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DIRS-4110

Power Supply Shelf

Operation Manual



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1. Specifications

1.1 Input Properties

1.1.1 Rated Input Voltage Range: 90VAC ~ 240VAC, Single Phase (Power derated at Low Line)*

Allowed Input Voltage Range: 85VAC ~ 264VAC (Power derated at Low Line)*

*Note: (DC Output Current derates 0.4%/VAC linearly from 180VAC, down to 85VAC)

1.1.2 Input Frequency Range: 47Hz ~ 63Hz

1.1.3 Power Factor : > 98% (50 ~ 100% load)

1.1.4 Efficiency Rating : > 92% (240VAC input, typical)

1.1.5 Line Regulation: $\pm 0.5\%$ max, across full load range

1.2 Output Properties

1.2.1 Rated Output Voltage: -54.0Vdc

1.2.2 Output Current: Maximum 111A (37A x 3 Modules)

1.2.3 Load Regulation: $\pm 0.5\%$ max, across full input range

1.2.4 Output Distribution: 10 individual circuits (L1-L10; GMT fuses; ~10A each)

1.3 Environmental Properties

1.3.1 Operating Temperature Range: -40°C ~ +65°C

1.3.2 Operating Humidity Range: 10% ~ 90% RH (non-condensing)

1.4 Safety Standards

1.4.1 Lightning Surge: INPUT terminal - EARTH: 1.2/50us, 2KV; between INPUT terminals: 1.2/50us, 1KV

1.4.2 Insulation Resistance: 500Vdc and > 10M Ω

1.4.3 Leakage Current: < 3mA (at rated input and output conditions, as measured via Rectifier Module)

1.4.4 High Frequency Electromagnetic Interference (EMI): EN55022 Level B

1.5 Protection Functions

1.5.1 Output Over-Voltage Protection Function: Blocks output within range of -59.0Vdc ~ -60.0Vdc

1.5.2 Output Over-Current Protection Function: 105% ~ 120% of rated current

2. Installation

2.1 Packing Condition

All power shelf equipment is shipped out using standard packing methods for DongAh rectifier systems.

2.2 Transportation

This power equipment shall be treated with special care as there is possibility of product damage due to severe impact or vibration during transport. Moreover, transporting equipment using car or other non-traditional carrier method must still protect the equipment from rain and other environmental hazards.

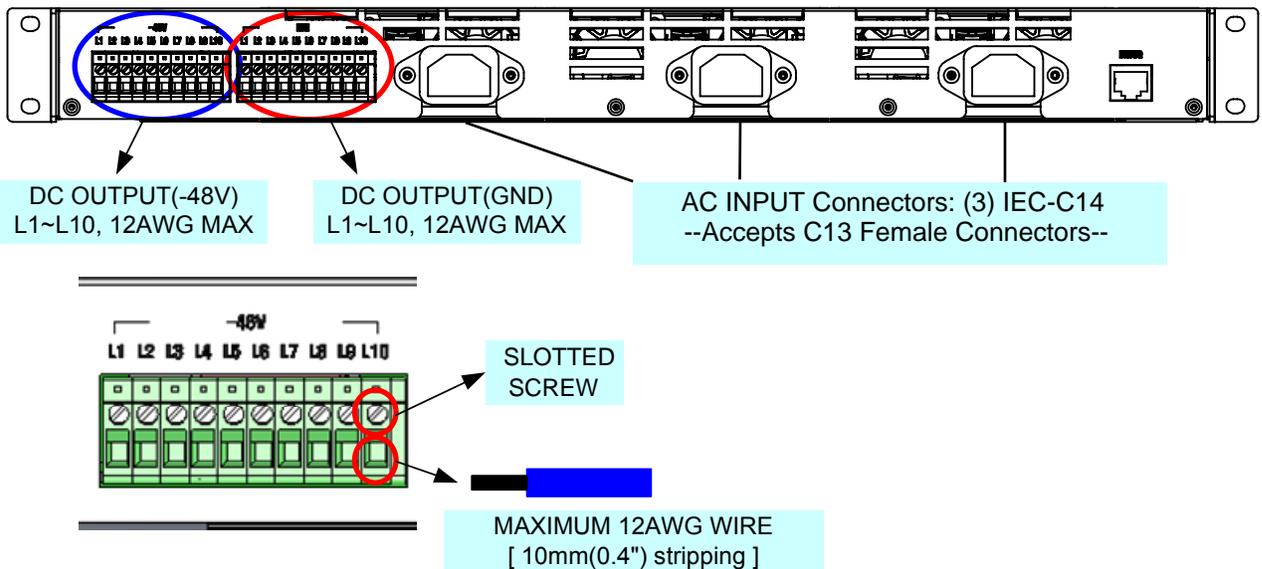
2.3 Packing / Disassembly

Unpack and disassemble the equipment as near as possible to point of installation, and pay attention that no impurities get onto or inside the equipment .

2.4 Wiring and Cable Connections

2.4.1 Connection Diagram of AC Input Connection(s) and Direct Current Output Terminal Block

Connect AC input wiring and output wiring as shown below in Picture 1.

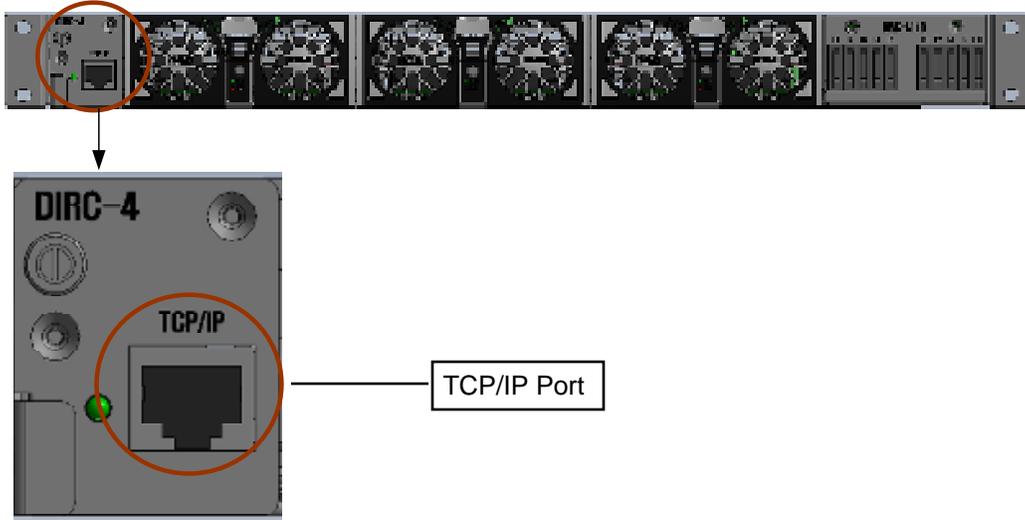


Picture 1. Input/Output Connection Diagram

For AC Input connections, use the IEC-style cords included in the shipment from the factory. AC Input wiring uses IEC-C14 panel-mount male plugs to accept C13 female connectors; cable wire should be 8-10 AWG. DC output connector uses a wire with maximum thickness of 12AWG, and can adjust thickness to less than 12AWG according to output capacity. Connect wires using standard slotted screwdriver.

2.4.2 TCP/IP Connection Diagram

Connect as shown below in Picture 2.

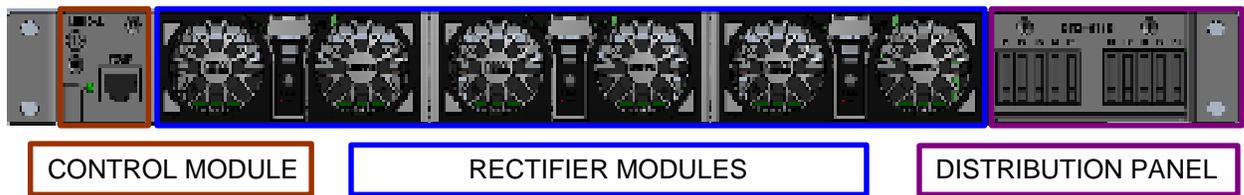


Picture 2. TCP/IP Connection Diagram

TCP/IP PORT is located at the left of the shelf, on the front panel of the DIRC-4 control module and it is used by attaching a standard Ethernet cable to the TCP/IP port.

3. Rectifier System: Shelf Components and Functions

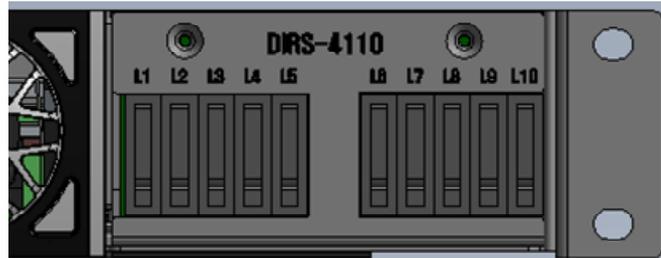
A full Rectifier System consists of (1) 1U Shelf, (1) Control Module, (3) Rectifier Modules, and (1) Distribution Panel. Picture 3 diagrams a 19" Shelf with the DIRC-4 Control Module, (3) DIRS-440 Rectifier Modules, and the Distribution Panel with 10 GMT Fuse locations.



Picture 3. DIRS-4110 Shelf Diagram (Front)

3.1 SHELF (DIRS-4110)

The DIRS-4110 Shelf includes the Control Module, (3) Rectifier Modules, and the Output Distribution Panel. The Distribution Panel, as shown in Picture 4, fits (10) GMT Fuses to protect individual outputs connected via the rear-panel connector.



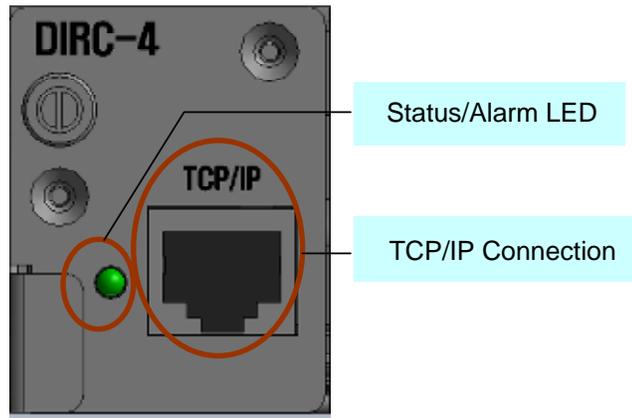
DISTRIBUTION PANEL (front view)
L1 - L10 GMT FUSES

Picture 4. GMT FUSE Diagram (Front)

3.2 Control Module (DIRC-4)

3.2.1 Main Control Module

The DIRC-4 Control Module controls and monitors the status of the rectifier modules. The Control Module also sends all alarms that may occur during Rectifier System operation.

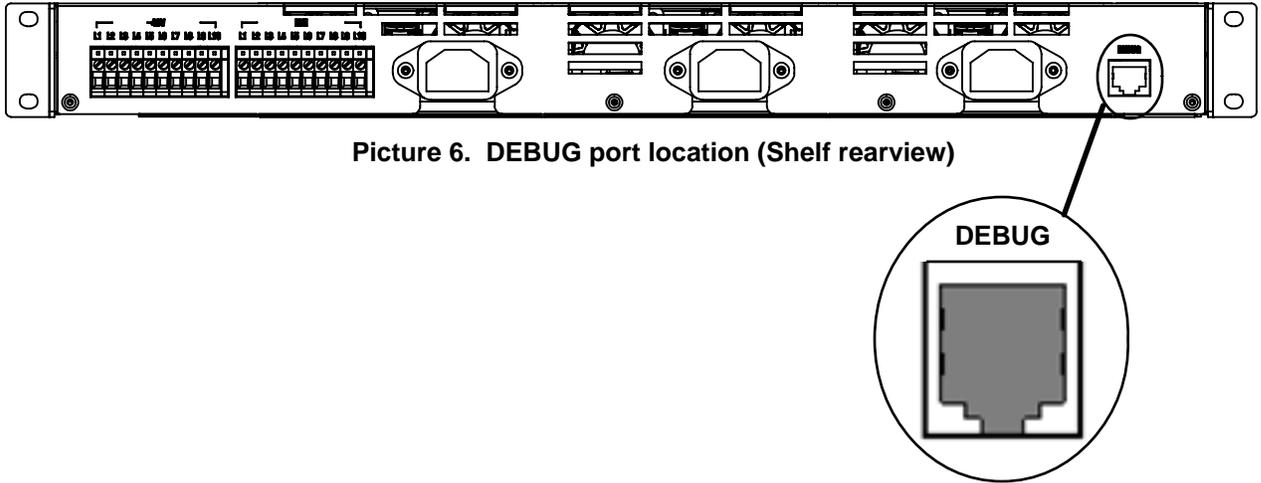


Picture 5. DIRC-4 Control Module (Front)

No.	Rectifier Status	LED Status	Note
1	Normal; All Conditions OK	LED: Green	
2	Rectifier System is Off	LED: Off	
3	AC Fail, DC Fail, Fuse Open, Rectifier Mode Fail	LED: Red	

3.2.1.1 Communication Function

On the DIRC-4 Control Module, the TCP/IP port supports TCP/IP and SNMP via Ethernet protocol. Program updates can be made either through the TCI/IP port or the DEBUG port (located on shelf rear). Refer to the chart below for the DEBUG port pin assignments.



Picture 6. DEBUG port location (Shelf rearview)

Pin Assignment	Description
	Control Module Rear Debug(8Pin RJ45)
1	Reserved
2	TXD
3	RXD
4	Reserved
5	GND
6	Reserved
7	Reserved
8	Reserved

3.2.2 Measuring and Observation Function

3.2.2.1 Measuring Function

Measure DC output voltage and DC output current then send it to Debug (RS232) or Ethernet.

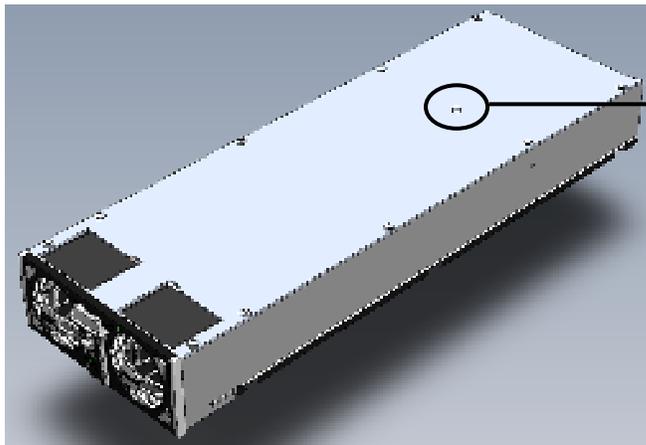
3.2.2.2 Alarm Observation Function

Monitor DC NFB and DC FUSE then send it to Main Debug (RS232) or Ethernet.

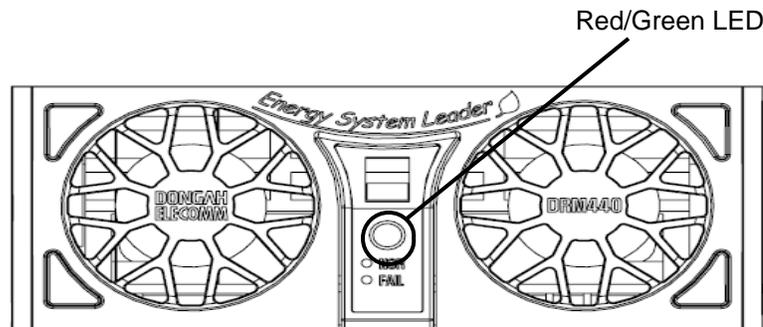
No.	Type	Contents	Note
1	ACF	AC INPUT FAIL	AC Input less than 85VAC or greater than 280VAC
2	DCF	DC HIGH VOLTAGE DC LOW VOLTAGE	DC Output less than 48.0Vdc or greater than 58.0Vdc
3	FUSE	DC NFB TRIP DC FUSE OPEN	DC Output protective device open (No-Fuse Breaker -NFB or GMT Fuse)

3.3 Rectifier Module (DRM-440H44R0)

The DRM-440 Rectifier is a SMPS that rectifies the Input AC Voltage to a DC Output Voltage (54V). The Rectifier and the DIRC-4 Control Module internally communicate to control, monitor, and alarm as needed to deliver the regulated 54V @ 50A, per module, to the load. Each rectifier actively current-shares and is hot-swappable.



CAUTION
<p>"Vadj" allows fine-tuning of the output voltage and is a FACTORY ADJUSTMENT ONLY. Any modification to this factory setting may cause module-to-module current-sharing to exceed module and/or shelf specifications. Actual Vout adjustments can be performed via monitoring/alarm software provided by DongAh.</p>



Picture 6. Rectifier Module (Front Panel): Green/Red LED Indicator

1. Green LED ('NOR'): Indicates Normal Rectifier status; no alarms or failures.
2. Red LED (FAIL): Indicates Failed Rectifier status.

4. System Management

4.1 In Normal operation, all rectifiers in the shelf supply power to the outputs.

4.1.1 Shelf (DIRS-4110)

In Normal operation, AC input(s) should be within specifications and output fuses must be active.

4.1.2 Control Module (DIRC-4)

The Control Module front panel LED is GREEN in Normal operation (RED indicates a failure).

4.1.3 Rectifier Module (DRM-440H44R0)

Within the shelf, each Rectifier Module front panel LED is GREEN in Normal operation (RED indicates a failure).

5. Rectifier System

5.1 Rectifier System Operating Principles

5.1.1 Rectifier System Basic Operation

The Rectifier System receives commercial AC power to the Shelf, and internally to the Controller and Rectifier Modules. With intelligent control, the AC is rectified and DC power is delivered through fuse-protected output terminals of the shelf.

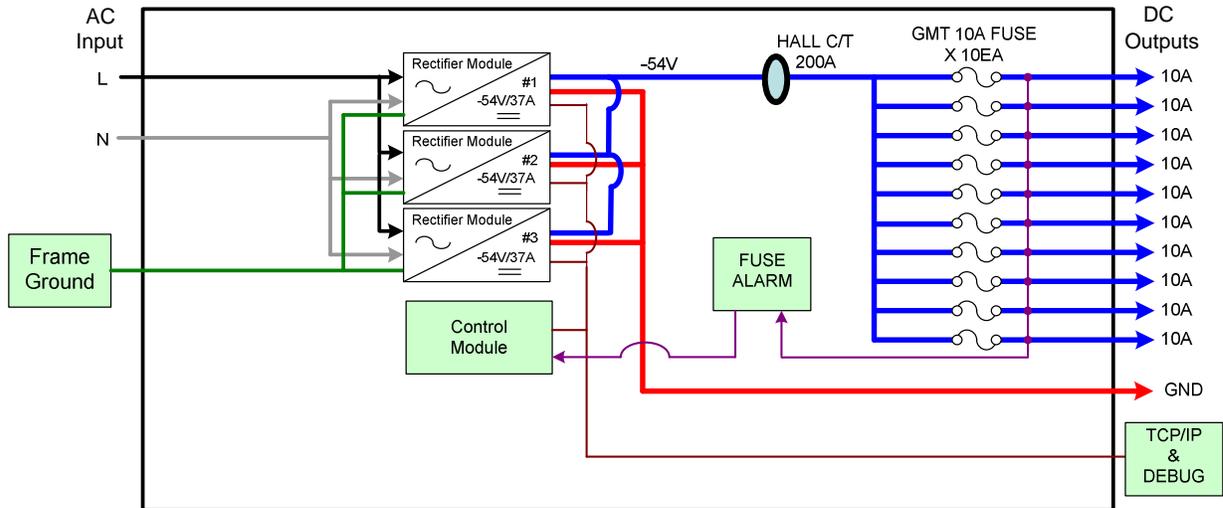
5.1.2 System Components

The Rectifier System is composed of up to (3) DRM-440 Rectifier Modules, a DIRC-4 Control Module, and a Power Distribution block. The system accepts an 85-264VAC, single-phase input, filters, rectifies, and delivers a well-regulated, factory-set 54V output at 111A (with 3 rectifiers at 37A each).

Designed to efficiently and reliably power a customer's system, the DIRS-4110 System includes protection and alarm features, hot-swappability, solid current-sharing, and system monitoring via TCP/IP and SNMP. Output distribution includes (10) GMT fuses visible at the front of the shelf, with output connections that screw-lock into (2) 10-terminal block load connectors (one for 54V and one for GND) at rear of the shelf.

5.2 Rectifier System Block Diagram

DIRS-4110 BLOCK DIAGRAM



5.3 Initial Inspection and Power-Up

5.3.1 Preliminary Inspection

5.3.1.1 Disconnect the AC Input power. Visually inspect the GMT fuses to ensure correct ratings and proper insertion into the fuse block. Ensure the Control Module and Rectifiers are fully inserted and locked into the Shelf.

5.3.1.2 Visually inspect the input and output wiring for clean, secure connections. Ensure shelf mounting brackets are tight and secure.

5.3.2 Rectifier System Power-Up

5.3.2.1 When preliminary inspection is complete, confirm the AC input voltage is within specifications that all output cables are connected properly between the Rectifier System outputs and the inputs to the customer's system (loads).

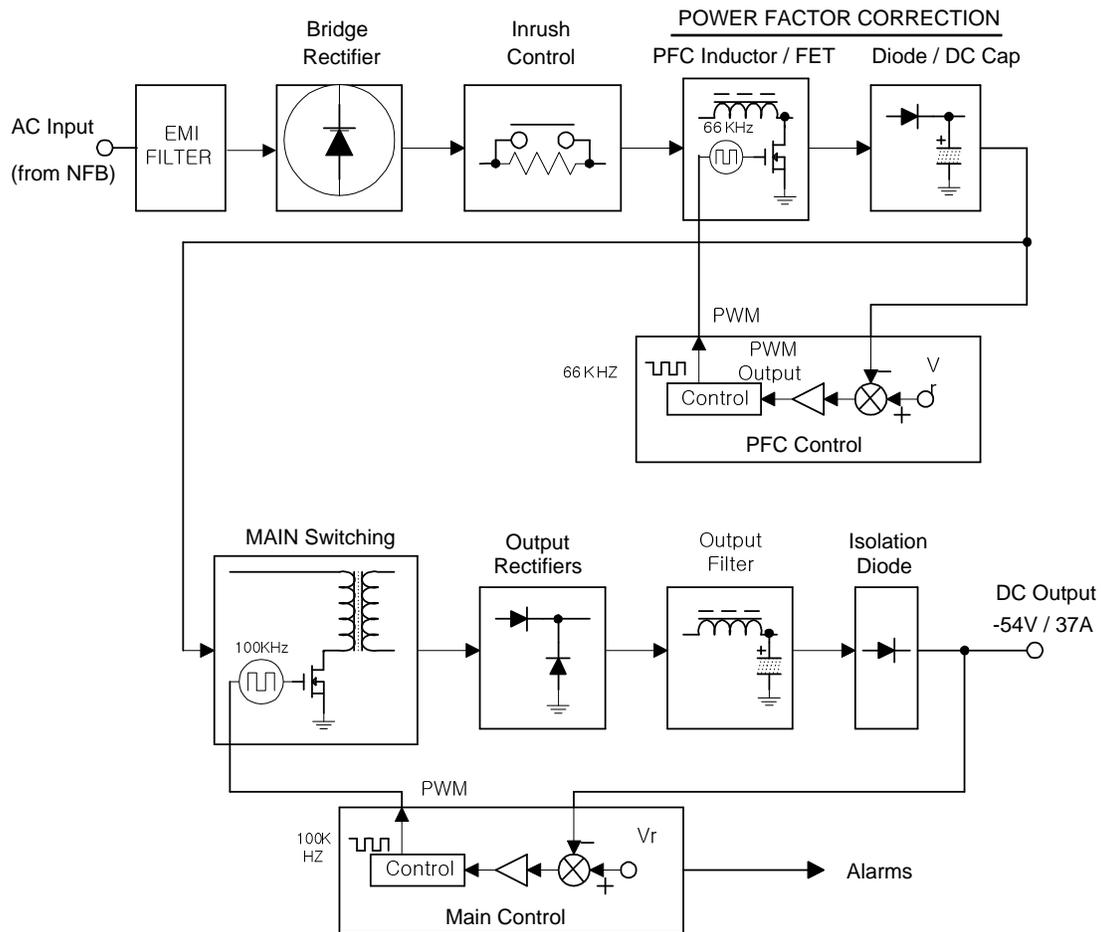
5.3.2.2 Power On

- Apply AC Input power to shelf.
- Confirm that the Rectifier Modules (DRM-440) operate normally by observing Green LED is lit steadily on the front panel of each module.
- Confirm that the Control Module (DIRC-4) is monitoring, controlling, and communicating within the shelf properly by observing GREEN Led is lit steadily on the front of the Control Module.
- Set up and run Shelf software to ensure proper operation and no alarms are present.

6. Rectifier Module (DRM-440H44R0)

6.1 Rectifier Module Operating Principles

The Rectifier Module filters the single-phase AC Input (85~264VAC) while the Inrush Control limits the inrush current during module startup. The Bridge Rectifier feeds a pulsating current signal into the PFC, which phase-shifts the signal for maximum input power efficiency. Typically 385Vdc, this PFC output is FET-switched via the MAIN transformer, rectified, and filtered to deliver the -54V/37A output. The Main PWM Control provides the regulation and loop response. Detailed circuit descriptions are below.



- Rectifier Module System Diagram -

6.2 Rectifier Module Circuit Description

6.2.1 Input Circuit

The input circuitry passes Input AC through a No-Fuse Breaker (NFB), an EMI Filter, and Inrush Control. The Bridge Rectifier converts the AC into a pulsating DC current, which the Active Power Factor Control (PFC) circuit, which reduces the reactive current component to efficiently manage input power.

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6.2.2 Inrush Control Circuit

The Inrush Control circuitry limits large peak currents that occur during module startup, often attributed to currents pulled directly from the input capacitor.

6.2.3 Power Factor Correction (PFC)

The Active Boost PFC topology controls the duty cycle of the FET so the PFC Inductor pulls sinusoidal current from the AC Line. The PFC Circuit components include the Inductor, a switching FET, a rectifier diode, a DC capacitor, and a Control Circuit that feeds back into the gate of the switching FET.

The PFC Circuit operates as follows:

a. PFC Inductor

When the PFC switching FET is on, the current increases in the PFC Inductor. When the FET is off, the magnetic field collapses and inductor current decreases as it feeds current into the PFC capacitor.

b. PFC FET

The PFC FET controls the current in the PFC Inductor, forming a sinusoidal current based on the duty cycle changes delivered from the variable PWM signal delivered by the PFC Control Circuit.

c. PFC Diode / Capacitor

The PFC diode allows energy stored in the PFC Inductor to transfer into the PFC DC Bus capacitor.

d. PFC Control Circuit

The PFC Control Circuit feeds a 66KHz PWM gate signal to the PFC FET. The duty cycle of the PWM signal is based on comparing the input current/voltage waveforms to the output voltage (~385Vdc).

The Control Circuit includes a protection circuit that will shut down the output of the rectifier when the output becomes less than 300Vdc due to failure of the feedback loop or other critical circuit elements.

6.2.5 Main Switching Circuit

The Main Switching circuit uses a FET-switched DC to transfer power across the main transformer.

The Main Switching Circuit operates as follows:

a. Main FET

The Main FET switches at ~100KHz with a variable duty cycle from the Main Control Circuit, which regulates the output voltage. As a result, the ~385Vdc PFC Bus voltage is sinusoidal and the energy is transferred from the Main transformer primary to the secondary windings.

b. Main Transformer

The Main Transformer passes the power from the primary winding over to the magnetically-coupled secondary during the on-time of the Main FET. The primary-to-secondary windings have a turns ratio that steps down the voltage on the secondary, which will then be rectified to the desired DC output.

6.2.6 Output Rectifier / Output Filter

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The output diodes are fast-recovery, low voltage drop rectifiers that convert the AC voltage to a DC level. The Output Filter circuitry further filters out the AC ripple and high-frequency switching noise to deliver a clean DC Output voltage.

6.2.7 Inverse Current Prevention Circuit

It is a circuit that is composed to normally output other rectifier module when there is disorder in rectifier module during parallel operation, and it used diode at the final output part.

6.2.8 PWM Control and Production Circuit (Power factor improvement part)

PWM control of power factor improvement part PWMs output pulse on duty of control part to 10%~90% by comparing output power (DC385V) with input pulsating current voltage and waveform of current, and it is composed of a circuit that controls on duty of switch (FET) in order to changed into current sine by flowing input current as 100 kHz(within 120 Hz) after chopping pulsating voltage as 75 kHz within 120 Hz and a circuit that protects by shutting down output of the rectifier when output (300V) becomes low tension due to disorder of feedback loop and element.

6.2.9 PWM Control Circuit (Main circuit part)

It is composed of feedback circuit that controls output voltage, operating circuit that operates the main switch, and soft start circuit to eliminate transient phenomenon. It is a voltage that compared output feedback voltage with a chopping wage, it controls duty ratio of the main switch by amplifying at operation circuit by outputting 75 kHz pulse.

6.2.10 Electric Current Share Circuit

An electric current share circuit is a circuit to prevent current being leaning to a particular rectifier module when a rectifier module is operated in parallel, it detects output current, adjusts feedback voltage by sensing each rectifier module current that is amplified in control IC, and controls output current.

6.2.11 Protection Circuit

A protection circuit is composed of current limitation circuit that limits current when output current increase, over voltage shutdown circuit that stops output when output becomes high voltage due to feedback failure, and a circuit that sends alarm when output does not occur.

6.2.12 Alarm Delivery Circuit

It is a circuit that sends failure status that occurs in the rectifier module to the control unit, and alarm is sent when there's disorder in rectifier module (excessive voltage of output, short circuit), excessive discharge of a short battery, and disorder in alternating current input (power failure or when it strays from the allowed range).

7. Control Module (DIRC-4)

7.1 Control Module Function

7.1.1 Monitoring Operation Range

DIRC-4 control UNIT can monitor operation of maximum 3 of control modules (DRM-440).

7.1.2 Alarm Function

7.1.2.1 AC Input Fail

It occurs when Input AC voltage of rectifier less than 180V and more than 280V.

LED turns to red light at the front panel.

7.1.2.2 DC High Voltage

It occurs when output voltage of rectifier is more than 58.0V. LED turns to red light at the front panel.

Changing setting value to Debug Port and SNMP is possible.

7.1.2.3 DC Low Voltage

It occurs when output voltage of rectifier is less than 48.0V. MAJOR LED is on at the front panel.

Changing setting value to Debug Port and SNMP is possible.

7.1.2.4 DRM-440H44R0 Rectifier Unit Fail

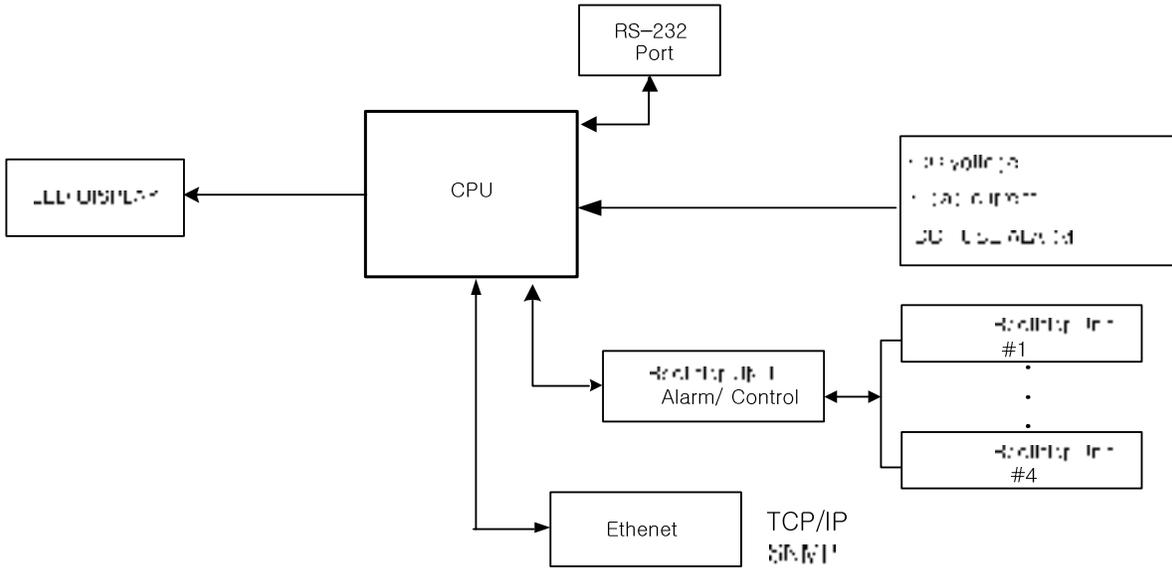
Fail occurs if it does not operate after unit installment or unit itself fails while operation.

MAJOR LED is on at the front panel.

7.1.3 Deliver rectifier measuring data and alarm data to TCP/IP or SNMP.

7.2 Control Module Block Diagram

Control Unit Block Diagram

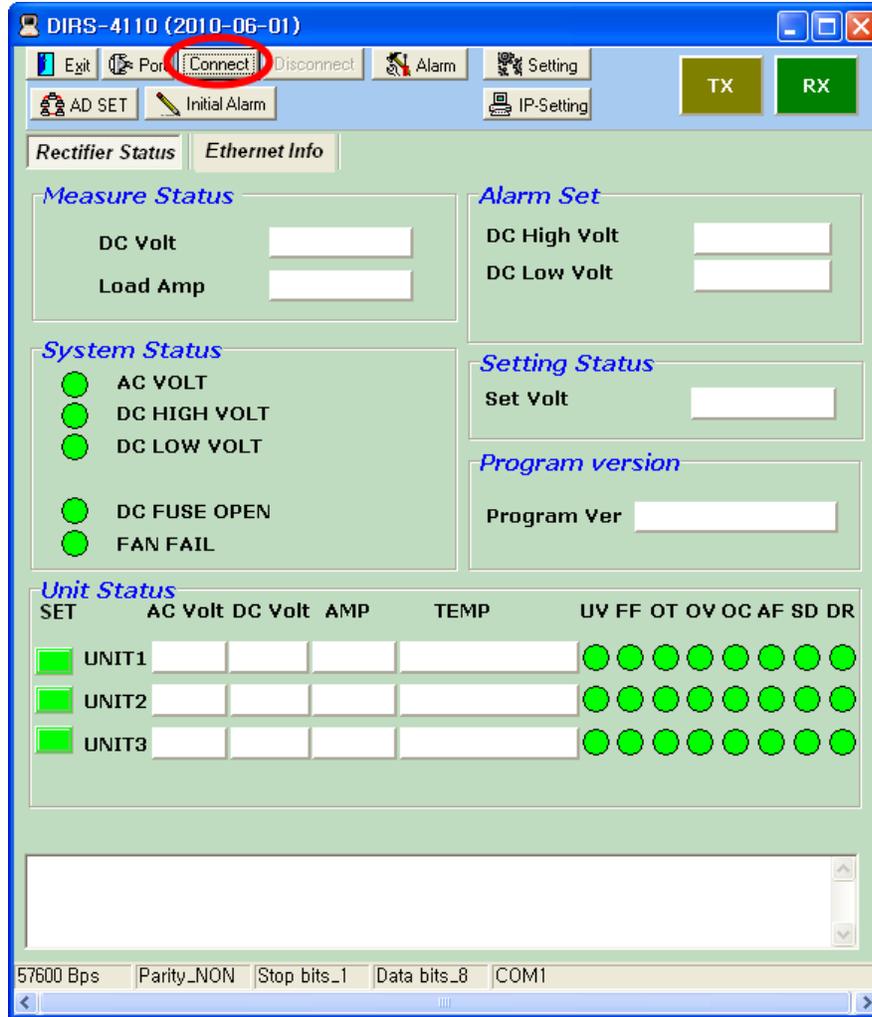


7.3 Debug Operation

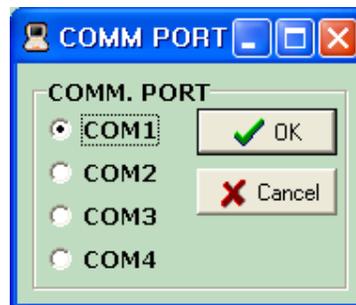
7.3.1 Function of Monitor Program

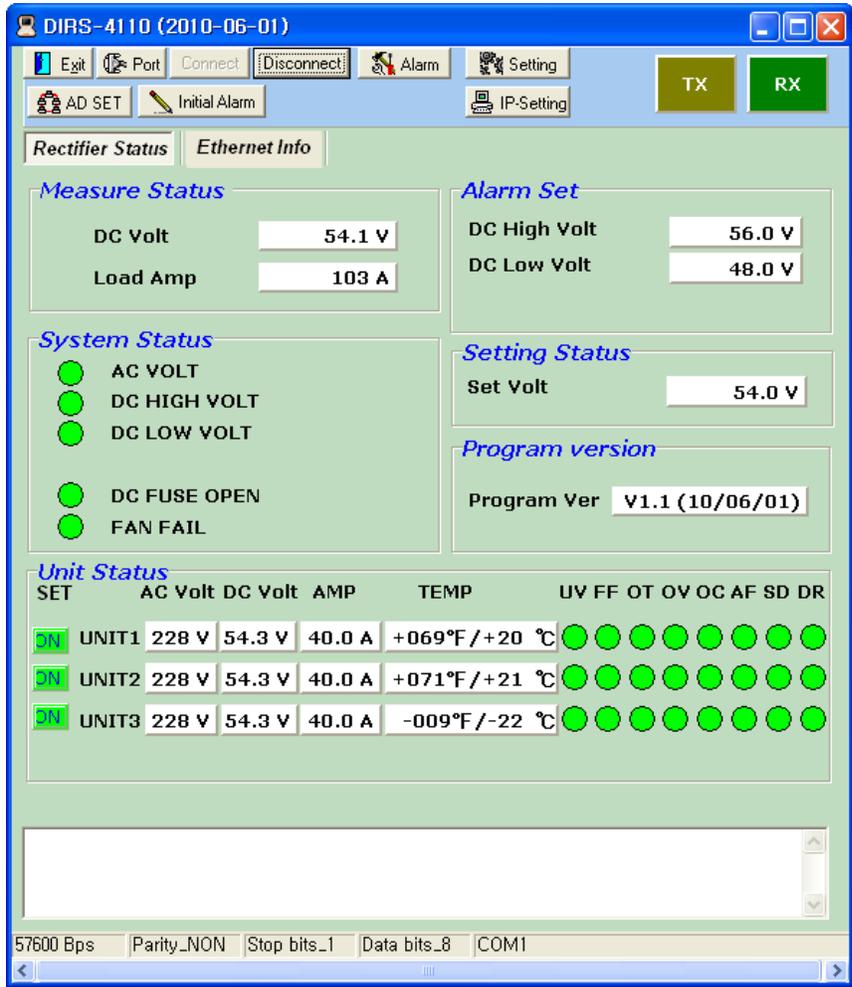
- Rectifier operation status inquiry (Output voltage/current, alarm status of rectifier module)
- Setting network information setting is possible.
- Can set up the upper/lowest limit of measuring alarm.

7.3.2 Run pDIRS_4110.exe.



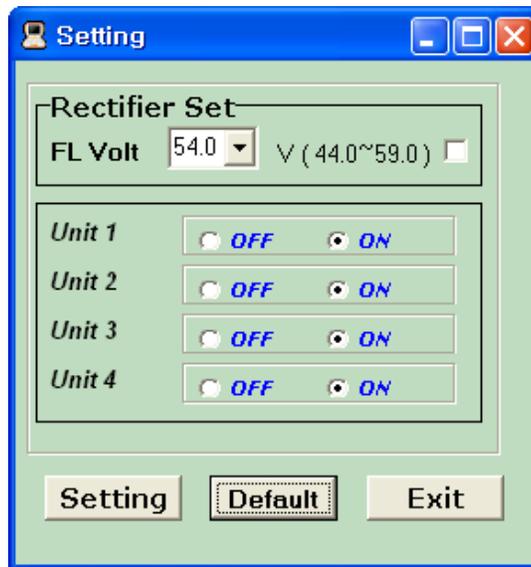
- Try to connect by pushing Connect button.
- If connection fails, reset the port. (initially set as COM1)



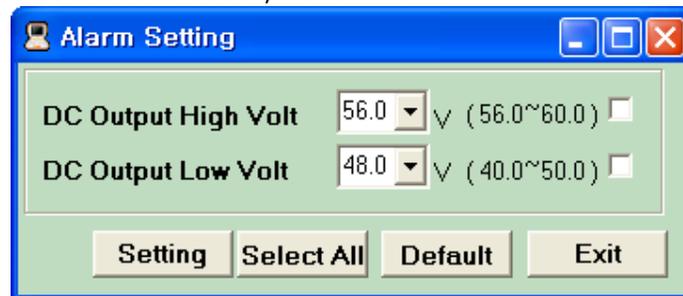


- If connection is successfully made, status of rectifier is shown as the above.
- For now Rectifier Status section is shown, and push Ethernet Info section in order to see other section.

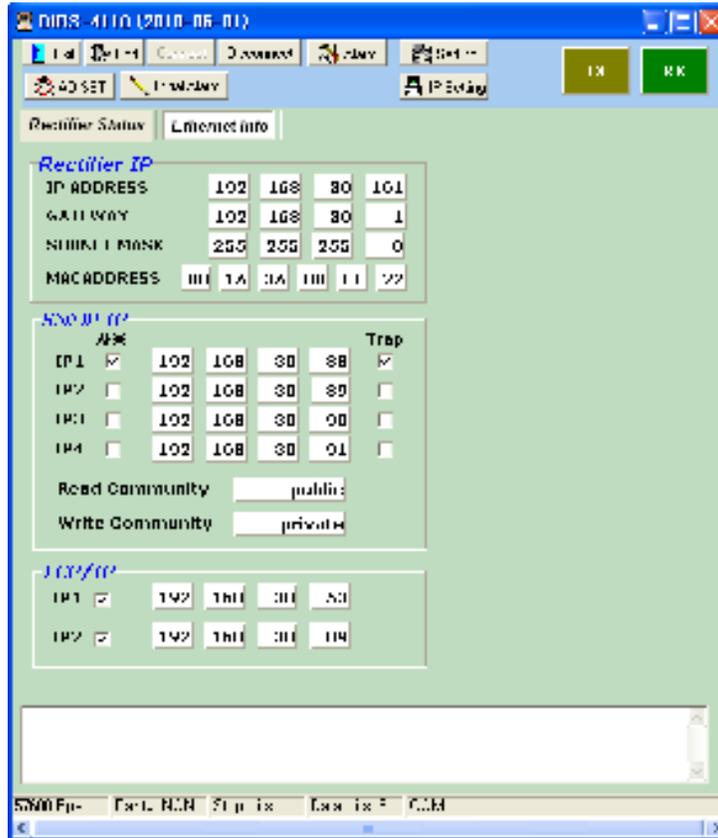
- Reenter each section by pushing Setting icon, check 'V', and push Setting to change rectifier module ON/OFF and output voltage setting.



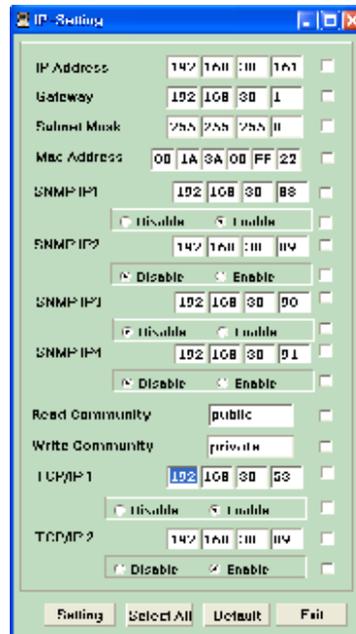
- Reenter each section by clicking Alarm icon, check 'V', and push Setting to change alarm setting value of DC HIGH VOLT, DC LOW VOLT.



- Push Initial Alarm icon In order to change DC HIGH VOLT, DC LOW VOLT alarm as the basic setting value. (Basic setting DC HIGH VOLT : 58V, DC LOW VOLT : 48V)



- Show rectifier IP and server IP in Ethernet Info tab.
- Reenter each section by pushing IP-Setting icon, check 'V' and push Setting in order to change setting value.

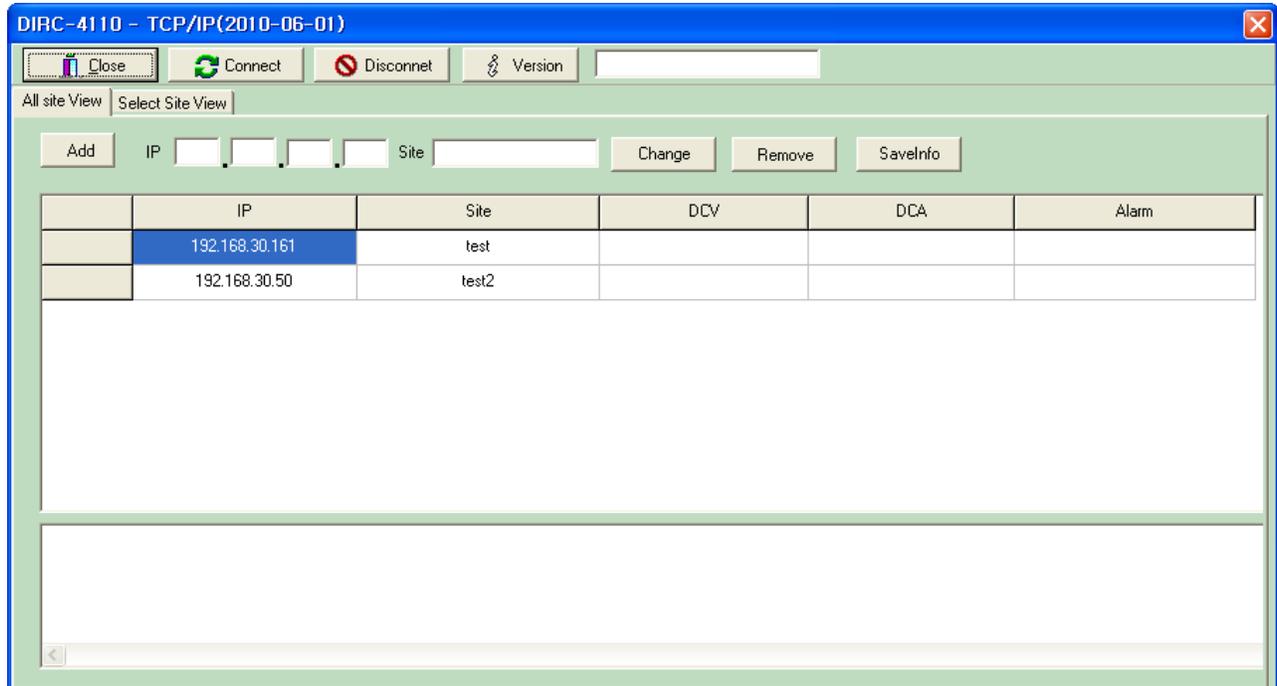


7.4 TCP/IP Operation

7.4.1 Function of Monitor Program

- Rectifier operation status inquiry (In/Output voltage, current, alarm status of rectifier module, and etc)

7.4.2 All Site View



7.4.2.1 Fill in IP and Site name. Content is specified by clicking  button.

7.4.2.2 Repeat content of 7.4.2.1 in order to add.

7.4.2.3 To change content, write content in IP and Site section after clicking the relevant content, and then click  button.

7.4.2.4 If to erase content, select the relevant section and push  button.

7.4.2.5 Connection is made when  button is pushed after content is specified.

7.4.2.6 If the relevant site is on alarm it is changed to , if connection fails then , and if it is in normal state it is changed to .

7.4.2.7 If alarm occurs, site name and time are written on the below blank.

7.4.2.8 Click  button to save current IP and site name.
It takes about 5 sec to save.

7.4.2.9 Information of the relevant site is shown as the below window.

The screenshot shows a monitoring interface for 'DIRC-4110 - TCP/IP(2010-06-01)'. It features several panels:

- Measure Status:** DC Volt (54.0 V), Load Amp (000 A).
- Alarm Set:** DC High Volt (58.0 V), DC Low Volt (48.0 V), Set Volt (54.0 V), Main Board (V1.1 (10/06/01)).
- System Status:** AC VOLT, DC HIGH VOLT, DC LOW VOLT, DC OVER CURRENT, DC FUSE OPEN, FAN FAIL (all indicated by green circles).
- 경유기 IP SET (Gateway IP SET):** IP ADDRESS (192.168.30.50), GATEWAY (192.168.30.1), SUBNET MASK (255.255.255.0), MACADDRESS (00 1A 3A 00 FF 29).
- SNMP SET:** Includes a '사용' (Use) table with IP1-4 and Trap settings, and Read/Write Community fields (public/private).
- Unit Status:** Table with columns for AC Volt, DC Volt, AMP, TEMP, and various fault indicators (UV, FF, OT, OV, OC, AF, SD, DR) for UNIT1 through UNIT4.
- TCP/IP SET:** IP1 (192.168.30.71) and IP2 (192.168.30.89).

Information of the selected site can be seen here.