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Engineering Requirement

TITLE: MOTOR STARTING REQUIREMENT	
APPROVED BY / DATE	QUALIFICATION APPROVAL / DATE
Steve Bayes 3/6/03	Phillip Johnson 3/6/03

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1. Purpose and Use

This engineering requirement provides information and data needed to design, build, and apply motor starting equipment for Carrier rotary chillers with Product Integrated Controls II (PIC II). It applies to both unit-mounted starters (installed on the chiller) and free-standing starters (floor standing). Requirements may vary depending on whether the starter is unit-mounted (UM) or free-standing (FS); these will be denoted as “*UM only*” or “*FS only*” to indicate to which type it applies.
*

In general, all new production, 19XR, 19XRT, and 23XL chillers have PIC II controls. This requirement only applies to starters used for chillers with PIC II controls.

All starters for Carrier chillers with PIC II controls require the Carrier Integrated Starter Module (ISM). Exception: Carrier unit mounted solid state starters. The ISM initiates or controls the starting sequence and provides 3 phase motor protection and metering for all starters in which it is installed.

<u>Motor Protection</u>	<u>Metering</u>
Overload	Voltage L1, L2, L3
Undervoltage	Current L1, L2, L3
Phase Loss	Power Factor
Voltage	Kilowatts
Current	Kilowatt Hours
Voltage Imbalance	Demand Kilowatts
Current Imbalance	Ground Fault Current
Phase Reversal	Frequency (Hz)
Ground Fault	
Phase to Phase	
Phase to Ground	
Single Cycle Power Loss	
Motor Locked Rotor	
Excessive Motor Acceleration	

CAUTION: The ISM is a microprocessor based device with static sensitive components. Use anti-static protective devices whenever making contact with the printed circuit board or terminals to avoid damage from ESD.

2. Application

2.1. Compressor Motors

Motors to be started and controlled are NEMA B 50/60 Hz three-phase squirrel cage induction motors driving centrifugal and screw refrigeration compressors. With a power supply phase rotation A-B-C, motors rotate in the proper direction when phase A is connected to T1, phase B is connected to T2, and phase C is connected to T3.

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2.2. Starting Methods

Allowable 19 series and 23XL starting methods for squirrel cage induction motor-starter combinations are:

*

Model Series	Motor Voltage	No. of Motor Leads	Full Voltage	Wye-Delta	Auto Xfmr	Prim. Reactor	Prim. Res.	Solid State
19, 23XL (Hermetic)	Under 600	6	◆	◆	◆	◆	◆	◆
	2300 to 13,200 (FS only)	3	◆	§ No	◆	◆	◆	◆

§ May be approved on a per job basis. Requires six motor leads. Prior approval by Carrier Engineering is required.

2.3. Non-Standard Equipment

Prior approval by Carrier Engineering is required on a per-job basis for equipment not in accordance with or described in this requirement.

3. General

3.1. Standards

Starting equipment shall be designed, constructed and labeled to comply with the latest editions of the following standards applicable at the time of shipment.

*

- 3.1.1 ANSI/NEMA standards publications, industrial controls and systems, pub. no. ICS 1,2,3,4,6, UL Standard 508 or 508A.
- 3.1.2 Other applicable codes specified on the purchase order. Example: NFPA-70.
- 3.1.3 All starters shall be suitable for installation in accordance with the National Electric Code or, in Canada, the Canadian Electrical Code.
- 3.1.4 Warning, Danger, and Caution labels shall use pictographs and label design per ANSI Standard Z535.4-1991 (or later).

3.2. Documentation

3.2.1 Order Information

Purchase orders from Carrier to the manufacturer will include the following information:

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3.2.1.1 Job data

- * (A) Carrier job number, name, ship to address and mark for.
- (B) When applicable, reference to customer specification and/or manufacturer quotation number.
- * (C) Required manufacturer's ship date, or required receipt date.
- * (D) Carrier salesperson's name and address. (*FS only*)
- * (E) When applicable, special documentation requirements.
- * (F) Bill of materials, including the starter and all options. (*FS only*)

3.2.1.2 Specification and special codes

- (A) This equipment shall comply with the latest edition of Carrier Engineering Requirement Z-415.
- (B) (Only if applicable) This equipment shall comply with (name and number of national codes) applicable on the delivery date of the equipment.
- (C) (Only if applicable) This equipment shall comply with (name and number of local codes) applicable on the delivery date of the equipment.

* 3.2.1.3 Chiller Model and control type (*FS only*)

Example: 19XR with PIC II control

3.2.1.4 Motor data

- (A) Compressor motor voltage and frequency.
- (B) Compressor motor: rated load amps (RLA), overload trip amps (OLTA=1.08×RLA) and locked-rotor amperes. Wye-Delta starters will have locked-rotor ampere values for both Wye (LRAY) and Delta (LRAD).
- (C) (If applicable) Motor power factor correction capacitor rating and corresponding nominal voltage.
- * (D) (If applicable) Oil pump motor voltage. (*FS only*)
- * (E) (If applicable) Pump out unit motor voltage. (*FS only*)

3.2.1.5 Starter data

- (A) Starter type (e.g., solid state, full-voltage, auto-transformer, Wye-delta, primary reactor).
- (B) Starter enclosure (e.g., NEMA type, style, cable entry/exit)
- * (C) Carrier starter order code number & drawing number (*UM only*)

3.2.1.6 Ambient Conditions

- (A) Ambient temperature, if over 104°F (40°C)

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- (B) Location elevation; for medium and high voltage if over 3300 ft. (1000 m) above sea level. For low voltage if over 6000 ft (1800 m) above sea level
- (C) Special environmental conditions.

3.2.1.7 Options

Carrier designations for options and other options indicated on the purchase order. (Per Section 6.0)

- * 3.2.2 Order Confirmation and Submittal Data (*exception: this section does not apply to factory installed UM starters*)

The type, quantity and distribution of documents shall be as specified in Table 3.2.2.

Order Confirmation and Hold-for-Approval Submittals:

Description	Send To	No. of Copies	Within Weeks after P.O.
Acknowledgment copy of Carrier's Purchase Order	Field Purchasing Expediter (Syracuse)	1	1
Transmittal Sheet	Field Purchasing Expediter (Syracuse)	1	1
	Carrier Salesman (Address per P.O.)	1	1
Compressor Starter Outline Drawing	Carrier Salesman (Address per P.O.)	Per P.O.	1 Note: For med. voltage (> 600V) units, up to 4 weeks are allowed for Hold-For-Approval submittals.
Accessories & Modification Outlines	Carrier Salesman (Address per P.O.)	Per P.O.	
Schematic & Wiring Diagrams	Carrier Salesman (Address per P.O.)	Per P.O.	
Installation, Operation and Maintenance Instructions	Carrier Salesman (Address per P.O.)	Per P.O.	

Final Submittal:

All of the above information except for the acknowledgment copy of Carrier's purchase order is to be sent as indicated on the purchase order to the Carrier salesman at the time of starter shipment. In addition, one set is to be securely fastened to the starter.

Table 3.2.2. Starter Documentation Flow

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3.2.2.1 Order confirmation. This shall consist of:

- (A) Acknowledgment copy of Carrier's purchase order reflecting
 - (1) Information under 3.2.1
 - (2) Promised ship date.
 - (3) Price Discrepancies
 - (4) Exceptions to any terms and conditions of order
- (B) Transmittal Sheet

Transmittal sheet reflecting job name, Carrier job number (if applicable), Carrier order number, manufacturer reference number, location of the manufacturer's service/sales office nearest the destination point (including contact name and phone number), and bill of material of all equipment, accessories and modifications shall be included in order.

*

- (C) Starter Outline Drawing.
 - (1) Overall dimensions
 - (2) Approximate power and control conduit and raceway connection locations.
 - (3) Minimum service clearance requirements.
 - (4) Applicable lug sizes (if required) to be provided.
 - (5) Volt ampere rating of control transformers. This rating shall also be indicated on the starter schematic
 - (6) Short circuit interrupt rating. (also indicate on nameplate)
 - (7) Starter maximum locked rotor amp rating (also indicate on nameplate)
 - (8) Motor current transformer ratio (also indicate on nameplate)
- (D) For accessories not installed within the compressor starter enclosure, corresponding outline drawings containing similar information, as well as how shipped and where and how to be installed.

3.2.2.2 Hold-for-Approval Submittal

- (A) Transmittal Sheet
- (B) Certified Dimension Drawings
- (C) Schematic and Wiring Diagrams

3.2.2.3 Final Submittals

This certified submittal shall include:

- (A) All Documentation under 3.2.2.2
- (B) Installation, operation and maintenance instructions.

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3.3. Quality *

- * 3.3.1. As part of a production quality program, completeness, correctness, and integrated functionality of each unit shall be verified prior to shipment.
- * 3.3.2. Continuity of all wiring within the starter shall be checked, and additional UL or other agency tests shall be conducted including, but not limited to, insulation integrity (hi-pot) tests. Hi-pot tests shall not expose the ISM module to test voltages.
- * 3.3.3. Starters shall be given a complete functional test by the supplier in which a 3-phase load is applied. As a minimum, this test shall include the power-up, start-up, transition (if applicable), up-to-speed, and shutdown operations of the starter when controlled by the ISM test program (available from Carrier). The 3-phase load shall be provided by a test motor and shall be made to simulate a minimum of 10% of the rated load current. Appropriate tests shall be conducted to demonstrate that components (e.g. transition resistors) are adequately protected for the duration of an incomplete transition. (See also 4.1.3.)
- * 3.3.4. Functionality shall be demonstrated for all input and output circuitry which involve starter components other than the ISM (for example, breaker shunt trip), and for all included options (for example, ground fault protection).
- * 3.3.5. Circuits which are intended for current measurement or detection (e.g., using current transformers) or voltage measurement (when potential transformers are used) shall have their output measured and calibrated to the required accuracy on each phase. Line currents shall be tested for accuracy at a minimum of one point at 10% RLA or greater. Ground fault or phase to phase fault circuits shall be tested at the configured trip level (ISM default = 15A) as a minimum. Appropriate measures shall be taken during both qualification and production to assure that reported currents meet the accuracy and the requirements of Sections 4.9, 4.10, and 6.15.3.
- * 3.3.6. The supplier shall enter starter (ISM) configuration parameters for the job in accordance with the sales order and this document using the ISM test program (available from Carrier).
- * 3.3.7. The starter supplier shall establish and maintain records, which provide evidence that the starter has been inspected and tested per the requirements of this specification. These records shall include starter assembly serial number, inspection and test failure records, and shall indicate the person who verified conformance to this requirement. Results of current and voltage measurement calibration and/or confirmation shall be included. For microprocessor-based control components, the serial number and version of hardware and version of software shall be permanently marked on the parts and retained in production quality records along with test documentation. The supplier shall maintain documentation that can be accessed either from the supplier's starter serial number or from the associated Carrier 5-digit chiller serial number. In addition, it is recommended that production records include the ISM serial number. (See Figure 7 for serial number location.)
- * 3.3.8. No hardware or software changes shall be made to the as-qualified assembly without pre-notification of and approval by Carrier Engineering, following Carrier's Supplier Deviation Request procedures.

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- * 3.3.9. Starters shall be audited either at Carrier or manufacturer's plant. Upon request (*FS only*), the starter shall be shipped to Carrier at Syracuse, New York, or Charlotte, North Carolina, enroute to the jobsite.

3.4. Materials and Workmanship

Only new materials shall be used. Appearance must be neat and orderly. There shall be no sharp metal edges left unprotected within the enclosure which might cut or wear through wiring or cables in an environment of moderate vibration.

3.5. Reliability

System Reliability-	As Shipped-	99.9%
	First 100 Operating Hours-	98.0%
	First 3600 Operating Hours	93.0%
	First 15 Years	90.0
Component Reliability-	First 3600 Operating Hours-	99.8%

Reliability Requirement assumes scheduled maintenance as recommended by the manufacturer. The typical starter operates 3600 hours/year.

The minimum number of starts is 20,000, with a nominal 15-minute interval between starts and a nominal 3-minute interval between stop and start. Minimum interval between starts can be 2 minutes with manual override of controls. (15 minute start-to-start and 3 minute stop-to-start intervals are provided by Carrier controls.) Refer to Carrier Corporation Reliability Procedure D-5.

3.6. Ambient Operating Conditions

Temperature: 40°F to 104°F (5°C to 40°C)

This is the temperature of the space in which the starter is located. The maximum temperature inside the starter is 40°C plus the temperature rise of the operating starter.

Relative Humidity	10% min., 95% max.
Elevation- Low Voltage	6000 ft. (1800 m) max.
Elevation- High/Medium Voltage	3300 ft. (1000 m) max.

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3.7. Shipping and Storage Conditions

Temperature -40°F to 140°F (-40°C to 60°C)

Relative Humidity 5% to 100% non-condensing

Packaging Starter shall be adequately packaged to provide protection from short-term exposure to the elements, shipping damage, dirt and moisture.

All packaging materials must conform to Carrier Engineering Requirement N-027.

* Returnable crating is preferred (*for factory installed unit-mount only*).

* Starter shall be adequately packaged to provide protection for up to six months of unheated “covered” storage (*FS only*).

* If applicable, export crating shall adequately provide protection during normal overseas open container shipping. See section 6.0 for export crating option.

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4. General Starting Equipment

4.1. Description By Starter Type

Power switches shall be alternating current, magnetic, air break or vacuum contactors, or solid state devices (semiconductors). Starter type options are full voltage or reduced voltage. Typical reduced voltage starters include Wye-Delta, Solid State, Primary Resistance, Primary Reactor, and Auto Transformer. Typical schematics are shown in Figures 2, 3, 4, 5, and 6 for basic starter types. The ISM initiates and monitors the start sequence for full voltage and Solid State starters, and the start and transition sequence for other reduced voltage starter types. Starters shall function in any three or four-wire commercial power system.

4.1.1 Full Voltage Starters

- * Magnetic air break or vacuum contactors shall be used. The ISM monitors the closure of 1M auxiliary contacts to confirm initiation of the start sequence and closure of 2M auxiliary contacts to acknowledge when full voltage is applied to the motor. ISM input for 2M auxiliary contact closure may be connected to the 1M auxiliary contact. The ISM will terminate the start sequence on an “excessive acceleration time” fault if starting current exceeds 100% RLA after 10 seconds.

4.1.2 Reduced Voltage Starters

Transition type shall be closed circuit, current-controlled by the ISM. The ISM initiates transition when starting amps > 5% and < 100% RLA within 20 seconds, or if starting amps < 150% RLA at 20 seconds. If starting current exceeds 150% RLA at 20 seconds, the ISM will terminate the start sequence on an “excessive acceleration time” fault. The ISM monitors the closure of 1M auxiliary contacts to confirm initiation of the start sequence and closure of 2M auxiliary contacts to provide incomplete transition protection and to acknowledge when full voltage is applied to the motor.

4.1.3 Wye-Delta Starters

- * Contactors shall be electrically interlocked to ensure that the whole starting impedance is inserted in the motor circuit before the line contactor can be closed. (See typical schematic.) Unbreakable metallic transition resistors shall be provided in each phase. Incomplete transition protection by the ISM disables the starter to protect the resistors from overheating if 2M auxiliary contacts are not closed within 1 second after activating the Transition output. Starter design shall ensure that no component damage will occur in the case of incomplete transition. This may be accomplished, for example, by selection of resistors that can withstand current until the ISM aborts the startup (approximately 1.05 seconds), or addition of other components which assure that the current-carrying duration is appropriately limited. Line and Wye contactors shall be mechanically and electrically interlocked to

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prevent simultaneous closure that could result in a line-to-line fault. Otherwise, the transition sequence is the same as described in 4.1.2.

4.1.4 Primary Resistance Starters

Designs shall have three-phase, unbreakable metallic resistors for reduced voltage motor starting, with taps at 65% and 80% volts. The factory connection shall be to the 65% tap. Otherwise, the transition sequence is the same as described in 4.1.2.

4.1.5 Primary Reactor Starters

Designs shall have three-phase air-cooled reactors for reduced voltage motor starting, with taps at 65% and 80% volts, medium duty service. The factory connection shall be to the 65% tap. Otherwise, the transition sequence is the same as described in 4.1.2.

4.1.6 Auto-Transformer Starters

Designs shall have three-phase air-cooled auto-transformers for reduced voltage motor starting, with taps at 65% and 80% volts, medium duty service. The factory connection shall be to the 65% tap. Otherwise, the transition sequence is the same as described in 4.1.2.

Note: If supplied, the 50% tap of resistors, reactors, or auto-transformers shall be labeled as follows: "Do not use 50% tap without consulting Carrier Corporation."

4.1.7 Solid State Starters

Solid state starters may only be used in applications up to 600 volts without prior approval from Carrier Engineering. Such starters shall comply with all provisions of Z-415 as specified.

Solid state starters shall have open and shorted SCR protection which reacts within 30 cycles of a fault, and SCR control shall operate at rated frequency $\pm 3\%$ -10 Hz.

Solid State starters shall have an electrical or mechanical interlock that prevents closure of the motor circuit breaker when the control power circuit breaker or disconnect is open.

4.1.7.1 Current Ramp

The preferred method of starting current regulation is current ramp, defined by an initial level, a ramp rate, and an upper limit.

In this method the starter rapidly applies an initial voltage step to develop enough starting current to prevent unnecessary energy input prior to motor rotation. This starting current shall be adjustable from 100 to 300% RLA, factory set at 125%. The starter then increases voltage in a controlled manner, causing the current to increase linearly with time until the current falls off rapidly, indicating that the motor is up to speed.

A preset maximum current shall also be defined for this ramp. This current limit shall be adjustable from 30 to 70% of the LRAD, factory set to 55%.

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(The maximum current limit is not required to be > 600% RLA.) Maximum ramp time (between application of initial current and maximum current) shall be adjustable from 5 to 20 seconds, factory set at 15 seconds.

The configurable range of the starter should be such that the SCRs can provide at least 45% locked rotor current, if required, prior to the up-to-speed signal.

Motor current regulating circuits must be designed so that there is no oscillation in motor current or torque at any time due to the action of the starter.

The starter then rapidly increases the voltage to full voltage.

4.1.7.2 Starter Fault Detection

When installed in a solid state starter, the ISM provides motor overload protection and protection from motor power faults. It does not provide protection for the starter control. The starter must include circuits which will protect itself and detect shorted and/or open power semiconductors. Such protection shall open a manual reset isolation contactor, or trip a circuit breaker or molded case switch which is load-break-rated to clear the fault. This protection is to be operational any time the starter is energized. Open semiconductor protection must operate reliably with current imbalance as low as 5%. A starter fault shall open a contact wired to the ISM starter fault input (terminals J2 7-8). Other starter-related faults which may reflect temporary conditions, such as heat sink over-temperature, should open the start fault contacts but not trip a breaker or switch.

When either the ISM or the solid state control module declares a fault, the SCRs and bypass contactors (if applicable) shall be opened and kept in the open state until the fault is cleared and the system reset (manually or automatically). Opening the starter fault contact will result in the ISM declaring a "Starter Fault". Only faults which are not otherwise interpreted by the ISM as specific faults (e.g., undervoltage, overvoltage, phase voltage imbalance, phase current imbalance, phase loss, motor phase overload, etc.) shall be manifested as generic Starter Faults by the system.

When any fault recognized by the solid state module and manifested as an ISM Starter Fault is declared, the system shall be capable of subsequently displaying any diagnostic aids that have been provided (i.e., after the compressor has been stopped).

If a phase loss, undervoltage, overvoltage, single cycle dropout, or ISM power-on-reset fault occurs while the motor is running, following power restoration the solid state module shall be ready to start if the start command is applied.

For inside-the-delta arrangements, circuitry is required to provide the functionality shown in the following table. (CB = Circuit Breaker; CPCB = Control Power Circuit Breaker)

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State Before Line Power is Applied		Required Functionality When Line Power is Applied
Main CB	Control Power CB	
Open	Open	Prevent closing of main CB until 30 sec after CPCB is closed. (Shunt trip may be activated.)
Closed	Open	Shunt trip main CB. Prevent closing of main CB until 30 sec after CPCB is closed.
Closed	Closed	Ready to start when start signal is applied.
Open	Closed	Prevent closing of main CB until 30 sec after power is applied.

4.1.7.3 Electromechanical Isolation

An isolation contactor that closes before the motor starts and opens after the motor is stopped shall be provided if specified.

If a load break isolation contactor is provided, it may be utilized for electromechanical isolation (auto reset), as well as a means of disconnecting the starter in the event that a fault is detected (manual reset), as long as its interrupting capacity is not exceeded.

4.1.7.4 Bypass Contactor

A contactor that bypasses the SCR's shall be provided, if specified. This contactor closes after the motor is fully started and opens prior to stopping the motor.

4.1.7.5 ISM Inputs

The starter must close a "Start" contact (equivalent to 1M-aux) connected across ISM terminals J2 9-10 within 2 seconds of the start command. The start command event should be considered to occur at the time when ISM terminal J9-2 is energized (115 VAC).

The starter shall close a 2M-aux contact connected across ISM terminals J2 11-12 to indicate when full voltage is applied to the motor. (See also Section 4.1.2.)

The starter must open "Start" and "Up-to-speed" auxiliary contacts within 2 seconds of the stop command event. The stop command event should be considered to occur at the time when ISM terminal J9-2 is deenergized (115 vac).

There shall be no condition under which the solid state module will start the motor when the ISM has not closed its 1CR relay on a start command.

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4.1.7.6 Energy Saving Control Systems

Energy saver control systems which operate by reducing motor voltage at reduced load shall not be used. These systems adversely affect certain chiller control systems.

4.1.7.7 Power Factor Correction Capacitors

If power factor correction capacitors are specified, they must be connected to the line side of a solid state starter and switched "ON" using a contactor after the motor is up to speed and switched "OFF" before the motor is stopped.

4.1.7.8 Start-Up Service

Starter manufacturers other than those listed below must provide start-up service by factory-trained personnel as part of the price of the solid state starter:

Benshaw Inc.

4.2. General Starter Design Requirements

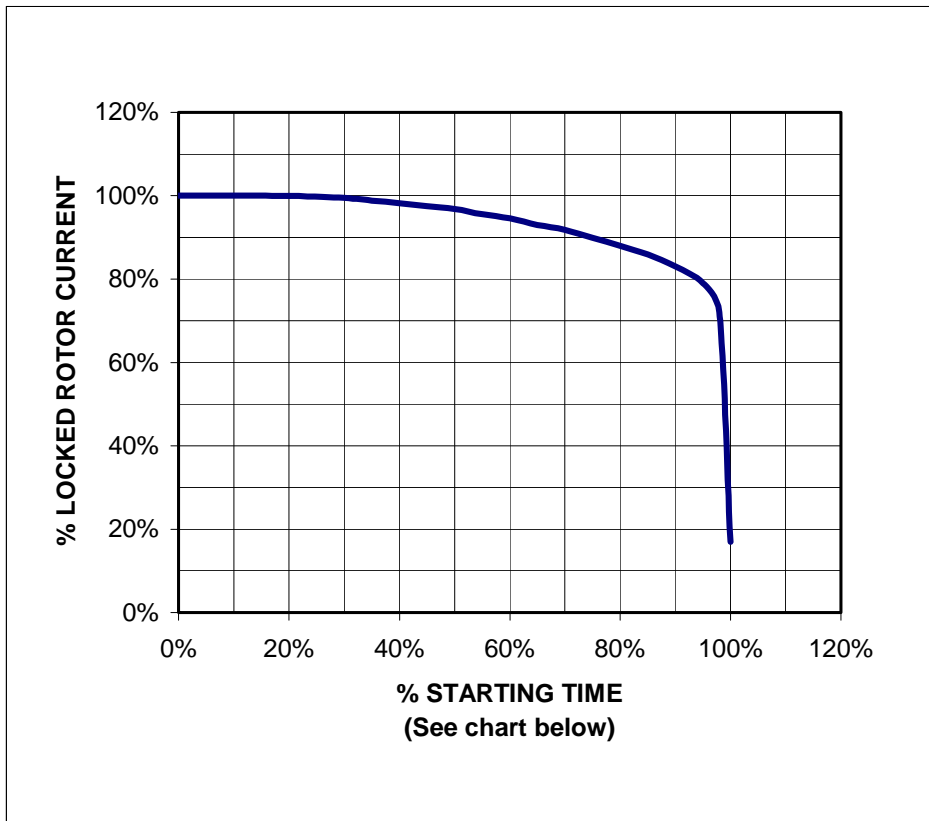
The motor starter is remotely controlled by the chiller control to ensure that compressor lubrication has been established and inlet vanes (in the case of centrifugal chillers) are closed, thus imposing minimum starting load before the motor is energized. The starter shall be designed to meet all applicable agency requirements when operated in the thermal environment specified in Section 3.6.

An integrated starter management module, Carrier Part No. CESO130037 (package P/N 19XR04012202) is required in all starters except the Carrier unit mounted solid state. Do not mount the ISM on a swinging or moveable panel, door, etc. The ISM shall be located at least 1 foot from all main motor conductors and contactors to minimize effects from EMI and to provide unrestricted access to ISM terminals for field connections and troubleshooting. The ISM shall be located in the low voltage section of medium/high voltage starters to minimize effects from EMI. The ISM shall be wired as shown on the applicable schematic (Figures 2, 3, 4, 5, or 6). The starter layout shall be planned to provide easy access to terminals on the ISM to facilitate field wiring and troubleshooting. (See Figure 7 for mounting hole layout.)

The ISM serial number shall be recorded during starter inspection, and test records shall be retained for future reference. (See Figure 7 for S/N location.)

Typical percent locked rotor current as a function of starting time is shown in Figure 1.

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Percent Rated Volts	Typical Starting Times: 19XR, 23XL, 19XRT Chillers
100%	5 s
80%	9 s
65%	12 s
58%	15 s
100% in wye	15 s

Figure 1. Typical Starting Times

The ISM’s “1CR” and “TRANS” contact outputs are each rated for 5 amps sealed, and 50 amps inrush current. The specified limits shall not be exceeded. If contactor coil(s) or/and other loads exceed this limit, pilot relays for 1CR and TRANS shall be provided which meet the required contact rating.

4.3. Condenser High Pressure cut-out Relay

A high pressure relay (HPR) shall be provided with a 24VAC coil and contacts rated for minimum 10 amps sealed, 100 amps inrush, or as required to accommodate the total loads connected to the “1CR” and “TRANS” outputs; whichever is greater.

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4.4. Enclosure

- * The design shall employ a floor mounted, sheet steel NEMA type 1 enclosure, formed, welded, bolted, and braced into a rigid self-supporting structure, accommodating all basic starter equipment, accessories, and modifications. All shall be completely factory installed, wired, and connected. At least 4 holes or other means shall be provided in the base for floor-mount anchoring (*FS only*). Removable eyebolts, lifting lugs, or other means for lifting the enclosure shall be provided. Lifting points shall be located to balance the assembly based on center of gravity. (Note: Drawings for unit mounted or certain special starter enclosures define additional requirements not specified in Z-415.)

Accommodations for field-installation of power conduits and other interface wiring shall be designed to avoid the need for field drilling of holes in the enclosure, e.g., providing plate(s) with plugged holes.

- * Doors shall be hinged with front interlocked access. Doors shall be padlock-able in the closed position to prevent unauthorized access to the enclosure, independent of the main circuit breaker handle position (when provided, see section 6.6). Door latching shall be designed to take into consideration deflections resulting from internal component weights, mounting, and motor lead installation.

All metal surfaces, inside and out, shall be phosphatized or cleaned, and primed with a suitable corrosion inhibitor. The final finish shall be enamel top coat or an equivalent. Latches, handles, and all other cabinet hardware shall be plated or painted to prevent corrosion from humidity and exposure to normal industrial environments.

Starters rated above 600 volts shall have separate compartments (1) for the ISM and other low-voltage control components, (2) for the medium-voltage contactors and components, and (3) for the medium-voltage disconnect and HIC fuse components. Access doors to these compartments shall be electrically and mechanically interlocked as needed to prevent opening or closing the disconnect switch when any medium-voltage compartment door is open and to prevent operating the disconnect switch while the medium-voltage contactors are closed.

4.5. Power Connections and Grounding Lug

All lugs for field wiring connections must be sized for conductors selected per the NEC for 75° C wiring material. Multiple lugs per phase shall be provided if required.

Lugs for line and load power connections must be located to provide adequate clearance and easy connection of cables at entry/exit location(s) per job order. Terminals and lugs must be UL or ETL listed for use with copper conductors. A ground lug and lugs for line and load connections must be provided.

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4.6. Control Connections

Terminal blocks required for field connections must be permanently and clearly identified to match schematic and wiring diagrams. Terminal blocks shall not be mounted on a swinging or moveable panel, door, etc. Adequate clearance shall be provided for easy connection and inspection of field wiring.

Field wiring terminal blocks shall be provided as required for specified modifications. Terminal blocks shall be separated and identified by voltage and arranged in numerical sequence. Low voltage terminal blocks must be located in the low voltage compartment of medium voltage starters.

Screw-clamp pressure plate terminals shall be employed and rated for at least 10A, and for at least line voltage or 600 volts for medium voltage starters. Class 1 wire size is 14 AWG.

All internal panel wiring shall be connected to one side of a terminal block. The opposite side shall be reserved for field-wired conductors.

Wire connections per terminal shall not exceed three. Extra blocks and factory-formed jumpers may be added to obtain the required accommodation. Usage of terminal strip hardware which minimizes the chances for strand shorts between adjacent terminals is recommended.

4.7. Conductors

Continuously rated copper main conductors shall be utilized. Conductors shall be properly designed for at least the basic starter short circuit withstand current, (symmetrical amps), or for the interrupting capacity specified, whichever is greater. All control and power cable is to be stranded copper, 18 AWG minimum size, type THNN, THWN MTW or equivalent.

Conductors carrying 30V or less shall be separated from higher voltage conductors, and they shall not be located in the same bundle or raceway. Shielded or twisted conductors shall be used for control wiring where required and where EMI/RFI exceeds CE Standards.

4.8. Contactors

4.8.1. Contactor Types.

Air break contactors shall be continuously rated, magnetic types, with arc extinguishing devices, mechanical interlocks, and auxiliary contacts. (Oil immersed contactors shall be used when specified). Starter contactor coils must have noise suppression which maintains transient voltage below 300 volts glow discharge. Contactors shall be designed to withstand 10 seconds at locked rotor delta current (100% volts) or 30 seconds at locked rotor wye current (58% volts). *Exception:* Carrier unit mounted wye-delta starters shall be designed to withstand 10 seconds at

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the starter's locked rotor rating or 30 seconds at locked rotor wye current. Starting methods using other reduced voltage ratios shall be limited to the same time limits.

Contactors rated above 600 volts shall have interrupting capacities adequate to meet the requirements for ANSI/NEMA standard ICS class E2 controllers, with fuses or circuit breaker properly coordinated with the motor overload trip setting.

Vacuum contactors must not generate potentially damaging voltage surges due to current chopping or multiple re-ignition. Manufacturers other than Cutler Hammer, General Electric, and Siemens must provide surge arresters on the load side of vacuum contactors. Vacuum contactors must have loss-of-vacuum indicators and operate safely if vacuum is lost. Otherwise, N.C. vacuum switches connected in series at the ISM starter fault input must be provided. Switches must open on loss of vacuum.

Vacuum circuit breakers shall not be used in place of contactors.

4.8.2. Hold-in/Drop-out Voltages.

Contactor coils shall maintain design contact tip pressure when coil voltage is $> 75\%$ and $< 120\%$ of nominal.

4.8.3. Auxiliary Contacts.

Auxiliary contact ratings are specified in Section 5.3. These contacts must remain closed if the main contactor is closed or welded. The following auxiliary contacts shall be provided:

- For full-voltage starters: three normally open status contacts on the main contactor (2 start and 1 run)
- For reduced voltage starter types: two (2) normally open status contacts on the start contactor (1M) or equivalent, and one normally open status contact on the run contactor (2M) (up-to-speed contact for solid state starters).
- Refer also to Figures 2 through 6.

4.9. Starter Current Limit and Overload Protection

The starter manufacturer shall verify that the starter current rating is suitable for the motor load and locked-rotor amperes specified. If an improper size starter is specified, the manufacturer shall notify Carrier and defer further action pending receipt of an official change notice.

Three current transformers shall be installed between the line lugs and the contactors or semiconductors to monitor line currents on each phase. This signal is used by the ISM to provide three phase current limiting, and current loss, current and voltage imbalance, current overload, current when stopped, and locked rotor protection for the motor.

Current limiting via the ISM occurs between 100% and 105% RLA. Compressor unloading occurs when motor current is $> 105\%$ RLA. The overload trip is set at 108% RLA. The

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motor rated load amps and locked rotor current specified on the order for rating purposes, and the starter locked rotor current rating, are to be programmed into the ISM to provide this protection using “ISM test software” before the starter is shipped from the supplier.

Extreme care must be taken to account for the actual current being sensed by the ISM versus the true motor line current as specified on the order, i.e. phase versus line and the effect of power factor correction capacitors. Current transformers shall be installed such that they sense line current in accordance with the applicable schematic, (Figure 2, 3, 4, 5, or 6).

The current sensed shall not be influenced by power factor correction capacitors. If capacitors are included (per the order specification), the capacitor leads should be connected ahead of the current transformers, or the leads must be routed back through the current transformers to achieve the same result.

* The current transformer ratio shall be selected to produce a 4.0 ± 0.5 ampere signal at rated load amps with a 1.0 ohm burden. Alternatively the ratio may be selected from Table 4.9 based on the min/max. rated load amps range. The signal must be proportional to compressor motor current between 0 amperes and locked rotor Delta amperes. The current transformers shall be connected as indicated on the typical schematic using twisted pair leads. The CT ratio shall be permanently marked on the current transformer and on a data plate inside the starter door. If the CT ratio must be adjusted from the nominal value (see section 3.3.5) then the calibrated value shall be the one used on permanent markings.

Line current CT ratios shall be accurate within 1% of actual value between 10% RLA and 600% RLA, within 10% of actual value between 5% and 10% RLA, and within 3% of actual value between 600% RLA and Locked Rotor Amps.

If the same current transformers are used for the ISM signal inputs and for other function(s), their circuits must be made continuous and permanent to avoid the possibility of inaccurate ISM current readings or damage to the ISM resulting from open-circuit current transformer voltage. Phase selector switches shall not be used with the current transformers supplying ISM signal inputs in order to provide inputs to other devices (e.g., analog ammeters).

4.10. Line Voltage Transformer

A 3-phase line voltage potential transformer shall be included in all starters over 600 volts. Secondary output voltage shall not exceed the range of 115 to 575 volts, and the transformer ratio be within the range of 3:1 to 35:1. Transformer accuracy shall be $\pm 0.5\%$. Provide protection as required.

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CT RATIO	RATIO : 1	MIN RLA	MAX RLA	CT RATIO	RATIO : 1	MIN RLA	MAX RLA
15 : 5	3	10.05	13.5	400 : 5	80	272	360
20 : 5	4	13.6	18	500 : 5	100	350	450
25 : 5	5	17	23.25	600 : 5	120	420	540
35 : 5	7	23.8	32.55	800 : 5	160	536	720
50 : 5	10	33	45	1000 : 5	200	700	900
60 : 5	12	42	54	1200 : 5	240	840	1080
75 : 5	15	52.5	67.5	1500 : 5	300	1050	1350
100 : 5	20	67	90	1800 : 5	360	1260	1620
125 : 5	25	87.5	112.5	2000 : 5	400	1400	1800
150 : 5	30	105	138	2500 : 5	500	1750	2250
200 : 5	40	136	180	3000 : 5	600	2100	2760
250 : 5	50	175	225	4000 : 5	800	2760	3600
300 : 5	60	210	276	5000 : 5	1000	3500	4500

Table 4.9. Phase Current Transformer Ratio Selection

4.11. Control Power Disconnect and Transformer

4.11.1 Control Power Circuit Breaker - Low Voltage Starters

In all starters up to 600 volts, one 3 pole 15 amp max circuit breaker shall be installed to supply the control power transformer and line voltage inputs to the ISM. The connection shall be made to the line side of the starter disconnect or circuit breaker, or, if no disconnect means is provided, to the main line lugs. *Exception:* Carrier unit mounted solid state starter shall have HIC fuses with a circuit breaker on the load side of the control power transformer.

4.11.2 Control Power Disconnect - Medium Voltage Starters

When specified, in starters rated over 600 volts a fused disconnect shall be provided to supply line power to the control power transformer and line potential voltage transformer. The connection shall be made to the load side of the starter disconnect or circuit breaker. If no disconnect means is provided, connection shall be to the main line lugs.

4.11.3 Control Power Transformer

One 1 kVA or one 3 kVA 115 volt, single phase double-wound, dry type, continuously rated transformer shall be provided. In all starters up to 600 volts, the primary shall be connected to the load side of the control power circuit breaker.

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(Exception: Carrier unit-mounted solid state starters per 4.12.1.) For starters rated over 600 volts with no main disconnect specified, the primary shall be connected to the load side of the control power disconnect.

Fuses shall be provided to protect each primary leg as required. TB6 and transformer secondary legs LL1, and LL2 shall be protected at 15 or 30 amps, for 1 kVA and 3 kVA transformers, respectively. The transformer secondary shall be connected in accordance with the applicable typical schematic, Figures 2 - 6. The transformer secondary must be grounded. When starters use 115V contactor and relay coils, up to 0.3 KVA of the specified transformer kVA rating may be used for starter control.

On starters above 600V having provision for a separate 115 V control test supply, interlocking means shall be provided to ensure that control transformer's 115V terminals cannot become energized from the test supply. Energizing the medium voltage side of the control transformer in this manner must be avoided.

Unless otherwise specified, transformer sizes shall be selected according to chiller model as follows:

23XL - 1 kVA

19XR (and 19XRT retrofits) - 3 kVA (units using 115 V oil heaters)

4.12. Control Components

Control components shall be provided in accordance with diagrams, supplemented as necessary to perform all required functions.

No contacts are permitted on the grounded neutral side of contactor coils, relay coils, or other devices. Control circuit coil and contact ratings are specified in Section 5.3.

Control relays not specified in Section 5.3 shall have 240V minimum rated contacts for 120V circuits, and 600V rated contacts in circuits above 300V (quantity and type as required).

Only industrial or heavy-duty push button switches, indicating lights, and control switches shall be mounted on the front of the enclosure.

4.13. Identification and Labels

4.13.1 General

All identification shall be clearly legible and permanent.

Symbols and labeling shall be provided to meet warning and safety requirements of all applicable codes, including but not limited to: OSHA (Standards-29 CFR) 1910.145 - specifications for accident prevention signs and tags; and ANSI Standard

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Z535.4-1991 or later. Accordingly, all danger labels shall include a pictograph (a pictorial representation which identifies a hazardous condition or conveys a safety instruction).

4.13.2 Schematic Labels and Component Identification

A copy of a detailed schematic and wiring diagram(s) shall be permanently attached to the inside of the control enclosure front door or some other accessible internal surface, or enclosed in transparent film and print pocket. The drawing shall be a reproduction of the highest quality, non-fading, easy to read, and absolutely legible with good definition. The drawing material shall be PVC-based or laminated to resist oil, grease, and mild solvents. A basic schematic plus options sheets may be used as long as included options are clearly identified.

The electrical schematic must clearly show proper routing of motor leads through current transformers, which may be provided for monitoring contactor or semiconductor line currents for general protection, or line or load currents for ground fault protection.

All components and terminals shall be permanently identified to correspond to the drawing. Component identification must be attached to a non-removable unobstructed surface.

Special internal wire and terminal block designations assigned by the starter manufacturer shall be coded or otherwise identified to be easily distinguishable from Carrier-assigned designations.

All conductors shall be color-coded and labeled at each end. All conductors supplying power to a control power transformer, control circuit breaker, and oil pump circuit breaker or disconnect when a main disconnect is open shall be colored solid yellow. Neutral conductors shall be white. Ground conductors shall be green or bare.

4.13.3 Starter Nameplate Information

A starter nameplate shall include the following:

- Carrier starter model number (*for unit-mounted and Carrier-supplied free-standing starters only*)
- Starter maximum locked rotor current rating (See also paragraph 3.2.2.1.)
- Motor rated load amps
- Motor rated load voltage and frequency
- Motor locked rotor current rating
- Motor current transformer (CT) ratio (See also paragraph 3.2.2.1.)
- Main disconnect or breaker short circuit interrupt rating, if either is included (See also paragraph 3.2.2.1.)
- Starter enclosure short circuit rating (if required for agency approval)

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4.13.4 Other Labels and Marking

The starter supplier shall establish procedures and maintain documentation for identifying and tracking each starter from receipt of order through all stages of production. A serial number or other reference to this identification shall be permanently marked on the starter nameplate.

A UL/CUL, ETL, CSA, or other agency label shall be installed on recognized or listed starters if specified.

A label stating the following shall be displayed: "This equipment conforms with Carrier Engineering Requirement Z-415."

A label shall be affixed adjacent to all 120 volt field wiring terminal strips stating: "WARNING: ELECTRICAL SHOCK HAZARD with back-feeding of voltage through control power transformer. Do not connect separate external 120v power source to LL1 and LL2 in this starter."

A label shall be affixed in prominent position stating: "Important: The field wiring terminal connectors supplied on this controller are suitable for use with copper conductors only. If user/installer elects to use aluminum conductors, the sole responsibility for adequate termination is his own. Successful use of aluminum requires special care and maintenance and falls beyond the scope of normal equipment warranties."

A label shall be located inside the starter door which provides the name and phone number of the person to call in the event that service is required. The name is not required if the number is for a warranty administration or customer service department.

When an ISM is supplied, labels and protective barriers shall be affixed to the ISM package in accordance with supplied instructions.

For all solid state the following label must, as a minimum, be applied to the outside of the front door of the starter, unless an isolation contactor is provided:

"WARNING: ELECTRICAL SHOCK HAZARD High voltage is at load side terminals and motor terminals when starter is turned off. Disconnect main power before servicing equipment."

As a minimum, one of the following danger labels (or an equivalent) must be applied to the outside of the front door of the starter enclosure. If a starter disconnect is supplied, the label shall be adjacent to the handle of the disconnect:

- (No Starter Disconnect Provided) - "WARNING: ELECTRICAL SHOCK HAZARD Open all remote disconnects and confirm the absence of power before servicing this equipment. Contact with hazardous voltage when present will result in severe personal injury or death."
- (Starter Disconnect Provided) - "WARNING: ELECTRICAL SHOCK HAZARD This disconnect will not de-energize all internal circuits. Open all

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internal and remote disconnects, including control power/oil heater and oil pump disconnects, and confirm the absence of power before servicing this equipment. Contact with hazardous voltage when present will result in severe injury or death.”

5. General Control Interface Devices

5.1. Application

This section applies to the discrete devices provided by the starter supplier which interface with the ISM to provide the required motor control and protection.

5.2. Chiller-Starter Interface Schematic

Typical chiller-starter interface schematics are shown in Figures 2, 3, 4, 5, or 6.

5.3. Relay coil and Contact Ratings

Relay and contactor coils and contacts which interface with the chiller control must operate reliably under the following conditions. Relay coils not specified below shall not drop out above 84% and below 116% of nominal voltage.

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<u>Coil Requirements</u>					
<u>Devices</u>	<u>Nom. Voltage</u>	<u>Min. Pick-Up Voltage</u>	<u>Max. Inrush Current</u>	<u>Max. Sealed Current</u>	<u>Must Drop-Out Amps/Volts</u>
High Pressure Relay (HPR)	24 VAC	18 VAC	5 Amps	0.4 Amps	10 mA @ 24 VAC
ISM Module: 1M (Start), 2M (Run), and Shunt trip	115 VAC	95 VAC	50 Amps	5.0 Amps	5 mA @ 115 VAC

<u>Contact Requirements</u>					
<u>Devices</u>	<u>Nom. Voltage</u>	<u>Min. Voltage</u>	<u>Max. Current</u>	<u>Min. Current</u>	
1M Contactor Aux. (to terminals 50 & 51)	24 VAC	18 VAC	2.0 Amps	0.4 Amps	
1M Aux (Start), 2M Aux (Run), and starter fault inputs to ISM	24 VAC	18 VAC	20 mA	4 mA	
High Pressure Relay (HPR)	115 VAC	97 VAC (per Section 5.3)	See Section 4.3		

6. Options

6.1. General

* The optional equipment listed in this section is to be provided in the starter when specified. Not all of these options are available on standard factory installed unit mount starters, but may be specified for special requests.

Other options not mentioned here may be specified to meet customers' specifications. In applying such modifications, the requirements and intent of this specification must still be met. In addition, prior approval by Carrier Product Engineering is required.

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Options which require field control wiring shall be wired to terminal blocks in the low-voltage compartment. The terminal blocks shall be rated for 10 amperes at 600 volts. Terminals shall be identified in accordance with the figures in the appendix.

Wired components or terminals mounted on the inside of the enclosure door shall have protected "no touch" covers to prevent contact with hazardous voltage by service personnel working with an open door.

6.2. Oil Pump Power and Circuit Breaker or Disconnect

6.2.1 Low Voltage Starters

One 15 amp 3 phase circuit breaker shall be connected to the line side of the starter disconnect or to the main line lugs if no disconnect is provided. The load side of the breaker shall be connected to terminals labeled OS1, OS2, and OS3.

6.2.2 Medium Voltage Starters - Circuit Breaker Only

A 15 amp, 3 phase circuit breaker (as specified on the purchase order) shall be installed and wired within the starter enclosure for connecting to a field power source. The load side of the breaker shall be connected to terminals labeled OS1, OS2, and OS3. The associated disconnect shall be lockable in the open position.

6.2.3 Medium Voltage Starters - Power Source and Disconnect Means

One medium voltage step-down transformer shall be provided, including a fusible disconnect on the primary and circuit breaker protection on the secondary. (Fusible disconnect protection shall be provided on the secondary if specified on the purchase order.) Primary voltage shall match the starter line voltage, and secondary voltage shall be as specified on the purchase order. The transformer may be mounted and wired in a separate NEMA 1 enclosure, or as specified on the purchase order. If a non-load break type primary disconnect is supplied, interlocking shall be provided which ensures that the secondary is disconnected before the primary is opened. The disconnect shall be lockable in the open position. Line and load terminals shall be provided which are suitable for the application.

6.3. Enclosure Options

- * 6.3.1 NEMA type 1A, 1, 2, 3, 3R, 4, 12, etc.
- 6.3.2 Special color paint (exterior only)
- 6.3.3 Special paint (exterior and interior)
- 6.3.4 Kirk key interlock or equivalent
- 6.3.5 Space Heater

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6.4. Surge Protection

Voltage surge protection capacitors and lightning arresters are to be installed on the line side of the starter disconnect unless otherwise specified. Surge capacitors shall have visual failure indication.

6.5. Meters

* Meters shall have a 1-1/2" radius (minimum) scale and be installed on the front door of starters. Current transformers and potential transformers shall be installed with fuse protection of appropriate accuracy and burden. Metering current transformers shall be installed on the load side of power factor correction capacitors in order to measure actual motor current. Meters whose signal is supplied through a selector switch shall not share the same current transformers used by the ISM. (Note: Drawings for unit mounted or certain special starter enclosures define which of the following meter types are required.)

6.5.1 Ammeter, single phase

6.5.2 Ammeter with three-phase, four position selector switch

6.5.3 Voltmeter, single phase

6.5.4 Voltmeter with three-phase, four position selector switch

6.4.5 Watthour meter, three-phase

6.5.6 Wattmeter, three-phase

6.5.7 Power factor meter (indicating corrected PF when PFCC's are installed)

6.6. Low Voltage Disconnect and Short Circuit Protection

A door-interlocked, externally gang-operated three-pole main power disconnect means shall be provided, including a mechanical position indicator on the enclosure exterior and short circuit protective means. Short circuit protection shall be coordinated with motor overload protection. A means of pad-locking the disconnect in the open position shall be provided. Fuse and circuit breaker ratings must be derated as necessary to avoid premature trip based on the specified ambient temperature plus the temperature rise in the starter.

Any current-limiting features built into the disconnect or breaker, such as IOC (instantaneous overcurrent) trip, should be selected or set high enough so that such limits do not preempt ISM-based motor protection features.

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One of the following shall be provided as specified on the purchase order:

- 6.6.1 Fusible, current rated molded case disconnect switch with shunt trip, capable of interrupting motor stalled current and if applicable, set for the maximum current allowed by code
- 6.6.2 Molded case circuit breaker with shunt trip and an instantaneous overcurrent element in each phase set for the maximum current allowed by code.

6.7. Motor Protective Relays

The ISM provides motor protection for faults under this heading. If additional protection is provided or required, it must comply with the following:

Relays under this heading may be provided individually or may be combined into a single relay where available. Relay contacts shall be connected in the starter fault circuit as shown on the schematics (Figures 2, 3, 4, 5, or 6). Contact ratings are specified in Section 5.3.

6.7.1 Undervoltage Protection (UV)

Features shall include: a three-phase undervoltage relay complete with potential transformer (if needed); one contact which is closed under normal voltage conditions, opening at 85% volts or less after 5 seconds, minimum; automatic reset after a 10 second minimum time delay.

6.7.2 Overvoltage Protection (OV)

Features shall include: a three-phase overvoltage relay complete with potential transformer (if needed); one contact which is closed under normal voltage conditions, opening at 115% volts or more after 5 seconds minimum; automatic reset after a 10 second minimum time delay.

6.7.3 Ground Fault Protection

Features shall include: low level ground fault detection; a relay with instantaneous operation and manual-reset normally closed contacts; current transformer(s).

The relay must be capable of being set to trip within the range of from 5 to 25 amps to ground.

The relay contacts are to be wired in the starter fault circuit. When a shunt trip molded case switch or circuit breaker is provided, the shunt trip circuit shall be activated by a separate contact. The current transformer shall be located such that it will not be affected by single phase loads, such as the control power transformer which might create a transient current imbalance.

See also Section 6.15.

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6.7.4 Phase Reversal Protection

Features shall include: a voltage or current sensing phase reversal (or phase rotation) relay; manual or automatic reset normally closed contacts which open on reversal of normal phase rotation as defined in Section 2.1; automatic reset after a 10 second minimum time delay.

6.7.5 Phase Failure and Phase Unbalance Protection

Features shall include: a current or voltage sensing three-phase relay to detect phase loss and phase unbalance using the negative sequence principle; manual or automatic reset normally closed contacts; automatic reset after a 10 second minimum time delay; relay calibrated to trip when voltage imbalance is more than 10%.

6.8. Chiller Control Packages

The specified control shall be installed within the starter enclosure or in a separate NEMA enclosure, as specified. These controls are for operation with the Carrier chiller control and may be electrically separated from starter controls.

6.8.1 Auxiliary Pilot Relay

Used for any applicable auxiliary control application where spare pilot relay contacts are specified. ISM contacts at terminals J9-7&8, -9&10, -11&12, -13&14, or -15&16 shall be used to control the line side of the specified pilot relay coil. The neutral side of the coil shall be connected to the neutral side of the control voltage supply source.

6.8.2 Stop Switch

Used to stop the chiller from the starter. On starters without shunt trip, a normally closed, maintained contact pushbutton switch, colored red on the starter door shall be used. The switch shall be a push-push or push-pull, maintained contact device. This device is to be wired in series with the high pressure relay contacts. Voltage and current rating must be in accordance with the HPR contacts (Section 4.3). If a shunt trip circuit breaker or disconnect is provided, a normally open, maintained contact pushbutton switch shall be provided to activate the shunt trip coil. This may be provided in addition to the contact which interrupts the HPR contact current path.

6.9. Power Factor Correction Capacitors

This option shall consist of three-phase power factor correction capacitors, complete with fuses in each ungrounded conductor, insulated terminals, and discharge resistor. Capacitors shall have blown fuse indication. Capacitors are not to be connected between the motor current signal transformers and the motor terminals unless the capacitor leads are run back through the current transformer to cancel out the capacitor current. They shall be installed

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within or external to the starter enclosure and connected at locations on the line side of the motor current signal transformers. Capacitor KVAR ratings on the starter order are at the capacitor rated voltage.

See also Section 6.15.3.

6.10. Pumpout Unit Disconnect

A 600V, 15 amp minimum, three-pole circuit breaker for this purpose shall be mounted inside the main compressor starter enclosure.

6.11. Auxiliary Disconnect Devices

If an auxiliary disconnect device such as for an oil pump or pumpout unit is ordered, the device shall be installed such that the operating handle is within the enclosure and not operable from the outside. The taps between the primary overcurrent protection and the power source must be less than ten feet long and must have short circuit and overcurrent protection in each leg.

If a main motor starter disconnect is not supplied, the auxiliary disconnect device shall be wired to the line side of the main motor starter. The disconnect device shall not be wired to the load side of the main motor starter.

The device must be a circuit breaker or fused disconnect, located such that it can be easily tripped without requiring an operator to be near any live metal parts. It shall be clearly identified as "Pumpout Power Disconnect," or "Oil Pump Disconnect". A preferred location is at eye level in the front portion of the enclosure. Any live metal parts on the device must be shielded to prevent personal contact.

6.12. Starter Auxiliary Contacts

Additional normally open or normally closed auxiliary contact(s) shall be installed as specified on starter contactors, rated for at least 10 amperes at 115VAC and wired to terminal blocks.

6.13. Modifications To Meet Special Codes

- * It shall be the manufacturer's responsibility to ascertain the requirements of, and ensure that the starter includes any necessary accessories and/or modifications required to comply with, any special codes and regulations specified on the order. One such code is CE Marking.

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6.14. Miscellaneous

6.14.1 Indicating Light

This shall be colored red, labeled “Run”, installed on the starter door, and either connected to the ISM’s 1CR output (ISM terminal J9-2) or, if a separate 1CR relay is provided external to the ISM, in parallel with the external 1CR relay coil or energized through an auxiliary contact on the run contactor.

6.14.2 Start Counter

A 5- or 6-digit counter shall be wired to increment by 1 each time when energized by the ISM’s 1CR output (ISM terminal J9-2) or, if a separate 1CR relay is provided external to the ISM, in parallel with the external 1CR relay coil, or by an auxiliary contact on the start contactor.

6.14.3 Elapsed Time Meter

An elapsed time meter shall accumulate and display compressor run time in hours using a minimum of 6 digits. It shall be wired to be energized by the ISM’s 1CR output (ISM terminal J9-2) or, if a separate 1CR relay is provided external to the ISM, in parallel with the external 1CR relay coil, or by an auxiliary contact on the start contactor.

6.15. Phase to Phase and Phase to Ground Current Transformers

6.15.1 Phase-to-Phase Fault Detection Using Multiple CTs

When specified, zero-sequence current transformers (CTs) shall be installed between the contactors or semiconductors and load lugs to monitor currents in each motor phase to provide phase to phase and phase to ground fault protection in low voltage starters. Output current greater than 0.5 amps will damage the ISM. The current transformer leads shall be connected to the ISM in accordance with the low voltage schematics. Route phase conductors 1 and 4 through CT-14, phase conductors 2 and 5 through CT-25, and phase conductors 3 and 6 through CT-36 as shown on the schematic. Color coding and labeling shall be used to prevent installation mistakes to the greatest extent possible.

When this option is specified, the CTs shall be installed on conductors within the starter such that motor lead pairs do not have to be routed through these CTs at time of motor lead installation or field assembly.

6.15.2 Ground Fault Detection Using One CT

When specified, a single zero-sequence current transformer shall be installed such that all load or all line side conductors, with the exception of any ground lead, pass through it to provide phase to ground fault protection. Current transformer leads

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shall be connected to the ISM in accordance with the applicable medium or low voltage schematic. When only one CT is used, jumpers shall be installed in place of the other two CTs, i.e. J5-3 to J5-4 and J5-5 to J5-6.

6.15.3 General

The Phase/Ground current transformer ratio shall be 150:1 with accuracy $\pm 10\%$ of actual value at a 10 ohm burden with a ground fault current between 0 and 25 amps. Suppliers should verify that CTs selected for this options provide the desired output level for a primary signal which matches the configured ground fault trip level (e.g., default level of 15 amps).

Appropriate measures shall be taken to assure that power conductors are routed through the current transformer(s) in the proper direction. Current transformer(s) shall be mounted to the enclosure or an enclosure bracket and protected against shipping damage.

If power factor correction capacitors are specified along with this option, adequate measures must be taken to assure that capacitor charging current will not generate a false ground fault indication.

NOTE: Do not route ground conductor(s) through phase/ground current transformer(s).

6.16. Line Side Control Power Source - Medium Voltage Starters

When specified, in starters rated over 600 volts the control power source may originate from the line side of the main breaker or disconnect. (Load side connection is standard as described in Section 4.11.2.) An additional fused disconnect or circuit breaker may be required. (Refer to Figure 3, 5, or 6.)

6.17. Constant Voltage Control Power Transformer (Low Voltage Only)

When specified for starters rated for less than 600 volts, a constant voltage transformer (also known as regulation transformer or ferro-resonant transformer) may be used in place of, or on the 115v secondary side of, a standard control power transformer. This device has the capability of maintaining current on the secondary through brief voltage dips and current interruptions on the primary, and may significantly improve chiller availability and ability to remain on line in sites where power quality is marginal.

7. Special starter requirements

Carrier's Solid State and unit mounted Wye Delta starters have additional packaging and performance requirements not specified in this requirement. These special requirements are included on drawings and documentation only relevant to these OEM suppliers.

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8. Engineering Approved Manufacturers

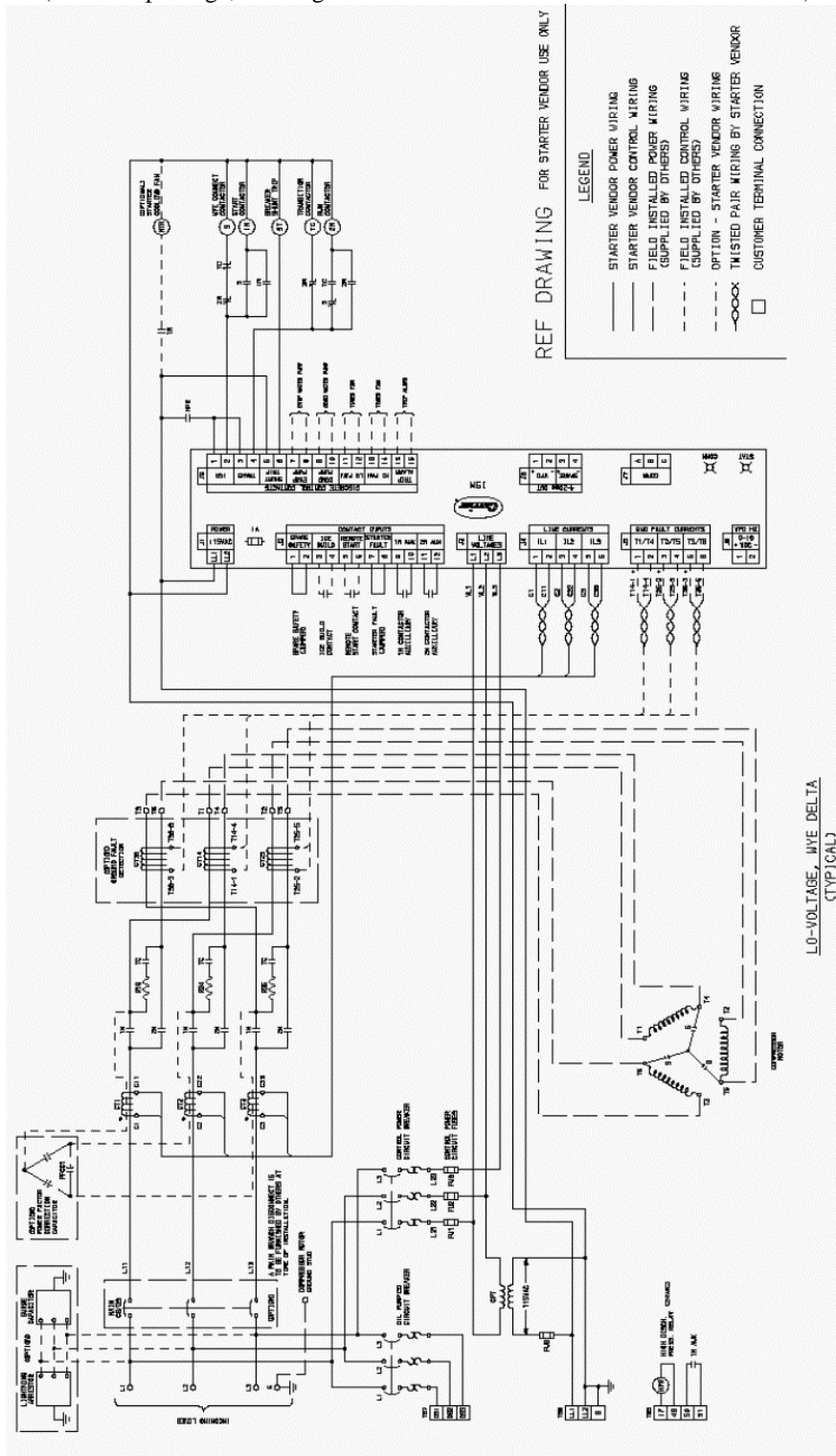
The manufacturers listed below have experience in supplying starters that meet this specification.

<u>Low Voltage</u>	<u>Medium Voltage</u>	<u>Solid State</u>
Cutler Hammer	Cutler Hammer	Benshaw
Siemens	Siemens	
Allen Bradley	General Electric	
Square D	Square D	

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FIGURE 2
(See ISM package, drawing 19XR05013301 sheet 2 for full size schematic)



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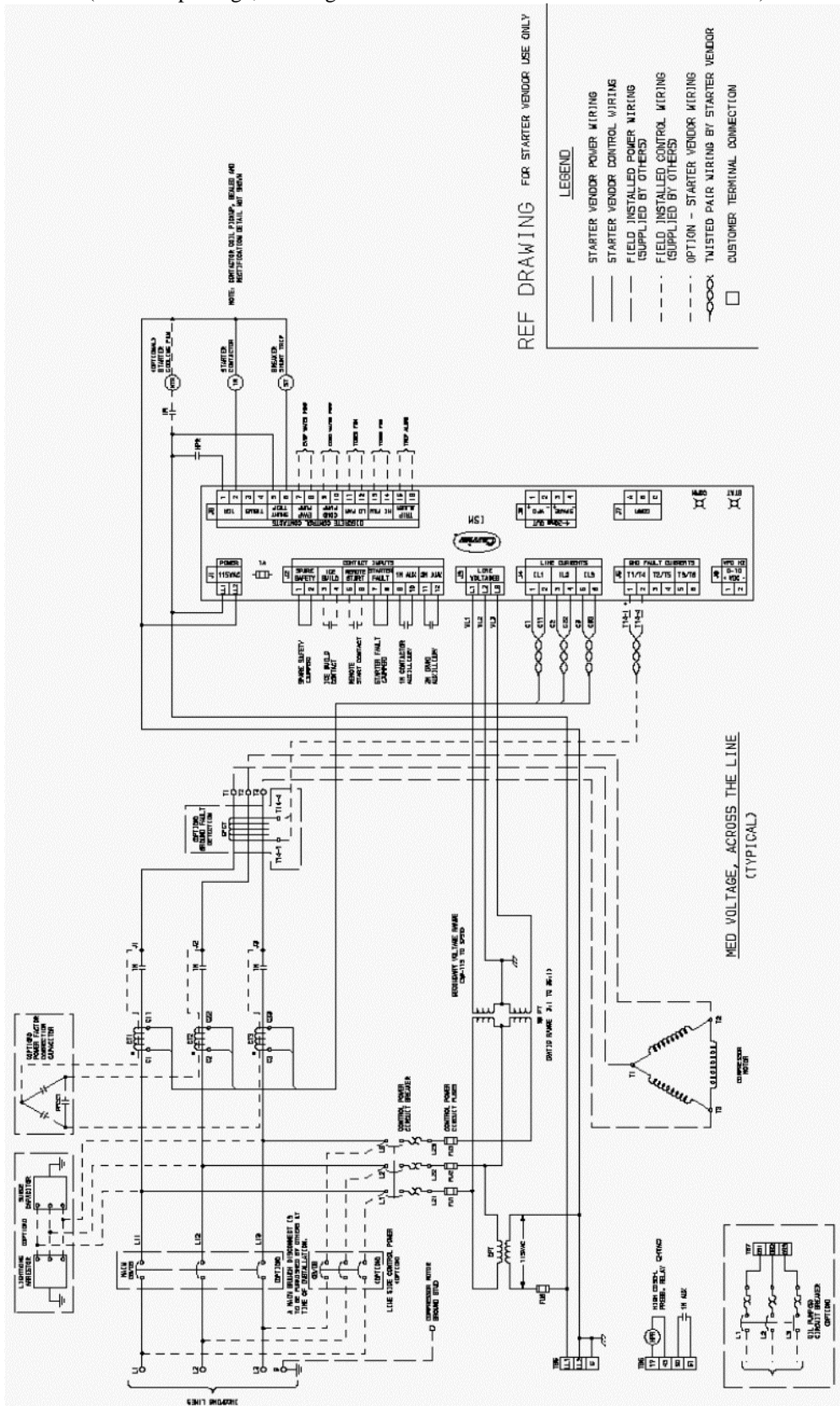
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FIGURE 3

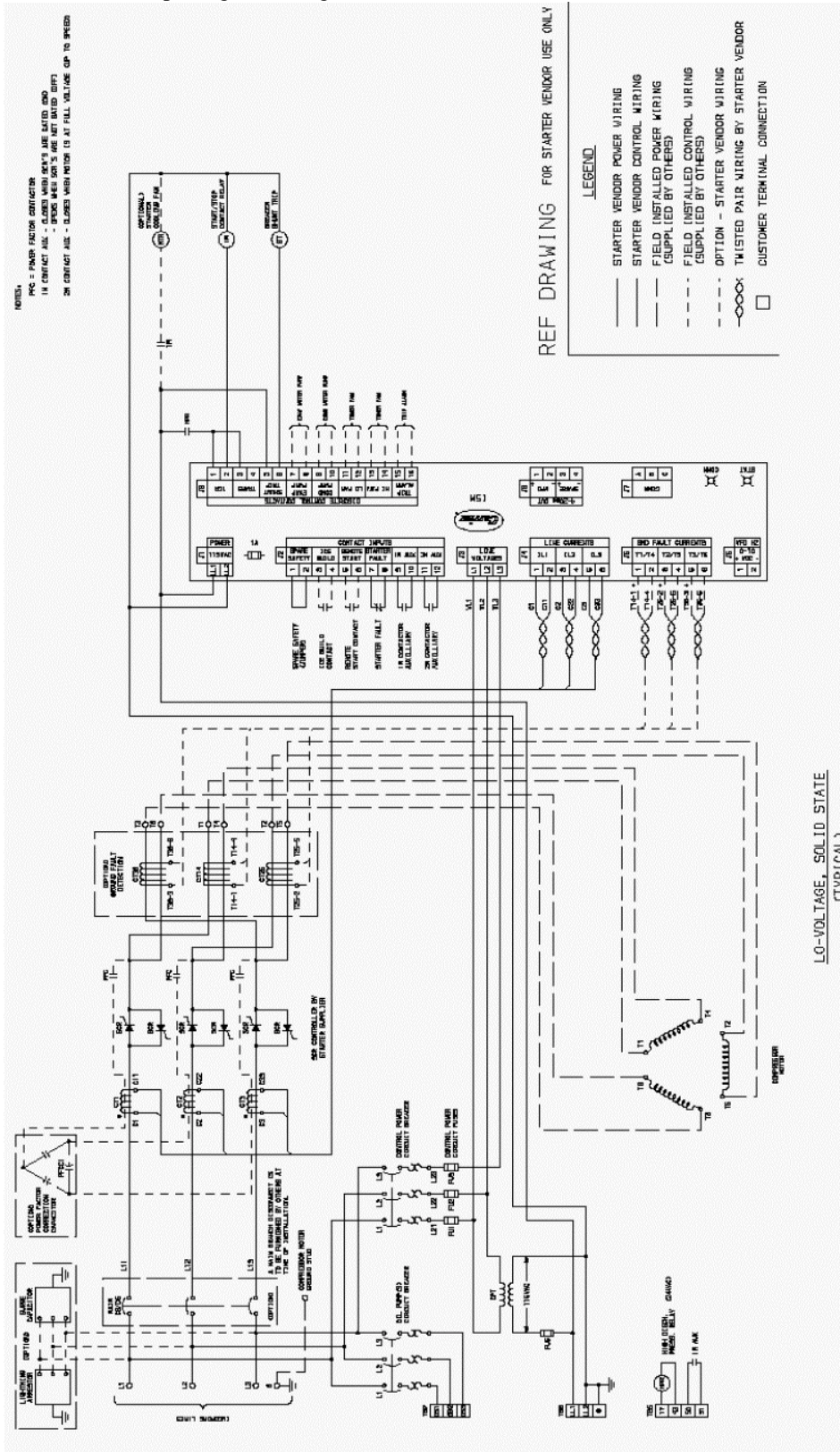
(See ISM package, drawing 19XR05013301 sheet 3 for full size schematic)



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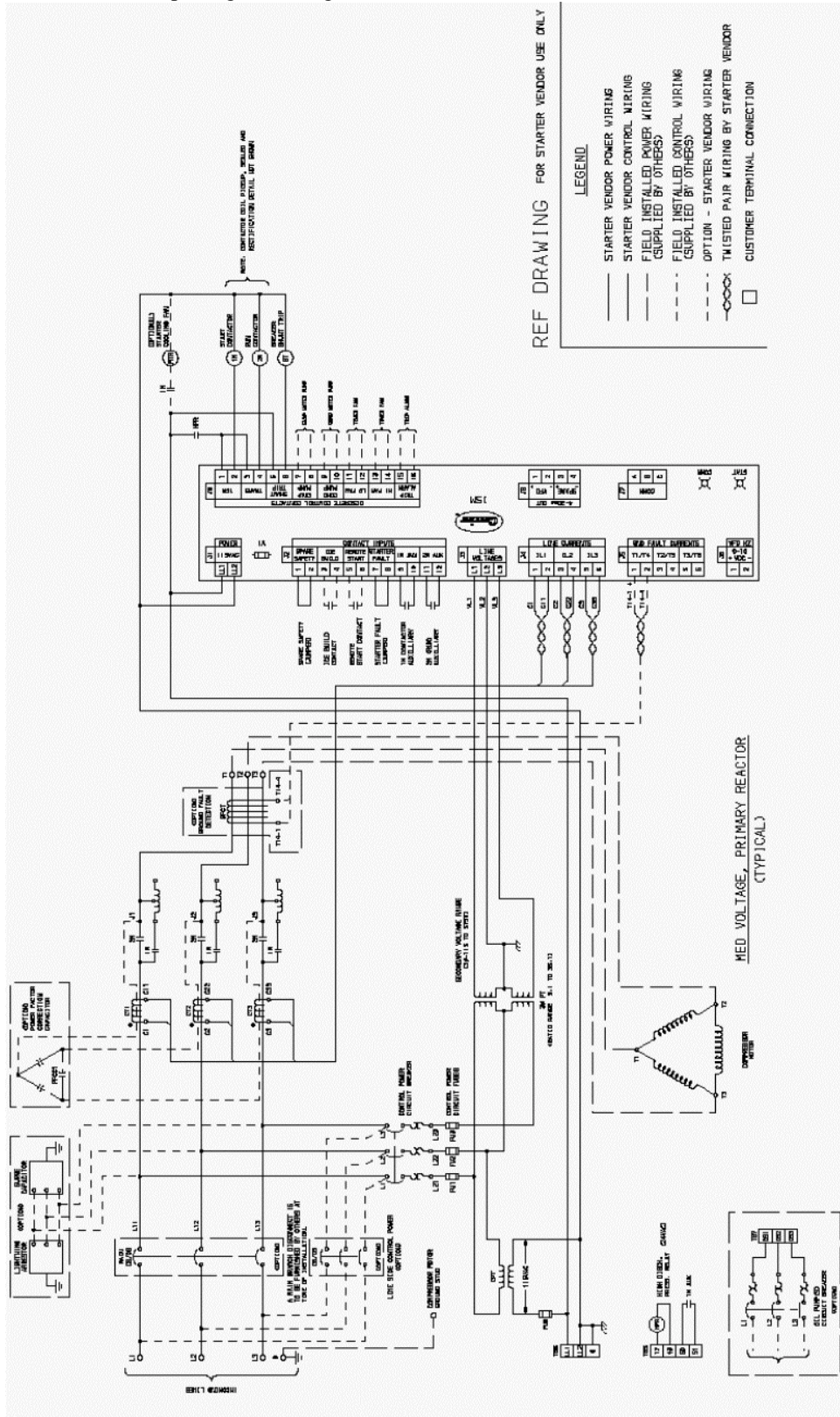
FIGURE 4
 (See ISM package, drawing 19XR05013301 sheet 4 for full size schematic)



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FIGURE 5
 (See ISM package, drawing 19XR05013301 sheet 5 for full size schematic)



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