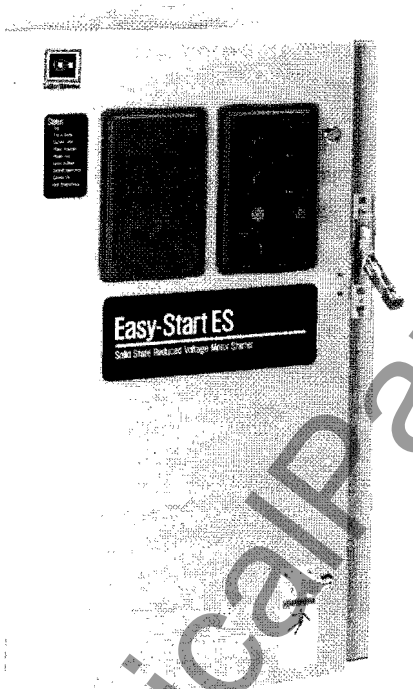
Easy-Start ES Solid State Reduced Voltage Motor Starter



Easy-Start ES is the industry's most complete line of solid state reduced voltage motor starters. It includes features like Digital Firing Circuit, Current Ramp, 5 Cycle Ride through Capability, and 6 Cycle Delayed Stop.

Easy-Start ES models are U.L. and C-UL listed.

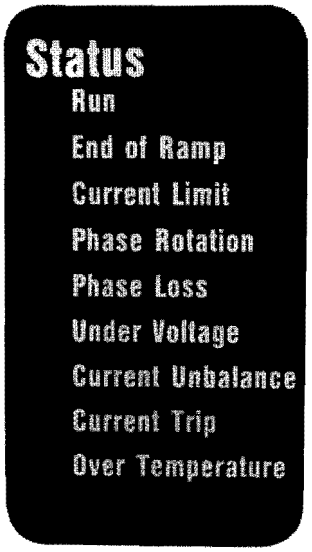
Easy-Start ES controls the voltage/current applied to the induction motor by phasing back the power semiconductors through electronic logic. It provides a smooth stepless start and can be used with standard 3-phase induction motors.

Six time proven silicon controlled rectifiers (SCR's) also called thyristors are used in all models.

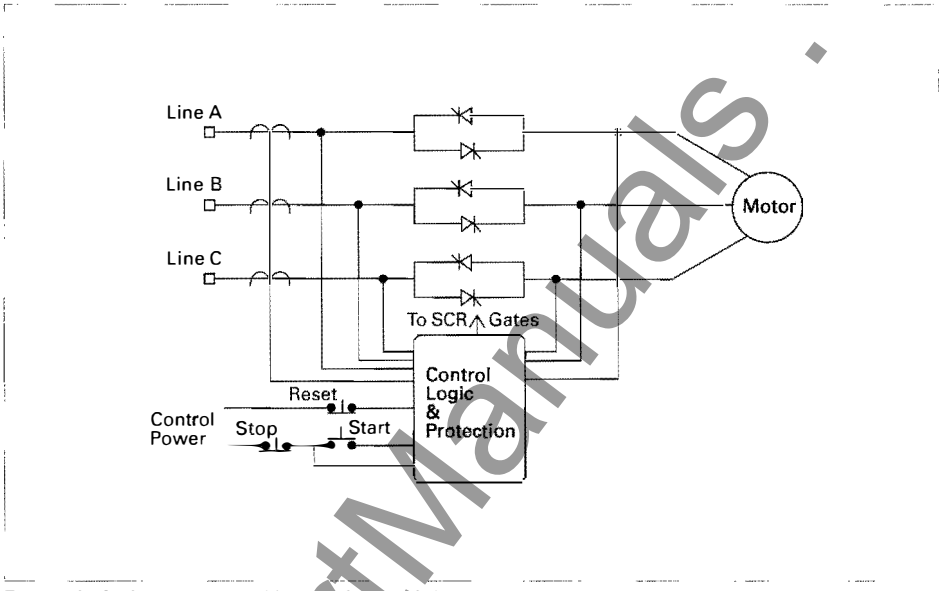
UL® Listed

c UL® Listed

Easy-Start ES Solid State Reduced Voltage Motor Starter



Easy-Start ES Status and Diagnostic Panel

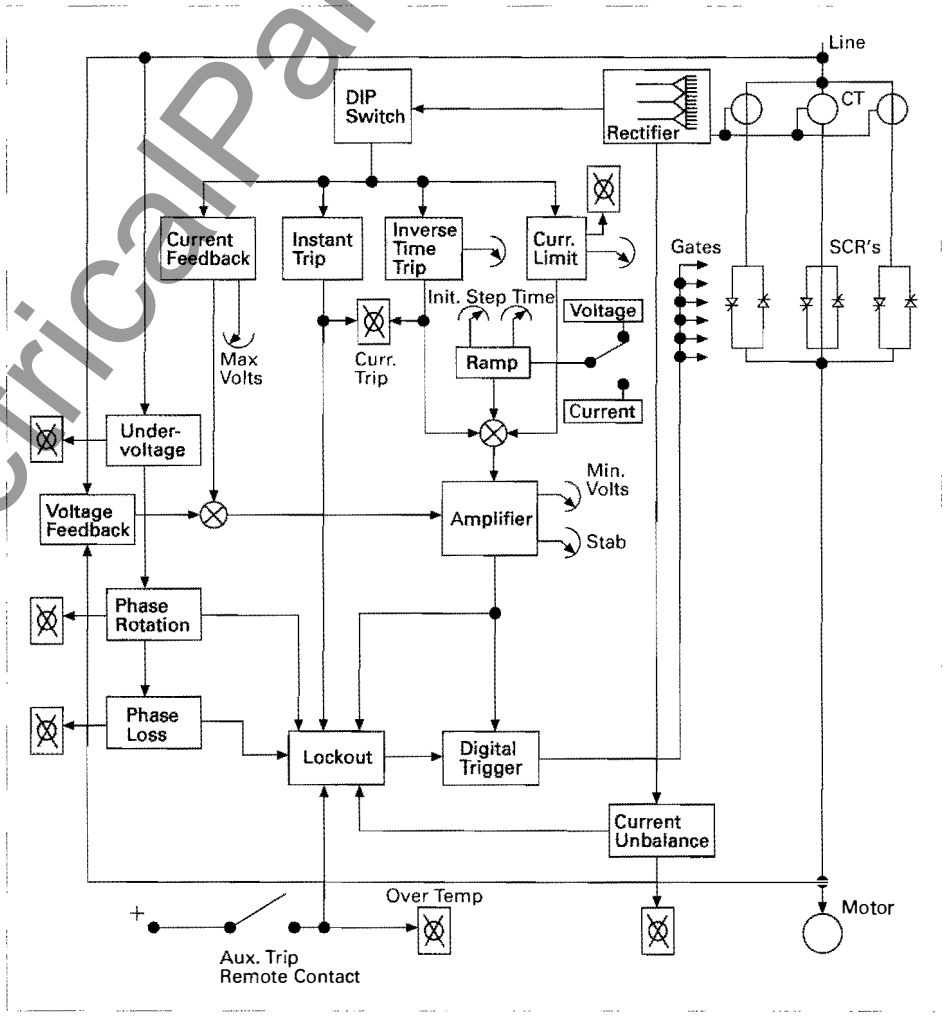


Typical Solid State Reduced Voltage Starter Schematic

WARNING: This literature is a general description of the equipment only. For proper installation, operation and maintenance of the equipment, consult the Instruction Manual. This should not be considered all inclusive. Improperly installing and maintaining these products can result in death or serious personal injury. Before attempting installation or maintenance, read and understand all instructional materials related to the product. If further information is required, you should consult Cutler-Hammer.

Sale of the product discussed in this literature is subject to terms and conditions outlined in appropriate Cutler-Hammer selling policies. The sole source governing the rights and remedies of any purchaser of this equipment is the relevant Cutler-Hammer selling policy.

NO WARRANTIES, EXPRESS OR IMPLIED, INCLUDING WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE OR MERCHANTABILITY, OR WARRANTIES ARISING FROM COURSE OF DEALING OR USAGE OF TRADE, ARE MADE REGARDING THE INFORMATION, RECOMMENDATIONS AND DESCRIPTIONS CONTAINED HEREIN. In no event will Cutler-Hammer be responsible to the purchaser or user in contract, in tort (including negligence), strict liability or otherwise for any special, indirect, incidental or consequential damage or loss whatsoever, including but not limited to damage or loss of use of equipment, plant or power system, cost of capital, loss of power, additional expenses in the use of existing power facilities, or claims against the purchaser or user by its customers resulting from the use of the information, recommendations and descriptions contained herein.



Easy-Start ES Block Diagram

Easy-Start ES Solid State Reduced Voltage Motor Starter

Features	What They Are	What They Do For You
• UL listed① • C-UL listed①	• Underwriter Laboratories Listing • Canadian Underwriters Laboratories	• Independent third party certification • Help in meeting local code requirements
• Status and diagnostic LED's on door	• Door mounted LED's for run, end of ramp, current limit, phase rotation, phase loss, undervoltage, current unbalance, current trip and over temperature (for fan cooled units only)	• Product differentiation • Increased user comfort with solid state • Reduced downtime • Increased productivity
• Higher current limit	• 500% current limit for 20 sec on all models • Adjustable 200-500%	• Setting can be tailored to specific application • Higher limit can be set for hard to start loads
• Two modes of starting	• Voltage ramp starting • Current ramp starting	• Voltage ramp starting is good for most applications • Current ramp starting is preferred for high inertia and long acceleration loads and where limiting the inrush current is prime consideration
• 6-SCR power section	• Each leg has 2-SCR's • SCR PIV (peak inverse voltage): 208 to 460V SCR – 1200 PIV 575V SCR – 1500V PIV	• Better control and less motor heating than 3 SCR 3 diode models
• Digital firing circuit	• Digital trigger is used for firing	• Digital trigger output provides more balanced voltage to motor • Digital trigger responds faster to rapidly changing loads
• Current calibration DIP switches • Common logic board • Multiple voltage rating	• Each model covers a wide range of motor full load amps • Can be calibrated to specific motor amps by DIP switches • Each model suitable for multiple line voltages • Common logic board for each multiple voltage model for all ampere ratings	• Reduced distributor inventory • Increased user/OEM flexibility • Reduced spare parts inventory • 460/500/575V Models cover the need of 1500 PIV SCR's in 460V applications • High-Low jumper on logic board provides closer matching of motor and starter voltage ratings
• Six cycle delayed stop	• SCR's phase back the motor voltage in about six cycles after stop command is given	• Minimizes high voltage from building up across SCR's on high inertia or over-hauling load
• Ride through capability	• 5-cycle power outage ride through	• Minimizes nuisance tripping
• More protection. Many new protective features have been incorporated	• Phase reversal protection • Current unbalance protection • Most protective features have LED indication and alarm relay • See Table 1 for complete list of protective features • Full time class 20 inverse time overcurrent protection • Built-in time delay for UV trip	• Increased user confidence in solid-state control • Reduced downtime • Increased productivity • Minimize nuisance tripping
• Energy savings	• Reduces voltage applied to the motor if the motor is underloaded • Can be defeated if desired	• Reduced power costs
• High line voltage control	• With energy saver circuit on, the Easy-Start ES will limit the voltage applied to the motor to controller's rated voltage under high-line conditions. Incoming voltage should be within the Easy-Start's ES rating	• Reduces power costs in installation with high line voltage which are common in off-peak hours
• Alarm Contact and Start Contacts	• Auxiliary – one isolated form 'C' contact rated 5 amps 120 Vac. Changes state on start. • Alarm – one non-isolated 120 Vac N.O. contact rated 1 amp	• Remote status or trip indication
• Continuous 120% rating	• Overload capability 20 seconds – 500% 30 seconds – 350% Continuous – 120% The above overload ratings are percentage of Easy-Start ES base current rating	• Can be applied on 1.15 service factor motors without derating

① ES950 Models have not been submitted for UL or C-UL Approval.

Easy-Start ES Solid State Reduced Voltage Motor Starter

Table 1: Easy-Start ES Protective Functions

Function	Range and Description
Inverse-Time Overcurrent Trip	See time current curve Class 20 protection
Phase Loss	Trips on phase loss after a nominal 0.5 sec. delay to minimize nuisance tripping
Under Voltage	Trips when voltage reaches 75% after a nominal 2 sec. delay to minimize nuisance tripping
Current Unbalance	Trips on 20% unbalance from average
Phase Rotation	Inhibits starting unless incoming line voltage is in A-B-C phase rotation
Instantaneous Trip	Trips at 900% current in one cycle or less
Six Cycle Delayed Stop	SCR's are phased off for approximately 6 cycles after stop command to minimize voltage buildup at load terminals while stopping high inertia loads
5 Cycle Power Outage Ride Through	Easy-Start ES will not trip if power outage lasts 5 cycles or less. This minimizes nuisance trips due to utility switching
Over Temperature	3-Thermostats, one in each leg trip the unit on over temperature. Provided on fan cooled units only to protect against fan failure
Current Limit	Adjustable 200-500% effective during starting only
Transient Voltage Suppression	Three MOV's (Metal Oxide Varistors) are provided
DV/DT Protection	R-C snubber networks are provided
Fault Withstand Ratings	UL Tested for 3 1/2 cycles 5,000 Amps: ES045 10,000 Amps: ES070 to ES180 18,000 Amps: ES250 to ES360 30,000 Amps: ES500 to ES560 42,000 Amps: ES750

Note: After trip the Easy-Start ES should be reset by pressing reset push button (optional). Automatic reset is not recommended.

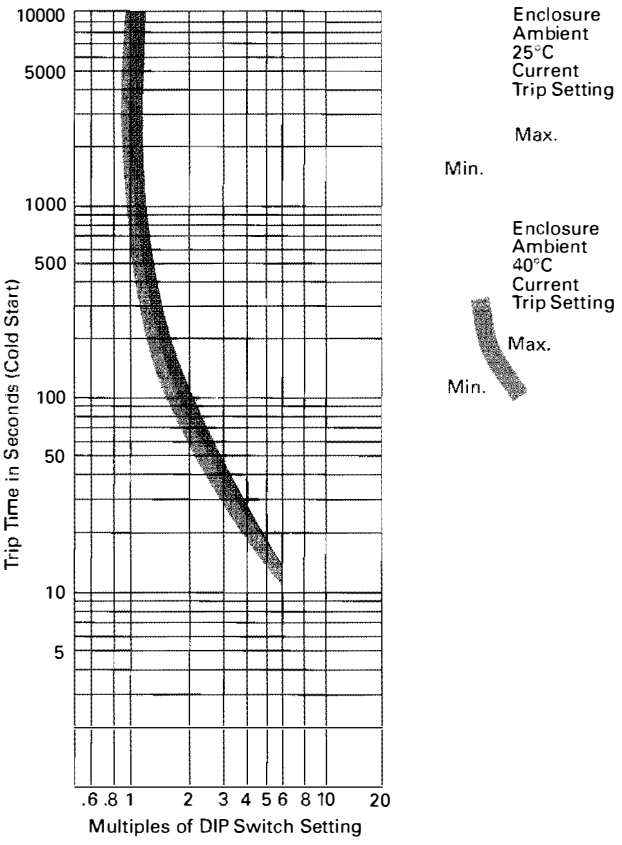
Table 2: Easy-Start ES Standard Conditions for Application

- Humidity: 20%-95% non-condensing, non-corrosive
- Altitude: To 3300 feet (1000 meters)
- Ambient temperature operations: -20°C to +40°C storage: -40°C to +65°C
- AC control voltage 120V single phase 50/60 Hz (approximately 50VA required) supplied externally by others or by optional control power transformer
- AC line voltage 208, 230, 380, 415, 460, 500 or 575V + 10-15% 3 phase 50/60 Hz

① In voltage ramp mode initial voltage applied is as selected by initial step adjustment and is increased until 100% voltage is applied over a period of time selected by ramp time adjustment. In current ramp mode initial current drawn is as selected by initial step adjustment and is increased up to the current limit adjustment setting over a period of time selected by ramp time adjustment.

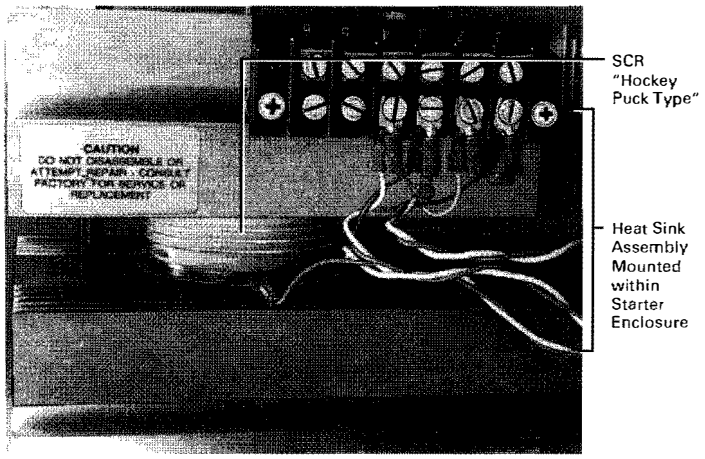
Table 3: Easy-Start ES Adjustments

Adjustment	Range	Approx. Factory Setting/ Comments
Ramp Mode①	Voltage Ramp Current Ramp	Voltage Ramp (DS3-1 Open) to change to current ramp close DS3-1
Initial Step – Voltage Ramp – Current Ramp	 20-90% 100-200%	 50% 150%
Ramp Time	1-40 seconds	20 sec.
Current Limit	200-500%	450%
Current Trip	100-120%	100%
Current Calibration DIP Switches	15% to 100% of current rating	Set in field for motor full load amps
Energy Saver Circuit	On/off	On: DS3-2 open. To disable energy savings close DS3-2
Voltage Rating Plug	230 or 460V 380 or 415V 500 or 575V	2 plugs supplied install one in field
Voltage Jumper	"High" – "Low"	"High" Install in "Low" when using 208/230/460V models on 208V. 460/500/575V models on 460V

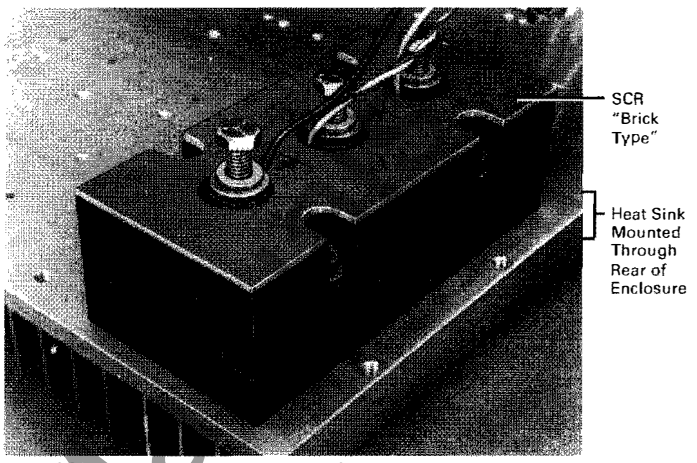


Overload Time – Current Characteristics

Easy-Start ES Solid State Reduced Voltage Motor Starter



SCR and Non-Isolated Heat Sink (Stack Assembly)



Dual SCR "Brick" and Isolated Heat Sink

Easy-Start ES Catalog Numbers and Ratings

Easy-Start ES is offered in two types of SCR's and Heat Sink combinations.

- Non-isolated heat sinks and hockey puck SCR's. These are offered in open panel construction and in NEMA 1 enclosures.
- Isolated heat sinks and brick type SCR's. These are offered in open panel construction and in NEMA 12 enclosures.

For mounting open panel units in box supplied by others refer to application considerations section.

Nominal HP or KW ratings are listed for reference only. Easy-Start ES should be sized for the motor nameplate Full Load Amps and application considerations. (See page 9.)

For pricing and availability refer to Price List 8650.

Nominal HP ratings are listed for reference only. The Easy-Start ES should be sized depending on the motor full-load amps. For example, an ES180 has a base rating of 180 full load amps.

Unit	AMP Ratings			Nominal Horsepower or KW					
	Min.	Base	Max.①	HP 208V	HP 230V	KW 380/415V	HP 460V	KW 500V	HP 575V
NEMA 12									
ES045②	7	45	54	5- 10	5- 15	4- 22	5- 30	4- 30	7- 40
ES070②	10	70	84	15- 20	20- 25	30- 37	40- 50	37- 45	50- 60
ES120②	18	120	144	25- 40	30- 40	45- 55	60-100	55- 75	75-100
ES250	36	250	300	40- 75	50-100	75-110	150-200	90-160	200-250
ES360	51	360	432	75-100	100-150	110-200	200-300	200-250	250-300
ES500	71	500	600	100-150	125-200	200-250	250-400	300-355	300-500
NEMA 1									
ES180	26	180	216	40- 60	40- 60	75- 90	75-150	55-110	100-150
ES260	38	260	312	60- 75	75-100	110	150-200	160	200-250
ES560	80	560	672	100-200	125-200	160-230	250-450	200-400	300-500
ES750	107	750	900	250-300	250-300	355-400	500-600	450-500	600-750
ES950	135	950	1140	350-400	300-350	450	600-750	600	800-900

Catalog Numbering System

ES 120 — 4EL XXX

- **ES** — Easy-Start ES
- **120** — Base ampere rating: 045, 070, 120, 180, 250, 260, 360, 500, 560, 750, 950
- **4** — Voltage: 3 – 380/415V; 4 – 208/230/460V; 5 – 460/500/575V
- **EL** — Enclosure: ER - Regular NEMA 12; NR - Regular NEMA 1; EL - Large NEMA 12; NL - Large NEMA 1; EP - Open Panel isolated heat sink; EC - Open panel isolated heat sink suitable for mounting in 20-inch wide MCC Structure; NP - Open panel non-isolated heat sink; NC - Open panel non-isolated heat sink suitable for mounting in 20-inch wide MCC structure (ES180 and ES250)
- **XXX** — Options (any sequence)

① Max. rating is 1.2x base rating due to 120% continuous capability.
② Utilizes isolated heat sinks.

Easy-Start ES Solid State Reduced Voltage Motor Starter

Factory Modifications

The following items are available as factory modifications.

Cat. No. Suffix	Description
Operator Devices – Door Mounted and Wired	
A	Start (Green), Stop (Red), Reset (Gray) Pushbuttons
B	Hand-Off-Auto (Gray) Selector Switch and Reset (Gray) Pushbutton. With selector switch in hand position the starter is controlled by start-stop pushbuttons. In auto position the starter is controlled by a remote maintained contact input.
A2	Start (Green), Stop (Red), Reset (Gray) Pushbuttons and Hand-Off-Auto (Gray) Selector Switch.
R	Reset (Gray) pushbutton
L5	"Power On" red push to test pilot light
L6	"Run" green push to test pilot light
L4	"Trip" amber push to test pilot light
Control Devices	
T②	150VA Control Power Transformer① with 2 fuses on primary. This is a multi-voltage transformer. The primary can be connected for 208, 230, 380, 415, 460, 500, 575 volts. Secondary voltage is between 110-120 volts depending upon primary voltage. The transformer is factory wired as follows: 208/230/460V models are wired for 460V 380/415V models are wired for 380V 460/500/575V models are wired for 575V For other incoming line voltages the transformer must be rewired in field.
T2②	Same as T except 300VA①
T4②	Same as T except 500VA① (Models 180A and above only)
Y	Auxiliary Run Relay. 2 NO 2 NC contacts. Relay coil is rated 110-120V AC and is prewired to the C.P. transformer. Relay is initiated from start command. Wiring to relay contacts is to be done directly on the relay.
Y2	Time Delay Run Relay: Running contacts will delay energization upon a Run command. 1 sec/10 min programmable.
Y3	Auxiliary Relay, 2 No 2 NC contacts. Relay coil is rated 110-120V AC. Wiring to contacts and to relay coil is by customer.
U②	Shorted SCR Detector: 4 LED's are provided. Shorted SCR LED comes on and a relay is energized. 1 NO and 1 NC contact can be used for indication, alarm, or trip functions.
U1②	Same as U with Red Door light.
Logic Board Plug-in Options (Factory Mounted)	
E③	• Extended Start-Time (up to 10.5 minutes)
E1③	• Extended Start-Time with Door Light
S	• Smooth Stop (1-30 seconds adjustable)
S1	• Smooth Stop with Door Light
S2	• Smooth Stop with Two Door Lights (Ramp-up and Smooth Stop)
J	• Jam/Underload When a specific motor load is definable, Jam protection will enable the starter to trip out immediately when the motor load rises above a specific set point. Underload is similar to Jam except the starter will trip when the motor load drops below a specific set point.
J1	• Same as J with Jam Door Light
J2	• Same as J with Underload Door Light

Cat. No. Suffix	Description
Instruments	
F2②	Ammeter, Single Phase, Door Mounted, with CT
F3②	Ammeter, Single Phase, Door Mounted, with 3 Position Selector Switch and 3 CT's
H	Elapsed Time Meter Door Mounted
G2	Voltmeter, Single Phase, Door Mounted (No PT Furnished)
G3	Voltmeter, Single Phase, Door Mounted with 3 Position Selector Switch (No PT's Furnished)
Special Functions	
•	Cutler-Hammer IQ DP-4000 monitoring module to monitor AC Amperes Phase A, B, C AC Voltage Line to Line, Line to Neutral Megawatts Megavars Power Factor Frequency Megawatt Demand
•	Cutler-Hammer IQ Data Line Metering System AC Motor Current Phase A, B, C AC Motor Voltage Phase A, B, C AC Line to Neutral Voltage (Four-wire Systems – all three) IQ DP-4000 and IQ Data are offered as monitoring devices only and all protective functions are disabled or set so they do not conflict with Easy-Start ES protective functions.

Cat. No. Suffix	Description
Q7④	IQ Data with Three CT's and 120 Volt Control Power Transformer
Q8④	IQ DP-4000 with Three CT's

If local codes or customer preference prohibit line voltage on door do not use this option.

Plug-In Option Kits for Field Mounting⑤

Available for customer mounting to existing Easy-Start Units.

Cat. No.	Description
KITESD⑤	Option Kit Interface Board
KITESE③	Extended Start-Time
KITESE1③	Extended Start-Time with Light
KITESS	Smooth Stop
KITESS1	Smooth Stop with Light
KITESS2	Smooth Stop with Two Lights
KITESJ	Jam and/or Underload
KITESJ1	Jam and/or Underload with Jam Light
KITESJ2	Jam and/or Underload with Underload Light
KITESU	Shorted SCR Detector

① Control power transformer also supplies power to logic board approximately 50VA; rest is available for customer use. **If a control power transformer option is not included, 120V 1 phase control power must be supplied from separate source for logic board.**
② F2, F3, T, T2, T4, U and U1 options not available on ES045, ES070, or ES120 open panel design or ES045 and ES070 NEMA 12 regular enclosure design.
③ Starter must be oversized to handle the high starting current for the extended time. See application note on page 10 and curves on page 12.
④ Requires large enclosure for ES045, ES070, or ES120.
⑤ Mounting of more than one option kit requires Option Kit Interface Board.

Easy-Start ES Solid State Reduced Voltage Motor Starter

Factory Modifications, *Continued*

Circuit Breakers
The circuit breakers offered with Easy-Start ES are listed in the following table and should be used with the corresponding Easy-Start ES model in the table.

Easy-Start ES in large enclosure must be priced for circuit breaker modification.

Thermal-Magnetic Series C Breaker①②

Easy-Start ES Model	Breaker Suffix (Rating Plug Amps)	Shunt Trip Suffix (If Required)	Cutler-Hammer Series C Breaker Frame	Breaker Amps	Breaker Lug Size
ES045-__EL	C01 (30 Amp) C02 (60 Amp)	N/A N/A	FD3030 FD3060	30 Amps 60 Amps	1/0 1/0
ES070-__EL	C03 (100 Amp)	S10	JD3250	250 Amps	350 MCM
ES120-__EL	C04 (150 Amp) C05 (200 Amp) C06 (250 Amp)	S10 S10 S10			
ES180-__NL	C08 (250 Amp) C09 (300 Amp) C10 (400 Amp)	S11 S11 S11	KD3400	250/300 Amps	500 MCM
ES250-__EL	C08 (250 Amp) C09 (300 Amp) C10 (400 Amp)	S11 S11 S11			
ES260-__NL	C08 (250 Amp) C09 (300 Amp) C10 (400 Amp)	S11 S11 S11		400 Amps	250 MCM (2)
ES360-__EL	C11 (800 Amp)	S12	MC3800	800 Amps	500 MCM (2)
ES500-__EL	C11 (800 Amp)	S12			
ES560-__NL	C11 (800 Amp)	S12			
ES750-__NL	C12 (1200 Amp)	S13	NC31200	1200 Amps	500 MCM (4)
ES950-__NL	C13 (1200 Amp)	S13			

Table 4: Dimensions and Weights

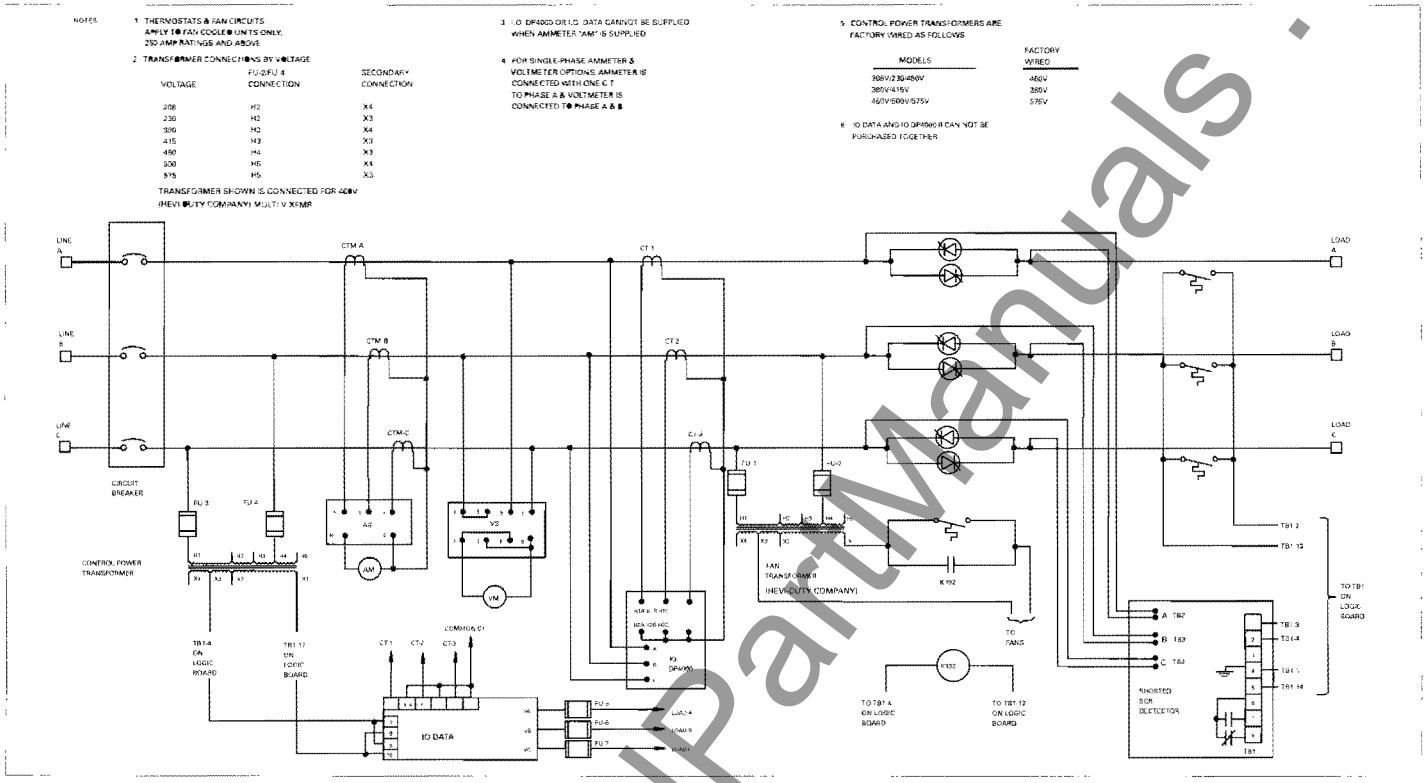
Approximate only. Not to be used for construction purposes.

Catalog Number③	Mounting	Enclosure	Height (In.)	Width (In.)	Depth (In.)	Weight (Lbs.)	Line/Load Lugs④	Minimum Clearance Required⑤	
								Sides (In.)	Top and Bottom (In.)
ES045-__EP	—	Open	16	19	11.5	32	#2	—	—
ES070-__EP	—	Open	16	19	11.5	33	#2	—	—
ES070-__EC	—	Open	15	14	8.3	33	1/0	—	—
ES120-__EP	—	Open	16	19	11.5	35	2/0	—	—
ES120-__EC	—	Open	27	14	8.3	60	250 MCM	—	—
ES180-__NP⑥	—	Open	39	26.75	14	100	250 MCM	—	—
ES180-__NC⑥	—	Open	48	18.5	9.5	100	350 MCM	—	—
ES260-__NP⑥	—	Open	39	26.75	14	112	500 MCM	—	—
ES250-__NC⑥	—	Open	48	18.5	9.5	100	350 MCM	—	—
ES560-__NP⑥	—	Open	39	26.75	14	137	500 MCM (2)	—	—
ES750-__NP⑥	—	Open	45	30.75	17	320	600 MCM (4)	—	—
ES950-__NP⑥	—	Open	78	33.00	21	400	600 MCM (4)	—	—
ES180-__NR⑥	Wall	NEMA 1	46.5	31	15.5	220	250 MCM	12	—
ES260-__NR⑥	Wall	NEMA 1	46.5	31	15.5	232	500 MCM	12	—
ES560-__NR⑥	Wall	NEMA 1	46.5	31	15.5	257	500 MCM (2)	12	—
ES180-__NL⑥⑦	Floor	NEMA 1	90	32	21	500	250 MCM	—	—
ES260-__NL⑥⑦	Floor	NEMA 1	90	32	21	510	500 MCM	—	—
ES560-__NL⑥⑦	Floor	NEMA 1	90	32	21	525	500 MCM (2)	—	—
ES750-__NL⑥⑧	Floor	NEMA 1	90	32	21	720	600 MCM (4)	—	—
ES950-__NL⑥	Floor	NEMA 1	90	38	22.5	800	600 MCM (4)	12	—
ES045-__ER	Wall	NEMA 12	28.5	25	14	95	#2	6	6
ES070-__ER	Wall	NEMA 12	28.5	25	14	95	#2	6	6
ES045-__EL	Wall	NEMA 12	43.5	24.5	15.5	120	#2	6	6
ES070-__EL	Wall	NEMA 12	43.5	24.5	15.5	120	#2	6	6
ES120-__EL	Wall	NEMA 12	43.5	24.5	15.5	121	2/0	6	6
ES250-__EL⑥	Floor	NEMA 12	90	32	21	520	500 MCM (2)	12	—
ES360-__EL⑥	Floor	NEMA 12	90	32	21	525	500 MCM (2)	12	—
ES500-__EL⑥	Floor	NEMA 12	90	32	21	550	500 MCM (2)	12	—

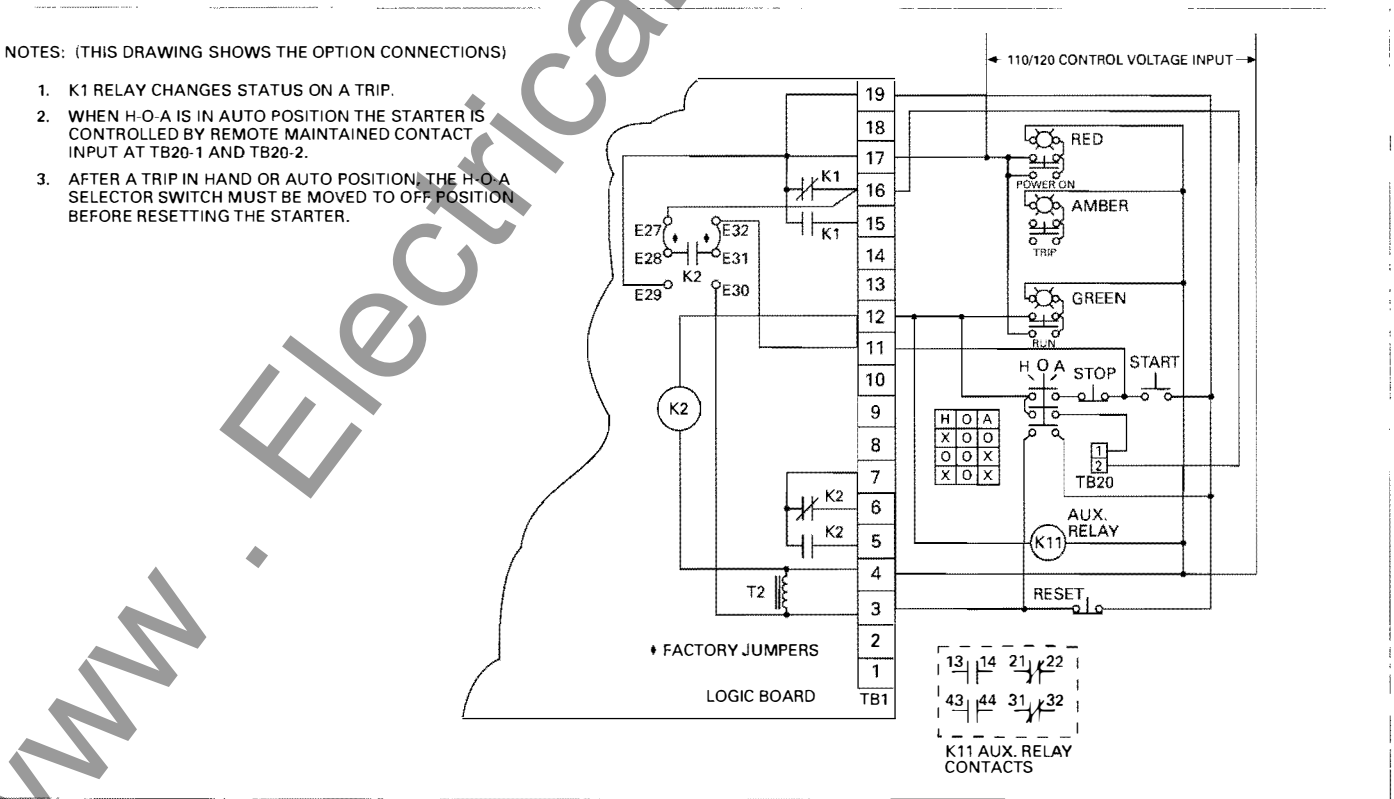
① For interrupting ratings and wire range terminals refer to Cat. 25-000.
② See application note on page 10 under circuit breakers.
③ __ in Cat. No. is 4 for 208/230/460V models, 3 for 380/415V models, 5 for 460/500/575V models.
④ Line lug sizes shown are for Easy-Start ES lug. If circuit breaker option is ordered line connections will be made on circuit breaker. Wall mounted units arranged for top entry, bottom exit.
⑤ Minimum clearance sides is minimum clearance required between adjacent units.
For NEMA 1 enclosure this clearance should be provided between unit and sidewall also.
For NEMA 12 enclosures the clearance between unit and sidewall is not required.
Minimum clearance top and bottom is required for NEMA 12 models only.
Minimum clearance required for open models will depend upon enclosure provided by others.
⑥ Use non-isolated heat sinks. Heat is dissipated via the enclosure surfaces.
⑦ MCC structure with 4" wire-way, could have cable entry/exit top or bottom.
⑧ ES750 arranged for top entry and exit only.

Easy-Start ES Solid State Reduced Voltage Motor Starter

Easy-Start ES Connection Diagrams



Easy-Start ES Power Connection With Options



Easy-Start ES Control Connections Start-Stop Pushbuttons With Hand-Off-Auto Selector Switch

Easy-Start ES Solid State Reduced Voltage Motor Starter

Application Considerations

Installation

A. Ventilated NEMA 1 enclosures should be mounted so that enough clearance is available for air to enter and exit the enclosure. Specific clearance requirements are shown on dimensions table.

B. NEMA 12 enclosures should be mounted so that heat sink fins are vertical. For wall mounted units a minimum clearance of 6 inches on top and bottom is required. For NEMA 12 units without heat sinks clearances should be maintained surrounding the enclosure. See Table 4.

C. Open panel units should be mounted in a box so the temperature inside the box does not exceed **50°C** (122°F).

For sizing the enclosure the heat loss in watts can be estimated at 3 times the full load current.

EXAMPLE: For ES180-4NR the maximum current rating is 180 amps. The approximate watts loss at maximum current rating is 3 x 180 = 540 watts.

For units with non isolated heat sinks, all the watt loss must be dissipated through the exposed box surfaces.

For units with isolated heat sinks; the heat sink fins should be brought out in open air through a properly gasketed cut out in the enclosure. Approximately 50% watt loss is dissipated through the heat sinks and the remaining 50% should be dissipated through the remainder of the box surface, not counting the heat sink.

Ambient Temperature

Easy-Start ES is rated for 40°C (104°F) ambient temperature. For above 40°C derate by 5% for every **5°C** rise over **40°C** up to **50°C** (122°F) max.

EXAMPLE: ES180-4NR is rated 180 Amps at 40°C. For 50°C the rating would be 180 x .9 = 162 Amps.

Altitude

Easy-Start is rated for 3300 ft. [1000 meters]. Use Derate Curve for derating above 3300 ft.

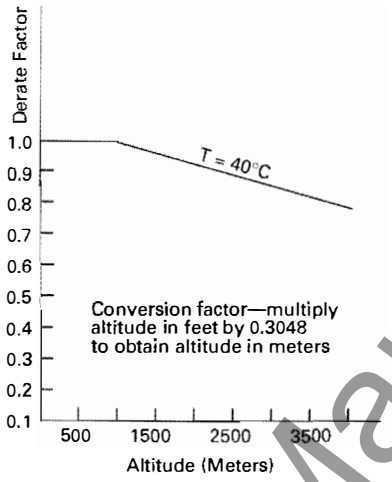
Multi-Motor Operation

Easy-Start ES can be used to control multiple motors if the following conditions are met:

— The current rating of Easy-Start ES should be equal to or greater than the total of individual motor full load amps and dip switches must be set for the cumulative full load amps of the motors.

— Individual motor overcurrent protection is provided by others.

— Energy Saver circuit should be turned OFF.



Derate Curve For Altitude

— The motors should not be mechanically coupled together, i.e. two motors on same shaft.

— NEC and local code requirement for individual motor protection and branch circuit protection are met.

Frequent Starting/Stopping

The number of starts and stops depends upon many factors. The most important ones are:

1. Position of current limit potentiometer which can be anywhere from 200-500% of the current rating set by the DIP switches.
2. Start time.
3. Run time.
4. Off time before next start.

The following tables (Table 5 through Table 14) can be used for guidance in frequent starting/stopping applications. These tables are based on the worst case condition of the controller running at the indicated starting current during the entire start time.

The number of starts per hour in the tables is based on the current carrying capacity of the SCR's. If a high number of multiple starts is used, the starter may trip due to the inverse-time overload current protection function.

If a trip should occur, due to multiple starts, it is advisable to wait a period of 10 minutes before restarting to avoid damage to the Easy-Start ES.

The motor manufacturer should be consulted about the effect of a high number of multiple starts on motor life.

Zero off-time in the starts per hour tables indicates jog duty.

EXAMPLE: If an application requires 1 start per minute, 60 starts per hour, for a 460V, 50 HP, 70 Amp motor; the cycle time is 60 seconds between starts. Assume a start time of 5 seconds, at a starting current of 500% (350 amps) is needed, with an off-time between run and start of 12 seconds, and a run time of 43 seconds.

The percent off-time is therefore 12/60 x 100 = 20%. We next look at the starts per hour tables on page 11 for a 70 amp starter (ES070)①. We can see that the model ES070 can do only 40 starts per hour at 350 amps with a start time of 5 seconds and an off-time of 20%.

Therefore, we need to use the next larger size starter, (ES120) from the tables on pages 11 and 12 we can see that 80 starts per hour are allowed at a starting current of 360 amps with a start time of 5 seconds and a 20% off-time, by using the model ES120. Easy-Start may trip due to overcurrent if repeated starts at high current and long starting times are used.

Starting Torque

The reduced voltage applied to the motor results in reduced inrush current and soft start. However, it reduces the starting torque of the motor. The relationship is as follows:

$$\frac{\text{Torque at Reduced Current}}{\text{Torque at Full Current}} = \left[\frac{\text{Current at Reduced Voltage}}{\text{Current at Full Voltage}}\right]^2$$

EXAMPLE: A 100 HP 1800 RPM 460V NEMA B motor draws six time full load amps for starting and starting torque is 150% of full load torque.

If the same motor is started with Easy-Start at 300% current limit.

$$\text{Starting Torque at 300\% Current Limit} = \left[\frac{300}{600}\right]^2 \times \text{starting torque at 600\% current}$$

= 1/4 x 150% full load torque
= 37.5% full load torque

NEMA Design C & D Motors, Wound Rotor Motors

These motors are used due to their high starting torque characteristics. When high starting currents and high starting torques are required, the extended time current option must be supplied with an oversized unit. Consult the factory for application considerations.

① 70 amp rating used for example only.

Easy-Start ES Solid State Reduced Voltage Motor Starter

Reversing Starters
If all the limitations are understood and accepted the Easy-Start ES can be used on line side of an electro mechanical reversing starter. The operation should be to start the motor in forward or reverse after a complete stop. Plug reversing i.e. going from forward to reverse directly will damage the starter. It is recommended that enough time delay be built into the reversing starter circuit (by others) to prevent restarting until the motor has come to complete stop.

WYE Delta (Six Lead) Motors
These should be connected in Delta and can then be started with Easy-Start ES.

Part Winding Motors
Part winding motors are started by applying full voltage to part of the winding and after a time delay full voltage is applied to the remaining winding.

For part winding motors the Easy-Start ES can be used by connecting the two windings in parallel.

2-Speed Motors
If all the limitations are understood and accepted Easy-Start ES may be used on the line side of an electromechanical 2-speed motor starter, but will provide soft start only if the motor is started in either speed from complete stop. The ramp (soft start) can be optimized for one speed only.

Going directly from low speed to high speed or high speed to low speed would not give smooth transition and may cause a current surge. It is recommended that enough time delay be built into the 2-speed starter circuit (by others) to prevent changing speeds without coming to full stop.

It should be checked with the motor manufacturer if the motor will develop enough starting torque to start the load from standstill in both low and high speed with a reduced voltage start.

Capacitors
Power factor correction capacitors should not be connected between load side of Easy-Start ES and the motor. This will cause damage to the starter.

Due to harmonics capacitors will have a higher temperature rise, and there is a risk of resonance. This situation can be minimized by the following:

– If a contactor is used to switch capacitors it should have a time delay built in the circuit so that the contactor closes after the Easy-Start has ramped up to full voltage.

The capacitors should be mounted as far upstream from the solid state starter as possible.

If capacitors must be used they must be connected on the line side of Easy-Start ES with at least 10 feet of cable between starter and the capacitors.

Starting Time
Easy-Start ES is rated for maximum current limit for 20 seconds. For longer starting time the rating curves on page 12 should be used and the extended start time option must be purchased. Maximum start time using this option is 12 minutes. This option inhibits the Inverse-Time Current Trip during the extended start time.

Consult Motor Manufacturer for Effect of Longer Starting Time on Motor Life.
If we have a 150 HP, 180A FLA motor which is driving a load with 120 second start time and if the current limit is set for 500%.

The maximum current draw is 180 x 5 = 900 amp; using the NEMA 1 Curves on page 12 we see that ES180-4NR will take 900A for 40 seconds. So we will have to go to a higher rated model ES260-4NR. Using the same curves we see ES260-4NR will handle 900 amps for almost 200 seconds. So ES260-4NR with extended start time option can be used for this application.

Circuit Breakers
Easy-Start ES has 500% current limit for 20 seconds. The upstream circuit breakers or protective devices should be sized so they can handle the maximum current for 20 seconds or longer if extended start times are required.

Automatic Reset
Due to power outage ride through capability Easy-Start ES cannot be wired for automatic reset after a trip. A manual reset pushbutton must always be used as shown on connection diagrams.

Software Programs Available for Help in Application Consideration①

- Motramp
  Calculates starting time of induction motors according to load characteristics and aids in selection of Easy-Start ES Model size.

- Starts
  Calculates number of starts per hour permissible with selected Easy-Start ES model. Takes duty cycle and current limit values into consideration.

- NEMA 4
  Calculates enclosure size according to the heat dissipation of the Easy-Start ES model selected. Note full load current ambient temperature and number of enclosure surfaces exposed to open air are taken into consideration.

Table 5

Model Number ES045			Starts Per Hour			
Curr. Lim.	Starting Current AC Amps	Start Time Sec.	Percent Off-Time			
			0%	10%	20%	30%
250%	113	2	180	240	320	480
		5	80	120	160	200
		10	50	70	85	100
		20	20	30	40	50
300%	135	2	150	220	300	360
		5	60	100	130	150
		10	40	50	60	70
		20	16	25	30	35
400%	180	2	100	160	200	240
		5	40	60	80	100
		10	20	30	40	50
		20	10	16	20	24
500%	225	2	80	120	150	180
		5	30	40	50	60
		10	12	16	20	24
		20	1	4	8	12

Table 6

Model Number ES070			Starts Per Hour			
Curr. Lim.	Starting Current AC Amps	Start Time Sec.	Percent Off-Time			
			0%	10%	20%	30%
250%	175	2	180	240	320	480
		5	80	120	150	180
		10	40	60	70	80
		20	20	30	35	45
300%	210	2	120	200	240	320
		5	40	60	100	120
		10	20	30	40	60
		20	8	16	20	30
400%	280	2	60	120	160	200
		5	30	40	60	80
		10	12	20	30	40
		20	4	8	16	20
500%	350	2	40	80	120	140
		5	12	24	40	60
		10	4	8	16	20
		20	—	4	8	12

① Refer to factory for software availability to run a specific program to aid in Easy-Start ES selection.

Easy-Start ES Solid State Reduced Voltage Motor Starter

Table 7

Model Number ES120			Starts Per Hour			
Curr. Lim.	Starting Current AC Amps	Start Time Sec.	Percent Off-Time 0%	10%	20%	30%
250%	300	2	120	180	240	360
		5	70	90	120	150
		10	30	50	60	70
		20	15	20	25	30
300%	360	2	100	120	180	240
		5	40	60	80	100
		10	20	30	40	50
		20	10	16	20	24
400%	480	2	60	80	100	120
		5	30	40	50	60
		10	4	8	16	20
		20	—	2	4	6
500%	600	2	12	20	40	50
		5	8	12	20	24
		10	—	2	4	6
		20	—	—	—	1

Table 8

Model Number ES180			Starts Per Hour			
Curr. Lim.	Starting Current AC Amps	Start Time Sec.	Percent Off-Time 0%	10%	20%	30%
250%	450	2	100	160	240	300
		5	40	60	80	100
		10	20	30	45	60
		20	10	15	20	30
300%	540	2	80	120	180	220
		5	30	40	60	80
		10	12	20	30	40
		20	8	10	12	16
400%	720	2	40	60	90	120
		5	20	30	40	50
		10	8	12	16	20
		20	4	8	10	12
500%	900	2	24	40	80	100
		5	12	20	30	40
		10	4	8	12	16
		20	—	2	4	6

Table 9

Model Number ES250			Starts Per Hour			
Curr. Lim.	Starting Current AC Amps	Start Time Sec.	Percent Off-Time 0%	10%	20%	30%
250%	625	2	120	180	240	300
		5	50	70	100	120
		10	25	40	50	60
		20	12	20	24	30
300%	750	2	80	120	160	220
		5	40	60	80	100
		10	20	30	40	50
		20	10	15	20	25
400%	1000	2	60	90	120	140
		5	24	35	50	60
		10	12	16	20	30
		20	4	8	12	15
500%	1250	2	30	50	70	100
		5	16	20	30	35
		10	8	10	15	20
		20	2	4	6	8

Table 10

Model Number ES260			Starts Per Hour			
Curr. Lim.	Starting Current AC Amps	Start Time Sec.	Percent Off-Time 0%	10%	20%	30%
250%	650	2	120	180	240	300
		5	40	60	100	120
		10	20	30	50	60
		20	10	15	25	30
300%	780	2	60	120	160	220
		5	30	50	70	90
		10	12	20	30	40
		20	8	12	16	20
400%	1040	2	40	60	100	120
		5	20	30	40	50
		10	8	12	16	24
		20	4	6	8	12
500%	1300	2	20	40	60	80
		5	8	12	20	30
		10	4	8	12	16
		20	—	2	4	6

Table 11

Model Number ES360			Starts Per Hour			
Curr. Lim.	Starting Current AC Amps	Start Time Sec.	Percent Off-Time 0%	10%	20%	30%
250%	900	2	120	200	300	400
		5	60	100	120	160
		10	30	50	60	80
		20	16	25	30	40
300%	1080	2	100	150	200	250
		5	40	60	100	120
		10	20	30	45	60
		20	10	20	25	30
400%	1440	2	60	100	140	180
		5	30	40	50	60
		10	15	20	25	30
		20	8	10	12	16
500%	1800	2	40	60	80	100
		5	20	30	40	50
		10	10	15	20	25
		20	4	8	10	12

Table 12

Model Number ES500			Starts Per Hour			
Curr. Lim.	Starting Current AC Amps	Start Time Sec.	Percent Off-Time 0%	10%	20%	30%
250%	1250	2	200	240	360	480
		5	80	120	160	200
		10	40	60	80	100
		20	20	30	40	50
300%	1500	2	120	200	240	300
		5	60	80	100	120
		10	30	40	50	60
		20	15	20	25	30
400%	2000	2	80	120	160	200
		5	40	60	80	100
		10	20	30	40	50
		20	10	15	20	25
500%	2500	2	60	80	100	120
		5	25	30	40	50
		10	10	15	20	25
		20	4	8	12	16

Table 13

Model Number ES560			Starts Per Hour			
Curr. Lim.	Starting Current AC Amps	Start Time Sec.	Percent Off-Time 0%	10%	20%	30%
250%	1400	2	100	180	300	400
		5	50	80	100	120
		10	24	40	60	80
		20	12	20	30	40
300%	1680	2	80	140	200	240
		5	40	60	80	100
		10	16	20	30	40
		20	8	16	20	24
400%	2240	2	50	100	120	140
		5	20	30	40	60
		10	8	16	20	24
		20	4	8	12	16
500%	2800	2	30	40	60	100
		5	12	20	30	40
		10	4	8	12	16
		20	—	2	4	6

Table 14

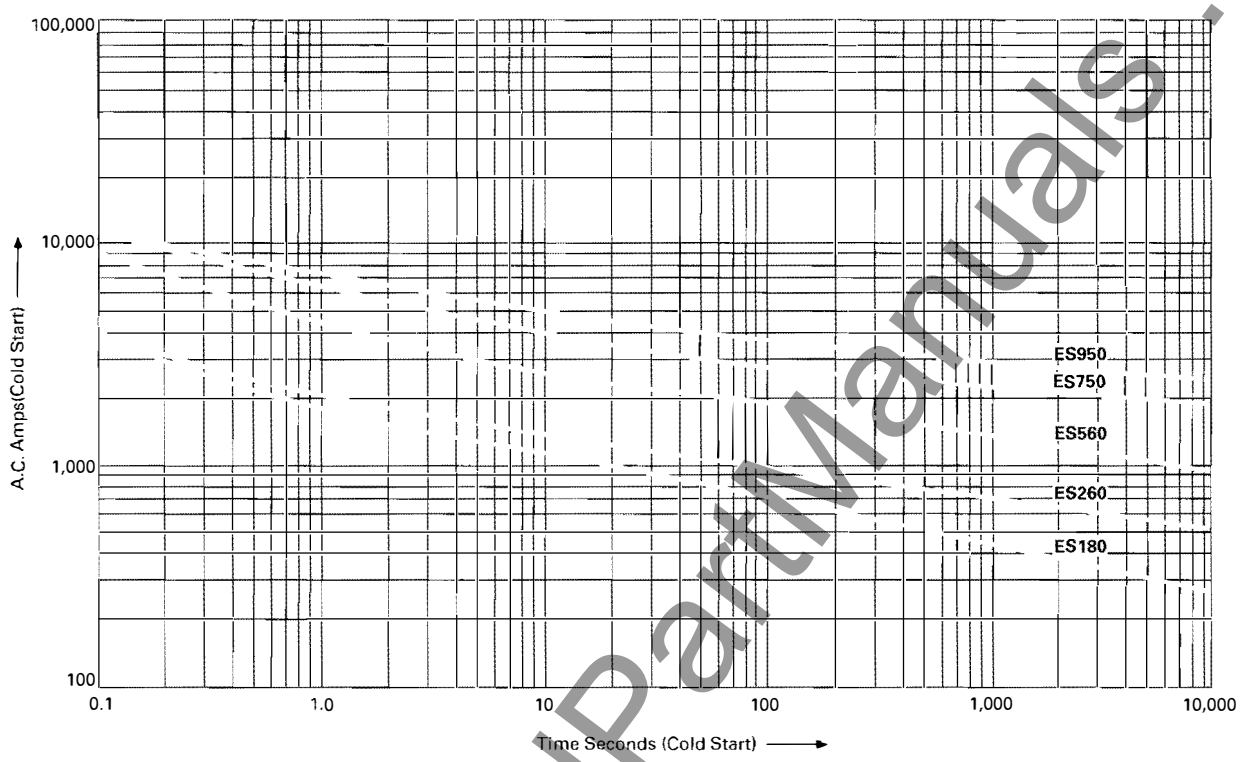
Model Number ES750			Starts Per Hour			
Curr. Lim.	Starting Current AC Amps	Start Time Sec.	Percent Off-Time 0%	10%	20%	30%
250%	1875	2	180	240	320	400
		5	80	100	120	150
		10	40	50	70	80
		20	20	25	30	40
300%	2250	2	120	200	240	300
		5	60	80	100	120
		10	30	40	50	60
		20	10	20	25	30
400%	3000	2	80	120	150	180
		5	30	40	50	60
		10	15	25	30	35
		20	8	10	12	16
500%	3750	2	60	80	100	120
		5	25	30	40	50
		10	10	15	20	25
		20	4	8	10	12

Table 15

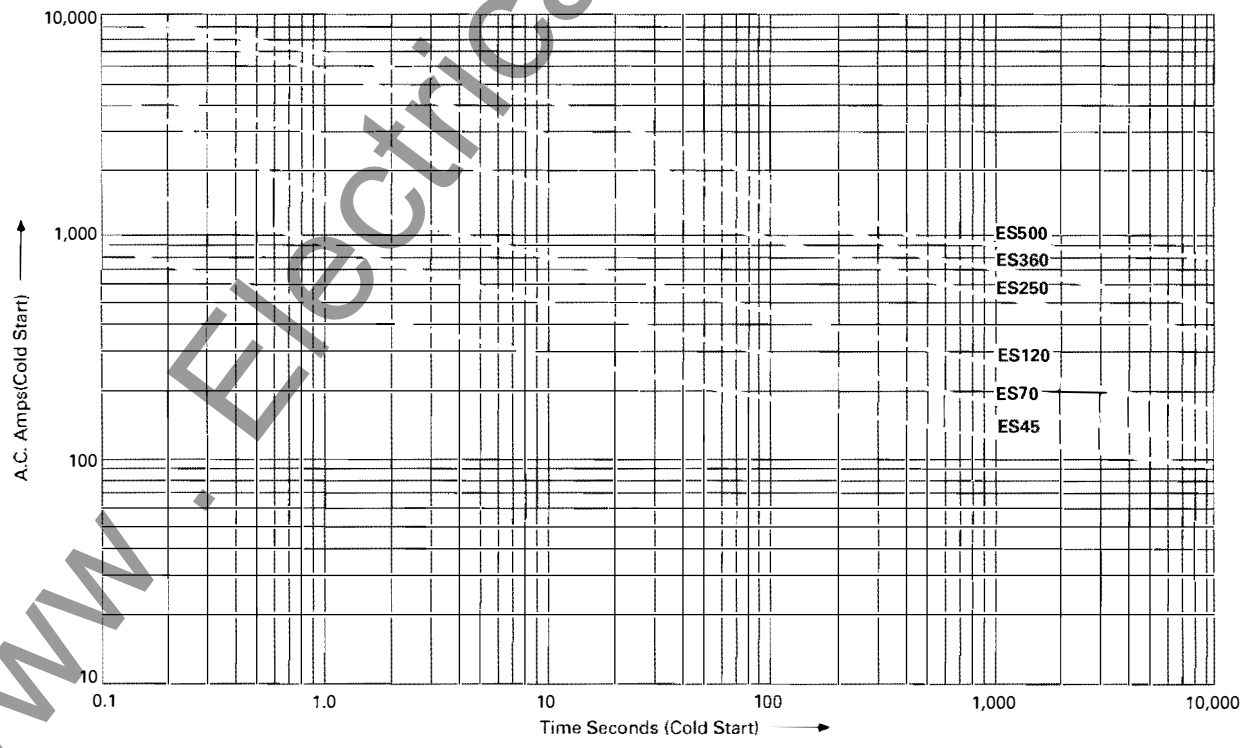
Model Number ES950			Starts Per Hour			
Curr. Lim.	Starting Current AC Amps	Start Time Sec.	Percent Off-Time 0%	10%	20%	30%
250%	2375	2	150	200	300	360
		5	60	90	120	150
		10	30	45	60	70
		20	15	20	30	35
300%	2850	2	100	150	200	250
		5	40	60	80	100
		10	20	30	40	50
		20	10	15	20	25
400%	3800	2	60	100	120	150
		5	25	40	50	60
		10	10	20	25	30
		20	4	8	12	15
500%	4750	2	30	50	80	100
		5	15	20	30	40
		10	6	8	10	12
		20	1	2	4	8

Easy-Start ES Solid State Reduced Voltage Motor Starter

NEMA-1 Current vs. Time Ratings



NEMA-12 Current vs. Time Ratings



Easy-Start ES Solid State Reduced Voltage Motor Starter

Standard Specification

Description
The Solid State Reduced Voltage Starter shall be UL and C-UL listed and consist of a power section and a one piece printed circuit logic board as specified hereinafter.

The power section shall be rated for the given amperes, volts, three phase, 50/60 Hertz. It shall consist of three (3) sets of back-to-back silicon controlled rectifiers (SCR's).

The power section shall have surge suppressors across the SCR's rated 10% above rated and not less than 300 joules for starters 250 hp and up. They shall be metal oxide varistor (MOV) type.

Resistor/Capacitor snubber networks shall be used to prevent false firing of SCR's due to dv/dt characteristics of the electrical system.

When fans are used, thermal sensors shall be installed on the heat sink to trip the control protective logic if there is an overtemperature condition. Thermal sensors shall be rated 90°C maximum.

SCR's shall be rated with peak inverse voltage at least 2.5 times rated line-to-line voltage.

The one piece logic board shall be mounted for easy testing, service and replacement. Three-phase current sensing is required.

The logic board shall use quick disconnect, plug-in connectors for current transformer inputs, line and load voltage inputs and SCR gate firing output circuits. The logic board shall be identical through all ampere ratings with DIP (Dual Inline Package) switches to set up various ampere ratings.

All user interface wiring shall connect to a common barriered terminal strip rated 1000 volts or greater.

The logic board shall include as a minimum:
- 5-cycle, three-phase power interruption ride-through.
- 6-cycle delay stop.
- Single-phase protection.
- Undervoltage protection.
- Short circuit "electronic fuse" overcurrent protection. Trip time shall not exceed 1 cycle or 16 milliseconds.
- Inverse time overcurrent protection.
- Heat sink overtemperature protection for fan failure.
- Auxiliary trip circuitry.
- Gate firing circuit lockout protection on trip.
- 100%-120% full load running current trip adjustment.
- 200%-500% current limit adjustment.
- 1-40 second voltage or current ramp (switch selectable).
- 20-90% initial voltage step or 100 to 200% initial current step adjustment.
- The capability to handle the following control schemes:
  1) 3-wire control, momentary contact, manual reset control logic.
  2) 2-wire control, maintained contact, manual reset control logic.
- Green run light emitting diode (LED).
- Green end of ramp LED.
- Red phase rotation incorrect LED.
- Red undervoltage trip LED.
- Red phase current unbalance LED.
- Red overcurrent trip LED.
- Red phase loss trip LED.
- Red current limit LED.
- Minimum voltage adjustment.
- Maximum voltage adjustment.
- Voltage stability adjustment.

The logic board shall include, as standard, an energy savings circuit which consists of current and motor slip sensing circuitry that continually monitor motor load and regulate motor voltage to minimize motor kwh energy consumption.

The customer interface circuitry shall include relay logic interface capability functions.

Tripped functions shall be designed to be cleared by interrupting customer control power from the solid state logic board. The three-phase line voltage must be interrupted to clean phase rotation trip function, and phase loss function. The logic board soldering shall be treated with a conformal protective coating system.

The solid state logic shall be phase sensitive, and shall inhibit starting, on incorrect rotation. Improper phase rotation shall be indicated on status panel and logic board of starter.

A transparent cover shall be mounted above the logic board to provide (a) an insulating safety barrier and (b) silk-screened with information to aid in starting and set-up of DIP Switches. Identified holes will be located above adjustment pots so that screwdriver adjustments can be made without removing the transparent cover.

Options that require auxiliary logic boards such as shorted SCR detection, smooth stop, jam protection, underload protection, extended start time, and relay output contacts shall be designed for factory mounting and wiring or for field mounting kits after installation of basic unit, inside the original enclosure.

Two ground lugs shall be furnished, one for line side and one for load side ground connections.

Power terminations shall consist of pressure type terminals for top or bottom entrance.

Door Devices – Enclosure Construction
All enclosures shall be not less than 16-gauge steel. NEMA 12 enclosures shall be of welded construction with gasketed heat sink and doors.

Doors shall include plastic device holders for mounting up to eight operator devices. Factory-mounted operator devices shall be factory wired.

Operating handle of disconnect, when supplied, shall always remain connected to the breaker or switch. The operating handle shall not be mounted on the door of the enclosure, but on the controller for safe "stand-aside" operation. Position of operating handle will indicate ON, Off or Tripped condition of switch or circuit breaker to include provision for padlock in Off position.

Interlock provisions shall prevent unauthorized opening or closing of the starter door with the disconnect in the On position.

The structure when floor-mounted shall be provided with adequate lifting means and shall be capable of being rolled or lifted into installation position and bolted to the floor.

Adequate conduit space shall be provided to meet the NEC requirements.

A door mounted status panel will be provided with LED's (which duplicate the logic board LED's) to indicate:

- Run
- End of ramp
- Current limit
- Phase rotation
- Phase loss
- Undervoltage
- Current unbalance
- Current trip
- Overtemperature (Not on logic board)

Easy-Start ES Solid State Reduced Voltage Motor Starter

Technical Assistance/Solid State Starter Startup

I. Why Use this Service

Due to the difference between Solid State Starters and other means of reduced voltage starting, Cutler-Hammer recognizes that users or the user's agents may not be familiar with the new technology. There are a few adjustments and operational checks unique to Solid State Starters which make them more flexible in range and versatile in application. These adjustments, though not difficult to make, are critical to the overall performance of the starter. A non-optimum adjustment and difficulties in scheduling man-power may cause startup and project delays.

II. Description

To help users avoid these situations, Cutler-Hammer recommends a special startup service① for all solid state starters, consisting of the following technical assistance (Refer to Service Policy SA 11423 for additional details):

1. Electrical and mechanical inspection of the Starter after it is installed and wired per the Starter drawings.
2. Final application related adjustments of the standard features such as DIP switch setting for motor amperes, current trip, starting voltage, current limit, energy saver, plus an operational check of starting, stopping, interlocking and sequencing all per the Starter Instruction Manual and drawings.
3. Operational check and adjustment for standard purchased options such as extended start time, smooth stop, jam and underload.
4. Checkout of spare parts if purchased and available during startup.
5. Formal report and record listing (a) equipment as found, (b) technical assistance rendered, (c) final controller settings, and (d) final recommendations to user.
6. Startup Service is provided on a per unit basis by Cutler-Hammer qualified startup engineers.
7. Purchase of startup service allows the purchase of extended warranty coverage at favorable pricing. The extended warranty must be puchased prior to starter shipment.

III. Cutler-Hammer Can Also Provide the Following Additional Technical Assistance

1. Pre-startup

Recommendations on spare parts, if not purchased with the original equipment.

Equipment inspection on receiving.

Recommendations for storage and installation, including environments, checks and wiring practices.

2. Post-startup

Standby service after equipment is operating.

On-site training in maintenance and troubleshooting.

Periodic site visits to assist in resolving questions, performance and maintenance.

Preventive maintenance programs.

① Refer to factory for pricing and scheduling parameters.

Easy-Start ES Solid State Reduced Voltage Motor Starter

Easy-Start ES Solid State Reduced Voltage Motor Starter

Cutler-Hammer
110 Douglas Road East
Oldsmar, Florida, U.S.A. 34677

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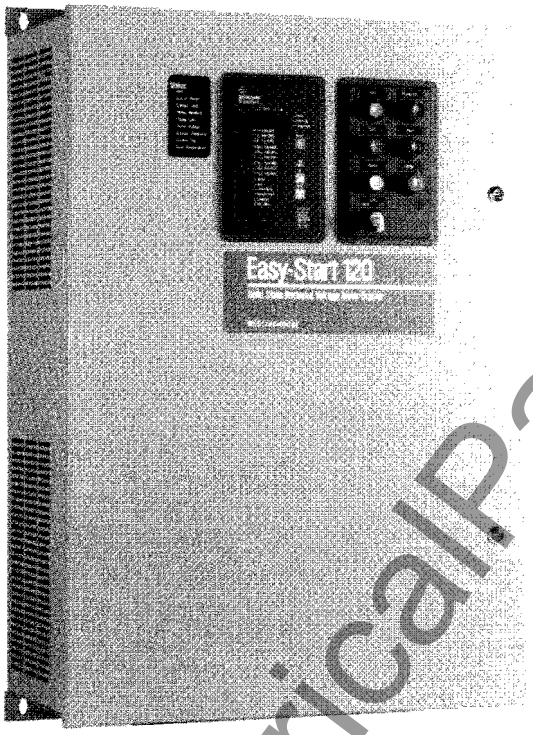
Easy-Start 120 Solid State Reduced Voltage Motor Starter



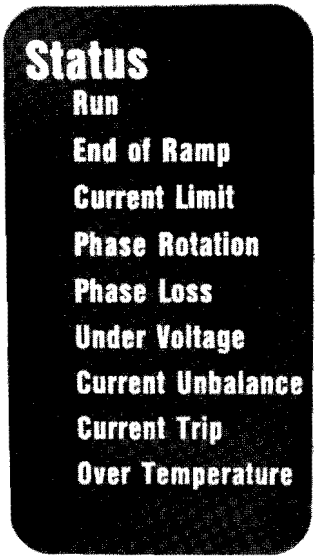
Easy-Start 120 is the industry's most complete line of solid state reduced voltage motor starters. It includes features like Digital Firing Circuit, Current Ramp, 5 Cycle Ride Thru Capability, and 6 Cycle Delayed Stop.

Easy-Start 120 models are U.L. and CSA listed.

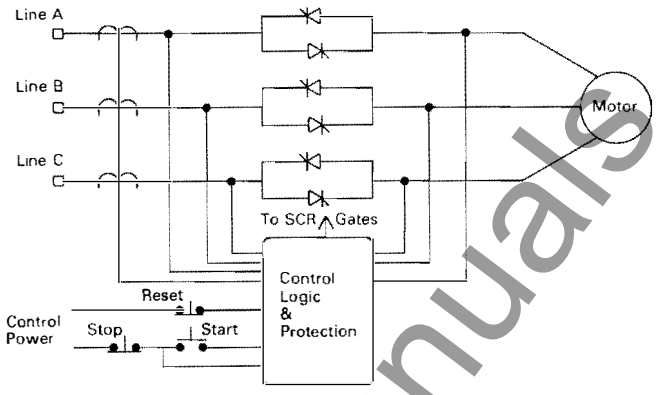
Easy-Start 120 controls the voltage/current applied to the induction motor by phasing back the power semiconductors thru electronic logic. It provides a smooth stepless start and can be used with standard 3-phase induction motors.

Six time proven silicon controlled rectifiers (SCR's) also called thyristors are used in all models.

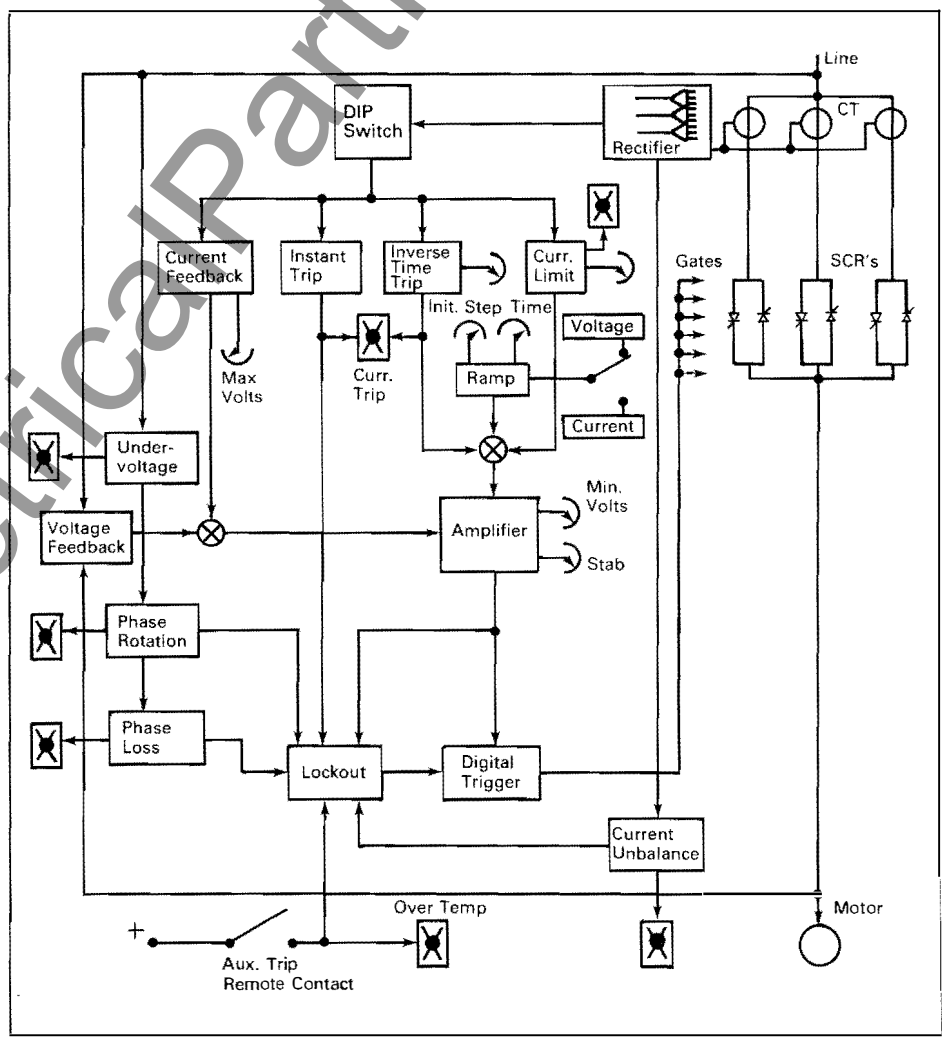
Easy-Start 120 Solid State Reduced Voltage Motor Starter



Easy-Start 120 Status and Diagnostic Panel



Typical Solid State Reduced Voltage Starter Schematic



Easy-Start 120 Block Diagram

WARNING: This literature is a general description of the equipment only. For proper installation, operation and maintenance of the equipment, consult the Instruction Manual. This should not be considered all inclusive. Improperly installing and maintaining these products can result in death or serious personal injury. Before attempting installation or maintenance, read and understand all instructional materials related to the product. If further information is required, you should consult Westinghouse Electric Corporation.

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Easy-Start 120 Solid State Reduced Voltage Motor Starter

Features	What They Are	What They Do For You
UL listed① CSA listed①	Underwriter Laboratories Listing Canadian Standards Association	Independent third party certification Help in meeting local code requirements
Status and diagnostic LED's on door	Door mounted LED's for run, end of ramp, current limit, phase rotation, phase loss, undervoltage, current unbalance, current trip and over temperature (for fan cooled units only).	Product differentiation Increased user comfort with solid state Reduced downtime Increased productivity
Higher current limit	500% current limit for 20 sec on all models Adjustable 200-500%	Setting can be tailored to specific application Higher limit can be set for hard to start loads
Two modes of starting	Voltage ramp starting Current ramp starting	Voltage ramp starting is good for most applications Current ramp starting is preferred for high inertia and long acceleration loads and where limiting the inrush current is prime consideration.
6-SCR power section	Each leg has 2-SCR's SCR PIV (peak inverse voltage): 208 to 460V SCR – 1200 PIV 575V SCR – 1500V PIV	Better control and less motor heating than 3 SCR 3 diode models.
Digital firing circuit	Digital trigger is used for firing	Digital trigger output provides more balanced voltage to motor. Digital trigger responds faster to rapidly changing loads.
Current calibration DIP switches Common logic board Multiple voltage rating	Each model covers a wide range of motor full load amps Can be calibrated to specific motor amps by DIP switches Each model suitable for multiple line voltages Common logic board for each multiple voltage model for all ampere ratings	Reduced distributor inventory Increased user/OEM flexibility Reduced spare parts inventory 460/500/575V Models cover the need of 1500 PIV SCR's in 460V applications High-Low jumper on logic board provides closer matching of motor and starter voltage ratings.
Six cycle delayed stop	SCR's phase back the motor voltage in about six cycles after stop command is given	Minimizes high voltage from building up across SCR's on high inertia or over hauling load.
Ride thru capability	5-cycle power outage ride thru	Minimizes nuisance tripping
More protection. Many new protective features have been incorporated.	Phase reversal protection Current unbalance protection Most protective features have LED indication and alarm relay See Table 1 for complete list of protective features. Full time class 20 inverse time overcurrent protection. Built in time delay for UV trip	Increased user confidence in solid state control Reduced downtime Increased productivity Minimize nuisance tripping
Energy savings	Reduces voltage applied to the motor if the motor is underloaded. Can be defeated if desired.	Reduced power costs
High line voltage control	With energy saver circuit on, the Easy-Start 120 will limit the voltage applied to the motor to controller's rated voltage under high-line conditions. Incoming voltage should be within the Easy-Start's 120 rating.	Reduces power costs in installation with high line voltage which are common in off-peak hours.
Alarm Contact and Start Contacts	Auxiliary – one isolated form 'C' contact rated 5 amps 120 Vac. Changes state on start. Alarm – one non isolated 120 Vac N.O. contact rated 1 amp	Remote status or trip indication
Continuous 120% rating	Overload capability 20 seconds – 500% 30 seconds – 350% Continuous – 120% The above overload ratings are percentage of Easy-Start 120 base current rating	Can be applied on 1.15 service factor motors without derating.

● ES950 Models have not been submitted for UL or CSA Approval.

Easy-Start 120 Solid State Reduced Voltage Motor Starter

Table 1: Easy-Start 120 Protective Functions

Function	Range and Description
Inverse-Time Overcurrent Trip	See time current curve Class 20 protection.
Phase Loss	Trips on phase loss after a nominal 0.5 sec. delay to minimize nuisance tripping
Under Voltage	Trips when voltage reaches 75%. after a nominal 2 sec. delay to minimize nuisance tripping
Current Unbalance	Trips on 20% unbalance from average
Phase Rotation	Inhibits starting unless incoming line voltage is in A-B-C phase rotation
Instantaneous Trip	Trips at 900% current in one cycle or less
Six Cycle Delayed Stop	SCR's are phased off for approx. 6 cycles after stop command to minimize voltage build up at load terminals while stopping high inertia loads.
5 Cycle Power Outage Ride Thru	Easy-Start 120 will not trip if power outage lasts 5 cycles or less. This minimizes nuisance trips due to utility switching
Over Temperature	3-Thermostats, one in each leg trip the unit on over temperature. Provided on fan cooled units only to protect against fan failure
Current Limit	Adjustable 200-500% effective during starting only.
Transient Voltage Supression	Three MOV's (Metal Oxide Varistors) are provided
DV/DT Protection	R-C snubber networks are provided
Fault Withstand Ratings	UL Tested for 3½ cycles 10,000 Amps: ES120, ES180 18,000 Amps: ES260 30,000 Amps: ES560, ES750

Note: After trip the Easy-Start 120 should be reset by pressing reset push button (optional). Automatic reset is not recommended.

Table 2: Easy-Start 120 Standard Conditions for Application

Humidity: 20%-95% non condensing, non corrosive

Altitude: To 3000 feet (1000 meters)

Ambient temperature operations: −20°C to +40°C (enclosed)
storage: −40°C to +65°C −20°C to +50°C (open)

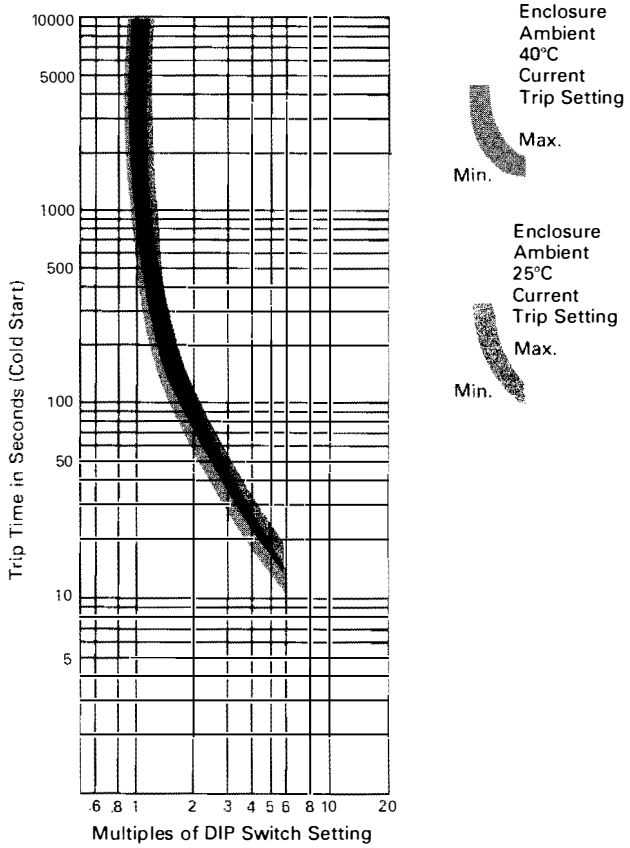
AC control voltage 120V single phase 50/60 Hz (approx. 50VA required) supplied externally by others or by optional control power transformer.

AC line voltage 208, 230, 380, 415, 460, 500 or 575V +10-15% 3 phase 50/60 Hz

① In voltage ramp mode initial voltage applied is as selected by initial step adjustment and is increased till 100% voltage is applied over a period of time selected by ramp time adjustment. In current ramp mode initial current drawn is as selected by initial step adjustment and is increased up to the current limit adjustment setting over a period of time selected by ramp time adjustment.

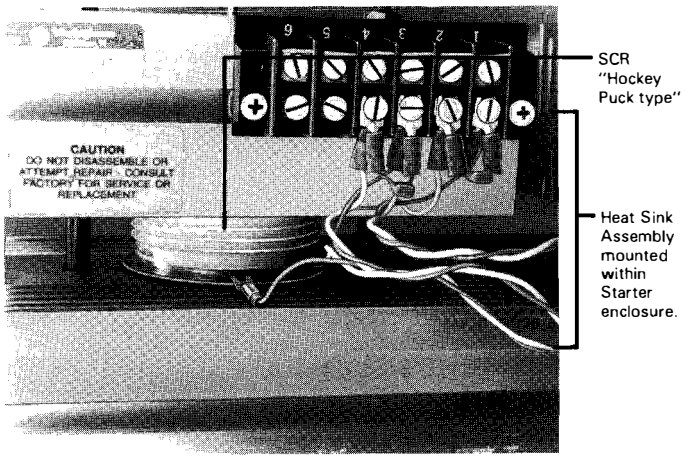
Table 3: Easy-Start 120 Adjustments

Adjustment	Range	Approx. Factory Setting/ Comments
Ramp Mode①	Voltage Ramp Current Ramp	Voltage Ramp (DS3-1 Open) to change to current ramp close DS3-1
Initial Step – Voltage Ramp – Current Ramp	 20-90% 100-200%	 50% 150%
Ramp Time	1-40 seconds	20 sec.
Current Limit	200-500%	450%
Current Trip	100-120%	100%
Current Calibration DIP Switches	15% to 100% of current rating	Set in field for motor full load amps
Energy Saver Circuit	On/off	On: DS3-2 open. To disable energy savings close DS3-2
Voltage Rating Plug	230 or 460V 380 or 415V 500 or 575V	2 plugs supplied install one in field
Voltage Jumper	"High" – "Low"	"High" Install in "Low" when using 208/230/460V models on 208V. 460/500/575V models on 460V

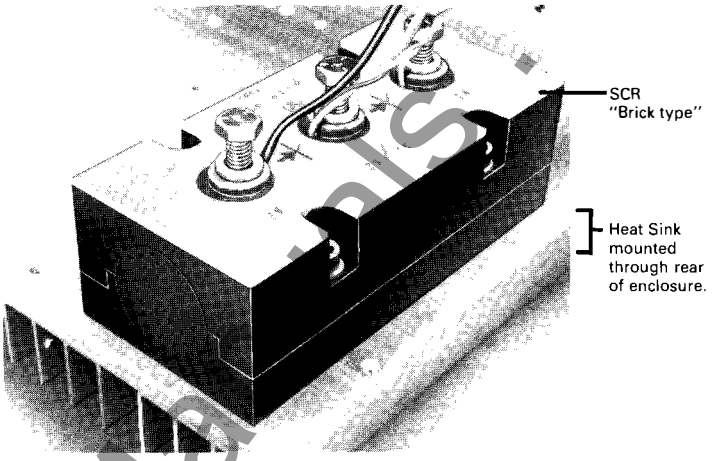


Overload Time – Current Characteristics

Easy-Start 120 Solid State Reduced Voltage Motor Starter



SCR and Non-Isolated Heat Sink (Stack Assembly)



Dual SCR "Brick" and Isolated Heat Sink

Easy-Start 120 Catalog Numbers and Ratings

- Easy-Start 120 is offered in two types of SCR's and Heat Sink combinations
  - Non-isolated heat sinks and hockey puck SCR's. These are offered in open panel construction and in NEMA 1 enclosures.
  - Isolated heat sinks and brick type SCR's These are offered in open panel construction and in NEMA 12 enclosures.
- For mounting open panel units in box supplied by others refer to application considerations section
- Nominal HP or KW ratings are listed for reference only. Easy-Start 120 should be sized for the motor nameplate Full Load Amps and application considerations. (See page 10.)
- For pricing and availability refer to Price List 8650.

- Nominal HP ratings are listed for reference only. The Easy-Start 120 should be sized depending on the motor full-load amps. For example, an ES180 has a base rating of 180 full load amps.

Unit	AMP Ratings			Nominal Horsepower or KW					
NEMA 12	Min.	Base	Max.①	HP 208V	HP 230V	KW 380/415V	HP 460V	KW 500V	HP 575V
ES045②	7	45	54	5- 10	5- 15	4- 22	5- 30	4- 30	7- 40
ES070②	10	70	84	15- 20	20- 25	30- 37	40- 50	37- 45	50- 60
ES120②	18	120	144	25- 40	30- 40	45- 55	60-100	55- 75	75-100
ES250	36	250	300	40- 75	50-100	75-110	150-200	90-160	200-250
ES360	51	360	432	75-100	100-150	110-200	200-300	200-250	250-300
ES500	71	500	600	100-150	125-200	200-250	250-400	300-355	300-500
NEMA 1									
ES180	26	180	216	40- 60	40- 75	75- 90	75-150	55-110	100-150
ES260	38	260	312	60- 75	75-100	110	150-200	160	200-250
ES560	80	560	672	100-200	125-200	160-230	250-450	200-400	300-500
ES750	107	750	900	250-300	250-300	355-400	500-600	450-500	600-750
ES950	135	950	1140	350-400	300-350	450	600-750	600	800-900

① Max. rating is 1.2x base rating due to 120% continuous capability.
② Utilizes isolated heat sinks.

Easy-Start 120 Solid State Reduced Voltage Motor Starter

Factory Modifications

The following items are available as factory modifications.

Cat. No. Suffix	Description
Operator Devices – Door Mounted and Wired	
A	Start (Green), Stop (Red), Reset (Gray) Pushbuttons
B	Hand-Off-Auto (Gray) Selector Switch & Reset (Gray) Pushbutton. With selector switch in hand position the starter is controlled by start-stop pushbuttons. In auto position the starter is controlled by a remote maintained contact input.
A2	Start (Green), Stop (Red), Reset (Gray) Pushbuttons and Hand-Off-Auto (Gray) Selector Switch.
R	Reset (Gray) pushbutton
L5	"Power On" red push to test pilot light
L6	"Run" green push to test pilot light
L4	"Trip" amber push to test pilot light
Control Devices	
T	150VA Control Power Transformer① with 2 fuses on secondary. This is a multi-voltage transformer. The primary can be connected for 208, 230, 380, 415, 460, 500, 575 volts. Secondary voltage is between 110-120 volts depending upon primary voltage. The transformer is factory wired as follows: 208/230/460V models are wired for 460V 380/415V models are wired for 380V 460/500/575V models are wired for 575V For other incoming line voltages the transformer must be rewired in field.
T2	Same as T except 300VA①
T4	Same as T except 500VA① (Models 180A and above only)
Y	Auxiliary Run Relay. 2 NO 2 NC contacts. Relay coil is rated 110-120V AC and is prewired to the C.P. transformer. Relay is initiated from start command. Wiring to relay contacts is to be done directly on the relay.
Y2	Time Delay Run Relay: Running contacts will delay energization upon a Run command.10sec/10 min programmable.
Y3	Auxiliary Relay, 2NO 2NC contacts. Relay coil is rated 110-120V AC. Wiring to contacts and to relay coil is by customer.
U②	Shorted SCR Detector: 4 LED's are provided. Shorted SCR LED comes on and a relay is energized. 1 NO and 1 NC contact can be used for indication, alarm, or trip functions.
U1②	Same as U with Red Door light
Logic Board Plug-In Options (Factory Mounted)	
E③	● Extended Start-Time (up to 12 minutes)
E1③	● Extended Start-Time With Door Light
S	Smooth Stop (1-30 seconds adjustable)
S1	Smooth Stop With Door Light
S2	Smooth Stop With Two Door Lights (Ramp-up and Smooth Stop)

① Control power transformer also supplies power to logic board approximately 50VA; Rest is available for customer use. **If a control power transformer option is not included, 120V 1ø control power must be supplied from separate source for logic board.**

● U and U1 option is not available on ES045, ES070, or ES120 open panel design.

Cat. No. Suffix	Description
Logic Board Plug-In Options, (Continued)	
J	● Jam/Underload When a specific motor load is definable, Jam protection will enable the starter to trip out immediately when the motor load rises above a specific set point. Underload is similar to Jam except the starter will trip when the motor load drops below a specific set point.
J1	● Same as J with Jam Door light
J2	● Same as J with Underload Door light
Instruments	
F2	Ammeter, Single Phase, Door Mounted, with CT
F3	Ammeter, Single Phase, Door Mounted, with 3 Position Selector Switch and 3 CT's
H	Elapsed Time Meter Door Mounted
G2	Voltmeter, Single Phase, Door Mounted (No PT Furnished)
G3	Voltmeter, Single Phase, Door Mounted with 3 Position Selector Switch (No PT's Furnished)
Special Functions	
●	Westinghouse IQ Data Plus II monitoring module to monitor AC Amperes Phase A, B, C AC Voltage Line to Line, Line to Neutral Megawatts Megavars Power Factor Frequency Megawatt Demand
●	Westinghouse IQ Data Line Metering System AC Motor Current Phase A, B, C AC Motor Voltage Phase A, B, C AC Line to Neutral Voltage (Four-wire Systems – all three) IQ Data Plus II and IQ Data are offered as monitoring devices only and all protective functions are disabled or set so they do not conflict with Easy-Start 120 protective functions.

Cat. No. Suffix	Description
Q7④	IQ Data with three CT's and 120 volt Control Power Transformer
Q8④	IQ Data Plus II with Three CT's

If local codes or customer preference prohibit line voltage on door do not use this option.

Plug-In Option Kits for Field Mounting⑤

Available for customer mounting to existing Easy-Start Units.

Cat. No.	Description
KITESD⑤	Option Kit Interface Board
KITESE	Extended Start-Time
KITESE1	Extended Start-Time With Lite
KITESS	Smooth Stop
KITESS1	Smooth Stop With Lite
KITESS2	Smooth Stop With Two Lites
KITESJ	Jam And/or Underload
KITESJ1	Jam And/or Underload With Jam Lite
KITESJ2	Jam And/or Underload With Underload Lite
KITESU	Shorted SCR Detector

③ Starter must be oversized to handle the high starting current for the extended time. See application note on page 10 and curves on page 12.
④ Requires large enclosure for ES045, ES070, or ES120.
⑤ Mounting of more than one option kit requires Option Kit Interface Board.

Easy-Start 120 Solid State Reduced Voltage Motor Starter

Factory Modifications, *Continued*

Circuit Breakers

The circuit breakers offered with Easy-Start 120 are listed in the following table and should be used with the corresponding Easy-Start 120 model in the table.

Easy-Start 120 in large enclosure must be priced for circuit breaker modification.

Thermal-Magnetic Series C Breaker① ②

Easy-Start 120 Model	Breaker Suffix (Rating Plug Amps)	Shunt Trip Suffix (If Required)	Westinghouse Series C Breaker Frame	Breaker Amps	Breaker Lug Size	Series C Frame
ES045-___EL	C01 (30 Amp)	N/A	FD3030	30 Amps	1/0	FD
ES070-___EL	C03 (100 Amp)	S10	JD3250	250 Amps	350 MCM	JD
ES120-___EL	C04 (150 Amp) C05 (200 Amp) C06 (250 Amp)	S10 S10 S10				
ES180-___NL	C08 (250 Amp) C09 (300 Amp) C10 (400 Amp)	S11 S11 S11	KD3400	250/300 Amps	500 MCM	KD
ES250-___EL	C08 (250 Amp) C09 (300 Amp) C10 (400 Amp)	S11 S11 S11				
ES260-___NL	C08 (250 Amp) C09 (300 Amp) C10 (400 Amp)	S11 S11 S11		400 Amps	250 MCM (2)	
ES360-___EL	C11 (800 Amp)	S12	MC3800	800 Amps	500 MCM (2)	MC
ES500-___EL	C11 (800 Amp)	S12				
ES560-___NL	C11 (800 Amp)	S12				
ES750-___NL	C12 (1200 Amp)	S13	NC31200	1200 Amps	500 MCM (4)	NC
ES950-___NL	C13 (1200 Amp)	S13				

① For Interrupting Ratings and Wire Range Terminals Refer to Cat. 29-000.
② See Application Note on Page 10 under Circuit Breakers.

Table 4: Dimensions and Weights

Approximate only. Not to be used for construction purposes.

Catalog No.③	Mounting	Enclosure	Height (In.)	Width (In.)	Depth (In.)	Weight (Lbs.)	Line/Load Lugs④	Minimum Clearance Required⑤	
								Sides (In.)	Top and Bottom (In.)
ES045-_EP	—	Open	16	19	11.5	32	#2	—	—
ES070-_EP	—	Open	16	19	11.5	33	#2	—	—
ES070-_EC	—	Open	15	14	8	26	1/0	—	—
ES120-_EP	—	Open	16	19	11.5	35	2/0	—	—
ES120-_EC	—	Open	27	14	8	40	1/0	—	—
ES180-_NP⑥	—	Open	39	26.75	14	100	250 MCM	—	—
ES180-_NC⑥	—	Open	48	18.5	9.5	100	350 MCM	—	—
ES260-_NP⑥	—	Open	39	26.75	14	112	500 MCM	—	—
ES250-_NC⑥	—	Open	48	18.5	9.5	100	350 MCM	—	—
ES560-_NP⑥	—	Open	39	26.75	14	137	500 MCM(2)	—	—
ES750-_NP⑥	—	Open	45	30.75	17	320	600 MCM(4)	—	—
ES950-_NP⑥	—	Open	77.12	33.00	21	400	600 MCM(4)	—	—
ES180-_NR⑥	Wall	NEMA 1	46.5	31	15.5	220	250 MCM	12	—
ES260-_NR⑥	Wall	NEMA 1	46.5	31	15.5	232	500 MCM	12	—
ES560-_NR⑥	Wall	NEMA 1	46.5	31	15.5	257	500 MCM(2)	12	—
ES180-_NL⑥⑦	Floor	NEMA 1	90	32	21	500	250 MCM	12	—
ES260-_NL⑥⑦	Floor	NEMA 1	90	32	21	510	500 MCM	12	—
ES560-_NL⑥⑦	Floor	NEMA 1	90	32	21	525	500 MCM(2)	12	—
ES750-_NL⑥⑥	Floor	NEMA 1	90	32	21	720	600 MCM(4)	12	—
ES950-_NL⑥	Floor	NEMA 1	90	38	21	900	—	12	—
ES045-_ER	Wall	NEMA 12	28.5	25	14	95	#2	6	6
ES070-_ER	Wall	NEMA 12	28.5	25	14	95	#5	6	6
ES045-_EL	Wall	NEMA 12	43.5	24.5	15.5	120	#2	6	6
ES070-_EL	Wall	NEMA 12	43.5	24.5	15.5	120	#2	6	6
ES120-_EL	Wall	NEMA 12	43.5	24.5	15.5	121	2/0	6	6
ES250-_EL⑥	Floor	NEMA 12	90	32	21	520	500 MCM	12	—
ES360-_EL⑥	Floor	NEMA 12	90	32	21	525	500 MCM(2)	12	—
ES500-_EL⑥	Floor	NEMA 12	90	32	21	550	500 MCM(2)	12	—

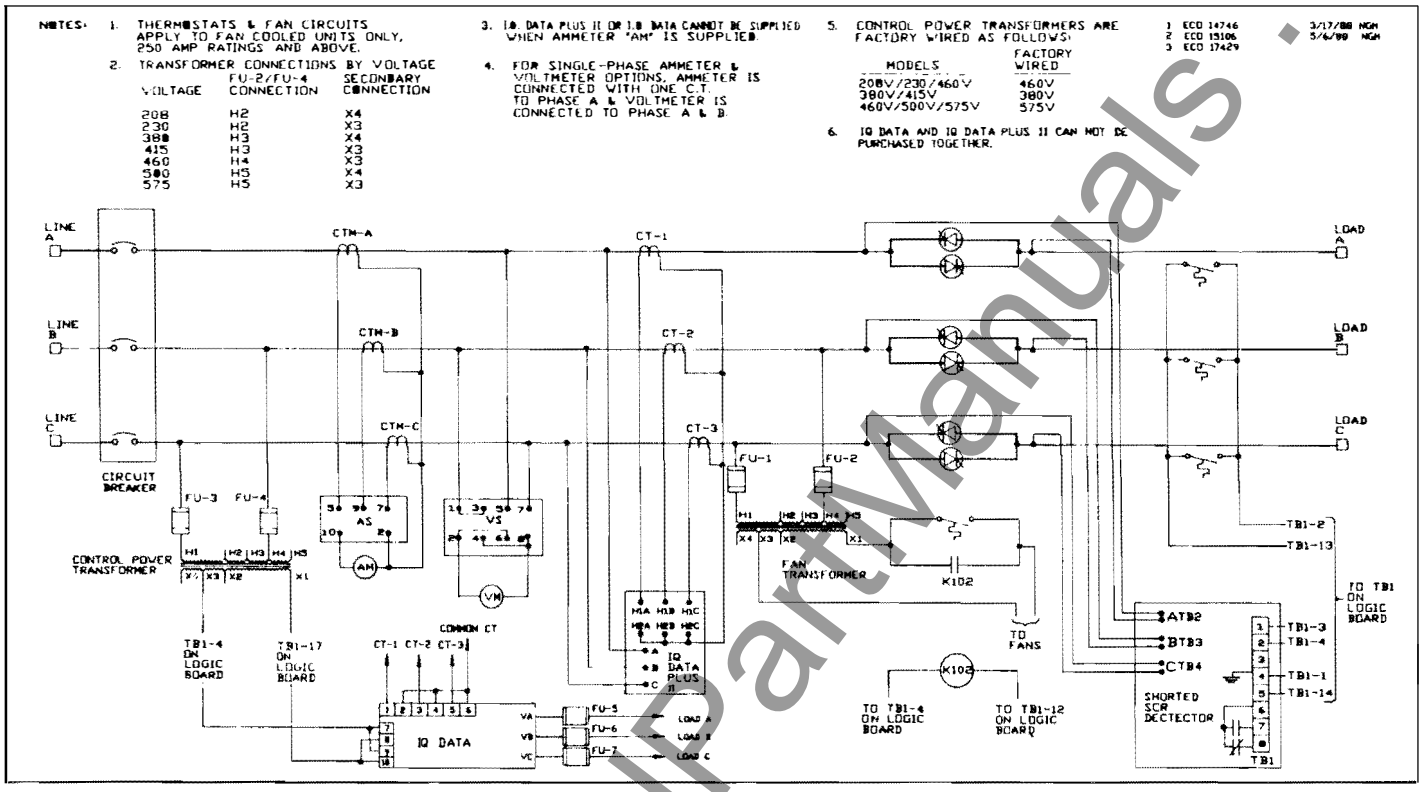
③ _in Cat. No. is 4 for 208/230/460V models, 3 for 380/415V models, 5 for 460/500/575V models.
④ Line lug sizes shown are for Easy-Start 120 lug. If circuit breaker option is ordered line connections will be made on circuit breaker.
Wall mounted units arranged for top entry, bottom exit.

⑤ Minimum clearance sides is minimum clearance required between adjacent units
For NEMA 1 enclosure this clearance should be provided between unit and sidewall also.
For NEMA 12 enclosures the clearance between unit and sidewall is not required. Minimum clearance top and bottom is required for NEMA 12 models only.
Minimum clearance required for open models will depend upon enclosure provided by others.

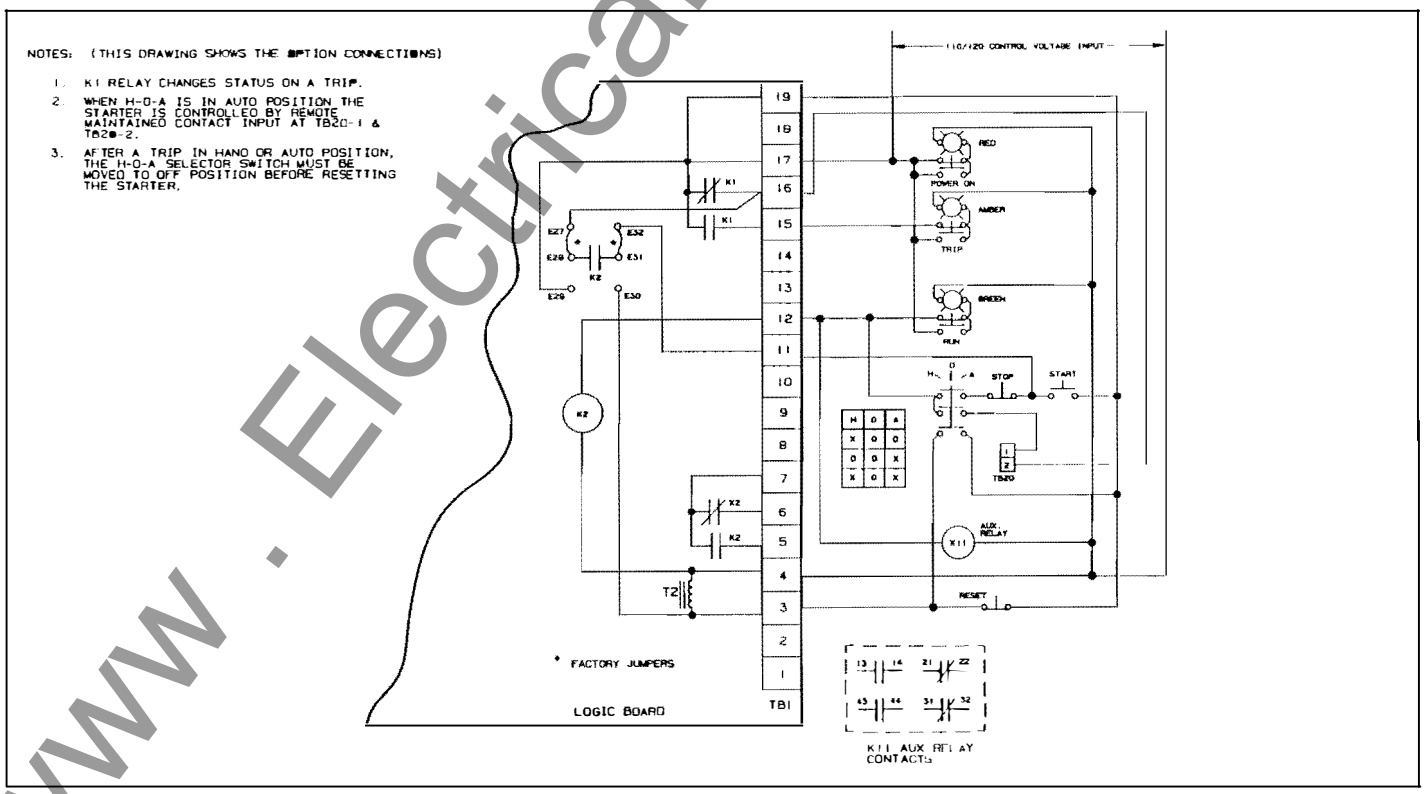
⑥ Use non-isolated heat sinks. Heat is dissipated via the enclosure surfaces.
⑦ MCC structure with 4" wire-way, could have cable entry/exit top or bottom.
⑥ ES750 arranged for top entry and exit only.

Easy-Start 120 Solid State Reduced Voltage Motor Starter

Easy-Start 120 Connection Diagrams



Easy-Start 120 Power Connection With Options



Easy-Start 120 Control Connections Start-Stop Pushbuttons With Hand-Off-Auto Selector Switch

Easy-Start 120 Solid State Reduced Voltage Motor Starter

Application Considerations

Installation

A. Ventilated NEMA 1 enclosures should be mounted so that enough clearance is available for air to enter and exit the enclosure. Specific clearance requirements are shown on dimensions table.

B. NEMA 12 enclosures should be mounted so that heat sink fins are vertical. For wall mounted units a minimum clearance of 6" on top and bottom is required. For NEMA 12 units without heat sinks clearances should be maintained surrounding the enclosure. See Table 4.

C. Open panel units should be mounted in a box so the temperature inside the box does not exceed **50°C** (122°F).

For sizing the enclosure the heat loss in watts can be estimated at 3 times the full load current.

EXAMPLE: For ES180-4NR the maximum current rating is 180 amps. The approximate watts loss at maximum current rating is 3 x 180 = 540 watts.

For units with non isolated heat sinks, all the watt loss must be dissipated thru box surface.

For units with isolated heat sinks; the heat sink fins should be brought out in open air thru a properly gasketed cut out in the enclosure. Approximately 50% watt loss is dissipated thru the heat sinks and the remaining 50% should be dissipated thru the remainder of the box surface, not counting the heat sink.

Ambient Temperature

Easy-Start 120 is rated for 40°C (104°F) ambient temperature. For above 40°C derate by 5% for every **5°C** rise over **40°C** up to **50°C** (122°F) max.

EXAMPLE: ES180-4NR is rated 180 Amps @ 40°C. For 50°C the rating would be 180 x .9 = 162 Amps

Altitude

Easy-Start is rated for 3300 ft. [1000 meters]. Use Derate Curve for derating above 3300 ft.

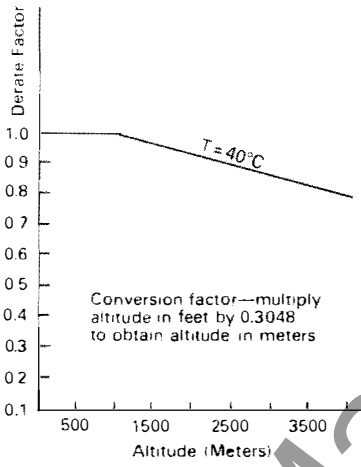
Multi-Motor Operation

Easy-Start 120 can be used to control multiple motors if the following conditions are met:

— The current rating of Easy-Start 120 should be equal to or greater than the total of individual motor full load amps and dip switches must be set for the cumulative full load amps of the motors.

— Individual motor overcurrent protection is provided by others.

— Energy Saver circuit should be turned OFF.



Derate Curve For Altitude

— The motors should not be mechanically coupled together, i.e. two motors on same shaft.

— NEC and local code requirement for individual motor protection and branch circuit protection are met.

Frequent Starting/Stopping

The number of starts and stops depends upon many factors. The most important ones are:

1. Position of current limit potentiometer which can be anywhere from 200-500% of the current rating set by the DIP switches.
2. Start time.
3. Run time.
4. Off time before next start.

The following tables (Table 5 thru Table 13, page 11) can be used for guidance in frequent starting/stopping applications. These tables are based on worst case condition that the controller will be running at the indicated starting current during the entire start time.

The number of starts per hour in the following tables is based on the current carrying capacity of the SCR's. If a high number of multiple starts is used, the starter may trip due to the inverse-time overload current protection function.

If a trip should occur, due to multiple starts, it is advisable to wait a period of 10 minutes before re-starting to avoid damage to the Easy-Start 120.

The motor manufacturer should be consulted about the effect of a high number of multiple starts on motor life.

Zero off-time in the starts per hour tables indicates jog duty.

EXAMPLE: If an application requires 1 start per minute, 60 starts per hour, for a 460V, 50 HP, 70 Amp motor; the cycle time is 60 seconds between starts. Assume a start time of 5 seconds, at a starting current of 500% (350 amps) is needed, with an off-time between run and start of 12 seconds, and a run time of 43 seconds.

The percent off-time is therefore 12/60 x 100 = 20%. We next look at the starts per hour tables on page 11 for a 70 amp starter (ES070)①. We can see that the model ES070 can do only 40 starts per hour at 350 amps with a start time of 5 seconds and an off-time of 20%.

Therefore, we need to use the next larger size starter, (ES120) from the tables on page 11 we can see that 80 starts per hour are allowed at a starting current of 360 amps with a start time of 5 seconds and a 20% off-time, by using the model ES120. Easy-Start may trip due to overcurrent if repeated starts at high current and long starting times are used.

Starting Torque

The reduced voltage applied to the motor results in reduced inrush current and soft start. However, it reduces the starting torque of the motor. The relationship is as follows:

$$\frac{\text{Torque at Reduced Current}}{\text{Torque at Full Current}} = \left[\frac{\text{Current at Reduced Voltage}}{\text{Current at Full Voltage}}\right]^2$$

EXAMPLE: A 100 HP 1800 RPM 460V NEMA B motor draws six times full load amps for starting and starting torque is 150% of full load torque.

If the same motor is started with Easy-Start at 300% current limit.

$$\text{Starting Torque at 300\% Current Limit} = \left[\frac{300}{600}\right]^2 \times \text{starting torque at 600\% current}$$

= 1/4 x 150% full load torque = 37.5% full load torque

NEMA Design C & D Motors, Wound Rotor Motors

These motors are used due to their high starting torque characteristics. When high starting currents and high starting torques are required, the extended time current option must be supplied with an oversized unit. Consult the factory for application considerations.

① 70 amp rating used for example only.

Easy-Start 120 Solid State Reduced Voltage Motor Starter

Reversing Starters
If all the limitations are understood and accepted the Easy-Start 120 can be used on line side of an electro mechanical reversing starter. The operation should be to start the motor in forward or reverse after a complete stop. Plug reversing i.e. going from forward to reverse directly will damage the starter. It is recommended that enough time delay be built into the reversing starter circuit (by others) to prevent restarting until the motor has come to complete stop.

WYE Delta (Six Lead) Motors
These should be connected in Delta and can then be started with Easy-Start 120.

Part Winding Motors
Part winding motors are started by applying full voltage to part of the winding and after a time delay full voltage is applied to the remaining winding.

For part winding motors the Easy-Start 120 can be used by connecting the two windings in parallel.

2-Speed 2-Winding Motor
If all the limitations are understood and accepted Easy-Start 120 may be used on the line side of a electromechanical 2-speed 2-winding motor but will provide soft start only if the motor is started in either speed from complete stop. The ramp (soft start) can be optimized for one speed only.

Going directly from low speed to high speed or high speed to low speed would not give smooth transition and may cause a current surge. It is recommended that enough time delay be built into the 2-speed 2-winding starter circuit (by others) to prevent changing speeds without coming to full stop.

It should be checked with motor manufacturer if the motor will develop enough starting torque to start the load from stand still in both low and high speed with reduced voltage start.

Another way is to connect Easy-Start 120 between low speed contactor of electromechanical 2-speed starter and low speed winding of the motor. This will provide a soft start on low speed only.

2-Speed Single Winding Motors
The Easy-Start 120 is not recommended for use with 2-speed single winding motors.

Capacitors
Power factor correction capacitors should not be connected between load side of Easy-Start 120 and the motor. This will cause damage to the starter.

Due to harmonics capacitors will have a higher temperature rise, and there is a risk of resonance. This situation can be minimized by the following:

– If a contactor is used to switch capacitors it should have a time delay built in the circuit so that the contactor closes after the Easy-Start has ramped up to full voltage.

The capacitors should be mounted as far upstream from the solid state starter as possible.

If capacitors must be used they must be connected on the line side of Easy-Start 120 with at least 10 feet of cable between starter and the capacitors.

Starting Time
Easy-Start 120 is rated for maximum current limit for 20 seconds. For longer starting time the rating curves on page 12 should be used and the extended start time option must be purchased. Maximum start time using this option is 12 minutes. This option inhibits the Inverse-Time Current Trip during the extended start time.

Consult Motor Manufacturer for Effect of Longer Starting Time on Motor Life.
For example ES180-4NR has a rating of 180 amps and will handle 180 x 5 = 900 amps for 20 seconds. If we have a 150 HP, 180A FLA motor which is driving a load with 120 second start time and if the current limit is set for 500%.

The maximum current draw is 180 x 5 = 900 amp; using the NEMA 1 Curves on page 12 we see that ES180-4NR will take 900A for 40 seconds. So we will have to go to a higher rated model ES260-4NR. Using the same curves we see ES260-4NR will handle 900 amps for almost 200 seconds. So ES260-4NR with extended start time option can be used for this application.

Circuit Breakers
Easy-Start 120 has 500% current limit for 20 seconds. The upstream circuit breakers or protective devices should be sized so they can handle the maximum current for 20 seconds or longer if extended start times are required.

Automatic Reset
Due to power outage ride thru capability Easy-Start 120 can not be wired for automatic reset after a trip. A manual reset pushbutton must always be used as shown on connection diagrams.

Software Programs Available for Help in Application Consideration①

Motramp
Calculates starting time of induction motors according to load characteristics and aids in selection of Easy-Start 120 Model size.

Starts
Calculates number of starts per hour permissible with selected Easy-Start 120 model. Takes duty cycle and current limit values into consideration.

NEMA 4
Calculates enclosure size according to the heat dissipation of the Easy-Start 120 model selected. Note full load current ambient temperature and number of enclosure surfaces exposed to open air are taken into consideration.

① Refer to factory for software availability to run a specific program to aid in Easy-Start 120 selection.

Easy-Start 120 Solid State Reduced Voltage Motor Starter

Table 5

Model Number ES070			Starts Per Hour			
Curr. Lim.	Starting Current AC Amps	Start Time Sec.	Percent Off-Time 0%	10%	20%	30%
250%	175	2	180	240	320	480
		5	80	120	150	180
		10	40	60	70	80
		20	20	30	35	45
300%	210	2	120	200	240	320
		5	40	60	100	120
		10	20	30	40	60
		20	8	16	20	30
400%	280	2	60	120	160	200
		5	30	40	60	80
		10	12	20	30	40
		20	4	8	16	20
500%	350	2	40	80	120	140
		5	12	24	40	60
		10	4	8	16	20
		20	–	4	8	12

Table 6

Model Number ES120			Starts Per Hour			
Curr. Lim.	Starting Current AC Amps	Start Time Sec.	Percent Off-Time 0%	10%	20%	30%
250%	300	2	120	180	240	360
		5	70	90	120	150
		10	30	50	60	70
		20	15	20	25	30
300%	360	2	100	120	180	240
		5	40	60	80	100
		10	20	30	40	50
		20	10	16	20	24
400%	480	2	60	80	100	120
		5	30	40	50	60
		10	4	8	16	20
		20	–	2	4	6
500%	600	2	12	20	40	50
		5	8	12	20	24
		10	–	2	4	6
		20	–	–	–	1

Table 7

Model Number ES180			Starts Per Hour			
Curr. Lim.	Starting Current AC Amps	Start Time Sec.	Percent Off-Time 0%	10%	20%	30%
250%	450	2	100	160	240	300
		5	40	60	80	100
		10	20	30	45	60
		20	10	15	20	30
300%	540	2	80	120	180	220
		5	30	40	60	80
		10	12	20	30	40
		20	8	10	12	16
400%	720	2	40	60	90	120
		5	20	30	40	50
		10	8	12	16	20
		20	4	8	10	12
500%	900	2	24	40	80	100
		5	12	20	30	40
		10	4	8	12	16
		20	–	2	4	6

Table 8

Model Number ES250			Starts Per Hour			
Curr. Lim.	Starting Current AC Amps	Start Time Sec.	Percent Off-Time 0%	10%	20%	30%
250%	625	2	120	180	240	300
		5	50	70	100	120
		10	25	40	50	60
		20	12	20	24	30
300%	750	2	80	120	160	220
		5	40	60	80	100
		10	20	30	40	50
		20	10	15	20	25
400%	1000	2	60	90	120	140
		5	24	35	50	60
		10	12	16	20	30
		20	4	8	12	15
500%	1250	2	30	50	70	100
		5	16	20	30	35
		10	8	10	15	20
		20	2	4	6	8

Table 9

Model Number ES260			Starts Per Hour			
Curr. Lim.	Starting Current AC Amps	Start Time Sec.	Percent Off-Time 0%	10%	20%	30%
250%	650	2	120	180	240	300
		5	40	60	100	120
		10	20	30	50	60
		20	10	15	25	30
300%	780	2	60	120	160	220
		5	30	50	70	90
		10	12	20	30	40
		20	8	12	16	20
400%	1040	2	40	60	100	120
		5	20	30	40	50
		10	8	12	16	24
		20	4	6	8	12
500%	1300	2	20	40	60	80
		5	8	12	20	30
		10	4	8	12	16
		20	–	2	4	6

Table 10

Model Number ES360			Starts Per Hour			
Curr. Lim.	Starting Current AC Amps	Start Time Sec.	Percent Off-Time 0%	10%	20%	30%
250%	900	2	120	200	300	400
		5	60	100	120	160
		10	30	50	60	80
		20	16	25	30	40
300%	1080	2	100	150	200	250
		5	40	60	100	120
		10	20	30	45	60
		20	10	20	25	30
400%	1440	2	60	100	140	180
		5	30	40	50	60
		10	15	20	25	30
		20	8	10	12	16
500%	1800	2	40	60	80	100
		5	20	30	40	50
		10	10	15	20	25
		20	4	8	10	12

Table 11

Model Number ES500			Starts Per Hour			
Curr. Lim.	Starting Current AC Amps	Start Time Sec.	Percent Off-Time 0%	10%	20%	30%
250%	1250	2	200	240	360	480
		5	80	120	160	200
		10	40	60	80	100
		20	20	30	40	50
300%	1500	2	120	200	240	300
		5	60	80	100	120
		10	30	40	50	60
		20	15	20	25	30
400%	2000	2	80	120	160	200
		5	40	60	80	100
		10	20	30	40	50
		20	10	15	20	25
500%	2500	2	60	80	100	120
		5	25	30	40	50
		10	10	15	20	25
		20	4	8	12	16

Table 12

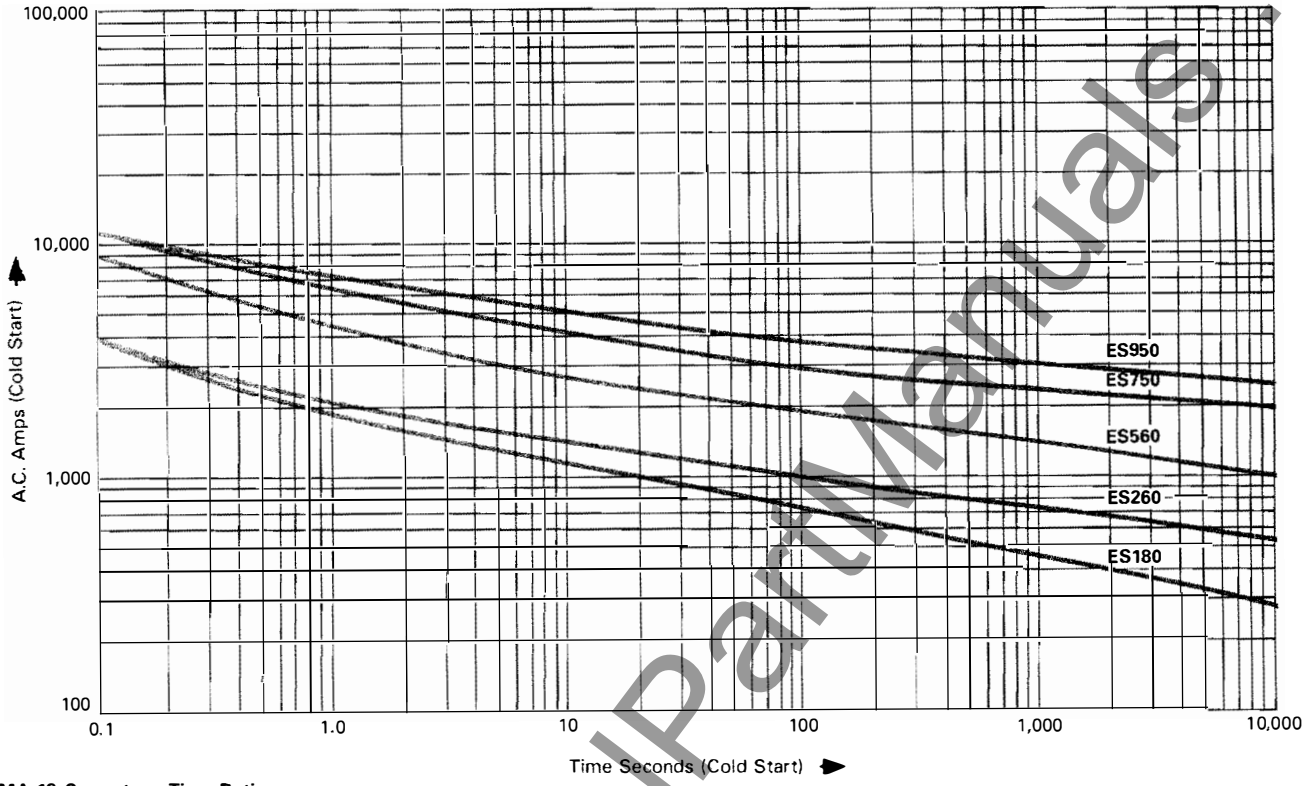
Model Number ES560			Starts Per Hour			
Curr. Lim.	Starting Current AC Amps	Start Time Sec.	Percent Off-Time 0%	10%	20%	30%
250%	1400	2	100	180	300	400
		5	50	80	100	120
		10	24	40	60	80
		20	12	20	30	40
300%	1680	2	80	140	200	240
		5	40	60	80	100
		10	16	20	30	40
		20	8	16	20	24
400%	2240	2	50	100	120	140
		5	20	30	40	60
		10	8	16	20	24
		20	4	8	12	16
500%	2800	2	30	40	60	100
		5	12	20	30	40
		10	4	8	12	16
		20	–	2	4	6

Table 13

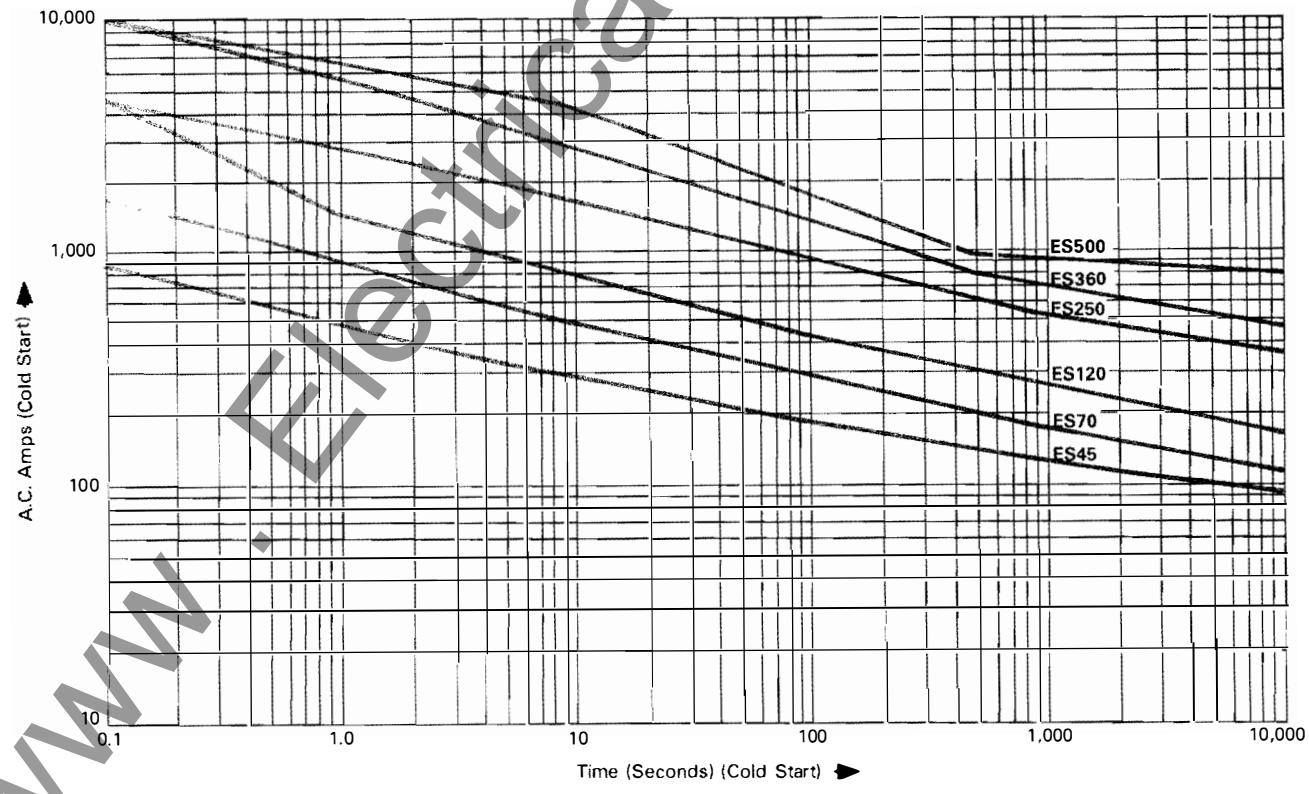
Model Number ES750			Starts Per Hour			
Curr. Lim.	Starting Current AC Amps	Start Time Sec.	Percent Off-Time 0%	10%	20%	30%
250%	1875	2	180	240	320	400
		5	80	100	120	150
		10	40	50	70	80
		20	20	25	30	40
300%	2250	2	120	200	240	300
		5	60	80	100	120
		10	30	40	50	60
		20	10	20	25	30
400%	3000	2	80	120	150	180
		5	30	40	50	60
		10	15	25	30	35
		20	8	10	12	16
500%	3750	2	60	80	100	120
		5	25	30	40	50
		10	10	15	20	25
		20	4	8	10	12

Easy-Start 120 Solid State Reduced Voltage Motor Starter

NEMA-1 Current vs. Time Ratings



NEMA-12 Current vs. Time Ratings



Easy-Start 120 Solid State Reduced Voltage Motor Starter

Standard Specification

Description
The Solid State Reduced Voltage Starter shall be UL and CSA listed and consist of a power section and a one piece printed circuit logic board as specified hereinafter.

The power section shall be rated for the given amperes, volts, three phase, 60 Hertz. It shall consist of three (3) sets of back-to-back silicon controlled rectifiers (SCR's).

The power section shall have surge suppressors across the SCR's rated 10% above rated and not less than 300 joules for starter 250 hp and up. They shall be metal oxide varistor (MOV) type.

Resistor/Capacitor snubber networks shall be used to prevent false firing of SCR's due to dv/dt characteristics of the electrical system.

When fans are used, thermal sensors shall be installed on the heat sink to trip the control protective logic if there is an over-temperature condition. Thermal sensors shall be rated 90°C maximum.

SCR's shall be rated with peak inverse voltage at least 2.5 times rated line-to-line voltage.

The one piece logic board shall be mounted for easy testing, service and replacement. Three-phase current sensing is required.

The logic board shall use quick disconnect, plug-in connectors for current transformer inputs, line and load voltage inputs and SCR gate firing output circuits. The logic board shall be identical through all ampere ratings with DIP (Dual Inline Package) switches to set up various ampere ratings.

All customer interface wiring shall connect to a common barriered terminal strip rated 1000 volts or greater.

The logic board shall include as a minimum:

- 5-cycle, three-phase power interruption ride-through.
- 6-cycle delay stop.
- Single-phase protection.
- Undervoltage protection.
- Short circuit "electronic fuse" overcurrent protection. Trip time shall not exceed ½ cycle or 8 milliseconds.
- Inverse time overcurrent protection.
- Heat sink overtemperature protection for fan failure.
- Auxiliary trip circuitry.
- Gate firing circuit lockout protection on trip.
- 100%-120% full load running current trip adjustment.
- 200%-500% current limit adjustment.
- 1-40 second voltage or current ramp (switch selectable).
- 20-90% initial voltage step or 100 to 200% initial current step adjustment.

- The capability to handle the following control schemes:
  1) 3-wire control, momentary contact, manual reset control logic.
  2) 2-wire control, maintained contact, manual reset control logic.
- Green run light emitting diode (LED).
- Green end of ramp LED.
- Red phase rotation incorrect LED.
- Red undervoltage trip LED.
- Red phase current unbalance LED.
- Red overcurrent trip LED.
- Red phase loss trip LED.
- Red current limit LED.
- Minimum voltage adjustment.
- Maximum voltage adjustment.
- Voltage stability adjustment.

The logic board shall include, as standard, an energy savings circuit which consists of current and motor slip sensing circuitry that continually monitor motor load and regulate motor voltage to minimize motor kwh energy consumption.

The customer interface circuitry shall include relay logic interface capability functions.

Tripped functions shall be designed to be cleared by interrupting customer control power from the solid state logic board. The three-phase line voltage must be interrupted to clean phase rotation trip function, and phase loss function. The logic board soldering shall be treated with a conformal protective coating system.

The solid state logic shall be phase sensitive, and shall inhibit starting, on incorrect rotation. Improper phase rotation shall be indicated on status panel and logic board of starter.

A transparent cover shall be mounted above the logic board to provide (a) an insulating safety barrier and (b) silk-screened with information to aid in starting and set-up of DIP Switches. Identified holes will be located above adjustment pots so that screwdriver adjustments can be made without removing the transparent cover.

Options that require auxiliary logic boards such as shorted SCR detection, smooth stop, jam protection, underload protection, extended start time, and relay output contacts shall be designed for factory mounting and wiring or for field mounting kits after installation of basic unit, inside the original enclosure.

Two ground lugs shall be furnished, one for line side and one for load side ground connections.

Power terminations shall consist of pressure type terminals for top or bottom entrance.

Door Devices – Enclosure Construction
All enclosures shall be not less than 16-gauge steel. NEMA 12 enclosures shall be of welded construction with gasketed heat sink and doors.

Doors shall include plastic device holders for mounting up to eight operator devices. Factory-mounted operator devices shall be factory wired.

Operating handle of disconnect, when supplied, shall always remain connected to the breaker or switch. The operating handle shall not be mounted on the door of the enclosure, but on the controller for safe "stand-aside" operation. Position of operating handle will indicate ON, Off or Tripped condition of switch or circuit breaker to include provision for padlock in Off position.

Interlock provisions shall prevent unauthorized opening or closing of the starter door with the disconnect in the On position.

The structure when floor-mounted shall be provided with adequate lifting means and shall be capable of being rolled or lifted into installation position and bolted to the floor.

Adequate conduit space shall be provided to meet the NEC requirements.

A door mounted status panel will be provided with LED's (which duplicate the logic board LED's) to indicate:

Run
End of ramp
Current limit
Phase rotation
Phase loss
Undervoltage
Current unbalance
Current trip
Overtemperature (Not on logic board)

Easy-Start 120 Solid State Reduced Voltage Motor Starter

Technical Assistance/Solid State Starter Startup

I. Why Use this Service

Due to the difference between Solid State Starters and other means of reduced voltage starting, Westinghouse recognizes that users or the user's agents may not be familiar with the new technology. There are a few adjustments and operational checks unique to Solid State Starters which make them more flexible in range and versatile in application. These adjustments, though not difficult to make, are critical to the overall performance of the starter. A non-optimum adjustment and difficulties in scheduling man-power may cause start-up and project delays.

II. Description

To help users avoid these situations, Westinghouse recommends a special startup service① for all solid state starters, consisting of the following technical assistance (Refer to Service Policy SA 11423 for additional details):

1. Electrical and mechanical inspection of the Starter after it is installed and wired per the Starter drawings.

2. Final application related adjustments of the standard features such as DIP switch setting for motor amperes, current trip, starting voltage, current limit energy savers, plus an operational check of starting, stopping, interlocking and sequencing all per the Starter Instruction Manual and drawings.

3. Operational check and adjustment for standard purchased options such as DC braking, dwell time and reversing logic, two speed logic, tachometer ramp and smooth stop.

4. Checkout of spare parts if purchased and available during startup.

5. Formal report and record listing (a) equipment as found, (b) technical assistance rendered, (c) final controller settings, and (d) final recommendations to user.

6. Startup Service is provided on a per unit basis by Westinghouse qualified startup engineers.

7. This service extends the standard solid state starter parts only warranty from 12 months to 24 months from date of shipment. The startup spare parts purchased on the same order will also be warranted for 24 months from date of shipment. "Repair or replacement labor by a Westinghouse Service Engineer is included during startup only."

III. Westinghouse Can Also Provide the Following Additional Technical Assistance.

1. Pre-startup

Recommendations on spare parts, if not purchased with the original equipment.

Equipment inspection on receiving.

Recommendations for storage and installation, including environments, checks and wiring practices.

2. Post-startup

Standby service after equipment is operating.

On-site training in maintenance and troubleshooting.

Periodic site visits to assist in resolving questions, performance and maintenance.

Preventive maintenance programs.

① Refer to factory for pricing and scheduling parameters.

Easy-Start 120 Solid State Reduced Voltage Motor Starter

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Westinghouse Electric Corporation
Distribution and Control Business Unit
Electrical Components Division
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