LINE INTERACTIVE UNINTERRUPTIBLE POWER SUPPLY

GUIDE SPECIFICATION:

EATON FX 3100, SINGLE PHASE OUTPUT, UNINTERRUPTABLE POWER SYSTEM

PART 1 – GENERAL

1.01 SUMMARY

A. The Eaton Ferrups FX is an industrial platform of Line-Interactive, Ferro-Resonant Transformer-based, UPS Platform of Products ranging from 1kVA to 18kVA Power Ratings. The Eaton Ferrups FX products shall be designed for tower mount, and for 60 Hz operation. The Eaton Ferrups FX will be designed for the North American market with the following configuration(s):

1. FX3100 - Small Tower Chassis

The UPS shall operate in conjunction with the existing building electrical system to protect electronic equipment from power disturbances that may occur in utility power such as power failures, power sags, power surges, under voltages, over voltages, electrical line noise, switching transients, and harmonic distortion.

1.02 SYSTEM DESCRIPTION

A. Modes of Operation: The UPS shall operate as a line interactive, ferroresonant, UPS with the following operations modes:

1. **Standby Mode:** The UPS is in standby mode and powered with utility voltage but the output has not yet been turned on or was on and has been turned off. When in standby mode the AC utility voltage generates the 24V used to power the power supply board and control board. The flyback power supply on the AC board (TX1) generates all necessary voltages. The fan signal(s) are then sent from the control board to power the DC fans. If the FX UPS UPS includes AC fans connected to the output, these would remain off during standby. Standby mode also allows the customer to connect to USB or network cards to monitor the UPS remotely.

2. **Line Mode:** Line mode is the most common operational mode of the UPS. This represents normal operation. When in line mode, the charger is off either because the batteries are fully charged, or the customer has commanded the charger to be off. The UPS supplies load through the ferroresonant transformer and the batteries are not being used. The UPS enters line mode by using the on-off switch on the UPS or by commanding "Auto" on the RCD. Depending on the utility input voltage, the UPS could be on the bypass, buck, or boost tap supplying load. The RCD also gives the option to put the UPS in line conditioning mode, which is for testing. Line conditioning puts the UPS in line mode but prohibits transfer to battery if voltage rises or falls out of range for voltage regulation.

3. **Charger Mode-** Charger mode offers the same functionality as line mode except the battery charger is being used on the inverter board. The utility voltage generates a voltage on the inverter winding of the ferroresonant transformer, which is used as the input to the battery charger. This AC voltage is rectified through a diode bridge before being used in the battery charger circuit. The UPS will charge the batteries any time the charging control algorithm

determines the batteries need to be charged (so long as the charger has not been disabled). If the battery voltage is lower than the peak of the inverter winding voltage, the batteries will be peak charged regardless of if the charger is enabled or disabled.

4. **Line Conditioning Mode**- Line conditioning mode is a testing mode for the UPS. When the UPS is in line conditioning mode the UPS provides power to the output through the ferroresonant transformer; however, should input utility fail the UPS will not transfer to battery. Line Conditioning Mode must be set through the RCD.

5. **Battery Mode-** The UPS switches to battery mode when input utility voltage is not healthy enough to provide the output voltage. This could be from high/low line voltage or high/low line frequency. When the input voltage exits the acceptable ranges the UPS transfers to battery mode and supplies load through the stored energy. A combination of the ferroresonant transformer and the ferro-tank capacitors help maintain the load during the transfer. This is how FX UPS is able to provide 0 ms transfer time. The UPS operates in battery mode until either the UPS reaches battery DC undervoltage or until a healthy utility voltage returns. When on battery mode, the UPS powers the flyback power supply on the AC board through a battery boost converter circuit (for 48V battery models) or directly through the battery voltage for 120V battery models.

6. **Keep Alive Mode-** The UPS enters keep-alive mode when the UPS reaches DC undervoltage after operating in battery mode. For 48V battery FX UPS models, keep-alive mode duration is set in FW. When the keep-alive time is exceeded, the battery boost converter on the AC board is disabled. At this time, the battery can no longer power the flyback power supply and the UPS shuts off completely. When the UPS is in Keep-alive mode, the output of the UPS is off. However, similar to standby mode, all communication options including USB and network cards are available for customer use. Should the utility voltage return during keep-alive time, the UPS can return to its functional state if the customer enables the output again.

1.03 APPLICABLE STANDARDS

The UPS shall be designed in accordance with the applicable sections of the current revision of the following documents. Where a conflict arises between these documents and statements made herein, the statements in this specification shall govern.

Regulatory Requirements: The UPS shall be listed or certified to the following agency requirements or standards:

1. UL1778 5th edition
2. CSA C22.2 No.107.3
3. NOM
4. CE
5. FCC 47 CFR
6. EN 62040–2 (UPS EMC)
7. IEC 61000 —2–2 (Environment)
8. EN 61000–4–2 (ESD)
9. EN 61000–4–3 (Radiated field 80–1000 MHz)
10. EN-61000 – 4–4 (Fast transient / burst)
11. EN-61000 — 4— 5 (surge)
12. EN-61000–4–6 (Conducted radio frequency common mode)
13. EN-61000–4–8 (Immunity to power-frequency magnetic field)
14. ROHS
15. WEEE
16. REACH

Seismic Requirement

International Building Code (IBC) 2009, Site Classification D, Importance Factor 1.5

California Building Code (CBC) 2010, Site Classification D, Importance Factor 1.5

California State Office of Statewide Health Planning and Development (OSHPD), Special Seismic Certification per CBC section 1708A.5 and ASCE/SEI 7-05 Section 13.2.2

1.04 SUBMITTALS

Proposal Submittals:

1. Bid requirement bill of materials.
2. Product catalog sheets or equipment brochures.
3. Product guide specifications.
4. System single-line operation diagram.
5. Installation information, including weights and dimensions.
6. Information about terminal locations for power and control connections.
7. Drawings and details for requested optional accessories.

Delivery Submittals:

1. User Manual: One copy of a concise User or Operation Manual will be submitted including:
   a. Instructions for storage, handling, examination, preparation, installation, and start-up of UPS.
   b. Instructions for operating the system.

Final Test Printout:

1. One printed copy of a Final Test Printout will be submitted. The Final Test Printout shall indicate all of the values of adjustable settings of the UPS being tested.

Equipment Drawings:

1. Interconnect drawings.
2. Battery wiring diagram.
3. UPS one-line drawings.
4. Equipment outline drawings.

1.05 WARRANTY

Standard Warranty - The UPS shall be covered by a Two-Year Standard Warranty. The warranty shall cover defects in material and workmanship for a period of two years.

$250,000 Computer/Load Protection Guarantee - UPS manufacturer shall repair or replace protected equipment if it is damaged due to an AC line surge, spike, or other transient when protected by the properly installed and applied UPS.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

The Eaton FX UPS system is manufactured by Eaton Corporation.

2.02 QUALIFIED MODELS

Qualified models shall be: FX3100 Model

2.02 COMPONENTS

Standard UPS System will include a minimum of (1) Transformer, (1) Inverter and (1) Battery system.

1. **Ferroresonant Transformer** - The transformer used in the Eaton Ferrups FX UPS is a ferroresonant transformer designed to operate over a wider input voltage window with a buck and a boost tap added. The range over which a "ferro" must operate governs its size, weight and cost. By reducing the operating range and adding taps, each tap operates over roughly one third the normal input range, reducing the size of the transformer. An AC capacitor is connected to the resonant (secondary) winding of the transformer forming a tank circuit (energy is stored in the capacitor and in the magnetic circuit). This provides the resonant circuit function which contributes to the output voltage regulation. While the ferroresonant varies in power rating and output voltage options depending on the need of the customer, its functionality remains the same across all Eaton Ferrups FX UPS models. When operating on inverter, the ferroresonant transformer shall provide zero transfer time switching, voltage regulation, and inverter output filtering.

2. **Inverter -** The UPS inverter shall convert the DC power from the batteries into an AC waveform to be filtered by the ferroresonant transformer. The inverter shall be a pulse-width modulated (PWM) design.

3. **AC Line Board -** The AC board includes an EMI filter, TMOVs, relays & relay drivers, input fuse(s), SCRs, and the main power supply generating 24V_SELV from either the input AC voltage or battery voltage. The AC board output is connected to the primary winding of the ferroresonant transformer. The AC board takes the input voltage & battery voltage, and it generates 24V_SELV and all the required power supplies for different components in AC board (relay gate drive, SCR gate drive, hall effect sensor, fan circuit, etc.). The Fan drive circuit on the AC board provides the appropriate power for 12V DC fan. 24V_SELV generated in AC board is sent to power supply board to generate all the required power supplies in the system.

4. **Battery Charger -** The battery charger is a boost converter that converts the rectified AC voltage (from AC winding "1" to "4" of the ferro) to battery voltage. The boost circuit works to boost the rectified AC voltage when the charger is turned on by the UPS firmware.

5. **Batteries -** The UPS shall include sealed valve-regulated lead acid (VRLA) batteries sized properly to provide the runtime desired.

6. **Remote Control Display (RCD) -** The Remote-Control Display shall allow communications with the UPS to display the UPS status as well as program operational modes and firmware parameter values. The Remote-Control Display shall be attached to the front of the UPS and be removable to allow handheld ease of use. The Remote-Control Display shall have a magnetic strip to allow mounting to external metal surface. The Remote-Control Display ethernet cable

shall be 28 inches long with the option to be extended up to 150 feet with a customer supplied ethernet cable. The Remote-Control Display shall provide an audible alarm during an alarm condition. The Remote-Control Display shall consist of a 16-key keypad, status LEDs to reflect the status of UPS Ready, Battery Power, and Alarm, a 20-character x 1 line display.

7. **USB Ports -** UPS shall have two full-speed USB ports. Only one port can be active at a time. Port control is accomplished via the RCD. The front USB service port is for debugging and flashing of the UPS firmware and is disabled by default. The back USB customer port is used for monitoring software IPP / IPM.

8. **Communication Slots –** The UPS shall incorporate two communication bay slots to allow the UPS to communicate in a variety of networking environments and with different types of devices. The Eaton Ferrups FX has two available communication bays for SNMP/Web, AS400 relay capabilities, etc.

9. **Remote Emergency Power Off (EPO) connection -** The UPS shall provide a built-in landing for field connection of a Remote Emergency Power Off circuit. Upon initiation of the REPO circuit, the output will be de-energized, and battery will be disconnected, preventing power from being delivered to the attached loads.

10. **Remote ON/OFF connection -** If active the UPS output turns off regardless of mode of operation. Auxiliary power, communications and rectifier/battery charger shall remain functional.

11. **Floor Mounting Brackets –** The UPS shall provide floor mounting brackets as a protective stop to prevent the cabinet from rolling forward if unintentionally pushed.

12. (**Option) External Mounted Maintenance Bypass Module -** An externally mounted Make Before Break Bypass Module or Break Before Make can be ordered as needed for use with the UPS.

Bypass Model Number	Ratings (UL/CSA) Continuous	Ratings (TÜV) Continuous
BPEFXMBB02	40A/300 Vac	50A/300 Vac
BPEFXBBM02	40A/300 Vac	50A/300 Vac

13. **(Option) External Battery Cabinets -** Battery cabinets can be ordered for extended runtime requirements.

Runtime Option	Cabinet Type	Battery Type
FXEBM01	Type N	Qty 8 (12 volt)
FXEBM03	Type P	Qty 12 (12 volt)
FXEBM04	Type P	Qty 12 (12 volt)
FXEBM06	Type P	Qty 12 (12 volt)

14. (Option) Connectivity –

Communications Options			
Predict Pulse	**Intelligent Power Protector**	**Intelligent Power Manager**	**Network – M2 Card**
Industrial Gateway – M2	**Relay Card - MS**	**Industrial Relay – M2**	

2.03 PERFORMANCE REQUIRMENTS

1. AC Mains Voltage

    - The UPS shall operate on the following nominal AC mains voltage:

Nominal Voltage L-N	Input Voltage Range
120V	88-144 Vac

2. Ac Mains Frequency

    - The design operating frequency range, without transferring to battery power, shall be nominal 60 Hz ± 3 Hz.

3. Input Power Factor

    - The input power factor shall be .95 or greater.

4. Batteries and Charger

    - The battery charger shall utilize Advanced Battery Management (ABM).
    - The UPS battery charger shall be rated at 20 amps.
    - Battery type: Valve Regulated Lead Acid (VRLA), non-spillable, lead acid cells, maintenance free.
    - The float voltage shall be 2.30 V/ cell.
    - ABM charge time will be 48 hours.
    - ABM rest time will be 48 hours.

    ABM shall perform three tests of the battery:

    - Charge mode test- ensures the battery string reaches 2.3 VPC within the float or charge period.
    - Rest mode test- ensures the battery string does not fall below 2.1 VPC within the rest period.
    - Battery discharge test- will discharge the battery string automatically every 90 days.

5. Capability for addition of external battery cabinets to increase total runtime. Battery runtimes are approximate and vary depending on load configuration, battery charge, and environmental conditions. FX runtime options are located below.

Eaton Ferrups FX 3100 Runtimes			
FX EBM Option	**Runtime**		**Ah / Rating /DC Voltage**
	Full Load	**Half Load**	
**** Standard Internal Batteries only****	**14 Minutes**	**35 Minutes**	33 Ah/ 1 String / 48V
**** FXEBM01 w/o UPS Internal Batteries****	**139 Minutes**	**355 Minutes**	70 Ah/ 2 Strings / 48V
**** FXEBM01 With UPS Internal Batteries****	**189 Minutes**	**405 Minutes**	33 Ah/ 1 String / 48V 70 Ah/ 2 Strings / 48V
***** FXEBM03 w/o UPS Internal Batteries*****	**232 Minutes**	**551 Minutes**	70 Ah/ 3 Strings / 48V
***** FXEBM03 With UPS Internal Batteries*****	**282 Minutes**	**601 Minutes**	33 Ah/ 1 String / 48V 70 Ah/ 3 Strings / 48V
***** FXEBM04 w/o UPS Internal Batteries*****	**309 Minutes**	**730 Minutes**	100 Ah/ 3 Strings / 48V
***** FXEBM04 With UPS Internal Batteries*****	**359 Minutes**	**780 Minutes**	33 Ah/ 1 String / 48V 100 Ah/ 3 Strings / 48V

***** FXEBM06 w/o UPS Internal Batteries*****	**515 Minutes**	**1159 Minutes**	140 Ah/ 3 Strings / 48V
***** FXEBM06 With UPS Internal Batteries*****	**565 Minutes**	**1209 Minutes**	33 Ah/ 1 String / 48V 140 Ah/ 3 Strings / 48V

6. Surge Protection

   The Eaton Ferrups FX UPS provides 2000-to-1 spike attenuation. Tested using lightning standard per ANSI/IEEE C62.41 Category A (6000V spike and 200A) and Category B (6000V spike and 3000A) test, and ANSI/IEEE C62.45 test procedures.

7. AC Output

   - Waveform — Sinusoidal
   - Power Rating— 3.1kVA / 2.2kW
   - Output Voltage —Output Voltage Regulation in battery mode operation shall be < 5%
   - Output voltage regulation online shall be < 5% of nominal voltage.
   - Output Frequency — ±60Hz only
   - Output Voltage Regulation — Output Voltage Regulation in battery mode operation shall be < 5%
     - Output voltage regulation online shall be < 5% of nominal voltage.

   - Output Voltage Distortion (THD) — <10% at full resistive load, under normal operating conditions and with the batteries fully charged with the charger in the rest mode. connection between input and output, and less than 2 pF of effective input to output connection between input and output, and less than 2 pF of effective input to output capacitance.

8. Transfer Time
   - Transfer to Battery Mode operation from Normal Mode operation in zero milliseconds.

9. Overload Ratings

   - On line with 101 - 124% load, shutdown in 10 minutes
   - On inverter with 101 - 110% load, shutdown in 10 minutes
   - On line with more than 125% load, shutdown in 10 seconds
   - On inverter with more than 110% load, shutdown in 10 seconds

10. Environmental

    - Temperature — 0° to 40° (32° to 104°)
    - Humidity— 0–95% noncondensing
    - Altitude —The maximum operating ambient temperature decreases 1° C per 300 m above sea level (2° F per 1000 ft above sea level). Maximum elevation is 10000 m (32,808 ft)
    - Cooling — Forced air cooling.
    - Heat dissipation— FX3100 —905 BTU
    - Audible noise —FX3100 online 65 db, on battery 62db.

2.03 OPERATIONAL REQUIREMENTS

User Interface Panel

1. Control Functions

   The UPS Remote Control Display shall allow the user to control:

   - All modes of operation.
   - The battery charger.
   - System diagnostic tests.
   - Silencing the alarm.

2. Metered Parameters

   The UPS shall monitor and display via the User Interface Panel the following values:

   - AC Mains Voltage
   - UPS Output Voltage
   - UPS Output Current
   - Volt-Amps Out
   - UPS Input Current
   - UPS Output Current
   - Battery Voltage
   - Battery Current
   - Frequency
   - Estimated Battery Runtime
   - Ambient Temperature
   - Inverter Temperature
   - Transformer Temperature
   - Full Load%
   - Watts Out
   - Load Power Factor

3. The UPS shall provide a log containing events and alarms. The log shall display event number and if the event or alarm has CLR (cleared) or SET (set). Accessible via the Remote-Control Display.

4. The UPS shall provide a log containing the results of each battery test. Accessible via the Remote-Control Display.

5. User Adjustable Set-points

   The UPS User Interface Panel shall allow the user to access and program:

   - Alarm set-points and parameters.
   - Communication set-points and parameters.
   - Sensitivity set points and parameters for generator operation.
   - Diagnostic test set-points and parameters.

6. Status LEDs

The UPS shall provide LEDs designating:

- AC Line— AC mains available.
- Ready— UPS is ready to supply battery power.
- Charger— Battery charger is ON.
- Battery Power —UPS is operating on battery power.
- Alarm —An alarm condition exists.

7. Alarms

   - The UPS shall notify the user of alarm conditions via LED illumination, contact closure, and audible alarm tone for each alarm condition.

   - The following alarm conditions shall be monitored:

UPS Alarms		
Inverter Over Temperature	CTO Configuration Error	Fan Failure
Internal CAN Failure	Inverter Output Over Current	OS Failure
Site Wiring Fault	Gate Drive Power Supply Fail	Battery Current Limit
Level 2 Overload	Batteries Disconnected	Input Over Current
EEPROM Failure	System Initialization Error	Inverter Over Temperature Trip
DVR Over Current	Battery Low	FPGA Failure
Output Overload Trip	Ambient Overtemperature Trip	Battery DC Over Voltage
Low Battery Shutdown	Power Supply 5 Volt Fault	Charger Over Temperature
PWR Board EE Failure	Battery test Failed	Ambient Over Temperature
SCR Over Temperature	Battery Needs Service	Fuse Failure
Battery DCUV Imminent	SCR Over Temperature Trip	DVR Over Temperature
DV Over Temperature Trip	Transformer Over Temperature	Transformer Over Temperature Trip

PART 3 – EXECUTION

1. Install in accordance with manufactures instructions and associated User and Installations Manual.

2. Procedures shall be provided to allow Startup and commissioning by the customer.