
- 7.7 State the standard procedures and rules for static control, eye safety and working at heights

## **8.0 Mathematics**

- 8.1 Demonstrate ability to work basic math problems
- 8.2 Demonstrate ability to use scientific calculators
- 8.3 Use ohm's law current, voltage, resistance and power formulas. Also reactance; capacitance; inductance; parallel and series circuit calculations and to work resonance, wavelength and frequency problems; RC and RL time period calculations.
- 8.4 Demonstrate ability to utilize decibel measurements
- 8.5 Utilize exponential calculations
- 8.6 Explain the differences between decimal, binary, octal and hexadecimal numbering systems
- 8.7 Use Boolean truth tables
- 8.8 Convert electronic component color coding schemes
- 8.9 Demonstrate service-function and service-department cost and profitability factors
- 8.10 Construct a profitable service function estimate to perform a repair or installation job

## **9.0 Computers and Digital Concepts**

- 9.1. Demonstrate an understanding of basic computer operation
- 9.2 Identify computer component symbols
- 9.3 Utilize digital gates and truth tables
- 9.4 Demonstrate recognition of basic integrated circuit packages and their usages
- 9.5 Identify basic common chip types and usages

- 9.6 Describe DAC's, ADC's, interface devices, modems and special circuit boards
- 9.7 Demonstrate safety precautions pertaining to digital circuitry
- 9.8 Describe basic computer programming concepts
- 9.9 Explain the various methods of storing computer data and programs
- 9.10 Demonstrate ability to utilize software troubleshooting programs
- 9.11 Demonstrate the use of graphics translators, digital cameras and scanners
- 9.12 Explain how a computer keyboard matrix is used
- 9.13 Compare manual switch and relay control of machinery with CNC control
- 9.14 Draw a block diagram of a PLC circuit

## 10.0 Programmable Logic Controller

- 10.1 Demonstrate ability to utilize the following types of discrete controller modules:
  - a. DC and AC
  - b. Analog
  - c. Specialty (such as communications; coprocessors; encoders; motion)
  - d. Signal conditioning
- 10.2 Explain Sinking/Sourcing of I/O modules
- 10.3 Describe common connection diagrams used with PLCs
- 10.4 Define Scan time and Scan cycle
- 10.5 Compare memory size and mapping
- 10.6 Explain how data is input, output, filed and addressed
- 10.7 Describe the requirements for hardware and software interfacing including optical couplers
- 10.8 Compare CPU speed requirements
- 10.9 Calculate the power requirements for a PLC power supply
- 10.10 Identify the symbols for relays and other common ladder diagram devices and graphics
- 10.11 Write a short software program typical of a simple PLC application
- 10.12 Describe the operation of and application to automation of a production process for:
  - a. ladder logic instructions
  - b. time and counter instructions
  - c. discrete control functions
- 10.13 Explain how the following functions affect the process control cycle
  - a. loop
  - b. data comparison
  - c. branch
  - d. add
  - e. subtract
  - f. multiply
  - g. divide
- 10.14 Describe physical requirements or practices used in installation of:
  - a. panel layout
  - b. enclosure heating and cooling
  - c. NEMA enclosures
  - d. maintenance provisions
  - e. duct and cabling layout
  - f. DIN connector rack
  - g. circuit breaker panel
  - h. UPS uninterruptible power supplies
  - i. noise filtering
  - j. grounding
  - k. AC power circuit and surge protectors
- 10.15 Demonstrate visual inspection of an I/O circuit
- 10.16 Demonstrate continuity checks of cabling and components
- 10.17 Demonstrate operational test
- 10.18 Demonstrate emergency stop test-emergency disconnect test
- 10.19 Demonstrate safety control relay test
- 10.20 Demonstrate troubleshooting ability-locating hardware and software errors
- 10.21 Perform a program reload

## **11.0 Software**

- 11.1 Describe basic spread-sheet, word processor, graphics and network software programs, virus detectors and utilities programs
- 11.2 Demonstrate diagnostic programs for industrial electronics computerized systems

## **12.0 Safety**

- 12.1 Demonstrate the rules for handling static sensitive electronics components and products
- 12.2 List the concepts contained in the NEC, (National Electrical Code), which pertain to those areas of electronics work which technicians perform in industrial locations
- 12.3 Explain tagging of wiring or equipment which may be temporarily unsafe during servicing procedures
- 12.4 Explain ways electronics equipment may be hazardous even when turned off or disconnected
- 12.5 Understand the concept of ground faults and explain how building wiring can be checked to see if it is a possible shock hazard
- 12.6 Explain how and why isolation transformers are used when troubleshooting electronics products
- 12.7 Properly ground outdoor electronics equipment and show how to use ground blocks and rods
- 12.8 Explain rules for extinguishing an electrical or chemical fire
- 12.9 Explain the hazards technicians face who wear metal chains or other metal ornamentation
- 12.10 Explain procedures to use if a co-worker has suffered an electrical shock
- 12.11 Demonstrate the ability to administer simple First Aid
- 12.12 List ten examples of unsafe clothing when working around industrial materials
- 12.13 Explain why leaded solder is currently being replaced with other metal bonding alloys around the world

## **13.0 Satellite, Wireless and Data Communications**

- 13.1 Show an understanding of the basic concepts of the above three terms (satellite-wireless-data communications) as they may be used in industrial electronics applications
- 13.2 Explain the term BASEBAND relative to satellite communications
- 13.3 Be able to draw a block diagram of the interconnections between industrial satellite reception systems and industrial equipment
- 13.4 Outline basic and OSHA safety rules for workers who install roof, tower or other electronics equipment

## **14.0 Cabling**

- 14.1 Explain wavelength and its relation to frequency
- 14.2 Define impedance as it relates to RG 6, 59 and 58 coaxial cables
- 14.3 Describe fiber optics communications and telephone line principles
- 14.4 Describe long-run cable-loss characteristics and calculate the probable losses at various frequencies and various lengths of cable
- 14.5 Properly prepare coax and telephone cable ends, crimping fittings and testing for defects

## **15.0 Troubleshooting**

- 15.1 Prove proficiency in using common test equipment, including RF, volt, ohm and current meters - oscilloscopes - signal generators - power supplies - frequency meters - pulsers - logic probes - decade resistance boxes - meggers - dummy loads - cable checkers and capacitance meters.
- 15.2 Demonstrate ability to use software troubleshooting programs
- 15.3 Describe non-destructive testing procedures
- 15.4 Demonstrate component and subassembly substitution procedures
- 15.5 Prepare proper service records for equipment and for accounting purposes
- 15.6 Demonstrate ability to use parts and literature procurement procedures
- 15.7 Locate all schematic components, connections and test points
- 15.8 Locate PC board circuit problems such as - bad feed-through rivets, solder joints, open traces and open and/or shorted cables
- 15.9 List safety considerations for a service shop for both humans and equipment
- 15.10 List procedures for handling kinescopes and high voltage components

## 16.0 Motors

- 16.1 Explain the concepts of magnetism
- 16.2 Define ampere, coulomb, ferromagnetic material, permanent magnet, electromagnet, lines of force, Hall effect, hysteresis, magnetic saturation, gauss, eddy current and horsepower
- 16.3 Explain the purpose of laminating armatures
- 16.4 Explain the differences between a motor and a generator
- 16.5 Explain the use for a commutator
- 16.6 Describe how motor/generator brushes work
- 16.7 Discuss the differences between AC and DC motors
- 16.8 Explain the difference between series and shunt motors
- 16.9 Describe methods of speed control for AC and DC motors
- 16.10 Draw a diagram of a combination motor
- 16.11 Describe the differences between single-phase, split-phase and polyphase induction motors
- 16.12 Draw a circuit for a regulated speed control which incorporates feedback
- 16.13 Draw a circuit for a triac speed-control for universal motors
- 16.14 Describe the following motor control types and indicate possible uses: starting; stopping; reversal; positioning; torque and horsepower
- 16.15 Explain pulse-width motor control
- 16.16 Explain phase-locked-loop motor speed control
- 16.17 Describe dynamic braking for AC and DC motors
- 16.18 List ways in which optical electronics is used in motor controls

## 17.0 Workplace Practices

- 17.1 Explain the concepts contained in the CSS or Customer Service Specialist program
- 17.2 Demonstrate the ability to work cooperatively with fellow workers, including non-technical personnel
- 17.3 Explain common methods of defusing difficult customer problems
- 17.4 Demonstrate proper telephone techniques
- 17.5 Demonstrate excellent personal hygiene and appearance decisions
- 17.6 State examples of teamwork and list the benefits
- 17.7 Explain how emotions may cause lasting people problems with management, with co-workers and with those whom you may someday be supervising
- 17.8 List examples of improper service actions in the home or in an office situation
- 17.9 List examples of respect for your employer, for the company's products, facilities and assets, for fellow employees and for customers' feelings, possessions and families
- 17.10 Prepare work orders which other employees will be implementing

### End of Industrial Competencies Listings

#### **Find An ETA Test Site:**

<http://www.eta-i.org/testing.html>

#### **Suggested Study Materials:**

Check online for **NEETS** module content: <http://www.tpub.com/neets/index.htm>

**Modern Industrial Electronics,5E**; Maloney; ISBN 978-0130487414; Prentice-Hall, 2003

**Industrial Electronics: Applications for Programmable Controllers, Instrumentation and Process Control, and Electrical Machines and Motor Controls, 3E**; Kissell; ISBN 978-0130602411; Prentice Hall, 2002

**Industrial Control Electronics,3E**; Bartelt; ISBN 978-1401862923; Delmar Cengage, 2005

**Electronics Technology: Devices and Circuits**; Dugger, Gerrish; ISBN 978-0870060854; Goodheart-Willcox Co, 1994

**Basic Electricity and Electronics,2E**; U.S. Navy Press; ISBN 978-0486209739; Dover Pub., 1970

**Industrial Motor Control,6E**; Herman; ISBN 978-1435442399; Delmar Cengage, 2009

**Microprocessor and Microcontroller Fundamentals: The 8085 and 8051 Hardware and Software**; Kleitz; ISBN 978-0132628259; Prentice-Hall, 1997

**Industrial Electronics 4E**; Humphries, Sheets; ISBN 978-0827358256; Delmar Cengage 1993; Available through ETA-I at 800-288-3824 or [www.eta-i.org](http://www.eta-i.org)

**Industrial Electrical Troubleshooting**; Lundquist; ISBN 978-0766806030; Delmar Cengage 1999; Available through ETA-I at 800-288-3824 or [www.eta-i.org](http://www.eta-i.org)

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