

AGASTAT E7000 Series, Nuclear Qualified Time Delay Relays



Seismic and Radiation Tested

In order to satisfy the growing need for electrical control components suitable for class 1E service in nuclear power generating stations, AGASTAT timing relays have been tested for three applications. These E7000 Series electropneumatic devices have demonstrated compliance with the requirements of IEEE Standards 323-1974 (Standard for

Qualifying Class 1E Equipment for Nuclear Power Generating Stations) and IEEE Standard 344-1975 (Seismic Qualifications for Nuclear Power Generating Stations). Testing was also referenced to ANSI/IEEE C37.98 (formerly IEEE Standard 501-1978, Standard for Seismic Testing of Relays).

The present E7000 Series design has evolved over 40 years of continual field use in a wider range of industrial applications. On-Delay, Off-Delay and Four-Pole versions are available for use with a choice of 23 coil voltages, as well as time delay adjustment to as long as 60 minutes.

Test Procedure

Test Procedure

AGASTAT timing relay Models E7012, E7022, E7014 and E7024 were tested in accordance with the requirements of IEEE STD. 323-1974 (Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations), IEEE STD. 344-1975 (Seismic Qualification for Nuclear Power Generating Stations) and referenced to ANSI/IEEE C37.98 (formerly IEEE Standard 501-1978, Standard for Seismic Testing of Relays). The relays were tested according to parameters which in practice, should encompass the majority of applications. Documented data applies to timing relays which were mounted on rigid test fixtures. The following descriptions of the tests performed are presented in their actual sequence.

Baseline Performance

In addition to aging tests, a series of baseline tests were conducted before, and immediately after each aging sequence:

- Pull-in Voltage
- Drop-out Voltage
- Dielectric Strength at 1650V 60Hz
- Insulation Resistance

- Operate Time (milliseconds)
- Recycle Time (milliseconds)
- Time Delay (seconds)
- Repeatability (percent)
- Contact Bounce (milliseconds at 28VDC, 1 amp)
- Contact Resistance (milliohms at 28VDC, 1 amp)

Data was measured and recorded and used for comparison throughout the qualification test program in order to detect any degradation of performance.

Radiation Aging

Relays were subjected to a radiation dosage of 2.0×10^5 Rads, which is considered to exceed adverse plant operating requirements for such areas as auxiliary and control buildings.

Cycling with Load Aging

The radiated units were then subjected to 27,500 operations at accelerated rate, with one set of contacts loaded to 120VAC, 60Hz at 10 amps; or 125VDC at 1 amp, and the number of mechanical operations exceeding those experienced in actual service.

Temperature Aging

This test subjected the relays to a temperature of 100°C for 42 days, with performance measured before and after thermal stress.

Seismic Aging

Sufficient interactions were performed at levels less than the fragility levels of the devices in order to satisfy the seismic aging requirements of IEEE STD 323-1974 and IEEE STD 344-1975.

Seismic Qualification

Artificially aged relays were subjected to simulated seismic vibration, which verified the ability of the individual device to perform its required function before, during and/or following design basis earthquakes. Relays were tested in the non-operating, operating and transitional modes.

Hostile Environment

Since the timing relays are intended for use in auxiliary and control buildings, and not in the reactor containment areas, a hostile environment test was performed in place of the Loss of Coolant Accident (LOCA) test. Relays were subjected to combination extreme temperature/humidity plus under/over voltage testing to prove their ability to function under adverse conditions even after having undergone all the previous aging simulation and seismic testing. The devices were operated at minimum and maximum voltage extremes: 85 and 120 percent of rated voltage for AC units, and 80 and 120 percent of rated voltage for DC units, with temperatures ranging from 40°F to 172°F at 95 percent relative humidity.

The SRS shape (at 5 percent damping), is defined by four points:

- point A = 1.0 Hz and an acceleration equal to 25 percent of the Zero Period Acceleration
- point D = 4.0 Hz and 250 percent of the ZPA
- point E = 16.0 Hz and 250 percent of the ZPA
- point G = 33.0 Hz and a level equal to the ZPA

SPECIMEN 1 & 3 (E7012 SERIES)

RELAY STATE: TRANSITIONAL MODE (TD X 2)

AXIS (H + V):

TEST RUN NO. 41, 45, 60, 63

COMPOSITE OF FB/V-, SS/V-, SS/V+, FB/V+ X .707

DUE TO 45° INCLINATION OF TEST MACHINE.

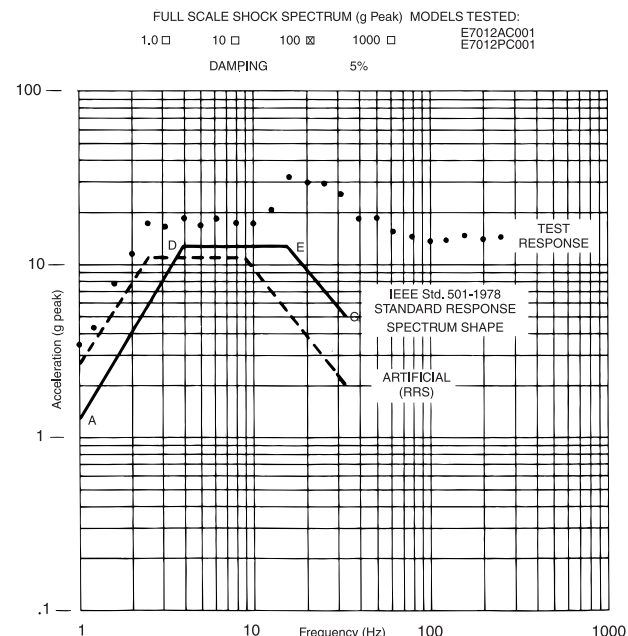


Figure 1. Response Spectrum, Transitional Mode

AGASTAT E7000 Series, Nuclear Qualified Time Delay Relays (Continued)



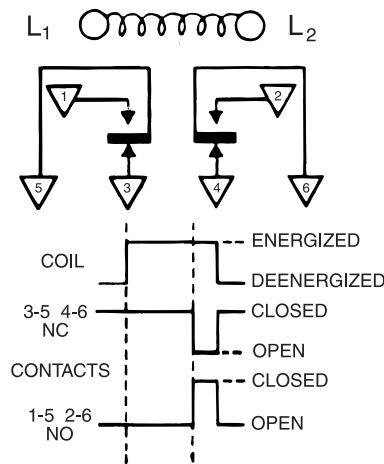
Operation

Two basic operating types are available: **On-delay** models provide a delay period on energization, at the end of which the switch transfers the load from one set of contacts to another. Deenergizing the unit during the delay period immediately recycles the unit, readying it for another full delay period on reenergization.

In **off-delay** models the switch transfers the load immediately upon energization, and the delay period does not begin until the unit is deenergized. At the end of the delay period the switch returns to its original position. Reenergizing the unit during the delay period immediately resets the timing, readying it for another full delay period on deenergization. No power is required during the timing period.

On-Delay Models, E7012

(Delay on pick-up)

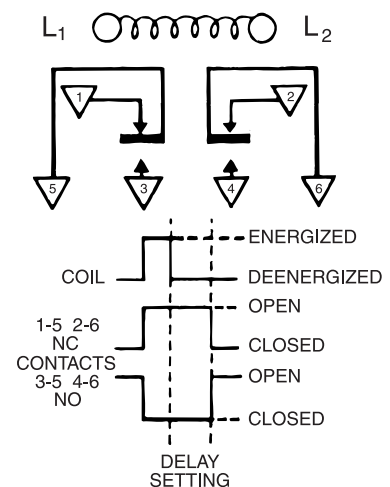


Applying for at least 50 msec voltage to the coil (L1-L2) starts a time delay lasting for the preset time. During this period the normally closed contacts (3-5 and 4-6) remain closed. At the end of the delay period the normally closed contacts break and the normally open contacts (1-5 and 2-6) make. The contacts remain in this transferred position until the coil is deenergized, at which time the switch instantaneously returns to its original position.

Deenergizing the coil, either during or after the delay period, will recycle the unit within .050 second. It will then provide a full delay period upon reenergization, regardless of how often the coil voltage is interrupted before the unit has been permitted to "time-out" to its full delay setting.

Off-Delay Models, E7022

(Delay on drop-out)



Applying voltage to the coil (for at least .050 second) will instantaneously transfer the switch, breaking the normally closed contacts (1-5 and 2-6), and making the normally open contacts (3-5 and 4-6). Contacts remain in this transferred position as long as the coil is energized. The time delay begins immediately upon deenergization. At the end of the delay period the switch returns to its normal position.

Reenergizing the coil during the delay period will immediately return the timing mechanism to a point where it will provide a full delay period upon subsequent deenergization. The switch remains in the transferred position.

Four Pole Models, E7014, E7024

With the addition of an extra switch block at the bottom of the basic units, this version of the E7000 Series offers four pole switch capacity with simultaneous timing or two-step timing. The two-step operation is achieved by factory adjustment to your specifications.

AGASTAT E7000 Series, Nuclear Qualified Time Delay Relays (Continued)



Time Delay Information

All units are furnished with dials in linear increments covering the range selected. (See "Catalog Number Code"). In addition, ranges B through K provide non-linear adjustment from .2 second to the beginning of the linear zone.

Repeat Accuracy

Repeat accuracy at any fixed temperature is defined as:

*The repeat accuracy deviation (A_R) of a time-delay relay is a measure of the maximum deviation in the time-delay that will be experienced in successive operations at any particular time setting of the relay and for any particular operating voltage or current.

Repeat accuracy is obtained from the following formula:

$$A_R = \pm 100 \frac{(T_1 - T_2)}{(T_1 + T_2)}$$

Where —

T_1 = Maximum time delay.

T_2 = Minimum time delay.

*NEMA part ICS 2-218.02

Repeat accuracy at any fixed temperature is $\pm 10\%$ of setting.

The first time delay afforded by units with H (3 to 30 minutes) and I (6 to 60 minutes) time ranges may be up to 15% longer than subsequent delays, due to coil temperature rise.

Dial position error is not included in the repeat accuracy specification above.

Delay Setting

Dial graduations are provided to minimize the time required to set the unit to a specific delay. Rotate the dial clockwise to increase the delay; counter-clockwise to decrease it.

The following procedure is recommended if the unit must be set to a very precise delay value:

1. Set dial to desired time delay. (On letter-graduated units, this requires an approximation of a percentage value between the arrowhead "▼" on the dial, which provides minimum time, and the letter "E," which provides maximum time.)
2. Record as many time delays as required to establish a stable average.
3. If the recorded average delay is shorter than the desired time, turn dial slightly clockwise; if it is longer, turn dial counter-clockwise.
4. Repeat step 2 after each adjustment, until required delay is recorded.

Because of the variety of environments in which time delay relays are applied, we recommend a re-check of the time delay after approximately three hours of operation. If any change from the initial time setting is apparent, the relay should be reset to the desired delay. The time delay accuracy should then be monitored on a monthly basis for several months, and if no substantial change in time delay has taken place, the frequency of checking may be reduced. It is recommended that this procedure be incorporated in the Operating Instructions for your equipment.

Contact Ratings — Nuclear

Resistive at 125 VDC 1.0 Amp
Resistive at 120 VAC 60 Hz. . . 10.0 Amp

Contact Ratings — Non-Nuclear

Contact Capacity in Amps
(Resistive Loads)

Contact Voltage	Min. 100,000 Operations
30VDC	15.0
110VDC	1.0
120V 60Hz	20.0
240V 60 Hz	20.0
480V 60 Hz	12.0

Four pole models add approximately 1-1/4" to the maximum height of the basic model, approximately 1/8" to the depth. They are designed for vertical operation only.

Timing Adjustment

The AGASTAT E7000 Series is the first electropneumatic timer to offer the ease of adjustment and resetting of a graduated dial head. Discrete ranges covering a total span from .1 second to 60 minutes are available. (See table on page 12-20.) Each has its own graduated, clearly identified dial. Timing is set by simply turning the dial to the desired time value. In the zone of approximately 25° separating the high and low ends of timing ranges A, D, E, and K, instantaneous operation (no time delay) will occur. All other ranges produce an infinite time delay when the dial is set in this zone.

AGASTAT E7000 Series, Nuclear Qualified Time Delay Relays (Continued)



Environmental Characteristics (Qualified Life) Parameter

Temperature —
 Minimum — 40°F
 Normal — 70°F - 104°F
 Maximum — 156°F

Humidity (R.H. %) —
 Minimum — 10%
 Normal — 40-60%
 Maximum — 95%

Pressure — Atmospheric

Radiation (rads) —
 2.0 X 10⁵ Gamma max.

Operating Conditions (Normal Environment)

Coil Operating Voltage, Nominal (Rated) —
 Pull-in (% of rated value) —
 80% min. with DC; 85% min. with AC coils
 Drop-out (% of rated value) —
 10% approx. with DC coils;
 50% approx. with AC coils
 Power (Watts at rated value) —
 8 approx. with DC or AC coils

Relay Operate Time —
 Model E7012 — N/A
 Model E7022 — 50 ms. max. with DC or AC coils

Relay Release (Recycle) Time —
 Model E7012 — 50 ms max. with DC or AC coils
 Model E7022 — N/A

Contact Ratings, Continuous —
 (Resistive at 125 Vdc) —
 1.0 amp with DC or AC coils
 (Resistive at 120 Vac, 60 Hz) —
 10.0 amp with DC or AC coils

Insulation Resistance (In megohms at 500 Vdc) —
 500 min. with DC or AC coils

Dielectric (Vrms, 60 Hz) —
 Between Terminals and Ground —
 1,500 with DC or AC coils
 Between Non-connected Terminals — 1,000 with DC or AC coils

Repeat Accuracy — ±10% with DC or AC coils

Operating Conditions (Abnormal Environment)

Adverse Operating Specifications	Normal	DBE "A"	DBE "B"	DBE "C"	DBE "D"
Temperature (°F)	70-104	40	120	145	156
Humidity (R.H. %)	40-60	10-95	10-95	10-95	10-95
Coil Operating Voltage * (% of Rated)					
Model E7012 (AC)	85-110	85-110	85-110	85-110	85-110
(DC)	80-110	80-110	80-110	90-110	90-110
Model E7022 (AC)	85-110	85-110	85-110	85-110	85-110
(DC)	80-110	80-110	80-110	80-110	80-110

*All coils may be operated on intermittent duty cycles at voltages 10% above listed maximums (Intermittent Duty = Maximum 50% duty cycle and 30 minutes "ON" time.)

REPLACEMENT SCHEDULE

The qualified life of this unit is 25,000 operations or 10 years from the date of manufacture, whichever occurs first.

Contact ratings as listed under the UL Component Recognition Program for 100,000 operations (Per pole) —

10 Amps, resistive, 240 VAC;
 1/4 horsepower, 120 VAC/240 VAC;
 15 Amps, 30 VDC;
 5 Amps, General Purpose, 600 VAC

Coil Data —

All units draw approximately 8 watts power at rated voltage.
 The operating voltage range for AC relays is 85 to 110 percent of nominal rated value.
 AC units drop-out at approximately 50% of rated voltage.
 The operating range of DC relays is 80 to 110 percent of nominal rated value.
 DC units drop-out at approximately 10% of rated voltage.
 All units may be operated on intermittent duty cycles (50% on/off, maximum 30 minutes on) at voltages 10% above the listed maximums.

Approximate Weight —

Model E7012 and E7022 with AC Coils — 2.13 lbs.
 Model E7012 and E7022 with DC Coils — 2.25 lbs.
 Model E7014 and E7024 with AC Coils — 2.43 lbs.
 Model E7014 and E7024 with DC Coils — 2.57 lbs.
 (Weight may vary slightly with particular coil voltage.)

Terminals —

Standard screw terminals (#8 – 32 truss head screws supplied) are located on the front of the unit, with permanent schematic markings. Barrier isolation is designed to accommodate spade or ring-tongue terminals with spacing to meet industrial control specifications.

Note: TE Connectivity Corporation cannot recommend the use of its products in the containment areas of Nuclear Power Generating Stations.

The date of manufacture can be found in the first four (4) digits of the serial number on the nameplate:

First two digits indicate XX XX the year
 Second two digits indicate the week.

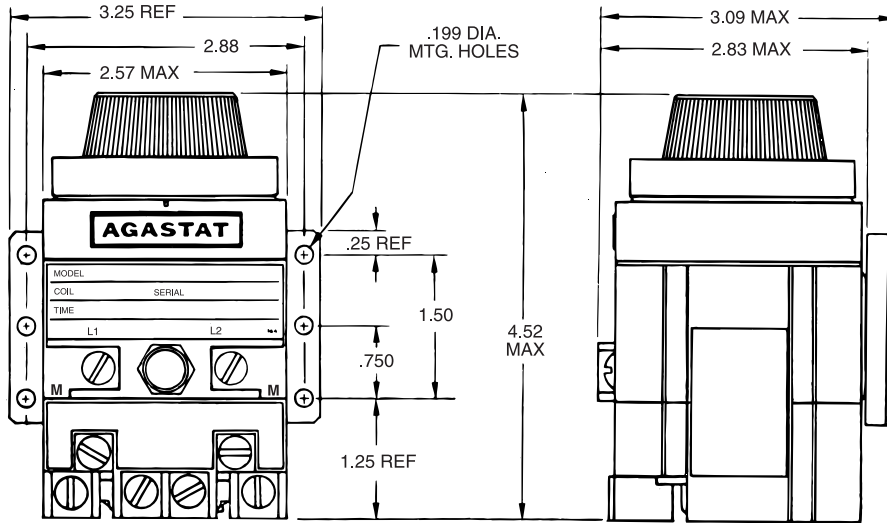
Example: Date code 8014: 80 indicates 1980; 14 indicates the week of April 2 through 8.

MODEL	E7012PC003
COIL	125VDC Serial 8014 -
TIME	1.5 TO 15 SEC.
	L1 L2

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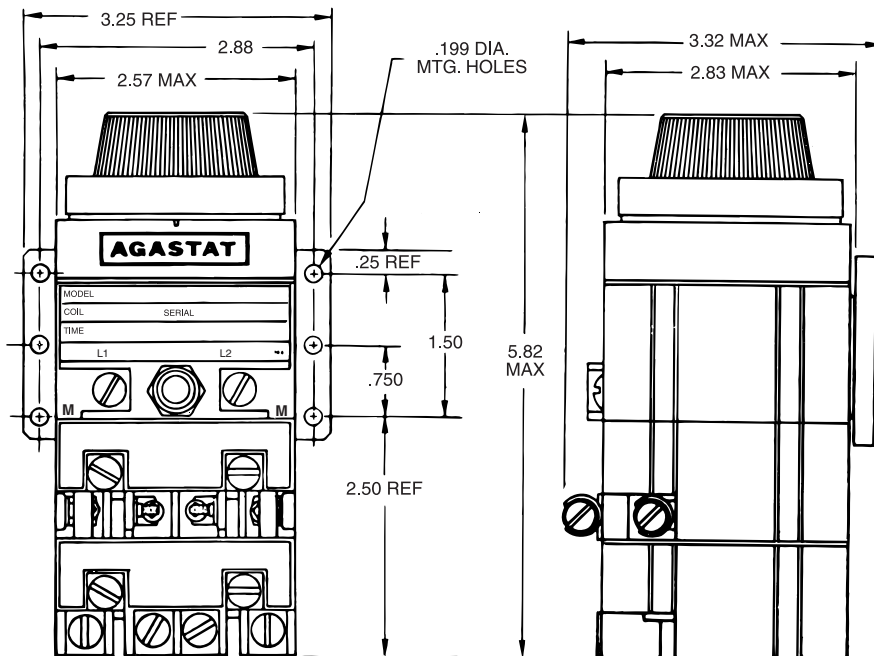
Dimensions and Mounting

MODEL E7012, E7022



QUALIFICATION TESTED FOR VERTICAL OPERATION ONLY

MODEL E7014, E7024



QUALIFICATION TESTED FOR VERTICAL OPERATION ONLY

Mounting Instructions

The E7000 Series relay must be mounted in the vertical position. All performance specifications of these units are valid only when they are mounted in this manner.

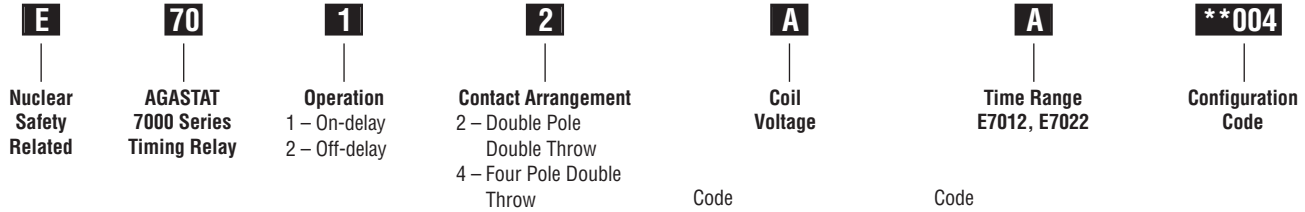
A bracket for mounting the device and the screws and lockwashers required to attach it to the relay are supplied with each unit. Four #8-32 tapped holes

are provided in the rear of the device for attaching the mounting bracket, or for mounting the relay directly to a panel, from the rear.

AGASTAT E7000 Series, Nuclear Qualified Time Delay Relays (Continued)

Ordering Information

Catalog Number Code



	Code		Code
AC	A	120V 60 Hz	A .1 to 1 sec.
		110V 50 Hz	B .5 to 5 sec.
	B	240V 60Hz	C 1.5 to 15 sec.
		220V 50Hz	D 5 to 50 sec.
	C	480V 60Hz	E 20 to 200 sec.
	D	550V 60Hz	F 1 to 10 min.
	E	24V 60Hz	H 3 to 30 min.
	F	127V 50Hz	I 6 to 60 min.
	G	240V 50Hz	K 1 to 300 sec.
	H	12V 60Hz	
	I	6V 60Hz	
DC	J	208V 60Hz	*E7014
			A .2 to 2 sec.
	M	28 VDC	B .7 to 7 sec.
	N	48 VDC	C 2 to 20 sec.
	O	24 VDC	D 10 to 100 sec.
	P	125 VDC	E 30 to 300 sec.
	Q	12 VDC	F 1.5 to 15 min.
	R	60 VDC	H 3 to 30 min.
	S	250 VDC	E7024
	T	550 VDC	A .1 to 1 sec.
	U	16 VDC	B .5 to 5 sec.
V	32 VDC	C 1.5 to 15 sec.	
W	96 VDC	D 5 to 50 sec.	
Y	6 VDC	E 20 to 200 sec.	
Z	220 VDC	F 1 to 10 min.	
		H 3 to 30 min.	
		I 6 to 60 min.	
		K 1 to 300 sec.	

* Model E7014 is available with letter-graduated dials only. The upper end of the time ranges in these models may be twice the values shown.

**** Configuration Code**

The Configuration Code is a suffix to the Model Number which provides a means of identification. When a significant product change is introduced, the Configuration code and specification sheets will be revised. (001, 002, 003, 004, etc.).

Relay Classifications Control Code Summary

Configuration Control

Product	Code – 001	Code – 002	Code – 003	Code – 004
E7000	Contains all materials present in original qualification testing.	Sept. 1981 — Elastomer gasket material change to improve thermal aging properties. Material changed for Buna-N or Neoprene to Neoprene only.	March 1989 — Paint change to timing head portion of relay. New paint: Sherwin-Williams E61YC37 primer and PPG W48392 silver polyester top coat.	Dec. 1991 — Paint change to timing head portion of relay. New paint: Prime coatings No. 28032 Enamel. No primer is used with this finish.

Configuration Code: The Configuration code is a suffix to the Model Number which provides a means of identification. When a significant product change is introduced, the Configuration code and specification sheets will be revised. (001, 002, 003, 004, etc.)

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