

# 3<sup>RD</sup> Rail Inverter Specification

## DC TO AC INVERTER

### PART 1 GENERAL

#### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of contract, including General and Special Conditions and Division 01 Specification sections, apply to this section.

#### 1.02 SUMMARY

- A. This specification covers the furnishing and testing of complete and workable direct current (DC) to alternating current (AC) inverter packages used to convert the existing 600-Volt DC transit power supply to a single or three phase, ungrounded or grounded, 50 or 60Hz, AC power supply, for indoor or outdoor operation.
- B. The inverter packages shall include the normal or preferred source is the 600-Volt DC, and the local utility AC service shall be the backup or the secondary source.

#### 1.03 REFERENCES AND STANDARDS

- A. The following is a list of references, codes, and standards that shall be utilized during the electrical design process.
  - 1. National Electrical Code (NEC)
  - 2. National Fire Protection Association (NFPA)
  - 3. National Electrical Manufacturers Association (NEMA)
  - 4. American National Standards Institute (ANSI)
  - 5. Underwriters Laboratories (UL)
  - 6. Local codes and standards that may apply and are approved for use by the Chicago Transit Authority or the Authority's Representative.
  - 7. Exhibit 1 (attached)

#### 1.04 SUBMITTALS

- A. Shop Drawings for approval shall be provided and shall consist of the following categories:
  - 1. Fabrication, assembly and details.
  - 2. Shop Drawing of all component parts.
  - 3. Point to point interconnection wiring diagrams for field assembly and overall assembly.

## 1.05 QUALITY ASSURANCE

- A. Contractor is solely responsible for the quality control of the work and shall comply with the requirements in Division One sections as well as all the regulatory requirements.

## 1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliver and store materials in manufacturer's original packaging. Store materials in climate controlled and protected dry locations off ground in accordance with manufacturer's instructions. Follow handling procedures approved by the manufacturer.

## 1.07 WARRANTY

- A. Manufacturer and installer shall warranty the equipment and installation for a period of One (1) years from date of final installation or 18 months from date of shipment, which ever comes first.

## PART 2 PRODUCTS

### 2.01 DETAILED REQUIREMENTS

#### A. Utilization Voltages

- 1. Utilization voltages shall be as follows:
  - a. Incoming power to the inverter package will be provided by the Authority at 600-Volt DC from the existing transit system, and Volt AC from the local utility system.
  - b. Outgoing power from the inverter package shall be Volts AC, single-phase or three-phase, 50 or 60Hz, ungrounded or grounded.

#### B. DC/AC Service Equipment

- 1. Main service equipment connections - the inverter package will be connected to the Utility-Volt AC distribution equipment. The Installer will furnish and install the 600-Volt DC power connections to the transit rail system. The Installer will provide a DC power disconnect switch and protective fuses to protect the Authority's equipment ONLY. The Installer will furnish and install properly sized and rated conductors for the incoming DC power to the inverter package. The Contractor shall supply and furnish the protection required for the inverter package.

#### C. Inverter Package

- 1. The inverter in the package shall be rated \_\_\_\_ KVA @ \_\_\_\_ VAC. The Authority shall not be required to supply additional isolation transformers on the Volt AC output; therefore, the inverters shall provide low total harmonic distortion. The inverter package shall contain a static switch that shall automatically and seamlessly switch from the preferred source to the existing standby source or from the standby source to the preferred source.

2. The inverter package shall meet the following technical specifications:
  - a. The inverter shall be designed with two separate transient protection systems to provide maximum protection to critical loads. See Exhibit 1 and Section 2.02 below for typical peak surge DC voltage wave shapes that the inverter shall be designed to withstand without shutdown.
  - b. It is essential to decouple the load from the incoming DC power. It is acceptable to supply an output isolation transformer (within the Inverter enclosure) for this purpose and to obtain the required output of Volt AC, 50 or 60 Hz. ungrounded or grounded power supply.
3. During normal operation, the preferred source for the inverter unit shall be the 600-Volt DC transit power source. However, a simple selection method shall be supplied that will enable the Unit to select the 600-Volt DC traction source or the Utility source as the preferred source. When the inverter equipment with the 600-volt DC as the preferred source senses a track power disturbance, or if the inverter input voltage is outside the specified operating limits, the inverter static switch shall automatically and seamlessly switch power from the DC power source to Utility-Volt AC source. If AC power source is not available, the unit shall automatically transfer back to the track (DC) power. The Inverter Package shall be designed so that DC track voltage surges of section 3.4.1.1 do not cause the unit to fail, shutdown, go off-line, or otherwise malfunction. (See Exhibit 1 for the wave shape of the expected typical 40 milli-second voltage surge.)
4. The unit shall have a full static bypass switch and a mechanical functional bypass switch. The Unit will have an external bypass switch option such that the unit can be isolated for maintenance, while maintaining a Utility Volt AC supply to the connected load.

## 2.02 TECHNICAL SPECIFICATIONS

- A. The detailed technical specifications are as follows:

### Electrical Input

Input Voltage No. 1 (DC Track):	600 VDC nominal, 350-900 VDC
DC Voltage Surge Rating:	1500 Volts DC surge for 40 milliseconds (msec.) 3000 Volts surge for 50 microseconds (μsec.)
Input Voltage #2 (Utility):	120, 208, 240, 277 208Y/120, or 480Y/277 -Volt AC, three phase or single-phase, 50 or 60 Hz ungrounded/grounded
Voltage Range:	+10%, -15% input No. 2

### Electrical Output

Output Power	8, 16, 24, 32 KVA
Output Voltages:	120, 120/240, 277, 208Y/120, 480Y/277VAC, single or three phase, 50 or 60HZ, ungrounded/grounded
Voltage Regulation: Static:	±3%
Voltage Distortion:	≤ 3% for linear load
Frequency Regulation:	Synchronization: ±0.5 Hz.
Overcurrent (inverter):	150% for 30 sec. 200% for 5 sec.

## Environmental

Location	Indoors/outdoors, exposed to wind driven rain/snow and direct sunlight.
Ambient Temperature:	Operation -30°C to + 50°C
Relative Humidity:	95% maximum
Altitude:	1000 meters (3280ft) max.
	Without Load Derating
Audible Noise:	Less than 55dBA typical at 1 m.
Electrostatic Discharge:	Withstands 3kV without damage or disturbance to the load

## Mechanical

Cable Entry:	Bottom.
Cooling:	Convection only
Access:	Front hinged doors with 3-point latch required for service. Latch to have 0.5 in. diameter hole for lock shackle.
Dimension:	50 in. (Width)max x 34 in. (depth)max x 80 in. (Height) max.
Housing/Enclosure:	Enclosure shall be stainless steel or aluminum

	Classified as NEMA Type 4X for outdoor use; enclosure shall contain all equipment in a common enclosure
Ventilation/Cooling/Heating:	As required for proper operation in an ambient condition of -30°C to + 50°C
Cable Connection Points:	All cable connection points shall be rated for copper conductors.
Service Receptacle:	120-Volt, 20-Amp AC connected to output source and accessible inside front doors
Ground Pad:	Tin plated, supplied at base of enclosure providing an equipment ground point for all internal metal parts

### User Interface Panel

English Alphanumeric Display: 4 Lines by 20 characters (minimum)

## Serial Port

Type: RS-232 (PTU connector)

- A. The inverter package shall be provided with diagnostic alarm and trip indicators and associated displays to aid maintenance and trouble shooting and shall include but not limited to the following meters, alarms and Type C rated (SPDT) dry contacts wired to a terminal strip for connection by others:
1. Door open
  2. Low line voltage transfer
  3. Over-voltage trip
  4. Over-frequency trip
  5. Over and under temperature trip
  6. Over and under temperature alarm (including loss of ventilation alarm)
  7. Inverter output fault
  8. Loss of 600 VDC (DC Input out of range)
  9. Loss of Bypass VAC
  10. Inverter fail
  11. Output line voltage (analog)
  12. Output line current (analog)
  13. Auto-bypass
- B. Diagnostic display shall contain battery or capacitor backup power as needed in order to retain last alarm indication on loss of power for a minimum of 90 days.
- C. All alarm contacts shall be wired in a "supervised" configuration wherein a closed contact will be considered normal or non-alarmed state.
- D. All analog outputs shall be 0 to +/- 1 milliamp capable of supplying a 10-volt burden (10k-ohm).
- E. Alarm contacts and analog outputs shall be accessible from the front of inverter unit without requiring the inverter to be shutdown or de-energized for access.

## 2.04 AC SERVICE EQUIPMENT

- A. Main Electronic Transfer and Bypass Switch
1. General
    - a. Upon loss of the preferred source, the inverter shall automatically switch to the secondary source.
    - b. When the preferred source has been restored to approximately 70% of the rated voltage, and after an adjustable time delay, the load shall retransfer automatically to the preferred source.
    - c. Upon loss of both primary and secondary sources, the unit shall be able to self- start and provide power to the load from any source that has been restored.
  2. Static Bypass Switch - A solid state Static Switch shall be supplied as part of the inverter package and meet the following minimum requirements:
    - a. Seamless transfer for three phase.
    - b. 1/2 cycle single phase.

- c. LCDs to indicate inverter connected to AC Source, DC source.
    - d. LCDs indicating "DC Source Available" and AC Source Available to monitor the respective source voltages.
  - 3. Manual Bypass Switch
    - a. A manual bypass switch shall be supplied as part of the inverter package. The bypass switch shall be operated when the inverter package requires maintenance or repair. The bypass switch shall be rated for full load rating of the inverter.
- B. Overloads
  - 1. The inverter shall supply overload current for the minimum values and times indicated in the sections above without failure or unit shutdown.
    - a. The inverter may be required to supply power to an isolation and/or step-up distribution transformer. The inverter unit must have the ability to provide the required inrush current. Where currents exceed that as specified herein, the inverter shall transfer to the bypass power to supply inrush.

## 2.05 GROUNDING SYSTEM

- A. The main grounding system is not connected to the incoming 120-Volt AC, 60 Hz power service. The 120-Volt incoming service to the Authority's facilities operates ungrounded. The main reason the system operates ungrounded is to eliminate circulating currents that can flow in the ground return cables. The circulating current originates from the track power system. All metallic parts are case bonded and may be connected to the DC negative return track system.

## 2.06 CABLE ENTRY SYSTEM

- A. Inverter unit shall provide for an internal cable entry wire trough and removable access panel that allows for access to input and output connections as well as any component that may require maintenance and replacement. Conduit entrance holes will be field drilled / punched by the installer.

## 2.07 SOLAR PROTECTION

- A. Inverter unit will be subjected to direct sunlight for long periods while under load. The design of the inverter package must be such that direct sunlight will not cause excessive heating of internal devices or power semi-conductor devices. The use of a sun shield over external heat sinks is allowed provided the total package outline dimensions are not exceeded. Use of external fan on heatsink(s) is not required.

## 2.08 INTERNAL PROTECTION

- A. The unit shall be designed such that when the doors are opened, the door open alarm contact is activated. The unit shall have internal parts of the unit exposed when the doors are open but still allow the operation of the manual bypass switch, the isolation breaker, viewing and use of the display, access to alarm contacts and analog outputs, and the service outlet.

## 2.9 OPERATION AND MAINTENANCE MANUALS

- A. The Contractor shall furnish Operation and Maintenance Manuals as specified in Division One section, Closeout Submittals. Follow the requirements specified for the number of manuals, format, type and information to be provided. The manuals shall be complete, and include all maintenance information and instructions required to properly maintain the equipment. As a minimum, the following items shall be provided:
1. Complete schematic and wiring diagrams down to component level (must show components and connections).
  2. Wiring diagrams shall show all wire terminations and terminal designations as well as dip switch or jumper settings.
  3. All board level printed circuits shall be shown and the plug-in modules properly designated by part number and function.
  4. A complete material list of component parts and replacement part numbers including description of part function (Bill of material).
  5. Diagnostic procedures, interrogation hardware and software.
  6. Recommended tests and test procedures.

## PART 3 EXECUTION

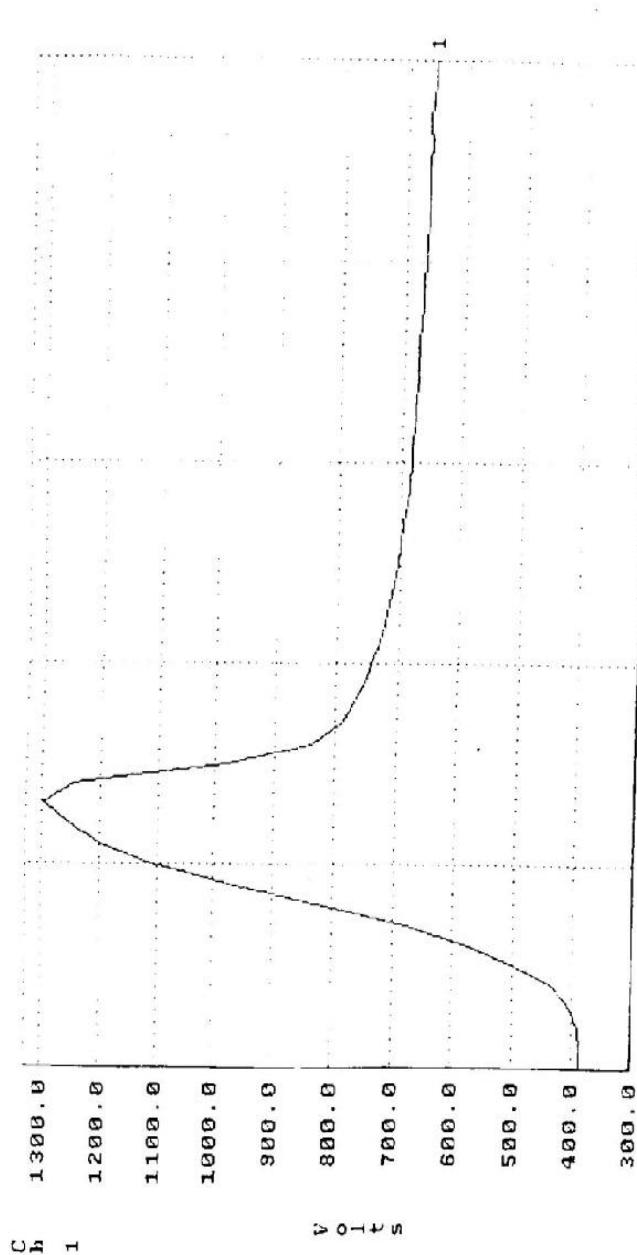
### 3.01 FACTORY TESTS

- A. The Chicago Transit Authority or the Authority's representative has the right to witness all factory tests to verify that the inverter units meet the Technical Specifications and applicable standards.
- B. Prior to shipment of the Inverter and DC transfer system, a thorough, formal, integrated Factory Test shall be conducted with at least two of the Authority's representatives. The Contractor shall notify the Authority in writing four (4) weeks prior to the test, that the system, in the opinion of the Contractor, is ready for the formal Factory Acceptance Test. The Factory Acceptance Test Procedure Document should follow a standard test format and be submitted to the Authority at least sixty (60) days prior to the scheduled formal Factory Acceptance Test, for review and approval. The formal Factory Acceptance Test shall not take place until the Factory Acceptance Procedures Document has been approved by the Authority's Project Manager.

### 3.02 SITE TESTS

- A. The Contractor may have a representative(s) available to assist and witness site testing of all installations. The Contractor's representative(s) shall obtain a rail safety pass in accordance with the Authority's requirements.

END OF SECTION



10/05/00 27.29 27.33 27.37 27.41 27.4

SECONDS

13:11:27.49200

Ch 1: Shoe Voltage

c:\addata\TEST51.DAT

SAMPLE RATE : 250.000 Hz

CHANNEL : 1

Wuport 1

Compression: 1 to 1

**EXHIBIT 1**