

## STANDARD INFORMATION

**Standard:** UL 347 / CSA C22.2 No. 253

**Standard ID:**

Medium-Voltage AC Contactors, Controllers, and Control Centers [UL 347:2020 Ed.7]

Medium-Voltage AC Contactors, Controllers, And Control Centers [CSA C22.2#253:2020 Ed.3]

**Previous Standard ID:**

Medium-Voltage AC Contactors, Controllers, and Control Centers [UL 347:2016 Ed.6]

Medium-Voltage AC Contactors, Controllers, And Control Centers [CSA C22.2#253:2016 Ed.2]

## EFFECTIVE DATE OF NEW/REVISED REQUIREMENTS

**Effective Date:** **July 24, 2023**

## IMPACT, OVERVIEW, AND ACTION REQUIRED

**Impact Statement:** Per our accreditation, Intertek is required to review reports against the standard revisions to confirm compliance. Once compliance is confirmed, the standard reference in the report is updated to show continued compliance to the technical requirements of the standard.

**Overview of Changes:**

- Revisions to Service Equipment requirements for US as a result of NEC updates
- Revisions to test procedures based upon rated frequencies
- Addition of requirements concerning isolation of fuses
- Addition of requirements concerning an unintentional ground in the remote control circuit causing the controller to energize the load
- Addition of requirements concerning the locations of cable and bus connections

Specific details of new/updated requirements are found in table below.

***Current Listings Not Active? – Please immediately identify any current Listing Reports or products that are no longer active and should be removed from our records. We will do this at no charge as long as Intertek is notified in writing prior to the review of your reports.***



## STANDARD INFORMATION

CLAUSE	VERDICT	COMMENT
		<i>Additions to existing requirements are <u>underlined</u> and deletions are shown <del>lined out</del> below.</i>
4	Info	<b><i>New section added;</i></b>
4.205		Rated maximum voltage ( $U_r$ )
		<b>Continuous duty (no bypass contactor)</b>
4.205.1		The controller shall be capable of operating at its maximum rated continuous current continuously, without exceeding the temperature limits specified in Clause 6.5.5.201.
		<b>Intermittent duty (with or without bypass contactor)</b>
4.205.2		The controller shall be capable of operating at its maximum rated continuous current for a duty as specified by the manufacturer and defined in a test sequence defined by the following parameters, without exceeding the temperature limits specified in Clause 6.5.5.201:  a) On time (in seconds or minutes). b) Off time (in seconds or minutes). c) Number of consecutive on/off operations. d) Rest time (in hours). e) Repeat step (a) through (d) for specified number of sequences.
5	Info	<b>Design and Construction</b>
5.14	Info	<b>Spacings</b>
		<b>General</b>
		The electrical through-air and over-surface spacings shall be not less than those indicated in Table 5.
5.14.201		The spacings indicated for control circuits in Table 5 are applicable between live parts of control circuit components and grounded metal and to live parts of other control circuit components.  The spacings in a component device (such as a snap-switch, lampholder, and the like) supplied as part of industrial control equipment, other than in motor circuits, shall not be less than the minimum spacings required for the component device or the spacings indicated in Table 5, whichever are smaller.



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		<p>The spacings at a field-wiring terminal shall be measured with wire of the appropriate size connected to the terminal as in actual service. The connected wire shall be the next larger size than would be required for the rating except that the required wire size shall be used if:</p> <ul style="list-style-type: none"><li>a) the terminal will not accept the larger size; or</li><li>b) the device is marked to restrict the use of oversized conductors.</li></ul> <p>The spacings at fuses and fuseholders, measured with the fuses in place, shall be based on the use of fuses having maximum standard dimensions and shall not be less than the spacings indicated in Table 5. Where the fuseholder construction permits a fuse to be partially inserted and remain in that position, spacings shall be measured with the fuse in the partially inserted position as well as in the fully inserted position.</p> <p><u>An uninsulated live part, including a terminal, shall be so secured to its supporting surface by a method other than friction between surfaces that it will be kept from turning or shifting in position if such motion might result in reduction of spacings to less than those required elsewhere in this standard. The security of a contact assembly shall provide for the continued alignment of contacts.</u></p> <p><u>A pressure terminal connector that is intended for field connection, and that is not capable of receiving a conductor larger than 3/0 AWG (85.0 mm<sup>2</sup>), need not be prevented from turning provided no spacings less than those required result when the connectors are turned 30 degrees toward each other, or toward other uninsulated parts of opposite polarity, or toward grounded metal parts.</u></p>
5.14.203	Info	<b>Considerations for circuits 1 500 V or less to ground</b> <i>New clause added;</i>
5.14.203.5		Spacing on printed wiring assemblies operating entirely at 1500 V or less to ground shall be in accordance with the spacing requirements as provided in Annex A, item 4.
5.202	Info	<b>Power circuit isolating means</b> <b>Isolation of fuses</b>
5.202.6		Controllers shall be arranged such that when the medium-voltage isolating means is open all medium-voltage fuses will be readily accessible, so that they may be replaced without a person being exposed to any live parts. The electrical arrangement of a single-throw switch shall be such that, when properly connected, fuse terminals will be de-energized when the switch contacts are open.



CLAUSE	VERDICT	COMMENT
		<b>Equipment protection</b>
		Medium-voltage Class E controllers shall be provided with the following protective features:
5.203		<p>a) Under-voltage protection or under-voltage release (two-wire control), except for latched contactors in special applications or solid state resistive load controllers.</p> <p>b) <u>Controllers shall be provided with overcurrent protection as follows:</u></p> <p>i) Motor controllers shall be provided with an overload current-sensing device in each phase. Overload current-sensing devices shall be arranged to open the contactor and may also energize a signal device. Motor controllers shall be provided with motor circuit overcurrent protection, ground fault protection, and motor running overload protection where required by Annex A, Item 1. Overload relays shall conform to the requirements of Annex A, Item 4.</p> <p>ii) <u>The fuses used in transformer and resistive load controllers shall be selected to provide branch circuit overcurrent protection and ground fault protection as required by Annex A, Item 1. Ground fault protection shall also be provided as required by Annex A, item 1.</u></p> <p>p) <u>If the wiring diagram of a controller indicates that one side of the control circuit is, or may be grounded, the control circuit shall be so arranged that an unintentional ground in the remote control device circuit will not cause the controller to energize the load.</u></p> <p>q) <u>All devices operating at 1500 V or less to ground shall be electrically isolated from devices operating at voltages above 1500 V through the use of isolation transformers, voltage dividers, or fiber optic signaling.</u></p>
5.205	Info	<b>Internal wiring</b>
5.205.4	Info	<b>Equipment above 7200 V</b>
5.205.4.2		The requirements of Clause 5.205.4.1 do not apply to printed circuit board assemblies, such as gate drive boards, which are located in the same high voltage compartment as the devices they control and are electrically connected to solid state switching devices operating at or near line potential. Such devices shall comply with 5.203(m).
6	Info	<b>Type Tests</b>
6.2	Info	<b>Dielectric tests</b>
6.2.201	Info	<b>Impulse withstand tests</b>
		<b>Impulse voltage withstand test sequence</b>
6.2.201.3		The test samples shall be subjected to the following sequence of tests. Control and auxiliary circuits shall be grounded in these tests, and the medium-voltage motor circuit fuses (in the case of Class E2 controllers) and control circuit fuses shall be in place.



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The test shall be conducted using at least one of the test voltage levels from Table 1 without any surge arresters connected. Additional tests may be performed with or without surge arresters. Dry-type core and coil assemblies, such as reduced-voltage-starting reactors, autotransformers, CPTs, and voltage transformers, may also be disconnected at the transformer terminals for this test. Cable and bus connections to the transformer shall be in locations representative of when connected to the transformer but may be insulated from the terminals.

If a higher impulse level is desired, based on the inclusion of surge arresters, the clamping voltage of the arresters shall be below the impulse levels verified by the initial impulse test. Testing shall demonstrate that no disruptive discharges will occur within the controller at the higher impulse level.

6.5	Info	<b>Temperature-rise tests</b>
6.5.3	Info	<b>Measurement of the temperature and the temperature rise</b>

**Test conditions**

To determine whether industrial control equipment complies with the temperature test requirements, the device shall be operated under normal conditions and shall carry its rated current until temperatures are constant. An overload relay shall not trip during the test. A source of supply of any convenient voltage may be used for temperature tests on parts other than coils.

6.5.3.205

A temperature rise shall be considered to be constant when three successive readings, taken at equal intervals of approximately 10% of the previously elapsed duration of the test (but not less than 10 min intervals), are constant within 1°C.

Tests shall be conducted at a frequency not less than the highest rated frequency. Tests conducted at a higher frequency shall be considered representative of lower frequency ratings for convection cooled equipment. Force cooled equipment shall be considered based upon any change in cooling air volume.

6.5.5	Info	<b>Temperature-rise test of the auxiliary and control equipment</b>
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**Temperature rise (during starting) of motor starting autotransformers and Reactors**

6.5.5.104

The current to the connected load shall be the tap ratio multiplied by six times the rated current of the controller. In the case of an autotransformer or reactor with several sets of taps, the test shall be made with the taps giving the highest power loss in the transformer or reactor. If the transformer or reactor is designed with constant current density, the losses shall be assumed to be equal. In order to facilitate this test, the tests may be run at reduced voltage with a star-connected impedance used in place of a motor.



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		The peak temperature rise shall not exceed the rated temperature rise of the device insulation class by more than 15°C. The temperature shall be measured by thermocouples, suitably insulated, and buried into the windings. <u>The temperature shall be monitored throughout the test and until the winding temperatures are shown to be decreasing after the final test cycle.</u>
6.6	Info	<b>Short-time, momentary, and peak withstand current bus tests</b>
6.6.2	Info	<b>Short-time current withstand and momentary current withstand test</b>
		<b>General</b>
		For short-time withstand tests, the short-circuit current shall be the rated short-time withstand current specified in Clause 4.5. The test duration shall be as specified in Clause 4.7. Random closing is acceptable for this test.
6.6.2.1		<u>Testing at 60 Hz shall be considered to be representative of 50 Hz ratings, provided that the duration of the short circuit is at least as long as it would be for 50 Hz. 50 Hz tests shall be considered to be representative of 60 Hz ratings, provided that the peak current is as indicated for 60 Hz.</u>
		For momentary withstand current tests, test duration and test current shall meet the requirements of Clause 4.6.2 and Table 8.
6.103	Info	<b>Overload test</b>
		<b>Test circuit</b>
		The test shall be performed at the rated maximum voltage and a lagging power factor not greater than 35% except for solid state resistive load controllers in which case the test may be conducted at any power factor, up to and including 1.0. The open-circuit voltage of the supply circuit shall be not less than 100% of the rated maximum voltage of the controller.
6.103.203		The closed-circuit voltage is not specified, but the power-frequency recovery voltage shall be not less than the rated supply voltage of the controller when measured in accordance with Annex A, Item 14. Circuit characteristics shall be determined using either laboratory-type meters or oscillographic means. When oscillographic means are employed, the method described in Annex A, Item 15, shall be used for determining power factor, or a method proven to yield equivalent results.
		<u>Tests shall be conducted at a frequency not less than the highest rated frequency. Tests conducted at a higher frequency shall be considered representative of lower frequency ratings.</u>



CLAUSE	VERDICT	COMMENT
		<p><b><i>New clause added;</i></b></p> <p><b>Overload test procedure – solid state resistive load controllers</b></p> <p>6.103.207 The controller shall make and break 1.5 times rated continuous current for 50 operations. The rate of operation shall be one operation per minute. These operations may be conducted in groups of 5 with 15 min maximum OFF time between groups. During each operation, the ON time shall be not less than four electrical cycles before contact parting commences as determined by oscillographic or equivalent measurements. When combined with the make and break test, see Clause 6.102.201.3.</p>
6.104	Info	<p><b>Fault interruption test</b></p> <p><b>General</b></p> <p>Interrupting tests are intended to prove the fault interrupting performance of a given controller design and are not to be considered production tests. Test samples shall be substantially the same as the commercial form, including all normally provided bus.</p> <p>6.104.201 Tests made to verify the fault interrupting rating of a Class E controller shall be made at line-to-line voltages equal to the rated maximum voltage (<math>U_r</math>) of the controller (see Clause 4.1), with a prospective current (symmetrical) at the line terminals of the controller at least equal to the interrupting rating of the controller.</p> <p>This current value is based on the average symmetrical current in the three phases (i.e. omitting any dc component). Each test circuit shall be capable of producing in one of the three phases a total rms current, including the dc component, not less than that shown in Table 8.</p> <p><u>Tests shall be conducted at a frequency not less than the highest rated frequency. Tests conducted at a higher frequency shall be considered representative of lower frequency ratings.</u></p> <p>The tests shall be made in accordance with Clauses 6.104.202 to 6.104.205. The controller shall meet the performance requirements of Clause 6.104.206.</p>
6.104.205	Info	<p><b>Fault interruption test cycle</b></p> <p><b><i>New section added;</i></b></p> <p><b>For solid state resistive load controllers</b></p> <p>6.104.205.3 Test circuit 2 (see Figure 2) shall be used. All current sensitivity and time delays shall be set at maximum for this test sequence.</p> <p>See standard for details.</p>



CLAUSE	VERDICT	COMMENT
6.201	Info	<b>Switching capacity test – isolating means</b>  A controller employing an isolating means other than a full-load interrupting switch complying with Annex A, Item 20, used to interrupt only the magnetizing current of CPTs and voltage transformers, shall be subjected to 25 close-open operations of the isolating means with the transformers unloaded.  6.201.1  An isolating means other than a full-load interrupting switch complying with Annex A, Item 20, that is not interlocked to prevent opening when the CPT and voltage transformers are providing secondary power shall be subjected to 25 close-open operations of the isolating means with the transformers operating at full load.  <u>This test shall be conducted at each rated frequency.</u>
6.202	Info	<b>Short-time capability</b>  <b>Electromagnetic controllers</b>  A controller shall carry a current of 15 times rated continuous current for 1 s and 6 times rated continuous current for 30 s. Upon completion of the short-time capability test, the controller shall comply with the requirements of the temperature test given in Clause 6.5 and the power-frequency voltage withstand test given in Clause 6.2.202. Between the short-time capability test and the temperature rise test, there shall be no repair or replacement of parts on the device, and the device shall not be operated except as necessary for the removal of shunts or replacement of dummy fuses with line fuses. A contactor or disconnecting means may be tested separately.  For Class E2 controllers, the overload current elements and the power circuit fuses shall be shunted during these tests.  6.202.1  In conducting this test, any convenient test voltage may be used, providing it can be demonstrated that the required current was caused to flow through all poles simultaneously for the required time. The contacts shall be held in the closed position, prior to the initiation of current flow and during current flow, by energizing the operating coil at its rated voltage.  <u>Tests shall be conducted at a frequency not less than the highest rated frequency. Tests conducted at a higher frequency shall be considered representative of lower frequency ratings.</u>  The sequence in which the tests at 15 and 6 times rated continuous current are conducted is not specified, and the sample may be cooled to ambient temperature between tests. The sample shall be connected in the same manner as required for the temperature test.





CLAUSE	VERDICT	COMMENT
6.202.2	Info	<p><b>Solid state controllers</b></p> <p><i>New clause added;</i></p> <p><b>Solid state resistive load controllers</b></p> <p>All portions of the controller shall be tested in accordance with Clause 6.202.1 and the following:</p> <p>The solid state switching elements of the controller shall be tested as follows:</p> <p>a) Any user adjustable current limit settings shall be at maximum. If there are no user adjustable settings, tests shall be conducted at the maximum factory setting.</p> <p>b) If the controller has a ramp function, the controller shall be started and allowed to ramp up to the fully on condition. A load of 15 times rated continuous current shall then be applied to the controller via a suitable switching means. The load shall remain applied for 1 second, unless the controller takes some action to prevent conducting 15 times rated continuous current (such as a trip, bypass, or an action that limits the current). If the controller takes such an action, the circuit shall be continuously applied until ultimate results are obtained.</p> <p>c) If the controller has a ramp function, the test described in (b) shall be repeated, except the controller shall be started and ramped into the load of 15 times rated continuous current.</p> <p>d) For controllers without a ramp function, the controller shall be caused to operate with a load of 15 times rated continuous current. The load shall remain applied for 1 second, unless the controller takes some action to prevent conducting 15 times rated continuous current (such as a trip, bypass, or an action that limits the current). If the controller takes such an action, the circuit shall be continuously applied until ultimate results are obtained.</p>
6.202.2.2		
		<p><i>New section added;</i></p> <p><b>Operation tests for all solid state controllers</b></p> <p>During each of the operation tests specified in Clauses 6.208.2 through 6.208.5, the equipment shall be mounted as described in the manufacturer's installation instructions. The equipment shall be connected and operated as described in the Temperature Test, Clause 6.5 with the test conducted at rated voltage.</p> <p>See standard for details.</p>
6.208		