Cutler-Hammer

CEP7 Solid-State Overload Relay for Motor Control Centers and Enclosed Control (Generation II)

Technical Data TD04303003E

Effective April 2007
Supersedes TD04303003E
pages 1 – 8, dated
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Contents

Product Description

The CEP7 Solid-State Overload Relay is now available in the Cutler-Hammer® Enclosed Control and Motor Control Center, as well as an open component for stand-alone overload relay applications and field wired to a contactor. The CEP7 Solid-State Overload provides enhanced protection and adjustment ranges as compared to fixed heater bimetal overload relays.

Solid-state overload relays are available through 1000 amperes with available selection for Class 10, 15, 20 and 30 with Manual/Automatic Reset. Key features of the Cutler-Hammer CEP7 Solid-State Overload Relays include:

- Self-powered — same wiring as standard bimetallic overload.
- Adjustment range of 5:1.
- Phase-loss protection.
- Low heat dissipation (1/40th of standard overload).
- +/- 1% repeat accuracy.

Specifications

General Data for Sizes 1 – 7

Standards

- UL® 508, CSA® C22.2 No. 14, NEMA® (CD2-1993 Part 4), EN 60947-4-1, EN 60947-5-1.

Approvals

- UL, CSA and Atex (pending).

Corrosion Resistance

- 95% relative humidity with condensation, 30 – 60°C.

Ambient Temperature

- Open: -20 – +60°C (-4 – 140°F).
- Enclosed: -20 – +40°C (-4 – 104°F).

Temperature Compensation

- Continuous.

Type of Protection (in connected state)

- IP20.

TABLE 1. SHORT CIRCUIT CURRENT RATINGS RMS SYMMETRICAL (AMPERES)

DESCRIPTION	VOLTAGE	FREEDOM MCC	FREEDOM ENCLOSED CONTROL	A200 MCC
HMCP	480 V	100,000	100,000	65,000
	600 V	50,000	25,000	25,000
HMCPE	480 V	—	100,000	—
Fusible	480 V	100,000	100,000	100,000
	600 V	100,000	100,000	100,000

Dimensions

TABLE 2. OVERLOAD RELAY — IN INCHES (MM)

DESCRIPTION	WIDTH	HEIGHT	DEPTH
CEP7-EE_B	1.77 (45.0)	3.41 (86.6)	3.35 (85.2)
CEP7-EE_D	1.77 (45.0)	3.41 (86.6)	3.98 (101.2)
CEP7-EE_E	2.83 (72.0)	3.63 (92.3)	4.74 (120.4)
CEP7-EE_F	4.72 (120.0)	5.52 (140.2)	6.01 (152.7)

Selection Table

TABLE 3. SOLID-STATE OVERLOAD RELAYS

FOR USE WITH:	FULL LOAD CURRENT ADJUSTMENT RANGE (A)	OVERLOAD RELAY CATALOG NUMBER
NEMA Size 0	0.1 – 0.5	**CEP7-ED1AB**
	0.2 – 1.0	**CEP7-ED1BB**
	1.0 – 5.0	**CEP7-ED1CB**
	3.2 – 16	**CEP7-ED1DB**
	5.4 – 27	**CEP7-ED1EB**
NEMA Size 1	0.1 – 0.5	**CEP7-EEAB**
	0.2 – 1.0	**CEP7-EEBB**
	1.0 – 5.0	**CEP7-EECB**
	3.2 – 16	**CEP7-EEDB**
	5.4 – 27	**CEP7-EEEB**
NEMA Size 2	1.0 – 5.0	**CEP7-EECD**
	3.2 – 16	**CEP7-EEDD**
	5.4 – 27	**CEP7-EEED**
	9 – 45	**CEP7-EEFD**
NEMA Size 3	5.4 – 27	**CEP7-EEEE**
	9 – 45	**CEP7-EEFE**
	18 – 90	**CEP7-EEGE**
NEMA Size 4	30 – 150	**CEP7-EEHF**
	40 – 200	**CEP7-EEJF**
NEMA Size 5	40 – 200	**CEP7-EEJG**
	60 – 300	**CEP7-EEKG**
	100 – 500	**CEP7-EELG**
NEMA Size 6	120 – 600	**CEP7-EEMH**
NEMA Size 7	160 – 800	**CEP7-EENH**

General Information

TABLE 4. SERIES CEP7 SOLID-STATE OVERLOAD RELAY

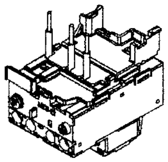
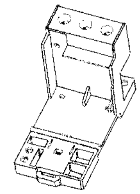
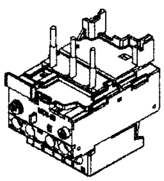
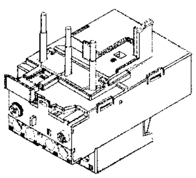
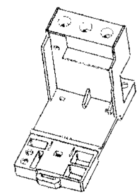
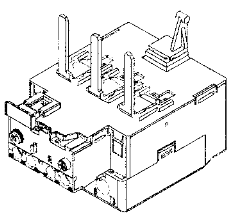
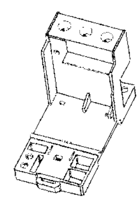
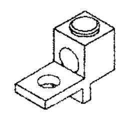
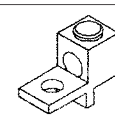
ILLUSTRATION/IMAGE	CATALOG NUMBER	3-PHASE ~ FLA	WIRE SIZE/ TORQUE	ACCESSORIES	CATALOG NUMBER
	**CEP7-EE_B**	0.1 – 27 A	#14 – 6 AWG 75°C Cu 30 lb-in		**CEP7-EPB**
	**CEP7-EE_C**	1 – 45 A	#14 – 6 AWG 75°C Cu 30 lb-in		
	**CEP7-EE_D**	1 – 45 A	#14 – 8 AWG 75°C Cu 30 lb-in		**CEP7-EPD**
	**CEP7-EE_E**	5.4 – 90 A	#12 – 1 AWG 75°C Cu 35 lb-in		**CEP7-EPE**
	**CEP7-EE_F**	30 – 800 A	#6 – 1/0 AWG 75°C Cu 90 – 110 lb-in		**CA6-L110**
	CEP7-EE_F	30 – 800 A	#6 – 1/0 AWG 75°C Cu 90 – 110 lb-in		**CA6-L180**

TABLE 5. ACCESSORIES

ILLUSTRATION/IMAGE	DESCRIPTION		CATALOG NUMBER
	**External Reset Button Adaptor** Provides a larger “target area” for resetting the overload relay when using an External Reset Button.	CEP7-EE (AB – GE) CEP7-EE (PB – GE)	**CEP7-ERA**
	**External Reset Button** Used for manually resetting overloads mounted in enclosures.	All CEP7	**Use D7 Reset — See Section H**
	**Jam Protection Remote Reset Module** Side mount module with trip level settings of 150, 200, 300 and 400% FLA, and delay time settings of 0.5, 2.0 and 4 seconds. For remote setting of a trip condition. Supply voltage required.	All CEP7	**CEP7-EJM**

Trip Curves and Wiring Diagrams

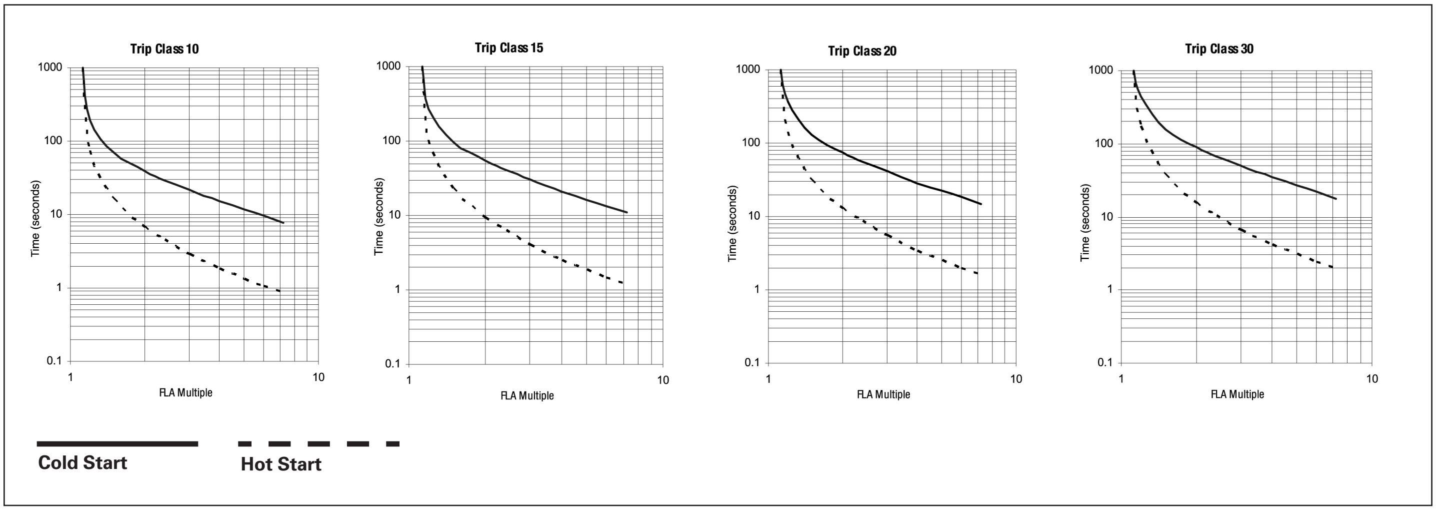


FIGURE 1. TRIP CURVES

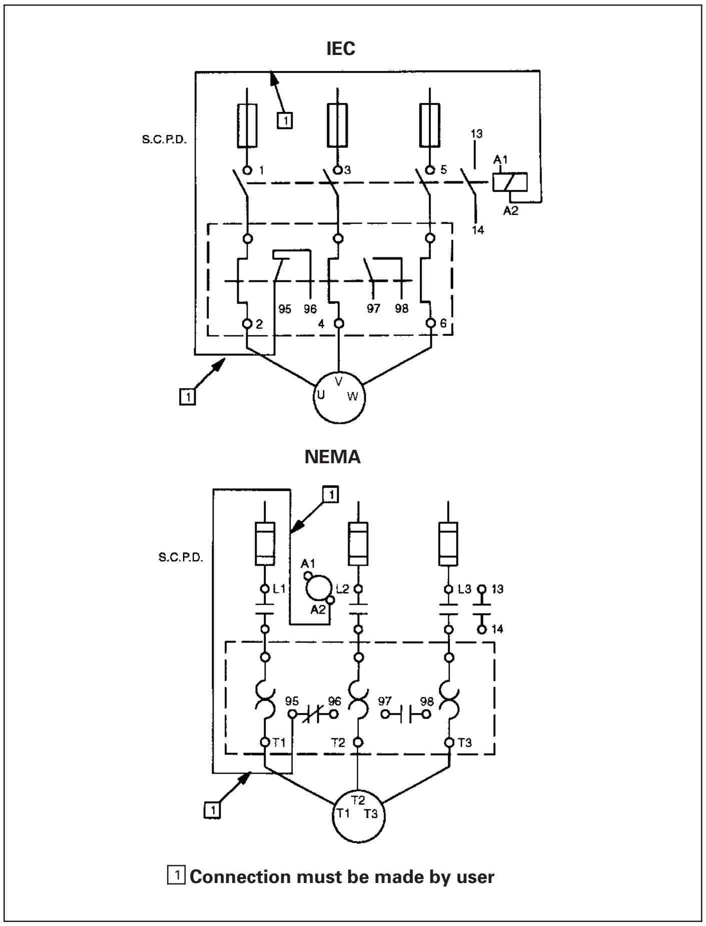


FIGURE 2. WIRING DIAGRAM — 3-PHASE FULL VOLTAGE ACROSS-THE-LINE STARTER

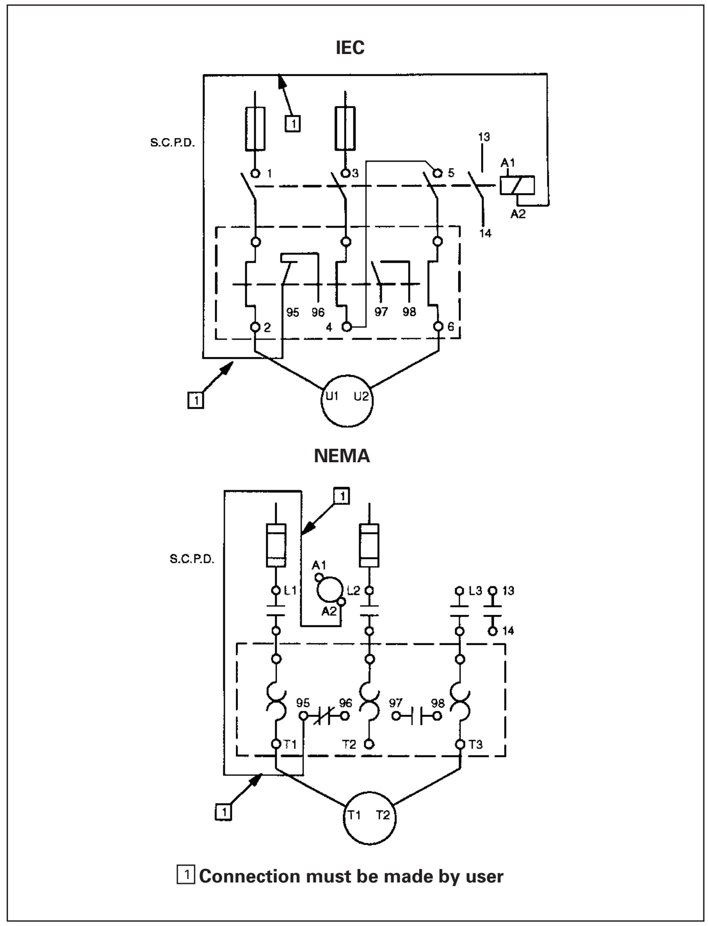
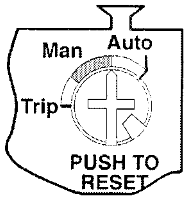


FIGURE 3. WIRING DIAGRAM — SINGLE-PHASE FULL VOLTAGE ACROSS-THE-LINE STARTER

Operating Modes

- **Auto**: Push and turn reset button to auto position. The relay resets automatically — approximately 180 seconds after tripping (optional offering).
- **Trip**: Push and turn reset button counterclockwise to manually trip. This action causes NO and NC contacts to change state. Releasing button reverts device to manual mode.



CEP7-EE__B
CEP7-EE__D
CEP7-EE__E
CEP7-EE__F
CEP7-EE__G
CEP7-EE__H

⚠ ATTENTION

DO NOT USE AUTOMATIC RESET MODE IN APPLICATIONS WHERE UNEXPECTED AUTOMATIC RESTART OF THE MOTOR CAN CAUSE INJURY TO PERSONS OR DAMAGE TO EQUIPMENT.

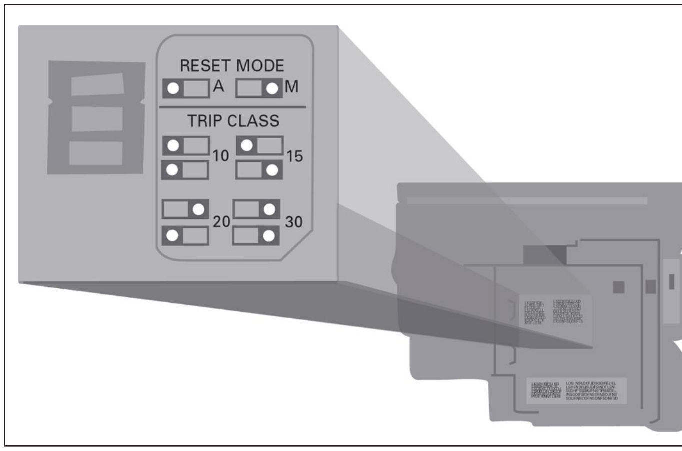


FIGURE 4. SELECTABLE DIP SWITCH FOR: MANUAL VS. AUTOMATIC MODE AND TRIP CLASS (10, 15, 20 OR 30)

Contact Status

Normal		Test	Tripped
95–⫽–96 (NC)	Closed	Open	Open
97–| |–98 (NO)	Open	Open	Closed

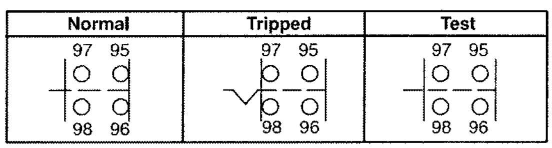


FIGURE 5. CONTACT STATUS

Adjustments

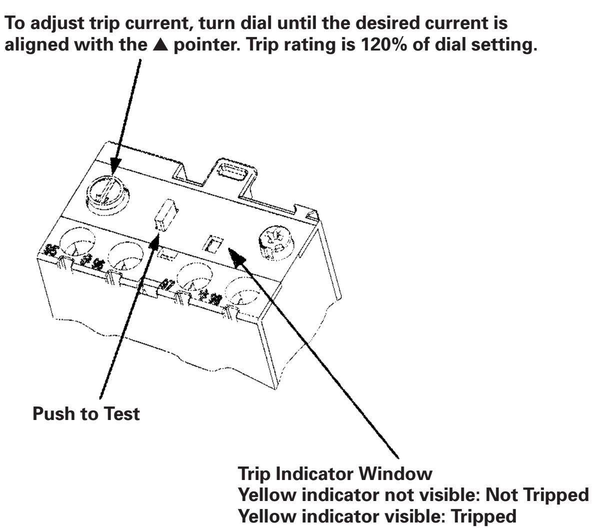


FIGURE 6. TRIP CURRENT ADJUSTMENT

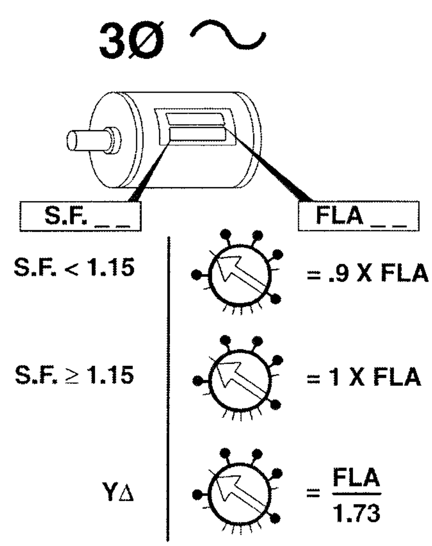


FIGURE 7. MOTOR CURRENT RATING

CEP7 Application with Three Current Transformers — Adjustment Guidelines

Cutler-Hammer Current Transformers to be used with CEP7 Solid-State Relays for Size 5 starters and above.

Setting the Overload Relay

1. Select **Table 6** Current Transformer Ratios.
2. Select the "Equivalent FLA," which most closely matches the motor FLA, then set the overload relay dial to the corresponding "Dial Set Position."
3. The motor FLA may not exactly match the value in the Equivalent FLA column.
4. The overload relay dial settings are calculated as:
Set Value = Dial Set Position/1/(CT Ratio) = Equivalent FLA.
Example: CT Ratio is 300:5, motor FLA is 240A, set overload Dial Set Position at 4.0; **Set Value = 4.0/(1/60) = 240**.

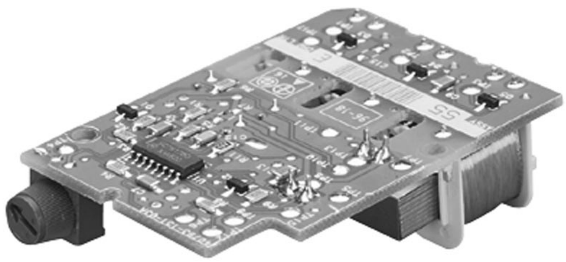
TABLE 6. CURRENT TRANSFORMER RATIOS

CURRENT SETTING	CT RATIO 300:5 EQUIVALENT FLA	CT RATIO 600:5 EQUIVALENT FLA	CT RATIO 1000:5 EQUIVALENT FLA
1.00	60	120	200
1.25	75	150	250
1.50	90	180	300
1.75	105	210	350
2.00	120	240	400
2.25	135	270	450
2.50	150	300	500
2.75	165	330	550
3.00	180	360	600
3.25	195	390	650
3.50	210	420	700
3.75	225	450	750
4.00	240	480	800

Technology Review — CEP7 Overload Relays

Design and Construction Comparison

There are significant differences in the construction and performance of electromechanical overload relays and solid-state motor protection devices. These differences must be understood in order to appreciate the benefits solid-state devices can provide.



Microelectronics Provide Flexible and Accurate Motor Overload Protection

Traditional electromechanical overload relays (eutectic alloy or bimetallic) do not measure current directly. These devices operate by passing current through a heater element, which simulates the actual heating effect taking place in the motor. During overload conditions, the heat generated within the heater element reaches a level that causes a mechanism to open an auxiliary contact. When the auxiliary opens, the contactor is de-energized, removing current from the motor.

On the other hand, solid-state motor protection devices actually measure current directly through the use of current transformers. The current transformers of the CEP7 create a magnetic field which induces a dc voltage into the ASIC board. This board is capable of identifying excessive current or loss of phase more accurately and reacts to the condition with greater speed and reliability than traditional electromechanical overload relays. By developing the power it requires from the applied voltage, the CEP7 is "self-powered," eliminating the need for a separate control power source. This is not the case with some other competitive electronic overload devices.

Once an overload condition is identified, the electronic circuit of the CEP7 causes a contact to open (similar to the electromechanical overload relay), de-energizing the contactor and removing current from the motor. Since the CEP7 is self-powered and a typical auxiliary contact is used to interface with the contactor, the user can apply the CEP7 in the same way as the electromechanical overload. No special control schematic diagram provision and no special connections for CEP7 are required.

Since the mid-1960s the T-frame motor has dominated sales of the older U-frame motor design. T-frame motors contain less copper and less steel and have a reduced capacity to dissipate heat buildup from overloading or locked rotor conditions. Most motor manufacturers agree that modern T-frame motors will require rewinding or replacement if subjected to locked-rotor (jam) condition for 15 seconds. A locked rotor condition is defined to be 6 x FLA (Full Load Amps). Certainly, a 10°C rise of the rated value will occur between 10 and 15 seconds (at 6 x FLA), halving the life of the motor. Class 10 bimetallic overload relays trip locked rotor current in less than 10 seconds to protect modern T-frame motors. This fact explains why Class 10 overloads have been accepted as the new industry standard over the past 10 years as opposed to Class 20 eutectic designs. The shortcoming of some Class 10 bimetallic electromechanical overload relays, however, is that they would not allow for long acceleration (run-up times greater than 10 seconds) in applications like air handling fans or centrifuges. The solid-state electronics in the CEP7 overload relay provide the user with the option of Class 10 or Class 20 protection. This ensures that the same solid-state performance can be used even in applications requiring longer run-up times.

CEP7 solid-state overload relays also provide increased setting and repeat tripping accuracy, exceeding that of electromechanical devices. Traditional electromechanical overload relays have setting accuracy between 10 and 15%. The CEP7, on the other hand, offers accuracies of 2.5 – 5% and a repeat accuracy of 1%.

Improved Phase Failure Protection

The phase loss detection method used in the CEP7 solid-state motor protection device is quite different in comparison to either of the electromechanical methods described above and so are the speeds involved. The three current transformers of the CEP7 will induce into the ASIC board three individual dc voltages, which are 120° out of phase. The ASIC then summarizes the values. When one of the phases is not present, a ripple is generated on the dc voltage. Sensing this ripple, the ASIC board triggers and initiates a trip condition. If single-phase occurs during a steady-state running condition on a 100% loaded motor, then the CEP7 will trigger in 2 seconds; estimate 2 – 3 seconds if the motor is lightly loaded. If the load is less than 65%, the phase loss will not be detected. If a single-phase condition is present when the motor is started; estimate 3 – 8 seconds for loads >80%. Trip times may be somewhat extended for motor loads from 65 to 85% due to cold start transformer saturation. Loss of a phase or zero voltage in one leg is the extreme case of phase imbalance. CEP7 will in fact detect a 50% phase imbalance in the same way as described for phase loss. Phase loss trip times for the CEP7 are much improved in comparison to any electromechanical trip times.

Wide Current Adjustment Range

Solid-state motor protective devices have a wide current adjustment range compared to electromechanical overload relays. Traditional bimetallic overload relays have an adjustment range of 1.5 to 1. This means that the maximum setting of the bimetallic overload relay is generally 1.5 times the lower setting. On a typical overload relay that has a 10 ampere minimum current setting, the maximum setting of that overload is generally 15 amperes. Eutectic alloy overload relays have much smaller current ranges for each heater element (typically 1.5 to 1). For example, a Size 1 starter requires 13 heater elements to cover a current range of 0.254 amperes to 38 amperes.

Solid-state protective devices have adjustment ranges anywhere from 5 to 1. This provides solid-state users a real benefit by enabling reduced overload relays stocks of up to 60%. The wider current adjustment range of the CEP7 means that equipment constructed for dual voltage, i.e., 460 or 230 volts, may be adjusted in the field from the 460 volt current setting to twice the current setting for 230 volt applications. This would only be possible by completely changing out the IEC style bimetallic overload relays or NEMA style heaters.

Energy Savings

In today's energy conscious environment, another benefit of solid-state motor protective devices is energy savings. Because traditional overload relays work on the principle of "modeling" the heat generated in the motor (recreating the heat in the bimetal elements or heaters), a significant amount of energy is wasted. In traditional overload relays, as many as six watts of heat are dissipated to perform the protective function. Because solid-state motor protective devices use sampling techniques to actually measure the current flowing in the circuit, very little heat is dissipated in the device…as little as 150 milliwatts.

This not only reduces the total amount of electrical energy consumed in an application, but it can also have a dramatic impact on the design and layout of control panels. The density of motor starters can be much greater because less heat is generated by each of the individual components. Higher density results in smaller panel space. In addition, special ventilation or air conditioning that might have been required to protect sensitive electronic equipment such as PLCs can now be reduced or eliminated.

The increased use of high efficiency motors goes hand-in-hand with the lower heat generation of solid-state motor protective devices. Use of the CEP7 solid-state device can add as much as 6% efficiency to the total efficiency increase realized when using a high efficiency motor.

Typical Specifications for the CEP7 Overload Relay

1 General

1.1. This specification describes the general requirements for solid-state overload relay protection.

1.2. The overload relay meets:

- 1.2.1 UL 508.
- 1.2.2 CSA C22.2 No.14.
- 1.2.3 IEC 947-4
- 1.2.4 The overload relays are modular in design with versions available for use on both IEC and NEMA starters.
- 1.2.5 The overload relay family provides a choice in levels of protection.
- 1.2.6 The overload relays directly replace existing electro-mechanical overload relays (eutectic alloy or bimetallic).

2 Solid-State Overload Relay — Basic Functionality

2.1. The overload relay is self-powered.

2.2. The overload relay is available in fixed tripping classes of 10 or 20.

2.3. The overload relay is available in manual reset or automatic/manual reset versions.

2.4. The overload relay trips in 2 seconds or less under phase loss conditions when applied to a fully loaded motor.

2.5. The overload relay operates on 150 mW of power.

2.6. The overload relay provides a visible trip indicator.

2.7. The overload relay provides 1 NO and 1 NC isolated auxiliary contact.

2.8. The overload relay provides a test button that operates the NC contact.

2.9. The overload relay provides a test trip function that trips both the NO and NC contacts.

2.10. The overload relay has trip-free construction.

2.11. The overload relay has a current adjustment range of as little as 5:1.

2.12. The overload relay is ambient temperature compensated.

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