SEMI F47 Compliance Certificate
EPRI PEAC Corporation PQ Star^{sm} Test Program

Certification Date: November 12th, 2003

PQ Star^{sm} Reference Number
SEMIF47.072

Manufacturer:

Product: *Voltage Dip Compensator(VDC)*
120 V_{ac}, 1-phase, 1kVA amps

Model Number: VDC S1K
Serial # 03-0009
Mfd Date:8/28/03
F/W Ver. 1.0

See Attachment C for SEMI F47 Description.

Test Configuration: *The 120Vac 1kVA VDC* was tested with a simulated industrial load using SEMI F42 compliant voltage sag generator equipment and installed according to SEMI F42. See Attachments A through D for details.

Test Date(s):
September 11th, 2003

Test Location:
EPRI PEAC Corporation
942 Corridor Park Blvd
Knoxville, TN 37932

Electrical Environment:
120V_{ac} Single-Phase, 60Hz.
(See Attachment A for details)

This letter and subsequent documentation certifies that the Dip Proofing Technologies 120Vac 1kVA VDC, in the specified test location and electrical environment, has been voltage sag tested per the **SEMI F42** test protocol and was found to comply to the **SEMI F47** voltage sag immunity standard. This certification remains valid as long as no component substitutions are made.

Certified by,

Mark Stephens, P.E.
Manager
SEMI F47 Compliance Program

120Vac, 1kVA VDC

Attachment A – SEMI F47 Test Results

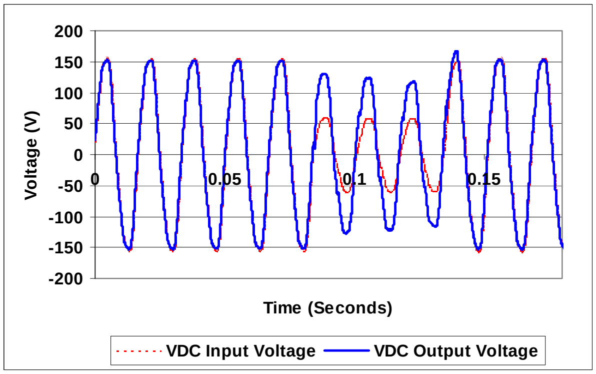
Testing was performed at the EPRI PEAC laboratory in Knoxville, TN. The test protocol used was SEMI F42 Test Method for Semiconductor Processing Equipment Voltage Sag Immunity. The VDC was loaded to 100% load with a power factor of 0.75 at 60 Hz.

Table A-1 list all points tested per SEMI F42 test method. The outcome column describes the status of the VDC and load as a result of the corresponding voltage sag event. For information about the Industrial Load Bank (ILB), see Appendix D.

Table A-1 120V_{ac} 1kVA VDC Voltage Sag Tabular Test Results

%Va	Duration	DUT Mode Process State	Results 60 Hz
40	0.05	Simulated Load with ILB	Dropped sensitive components in ILB
45	0.05	Simulated Load with ILB	No effect
45	0.20	Simulated Load with ILB	Dropped sensitive components in ILB
45	0.50	Simulated Load with ILB	Dropped sensitive components in ILB
45	0.50	Simulated Load with ILB	Dropped sensitive components in ILB
50	0.20	Simulated Load with ILB	No effect
50	0.05	Simulated Load with ILB	No effect
70	0.50	Simulated Load with ILB	No Effect
80	1.00	Simulated Load with ILB	No Effect

Figures A-1 and A-2 show the results of the sag applied to the VDC and its response to voltage sags below the SEMI F47 line. It should be noted from these figures that the VDC was able to maintain the output voltage within 10% of the nominal voltage.



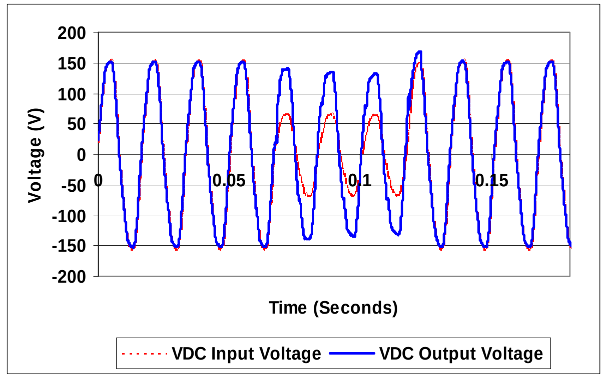
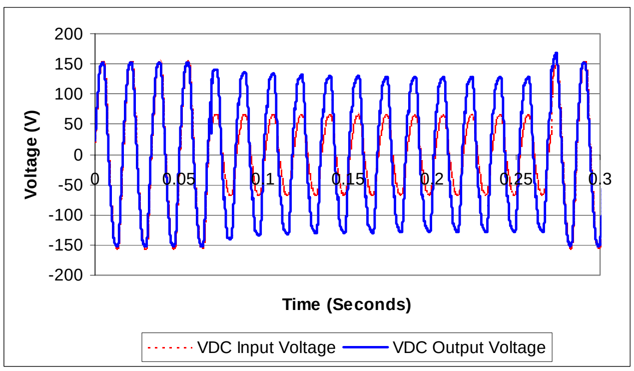


Figure A-1 VDC Input and Output Voltage Waveforms: 0.05 millisecond sag down to 40% of nominal Voltage(Left), 0.05 millisecond sag down to 45% of Nominal Voltage (Right)



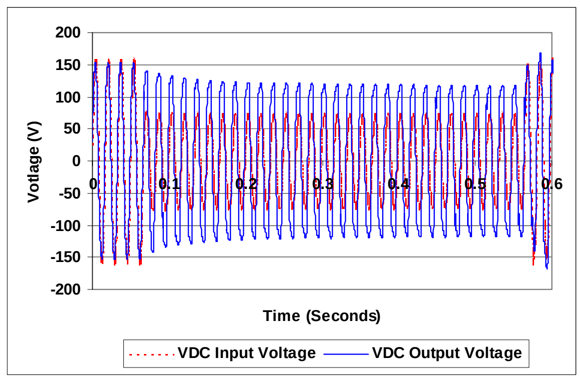


Figure A-2 VDC Input and Output Voltage Waveforms: 0.2 second sag down to 45%of nominal voltage (Left), 0.2 second cycle sag down to 45% of nominal voltage (Right)

Figure A-3 shows the SEMI F47 curve (solid line) along with the performance curve of VDC at 60 Hz with the ILB load bank.

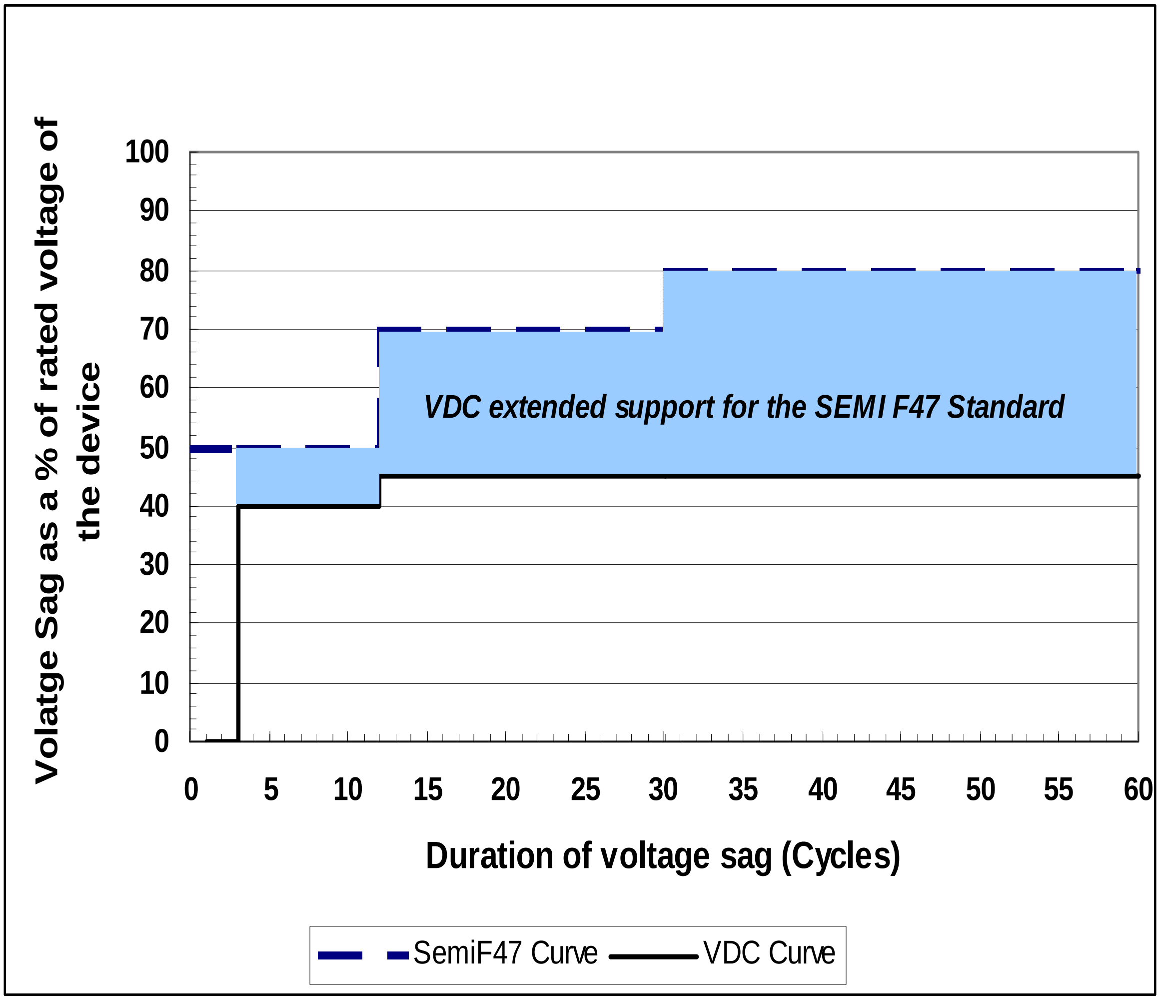


Figure A-3 – SEMI F47 Curve vs. VDC Response with ILB Load Bank

Electrical Environment

Steady state measurements were taken prior to testing. Table A-2 list measurements taken to characterize the electrical environment of the VDC prior to SEMI F47 compliance testing.

Table A-2 Steady State Measurements Main

Measurement Parameters:	Test Process State 60 Hz
Rated Voltage P-N	120 V
Voltage (Va-n)	120V
Current (Ia)	8.5A
Power (Wa-n)	765W
Volt Amps (VA)	1020
Vthd (Total)	5.7%
Ithd	68.5%
Power Factor	0.75
Hertz	60

Attachment B - Test Configuration

Test Configuration

The SEMI F42 compliant voltage sag generator was placed in series with the main power feed, in according with SEMI F42 and shown in Figure B-1.

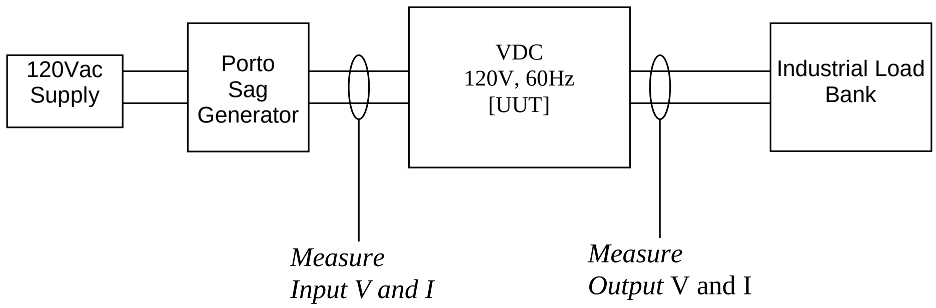


Figure B-1 – Test Configuration (See Attachment D for description of the ILB)

Attachment C - SEMI F47 Abstract

The SEMI F47 "Specification for Semiconductor Processing Equipment Voltage Sag Immunity" document defines the threshold that a semiconductor tool must operate without interruption (per SEMI F42) and it also provides a target for the facility and utility systems. The Recognizing semiconductor factories require high levels of power quality due to the sensitivity of equipment and process controls and that Semiconductor processing equipment is especially vulnerable to voltage sags, this document defines the voltage sag ride-through capability required for semiconductor processing, metrology, and automated test equipment.

The requirements in this international standard were developed to satisfy semiconductor industry needs. While more stringent than existing generic standards, this industry-specific specification is not in conflict with known generic equipment regulations from other regions or generic equipment standards from other organizations. It is the intent of this standard to provide specifications for semiconductor processing equipment that will lead to improved selection criteria for sub-components and improvements in equipment systems design. While it is recognized that in certain extreme cases or for specific functions battery storage devices may be appropriate, it is not the intent of this standard to increase the size or use of battery storage devices provided with equipment. Focus on improvements in equipment component and system design should lead to a reduction or elimination in the use of battery storage devices to achieve equipment reliability during voltage sag events.

The SEMI F47 document specifies the minimum voltage sag ride-through capability design requirements for equipment used in the semiconductor industry. The expected equipment performance capability is shown graphically on a chart representing voltage sag duration and percent deviation of equipment nominal voltage. The primary focus for this specification is semiconductor processing equipment including but not limited to the following tool types:

- Etch equipment (Dry & Wet)
- Film deposition equipment (CVD & PVD)
- Thermal equipment
- Surface prep and clean
- Photolithography equipment (Stepper & Tracks)
- Chemical Mechanical Polishing equipment
- Ion Implant equipment
- Metrology equipment
- Automated test equipment

The actual SEMI F47 ride-through curve is shown below.

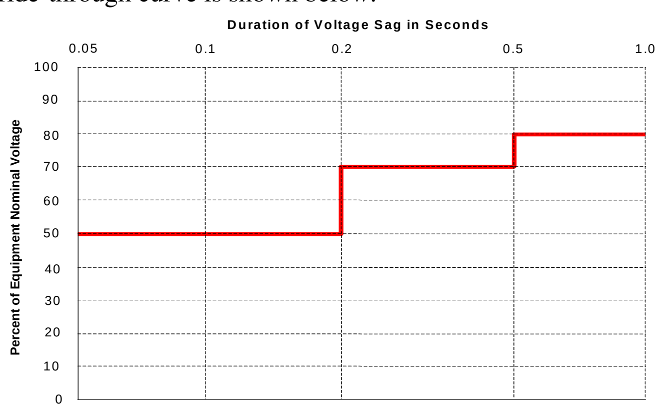


Figure A-1 The SEMI F47 Voltage Sag Ride-Through Curve

The specification states that Semiconductor processing, metrology, and automated test equipment must be designed and built to conform to the voltage sag ride-through capability per the defined curve. Equipment must continue to operate without interrupt (per SEMI E10) during conditions identified in the area above the defined line. In the context of SEMI F47, interrupt means any assist or failure. An assist is defined as an unplanned interruption that occurs during an equipment cycle where all three of the following conditions apply:

- The interrupted equipment cycle is resumed through external intervention (e.g., by an operator or user, either human or host computer).
- There is no replacement of a part, other than specified consumables.
- There is no further variation from specification of equipment operation.

Furthermore, a failure is any unplanned interruption or variance from the specifications of equipment operation other than assists. Although no variation in the tool's process is the goal, this standard addresses these issues as related to the equipment operation only.

Attachment D - Industrial Load Bank (ILB) Test Fixture

The Industrial Load Bank (ILB) was originally created as a permanent fixture to demonstrate the voltage sag susceptibility of support typical control components such as Programmable Logic Controllers (PLCs), relays, contactors, and power supplies and to characterize the ability of single-phase power conditioners to improve immunity of these loads. Used to create a real-life loading environment for power conditioning devices that will be used to demonstrate protection and immunity improvements, the ILB serves as an excellent test platform for evaluating the effectiveness of various power quality mitigation devices

The ILB contains four general-purpose relays, five motor starters, seven contactors, and five DC power supplies (see Table D-1). As in many semiconductor circuits, two of the relays, and four of the contactors are powered by 24 Vac. The remaining power supplies, relays, and contactors are powered by 120 Vac. Power supply loads on the ILB includes those typically found in PCs, semiconductor tool controller I/O applications (power factor corrected, multiple output), and programmable logic controllers. Unregulated and regulated supplies were also included.

The 24 Vac source used in the ILB is derived by stepping down 120 Vac through a 250VA, 500VA, or 1KVA transformer. The transformer is selectable with a 3 position rotary switch on the control panel. The 1kva transformer was utilized for these tests since it exhibited a linear response.

Table D-1, ILB Load Components

Load No.	Name	Voltage (V)	Size	Description
1	CR1	120	10 A	DPDT Relay
2	CR2	120	10 A	DPDT Relay
3	CR3	24	10 A	DPDT Relay
4	CR4	24	5 A	DPDT Relay
5	MS1	120	2 HP @ 230 V	3-Pole Motor Starter
6	MS2	120	3 HP @ 230 V	3-Pole Motor Starter
7	MS3	120	3 HP @ 230 V	3-Pole Motor Starter
8	MS4	120	1.5 HP @ 230 V	3-Pole Motor Starter
9	MS5	120	30 HP @ 230 V	3-Pole Motor Starter
10	MC1	120	10 Amp	4-Pole Contactor
11	MC2	120	10 Amp	4-Pole Contactor
12	MC3	120	3 HP @ 230 V	3-Pole Contactor
13	MC4	24	7.5 HP @ 230 V	3-Pole Contactor
14	MC5	24	10 HP @ 230 V	3-Pole Contactor
15	MC6	24	7.5 HP @ 230 V	3-Pole Contactor
16	MC7	24	40 HP @ 230 V	3-Pole Contactor
17	PS1	120	60 W	PLC Power Supply
18	PS2	120	140 W	Instrument Power Supply
19	PS3	120	200 W	Computer Power Supply
20	PS4	120	500 W	Multi-Output Power Supply
21	PS5	120	40 W	Unregulated Power Supply

A simplified depiction of the ILB test setup is shown in Figure D-1. The ILB utilizes three small PLCs to perform data acquisition and monitoring of the status of the twenty one test loads. Each test device has a dedicated input to the monitoring PLC that is connected across the contacts of each relay, contactor, and starter. If the device under test is energized, the PLC will see a 24 Vdc signal at the test devices dedicated input. If the contacts of the test device open during the sag event, the PLC will flash the corresponding indicator for the effected load, indicating that the device dropped out. There are two different methods of determining the state of the power supplies in the ILB. The output of each power supply is connected across the coil of a general-purpose relay and a potentiometer. The contacts of the relay are then connected to a dedicated input to the monitoring PLC. The potentiometer was adjusted so that the relay would drop out when the output of the DC power supply drops below 95% of its rated voltage. The second method of testing (the method used for this testing) is to connect the input of a PRTES or other metering device to the monitoring jacks on the outside of the panel corresponding the power supply in test as shown in Figure D-2. The monitoring jacks are connected across the output of the power supplies.

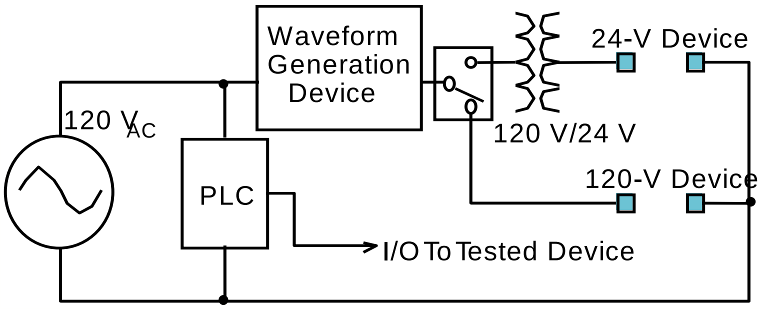


Figure D-1, Simplified ILB Test Setup

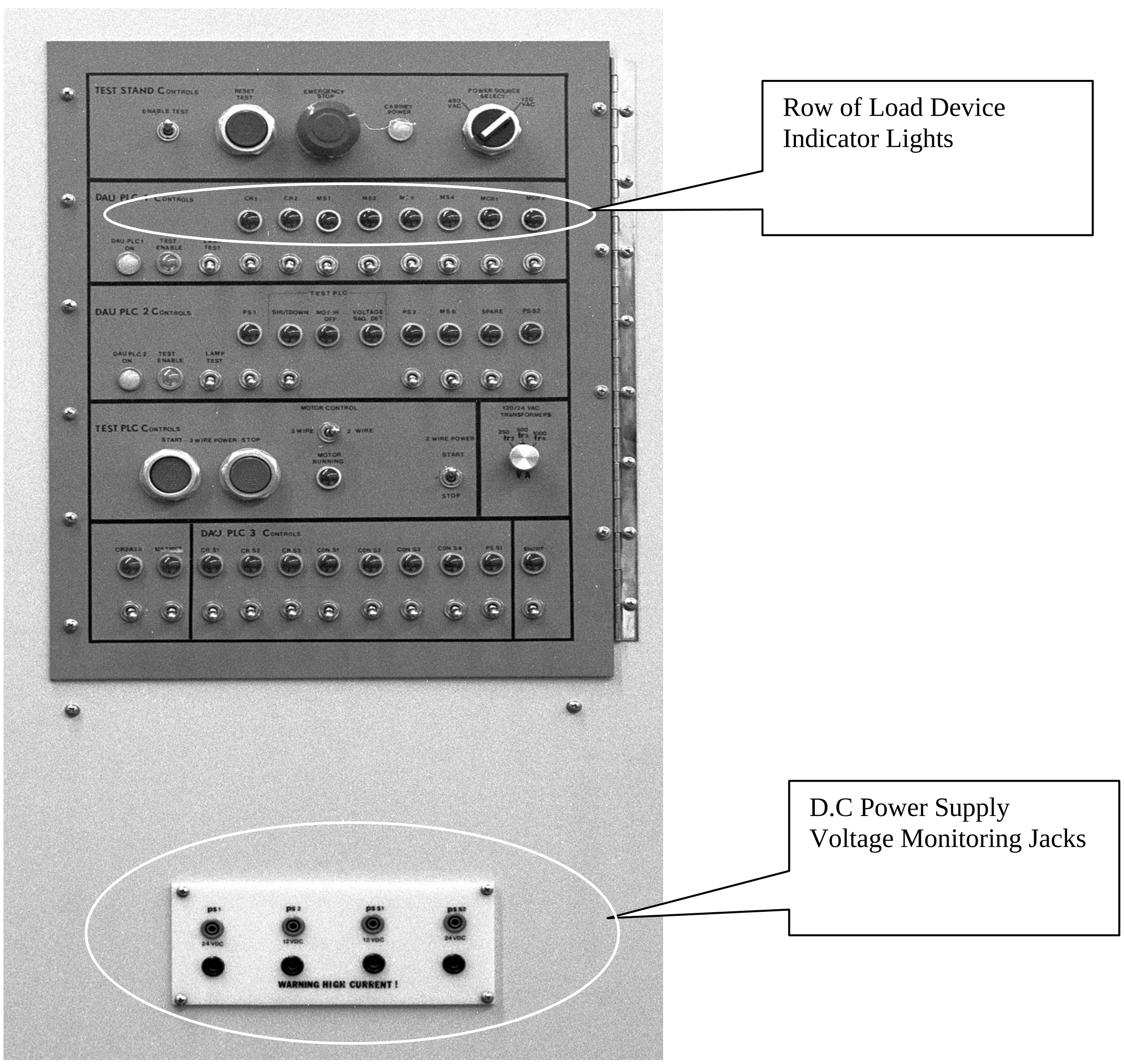


Figure D-2, ILB Control Panel

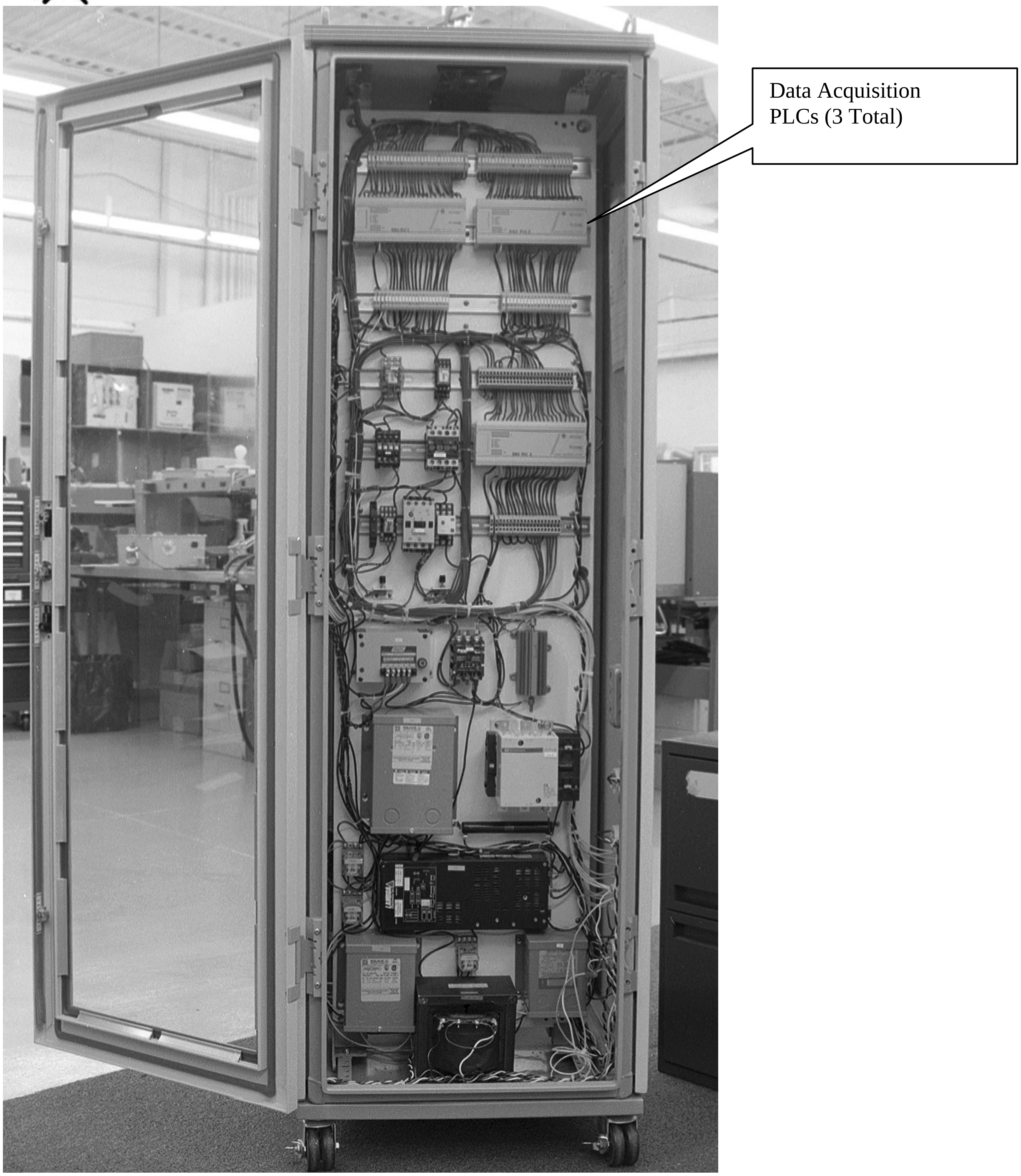


Figure D-3, ILB Component Side A

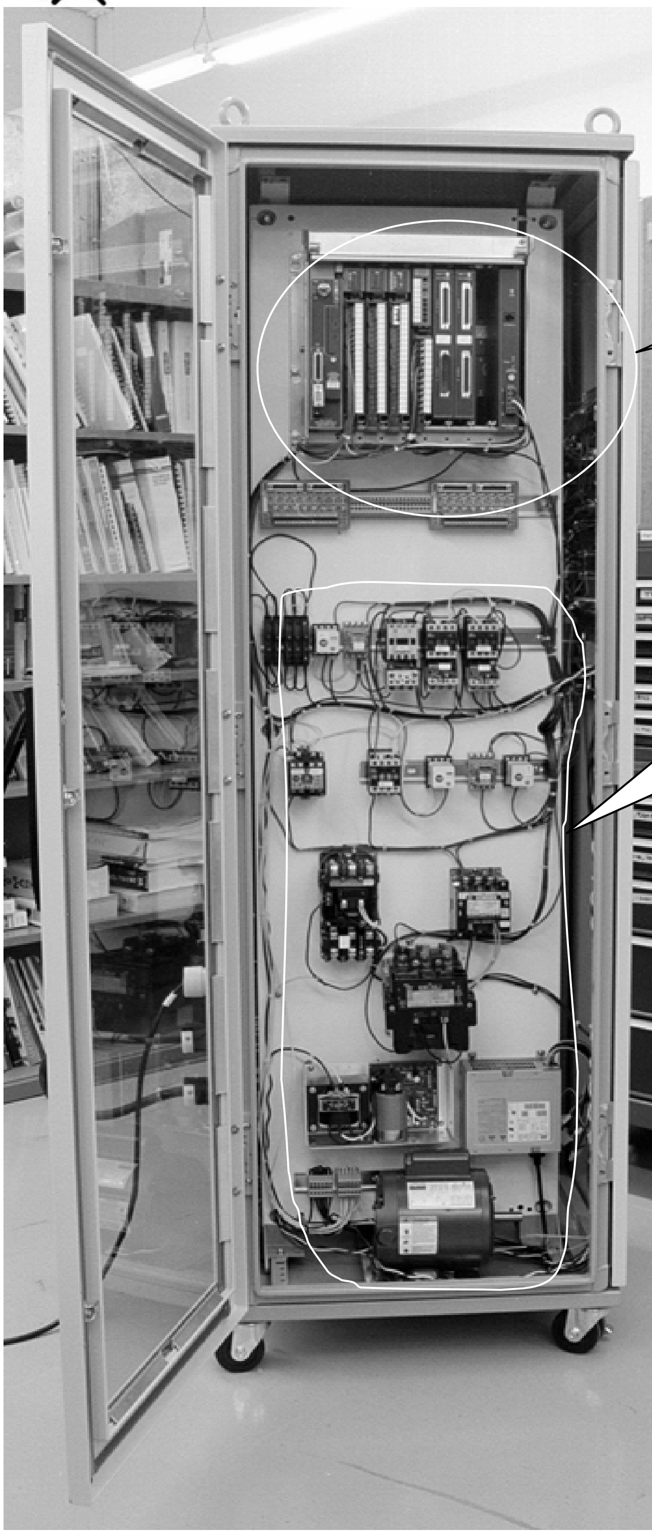


Figure D-4, ILB Component Side B

EPRI PEAC Corporation PQ Star^{SM} Certification for the Semiconductor Industry

Having conducted power quality tests on hundreds of devices and electrical equipment since 1992, EPRI PEAC Corporation is known worldwide for power quality testing expertise. Since April 1997, EPRI PEAC has conducted voltage sag testing on over 64 semiconductor processing tools. In order to serve the semiconductor industry, EPRI PEAC Corporation has established a certification program to test manufacturer equipment per established power quality standards. PQ Star^{sm} certification for the SEMI F47 standard (Specification for semiconductor Processing Equipment Voltage Sag Immunity) is now available for semiconductor equipment suppliers. EPRI PEAC utilizes the SEMI F42 test standard (Test Method for Semiconductor Processing Equipment Voltage Sag Immunity). With the PQ Star certification, EPRI PEAC Corporation offers a third party verification that the equipment tested meets this important new power quality standard.

For more information about the PQ Star^{sm} test program for the semiconductor industry or inquire about testing, contact Mark Stephens at mstephens@epri-peac.com

EPRI PEAC Corporation
942 Corridor Park Blvd
Knoxville, Tennessee 37932
(865)218-8000
www.f47testing.com