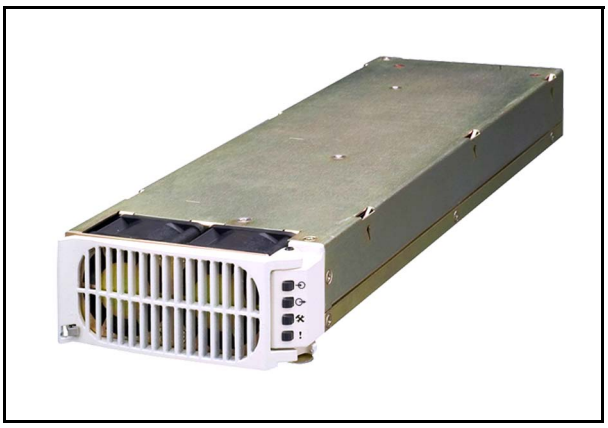
*Data Sheet*
*January 2008*

LINEAGE POWER

# Compact Power Line

## CP2000DC54 Power Entry Module

### Input: -40 to -72 Vdc; Outputs: ±54 Vdc at 2000W; 5 Vdc at 4W



## Applications

- 48Vdc distributed power architectures
- Power over Ethernet
- Routers/Switches
- VoIP/Soft Switches
- LAN/WAN/MAN applications
- File servers
- Indoor wireless
- Telecommunications equipment
- Enterprise Networks
- SAN/NAS/iSCSI applications
- Advanced workstations

## Features

- Compact 1-RU form factor providing 20 W/in$^3$
- Output voltage programmable from 44V – 58 Vdc; output defaulted to 54V
- PMBus compliant dual I$^2$C serial bus communications
- Designed to IEEE802.3af Compliance, 2250 output isolation to chassis/signals for POE applications. (see ordering info)
- DC Output over-voltage and over-current protection
- DC Input over-voltage and under-voltage protection
- Over-temperature warning and protection
- Redundant, parallel operation with active load sharing and redundant +5V Aux power
- Remote ON/OFF
- Hot insertion/removal (hot plug)
- Four front panel LED indicators
- UL* 60950 Recognized, cUL to CSA† C22.2 No. 60950-00 Certified, VDE‡0805 Licensed IEC60950, 3rd edition)
- CE mark meets 73/23/EEC and 93/68/EEC directives§
- Variable-speed fan control

***The CP2000DC54 Power Entry Modules (PEM)*** in the Compact Power Line platform are specifically designed to operate as an integral part of a complete distributed power system. The high-density, front-to-back airflow PEM is designed for minimal space utilization and is highly expandable for future growth. It is provided with many features including PoE isolation, and dual-redundant I$^2$C communications busses that allow it to be used in a broad range of applications. The flexible feature set makes this Power Entry Module an excellent choice for applications requiring modular dc-to-dc bulk intermediate voltages, such as in distributed power.

* UL is a registered trademark of Underwriters Laboratories, Inc.
† CSA is a registered trademark of Canadian Standards Association.
‡ VDE is a trademark of Verband Deutscher Elektrotechniker e.V.
§ This product is intended for integration into end-user equipment. All the required procedures for CE marking of end-user equipment should be followed. (The CE mark is placed on selected products.)
** ISO is a registered trademark of the International Organization of Standards.

## *Specifications*

| Input | | | | | |
|---|---|---|---|---|---|
| **Parameter** | **Min** | **Typ** | **Max** | **Units** | **Notes** |
| Operating Voltage Range | -40 | | -72 | Vdc | |
| Low Input Shutdown of Main Output | -38.5 | -39 | -39.5 | Vdc | Internal bias shall not shut down above -26Vdc. Loading for this test is between 25% to 100% FL. |
| Input Turn-on of Both Outputs | -43 | -43.5 | -44 | Vdc | |
| Reverse Input Voltage | The power supply shal not be damaged. | | | | |
| Idling Power: Output OFF<br>Output ON | | | 35<br>60 | W | No external secondary output load.<br>No output loads connected. |
| Input Current | | | 60 | A | |
| Cold Start Inrush | | | 60 | Adc | Measured at 25°C for all line conditions; does not include X-Capacitors charging. |
| Input Leakage Current | | 1.5 | | mA | Measured at -75 Vdc |
| Efficiency | 88<br>82 | 90<br>84 | | % | From 75% to 100% full load<br>For loads > 25% of full load |
| Holdup Time | 8 | | | ms | Measured at Vin = -48 Vdc at half load; the output can drop to -40 Vdc |
| Ride Through | 8 | | | ms | |
| Input Capacitance | | | 25 | µF | |

| Main Output | | | | | |
|---|---|---|---|---|---|
| **Parameter** | **Min** | **Typ** | **Max** | **Units** | **Notes** |
| Maximum Output Power | | | 2000 | W | |
| Voltage Regulation | | | | | |
| Set Point at 50% FL | | 54 | | Vdc | Resets to factory set value if power is removed. |
| Set Point Tolerance | -0.5 | | 0.5 | % | |
| Set Point Regulation | -1 | | 1 | % | All conditions (temp, drift, line) |
| Droop Regulation | | 1 | | Vdc | Linear from 1 to 37 A. Lower limit: 53 Vdc. |
| Droop Accuracy | -5 | | 5 | % | All conditions (temp, drift, load, line) |
| Output Voltage Range | 44 | | 58 | Vdc | Set either by $I^2C$ or analog margining. |
| Maximum Output Current | | | 37 | A | At 2000W, -54 Vdc |
| Redundancy Reverse Current | | | 0.5 | A | Isolation function required. |
| Active Current Share | -2.5 | | 2.5 | %FL | Single wire. Fault on the wire shall not cause a shutdown and shall revert to passive current share. |
| Passive Current Share | -5 | | +5 | %FL | Between the average currents of modules on two separate busses. |

## Specifications (continued)

| Output (continued) | | | | | |
|---|---|---|---|---|---|
| **Parameter** | **Min** | **Typ** | **Max** | **Units** | **Notes** |
| Output Ripple<br>RMS (5Hz to 20MHz)<br>Peak-to-Peak (5Hz to 20MHz)<br>Psophometric Noise | | | <br>250<br>500<br>2 | <br>mVrms<br>mVpk-pk<br>mVrms | Measured with 20MHz bandwidth under any condition of loading. Minimum load is 1A. |
| External Bulk Load Capacitance | 0 | | 5000 | µF | External capacitance can be increased but the power supply will not meet its turn-ON rise time requirement. |
| Turn-On<br>Delay<br>Rise Time - Standard (PMBus)<br>Overshoot | | <br>5<br>500 | <br><br><br>5 | <br>s<br>ms<br>% | Monotonic Turn-On after detection of valid dc input voltage. Measured from 30% to 100% of Vnom. |
| Restart Shutdown Delay | | 20 | | s | May delay shutdown during restart in order to guarantee system restart capability with multiple power modules. |
| Load Response<br>ΔI<br>ΔV<br>Response Time | | <br><br><br>2 | <br>50<br>2.0 | <br>%FL<br>Vdc<br>ms | ΔI/Δt slew rate 1A/µs.<br>Settling time to within regulation requirements. |
| Overload<br>Current Limit[1] | 38 | | 45 | A | Fold_down current limit. |
| System Power Up | Units should be able to be plugged in one at a time and guarantee system start up. Unit will stay in current limit for about 20 seconds to guarantee restart. | | | | |
| Over-voltage<br>Delayed<br>Immediate | | | <br>60<br>65 | <br>Vdc<br>Vdc | <br>200msec delayed shutdown to be implemented.<br>Instanataneous shutdown above this point. |
| Latchoff | Three restart attempts may be implemented within a one minute window prior to a latched shutdown. | | | | |
| Over-temperature<br>Warning<br>Shutdown | <br>5<br>20 | | | <br>°C<br>°C | <br>Implemented prior to commencement of an OT shutdown.<br>Below the maximum rating of the device being protected. |
| Auto-recoverable | Temperature hysteresis of at least 10°C provided between shutdown and restart. | | | | |

*1. Current limit performance shall revert to a hiccup mode of performance with approximately a 10% duty cycle via $I^2C$. During hiccup performance the PEM would shut down when the output voltage falls below 39Vdc.*

| Auxiliary Output | | | | | |
|---|---|---|---|---|---|
| **Parameter** | **Min** | **Typ** | **Max** | **Units** | **Notes** |
| Input Range | -26 | | -72 | Vdc | |
| Output Voltage Set Point | | 5.1 | | Vdc | Must be isolated from the main output. Diode or'ed for redundancy. Configured for 50mA internal use to power adjacent PEM control and 700mA for external use. |
| Output Current | 0 | | 0.75 (5V) | Adc | |
| Overall Regulation | -5 | | 5 | % | |
| Ripple and Noise | | | 50<br>25 | mVpk-pk<br>mVrms | 20MHz bandwidth. Measured across a 1µf tantalum and a 0.1µf ceramic capacitor. |
| Over-voltage Shutdown | | | 6.5 | Vdc | |
| Over-current Shutdown | 110 | | 150 | %FL | |

## *Specifications (continued)*

| **Physical** | |
|---|---|
| Length (in./mm) | 13.85 / 351.8 |
| Width (in./mm) | 4.00 / 101.6 |
| Height (in./mm) | 1.66 / 42.2 |
| Weight (lb/kg) | 4.6 / 2.1 |

| **Environmental** | | | | | |
|---|---|---|---|---|---|
| **Parameter** | **Min** | **Typ** | **Max** | **Units** | **Notes** |
| Ambient Temperature<br>Operating<br>Ambient Derating<br>Power Derating | <br>-5 | <br><br>1 | <br>45<br><br>1 | <br>°C<br>°C<br>%/°C | <br>Air inlet from sea level to 5,000 feet.<br>Per 1,000 feet above 5,000 feet.<br>Up to 55°C |
| Storage Temperature | -40 | | 85 | °C | |
| Humidity | 5 | | 95 | % | Relative humidity, non-condensing. |
| Shock and Vibration<br>Operational Test<br>Test Levels<br>Drop and Tip Over | | | | | <br>IEC 68-2<br>IEC 721-3-2<br>IEC 68-2-31 |
| Earthquake Rating | 4 | | | Zone | Per Telcordia GR-63-CORE, all floors, when installed in CP Shelf. |
| Acoustic Noise | | 55 | | dBA | Noise is proportional to fan speed, load and ambient temperature. |
| Radiated Emissions* | FCC and CISPR22 (EN55022) - Class A | | | | |
| Conducted Emissions- dc | Telcordia GR-1089-CORE and CISPR22 (EN55022) - Class A | | | | |
| ESD | Error free per EN/IEC 61000-4-2 Level 3 (6 kV contact discharge, 8 kV air discharge). | | | | |
| Radiated Immunity | Error free per EN/IEC 61000-4-3 Level 3 (10 V/m). | | | | |
| Differential Mode Surge | | | 100 | Vdc | ANSI TI.315, No Errors |
| Differential Mode Surge Transient | | | 1000 | Vdc | No errors. IEEE C62.41 defined pulse transient |
| Common Mode Surge (1.2/50µs pulse) | | | 1000 | Vdc | |
| Reliability (calculated) | | 400,000 | | Hours | At ambient of 25°C at full load per Telcordia SR-332, Reliability Prediction for Electronic Equipment, Method I Case III. |
| Isolation<br>Input / Output<br>Input / Frame<br>Output / Frame<br>Secondary POE to non-POE (standby) | <br>2250<br>1700<br>2250<br>2250 | | | Vdc | <br>POE Isolation per IEEE802.af<br>Per EN 60950-1 / UL 60950-1<br>Per IEEE 802.af<br>Per IEEE 802.af |
| Service Life | | 10 | | Years | 25°C ambient, full load excluding fans. |

**Radiated emissions compliance was met using a Lineage Power shelf. This shelf includes output common and differential mode capacitors that assist in meeting compliance.*

## *Status and Control*

The PEM provides three means for monitor/control: analog, PMBus compliant $I^2C$ serial communications buses.

Details of analog controls are provided in this data sheet under Signal Definitions. Lineage Power will provide separate application notes on PMBus protocol for users to interface to the CPL PEMs. Contact local Lineage Power representative for details.

### *Hot Plug*

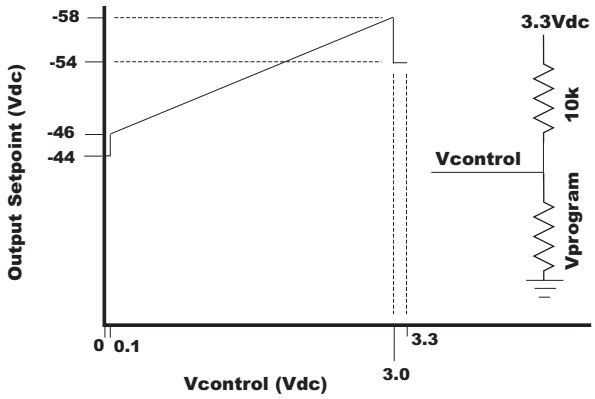
When rapidly extracting and reinserting modules care should be taken to allow for discharging the internal bias supply so that a predictable restart could be achieved. The way to ensure that the circuit sufficiently discharges is to observe the spinning of the fans after an extraction. The unit should not be reinserted until the fans stop spinning.

### *Control Definitions*

All signals are referenced to Logic GRD unless otherwise noted. See the Signal Definitions Table at the end of this document for further description of all the signals.

### Input Signals

**Margining:** Setpoint of the PEM can be changed via this input pin. Programming can be either a voltage source or a resistance divider. The margining pin is connected to 3.3Vdc via a 10kΩ resistor inside the PEM. See graphs below.




An open circuit on this pin reverts the voltage level back to the original setting.

**Module Present Signal:** The PEM alerts the system when it is properly plugged in via a 500Ω resistor in series between this signal and Logic GRD.

**Protocol Select:** Establishes the communications mode of the PEM between analog/$I^2C$ modes.

**Enable:** On/Off control when PMBus communications are utilized as configured by the Protocol pin. This pin must be pulled low to turn **ON** the PEM. The PEM will turn **OFF** if either the **Enable** or the **ON/OFF** pin is released. This signal is referenced to Logic_GRD.

**ON/OFF:** Permits output turn-ON via the ENABLE signal above when pulled to 54_OUT (-DC) and turns **OFF** the PEM if not connected. This is a short pin utilized for hot-plug applications to ensure that the PEM turns **OFF** before the power pins are disengaged. It also ensures that the PEM turns **ON** only after the power pins have been engaged.

### *Output Signals*

**Alert #:** PMBus interrupt signal.

**Fault:** This signal goes LO for any failure that requires PEM replacement. Some of these faults may be due to:

- Fan failure
- Over-temperature condition
- Over-temperature shutdown
- Over-voltage shutdown
- Internal PEM Fault

## *Alarm Table*

| | PEM Led State | | | | | Monitoring Signals (Referenced To LOGIC_GRD | | |
|---|---|---|---|---|---|---|---|---|
| **Condition** | **IN OK** Green | **DC OK** Green | **Service** Amber | **Fault** Red | | **Fault** | **OTW** | **Module Present** |
| OK | 1 | 1 | 0 | 0 | | HI | HI | LO |
| Thermal Alarm (5C before shutdown) | 1 | 1 | 1 | 0 | | HI | LO | LO |
| Thermal Shutdown | 1 | 0 | 1 | 1 | | LO | LO | LO |
| Defective Fan | 1 | 0 | 0 | 1 | | LO | HI | LO |
| Blown Input Fuse in Unit | 1 | 0 | 0 | 1 | | LO | HI | LO |
| No Input > 8mS (single unit) | 0 | 1 | 0 | 0 | | HI | HI | LO |
| Input Present but not within limits | Blinks | ? | 0 | 0 | | HI | HI | LO |
| Input not present | 0 | 0 | 0 | 0 | | | | |
| Over Voltage Latched Shutdown | 1 | 0 | 0 | 1 | | LO | HI | LO |
| Over Current | 1 | Blinks | 0 | 0 | | HI | HI | LO |
| Non-catastrophic Internal Failure * | 1 | 1 | 0 | 1 | | LO | HI | LO |
| 1 Missing Module | | | | | | | | HI |
| | | | | | | | | |
| Standby (remote) | 1 | 0 | 0 | 0 | | HI | HI | LO |
| Service Request (PMBus mode) | 1 | 1 | Blinks | 0 | | HI | HI | LO |

**Any detectable fault condition that does not result in the PEM shutting down.*

## *Output Connector*

**Mating Connector:** AMP 1450572-1

| | Signal | | | | | | Output Power | | Input Power | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **6** | **5** | **4** | **3** | **2** | **1** | **P7** | **P6** | **P5** | **P4** | **P3** | **P2** | **P1** |
| **A** | SCL_0 | MOD_PRES | | LOGIC_GRD | RS_485+ | UNIT_ADDR | 54_OUT (-DC) | 54_OUT (+DC) | CO_RTN (GND) | | EARTH (GND) | CO_LINE (HOT) | |
| **B** | SCL_1 | OTW | Alert#_0 | Alert#_1 | RS_485- | 8V_INT | | | | | | | |
| **C** | SDA_0 | Margin | Enable | Reset | Ishare | Protocol | | | | | | | |
| **D** | SDA_1 | Fault | 5VA | | ON/OFF | SHELF_ADDR | | | | | | | |

Connector is viewed from the rear positioned inside the PEM.

Signal pins columns 1 and 2 are referenced to 54_OUT (-DC).
Signal pins columns 3 through 6 are referenced to Logic GRD.

Last-to-make first-to-break shortest pins.

First-to-make last-to-break longest pin implemented in the mating connector.

### *Signal Definitions*

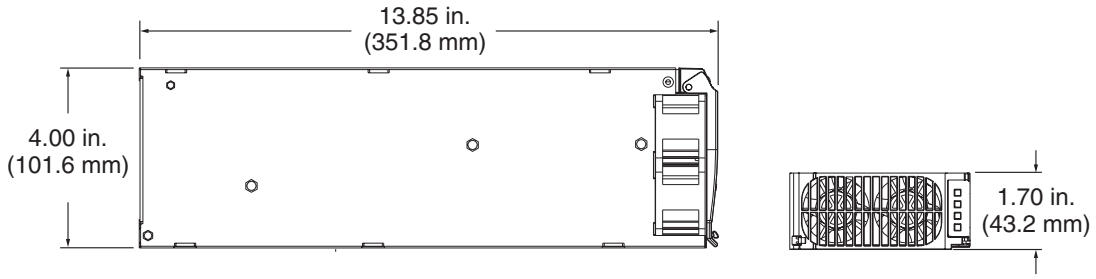
All hardware alarm signals ( Fault, OTW) are open drain FETs. An active LO signal (< 0.4Vdc) state is referenced to Logic GRD unless otherwise stated. Contact your Lineage Power representative for more details.

| Function | Label | Type | Description |
|---|---|---|---|
| Output Enable | Enable | Input | If shorted to LOGIC_GRD, the PEM output is enabled when using $I^2C$ mode of operation. May also be toggled to reset a latched OFF PEM. |
| $I^2C$ Interrupt | Alert#_0<br>Alert#_1 | Output | Interrupt signal via $I^2C$ lines indicating that service is requested from the host controller. This signal pin is pulled up to 3.3V via a 10kO resistor and switches to active LO when an interrupt occurs. |
| PEM Fault | Fault | Output | Indicates that an internal fault exists. An open drain FET; normally HI, changes to LO. |
| Module Present | MOD_PRES | Output | Used to Indicate presence of PEM. |
| ON/OFF | ON/OFF | Input | Short pin, connects last and breaks first; used to activate and deactivate output during hot-plugging and hot-removing, respectively. Ref: 54_OUT (-DC) |
| Protocol select | Protocol | Input | Used to place PEM in analog/$I^2C$ control/communication mode. Ref: 54_OUT (-DC). |
| Margining | Margin | Input | Allows changing of output voltage through an analog voltage input or via resistor divider. |
| Over-Temperature Warning | OTW | Output | An open drain FET; normally HI, changes to LO approximately 5°C prior to thermal shutdown. |
| PEM address | Unit_addr | Input | Voltage level addressing of PEMs within a single shelf. Ref: 54_OUT (-DC). |
| Shelf address | Shelf_addr | Input | Voltage level addressing of PEMs within multiple shelves. Ref: 54_OUT (-DC). |
| Back bias | 8V_INT | _ | Diode OR'ed 8Vdc drain; used to back bias microprocessors and DSP of failed PEM from operating PEMs. Ref: 54_OUT (-DC). |
| Mux Reset | Reset | Input | Resets the $I^2C$ lines to $I^2C$ line 0. |
| Standby power | 5VA | Output | Either 5V at 0.75A, or 3.4V at 1A provided for external use by either adjacent PEMs or the using system. |
| Current Share | Ishare | - | A single wire interface between each of the PEM forces them to share the load current. Ref: 54_OUT (-DC). |
| $I^2C$ Line 0 | SCL_0, SDA_0 | Input | $I^2C$ line 0. |
| $I^2C$ Line 1 | SCL_1, SDA_1 | Input | $I^2C$ line 1. |

## *Front Panel LEDs*

| | Analog Mode | I²C Mode | |
|---|---|---|---|
| | ◄ | **ON:** Input OK<br>**Blinking:** Input out of limits | ► |
| | ◄ | **ON:** Output OK<br>**Blinking:** Overload | ► |
| | **ON:** Over-temperature warning | **ON:** Over-temperature warning<br>**Blinking:** Service | |
| | ◄ **ON:** Fault ► | | |

## *Dimensions*




## *Ordering Information*

| Item | Description | Comcode |
|---|---|---|
| CP2000DC54PE | Active DC/DC Power Entry Module providing 2000W @ 54Vdc with Auxiliary Output of 5V @ 4W. PoE capability forthcoming, Consult factory for more details. | CC109121126 |

*Information on available shelves can be found in the Lineage Power Compact Power Line Shelves data sheet.*

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