Combination Starter Basics

A guide to understanding and selling combination starters.

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Introduction

If there is any fact of life in the electrical industry, it is that customers need fast, dependable service on even their small quantity orders. Combination starters are frequently ordered in small quantities by contractors and users, and they need prompt service. The challenge GE has faced in responding to this need is that combination starters include numerous choices, options and factory installed accessories. The need to provide fast customer service, shipment and competitive prices on "factory specials" demanded that GE take a new approach to the combination starter business.

Our approach is the "Quick Ship" combination starter program. Briefly, GE is introducing a family of pre-engineered combination starters with sufficient modifiability and choices so that the overwhelming majority of customer needs are met with a "Quick Ship" response!

GE's market research has determined that 80% of all combination starter requirements have the following common denominators:

- Standard duty, full-voltage, non-reversing
- NEMA Sizes 0 through 4
- Furnished with thermal magnetic or Mag-Break® circuit breaker, or with disconnect switch
- Furnished with or without control power transformer
- Furnished in choice of NEMA Type 1, 12, 4 and 3R enclosures
- Furnished with choice of popular accessories
  - Control power options
  - Choice of push buttons or selector switch in enclosure cover
  - Pilot lights

GE integrates all of these different customer requirements into the "Quick Ship" combination starter program.

How combination starters "fit" in customer power distribution systems

Because combination starters provide customers with numerous decisions and choices, assisting a customer in making a specific selection often requires patience and explanatory literature. Another objective of this manual is that it serve as a convenient sales and application reference for those who are in direct contact with customers and their combination starter needs.

The format of this manual is designed to assist sales and support personnel as they ask the questions necessary to provide the most competitive and appropriate combination starter from the "Quick Ship" combination starter program. These questions will help define customer needs. Where customers may be unsure of their specific requirements, information is presented here to help sales personnel resolve questions on the spot - and secure both a solution to a customer need, and an order!

Combination starters provide a key function in any large electrical power distribution system. However, unlike switchgear and substations, combination starters are found in the smallest enterprises. Apartments, supermarkets, churches and car washes are but a few of the buildings that will often use combination starters to control their motor loads.

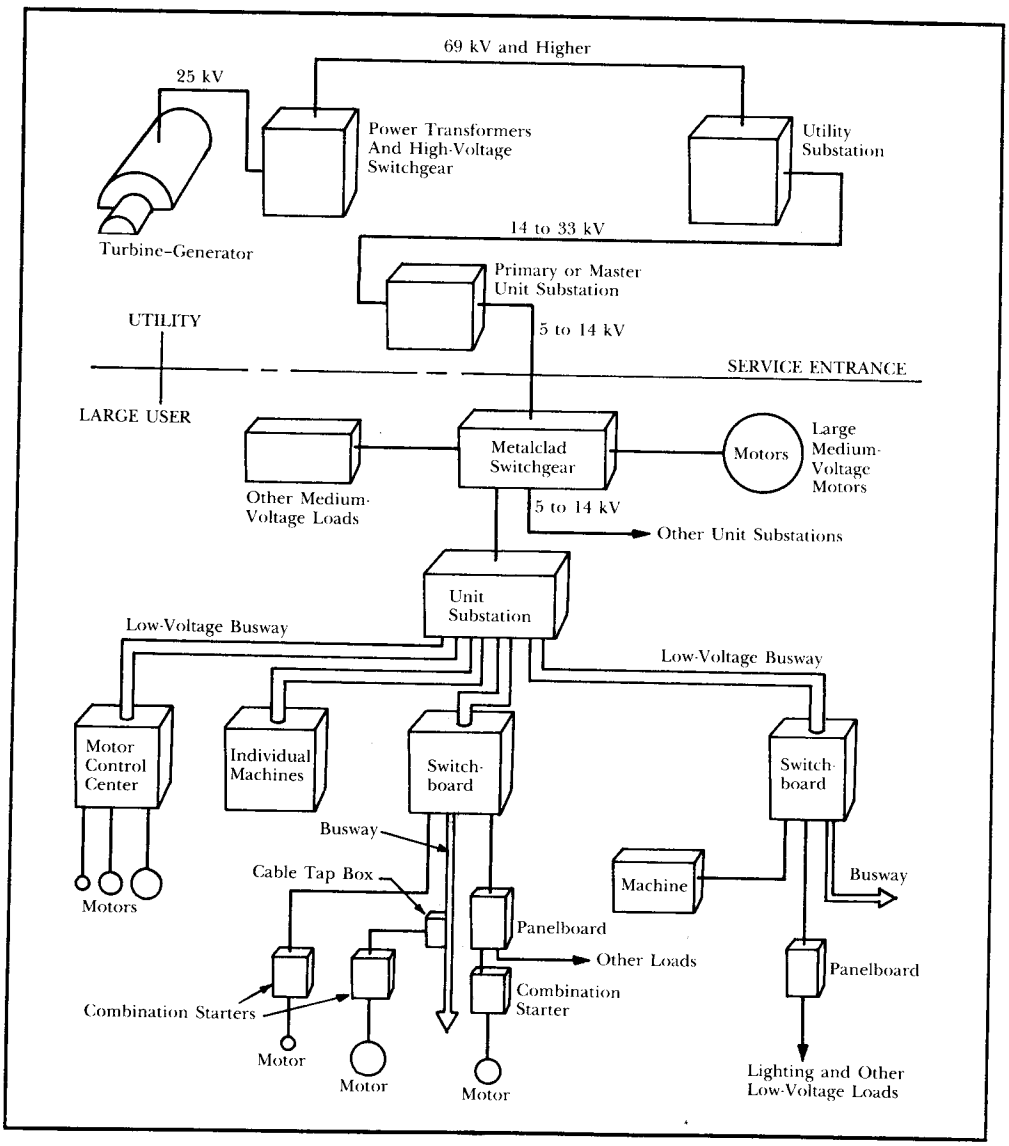
Figure 1 shows the flow of electrical power from the utility to the motor load, and some of the equipment sold to OEMs, contractors and users for control of their electrical equipment.

Power is generated by steam or gas turbines at voltages anywhere from 11,000 to 25,000 volts. At the generating station, power transformers will raise the system voltages to 69,000 volts - and higher. Transmission lines and towers then carry power from the generating station to utility substations, where the voltage is reduced to levels that can be conveniently controlled by substations, pad-mounted and pole transformers near customer loads.

The typical large industrial may buy power from the utility at 13,800 to 4,160 volts, and provide unit substations within the plant to reduce the working voltages down to the 480/277 volts required by motors and indoor lighting. Smaller users will buy power already reduced to 240 or 480 volts.

Combination starters are popular wherever a motor is installed in locations more than 50 feet away from the motor's electrical power distribution connection point that does not already contain the motor starter function. That power distribution connection point can be low voltage switchgear, busway, a motor control center a switchboard, a panelboard or equipment furnished by an OEM or some other third party.

Figure 1. Flow of electrical power from utility to user



Function of combination starter

Figure 2 is a simplified diagram of a combination starter.

A combination starter provides four important functions in a motor control circuit. They are:

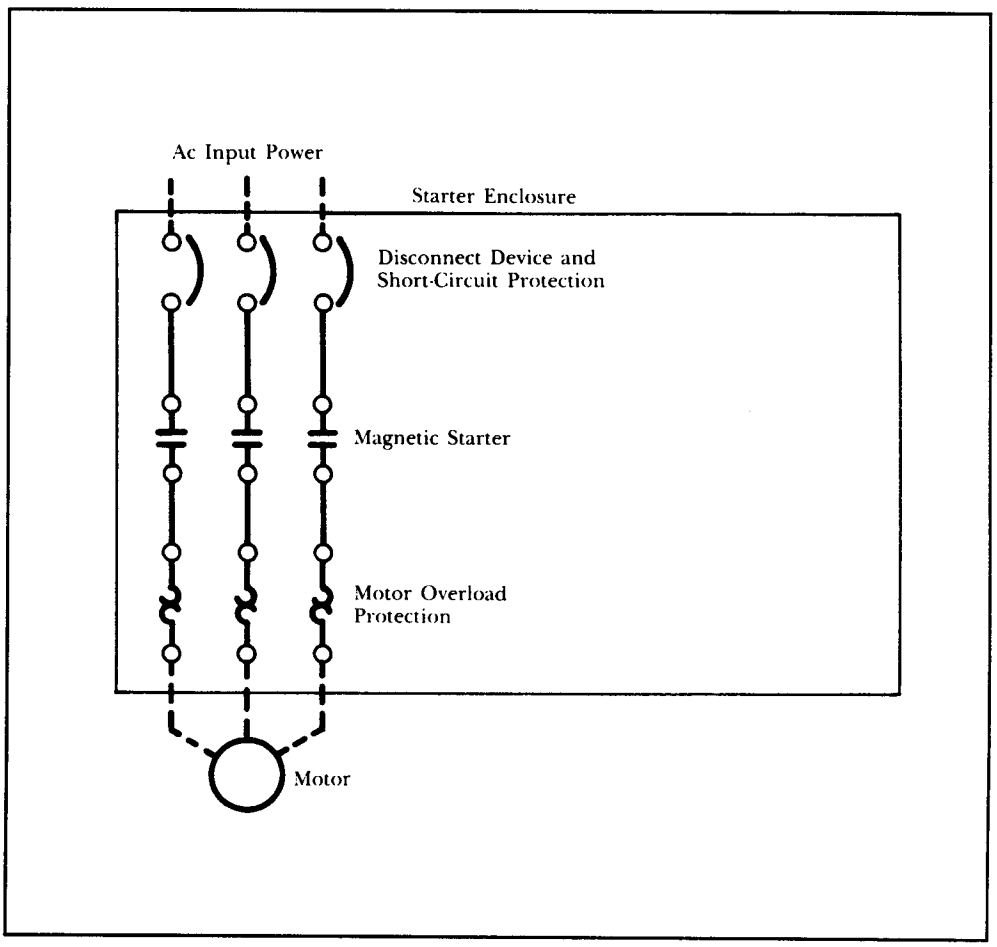
Motor starter function

A motor starter provides the means of starting and stopping the motor. In addition, the motor starter contains an overload device to disconnect the motor in the event it is overloaded. Combination starters *always* include a motor starter.

Line disconnect function

The National Electrical Code requires that every motor circuit include some form of disconnect function. Where the motor is mounted more than 50 feet from its connection to the power distribution system, a separate disconnect device is re-

Figure 2. Schematic diagram of combination starter



quired. The purpose of this function is to provide customer personnel with the ability to positively de-energize motor circuits during maintenance procedures.

Short circuit protection

Motor starters do not contain any provisions for protecting the branch circuit from damage due to short circuits "downstream" of the motor starter. Motor starters are not designed to interrupt short circuit current.

For example, if the insulation of a motor's stator windings suddenly failed, and the windings shorted to the motor frame, both the motor's starter and the conductors from the starter to the motor would be subjected to up to thousands of amperes of short circuit current. The starter's overload protection would sense the high values of current, and unless another device - a fuse, a circuit breaker or a motor circuit protector - designed to safely interrupt high values of current interrupts the short circuit current first, the starter would try to open the circuit.

The National Electrical Code does not describe how the circuit disconnect and short circuit protection functions must be provided. Consequently, customers and the electrical industry have settled on three. They are, 1) thermal magnetic circuit breakers - such as GE's E150, F225, J600 line breakers, 2) motor circuit protector type circuit breaker - such as GE's Mag-Break ® breakers and 3) fusible disconnect switches - such as GE's Spec-Setter ™ safety switches. All provide the same basic functions. Regional preferences generally dictate which method is required.

Mechanical protection

Finally, combination starters have an enclosure that houses all of its components to both protect them from environmental contamination and prevent accidental contact with live electrical components.

Distributor and GE sales personnel often need to provide quick answers to complex questions over the phone. Customers often are pressed for time to make their selections of equipment and their equipment suppliers. Where customers know exactly what their needs are, then the traditional factors of business relationships, brand preference, service and price become determining factors in who obtains the order for the combination starters.

Customer questions and answers

When the customer is uncertain concerning his combination starter requirements, a checklist set of questions and answers can be useful in refining needs ... and being certain that no vital piece of information is missing that would delay shipment.

1. What type of starter is needed?

GE offers four basic types of starters, 1) full-voltage, non-reversing, 2) reversing, 3) multi-speed and 4) reduced voltage. All are available as combination starters.

Full-voltage, non-reversing starters

Figure 3 shows a full-voltage, non-reversing combination starter. These starters are single speed, single direction devices. The vast majority of motor applications require this type of starter. It delivers fast starting of the motor, and because of its circuit simplicity, it is one of the most reliable pieces of industrial control equipment in use today. A common abbreviation for full-voltage, non-reversing starters is "FVNR."

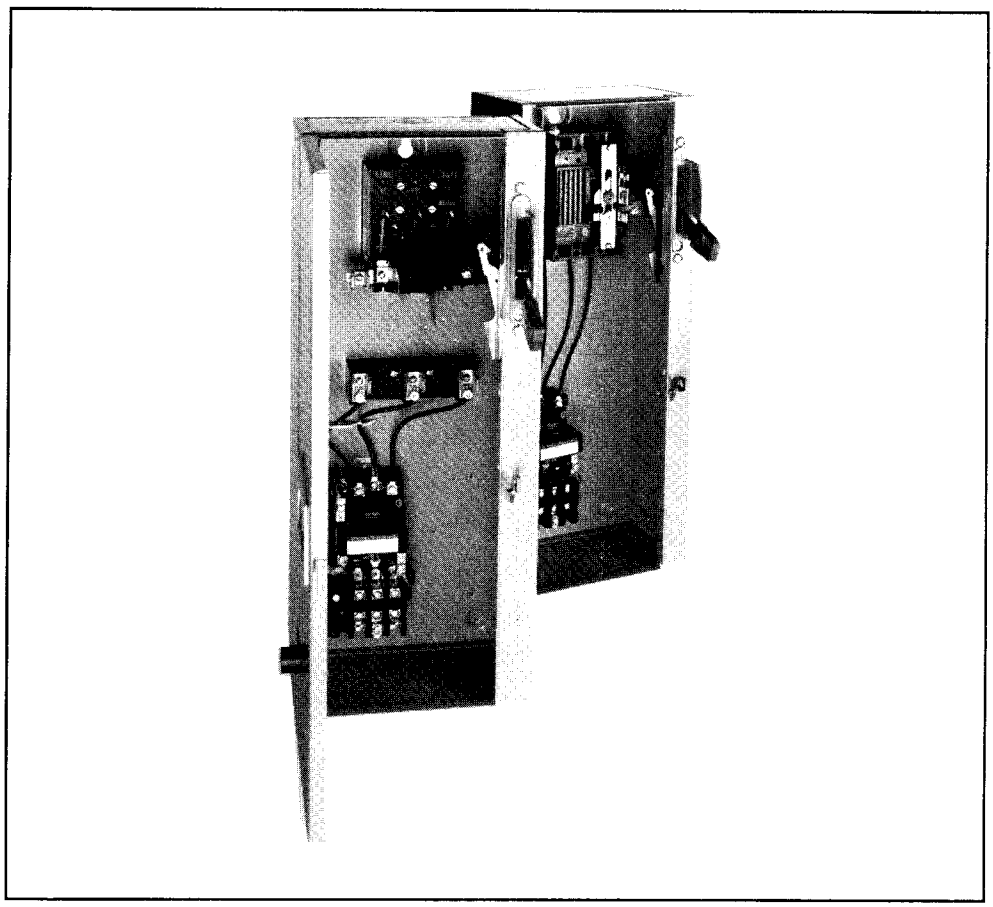


Figure 3. Full voltage, non-reversing starters (fused switch and circuit breaker disconnects shown)

All combination starters in the "Quick Ship" combination starter program are of the FVNR type.

Full-voltage, reversing starters

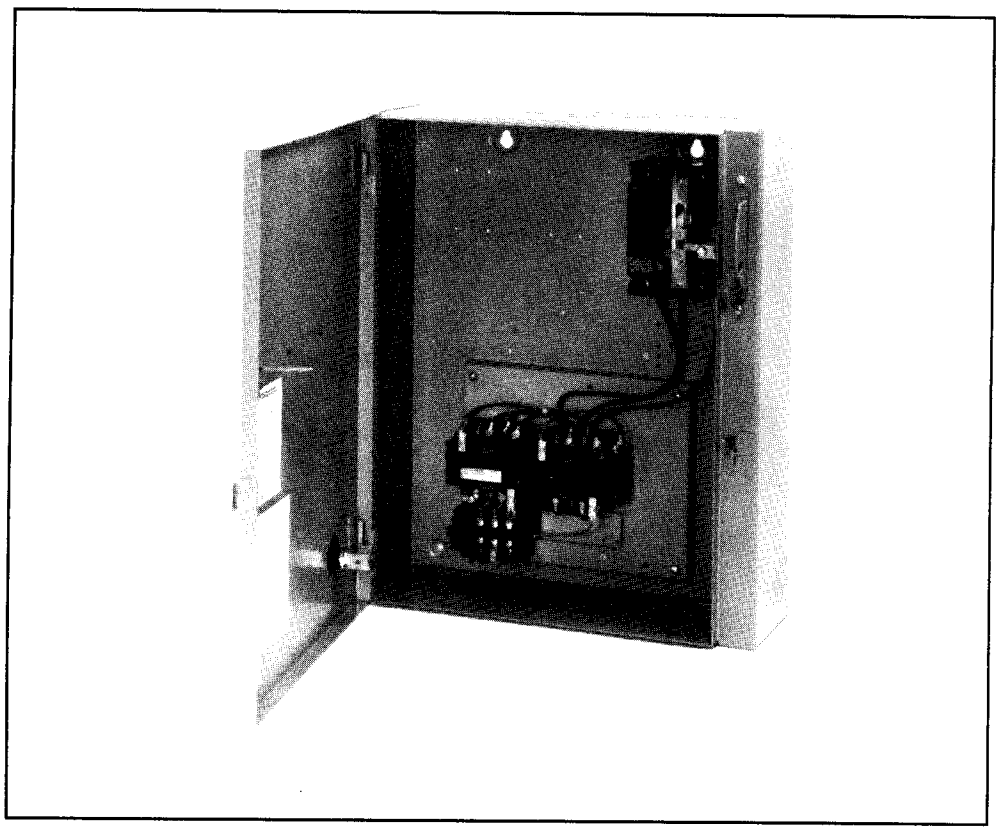
The next most popular magnetic motor starter provides for changing the motor's direction of rotation by pressing Forward/Reverse push button switches, or moving a selector switch. The motor is started at full-voltage in either direction. Full-voltage, reversing starters are often abbreviated as, "FVR." Figure 4 illustrates a full-voltage reversing starter.

The "Quick Ship" combination starter program does not include full-voltage, reversing starters.

Multi-speed (two-speed) starters

Squirrel cage induction motors can be designed to operate continuously at two or more speeds. GE offers a family of CR309 starters configured for use with two-speed motors. These starters are available as combination starters, but are not included in the "Quick Ship" program.

Figure 4. Full-voltage reversing starter



Reduced voltage starters

Some customers and utilities have rules concerning the maximum size motor that can be started "across-the-line," or at full-voltage. The reason for these restrictions is because squirrel cage induction motors typically draw 600 percent - and more - of their full load current during their starting cycle. Depending upon the motor's design and the characteristics of the load, the starting cycle can last anywhere from less than one second to more than ten seconds. Some high inertia loads, such as centrifuges, can take longer than one minute to reach full speed. The combination of time and momentary high current loading may cause lighting "flicker" or even serious system problems.

GE offers a full line of reduced voltage starters with and without combination starter features. These include autotransformer-type, wye-delta type and part-winding type of reduced voltage starters. Figure 5 illustrates an autotransformer-type reduced voltage starter.

The "Quick Ship" combination starter program does not include any reduced voltage starters.

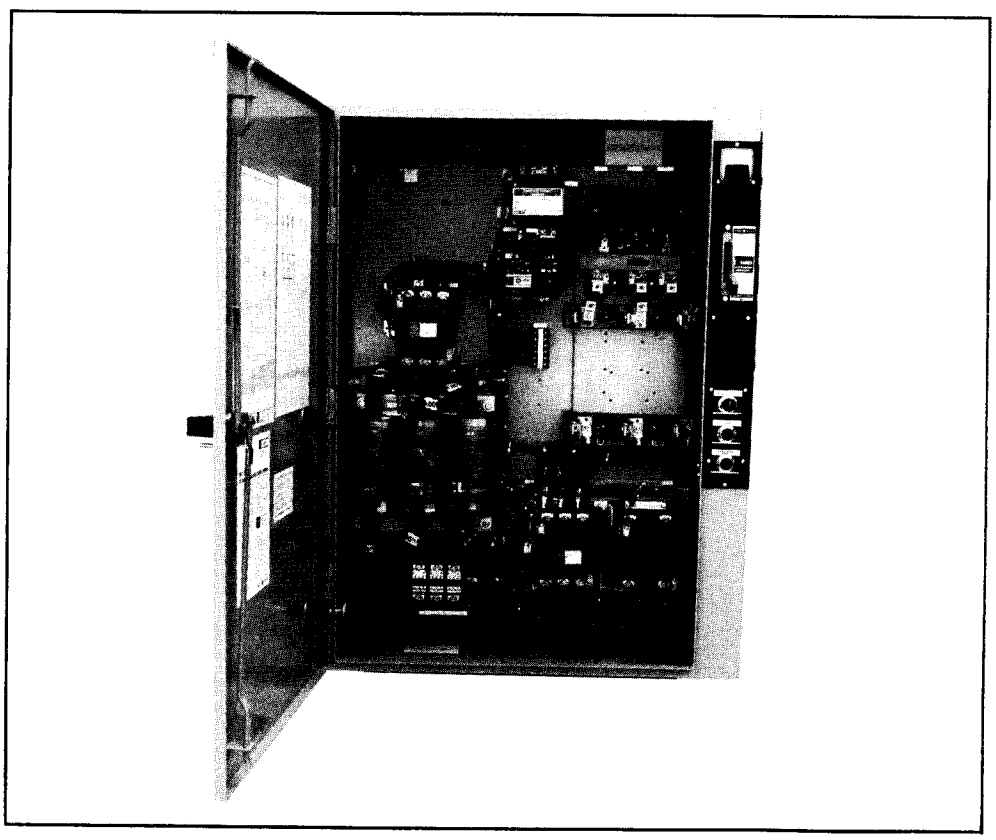
2. What starter duty is needed?

NEMA rated starters have three basic duty categories, 1) standard, 2) jogging or inching and 3) plug-stop.

Standard duty

The vast majority of starters meet the criteria for standard duty. Since a FVNR cannot be wired to provide the plug-stop function, standard duty entails infrequent starting and stopping of the motor. The motor may be used for occasional jogging

Figure 5. Reduced voltage starter



(or plugging for a FVR starter) for limited time periods, such as machine set-ups. During such periods the motor should not be stopped and restarted in excess of five times per minute, or more frequently than ten times in ten minutes.

Recommendation: If the customer doesn't know if what type of duty is required, it is suggested that the quotation be made on the basis of standard duty. It is also recommended that standard duty be explained to any customer unsure of requirements.

Jogging and/or inching duty

Jogging and inching control is commonly used in the machine tool industry, during initial set-ups of large machines and other machinery that requires precise position control of some load. While the details of a jogging and an inching control circuit may differ, there are no differences in the application rules for magnetic starters to jogging and inching applications. Both jogging and inching requires frequent stops and starts of the motor.

Jogging or inching duty is defined as starting and stopping the motor more frequently than five times per minute, or more frequently than ten times in ten minutes.

Application of "Quick Ship" combination starters to Jogging/Inching Duty: Answers to the next question (sizing the starter) provide application rules for derating starters for jogging and inching duty. However, be sure customers understand that the control circuits for equipment covered in the "Quick Ship" combination starter program provide basic stop/start control of the motor.

Plug-stop duty

Reversing starters can be configured to "plug-stop" an induction motor. Plug-stopping a motor involves reversal of two phase leads while the motor is operating. This causes the motor to stop suddenly. In effect, it is similar to being able to stop an automobile going at full speed in the forward direction by throwing it into reverse gear. While that can only be attempted once in an automobile, it is possible to routinely plug-stop a motor, it does represent a special duty cycle for both motor and starter.

Plug-stop duty is infrequently required, and consequently has not been incorporated into the "Quick Ship" combination starter program.

3. What size starter is needed?

When the customer already knows the answer to this question, proceed to the next question.

However, there are times when the customer does not know the starter size requirements. These situations provide an opportunity to assist the customer in solving a problem. There are two starter duties - standard and jogging/inching - that can apply to combination starters within the "Quick Ship" combination starter program.

The customer need only know the motor's voltage, horsepower rating, and duty cycle to select the NEMA size. Occasionally, locked rotor current may be specified and is included in the following tables as a reference but is not a necessary consideration if the motor is a standard type with 6X's inrush current or less. Tables 1 through 4 list maximum horsepower and locked rotor currents for both starter duties. *When unsure of starter duty requirements, remember to define and quote standard duty starters.*

Table 1. NEMA starter sizes vs. maximum motor horsepower rating, standard duty

NEMA Size	Rated Enclosed Cont. Amperes	Max. Hp Ratings by Frequency &Voltage				
		60 Hz				50 Hz
		200-208V	230-240V	460-480V	575-600V	380V
0	18	3	3	5	5	5
1	27	7 1/2	7 1/2	10	10	10
2	45	10	15	25	25	25
3	90	25	30	50	50	50
4	135	40	50	100	100	75

Table 2. NEMA starter sizes vs. maximum locked rotor current, standard duty

NEMA Size	Maximum Locked Rotor Current, Amperes				
	60 Hz				50 Hz
	200-208 V	230-240 V	460-480 V	575-600V	380 V
0	74	70	53	42	64
1	152	140	88	70	107
2	255	255	210	168	255
3	500	500	418	334	500
4	835	835	835	668	835

Table 3. NEMA starter sizes vs. maximum motor horsepower, jogging/ inching, plug-stop and plug-reverse duty

NEMA Size	Rated Enclosed Continuous Amperes	Max. Horsepower Ratings at 60 Hz by Voltage			
		200-208 V	230-240 V	460-480 V	575-600 V
0	18	1 1/2	1 1/2	2	2
1	27	3	3	5	5
2	45	7 1/2	10	15	15
3	90	15	20	30	30
4	135	25	30	60	60

Table 4. NEMA starter sizes vs. maximum locked rotor current, jogging/ inching, plug-stop and plug-reverse duty

NEMA Size	Maximum Locked Rotor Current, Amperes				
	60 Hz				50 Hz
	200-208 V	230-240 V	460-480 V	575-600 V	380 V
0	46	40	25	20	30
1	74	70	52	42	63
2	175	175	127	102	154
3	335	335	250	200	300
4	500	500	500	400	500

Notes, Tables 1 - 4:

1. Motor full load current must not exceed rated enclosed continuous current.
2. These tables apply to motors with both 1.0 and 1.15 Service Factors. Current at Service Factor loading must not exceed rated enclosed continuous amperes.

4. What starter enclosure is needed?

This is often the first or second question asked by the person assisting the customer in their starter selection.

The "Quick Ship" combination starter program offers four types of enclosure options. They are: NEMA Type 1, NEMA Type 3R, NEMA Type 4 stainless steel, and NEMA Type 12.

Option 1 - NEMA Type 1 general purpose enclosure

NEMA Type 1 enclosures are the single most popular control enclosure for equipment that will be installed indoors in a clean and dry environment. NEMA Type 1 enclosures provide "mechanical" protection from unintentional contact with live and moving parts inside the enclosure. They are the least expensive control enclosure.

NEMA Type 1 enclosures should never be recommended for outdoor installations. NEMA Type 1 enclosures provide little or no protection from dripping water and fluids, and they are not oil tight

Option 2 - NEMA Type 12 oil and dust-tight enclosure

NEMA Type 12 enclosures are the second most popular control enclosures and offer substantial protection for their cost. NEMA Type 12 enclosures are usually installed indoors in typical "dirty" industrial environments where the probability of contamination by oil, dirt, dripping water, airborne dust and non-corrosive liquids is high. The factory floors of an automobile engine plant might be representative of a NEMA 12 enclosure environment. These enclosures meet drip, dust and rust resistance tests.

NEMA Type 12 enclosures are not designed for outdoor installations. While many NEMA Type 12 enclosures may be found outdoors in sheltered locations, particularly in states with moderate climates, it is imprudent to recommend a NEMA Type 12 enclosure for outdoor use. All enclosures in the "Quick Ship" program come with external overload reset buttons.

Option 3 - NEMA Type 3 rain-tight enclosure

NEMA Type 3R enclosures are intended for protected outdoor installations. They provide protection from falling (not windblown) rain, falling sleet, and external icing. They also are rust-resistant. While NEMA Type 3R enclosures provide protection from external icing, cover-mounted controls may be inoperable while the enclosure is ice covered. The best NEMA Type 3R outdoor installations will provide the enclosure with protection from the wind as the result of building walls or shelters.

NEMA Type 3R enclosures are not designed to be dust-tight or protect against windblown rain and sleet.

Option 4 - NEMA Type 4 stainless-steel watertight enclosure

NEMA Type 4 (stainless steel) enclosures provide maximum protection for combination starters within the "Quick Ship" combination starter program. NEMA Type 4 enclosures are designed for outdoor locations where they may be subjected to windblown rain, dust and sleet. They are also widely used in indoor hosedown applications commonly found in the food and beverage industries. NEMA Type 4 (stainless steel) enclosures are obviously rust and corrosion resistant to a wide range of non-corrosive liquids.

General Comment: All of the enclosures offered within the program assume customers will protect the combination starter from both internal condensation and internal icing whenever the possibility of condensation or icing exists in some outdoor installations. Typically, a small amount of space heating is all that is required to prevent internal condensation or internal icing. Customers usually have their own favorite space heater circuits that are energized whenever the starter is in the "Stop" mode. Space heater kits are available as an add-on accessory.

5. What type of disconnect and short circuit protection is preferred?

Three choices are available:

- Thermal magnetic circuit breaker
- Mag-Break® motor circuit protector
- Fusible disconnect switch

Usually, customers already know their preference. However, if a customer requests assistance in making a selection, consider these factors: price, circuit interrupting capacity requirements, and cable protection strategy.

Price

The least expensive combination starter is the disconnect type. However, since disconnect type starters are sold less fuses, the price of the fuses must be added to the price of the starter to make a valid comparison. Properly sized fuses provide short circuit and long time overload protection of the conductors between the starter and the motor. Fuses can be obtained with any desired interrupting capacity. Fuses do "age" with time, and may subject the motor to unintentional single-phasing if one fuse opens under normal loading conditions.

Combination starters using Mag-Break® motor circuit protectors are higher in price than disconnect type combination starters. However, they are designed specifically to protect motor loads. They provide both companion tripping of all three poles.

Many customers prefer to use thermal magnetic circuit breakers in their combination starters. Thermal magnetic breakers provide companion tripping of all three poles and adjustment capability of both long time and instantaneous tripping points.

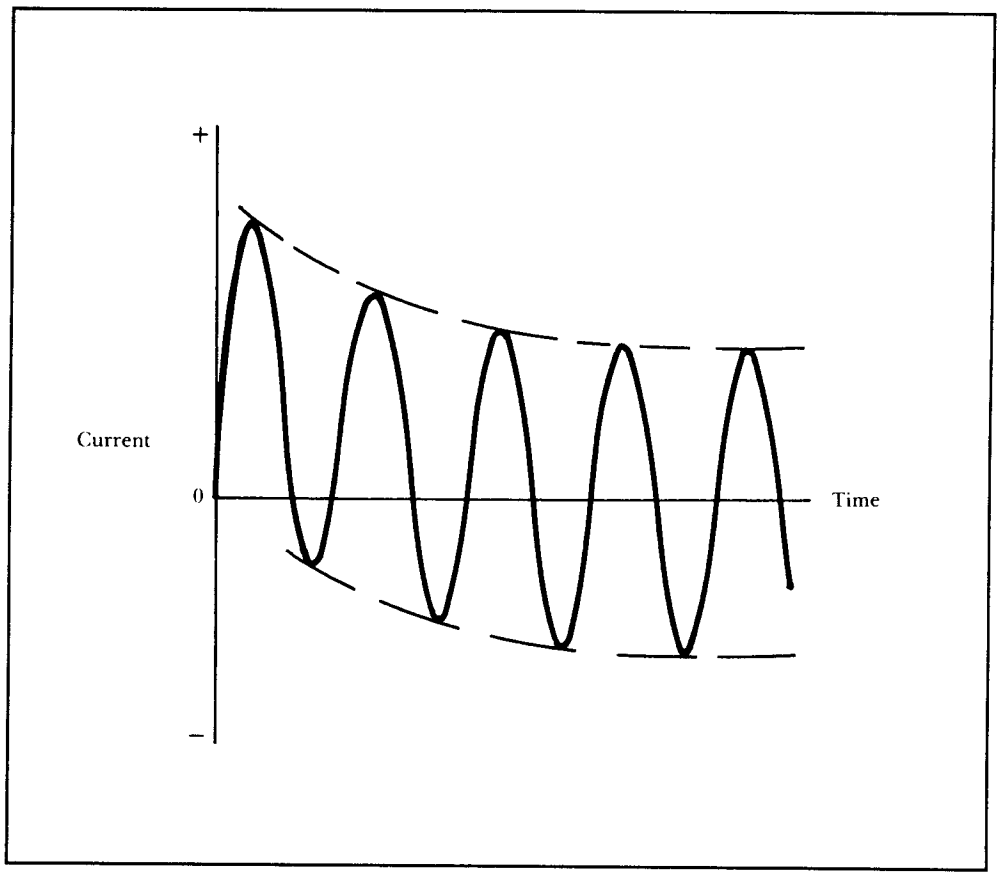
Interrupting capacity

The interrupting capacity of an electrical circuit interrupter is a measurement of the maximum current it can safely break. The term used in most circuit breaker and fuse literature is "maximum symmetrical rms amperes." Figure 6 shows a typical plot of current versus time for an ac short circuit.

Note that when the short circuit is first applied, there is a displacement around the zero current axis. The magnitude of this displacement depends upon both the exact moment when the short is applied and the ratio of circuit reactance to resistance. For simplicity's sake, the "symmetrical" short circuit current is measured at a time when the ac waveform around the zero axis has equal positive and negative values.

Calculating the magnitude of symmetrical short circuit current that can be delivered at the point of the short is very tedious and well beyond the scope of this manual. There are two important points to remember:

Figure 6. Plot of current versus time, short circuit applied to an alternating current circuit



- Modern electrical power distribution systems are increasing their ability to deliver high values of short circuit current. The reason for this is not that anyone wants high "fault" currents, but when an engineer designs a system for low voltage drops under high values of loading, high levels of possible short circuit current becomes an automatic by-product.
- If a protective device - a circuit breaker, switch or fuse - is called upon to interrupt a circuit where the amount of current flowing exceeds its interrupting capacity, any number of things can happen. First, the device may be unable to interrupt the short circuit because its contacts might weld. Second, the device might literally blow up and cause damage due to flying parts. Third, the probability of a fire somewhere in the system becomes likely.

Question: "Whose job is it to calculate the interrupting capacity required by the combination starter?" It's the responsibility of a qualified electrical engineer who has access to data unavailable to the supplier of the combination starter. In other words, it isn't yours.

Question: "What if the customer doesn't know the interrupting capacity required for the combination starter?" A responsible position to take is to let the customer choose which of the options - thermal magnetic breaker, motor circuit protector or fusible disconnect - he prefers. The interrupting capacity of the various options are listed in Table 5.

Cable protection strategy

Properly rated thermal magnetic circuit breakers and fuses are designed to protect conductors from damage due to overcurrent. Mag-Break® motor protector circuit breakers are designed to provide tailored instantaneous overcurrent protection to motor circuits. Motor circuit protectors are set to trip at current levels in excess of normal full voltage starting current, but are not intended to provide long time overcurrent protection for either motors or their interconnecting wiring. Mag-Break® circuit breakers are used for frequently started motors where repeated or prolonged cycles of inrush current could cause nuisance tripping.

Customers usually have well-defined protective strategies. Any one of the three different types of circuit interrupters work effectively with well-designed electrical power distribution systems.

Table 5. Maximum Interrupting Capacity of Combination Starters As a Function of Protective Device and System Voltage

Thermal Magnetic Circuit Breaker Protective Devices					
NEMA Size	Circuit Breaker		RMS Symmetrical Amps		
	Type	Amp Rating	200 to 240 Volts	460 to 480 Volts	575 to 600 Volts
0	TEB	15-50	5,000*	-	-
	TED	15-50	5,000	5,000*	5,000*
	THED	15-50	65,000	14,000	5,000
1	TEB	15-70	5,000*	-	-
	TED	15-30	25,000	25,000*	25,000*
	TED	35-70	5,000	5,000*	5,000*
	THED	15-50	65,000	25,000	25,000
	THED	60-70	65,000	14,000	5,000
2	TEB	15-100	5,000*	-	-
	TED	15-50	25,000	25,000*	5,000*
	TED	60-100	5,000	5,000*	5,000*
	THED	15-50	65,000	25,000	25,000
	THED	60-100	65,000	25,000	5,000
3	TEB	25-150	5,000*	-	-
	TED	25-100	25,000	25,000*	5,000*
	TED	110-150	5,000	5,000*	5,000*
	THED	25-100	65,000	25,000	25,000
	THED	110-150	42,000	25,000	5,000
4	TFJ, TFK	70-225	22,000*	22,000*	22,000*
	THFK	70-225	25,000	25,000	10,000
Mag-Break® Motor Circuit Protector					
0 to 4	TEC*		25,000	25,000	25,000
0 to 4	TEC w/ limiter		100,000	100,000	100,000
Fuses**					
	Fuse Type				
0 to 3	H*		5,000	5,000	5,000
4	H*		10,000	10,000	10,000
0 to 4	R*		100,000	100,000	100,000

* Available as standard for "Quick Ship" program.

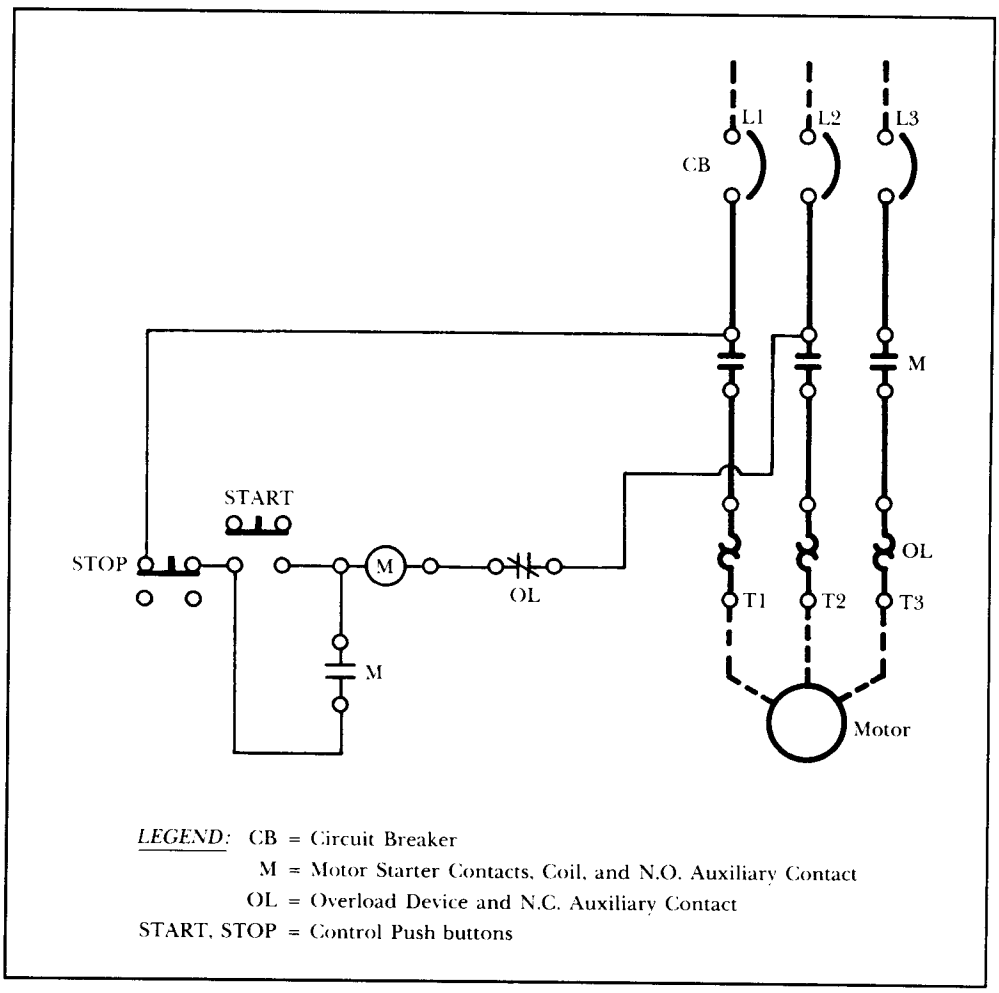
** Fuse Clips only. Fuses are not supplied with combination starters.

6. What control voltage will be used for the starter circuits?

Customers have three basic options. They are: 1) use an external source of control power, 2) use a self-contained control power transformer (CPT) rated for starter operation or 3) use a self-contained control power transformer rated for both starter operations and 100 volt-amps of additional loading. The "Quick Ship" combination starter program provides combination starters with all three options for all starter configurations.

The wiring diagrams for FVNR starters using external control power and an internal CPT are shown in Figures 7 and 8.

Figure 7. Wiring diagram of FVNR starter using external control power

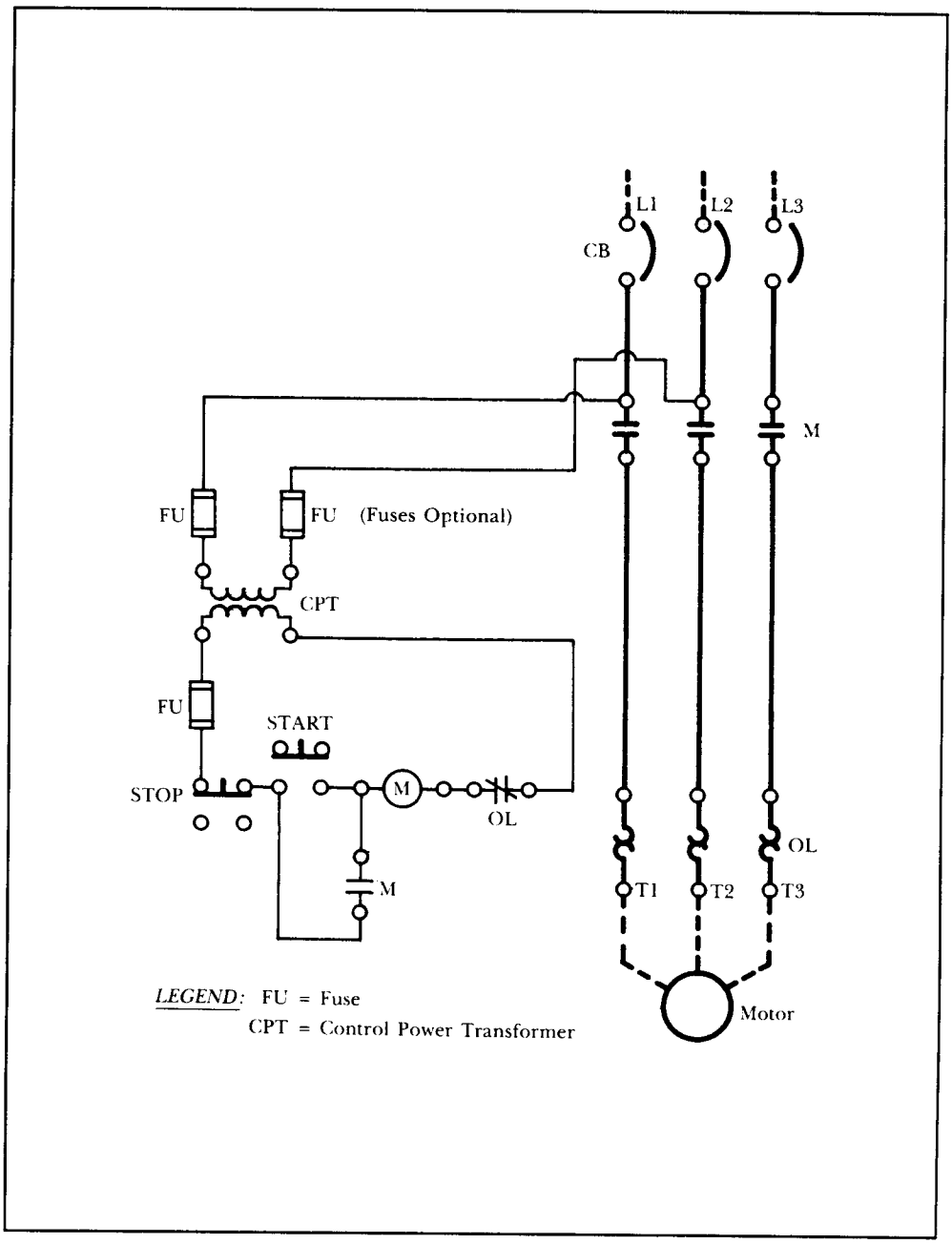


Option 1 - external control power

The customer may choose any of the following control voltages:

- 120 volts
- 208 volts
- 240 volts
- 480 volts
- 600 volts

Figure 8. Wiring diagram of FVNR starter using self-contained control power transformer



Except in those cases where 120 volts is selected, the control voltage and the working, or line, voltage to the starter should be the same. If they are not, question the customer to be sure of his selection.

Option 2 - self-contained control power transformer (CPT)

The most popular American control power voltage is 120 Vac, 60 Hz. When customers need starters with their own CPTs rated to provide operating power to starter control circuits, single phase CPTs are available for the following line voltages:

- 208/120 volts (i.e., 208 volts input and 120 volts output)
- 240/120 volts
- 480/120 volts
- 600/120 volts

Option 3 - self-contained CPT with 100 VA additional capacity

Frequently, customers want to insert additional control circuitry or a convenience outlet to a combination starter, and need additional capacity in the CPT. The "Quick Ship" combination starters offer an additional 100 VA CPT capacity as a pre-engineered option. Additional capacity CPTs are available for the following line voltages:

- 208/120 volts
- 240/120 volts
- 480/120 volts.
- 600/120 volts

Comment: Don't worry about customers who say their line voltages are 200, 230, 460 and 575 volts. These are so called "utilization" voltages seen by load equipment such as motors. For example, the theory is that in a 480 volt, three-phase power distribution system, voltage drop in the conductors to a motor will be such that the motor actually operates at 460 volts.

7. What current settings (for thermal magnetic and Mag-Break® circuit breaker type starters) or fuse clips (for fusible disconnect type starters) are needed?

Once the NEMA size is determined and protective device is selected, the customer needs to select either the current setting or the fuse clips for the combination starter. See Tables 6, 7, and 8.

Table 6. Horsepower/breaker ratings - combination starters with thermal magnetic circuit breakers

NEMA Size	200-208 Volts		240 Volts		480 Volts		600 Volts	
	Max Hp	Breaker Rating, Amps	Max Hp	Breaker Rating, Amps	Max Hp	Breaker Rating, Amps	Max Hp	Breaker Rating, Amps
0	2	15	2	15	3	15	5	15
	3	20	3	20	5	20		
1	5	35	5	35	7 1/2	30	7 1/2	20
	7 1/2	50	7 1/2	50	10	35	10	30
2	10	50	15*	50	25*	50	15	40
			15	100	25	70	25	50
3	25	125	30*	100	50	100	30	70
			30	125			50	100
4	40	200	40	150	60 75	125 150	75 100	125 150
			50	200	100	200		

* Setting for normal, or standard starting duty applications. Breaker with higher current setting recommended for applications with frequent starting or long accelerating times.

Table 7. Horsepower/interrupter ratings - combination starters with Mag-Break® motor circuit protectors

NEMA Size	200 to 240 Volts		480 Volts		600 Volts	
	Max Hp	Interrupter Rating, Amps	Max Hp	Interrupter Rating, Amps	Max Hp	Interrupter Rating, Amps
0	1/2	3	1	3	1	3
	1 1/2	7	3	7	3	7
	3	15	5	15	5	15
1			7 1/2	15	7 1/2	15
	7 1/2	30	10	30	10	30
2			15	30	20	30
	10 (200 V)	50	25	50	25	50
	15 (240 V)	50				
3			30	50	40	50
	25 (200 V)	100	50	100	50	100
	30 (240 V)	100				
4					60	100
	40 (200 V)	150	100	150	100	150
	50 (240 V)	150				

Table 8. Horsepower/clip size - combination starters with fusible disconnects

NEMA Size	Hp	Fuse Clip (Amps)	Hp	Fuse Clip (Amps)	Hp	Fuse Clip (Amps)	Hp	Fuse Clip (Amps)
Single Element								
	200 to 208 Volts		240 Volts		480 Volts		600 Volts	
0	3	30	3	30	5	30	5	30
1	7 1/2	60	7 1/2	60	7 1/2	30	7 1/2	30
					10	60	10	60
2	10	100	15*	100	15	60	20	60
					25	100	25	100
3	25*	200	30*	200	30*	100	30	100
					50	200	50	200
4	40	400	50	400	60*	200	60	200
					100	400	100	400
Dual Element								
0	3	30	3	30	5	30	5	30
1	7 1/2	30	7 1/2	30	10	30	10	30
2	10	60	15	60	25	60	25	60
3	25*	100	30*	100	50	100	50	100
	25	200	30	200	100	200	100	200
4	40	200	50	200	200	400	200	400

* Fuse rating for normal, or standard starting duty applications. Fuse with next higher current rating recommended for applications with frequent starting or long accelerating times Class H fuses are commonly classified as "NEC-type" fuses. Class R current-limiting fuses are recommended for applications that require high interrupting capacity. Class H and Class R fuses are offered both in single element, non-time delay; and in dual element, time delay construction. *Fuses are not supplied as part of the starter equipment.* When fusible starters are ordered, either non-rejection fuse clips (for Class H fuses) or rejection-type fuse clips (for Class R fuses) are furnished with the starter.

Example: Using Tables 6, 7, and 8, select the current settings/fuse rating and starter size for a 10 hp, 460 volt motor for a normal starting duty application with thermal magnetic, Mag-Break and fusible disconnect (Class H clips) devices.

8. What type of overload relay is needed?

There are three overload relay options. They are, 1) standard overload relay with one normally closed (NC) auxiliary contact, 2) ambient compensated overload relay with one NC auxiliary contact and 3) standard overload relay with both one NC and one normally open (NO) auxiliary contact.

Option 1 - standard overload relay with one NC contact

The majority of combination starter applications use "standard" overload relays with a single NC auxiliary contact. The normally closed contact is required to complete normal Start/Stop control circuits. When the overload relay has not tripped, the auxiliary contacts are closed - "normally" closed. Once the overload relay trips, the NC auxiliary contacts open, and power is removed from the starter's coil, and the motor starter opens, stopping the motor.

Standard overload relays are used when both the starter and the motor have nearly the same ambient temperatures.

Option 2 - ambient-compensated overload relay with one NC contact

Ambient-compensated overload relays are recommended when the starter and the motor may be subjected to different ambient temperature conditions.

Option 3 - standard overload relay with one NC and one NO contact

Some customers' control circuitry require an overload relay with one normally open (NO) auxiliary contact in addition to the NC contact used for Start/Stop control. The additional contact is most frequently used in conjunction with an external indicating light, a bell alarm, a programmable logic controller (PLC) or an industrial computer to assist in locating and diagnosing system malfunctions. The NO contact closes when the overload relay trips.

The additional NO contact is isolated, and suitable for 24 Vdc, 24 Vac and 120 Vac control circuits.

9. Are auxiliary contacts needed with the starter?"

All starters come standard with a N.O. "holding interlock." Additional options are:

1. None
2. One normally open (NO)
3. One NO and one normally closed (NC)
4. Two NO
5. Two NO and one NC
6. Two NO and two NC (this option is not available on size 0 and size 1 starters when the red and green light options are selected.)

Normally open (NO) auxiliary contacts on the starter duplicate the position of the starter's power contacts. When the starter is de-energized, the contacts are open, and when the starter is energized, the contacts close. Normally closed (NC) contacts work conversely, i.e., when the starter is energized, the NC contacts open.

Note the overload relay NC auxiliary contacts are usually closed regardless of whether the starter is energized (causing its NO contacts to close, and its NC contacts to open) or de-energized. Do not confuse the differences in functions between auxiliary contacts on the overloads and the starter.

10. What type of fusing is desired for the CPT and starter control circuit?

Three options are offered with "Quick Ship" combination starters for protection of the starter control circuit when a control power transformer (CPT) is ordered: 1) two fuses for the control circuit, 2) one fuse on the secondary of the CPT and 3) two fuses on the primary of the CPT and one on the secondary.

Option 1 - two fuses in the control circuit

This option provides control circuit busing when no CPT is required.

Option 2 - one fuse in the CPT secondary

This option provides a similar level of protection against sustained overloads in the control circuit and protection from most theoretical short circuits in the control circuit. This does not protect against short circuits in the primary or secondary windings of the CPT.

Option 3 - two CPT primary fuses and one secondary fuse

This option provides complete short circuit protection for both the CPT and the control circuit. Sustained overload protection is also provided for both circuit elements.

Customers must specify the type of fusing required for the CPT. Recent revisions in the National Electrical Code Article 450-3(b) makes fusing requirements more stringent than in the past. Two primary fuses are now required for most applications. When in doubt, use Option 3.

11. What type of door-mounted push buttons, or selector switch is needed?

Here, the important point to emphasize is the variety of options within the "Quick Ship" combination starter program. Most customers can be encouraged to select one of these options in order to take advantage of the "Quick Ship" values of the program.

There are eight door-mounted pilot device control options:

1. None
2. NEMA 1 Start/Stop push button
3. NEMA 1 H-O-A (Hand-Off-Automatic) selector switch
4. NEMA 1 Off/On selector switch
5. Oiltight Start/Stop push buttons
6. Oiltight H-O-A selector switch
7. Oiltight Off/On selector switch
8. Oiltight H-O-A selector switch and Start push button

All of the pilot device options are available with NEMA Type 1 enclosures. However, no NEMA 1 pilot devices can be used with NEMA 12, NEMA 3R and NEMA 4 (stainless steel) enclosures. The reason for this requirement is quite simple. Use of NEMA 1 door-mounted pilot devices would prevent NEMA 12, 3R and 4 enclosures from meeting their proof tests.

Option 1 - none

Many customers will have their external pilot devices mounted on some form of grouped control. Or they may choose to add door-mounted devices of their own to the combination starter after it is received.

Options 2 through 4 - NEMA 1 pilot devices

The least expensive pilot devices to use with NEMA Type 1 control enclosures are NEMA 1. The ability to choose either Start/Stop push buttons, a H-O-A selector switch or an Off/On selector switch covers most customer needs.

Options 5 though 8 - oil-tight pilot devices

Many customers have standardized on oiltight pilot devices regardless of their choice of control enclosure. Consequently, they use oiltight devices on NEMA 1, NEMA 12, NEMA 3R and NEMA 4 enclosures. There is one additional choice of door-mounted controls offered to users of oiltight devices, and that is furnishing both an H-O-A selector switch and a START push button (Option 8).

12. What type of indicating lights are needed to mount on the enclosure?

Here again, as with door-mounted pilot devices, GE offers considerable flexibility within the "Quick Ship" combination starter program. There are seven options offered:

1. None
2. NEMA 1 red light across starter coil
3. Oiltight red light across starter coil
4. Oiltight green light across coil
5. Oiltight red push-to-test light across coil
6. Oiltight green push-to-test light across coil

The same rules apply to indicating lights as selector switches and push button devices. All of the indicating light options are available with NEMA Type 1 control enclosures. However, either no lights or oiltight lights must be used with NEMA 12, 3R and 4 (stainless steel) enclosures.

General Comments - Options 2 through 6: Note that wiring from the starter coil to the indicating lights is done at the factory.

Push-to-test indicating lights are useful since they offer the operator a quick method of determining if the lamp filament is good (i.e., as long as power is on to the combination starter, pushing the lamp will cause it to light even when the starter is off).

The combination red/green indicating light option will illuminate the red light whenever the starter is on, and illuminate the green light whenever the starter is off. This assumes, of course, that electrical power to the starter control circuitry is on. When this option is chosen, a maximum of three auxiliary contacts may be added to Size 0 and Size 1 contactors.

Combination starters in the "Quick Ship" combination starter program have descriptive catalog numbers that define all of the many choices and options offered. No written descriptive instructions are required to describe the starter needed to serve customer needs besides the catalog number - except quantity.

Making a starter selection

1. Choose the protective device

Protective device	**CR number**
Thermal magnetic circuit breaker	CR307
Fusible disconnect switch	CR308
Mag-Break motor circuit protector	CR387

2. Choose the NEMA size starter

Starter size	**First suffix**
NEMA Size 0	B
NEMA Size 1	C
NEMA Size 2	D
NEMA Size 3	E
NEMA Size 4	F

3. Choose the enclosure

Enclosure type	**Second suffix**
NEMA Type 1, general purpose	1
NEMA Type 12, oil and dust tight	2
NEMA Type 3R, rain tight	6
NEMA Type 4, watertight, stainless steel	4

Example, first three choices: NEMA Size 2 combination starter with thermal magnetic breaker in a NEMA Type 12 enclosure: CR307D2

4. Choose the control voltage and control power transformer (CPT) requirements.

See Table 9.

Table 9. Suffixes for control voltage and CPT requirements

Input (Primary) Voltage	Starter Size, NEMA	Third Suffix in Catalog Number		
		No CPT	Standard CPT	100 VA Extra Capacity CPT
115-120	All	02	–	–
200-208	0 & 1	23	82	86
200-208	2	23	62	68
200-208	3	23	48	62
200-208	4	23	40	62
230-240	All	03	03	18
460-480	All	04	04	19
575-600	All	05	04	20

5. Choose the current rating/fuse rating

Tables 10, 11, 12 and 13 define the choices and the fourth catalog number suffix.

Table 10. Suffixes for CR307 (thermal magnetic breaker) starters vs. current rating

NEMA Size	Max. Hp	Fourth Suffix in Catalog Number							
		200-208 Volts		230-240 Volts		460-480 Volts		575-600 Volts	
		Rating	Suffix	Rating	Suffix	Rating	Suffix	Rating	Suffix
0	2	15A	4A	15A	4A	--	--	--	--
	3	20A	4B	20A	4B	15A	4F	--	--
	5	--	--	--	--	20A	4G	15A	4W
1	5	35A	4D	35A	4D	--	--	--	--
	7 1/2	50A	4E	50A	4E	30A	4H	20A	4X
	10	--	--	--	--	35A	4J	30A	4Y
2	10	50A	4E	50A	4E	--	--	--	--
	15	--	--	50A[4]	4E	50A	4M	40A	4Y
	20	--	--	--	--	50A	4M	50A	4Z
	25	--	--	--	--	50A[1]	4M	50A	4Z
3	15	100A	4C	--	--	--	--	--	--
	20	100A	4C	100A	4C	--	--	--	--
	25	100A[3]	4C	100A	4C	--	--	--	--
	30	--	--	100A[2]	4C	100A	4F	70A	4R
	40	--	--	--	--	100A	4F	100A	4S
	50	--	--	--	--	100A	4F	100A	4S
4	30	200A	4E	--	--	--	--	--	--
	40	200A	4E	150A[3]	4C	--	--	--	--
	50	--	--	200A	4E	--	--	--	--
	60	--	--	--	--	125A	4B	125A	4B
	75	--	--	--	--	150A	4C	125A	4B
	100	--	--	--	--	200A	4E	150A	4C

Notes:

1. For ordinary staring duting only; for frequent starts or long accelerating times use 70A suffix 4N.
2. For ordinary staring duting only; for frequent starts or long accelerating times use 125A suffix 4T.
3. For ordinary staring duting only; for frequent starts or long accelerating times use 200A suffix 4E.
4. For ordinary staring duting only; for frequent starts or long accelerating times use 100A suffix 4G.

Table 11. Suffixes for CR308 (disconnect switch) starters when dual element time delay fuses will be used

NEMA Size	Max. Hp	Fuse Clip	Fourth Suffix in Catalog Number							
			200-208 Volts		230-240 Volts		460-480 Volts		575-600 Volts	
			Rating	Suffix	Rating	Suffix	Rating	Suffix	Rating	Suffix
0	2	H	30A	1B	30A	1B	--	--	--	--
	2	R	30A	2P	30A	2P	--	--	--	--
	3	H	30A	1B	30A	1B	30A	1D	--	--
	3	R	30A	2P	30A	2P	30A	2R	--	--
	5	H	--	--	--	--	30A	1D	30A	1D
	5	R	--	--	--	--	30A	2R	30A	2R
1	5	H	30A	1B	30A	1B	--	--	--	--
	5	R	30A	2P	30A	2P	--	--	--	--
	7 1/2	H	60A	1C	30A	1B	30A	1D	30A	1D
	7 1/2	R	60A	2S	30A	2P	30A	2R	30A	2R
	10	H	--	--	--	--	30A	1D	30A	1D
	10	R	--	--	--	--	30A	2R	30A	2R
2	10	H	60A	1B	60A	1B	--	--	--	--
	10	R	60A	2P	60A	2P	--	--	--	--
	15	H	--	--	60A	1B	30A	1T	30A	1T
	15	R	--	--	60A	2P	30A	2W	30A	2W
	20	H	--	--	--	--	60A	1E	30A	1T
	20	R	--	--	--	--	60A	2S	30A	2S
	25	H	--	--	--	--	60A	1E	60A	1E
	25	R	--	--	--	--	60A	2S	60A	2S
3	15	H	100A	1B	--	--	--	--	--	--
	15	R	100A	2P	--	--	--	--	--	--
	20	H	100A	1B	100A	1B	--	--	--	--
	20	R	100A	2P	100A	2P	--	--	--	--
	25	H	100A[1]	1B	100A	1B	--	--	--	--
	25	R	100A[2]	2P	100A	2P	--	--	--	--
	30	H	--	--	100A[1]	1B	60A	1H	60A	1H
	30	R	--	--	100A[2]	2P	60A	2W	60A	2W
	40	H	--	--	--	--	100A	1E	60A	1H
	40	R	--	--	--	--	100A	2S	60A	2W
	50	H	--	--	--	--	100A	1E	100A	1E
	50	R	--	--	--	--	100A	2S	100A	2S
4	30	H	200A	1B	--	--	--	--	--	--
	30	R	200A	2P	--	--	--	--	--	--
	40	H	200A	1B	200A	1B	--	--	--	--
	40	R	200A	2P	200A	2P	--	--	--	--
	50	H	-	-	200A	1B	--	--	--	--
	50	R	-	-	200A	2P	--	--	--	--
	60	H	--	--	--	--	100A	1G	100A	1G
	60	R	--	--	--	--	100A	2W	100A	2W
	75	H	--	--	--	--	200A	1D	100A	1G
	75	R	--	--	--	--	200A	2S	100A	2W
	100	H	--	--	--	--	200A	1D	200A	1D
	100	R	--	--	--	--	200A	2S	200A	2S

Note: Unfused switches in all ratings have a "1A" suffix.

1. For ordinary staring duting only; for frequent starts or long accelerating times use 200A suffix 1C.
2. For ordinary staring duting only; for frequent starts or long accelerating times use 200A suffix 2R.

Table 12. Suffixes for CR308 (disconnect switch) starters when single element, non-time delay fuses will be used

NEMA Size	Max. Hp	Fuse Clip	Fourth Suffix in Catalog Number							
			200-208 Volts		230-240 Volts		460-480 Volts		575-600 Volts	
			Rating	Suffix	Rating	Suffix	Rating	Suffix	Rating	Suffix
0	2	H	30A	1B	30A	1B	--	--	--	--
	2	R	30A	2P	30A	2P	--	--	--	--
	3	H	30A	1B	30A	1B	30A	1D	--	--
	3	R	30A	2P	30A	2P	30A	2R	--	--
	5	H	--	--	--	--	30A	1D	30A	1D
	5	R	--	--	--	--	30A	2R	30A	2R
1	5	H	60A	1C	60A	1C	--	--	--	--
	5	R	60A	2S	60A	2S	--	--	--	--
	7 1/2	H	60A	1C	60A	1C	30A	1D	30A	1D
	7 1/2	R	60A	2S	60A	2S	30A	2R	30A	2R
	10	H	--	--	--	--	60A	1E	60A	1E
	10	R	--	--	--	--	60A	2T	60A	2T
2	10	H	100A	1C	100A	1C	--	--	--	--
	10	R	100A	2R	100A	2R	--	--	--	--
	15	H	--	--	100A	1C	60A	1E	60A	1E
	15	R	--	--	100A	2R	60A	2S	60A	2S
	20	H	--	--	--	--	TD**	--	60A	1E
	20	R	--	--	--	--	TD**	--	60A	2S
	25	H	--	--	--	--	TD**	--	TD**	--
	25	R	--	--	--	--	TD**	--	TD**	--
3	15	H	200A	1C	--	--	--	--	--	--
	15	R	200A	2R	--	--	--	--	--	--
	20	H	200A	1C	200A	1C	--	--	--	--
	20	R	200A	2R	200A	2R	--	--	--	--
	25	H	200A	1C	200A	1C	--	--	--	--
	25	R	200A	2R	200A	2R	--	--	--	--
	30	H	--	--	200A	1C	100A	1E	100A	1E
	30	R	--	--	200A	2R	100A	2S	100A	2S
	40	H	--	--	--	--	200A	1F	100A	1E
	40	R	--	--	--	--	200A	2T	100A	2S
	50	H	--	--	--	--	200A	1F	200A	1F
	50	R	--	--	--	--	200A	2T	200A	2T
4	30	H	400A	1C	--	--	--	--	--	--
	40	H	400A	1C	400A	1C	--	--	--	--
	50	H	--	--	400A	1C	--	--	--	--
	60	H	--	--	--	--	200A	1D	200A	1D
	60	R	--	--	--	--	200A	2S	200A	2S
	75	H	--	--	--	--	TD*	--	200A	1D
	75	R	--	--	--	--	TD*	--	200A	2S
	100	H	--	--	--	--	TD*	--	TD*	--
	100	R	--	--	--	--	TD*	--	TD*	

* Dual element, time delay fuses must be used for these ratings.

** 100A clips are available for non "Quick Ship" orders.

Fuses are not supplied with combination starters.

Table 13. Suffixes for CR387 (Mag-Break)® starters vs. current ratings

NEMA Size	Max. Hp	Fourth Suffix in Catalog Number							
		200-208 Volts		230-240 Volts		460-480 Volts		575-600 Volts	
		Rating	Suffix	Rating	Suffix	Rating	Suffix	Rating	Suffix
0	1/2	3A	6A	3A	6A	--	--	--	--
	1	7A	6B	7A	6B	3A	6A	3A	6A
	1 1/2	7A	6B	7A	6B	7A	6B	7A	6B
	2	15A	6C	15A	6C	7A	6B	7A	6B
	3	15A	6C	15A	6C	7A	6B	7A	6B
	5	--	--	--	--	15A	6C	15A	6C
1	5	30A	6D	30A	6D	--	--	--	--
	7 1/2	30A	6D	30A	6D	15A	6C	15A	6C
	10	--	--	--	--	30A	6D	30A	6D
2	10	50A	6E	50A	6E	--	--	--	--
	15	--	--	50A	6E	30A	6D	30A	6D
	20	--	--	--	--	50A	6E	30A	6D
	25	--	--	--	--	50A	6E	50A	6E
3	15	100A	6F	--	--	--	--	--	--
	20	100A	6F	100A	6F	--	--	--	--
	25	100A	6F	100A	6F	--	--	--	--
	30	--	--	100A	6F	50A	6E	50A	6E
	40	--	--	--	--	100A	6F	50A	6E
	50	--	--	--	--	100A	6F	100A	6F
4	30	150A	6G	--	--	--	--	--	--
	40	150A	6G	150A	6G	--	--	--	--
	50	--	--	150A	6G	--	--	--	--
	60	--	--	--	--	150A	6G	100A	6F
	75	--	--	--	--	150A	6G	150A	6G
	100	--	--	--	--	150A	6G	150A	6G

6. Choose the type overload required

Overload type	Fifth suffix
Standard with one NC contact	A
Ambient compensated with one NC contact	F
Standard with one NC and one NO contact	J

7. Choose the number of auxiliary starter contacts

Number/type of auxiliary contacts	Sixth suffix
None	A
One NO aux. contact	B
One NO and one NC contact	D
Two NO contacts	E
Two NO and one NC contact	G
Two NO and two NC contacts	N

8. Choose the type of fusing for the control power transformer

CPT protection	Seventh suffix
No CPT or CPT fusing	A
Two fuses of control circuit	D
CPT with one secondary fuse	S
CPT with 2 primary fuses and 1 secondary fuse	T

9. Choose the enclosure-mounted push buttons/selector switches

	Eighth suffix vs. enclosure	
Devices	**NEMA 1**	**NEMA 12, 3R, 4SS**
None	A	A
NEMA 1 Start/Stop push buttons	B	N/A*
NEMA 1 H-O-A selector switch	D	N/A*
NEMA 1 Off/On selector switch	E	N/A*
Oiltight Start/Stop push buttons	J	J
Oiltight H-O-A selector switch	L	L
Oiltight Off/On selector switch	M	M
Oiltight H-O-A switch and Start push button	S	S

N/A* = Not applicable for this enclosure type

10. Choose the type of enclosure-mounted indicating lights

	Ninth suffix vs. enclosure	
Indicating lights	**NEMA 1**	**NEMA 12, 3R, 4SS**
None	A	A
Oiltight red light across coil	B	N/A*
Oiltight red light across coil	J	J
Oiltight green light across coil	K	K
Oiltight red push-to-test light across coil	R	R
Oiltight green push-to-test light across coil	S	S
Oiltight red light across coil plus oiltight Green across coil through NC aux. contact	T	T

N/A* = Not applicable for this enclosure type.

Example: Continuing the example shown after the third choice, the partial catalog number for a NEMA Size 2 combination starter in a NEMA Type 12 enclosure with a thermal magnetic protective device is, "CR307D2."

Additional assumptions: Unit operates from 480 volts, 3 phase, 60 Hz and is sized to start a 25 hp motor with frequent starting. A CPT with an additional 100 VA will be used.

Table 13. Suffixes for CR387 (Mag-Break)® starters vs. current ratings

NEMA Size	Max. Hp	Fourth Suffix in Catalog Number							
		200-208 Volts		230-240 Volts		460-480 Volts		575-600 Volts	
		Rating	Suffix	Rating	Suffix	Rating	Suffix	Rating	Suffix
0	1/2	3A	6A	3A	6A	--	--	--	--
	1	7A	6B	7A	6B	3A	6A	3A	6A
	1 1/2	7A	6B	7A	6B	7A	6B	7A	6B
	2	15A	6C	15A	6C	7A	6B	7A	6B
	3	15A	6C	15A	6C	7A	6B	7A	6B
	5	--	--	--	--	15A	6C	15A	6C
1	5	30A	6D	30A	6D	--	--	--	--
	7 1/2	30A	6D	30A	6D	15A	6C	15A	6C
	10	--	--	--	--	30A	6D	30A	6D
2	10	50A	6E	50A	6E	--	--	--	--
	15	--	--	50A	6E	30A	6D	30A	6D
	20	--	--	--	--	50A	6E	30A	6D
	25	--	--	--	--	50A	6E	50A	6E
3	15	100A	6F	--	--	--	--	--	--
	20	100A	6F	100A	6F	--	--	--	--
	25	100A	6F	100A	6F	--	--	--	--
	30	--	--	100A	6F	50A	6E	50A	6E
	40	--	--	--	--	100A	6F	50A	6E
	50	--	--	--	--	100A	6F	100A	6F
4	30	150A	6G	--	--	--	--	--	--
	40	150A	6G	150A	6G	--	--	--	--
	50	--	--	150A	6G	--	--	--	--
	60	--	--	--	--	150A	6G	100A	6F
	75	--	--	--	--	150A	6G	150A	6G
	100	--	--	--	--	150A	6G	150A	6G

6. Choose the type overload required

Overload type	Fifth suffix
Standard with one NC contact	A
Ambient compensated with one NC contact	F
Standard with one NC and one NO contact	J

7. Choose the number of auxiliary starter contacts

Number/type of auxiliary contacts	Sixth suffix
None	A
One NO aux. contact	B
One NO and one NC contact	D
Two NO contacts	E
Two NO and one NC contact	G
Two NO and two NC contacts	N

8. Choose the type of fusing for the control power transformer

CPT protection	Seventh suffix
No CPT or CPT fusing	A
Two fuses of control circuit	D
CPT with one secondary fuse	S
CPT with 2 primary fuses and 1 secondary fuse	T

9. Choose the enclosure-mounted push buttons/selector switches

	Eighth suffix vs. enclosure	
Devices	**NEMA 1**	**NEMA 12, 3R, 4SS**
None	A	A
NEMA 1 Start/Stop push buttons	B	N/A*
NEMA 1 H-O-A selector switch	D	N/A*
NEMA 1 Off/On selector switch	E	N/A*
Oiltight Start/Stop push buttons	J	J
Oiltight H-O-A selector switch	L	L
Oiltight Off/On selector switch	M	M
Oiltight H-O-A switch and Start push button	S	S

N/A* = Not applicable for this enclosure type

10. Choose the type of enclosure-mounted indicating lights

	Ninth suffix vs. enclosure	
Indicating lights	**NEMA 1**	**NEMA 12, 3R, 4SS**
None	A	A
Oiltight red light across coil	B	N/A*
Oiltight red light across coil	J	J
Oiltight green light across coil	K	K
Oiltight red push-to-test light across coil	R	R
Oiltight green push-to-test light across coil	S	S
Oiltight red light across coil plus oiltight Green across coil through NC aux. contact	T	T

N/A* = Not applicable for this enclosure type.

Example: Continuing the example shown after the third choice, the partial catalog number for a NEMA Size 2 combination starter in a NEMA Type 12 enclosure with a thermal magnetic protective device is, "CR307D2."

Additional assumptions: Unit operates from 480 volts, 3 phase, 60 Hz and is sized to start a 25 hp motor with frequent starting. A CPT with an additional 100 VA will be used.

1. Third suffix - CPT with 100 VA and 480/120 Volts is "19."
2. Fourth suffix - Table 10, current rating is 70 amps, suffix is "4N."
3. Fifth suffix - overloads - assume standard overload with one NC contact. Suffix is "A."
4. Sixth suffix - auxiliary contacts - assume one NO and one NC. Suffix is "D."
5. Seventh suffix - CPT fusing - assume 2 primary and one secondary fuses. Suffix is "T."
6. Eighth suffix - pilot devices - assume oiltight Start/Stop push buttons. Suffix is "J."
7. Ninth suffix - indicating lights - assume oiltight Red push-to-test across coil. Suffix is "R."

Complete Catalog Number is: CR307D2194NADTJR

Fully modifiable starters

GE offers a complete line of combination starters that are factory engineered to provide a comprehensive array of custom modifications. Where time and volume justifies consideration of custom combination starters, excellent value is provided by these devices.

A partial listing of additional features and functions available in modifiable combination starters includes the following:

1. Larger NEMA sizes up to NEMA Size 9
2. Reversing and reduced voltage type starters
3. NEMA Type 4X enclosure with special corrosion resistant features
4. Additional pilot devices and elapsed time meters
5. Auxiliary relays and additional auxiliary contacts
6. Space heaters

Descriptions of modifiable combination starters are found in the GE Control Catalog and other product literature (e.g., publication GEA-10928).

Heater selection

To prevent overloading the starter do not select heaters for a motor of larger rating than the maximum given on the nameplate for the starter. *Heaters are not part of the "Quick Ship" combination starter program.* However, they may be obtained from a local GE distributor.

Motors with 1.15 service factor

For continuous rated motors with a service factor of 1.15, select the heater with the maximum motor amperes equal to or immediately greater than the motor full-load current. This provides a maximum of 125% protection.

Motors with 1.0 service factor

For continuous rated motors with a 1.0 service factor, multiply the full-load current of the motor by 0.90 and use this value to select the heater.

Short circuit protection

To protect the heaters and starter during a short circuit, select current settings of the combination starter protective device in accordance with Tables 6, 7 or 8. These tables provide branch circuit protection in accordance with Table 430-152 in Article 430 of the National Electrical Code.

Caution: Overload relays, when furnished with automatic reset, should not be used with two-wire, maintained contact pilot devices such as pressure, float and limit switches, as inadvertent starting of the motor can occur. Overload relays in the "Quick Ship" program are all manual reset.

How to select heaters

Table 14 should be used to determine which column of motor full-load current (amperes) in Tables 15 and 16 applies for heater selection. If the motor's full-load amperes falls between two ratings, select heaters for the higher rating.

Table 14. Full-load current guide for three-phase, three-pole, three-leg protection enclosed starters

Type of Overload Relay	Full-Load Amperes Column
Standard Overload Relay	
NEMA Sizes 0 to 4	2
Ambient Compensated Overload Relay	
NEMA Sizes 0 to 2	1
NEMA Size 3	2
NEMA Size 4	3

Table 15. Heaters for magnetic starters NEMA Size 0 through 2

NEMA Sizes 0 and 1			NEMA Size 2		
Maximum Motor Full - Load Amperes, Column			Maximum Motor Full - Load Amperes, Column		
1	2	CR123 Suffix	1	2	CR123 Suffix
2.05	1.98	C239A	5.85	5.72	C630A
2.28	2.24	C268A	6.47	6.30	C695A
2.47	2.43	C301A	7.35	7.04	C778A
2.79	2.75	C326A	8.06	7.91	C867A
3.31	3.25	C356A	9.03	8.80	C955A
3.70	3.43	C379A	9.61	9.27	C104B
4.06	4.03	C419A	10.5	9.99	C113B
4.47	4.43	C466A	11.6	11.1	C125B
4.95	4.94	C526A	12.5	12.1	C137B
5.49	5.36	C592A	13.6	13.1	C151B
5.91	5.77	C630A	16.7	15.5	C163B
6.47	6.35	C695A	17.9	16.8	C180B
7.20	6.92	C778A	18.7	18.0	C198B
8.22	7.99	C867A	20.4	19.7	C214B
8.72	8.47	C955A	22.7	21.6	C228B
9.67	9.19	C104B	24.7	23.9	C250B
10.4	10.0	C113B	26.3	25.5	C273B
11.0	10.7	C125B	29.5	28.2	C303B
12.4	12.0	C137B	32.5	31.6	C330B
13.2	12.9	C151B	36.7	34.7	C366B
15.4	15.1	C163B	41.9	37.8	C400B
17.1	16.3	C180B	43.2	40.6	C440B
18.1	17.9	C198B	45.0	45.0	C460B
20.0	19.7	C214B			
21.5	21.2	C228B			
22.5	22.3	C250B			
23.9	23.5	C273B			
26.3	25.5	C303B			
27.0	27.0	C330B			

Table 16. Heaters for magnetic starters NEMA Size 3 and 4

NEMA Size 3		NEMA Size 4		
Max. Motor Full Load Amperes, Column	CR123 Suffix	Maximum Motor Full Load Amperes, Column		CR123 Suffix
2		2	3	
18.4	F233B	32.0	32.0	F357B
21.1	F243B	34.2	34.2	F395B
22.1	F270B	36.7	36.7	F430B
26.1	F300B	43.9	43.9	F487B
28.0	F327B	46.6	46.6	F567B
31.3	F357B	52.6	52.6	F614B
33.3	F395B	55.6	55.6	F658B
34.3	F430B	58.7	58.7	F719B
40.9	F487B	67.1	67.1	F772B
44.7	F567B	70.6	70.6	F848B
51.0	F614B	76.3	76.3	F914B
52.0	F658B	88.7	88.7	F104C
55.4	F719B	93.4	93.4	F114C
63.3	F772B	102.0	105.0	F118C
66.1	F848B	110.0	114.0	F133C
73.5	F914B	122.0	128.0	F149C
82.2	F104C	131.0	131.0	F161C
90.0	F114C	135.0	135.0	F174C

Example: Select the heaters for a 25 hp, 1.15 Service Factor, GE Type K, drip-proof, normal efficiency, four pole, 460 Vac, three phase, 60 Hz motor with a full-load current of 30.0 amps and a locked rotor current of 182.5 amps. Standard starter duty is required, and a standard overload relay will be used.

A NEMA Size 2 starter has a horsepower rating of 25 hp at 460 Vac (see Table 1), and a maximum locked rotor current rating of 210 amps (see Table 2). Table 13 calls for use of Column 2 for heater selection. Table 14, NEMA Size 2 heaters, lists Catalog Number CR123C303B with a maximum full-load ampere rating of 28.2 A, and heater Catalog Number CR123C330B with a maximum full-load ampere rating of 31.6 A. Motor full-load current is 30.0 amps, therefore a heater rating of 31.6 amps is correct.

GE Electrical Distribution & Control

General Electric Company
41 Woodford Ave., Plainville, CT 06062

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