UNIPOWER
Powering Technology

Application Note: 0827-11

THREE-PHASE POWER WITH UNIPOWER FRONT-ENDS AND RECTIFIERS

1.0 Introduction. This application note discusses three-phase power and the operation of UNIPOWER front-ends and UNIPOWER Telecom rectifiers. Three-phase AC input power can be useful with high-power front ends and rectifiers in the several thousand watt area of power. This applies to many of UNIPOWER's power and rectifier modules that use the model RRS2U-19 three-unit rack/shelf (see Figure 1) and also the Gravitas Compact, Integrated DC Power Systems.

The three-module bulk power front ends and telecom rectifiers are readily adaptable to balanced three-phase power operation since there are separate, isolated AC inputs to each of the three modules.

2.0 Three-Phase Power. As a brief review, three-phase power may be represented by the phasor diagram of Figure 2. This diagram represents a 120/208 VAC North American three-phase power source. Each phase, A, B, and C, is 120 VAC in magnitude (to neutral) and each is separated from the other by a 120^0 phase angle. The phase relationship of the three voltages makes them sum to zero at all times. By trigonometry, the phase-to-phase voltage has a magnitude of 120x $\sqrt{3}$ VAC or 208 VAC. The three phase-to-phase voltages also sum to zero at all times. Connections can be made either from phase to phase (208 VAC), which is called a delta (Ä) connection, or phase to neutral (120 VAC), which is called a wye (Õ) connection.

The phasor diagram of Figure 3 represents a European (U.K.) three-phase power source with a 240 VAC phasor magnitude and a 240x $\sqrt{3}$ or 415 VAC phase-to-phase voltage. This is the United Kingdom standard whereas the standard for most other nations of Europe is 220/380VAC.

3.0 Connections for UNIPOWER Products. The following table lists the output power, input voltage range and correct three-phase connection for each of the pertinent UNIPOWER products.

UNIPOWER LLC
3900 CORAL RIDGE DRIVE, CORAL SPRINGS, FLORIDA 33065
Tel: 954-346-2442 • Fax: 954-340-7901
WEBSITE: http://www.unipowerco.com

TABLE 3.1 Three-Phase Connection of Unipower Products

UNIPOWER SERIES	TOTAL POWER (W)	INPUT VAC RANGE	NORTH AMER. CONNECTION	EUROPE CONNECTION
TMP	3,600	170-264	Ä	Õ
TRP	3,744	85-264	Õ or Ä	Õ
TRR	6,005	170-264	Ä	Õ
TRS	7,502	170-264	Ä	Õ
Meridan RMP	4,080	170-264	Ä	Õ
Ranger RRP	4,080	85-264	Õ or Ä	Õ
Ranger RRS	8,160	170-264	Ä	Õ
Gravitas X150/300				
RMP Modules	4,080	170-264	Ä	Õ
RRP Modules	4,080	85-264	Õ or Ä	Õ
RRS Modules	8,160	170-264	Ä	Õ

The rule is that for North America a unit with 170-264 VAC input must be connected only in the 208 VAC delta configuration; for 85-264 VAC input, the unit can be connected in either the 120 VAC wye or 208 VAC delta configuration.

For Europe, both input voltage ranges must be connected only in the 220 or 240 VAC wye configuration. The 380 or 415 VAC delta connection exceeds the input voltage range of the units.

4.0 AC Input Connections. Figure 4 shows the AC input terminal block for the RRS2U-19 three-unit rack which is the common rack/shelf for all the power/rectifier modules in the table, not including the Gravitas systems. AC input connections for the Gravitas X150 and X300 Compact, Integrated DC Power Systems are shown in Figure 5. In both cases the neutral (N) terminal is actually a neutral/line (N/L) terminal since it is isolated from the ground connection.

5.0 Three-Phase Delta Connection. Figure 6 shows the connection to three power or rectifier modules with 170-264 VAC input range to the North America three-phase 208 VAC delta source. The delta connection is from phase to phase with phases labeled A, B and C. For proper protection, two-pole circuit breakers are used at each module input as shown in the diagram. The source neutral connection is not used. It should be noted that the total current drawn from each phase is $\sqrt{3}$ times the input current for one module.

Note that the delta connection must not be used for a European three-phase power source since the voltage is 380 or 415 VAC, exceeding the maximum power or rectifier module input voltage of 264 VAC.

UNIPOWER LLC
3900 CORAL RIDGE DRIVE, CORAL SPRINGS, FLORIDA 33065
Tel: 954-346-2442 • Fax: 954-340-7901
WEBSITE: http://www.unipowerco.com

6.0 **Three-Phase Wye Connection.** Figure 7 shows the wye connection to three power or rectifier modules with 85-264 VAC input range. Each module is connected from one of the phases A, B or C to neutral. This is the connection that may be used to North American three-phase sources. It is also the connection that must be used for European 240/415 VAC three-phase sources for both 85-264 VAC and 170-264 VAC input ranges.

Here, a single-pole circuit breaker is used for each module, on the line side of each input, since the other side is neutral. For a fully loaded RRS rectifier module or TRS power module on North American three-phase power, the circuit breaker should be at least 20 amperes. For a European wye connection, the circuit breaker should be 20 amperes minimum for a fully loaded RRS or TRS module. Input current (RRS) as mentioned previously is approximately 19.2 amperes at 170 VAC.

7.0 **Additional Comments.** In either of the two three-phase connections, 2+1 redundancy may be used. This means that two of the three modules must be able to carry the full load. If one of the modules fails and trips its breaker, the other two will continue to function from the three phase source and carry the load. In this case, even though the phase currents are not balanced, the remaining two modules will continue to operate properly.

In similar fashion, more than three modules may be operated from a three-phase power source. For example, UNIPOWER Telecom also makes four-module, 23-inch shelves. Again, even though the phase currents are unbalanced, the units will operate properly. If more than four modules are operated, the units should be distributed evenly around the three phases.

UNIPOWER's RRS2U-19 rack/shelf has all module DC outputs internally connected in parallel while the AC inputs for each module are separate and isolated. This is true of all UNIPOWER racks and shelves.

Figure 1. Model RRS2U-19 Three-Unit Rack/Shelf with Power/Rectifier Module

UNIPOWER LLC
3900 CORAL RIDGE DRIVE, CORAL SPRINGS, FLORIDA 33065
Tel: 954-346-2442 • Fax: 954-340-7901
WEBSITE: http://www.unipowerco.com

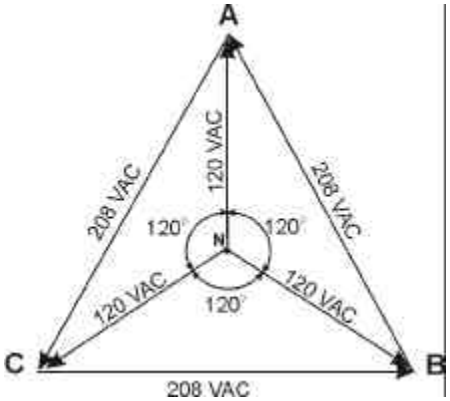

Figure 2. Phasor Diagram for North American 120/208 VAC 3-Phase Power

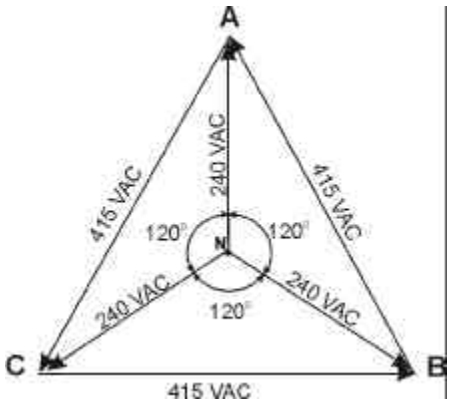

Figure 3. Phasor Diagram for European (U.K.) 240/415 VAC 3-Phase Power

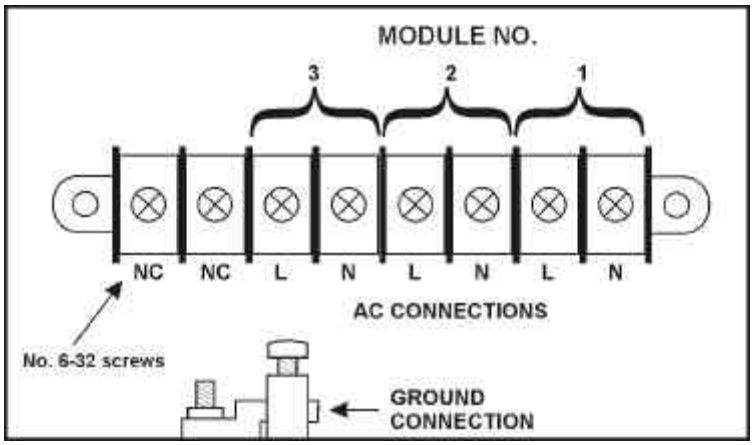

Figure 4. AC Input Connections for RRS2U-19 Three-Unit Rack/Shelf

UNIPOWER LLC
3900 CORAL RIDGE DRIVE, CORAL SPRINGS, FLORIDA 33065
Tel: 954-346-2442 • Fax: 954-340-7901
WEBSITE: http://www.unipowerco.com

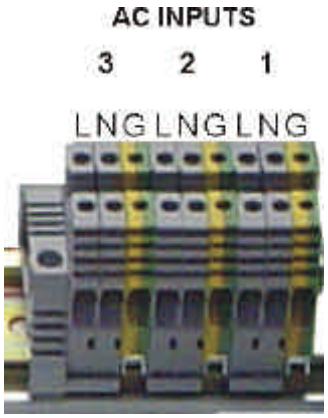

Figure 5. Connections to Gravitas X150/X300 Compact, Integrated DC Power Systems.

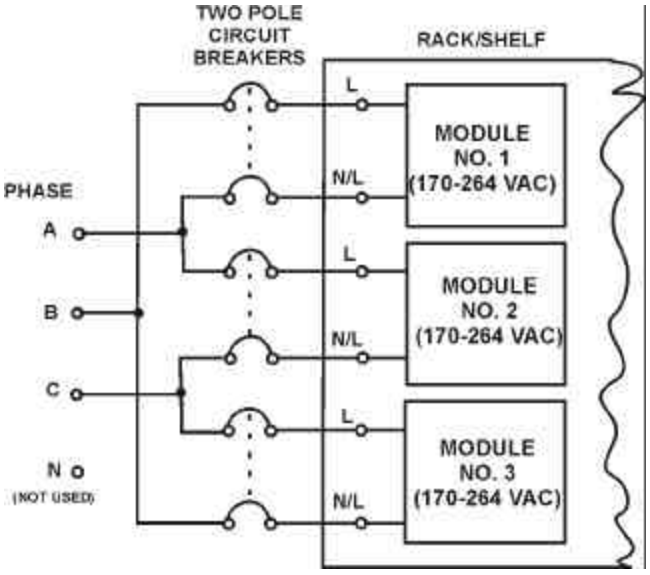

Figure 6. Delta Connection to 120/208 VAC 3-Phase Power Source

UNIPOWER LLC
3900 CORAL RIDGE DRIVE, CORAL SPRINGS, FLORIDA 33065
Tel: 954-346-2442 • Fax: 954-340-7901
WEBSITE: http://www.unipowerco.com

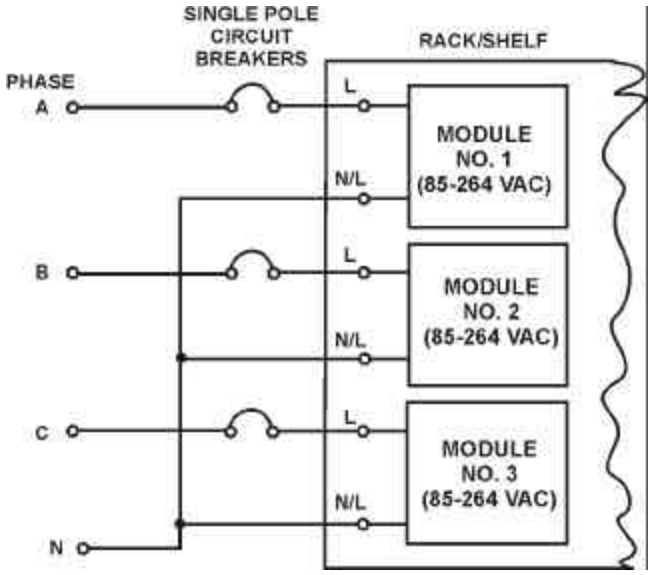

Figure 7. Wye Connection to 120/208 or 240/415 VAC 3-Phase Power Source