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# **Examination Standard for Temperature Limit and Supervisory Switches**

**Class Number 3545**

**May 2021**

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# Foreword

This standard is intended to verify that the products and services described will meet stated conditions of performance, safety and quality useful to the ends of property conservation. The purpose of this standard is to present the criteria for examination of various types of products and services.

Examination in accordance with this standard shall demonstrate compliance and verify that quality control in manufacturing shall ensure a consistent and reliable product.

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# 1 INTRODUCTION

## 1.1 Purpose

- 1.1.1 This standard states testing and certification requirements for temperature limit and supervisory switches. These switches use inputs from thermocouples or resistance temperature devices (RTDs). They may be stand-alone devices or incorporated into a temperature controller.
- 1.1.2 Testing and certification criteria shall include, but are not limited to, performance requirements, marking requirements, examination of manufacturing facility(ies), audit of quality assurance procedures, and a surveillance program.

## 1.2 Scope

- 1.2.1 This standard sets performance requirements for temperature limit and supervisory switches used as safety devices in industrial heating control systems. They are intended to operate electrical switching devices in order to initiate a safety shutdown or initiate an alarm under abnormal conditions. Process temperature controllers and/or recorders can also be certified if they are provided with limit and/or supervisory functions.
- 1.2.2 The requirements of this standard shall be used to measure and describe the performance of thermal switches in response to exposure from heat, cold, abnormalities, etc., under controlled laboratory conditions. The results of these controlled exposures shall not be used to describe or appraise actual exposure conditions since such conditions vary widely. Dielectric strength and proper operation with variations in supply voltage are also assessed.

## 1.3 Basis for Requirements

- 1.3.1 The requirements of this standard are based on experience, research and testing, and/or the standards of other organizations. The advice of manufacturers, users, trade associations, jurisdictions and/or loss control specialists was also considered.
- 1.3.2 The requirements of this standard reflect tests and practices used to examine characteristics of thermal switches for the purpose of obtaining certification. Switches having characteristics not anticipated by this standard may be certified if performance equal, or superior, to that required by this standard is demonstrated.

## 1.4 Basis for Certification

Certification is based upon satisfactory evaluation of the product and the manufacturer in the following major areas:

- 1.4.1 Examination and tests on production samples shall be performed to evaluate
  - the suitability of the product
  - the performance of the product as specified by the manufacturer and required for certification; and as far as practical,
  - the durability and reliability of the product.
- 1.4.2 An examination of the manufacturing facilities and audit of quality control procedures is made to evaluate the manufacturer's ability to produce the product which is examined and tested, and the marking procedures used to identify the product. Subsequent surveillance may be required by the certification agency in accordance with the certification scheme to ensure ongoing compliance.

### 1.5 Basis for Continued Certification

The basis for continual certification may include, but is not limited to, the following based upon the certification scheme and requirements of the certification agency:

- production or availability of the product as currently certified;
- the continued use of acceptable quality assurance procedures;
- satisfactory field experience;
- compliance with the terms stipulated by the certification;
- satisfactory re-examination of production samples for continued conformity to requirements; and
- satisfactory surveillance audits conducted as part of the certification agency's product surveillance program.

### 1.6 Effective Date

The effective date of this certification standard mandates that all products tested for certification after the effective date shall satisfy the requirements of this standard.

The effective date of this Standard is eighteen (18) months after the publication date of the standard for compliance with all requirements

### 1.7 System of Units

Units of measurement used in this Standard are United States (U.S.) customary units. These are followed by their arithmetic equivalents in International System (SI) units, enclosed in parentheses. The first value stated shall be regarded as the requirement. The converted equivalent value may be approximate. Conversion of U.S. customary units is in accordance with ANSI/IEEE/ASTM SI 10

### 1.8 Normative References

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the cited edition applies.

ANSI/IEEE/ASTM SI 10, *American National Standard for Metric Practice*

### 1.9 Terms and Definitions

For purposes of this standard, the following terms apply:

*Controller* — The device that provides process temperature control by simple on-off or proportional, integral, and/or derivative (PID) functions.

*Downscale burnout* — Failure of the temperature input device, for a low limit switch, that results in a process shutdown; for a supervisory device, failure that results in an alarm and/or process shutdown.

*Limit* — The preset point beyond which the switching element will turn off and initiate process shutdown.

*Supervisory* — Used to describe a device with a switching element that turns “on” or “off” at preset limits and generates an alarm signal and/or initiates shutdown. May be used interchangeably with “limit” when a shutdown function is provided.

*Upscale burnout* — Failure of the temperature input device, for a high limit switch, that results in a process shutdown; for a supervisory device, failure that results in an alarm and/or process shutdown.

## 2 GENERAL INFORMATION

### 2.1 Product Information

Temperature Limit and Supervisory Switches can be entirely mechanical in construction, or can be entirely electronic or a combination of both. Other designs meeting the criteria of this standard may also be considered for certification.

### 2.2 Certification Application Requirements

The manufacturer shall provide the following preliminary information with any request for certification consideration:

- A complete list of all models, types, sizes, and options for the products or services being submitted for certification consideration;
- General assembly drawings, complete set of manufacturing drawings, materials list, anticipated marking format, piping and electrical schematics, nameplate format, brochures, sales literature, spec. sheets, installation, operation and maintenance procedures, and
- the number and location of manufacturing facilities.
- All documents shall identify the manufacturer's name, document number or other form of reference, title, date of last revision, and revision level. All documents shall be provided with English translation.

### 2.3 Requirements for Samples for Examination

2.3.1 Following authorization of a certification examination, the manufacturer shall submit samples for examination and testing based on the following:

- Sample requirements to be determined by the certification agency

2.3.2 Requirements for samples may vary depending on design features, results of prior or similar testing, and results of any foregoing tests.

2.3.3 The manufacturer shall submit samples representative of production. Any decision to use data generated using prototypes is at the discretion of the certification agency.

2.3.4 It is the manufacturer's responsibility to provide any necessary test fixtures, such as those which may be required to evaluate the switches.

### 3 GENERAL REQUIREMENTS

#### 3.1 Review of Documentation

- 3.1.1 During the initial investigation and prior to physical testing, the manufacturer's specifications and details shall be reviewed to assess the ease and practicality of installation and use. The certification examination results may further define the limits of the final certification.

#### 3.2 Physical or Structural Features

- 3.2.1 A temperature switch, controller, or recorder shall be available as a complete and identifiable assembly. It shall perform to the manufacturer's specifications in all respects.
- 3.2.2 Electrical components, operating members, and setting adjustments shall be suitably protected against any detrimental effects from normally expected atmospheric conditions.
- 3.2.3 The devices shall be capable of proper operation within an ambient temperature range of at least 40° to 130°F (4° to 55°C).
- 3.2.4 Limit switches with an adjustable setpoint shall be configured so that the possibility of casual adjustment is minimized. This may be accomplished by requiring the removal of a cover, the use of a tool, mounting inside a control panel, or a password for electronic devices.
- 3.2.5 Reset of a limit switch shall not be possible until the process temperature is below the limit setpoint and shall require a manual action.
- 3.2.6 Sensor failure shall result in process shutdown for a limit switch; an alarm or process shutdown for a supervisory switch. Upscale burnout is required for a high limit switch, downscale burnout for a low limit switch.

#### 3.3 Markings

- 3.3.1 Marking on the product or, if not possible due to size, on its packaging or label accompanying the product, shall include the following information:
- name and address of the manufacturer or marking traceable to the manufacturer;
  - date of manufacture or code traceable to date of manufacture or lot identification;
  - model number, size, rating, capacity, wiring information etc., as appropriate.

When hazard warnings are needed, the markings should be universally recognizable.

- 3.3.2 The model or type identification shall correspond with the manufacturer's catalog designation and shall uniquely identify the certification agency's mark of conformity.
- 3.3.3 The certification agency's mark of conformity shall be displayed visibly and permanently on the product and/or packaging as appropriate and in accordance with the requirements of the certification agency. The manufacturer shall exercise control of this mark as specified by the certification agency and the certification scheme.
- 3.3.4 All markings shall be legible and durable.

### 3.4 Manufacturer's Operation Instructions

The manufacturer shall

- prepare instructions for the installation, maintenance, and operation of the product;
- provide facilities for repair of the product and supply replacement parts, if applicable; and
- provide services to ensure proper installation, inspection, or maintenance for products of such nature that it would not be reasonable to expect the average user to be able to provide such installation, inspection, or maintenance.

### 3.5 Calibration

- 3.5.1 Each piece of equipment used to verify the test parameters shall be calibrated within an interval determined on the basis of stability, purpose, and usage. A copy of the calibration certificate for each piece of test equipment is required. The certificate shall indicate that the calibration was performed against working standards whose calibration is certified and traceable to an acceptable reference standard and certified by an ISO/IEC 17025 accredited calibration laboratory. The test equipment shall be clearly identified by label or sticker showing the last date of the calibration and the next due date. A copy of the service provider's accreditation certificate as an ISO/IEC 17025 accredited calibration laboratory should be available.
- 3.5.2 When the inspection equipment and/or environment is not suitable for labels or stickers, other methods such as etching of control numbers on the measuring device are allowed, provided documentation is maintained on the calibration status of thus equipment.

## 4 PERFORMANCE REQUIREMENTS

### 4.1 Operating Characteristics

- 4.1.1 Temperature switches shall operate in accordance with the manufacturer's specifications and certification requirements.
- 4.1.2 The switches shall be tested to verify that they operate as described by the manufacturer, that limit switches must be reset manually, that the process temperature must be within limits before reset can be accomplished, that an adjustable setpoint is adequately protected against casual adjustment, and that sensor failure results in an alarm or process shutdown.

### 4.2 Actuation Point Accuracy and Repeatability

- 4.2.1 Accuracy: The actuation point shall be within the manufacturer's specification for accuracy or within  $\pm 5$  percent of full scale value for adjustable types ( $\pm 5$  percent of set value for factory pre-set types), whichever is less.
  - Note:** The scale markings for some adjustable switches may only be approximate, serving only as a starting point for adjustment upon installation. Therefore, the accuracy requirement does not apply.
- 4.2.2 Repeatability: The actuation point shall repeat within the manufacturer's specification or within  $\pm 1$  percent of the set value, whichever is less.
- 4.2.3 Reset, automatic for supervisory or manual for limit devices, shall not occur until the input is above (low limit) or below (high limit) the actuation value.
- 4.2.4 An input signal shall be applied, slowly, until the switch actuates. The input shall be applied as an increasing signal for a high limit switch, decreasing signal for a low limit. This test shall be repeated for a minimum of five times. Adjustable types shall be tested, as a minimum, at 25, 50, and 75 percent of range.
- 4.2.5 Accuracy is the deviation from the set value expressed as a percent of full scale value.
- 4.2.6 Repeatability (non-repeatability) is the difference between the highest and the lowest input value needed to cause actuation, expressed as a percentage of the set value.
- 4.2.7 As part of this test, it shall be verified that reset does not occur until the input is inside the limit.

### 4.3 Ambient Temperature Effects

- 4.3.1 Switches must be capable of operating properly at ambient temperatures between 40° and 130°F (4° and 55°C). Actuation point shall not change more than  $\pm 1$  percent of full scale from that at room temperature. Repeatability shall be within the requirement stated in 4.2 above.
- 4.3.2 The sample(s) shall be conditioned at temperatures of 40° and 130°F (4° and 55°C), or at the manufacturer's specified limits, whichever are greater, for a minimum of 4 hours at each temperature. The sample shall operate properly at these temperatures and upon return to room temperature. Actuation characteristics shall be as noted in 4.3.1 above.

#### 4.4 Endurance

4.4.1 Limit switches shall be capable of withstanding 1000 operational cycles, at rated electrical load, without failure or significant deterioration in performance. Supervisory switches (alarm type) or on-off controls shall withstand 100,000 operations.

Exception: This requirement does not apply to devices that use solid state relays.

4.4.2 Temperature devices equipped with electro-mechanical relays shall be subjected to an electrical load, equal to maximum contact rating, for the duration of the endurance test noted above. There shall be no evidence of relay failure or contact fusion.

#### 4.5 Voltage Variation

4.5.1 The temperature devices shall operate properly over a range of 85 to 110 percent of rated input voltage.

4.5.2 Input voltage shall be varied from 85 to 110 percent of rated voltage. There shall be no change in operating characteristics or any significant change in setpoint.

#### 4.6 Dielectric Strength

4.6.1 Electrical components shall be capable of withstanding a dielectric strength test without arcing or break- down.

4.6.2 A test voltage of 1000 V ac, plus twice the rated operating voltage, shall be applied between power input terminals and circuit ground (or conductive housing if applicable) for a period of one minute. There shall be no evidence of arcing or breakdown.

Exceptions:

1. For operating voltages of 60 V or less, the test voltage shall be 500 V ac.
2. This test is not required if input power terminals are not accessible to an operator *and* the device housing is non-conductive.

## 5 OPERATIONS REQUIREMENTS

### 5.1 Demonstrated Quality Control Program

5.1.1 A quality assurance program is required to assure that subsequent temperature devices produced by the manufacturer shall present the same quality and reliability as the specific devices examined. Design quality, conformance to design, and performance are the areas of primary concern.

- Design quality is determined during the examination and tests, and may be documented in the certification report.
- Continued conformance to this Standard is verified by the certifier's surveillance program.
- Quality of performance is determined by field performance and by periodic re-examination and testing

5.1.2 The manufacturer shall demonstrate a quality assurance program which specifies controls for at least the following areas:

- existence of corporate quality assurance guidelines
- incoming quality assurance, including testing
- in-process quality assurance, including testing
- final inspection and tests
- equipment calibration
- drawing and change control
- packaging and shipping
- handling and disposition of non-conforming materials.

5.1.3 Documentation/Manual

There should be an authoritative collection of procedures/policies. It should provide an accurate description of the quality management system while serving as a permanent reference for implementation and maintenance of that system. The system should require that sufficient records are maintained to demonstrate achievement of the required quality and verify operation of the quality system.

5.1.4 Records

To assure adequate traceability of materials and products, the manufacturer shall maintain a record of all quality assurance tests performed and shall maintain this record for a minimum period of two years from the date of manufacture.

5.1.5 Drawing and Change Control

The manufacturer shall establish a system of product configuration control that shall allow no unauthorized changes to the product. Changes to critical documents, identified in the certification report, may be required to be reported to, and authorized by the certification agency prior to implementation for production.

Records of all revisions to all certified products shall be maintained.

## 5.2 Surveillance Audit

- 5.2.1 An audit of the manufacturing facility may be part of the certification agencies surveillance requirements to verify implementation of the quality assurance program. Its purpose is to determine that the manufacturer's equipment, procedures, and quality program are maintained to ensure a uniform product consistent with that which was tested and certified.
- 5.2.2 Certified products or services shall be produced or provided at, or provided from, location(s) disclosed as part of the certification examination. Manufacture of products bearing a certification mark is not permitted at any other location prior to disclosure to the certification agency.

## 5.3 Manufacturer's Responsibilities

- 5.3.1 The manufacturer shall notify the certification agency of changes in product construction, components, raw materials, physical characteristics, coatings, component formulation or quality assurance procedures prior to implementation.

# 6 BIBLIOGRAPHY

*ISO/IEC 17025 General Requirements for the Competence of Testing and Calibration Laboratories.*

*FM 3810 Electrical Equipment for Measurement, Control and Laboratory Use*