



Together We Power On

Product Specifications

Guide Specification for E3/PPC Series

3.5, 5, 7.5, 10, 15, 20, 30, 40kVA

**Three-Phase, On-Line
Precision Power Conditioner**

01/01/2025

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SECTION 1.0 SCOPE

1.1 Summary

- A. This Specification defines the electrical and mechanical characteristics and requirements for the Staco E3/PPC Frequency Converter manufactured by Staco Energy Products Co. located in Miamisburg, OH.
- B. The E3/PPC shall be a continuous duty; three-phase, frequency converter, hereafter referred to as the E3/PPC designed to operate with the building supply to provide conditioned power as well as power back up for the critical loads.
- C. The E3/PPC shall use Adaptive Feed Cancellation (AFC) Technology that provides advanced control with AFC forward cancellation circuit for low harmonic distortion.

1.2 Qualifications

The manufacturer shall have a minimum of 20 years of experience in the design, manufacture, and testing of solid-state transistorized E3/PPC systems of similar capacity.

1.3 Standards

- A. The E3/PPC shall be designed in accordance with the applicable sections of the current revision of the following documents. Where conflict arises between these documents and statements made herein, the statements in this specification shall prevail.
 - 1. UL Standard 1778
 - 2. CSA 22.2, No. 107.3
 - 3. NEMA PE-1
 - 4. FCC PT 15, Class B
 - 5. National Electric Code
 - 6. OSHA
 - 7. ANSI C62.41
 - 8. ISO 9001

1.4 System Description

- A. The E3/PPC shall be a true double conversion, "On-Line" system consisting of the following major components:
 - 1. Rectifier complete with power factor correction
 - 2. Battery charger
 - 3. PWM Inverter utilizing IGBT's (Insulated Gate Bipolar Transistor)
 - 4. Continuous duty rated Static Switch
 - 5. Input Isolation switch (SWIN)
 - 6. Output Isolation switch (SWOUT)
 - 7. Maintenance Isolation switch (SWMB)
 - 8. Bypass Isolation switch (SWBY)
 - 9. DSP Control and Monitoring Panel with Graphic display

1.5 Warranty

The E3/PPC warranty shall be in effect 24 months after initial start-up but no more than 30 months after shipment, whichever occurs first. The warranty shall cover all parts and labor for units commissioned by the manufacturer's approved service representative.

SECTION 2.0 PRODUCT

2.1 Modes of Operation

- A.** The E3/PPC shall always start on Bypass and transfer to inverter after the rectifier and inverter have started. This means that the bypass source must be qualified (voltage, frequency, phase sequence) to start the E3/PPC. The rectifier input must be qualified (voltage, frequency, phase sequence) to start the rectifier.
- B.** The E3/PPC shall be designed to operate as an on-line, reverse transfer system in the following modes:
- 1. On-Line (Normal)**
The load shall always be powered by the inverter, with stabilized voltage and frequency, using the energy from the mains power supply (INPUT). If there is a fault in the INPUT, the E3/PPC will shut down. When the INPUT is restored, and the bypass is within acceptable limits the E3/PPC will retransfer the critical load back to the inverter.
 - 2. Bypass**
When the inverter overload capacity is exceeded, the static transfer switch shall perform a transfer of the load from the inverter to the bypass source with no interruption in power to the critical load.
 - 3. Uninterruptible Power Supply (UPS) Mode (Option)**
The E3/PPC operates as a Precision Power conditioner (PPC), (without batteries), and field upgraded to a complete UPS with the addition of batteries without major internal wiring.
 - 4. Frequency Conversion Mode (Option)**
The E3/PPC shall be capable of converting the frequency (60 to 50 Hz) or (50 to 60 HZ) programmable from the front panel.
- C. Paralleling** - The E3/PPC shall have expansion capabilities for up to 3 modules paralleled for capacity or redundancy. The E3/PPC units shall be connected in parallel and shall share the connected load. paralleling circuit and /or paralleling card shall be standard.

2.2 Components

A. Rectifier

The IGBT rectifier shall be capable of receiving utility input power.

- 1. Input Protection**
The rectifier shall include protection against primary power surges, (except for lightning transients) and under or over voltage conditions. This protection is provided via fuses, and Microprocessor Control of the rectifier.
- 2. In-Rush Limiting**
When the primary power is applied to the rectifier, there shall be no in-rush current.
- 3. Walk-In**
When the utility power is applied to the rectifier, the current shall gradually increase. Walk-in from 25% max to 100% full load rating in 5 seconds

B. Inverter

The inverter section of the power converter module shall utilize Insulated Gate Bipolar Transistors (IGBT's). This solid-state device that incorporates digital signal processing (DSP) pulse width modulation (PWM) technology capable of accepting the output of the rectifier or the battery system voltage and delivering AC power within specified limits to the critical load bus. The inverter shall be microprocessor controlled and include all necessary timing logic and control circuits.

C. Inverter Start-Up

The inverter shall automatically start up when a start command is generated, shall be stable, and ready to deliver power to the load.

1. Inverter Protection

Inverter IGBT's shall be protected by current limiting circuits. The inverter shall be capable of running indefinitely with the batteries disconnected. For rapid removal of the inverter from the critical load, the inverter's control electronics shall instantaneously turn off the inverter when the inverter's capacity is exceeded. Simultaneously, the static transfer switch shall transfer the load to utility power without interruption to maintain continuous power to the critical load.

2. Inverter Oscillator

The inverter shall contain an oscillator capable of operating and maintaining the output frequency of the inverter within specified limits. The inverter oscillator shall be capable of frequency synchronization and phase locking to the bypass utility power source frequency. When operating as a slave to the utility power and a failure occurs in the slaving signal, the inverter oscillator shall automatically revert to a free running state and maintain the specified limits. The oscillator shall not drift more than 0.05% while operating at maximum rated operating temperature.

3. Phase Balance

Electronic controls shall be provided to regulate each phase so that an unbalanced load will not cause the output voltage to go outside of the specified voltage unbalance or phase displacement limits.

D. Static Transfer Switch – 100% Rated, Continuous Duty

An internally mounted static transfer switch and bypass circuit shall be provided as an integral part of the E3/PPC. The static switch shall be naturally commutated high speed devices rated to conduct full load current continuously while on bypass power. The static switch shall be designed to avoid back-feed into the utility supply. Failure of one device shall not affect the operation of the E3/PPC and the failure shall be shown on the LCD display.

1. Bypass Transfer

The static switch shall automatically and successfully transfer the critical load from the inverter to the bypass source under the following conditions:

- DC voltage out-of-limits
- Inverter failure
- Critical load current exceeds inverter overload rating
- Over-temperature develops within the inverter
- Manual command is given
- Hot Standby Economy mode event clears

Transfer shall be automatically inhibited whenever bypass source parameters are outside predetermined (adjustable) limits, or E3/PPC output and bypass are not synchronized, and phase locked.

2. Retransfer

The static switch shall automatically and successfully retransfer the critical load from the bypass source to the inverter under the following conditions:

- Inverter output voltage returns to within specified limits.
- Critical load current reduces to within inverter limits.
- Hot Standby Economy mode event

E. Manual Internal Maintenance Bypass

Bypass switching shall allow the critical load to be fed from the bypass power source, while providing isolation of the static switch during maintenance.

2.3 Electrical Specifications

A. Ratings

1. The E3/PPC shall be available in power ratings of (kVA=kW): Unity Power Factor E3/PPC units. 3.5kVA/kW, 5kVA/kW, 7.5kVA/kW, 10kVA/kW, 15kVA/kW, 20kVA/kW, 30kVA/kW, 40kVA/kW

2. AC Input Characteristics

The E3/PPC shall be capable of providing any of the voltages below without the need for an external transformer cabinet and accept power from two (2) sources as standard (Dual Input).

a. Nominal Voltage:

208Y/120 VAC, 3 Phase, 4-wire + ground
or
 220/127 VAC, 3 Phase, 4-wire + ground configurable from the Front Panel
or
 208 VAC, 3 Phase, 3-wire (Delta, internal transformer)
or
 480Y/277 VAC, 3 Phase, 4-wire + ground (WYE, internal transformer)
or
 480VAC, 3 Phase, 3-wire (Delta, internal transformer)
or
 Other voltages available upon request

b. Nominal Voltage Range: +20/-17%

c. Frequency: 60 Hz or 50Hz, +/- 5.0Hz

d. Power Factor: ≥ 0.99 at full load, 0.98 minimum at 50% load.

e. Current Harmonic Distortion (THDi): < 3% at full load

f. Inrush current: Less than nominal input current for less than one cycle.

g. Input Surge Protection: E3/PPC shall be equipped to withstand surges per ANSI/IEEE C62.41.

h. Rectifier Walk-in: Input current shall ramp up from 25% to 100% over 5 seconds.

3. AC Output Characteristics

The E3/PPC shall be capable of providing any of the voltages below without the need for an external transformer cabinet.

- a. **Voltage:** $\pm 1\%$ steady state variation phase-to-phase voltage.
 - 208Y/120 VAC, 3 Phase, 4-wire + ground
 - or
 - 220/127 VAC, 3 Phase, 4-wire + ground configurable from the Front Panel
 - or
 - 208 VAC, 3 Phase, 3-wire (Delta, internal transformer)
 - or
 - 480Y/277 VAC, 3 Phase, 4-wire + ground (WYE, internal transformer)
 - or
 - 480VAC, 3 Phase, 3-wire (Delta, internal transformer)
 - or
 - Other voltages available upon request
- b. **Frequency:** 60 Hz or 50Hz ± 0.01 Hz free running.
- c. **Voltage regulation:** $\pm 1\%$ for balanced load.
- d. **Voltage Distortion (THDv):** $< 2\%$ linear loads, $< 4\%$ Non-linear loads.
- e. **Voltage Transient Response:** a) $< 5\%$ RMS for a 100% step load b) $\pm 1\%$ (loss or return of ACinput)
- f. **Voltage Recovery Time:** Return to within 1% of nominal value within 10 milliseconds.
- g. **Auto Restart:** System will restart and recover after input range is exceeded or power outage without intervention.
- h. **Non-Linear Load Capability:** Output voltage total harmonic distortion shall be less than 2% when connected to a 100% non-linear load with a crest factor not to exceed 3%.
- i. **Slew Rate:** ± 1 Hertz per second.
- j. **Power Factor:** 1.0 at the rated volt amperes (VA).
- k. **Inverter Overload Capability:** 110% of rated load for 60 minutes, 130% of rated load for 60 seconds.
- l. **Bypass Overload Capability:** less than 130% continuous; greater than 130% for 60 seconds.
- m. **Output Waveform:** Sinusoidal.
- n. **Efficiency:** Above 92% at Full Load.

2.4 Mechanical Design and Ventilation

- A. Enclosure: The E3/PPC shall be housed in a freestanding NEMA 1 enclosure with dead front construction. The mechanical structure of the E3/PPC shall be sufficiently strong and rigid to withstand handling and installation operations without risk and have provisions for forklift handling. The sheet metal elements in the structure shall be protected against corrosion by a suitable treatment, primed and powder coat painted black with a textured finish.
- B. Redundant, forced air-cooling shall be provided to ensure that all components are operated within specification with air entry at the front with rear air exit.
- C. Cable Access: The standard E3/PPC cabinet shall accommodate bottom cable entry. Provisions shall be available for top cable entry by the addition of a side car. Systems with transformer/maintenance bypass cabinet shall be standard with top cable entry.
- D. Clearance – 4" rear for air flow, Front access.
- E. Cabinet Dimensions: 72.44" (1840 mm) H x 23.13" (587 mm) W x 36.50" (927 mm) D
(Always reference the spec control drawing for the most accurate and up to date dimensions)
- F. Cabinet Weights shall have a maximum weight of 628 Lbs. without additional transformers added.
- G. Ventilation and Heat Rejection: The E3/PPC shall be designed for forced air cooling. Air inlets shall be provided from the front and bottom of the E3/PPC enclosure. Air exhaust shall be from the back of the unit. Full load heat rejection shall be:

BTU/Hr.	3.5 kVA	5.5 kVA	7.5 kVA	10 kVA	15 kVA	20 kVA	30 kVA	40 kVA
W/O Transformer	< 1,100	<1,500	< 2,300	< 3,900	< 5,800	< 7,700	<11,600	< 15,400
W/ Transformer	< 1,600	< 2,400	< 3,700	< 5,900	< 8,100	< 11,700	< 17,500	< 23,000

2.5 Environmental Requirements

- A. The System shall withstand any combination of the following external environmental conditions without operational degradation.
 1. Operating Temperature Range: 32°F (0°C) to 104°F (40°C) for electronics.
 2. Storage Temperature Range: -25°F (-32°C) to 122°F (50°C).
 3. Relative Humidity: Continuous operation with a relative humidity up to 95% non-condensing at 77°F (25°C).
 4. Altitude: Normal operation without de-rating is 3,281 feet. (1000m)
 5. Audible Noise: Audible noise generated by the E3/PPC shall not exceed 75 dBA when measured at 1 meter in front of the power converter using scale "A" of a standard ASA sound level-measuring device.

3.5-10kVA < 60dBA	15-30kVA < 70dBA	40kVA < 71dBA
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2.6 System Controls and Indicators

The E3/PPC unit shall incorporate the necessary controls, instruments, and indicators to allow the operator to monitor the system's status and performance, as well as take any appropriate action. The E3/PPC Control and Display shall have (3) sections.

A. LED Indicators

Line

Bypass

Battery

Fault

B. Power Button

C. LCD HMI Display Touchscreen

- A graphical screen display shall be on the E3/PPC door, which provides the user with a close-up, detailed overview in real time of the status of the E3/PPC. The user shall be able to switch the E3/PPC on and off, consult electrical mains, output, battery measurements, and perform the main E3/PPC settings. This display shall also incorporate a mimic diagram showing the current operating status of the E3/PPC.
- After initialization, the LCD will display Home screen. There are five sub-menus: CONTROL, MEASURE, SETTING, INFO AND DATA LOG. Touch any sub-menu icon to enter the sub-screen.

1. Control

On/Off E3/PPC

Mute All

2. Measure Screen 1. (The real time value)

LINE VOL: L1, L2, and L3 phase voltage, input power in VA and input frequency.

INVERTER VOL: L1, L2 and L3 inverter voltage and frequency.

BYPASS VOL: L1, L2 and L3 bypass voltage and frequency.

OUTPUT VOL: L1, L2 and L3 output voltage and frequency.

2. Measure Screen 2. (The real time value)

OUTPUTW: L1, L2 and L3 output power in watt.

OUTPUT VA: L1, L2 and L3 output power in VA.

OUTPUT W (%): L1, L2 and L3 output power watt in percentage.

OUTPUT VA (%): L1, L2 and L3 output power VA in percentage.

Total watt and VA: Total output load in watt and VA.

Temperature: Temperature of L1, L2 and L3 phases.

2. Measure Screen 3. (The real time value)

Input current: Input current L1/L2/L3 and L12/L23/L13.

Output current: Output current L1/L2/L3 and L12/L23/L13.

3. Settings Screen

GENERAL: It's to set up basic information about the E3/PPC. It's not related to any function parameter.

Date/Time: Set the date and time. The format is YYYY-MM-DD HH:MM:SS. The calendar day will be automatically changed when the year, month and date are set.

Language: Set the LCD language. Only English is available.

Input Source: Select the input source. There are two options: Line (utility) and generator. Line is default setting. This setting value will show on the main page. When "generator" is selected, the acceptable input frequency will be fixed at the range of 40~75Hz. This setting value will show on the status bar.

Service Contact: Set the name of the contact person and the maximum length is 18 characters.

Service Phone: Set the service phone number. Only 0~9, + and - are accepted. The maximum length is 14 characters.

Service Mail: Set the service email accounts up to two and the maximum length is 36 characters.

Audio Alarm: There are two events available to mute. You may choose "Enable" or "Disable" alarm when related events occur.

o Enable: When selected, the alarm will be mute when related events occur.

o Disable: When selected, E3/PPC will alarm when related events occur.

All Mute: When "enable" is selected, all the faults and warnings will be mute.

Mode Mute : E3/PPC status mode alarm enable/disable.

ADVANCE: It's required to enter password to access to the "ADVANCE" setting. There are two types of authority, User and Maintainer.

There are three sub-menus under "Advance User" setting: ELECTRONIC, BATTERY and MISCELLANEOUS.

4. Information Screen

There are three sub-menus: BASIC, PRATED, PARAMETER. Touch any sub-menu icon to enter the sub-screen.

Basic:

MCU Version: MCU version.

DSP Version: DSP version.

Serial NO.: The serial number of E3/PPC.

Manufacturer: The information about manufacturer.

Service Contact: The contact's name is set in "Basic Setting."

Service Phone: The listed numbers are set in "Basic Setting."

Rated:

Output Voltage: It shows output rated voltage.

Output FRE: It shows output rated frequency.

CVCF Mode : Enable/Disable CVCF mode.

Bypass Forbid: Enable/disable bypass function.

Auto Restart: Enable/disable auto-restart function.

Parameter:

Line Voltage Range: The acceptable line input voltage range.

Line FRE Range: The acceptable line input frequency range.

ECO Voltage Range: The acceptable input voltage range for ECO mode.

ECO FRE Range: The acceptable input frequency range for ECO mode.

Shutdown Voltage: If battery voltage is lower this point, E3/PPC will automatically shut down.

Shutdown Delay: E3/PPC will shut down in setting minutes. The countdown will start after confirming the pop-up screen.

Restore Delay: E3/PPC will automatically restart in setting minutes after the E3/PPC shuts down.

4. Data Log Screen

Data log is used to record the warning and fault information of the E3/PPC. The record contains date & time, code, type, and description.

Appendix A – Fault Codes

Fault code	Fault event
01	Bus start failure
02	Bus over
03	Bus under
04	Bus unbalance
06	Converter over current
11	Inverter soft start failure
12	High inverter voltage
14	Inverter Phase A output (line to neutral) short circuited
15	Inverter Phase B output (line to neutral) short circuited
16	Inverter Phase C output (line to neutral) short circuited
17	Inverter Phases A-B output (line to line) short circuited
18	Inverter Phases B-C output (line to line) short circuited
19	Inverter Phases C-A output (line to line) short circuited
1A	Phase A negative power fault
1B	Phase B negative power fault
1C	Phase A negative power fault
21	Battery SCR short circuited
23	Inverter relay open Circuited
24	Inverter relay short circuited
25	Line wiring fault
31	Parallel communication failure
36	Parallel output current unbalance
41	Over temperature
42	DSP communication failure
43	Overload

Fault code	Fault event
47	MCU communication failure
48	Two DSP firmware versions are incompatible in parallel system.
49	Input and output phase are incompatible
60	Bypass phase short circuited
61	Bypass SCR short circuited
62	Bypass SCR open circuited
63	Voltage waveform abnormal in A phase
64	Voltage waveform abnormal in B phase
65	Voltage waveform abnormal in C phase
66	Inverter current sample abnormal
67	Bypass O/P short circuited
68	Bypass O/P line to line short circuited
69	Inverter SCR short circuited
6C	BUS voltage drops too fast
6D	Current sampling error value
6E	SPS power error
6F	Battery polarity reverse
71	PFC IGBT over current in A phase
72	PFC IGBT over current in B phase
73	PFC IGBT over current in C phase
74	INV IGBT over current in A phase
75	INV IGBT over current in B phase
76	INV IGBT over current in C phase
77	LCD & MCU communication failure

D. Communications (Standard versus Optional)

The E3/PPC shall have the ability to communicate through the following options:

- **Modbus: *Standard*** Internal MODBUS, Protocol converter used to monitor the E3/PPC using the MODBUS protocol on RS232 or RS485 serial lines.
- The DB9 connector includes communication ports for the E3/PPC to connect to RS-232 and RS-485. These ports cannot be used simultaneously, as they are mutually exclusive. Connector J8 can be utilized to connect the PPC with any machine or unit that has a standard bus.

RS-232**Physical structure of the RS-232**

Pin-out

- Pin 2. RXD. Serial data reception.
- Pin 3. TXD. Serial data transmission.
- Pin 5. GND. Signal mass.

Communication protocol of the RS-232

The communication protocol used is of «MASTER/SLAVE» type. The computer or computer system (MASTER) asks about certain data, and the E3/PPC (SLAVE) answers immediately with the required data. First the communication channel of the computer will be programmed with the same parameters as the communication channel of the E3/PPC.

- Communication speed: 1200, 2400, 4800, 9600 or 19200 Bauds.
- No. information bits: 8 Bits.
- No. stop bits: 1 or 2 stop bits.
- Parity: - Even, Odd or None.

RS-485**Physical structure of the RS-485**

The unit uses only 2 wires (pins 4 and 9 of the female DB9 connector) to perform the dialogue between the systems connected to the network. Communication will be established by sending and receiving signals in a differential mode, which gives the system great immunity to noise over a long distance (approx. 800 m).

Pin-out

- Pin 4. Output signal A (+) of the RS-485.
- Pin 9. Output signal B (-) of the RS-485.

Communication protocol of the RS-485

The communication protocol of the RS-485 channel is developed to enable the E3/PPC to communicate with other computer systems that utilize the same protocol.

- Communication speed: 1200, 2400, 4800, 9600 or 19200 Bauds.
- No. information bits: 8 Bits.
- No. stop bits: 1 or 2 stop bits.
- Parity: - Even, Odd or None.

E. Optional Intellislot Communication Card (SNMP):

- Internal SNMP Card allows E3/PPC management across a LAN using any of the main network communication protocols - TCP/IP, HTTP, and network interface (SNMP), Modbus, and BacNet. NetAgent shutdown/monitoring software shall enable the E3/PPC to integrate easily into medium and large sized networks and provide reliable communication between the E3/PPC and management systems employed.

F. Form C Contact Alarm Relay Board (*Standard*)

- The Alarm Board is active (powered up) when the E3/PPC output is ON. It relays based upon the status of E3/PPC. (6) NO/NC 30v (AC or DC) <2 A shall be provided (non-Programmable) for: Normal Operation; On Bypass; On Battery; Low battery; Over Temp, and Summary Alarm Present.

G. Remote Emergency Power Off (EPO)

- The E3/PPC shall be equipped with provisions for local and remote emergency power off that shall be used to command E3/PPC shutdown remotely.

H. Environmental Sensor Kit (Optional)

- Provisions for temperature monitoring of the battery cabinet and integrates the battery charging temperature compensation to real time feedback.

2.7 Parallel Configuration

- A. The E3/PPC shall have expansion capabilities for up to 3 modules (same rating) in a parallel configuration for capacity or redundancy as required to support future growth and to increase reliability. The E3/PPC units shall be connected in parallel and shall share the connected load. The parallel card/circuit shall be standard without any field modification or added parts.

2.8 Options

A. External System Maintenance Bypass

- a. For 208Y/120 VAC and 480Y/277VAC applications, a three (3) Breaker Wall Mount External Maintenance Bypass (make-before-break) with electronic interlocks shall be available. The total enclosure shall provide a wrap-around bypass configuration for total E3/PPC isolation during maintenance or removal of the E3/PPC. Maintenance bypass transfers shall be without interruption and shall have electronic interlocks to protect the E3/PPC from damage in the event of out-of-sequence transfers.
- b. For 480Y/277VAC input – 208Y/120VAC output and/or 3 wire Delta input applications an external Transformer Cabinet with a three (3) Breaker External Maintenance Bypass (make-before-break) shall be available.

B. Power Distribution Unit (PDU)

- a. A Transformerless 208Y/120 PDU shall be available. It shall consist of (30) Poles in groups of 6 poles. Accepts 1, 2 & 3 Pole Branch Circuit Breakers Din Rail mounted in sidecar cabinet.

C. Harsh Environment Enclosure

- a. The E3/PPC and any accessory cabinet(s) shall have the capability to be mounted and completely wired internal to include AC cooling, inside any NEMA type enclosure (NEMA 12, 3R, 4X) by the E3/PPC Manufacturer.

D. Spare Parts

- a. Shall be available in three levels, Level 1- Minor, Level 2 - Medium and Level 3 - Major.

E. Service Agreements

- a. Multi-level service and maintenance agreements shall be available.

Section 3.0 Execution

3.1 Factory Testing

Before shipment, the manufacturer shall fully and completely evaluate the system to factory standards to ensure compliance with the specification. Each subassembly shall undergo thorough testing prior to installation in the system. The total system shall be exposed to a functional load test and shall be subjected to a minimum of 24 hours "burn-in" test prior to shipment.

A complete test report shall be available for each unit and kept on file for future reference.

3.2 Site Start-Up

Site start-up and testing shall be provided by the manufacturer's field service representative during normal working hours (M/F-8/5). Individual scheduling requirements shall be met with ten working days' advance notice. Site testing shall consist of a complete test of the E3/PPC and accessories by the E3/PPC manufacturer in accordance with manufacturer's standards. Commissioning must be performed by the manufacturer's approved service representative for warranty to be valid.

3.3 Field Engineering Support

The E3/PPC manufacturer shall have available a nationwide field service organization staffed by factory trained Field Service Engineers dedicated to the start-up, maintenance, and repair of E3/PPC equipment. The manufacturer shall have a toll-free service telephone number answered 24 hours a day / 365 days a year.

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