LCE Series

DC-AC Sinewave Inverter
Including 24VDC & 48VDC Models

OPERATION MANUAL REV. D

TRANSISTOR DEVICES, INC.
85 Horsehill Road
Cedar Knolls, NJ 07927
Phone: 973-267-1900 Fax: 973-267-1607
www.tdipower.com

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CERTIFICATE OF CONFORMANCE

CERTIFICATE OF CONFORMANCE

July 31, 2001

Equipment Identification:

Type of Equipment:	ITE, Light Industry
Equipment Function:	Power Inverter
Supplier / Manufacturer:	Transistor Devices, Inc.
Model Designations:	1) LCE15-48-120 2) LCE15-48-120/R 3) LCE15-48-120/S 4) LCE15-48-120/R/D 5) LCE15-48-120/S/D 6) LCE15-48-120-R-01 7) LCE15-48-220 8) LCE15-48-220/R 9) LCE15-48-220/S 10) LCE15-48-220/R/D 11) LCE15-48-220/S/D 12) LCE10-24-120 13) LCE10-24-120/R 14) LCE10-24-120/R/E 15) LCE10-24-220 16) LCE10-24-220/R 17) LCE10-24-220/R/E

Transistor Devices, Advanced Conversion Products Division certifies that the products referenced above have been tested in accordance with the essential requirements of the European Union EMC Directive and Low Voltage Directive. The products meet or exceed the criteria established in the below captioned requirements:

Emissions & Immunity per ETS 300-386-1: 1994
Radiated and Conducted Emissions – EN 55022: 1998, class A
Radiated and Conducted Immunity – EN 61000-4-3: 1996, ENV 50204: 1995,
EN 61000-4-6: 1996, EN 61000-4-4: 1995, EN 61000-4-2: 1995
Low Voltage Directive per IEC 60950:1991 +A1: 1992 +A2: 1993 +A3: 1995 + A4: 1996

Ted Trzesniowski
Engineering Manager
Advanced Development Group

Don Ashenbrenner
Quality Assurance Manager

ADVANCED CONVERSION PRODUCTS Division
85 Horsehill Road, Cedar Knolls, NJ 07927 • Phone: 973-267-1900 • Fax: 973-267-5232 • www.tdipower.com

SAFETY STATEMENT

Approvals are based on, but not limited to the following:

1) The DC input source is an approved SELV source

2) Use in a Restricted Access Area only

3) Warning: HIGH LEAKAGE CURRENT

   - Earth connection is essential before connecting supply

4) Earth grounding conductor must be properly sized to 1.5mm squared (minimum)

Diese Zustimmungen werden basieren an, aber nicht auf das folgende begrenzt:

1) Die Gleichstrominputquelle ist eine anerkannte SELV-Quelle

2) Gebrauch in einem eingeschränkten Zugriff Bereich nur

3) Warning: HOHER DURCHSICKERNCStrom

   - Masse Anschluß ist wesentlich, bevor man anschließt Zubehör

4) Erdungleiter muß richtig sortiert werden zu 1.5mm quadriertem (minimum)

INTRODUCTION TO THE LCE SERIES

This Operation Manual provides a general description of the LCE series Sinewave Inverter designed to provide a reliable AC power from a DC source. A battery plant (DC source) will provide the on-line input voltage for the Inverter.

Inverters are used to convert DC voltages to sinusoidal AC voltages for conventional AC applications (120 VAC @ 60 Hz or 220 VAC @ 50 Hz). The LCE series Inverter is an industrial designed power supply that incorporates state-of-the-art electronics to provide high power density and reliability in a compact unit.

The LCE Series Inverters, manufactured by Transistor Devices, Inc., delivers a near perfect sinewave from a variety of DC sources. These low cost, solid state inverters utilize high frequency pulse width modulation technology to "synthesize" a precision regulated sinusoidal output with less than 1% Total Harmonic Distortion. The wide input range allows the inverter to operate within the charge and discharge limits of any battery technology making it ideal for back-up UPS applications.

The LCE sinewave inverter is ideal for use in telecom sites, electric utility sub-stations, fuel cell, solar power applications, and for AC power on specialty vehicles such as ambulances and rescue vehicles. The LCE inverter delivers a fully isolated and precision regulated output capable of powering any load with a power factor from zero lead to zero lag. The ability to deliver high peak currents makes the LCE inverter ideal for driving non-linear loads such as rectifiers or motors. Units are capable of parallel and synchronized operation. Multiple units (up to 20) can be user configured for single or three phase output configuration. N+1 redundancy is achieved with 2 or more inverters connected in parallel. The unit is lightweight (under 12 lbs.) and is available in a modular, rack mount, or shelf mount enclosure.

FEATURES

- Hot-Bus Plug In
- Parallelable, supports N+1 Redundancy
- LCE15 Series: Scaleable From 1.5kVA to 36kVA
- LCE10 Series: Scaleable From 1.0kVA to 24kVA
- Failsafe - No Single Point Failure
- Demonstrated MTBF >900,000 Hours
- Stand-Alone Operation (shelf mount) or Rack Mount Option
- Lowest Profile, Highest Density
- Full Power from -20 to +55°C
- 1Ø, 2Ø or 3Ø Solutions
- Powers Any Load

SPECIFICATION FOR THE LCE SERIES

	LCE15-48	LCE10-24
Input		
Nominal Input – Custom Input Voltages Available	48 VDC	24 VDC
Input range	38 VDC to 56 VDC	19 VDC to 29 VDC
Inrush Current Controlled	< 50 Amps	
Maximum Input Current at low line	50 Amps DC/Unit Max	65 Amps DC/Unit Max
Output		
Sinusoidal waveform with less than 1% THD Typical 120 VAC / 60 Hz or 220 VAC / 50 Hz Available Voltage regulation better than 2% Frequency controlled better than 0.01% stability Fully Isolated Input to Output DC content: 10 mV max No preload required		
Power Rating		
Maximum Power, over full temperature range	1.5 kVA	1.0 kVA
Maximum Output Current	120 VAC Unit: 13 Amps (RMS) 220 VAC Unit: 6.9 Amps (RMS)	120 VAC Unit: 9 Amps (RMS) 220 VAC Unit: 4.5 Amps (RMS)
Peak Output Current Into Nonlinear Load: 36 A (peak) Max. for 120 VAC 18 A (peak) Max. for 220 VAC Output power factor: Linear – Powers all loads with 0 leading to 0 lagging PF, Nonlinear – Rectified loads with up to 2.8 Crest Factor at full load. Motor Starting: 4 kVA Output for 10 sec. minimum.		

EFFICIENCY
83% Min. Half Load to Full Load
Standby: Under 100 Watts No Load

PROTECTION
Input Undervoltage
Input Overvoltage
Output Overload
Output Short Circuit

RELIABILITY (Calculated)
MTBF: Exceeds 100,000 hours
CALCULATED: Contact the factory

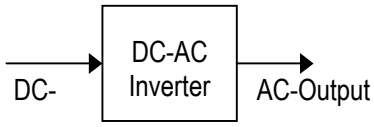
ENVIRONMENTAL
Cooling: internal fan
Operating Temp: -20° to +55°C
Storage Temp: -50° to +85°C
Humidity: 0-95% non-condensing
Safety Agency: UL, CSA, TUV/CE

MECHANICAL
Modular Mount, Universal Shelf Mount
Rack & Panel or Terminal Strip I/O
Weight: Under 12 lbs.
Size: 5.25” W x 5.25” H x 15.5” D
(See Appendix A - Outline Drawing)

THEORY OF OPERATION

INVERTER APPLICATIONS

In it's most basic form, an AC Power Supply converts DC input voltage into a regulated AC output. This configuration is commonly known as a *DC-AC Inverter* – or more simply – an Inverter.



Inverters are used to derive AC power from a DC bus. DC-AC Inverter technology offers options to the power system architect. It offers an elegant, cost-effective approach for generating an AC bus when:

* No AC is available within the system
* AC is not accessible within the system
* The primary AC supply is experiencing frequent interruptions
* The DC bus has built-in redundancy
* The available AC is of an unacceptable configuration
* Use of a DC bus is more convenient than routing AC throughout the system

TDI has the industry's widest offering of "near-perfect sinewave" DC-AC Inverters ranging in size from 200 Watts to over 30,000 Watts. Available in a wide variety of shapes and sizes, we can tailor the electrical and mechanical configurations to address almost any application. These low cost, solid state inverters utilize high frequency pulse width modulation (PWM) technology to "synthesize" a precision regulated sinusoidal output with typically less than 1% Total Harmonic Distortion (THD).

Wide input ranges allow the Inverters to operate within the charge and discharge limits of any battery technology, making them ideal for back-up UPS applications.

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LCE OPERATION

HOT BUS PLUG-IN

The LCE series inverter is a true hot-swap module. The hot-swap plug-in feature is facilitated via the integrated cam-actuated safety handle. The inverter is placed into its rack position and the handle mechanism, when moved to the locked/up position, will securely seat the module into place while simultaneously engaging all connections and then turning on DC input power via the internal on/off micro switch.

> **NOTE::** *Only LCE units with the interlocking handle (Model Numbers with the /H suffix) may be inserted or removed from a live system without damage to the unit.. All other models require removal of the source voltage prior to insertion or removal of the unit. Hot bus plugging or unplugging a non-interlocking unit in a live system can cause damage to the unit.*

REMOTE CONTROL

The LCE offers a remote on/off capability. An external switch can be wired to the signal connector at the rear of the shelf or module (see Table 1, Rear Connector Pin-outs, pins 32, 35). A switch arrangement for the remote control "On/Off" function is shown in Figure 2 (“ON” Position=Closed Switch Contact, “OFF” Position=Open Switch Contact).

To turn the unit(s) "On", for both stand-alone and parallel arrangements, the remote switch (if used) must be in the "On" position; The remote switch in the "Off" position will turn the unit off. The remote On/Off switch is referenced to “Input DC-“ (pin 40 on Fig.2).

In order to achieve optimum performance with multiple unit configurations, all the units must be turned On/Off simultaneously, by either removing the input power source or via the remote On/Off switch. If individual units are turned on or off, the output AC signal may show a slight, instantaneous degradation in waveform (i.e. THD may increase to approximately 3-5%) until all units are properly load sharing.

SHOOT-THROUGH PROTECTION

A "Shoot-Through" condition exists if the DC/AC Inverter shuts down while undergoing a short circuit condition. This will be detected from within the inverter and the control circuitry will shut the inverter down and open relay K2. The unit will then latch inthe shutdown state. This circuit protects the DC/DC Converter from experiencing a short circuit at its output. Relay K2 and output fuse F3 is used to disconnect the faulted unit from the non-faulted units.

In order to remove the "Latched Shutdown State", the unit must be turned off via a remote ON/OFF switch or by operating the CAM actuated handle and removed from the system.

FAULT ISOLATION / N+1 REDUNDANCY

If a unit failure occurs when operated in parallel with other units, the potential exists where the failed unit may load the other units with a short circuit or overload. To circumvent this, the

faulted unit will open relay K2, forcing fuse F4 to open, thus disconnecting the output from the other units. This design feature enables true N+1 redundancy with glitch-free operation . The typical fault clearing time is 8-10 ms (1/2 cycle).

THERMAL PROTECTION

Thermal protection is achieved by monitoring the power converter elements within the inverter. If the temperature reaches unsafe levels, the unit will be disabled internally in a latched state until the temperature returns to a safe level AND the unit is re-started (either a remote ON/OFF switch, operation of the CAM actuated handle or recycling input power).

OUTPUT PROTECTION

Although the inverter output is fully protected against external overload and short circuit, external protection devices such as fuses, circuit breakers, etc. may be used in accordance with Figure 3.

CURRENT SHARING

Pin No.12 provides an analog signal that corresponds to the degree of current sharing between parallel units. As stated above, for parallel operation all current sharing signals from each unit must be connected in parallel.

LCE ELECTRICAL SYSTEM OVERVIEW

A block diagram, highlighting the major functional elements of the LCE Inverter, is shown in Figure 1.

The major functional elements of the LCE Inverter, are listed below:

a) DC/DC Converter
b) DC/DC Control
c) DC/AC Inverter
d) DC/AC Control
e) EMI Input Filter
f) EMI Output Filter

A functional description of each major element follows:

DC/DC CONVERTER

The DC/DC Converter transforms the DC input voltage to an isolated DC link voltage.

The converter contains the following items:

a) High Frequency Pulse Width Modulator Inverter (HF-PWM/I)
b) Transformer
c) Output filter
d) Over current protection circuitry
e) Inrush current protection circuitry

- The HF-PWM/I converts a DC voltage to a series of high frequency pulses.
- The transformer provides reinforced insulation between the low-level input voltage and the AC output. A DC Link-bus is also created in order for the DC/AC Inverter to generate the proper AC output voltage.
- The output filter reduces internal harmonics to an acceptable level prior to reaching the DC/AC Inverter.
- The output DC/DC Converter output circuit (providing the link voltage) is protected by a fuse (F1), providing fault isolation from the DC/AC Inverter. The input circuit is protected by a fuse (F2) located in the negative bus return for 48V LCE and in the positive bus for 24V LCE.
- Inrush current is limited by relay K1 and resistor R1.

DC/DC CONTROL UNIT

This section controls the DC/DC Converter so the necessary DC-Link bus voltage is regulated over all line and load conditions. This bus enables the DC/AC Inverter to generate the proper AC output.

The DC/DC Control consists of following items:

a) Front panel LED Indicators
b) Remote control access circuitry
c) Link-voltage control circuitry

- The "ON" indicator (Green LED) is activated when the input voltage is within a safe operating range and the unit is correctly powered.

- The "FLT" (fault) indicator (Red LED) is activated when any fault condition exists as follows:

a) Short circuit at the inverter output
b) Overload at the inverter output
c) Inverter Fault
d) Over temperature

DC/AC INVERTER

The DC/AC Inverter unit converts the DC link voltage to the required AC output voltage.
This unit contains the following items:

a) High frequency Pulse Width Modulator Inverter (HF-PWM/I)
b) Output filter
c) Protection circuitry

- The HF-PWM/I inverter and output filter convert the link voltage to a sinusoidal output voltage.

- The output filter reduces high frequency harmonics to an acceptable level.

- Output circuitry is protected by fuse (F3). This circuit is active when relay (K2) is closed.

DC/AC CONTROL

The DC/AC Control provides main control for the Inverter. Protection features are incorporated from within to provide:

a) Over/Under Voltage Protection
b) Thermal Detection
c) Shoot-Through/Fault Isolation

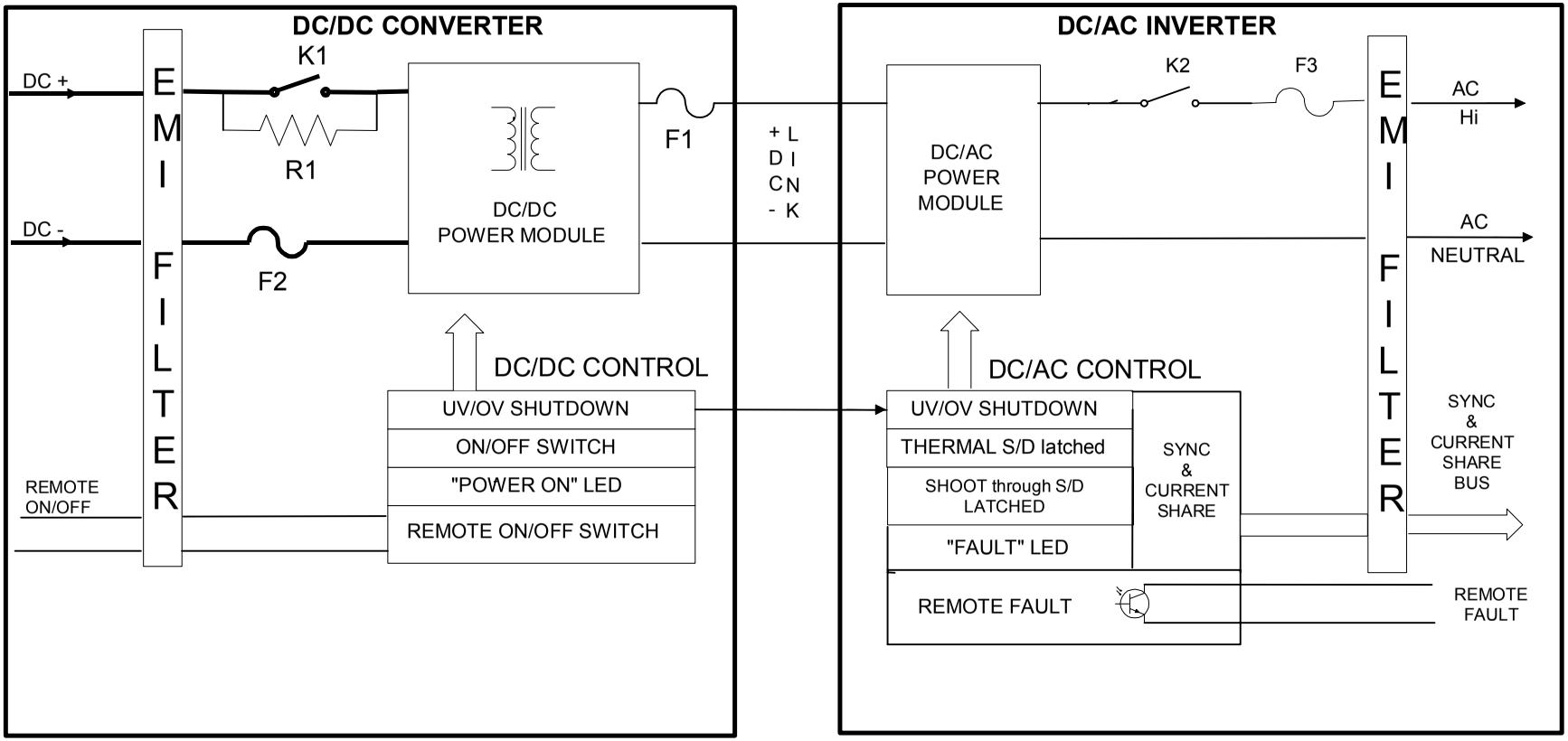
EMI INPUT FILTER

The EMI input filter protects the DC input source by attenuating the high frequency harmonics that are generated by the power switching elements

EMI OUTPUT FILTER

The EMI output filter protects the output load by attenuating the high frequency harmonics that are generated by the power switching elements from within the Inverter.

FIGURE 1- FUNCTIONAL BLOCK DIAGRAM



LCE SET-UP AND INSTALLATION

The LCE set-up and installation is for both the shelf mount and rack mount version. To ensure proper operation for either configuration, the wiring must be in accordance with the desired connections scheme (see Connection Scheme Section).

REAR CONNECTOR PINOUTS

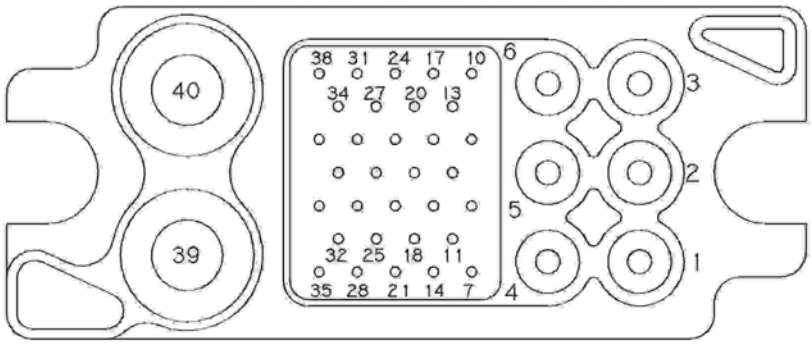
Table 1 lists the functions for each Pin on the rear connector (Figure 2). Depending on the configuration, different combinations of pin assignments are used. See configuration information.

Function	Pin No.	Notes
• AC High 120V	1	To Load Used only with
• AC Neutral 120V	3	120Vac units (LCE15-48-120 or LCE10-24-120)
• AC High 220V	4	To Load Used only with
• AC Neutral 220V	6	220Vac units (LCE15-48-220 or LCE10-24-220)
• Neutral for Control	7	Used with all arrangements
• Trigger In	8	Input Synchronization Signal
• Trigger Out 0 °	9	Parallel Operation
• Trigger Out 120 °	10	'Y'-Connections
• Trigger Out180 ° (standard)	11	120/220 V operation
• Trigger Out 60	11	Open Delta connection
• Current Sharing	12	Parallel Operation
• DC Plus	39	Used with all arrangements
• DC Return	40	Used with all arrangements
• On/Off Plus	32	Remote Control Access
• On/Off Minus	35	Remote Control Access
• Fault	36	Fault Signal Output
• Fault Rtn	34	Fault signal return
• Chassis Ground (Safety Ground)	2 & 5	Frame Ground Reference (Safety Ground)

* Note: See section on "Grounding"

Table 1 - Rear Connector Pinouts

(Mates with Elcon p/n 242-27-01100)



GROUNDING

1. The chassis ground terminals (pins 2 and 5 of the connector) must be connected to safety ground. The grounding strip shall withstand the rated inverter current.
2. The inverter input and output terminals are isolated from each other and from the inverter chassis. For reliable and safe operation, please follow the grounding instructions below:

   2a. *Grounding on the output terminals:* When left ungrounded, the output terminals (Line & Neutral) have the same potential with respect to the inverter chassis (60VAC for 120V unit and 110VAC for 220V unit). It is customary in the United States, 120VAC distribution system, to ground the neutral terminal. To minimize the local loop noise, it is recommended to ground the neutral at the point of use. If required, the user can also connect the neutral output terminal to the inverter chassis and safety ground.

   2b. *Grounding on the input terminals:* The LCE inverter is designed to operate from either the Negative or Positive ground bus. The most common applications are:

   (i) The telecom application with negative 48V bus, where the positive terminal is grounded.

   (ii) The telecom application with positive 24V bus, where the negative terminal is grounded.

   There is no need to ground any of the input terminals if the unit is operating from a grounded positive or negative bus. In applications where the input DC bus is floating, it is recommended to ground the positive input terminal for 48V applications or negative input terminal for 24V applications.

WIRING

The wiring requirements for the rear mating connector are defined in this section and as defined in table 1. Only use wires approved by the relevant safety / regulatory agency.

Wiring - Lengths & Gage

When interconnecting the "AC neutral" outputs from each unit, to a "Neutral Bus" and to each other, it is very important to keep the cabling lengths as short and as equal as possible. It is also important to use the same gage wires. These actions will provide an impedance that is as small and as equal as possible. Pin No.3 (pin No.6 for 220V LCE), on the rear connector, provides access to the AC neutral for each unit.

Wiring - Insulation Requirements

The remote "ON/Off" signal pins (No. 35) for each unit have galvanic connection to the DC minus pin (No.40). Reinforced insulation is provided, within the unit, between the ON/OFF signal, control leads, and the power leads. Similar reinforced insulation must also be provided for wiring outside the unit.

Wiring - Insulation for the Remote Fault Signal Wiring

The "Remote Fault Signal" wires are totally isolated from all other wires within the unit (via an opto-isolator). Reinforced insulation must also be provided for the Remote Fault Signal wiring outside the unit.

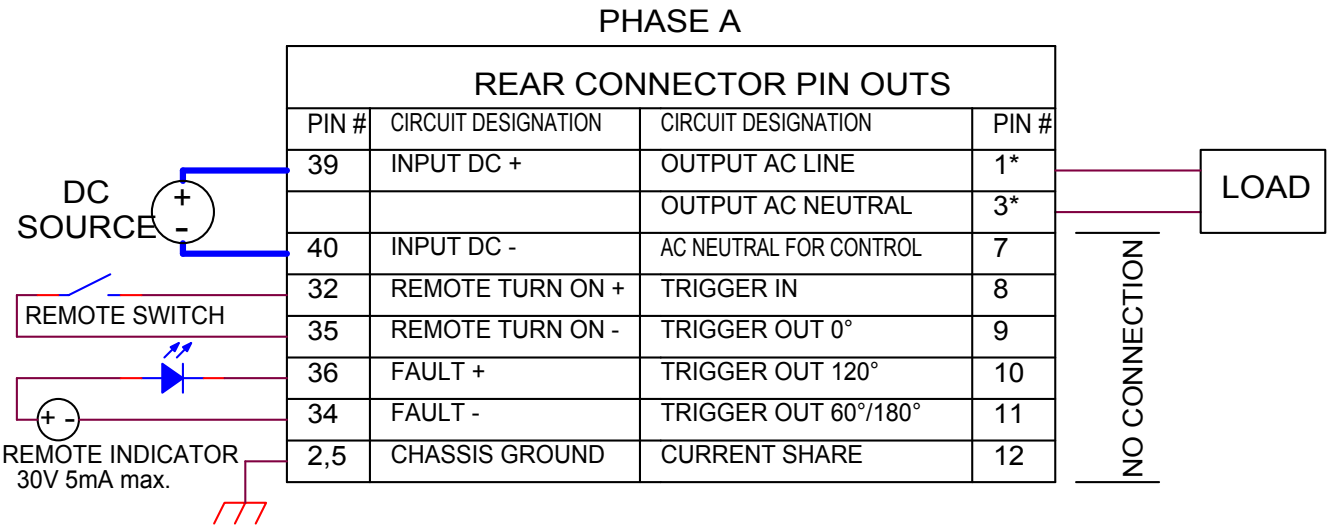
Fault signal output is an open collector of optocouple transistor.
The maximum current and voltage for fault signal output are 5mA and 32V.
User shall provide power supply and limiting resistor.
In reality the fault signal represents the OK status of inverter:

Inverter OK – optocouple transistor is closed,
Inverter fault or no input power – transistor is opened.

The Mating connector 242-27-01100 is a connector housing only (reference Figure 1 for pin-out location).

PIN#	DESC.	CONTACT	RATING	PART #	TERMINATION
1, 3	120VAC Out	#12 standard	250V/35A UL/TUV	702-32-01107	Crimp
			250V/25A CSA	708-21-01107	Solder cup
		#12 hot plug	120V/35A UL/TUV	708-73-01109	Crimp
			250V/25A CSA	708-76-01109	Solder Cup
4, 6	220VAC Out	#12 standard	250V/35A UL/TUV	702-32-01107	Crimp
			250V/25A CSA	708-21-01107	Solder cup
		#12 hot plug	250V/25A CSA	708-73-01109	Crimp
				708-76-01109	Solder Cup
39, 40	DC Input	#4	250V 125A UL/TUV	712-81-01107	Crimp
			250V/100A CSA	712-85-01107	External thread
				706-0113-01107	Internal thread
7,38	Control Bus	#20	250V/5A UL/TUV	702-92-01109	Crimp
			250V/4A CSA	708-66-01109	Solder cup
2,5	Safety Gnd	#12 Standard	250V/5A UL/TUV	702-32-01107	Crimp
			250V/4A CSA	708-21-01107	Solder cup
		#12 Hot Plug	250V/5A UL/TUV	708-73-01109	Crimp
			250V/4A CSA	708-76-01109	Solder cup

Table 2- Connector Wiring Definition



* For 220VAC units use pin 4 in place of pin 1 and pin 6 in place of pin 3

Figure 2 - Wiring: Stand Alone Unit

CONNECTION SCHEMES

Multiple LCE series inverters can be interconnected in different configurations depending on the user's needs. The types of interconnection arrangements are as follows:

a) Parallel connection
b) Three-wire Y connection
c) Four-wire Y connection
d) Open Delta (D) connection
e) 120/220 V connection, two or three wires

In addition to the different types of the configurations as shown above, these can also be ganged into groups, acting in parallel. As an example, a "Three-wire Y-Connected" group (3 units) can be connected in parallel with another "Three-wire Y-Connected" group to provide twice the output power rated for each individual group. The other arrangements produce the same general results.

The major concerns for the user are the intra-synchronization connections within each group and the inter-synchronization interconnections between groups. The details for interconnecting the different configurations are described below.

SYNCHRONIZATION

To optimize system performance and provide a reliable connection, the sources for reference voltages on each unit have to be properly synchronized. Diagrams for the reference voltage sources for each configuration are included with each section covering that specific configuration.

A digitally controlled crystal oscillator provides a sinusoidal reference voltage V_R operating at a factory set 50 or 60 Hz. Each unit has one Trigger Input (Pin No. 8) and three Trigger Outputs (Pins 9, 10, & 11) used for synchronization. All pins are accessed from the rear connector (reference Figure 1).

a) Rear connector pin No. 9 provides an Output Sync signal at zero (0) degrees, used with Parallel connections

b) Rear connector pin No. 10 provides an Output Sync signal at 120-degrees, used with Y-connections.

c) Rear connector pin No. 11 provides an Output Sync signal at 60-degrees, used with Open Delta connections (OPTION /D- see specification).

d) Rear connector pin No 11 provides an output Sync signal at 180-degrees, used with 120/240V connections.

Parallel Synchronization

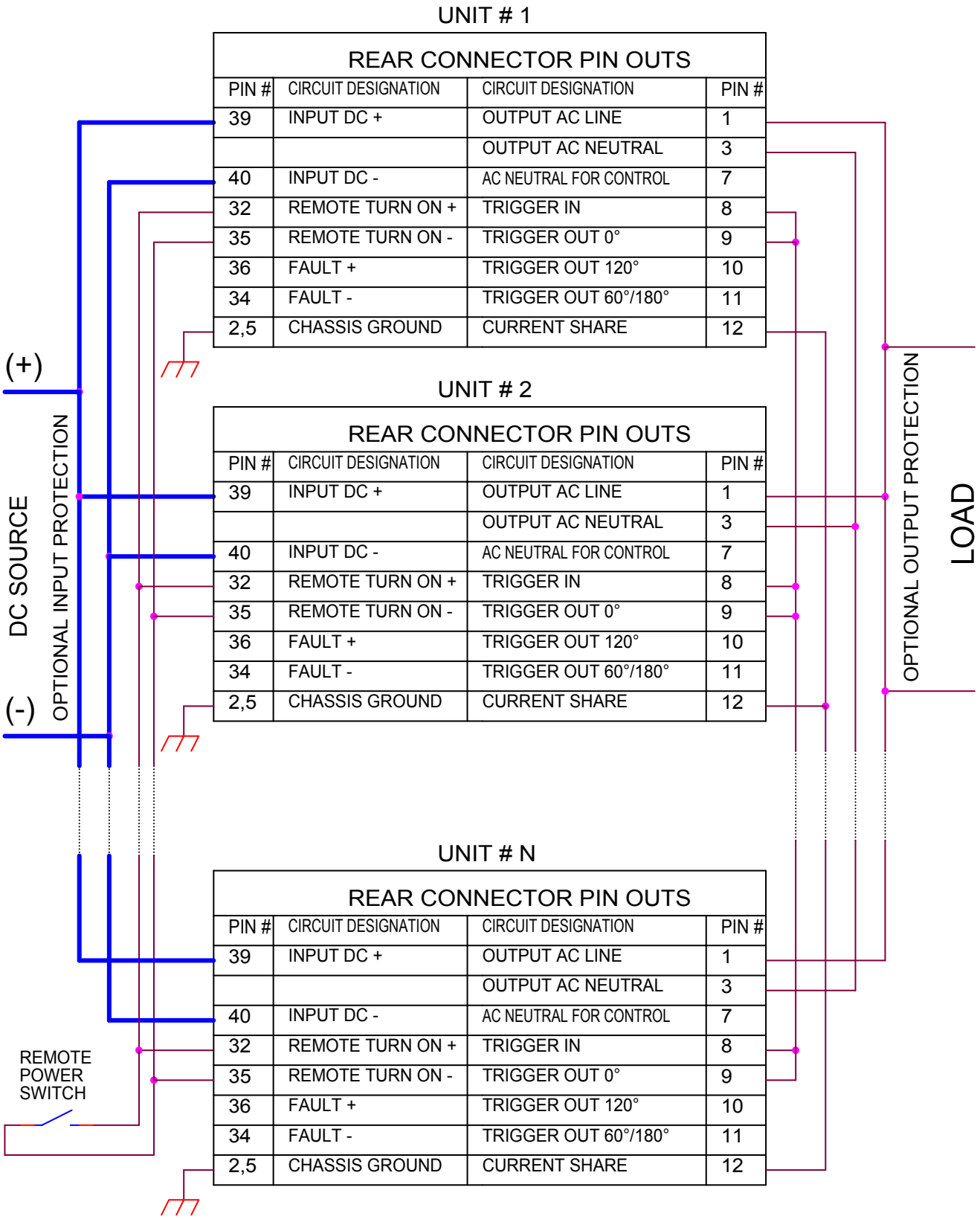
For parallel operation of N units, the inputs of all units (Trigger In) must be connected in parallel with (Trigger Out, zero degrees) of each unit. This will assure that all the units will be synchronized with each other.

Interconnections for Parallel Synchronization

Function	Unit No. 1	Unit No. 2 ---	Unit No. ------ N	Also Connected To
	Pin No.	Pin No.	Pin No.	
AC High	1*	1*	1*	Load
AC Neutral	3*	3*	3*	Load
Trigger In	8	8	8	Trigger out 0 Degrees
Trigger out 0 Degrees	9	9	9	Trigger in
Current Sharing	12	12	12	
DC Plus	39	39	39	DC Source +
DC Return	40	40	40	DC Source –
On/Off Plus	32	32	32	Remote Control Switch
On/Off Minus	35	35	35	Remote Control Return
Chassis Ground	2,5	2,5	2,5	Frame Ground

Table 3 - Wiring: Parallel Synchronization

* For 220VAC units use pin 4 in place of pin 1 and pin 6 in place of pin 3.



For 220VAC units use pin 4 in place of pin 1 and pin 6 in place of pin 3

Figure 3- Parallel Connection of 'N' Units

'Y' Connection Synchronization

The synchronization arrangement for Y-connection (three or four wire) with three units (one group) is as follows. The Trig Out 120° of the first unit (Phase-A) must be connected to Trig In of the second unit (Phase-B). The Trig Out 120 ° of the second unit (Phase-B) must be connected to Trig In of the third unit (Phase-C). This arrangement will provide a phase difference of 120-degrees between each phase.

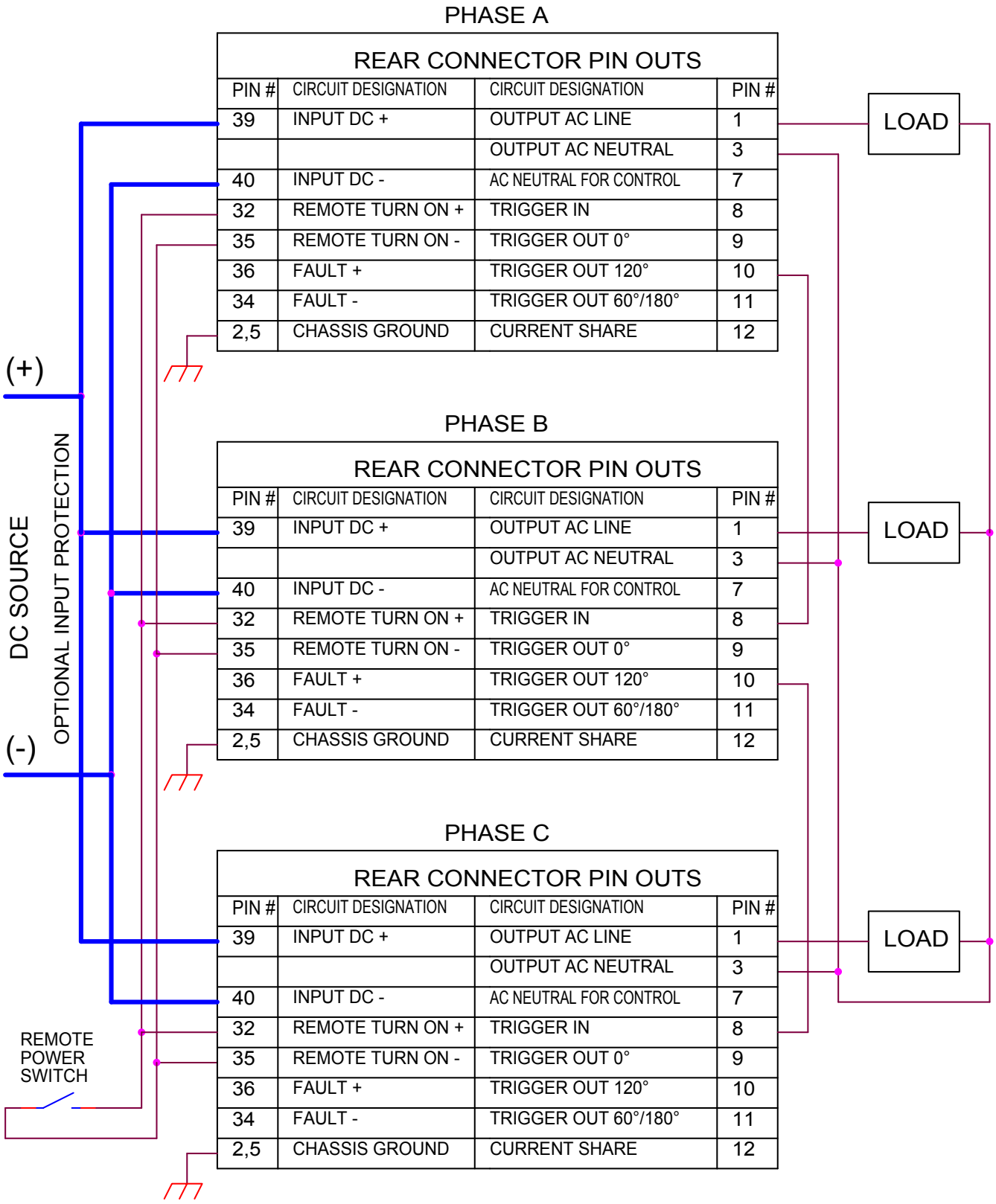
Each Phase of the Y connection can be made up of N units connected in parallel. These parallel units must be connected as per parallel-synchronized units described in the previous section, additionally all the Trig out 120° of each group, must be connected together.

Interconnections for Y-Synchronization

	Unit No.	**Unit No.**	**Unit No**.	
Function	**1**	**2**	**3**	**Also Connected To**
	Pin No.	Pin No.	Pin No.	
AC High	1*	-	-	Phase "A" Load
AC High	-	1*	-	Phase "B" Load
AC High	-	-	1*	Phase "C" Load
AC Neutral	3*	3*	3*	Neutral
Trigger out (120 Degrees)	10	8	-	
Trigger out (120 Degrees)	-	10	8	
DC Plus	39	39	39	DC Source +
DC Return	40	40	40	DC Source -
On/Off Plus	32	32	32	Remote Control Switch
On/Off Minus	35	35	35	Remote Control Return
Chassis Ground (Safety Ground)	2,5	2,5	2,5	Frame Ground (Safety Ground)

Table 4 - Wiring: Y- Synchronization

* For 220VAC units use pin 4 in place of pin 1 and pin 6 in place of pin 3



For 220VAC units use pin 4 in place of pin 1 and pin 6 in place of pin 3

Figure 4 - 'Y' Connection of Inverters

Open-Delta Connection Synchronization

Multiple units with a 60-degree phase lag (/D option) can be connected in an Open Delta configuration as shown in Figure 5. For this arrangement the Trig Out 60° of the first unit (Phase A) must be connected to the Trig In of the second unit (Phase B). This arrangement will provide a 60-degree phase lag of the second unit with respect to the first unit.

Each Phase of the Open Delta connection can be made up of N units connected in parallel. The parallel units must be connected as per parallel-synchronized units described in a previous section. Additionally, all Trig Out 60° from the Phase I units must be connected in parallel.

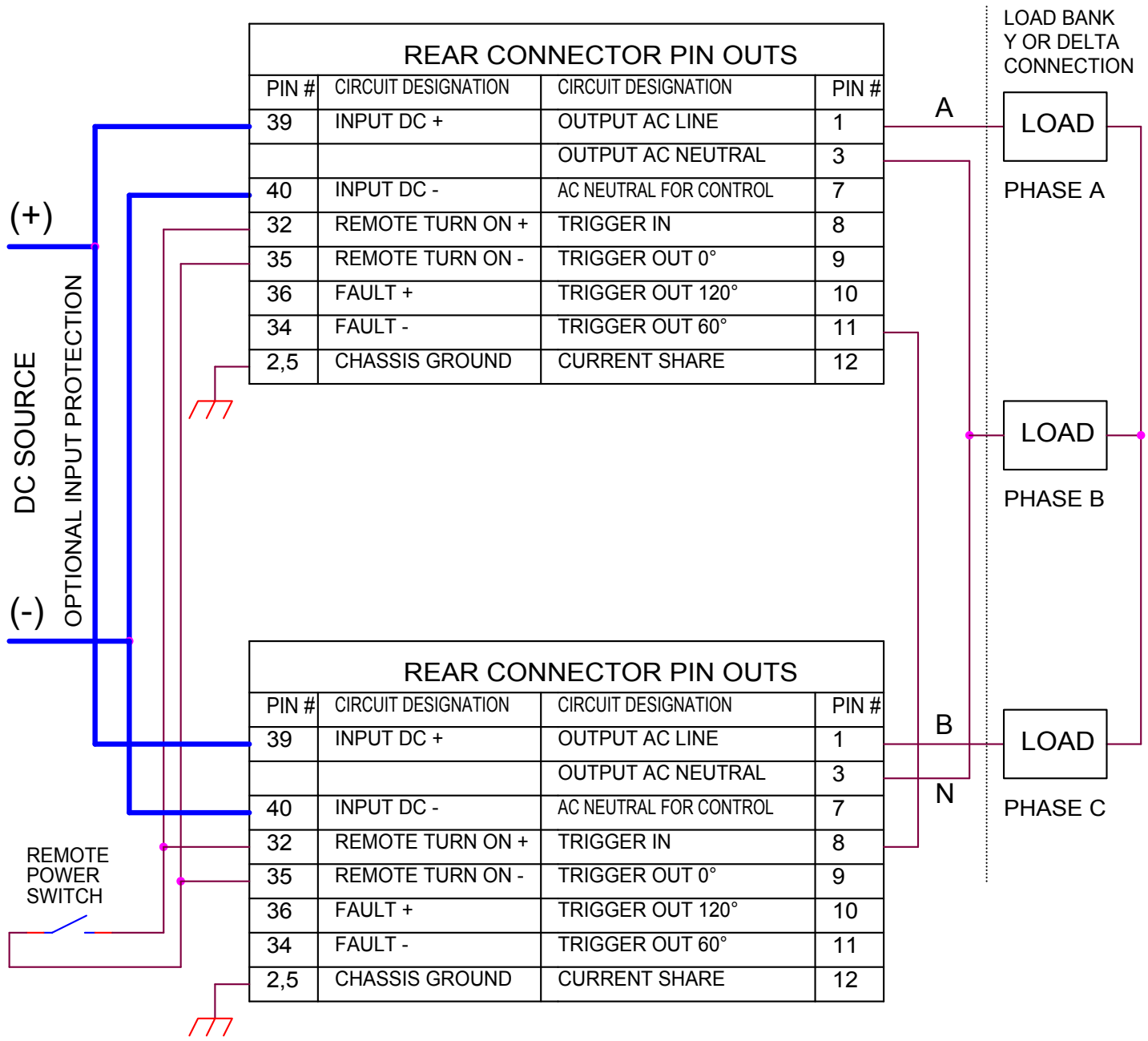
Interconnections, Open-Delta

Function	Unit No. 1	Unit No. 2	Also Connected To
	Pin No.	Pin No.	
AC High	1*	-	Phase "A" Load
AC High	-	1*	Phase "B" Load
AC Neutral	3*	3*	Phase “C” Load
Trigger Out (60/Degrees)	11	8	
DC Plus	39	39	DC Source +
DC Return	40	40	DC Source -
On/Off Plus	32	32	Remote Control Switch
On/Off Minus	35	35	Remote Control Return
Chassis Ground (Safety Ground)	2,5	2,5	Frame Ground (Safety Ground)

Table 5 - Wiring: Open Delta Synchronization

Note: The 60° configuration must be ordered with the /D option.

* For 220VAC units use pin 4 in place of pin 1 and pin 6 in place of pin 3.



REAR CONNECTOR PIN OUTS

PIN #	CIRCUIT DESIGNATION	CIRCUIT DESIGNATION	PIN #
39	INPUT DC +	OUTPUT AC LINE	1
		OUTPUT AC NEUTRAL	3
40	INPUT DC -	AC NEUTRAL FOR CONTROL	7
32	REMOTE TURN ON +	TRIGGER IN	8
35	REMOTE TURN ON -	TRIGGER OUT 0°	9
36	FAULT +	TRIGGER OUT 120°	10
34	FAULT -	TRIGGER OUT 60°	11
2,5	CHASSIS GROUND	CURRENT SHARE	12

REAR CONNECTOR PIN OUTS

PIN #	CIRCUIT DESIGNATION	CIRCUIT DESIGNATION	PIN #
39	INPUT DC +	OUTPUT AC LINE	1
		OUTPUT AC NEUTRAL	3
40	INPUT DC -	AC NEUTRAL FOR CONTROL	7
32	REMOTE TURN ON +	TRIGGER IN	8
35	REMOTE TURN ON -	TRIGGER OUT 0°	9
36	FAULT +	TRIGGER OUT 120°	10
34	FAULT -	TRIGGER OUT 60°	11
2,5	CHASSIS GROUND	CURRENT SHARE	12

For 220VAC units use pin 4 in place of pin 1 and pin 6 in place of pin 3

Figure 5 - Open Delta Connection

120/240 Volt Connection Synchronization

Two units (one group) with a phase lag of 180-degrees can be synchronized in a 120/240-Volt configuration as shown in Figure 6. For this arrangement the Trig Out 180 degrees of the first unit (Phase I) must be connected to the Trig In of the second unit (Phase II). This arrangement will provide a 180-degree phase lag for each unit.

Each Phase of the 120/240 connection can be made up of N units connected in parallel. The parallel units must be connected as per parallel-synchronized units described in the relevant section. Additionally, all the Trig Out 180° of the Phase 1units must be connected in parallel.

Interconnections for 120/240 Volt Connection Synchronization

	Unit No.	**Unit No.**	
Function	**1**	**2**	**Also Connected To**
	Pin No	Pin No.	
AC High	1*	-	High 1
AC High	-	1*	High 2
AC Neutral	3*	3*	Neutral
Trigger out (180 Degrees)	11	8	
DC Plus	39	39	DC Source +
DC Return	40	40	DC Source -
On/Off Plus	32	32	Remote Control Switch
On/Off Minus	35	35	Remote Control Return
Chassis Ground (Safety ground)	2,5	2,5	Frame Ground (Safety ground)

Table 6 - Wiring: 120/240VAC Synchronization

* For 220VAC units use pin 4 in place of pin 1 and pin 6 in place of pin 3.

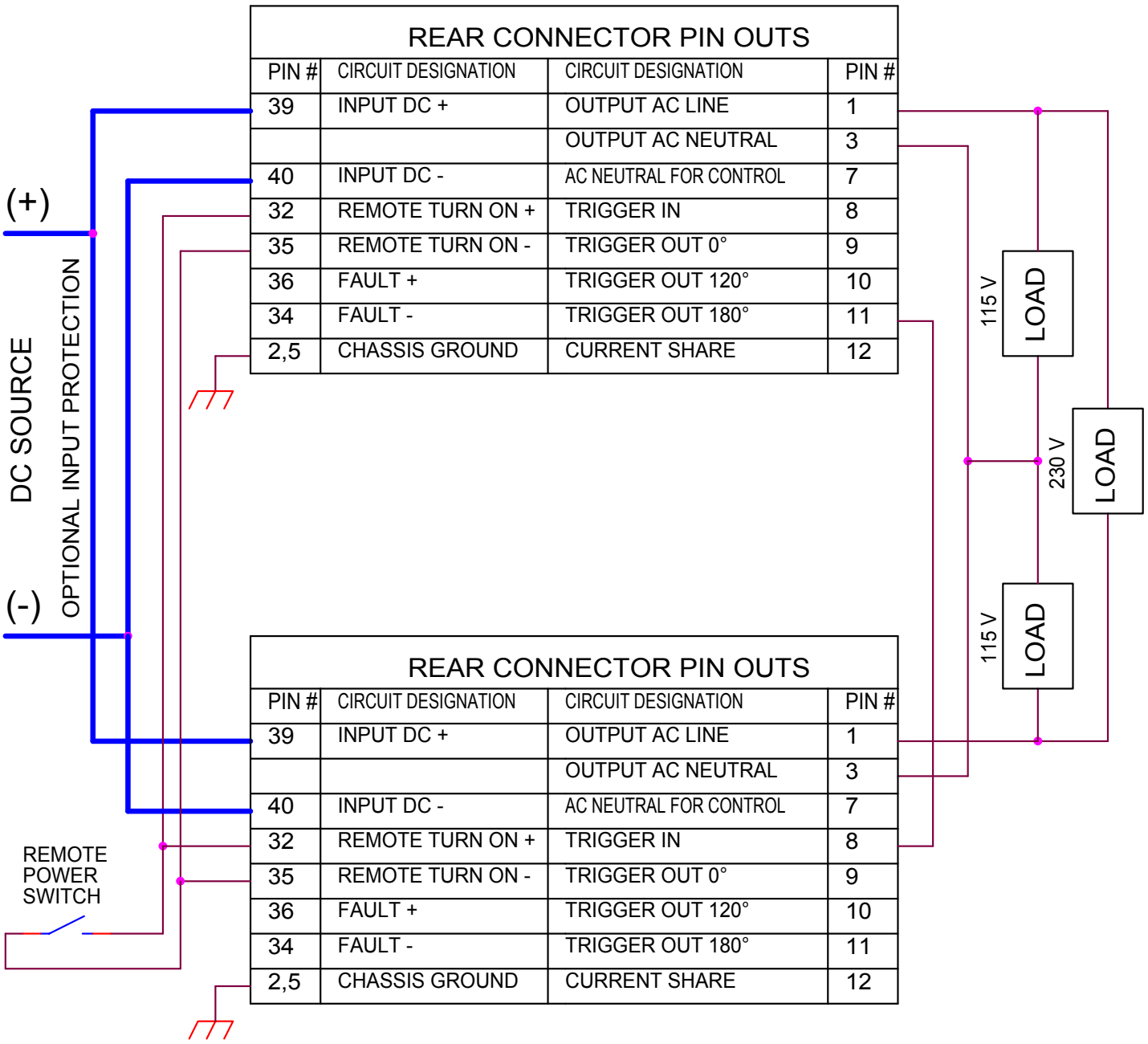


Figure 6 - 120 / 240VAC Connection

TROUBLESHOOTING/TECHNICAL SUPPORT

This section is a basic guide that will enable the user to perform basic level troubleshooting. If the suggested solution does not clear the fault, or if the problem cannot be located, please contact the factory for further assistance.

SYMPTOMS: Green and Red LED's are not activated. Unit or rack cannot be turned "ON".

POSSIBLE CAUSES:

a) Remote ON/OFF switch, connected to pins 32 and 35 of all connectors, is not shorted (disabled).

Short (enable) remote switch

b) The input DC voltage is not enough for normal operation

LCE15-48: Measure the input voltage and verify that the DC input is greater than the 42VDC required for unit activation. If less than 42 VDC, adjust accordingly. This feature is to ensure that the Inverter does not start-up with a "dead" or low battery. Run-down voltage, once activated, is 36VDC.

LCE10-24: Measure the input voltage and verify that the DC input is greater than the 21VDC required for unit activation. If less than 21 VDC, adjust accordingly. This feature is to ensure that the Inverter does not start-up with a "dead" or low battery. Run-down voltage, once activated, is 19VDC.

c) The input DC voltage is more than maximum rated voltage

LCE15-48: Measure the input voltage and verify that the DC input is less than 60VDC for unit activation. If greater than 60VDC, adjust accordingly.

LCE10-24: Measure the input voltage and verify that the DC input is less than 30VDC for unit activation. If greater than 30VDC, adjust accordingly.

d) The input DC voltage is reversed (wrong polarity)

Check polarity of the input DC voltage and reverse if necessary.

SYMPTOMS: Red LED is activated at turn on in one unit, or in all units in the rack.

POSSIBLE CAUSES:

a) Wrong connection of the output wires to the terminal blocks

Verify that the output connector wiring is in accordance with the appropriate rack schematic as specified in the wiring section of this manual. The AC neutral

outputs of all Inverters in the rack are tied together at the rack terminal block. **Never disconnect AC neutral outputs. Inverters will be damaged**. AC Hi outputs shall be connected together on the other terminals of the terminal block. The load shall be connected externally to the AC Neutral and AC Hi outputs.

b) Error in rack wiring

Verify that output connector wiring is in accordance with the appropriate rack schematic as specified in the wiring section of this manual. If there are multiple units then remove all units from the rack except one. Disconnect the load and turn “ON” one unit. If the Red LED is not illuminated then continue to insert units into the rack until the faulty Inverter is isolated. Once isolated, swap a known "good" Inverter with the faulty Inverter. If the LEDs are consistent with rack position then check rack wiring, if not then replace the faulty Inverter.

c) Overload or short circuit at the output.

For an overload condition, ensure that inverters are not overloaded beyond their rating. Enable the inverters at minimum load or at no load.

For a short circuit: Short circuit current of the individual inverter is approximately 38 Amps RMS for 10 seconds (20 Amps for 220V unit). After 10 seconds, the current decreases to approximately 1 Amp. The inverters attempt to recover from short circuit mode every 8 seconds. For a rack with multiple units, the load (after short circuit) shall be minimal or no load.

d) Over temperature shutdown

Ensure that the outside temperature is below 55 °C. Ensure that the fan is running and the front panel is not blocked. If over temperature shutdown occurs, it will lock-up the inverter. To remove the locked condition, the following steps must be completed:

(i) The temperature inside unit must be less than 55°C for turn on after over temperature shutdown.

(ii) After the temperature is less than 55°C, the Unit should be turned off by the remote switch or via the input circuit breaker. The unit cannot be turned on again until input power is disabled for at least one minute and the internal capacitors discharge.

SYMPTOMS: Red LED flickers in one unit (or on all units in a rack).

POSSIBLE CAUSES:

a) Overload

Ensure that Inverters are not overloaded beyond their rating. Ensure that the crest factor of load current is below 2.8 (ratio of peak current to RMS current). Decrease output load accordingly.

b) Turning off one unit in a rack

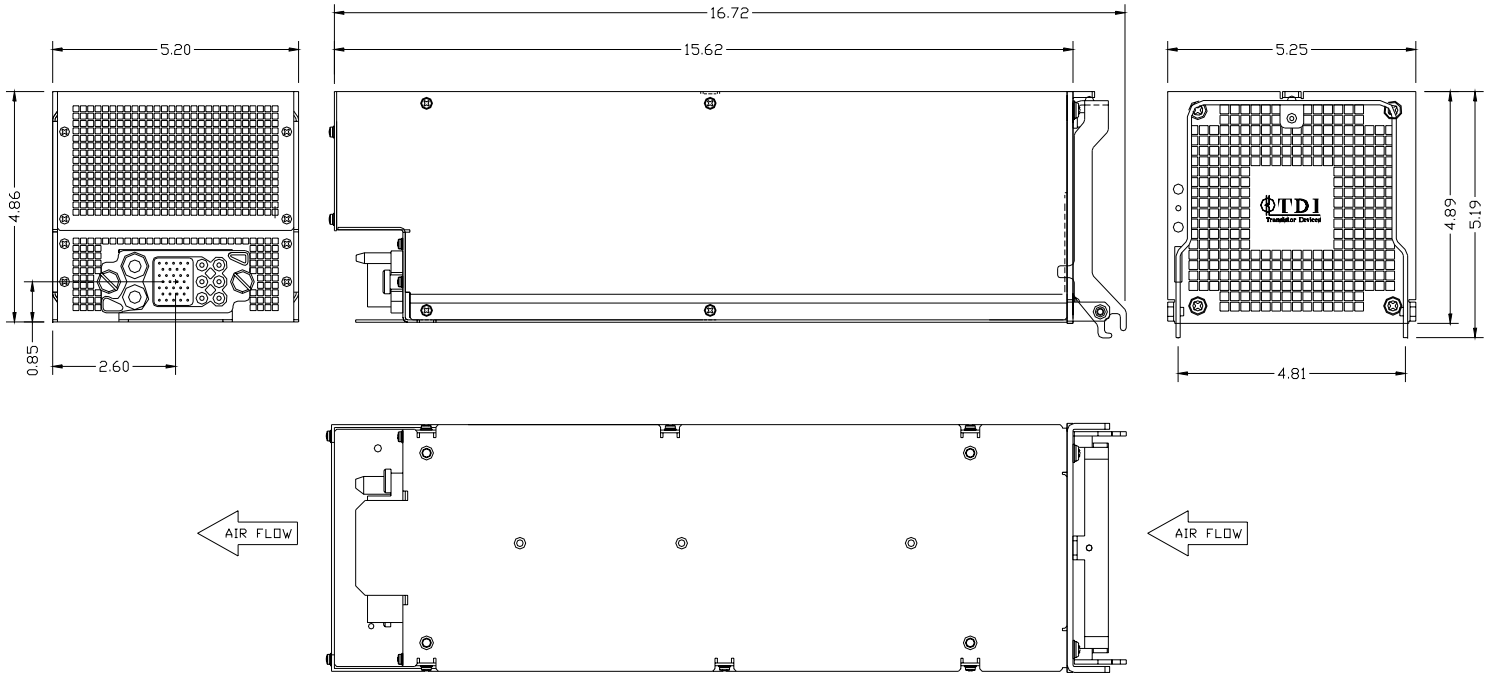
If one unit in the rack is turned off by the remote switch or input circuit breaker the red LED's in the other units can flicker for approximately one minute. This is not a failure.

FCC DISCLAIMER

NOTE: This equipment has been tested and found to comply with limits for a class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case user will be required to correct the interference at his own expense.

APPENDIX A

LCE OUTLINE DRAWING



REVISION HISTORY

Revision	Description	Date
A	Revised per ECN 51800	9/19/01
B	Revised per ECN 51803	9/27/01
C	Revised per ECN 52065	3/03/03
D	Revised to -H Module Per ECNXXXXX	TBD