GE Energy

Data Sheet

CAR2024FP series rectifier

Input: 90Vac to 264Vac; Output: 24Vdc @ 83A; 3.3Vdc or 5 Vdc @ 1A

Applications

- 24Vdc distributed power architectures
- Telecom Base Stations
- Mid to high-end Servers
- Enterprise Networking
- Network Attached Storage
- Telecom Access Nodes
- Routers/Switches
- Broadband Switches
- ATE Equipment

Features

- Universal input with PFC
- Constant power characteristic
- 3 front panel LEDs: input, output, fault
- Remote ON/OFF control of the 24Vdc output
- Remote sense on the 24Vdc output
- No minimum load requirements
- Redundant parallel operation
- Active load sharing (single wire)
- Hot Plug-ability
- Efficiency: typically 90% @ 50% load
- Standby orderable either as 3.3Vdc or 5Vdc
- Auto recoverable OC & OT protection
- Operating temperature: -10 - 70°C (de-rated above 50°C)
- Digital status & control: I^2C and PMBus serial bus
- EN/IEC/UL60950-1 2nd edition; UL, CSA and VDE
- EMI: class A FCC docket 20780 part 15, EN55022
- Meets EN6100 immunity and transient standards
- Shock & vibration: NEBS GR-63-CORE, level 3
- Operation at 4000m altitude

Description

The CAR2024FP series of Front-End rectifiers provide highly efficient isolated 2000 watts @ 24Vdc power from worldwide input mains in a compact 1U industry standard form factor in an unprecedented power density of 21W/in^3. These rectifiers are ideal for either datacom or telecom applications such as enterprise networking, remote base stations, mid to high-end servers, and storage equipment, where mid to light load efficiency is of key importance given the nature of the power consumption of the end application.

The high-density, front-to-back airflow is designed for minimal space utilization and is highly expandable for future growth. The industry standard PMBus compliant I^2C communications buss offers a full range of control and monitoring capabilities. The SMBAlert signal pin alerts customers automatically of any state change within the power supply.

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Absolute Maximum Ratings

Stresses in excess of the absolute maximum ratings can cause permanent damage to the device. These are absolute stress ratings only, functional operation of the device is not implied at these or any other conditions in excess of those given in the operations sections of the data sheet. Exposure to absolute maximum ratings for extended periods can adversely affect the device reliability.

Parameter	Device	Symbol	Min	Max	Unit
Input Voltage: Continuous	All	VIN	0	264	V_{ac}
Operating Ambient Temperature	All	TA	-10	70[1]	°C
Storage Temperature	All	Tstg	-40	85	°C
I/O Isolation voltage to Frame (100% factory Hi-Pot tested)	All			1500	V_{ac}

Electrical Specifications

Unless otherwise indicated, specifications apply over all operating input voltage, load, and temperature conditions.

INPUT

Parameter	Device	Symbol	Min	Typ	Max	Unit
Operational Range	All	V_{IN}	90	110/230	264	V_{ac}
Frequency Range (ETSI 300-132-1 recommendation)	All	F_{IN}	47	50/60	63	Hz
Main Output Turn_OFF	All	V_{IN}			85	V_{ac}
Maximum Input Current (V_O= $V_{O, set}$, I_O=$I_{O, max}$) V_{IN}= 100V_{ac} / V_{IN}= 180V_{ac}	All	I_{IN}			14.3 12.6	A_{ac}
Cold Start Inrush Current (Excluding x-caps, 25°C, <10ms, per ETSI 300-132)	All	I_{IN}			40	A_{peak}
Efficiency (T_{amb}=25°C, V_{in} = 230V_{ac}, V_{out}= 24Vdc, I_O=$I_{O, max}$) 100% load / 50% load / 20% load	All	η		90 90 84		%
Power Factor (Vin=230Vac, I_O=$I_{O, max}$)	All	PF		0.99		
Holdup time[2] (V_{out}= 24V_{dc}, Tamb 25°C, I_O=$I_{O, max}$) V_{in}= 220V_{ac} / V_{in}= 100V_{ac}	All	T		15 15		ms
Early warning prior to loss of DC output below regulation	All		3			ms
Ride through	All	T		10		ms
Leakage Current (Vin= 250Vac, Fin = 60Hz)	All	I_{IN}		3		mArms
Isolation Input/Output	All		3000			V_{ac}
Input/Frame			1500			V_{ac}
Output/Frame			100			V_{dc}

24V_{dc} MAIN OUTPUT

Parameter	Device	Symbol	Min	Typ	Max	Unit
Output Power HL / LL [180 – 264 / 90-132 Vac] V_{dc} ≥ 24V_{dc}	All	W	0	-	2000/1200	W
V_{dc} = 21V_{dc}			0	-	1743/1050	W
Set point	All	V_{out}	23.976	24.00	24.024	V_{dc}
Overall regulation (load, temperature, aging)	All		-3		+3	%
Remote sense voltage drop (both sense wires)					0.5	V_{dc}
Ripple and noise[3]	All				240	mV_{p-p}
Turn-ON overshoot	All				+3	%

[1] Derated above 50°C at 2.5%/°C

[2] 24V output can decay down to 20V

[3] Measured across a 10µf electrolytic and a 0.1µf ceramic capacitors in parallel. 20MHz bandwidth

$24V_{dc}$ MAIN OUTPUT (continued)						
Parameter	**Device**	**Symbol**	**Min**	**Typ**	**Max**	**Unit**
Turn-ON delay	All	T			2	sec
Remote ON/OFF delay time					40	ms
Turn-ON rise time (10 – 90% of V_{out})					60	ms
Transient response 50% step [10%-60%, 50% - 100%] (dI/dt – 1A/$_{out}$µs, recovery 300µs)	All	V_{out}	-5		+5	%V_{out}
Programmable range (hardware & software)	All		21		29	V_{dc}
Overvoltage protection, latched (recovery by cycling OFF/ON via hardware or software)	All		30	31	32	V_{dc}
Output current V_{in} = HL V_{in} = LL	All	I_{out}	0		83 50	A_{dc}
Current limit, Hiccup (programmable level)	All		110		130	% of FL
Active current share	All		-5		+5	% of FL

AUXILIARY OUTPUT						
Parameter	**Device**	**Symbol**	**Min**	**Typ**	**Max**	**Unit**
Set point	All	V_{out}		3.3 / 5.0		V_{dc}
Overall regulation (load, temperature, aging)	All	V_{out}	-5		+5	%
Ripple and noise	All				50	mVp-p
Output current	All	I_{out}	0		1	A_{dc}
Overload protection -						
Overvoltage protection						
Isolation Output/Frame	All		100			V_{dc}

General Specifications

Parameter	Min	Typ	Max	Units	Notes
Reliability		450,000		Hours	Full load, 25°C ; MTBF per SR232 Reliability protection for electronic equipment, issue 2, method I, case III,
Service Life		10		Years	Full load, excluding fans
Unpacked Weight		2.23/4.9		Kgs/Lbs	
Packed Weight		2.45/5.4		Kgs/Lbs	

Environmental, Reliability					
Parameter	**Min**	**Typ**	**Max**	**Units**	**Notes**
Ambient Temperature Operating Altitude Operating Power Derating	-10[4]		50 4000/13.1k 2.5 2.0	°C m / ft %/°C °C/1000 ft	Air inlet from sea level to 5,000 feet. 51°C to 70°C Above 5,000 ft
Storage Altitude non-operating	-40		85 8200/30k	°C m / ft	
Acoustic noise			55	dbA	Full load
Over-temperature Protection		125/110		°C	Shutdown / restart
Humidity Operating Storage	30 10		95 95	%	Relative humidity, non-condensing
Shock and Vibration acceleration			6	Grms	NEBS GR-63-CORE, Level 3, 20 -2000Hz, min 30 minutes
Earthquake Rating	4			Zone	NEBS GR-63-CORE, all floors, Seismic Zone 4 Designed and tested to meet NEBS specifications.
Reliability		400,000		Hrs	Full load, 25°C ; MTBF per SR232 Reliability protection for electronic equipment, method I, case III,
Service Life		10		Yrs	Full load, excluding fans

EMC				
Parameter	**Criteria**	**Standard**	**Level**	**Test**
AC input	Conducted emissions	EN55022, FCC Docket 20780 part 15, subpart J EN61000-3-2	A	0.15 – 30MHz 0 – 2 KHz
	Radiated emissions	EN55022	A	30 – 10000MHz
	Voltage dips	EN61000-4-11	A	-30%, 10ms
			B	-60%, 100ms
			B	-100%, 5sec
	Voltage surge	EN61000-4-5	A	4kV, 1.2/50µs, common mode
			A	2kV, 1.2/50µs, differential mode
immunity	Fast transients	EN61000-4-4	B	5/50ns, 2kV (common mode)
Enclosure immunity	Conducted RF fields	EN61000-4-6	A	130dBµV, 0.15-80MHz, 80% AM
	Radiated RF fields	EN61000-4-3	A	10V/m, 80-1000MHz, 80% AM
		ENV 50140	A	
	ESD	EN61000-4-2	B	4kV contact, 8kV air

[4] Designed to start at an ambient down to -40°C; meet spec after ≅ 30 min warm up period, may not meet operational limits below -10°C.

Status and Control

Some functions have two means of monitor/control; A signal level that represents the analog value being measured or controlled, or, reading/writing via the i^2C port the measured value or the control command.

Unless otherwise noted, control via the signals pins is 'active' so long that a firmware based command is not initiated. Once firmware initiates a command that is also represented on a signal pin, the firmware takes over and replaces the hardware based control signal. Firmware control is maintained until bias power to the processor is interrupted. Once bias power is removed the processor resets and the analog signal pin control is 'active' until firmware takes over control.

Details of analog controls are provided in this data sheet under Signal Definitions. GE Energy will provide separate application notes on the I2C protocol. Contact your local GE Energy representative for details.

Signal Definitions

All signals and outputs are referenced to Output return. These include 'Vstb return' and 'Signal return'.

Input Signals

Voltage programming (V_{prog}): An analog voltage on this signal can vary the output voltage ± 10% from 21Vdc to 29Vdc. The equation of this signal is:

$V_{out} = 21 + (V_{prog} * 3.2)$ $0 < V_{prog} < 2.5$

If $2.5 < Vprog < 3$, the output is 29V. If Vprog is > 3V or left open the programming signal is ignored and the unit output is set at the setpoint of 24Vdc.

Load share (Ishare): This is a single wire analog signal that is generated and acted upon automatically by power supplies connected in parallel. The Ishare pins should be tied together for power supplies if active current share among the power supplies is desired. No resistors or capacitors should get connected to this pin.

Remote ON/OFF: Controls the presence of the main 24Vdc output voltage. This is an open collector, TTL level control signal. This signal needs to be pulled HI externally through a resistor. Maximum collector voltage is 12Vdc and the maximum sink current is 1mA. A Logic 1 (TTL HI level) turns ON the 24Vdc output, while a Logic 0 (TTL LO level) turns OFF the 24Vdc output.

A turn OFF command either through this signal (Remote ON/OFF) or firmware commanded would turn OFF the 24V output.

Enable: This is a short signal pin that controls the presence of the 24Vdc main output. This pin should be connected to 'output return' on the system side of the output connector. The purpose of this pin is to ensure that the output turns ON after engagement of the power blades and turns OFF prior to disengagement of the power blades.

Write protect (WP): This signal protects the contents of the EEPROM from accidental over writing. When left open the EEPROM is write protected. A LO (TTL compatible) permits writing to the EEPROM. This signal is pulled HI internally by the power supply.

Output signals

Output current monitor (Imon): A voltage level of 0.1V/Amp proportional to the delivered output current is present on this pin. Accuracy: ± 500mV for loads > 25% FL.

AC OK: A TTL compatible status signal representing whether the input voltage is within the anticipated range. This signal needs to be pulled HI externally through a resistor. Maximum sink current ≤ 4mA and the max voltage is 12Vdc. Open collector (HI) on this signal indicates that the input voltage is applied within the specified input range.

DC OK: A TTL compatible status signal representing whether the output voltage is present. This signal needs to be pulled HI externally through a resistor. Maximum sink current ≤ 4mA and the max voltage is 12Vdc. Open collector (HI) on this signal indicates that the output voltage is present.

Over temp warning: A TTL compatible status signal representing whether an over temperature exists. This signal needs to be pulled HI externally through a resistor. Maximum sink current ≤ 4mA and the max voltage is 12Vdc. Open collector (HI) on this signal indicates that temperatures are normal.

If an over temperature should occur, this signal would pull LO for approximately 10 seconds prior to shutting down the power supply. The unit would restart if internal temperatures recover within normal operational levels. At that time the signal reverts back to its open collector (HI) state.

Fault: A TTL compatible status signal representing whether a Fault occurred. This signal needs to be pulled HI externally through a resistor. Maximum sink current ≤ 4mA and the max voltage is 12Vdc. Open collector (HI) on this signal indicates that no Fault is present.

This signal activates for OTP, OVP, OCP, AC fault or No output.

PS Present: This pin is connected to 'output return' within the power supply. Its intent is to indicate to the system that a power supply is present. This signal may need to be pulled HI externally through a resistor.

Interrupt (SMBAlert): A TTL compatible status signal, representing the SMBusAlert# feature of the PMBus compatible i^2C protocol in the power supply. This signal needs to be pulled HI externally through a resistor. Maximum sink current ≤ 4mA and the pull up resistor should be tied to 3.3Vdc. Open collector (HI) on this signal indicates that no Interrupt has been triggered.

Serial Bus Communications

The I²C interface facilitates the monitoring and control of various operating parameters within the unit and transmits these on demand over an industry standard I²C Serial bus.

All signals are referenced to 'Signal Return'.

Device addressing: The microcontroller (MCU) and the EEPROM have the following addresses:

Device	Address	Address Bit Assignments (Most to Least Significant)							
MCU	0xBx	1	0	1	1	A2	A1	A0	R/W
EEPROM	0xAx	1	0	1	0	A2	A1	A0	R/W

Address lines (A2, A1, A0): These signal pins allow up to eight (8) modules to be addressed on a single I²C bus. The pins are pulled HI internal to the power supply. For a logic LO these pins should be connected to 'Output Return'

Serial Clock (SCL): The clock pulses on this line are generated by the host that initiates communications across the I²C Serial bus. This signal is pulled up internally to 3.3V by a 10kΩ resistor. The end user should add additional pull up resistance as necessary to ensure that rise and fall time timing and the maximum sink current is in compliance to the I²C specifications.

Serial Data (SDA): This line is a bi-directional data line. . This signal is pulled up internally to 3.3V by a 10kΩ resistor. The end user should add additional pull up resistance as necessary to ensure that rise and fall time timing and the maximum sink current is in compliance to the I²C specifications.

EEPROM

The microcontroller has 96 bytes of EEPROM memory available for the system host.

Another separate EEPROM IC will provide another 128 bytes of memory with write protect feature. Minimum information to be included in this separate EEPROM: model number, revision, date code, serial number etc.

See the communications protocol for further information.

Communications Protocol

The I²C protocol is described in detail by the *I²C and PMBus Serial Communications Protocol for the CAR Family of Power Supplies* application note.

The following I²C protocol commands are not supported:

FAN1_SPEED_ I²C, FAN2_SPEED_ I²C

VIN_ I²C, IIN_ I²C, PIN_ I²C

The following PMBus protocol commands are not supported:

FAN_COMMAND_1	0 x 21
STATUS_FAN_1_2	0 x 81
READ_VIN	0 x 88
READ_IIN	0 x 89
READ_FAN_SPEED_1	0 x 90
READ_FAN_SPEED_2	0 x 91
READ_PIN	0 x A3

The STAUS_MFR_SPECIFIC (Register 0 x 80) has a bit changed;

Bit 5	0 = interrupt, 1 = no interrupt

LEDs

Three LEDs are located on the front faceplate. The AC LED provides visual indication of the INPUT signal function. When the LED is ON GREEN the power supply input is within normal design limits.

The second LED DC provides visual indication when the output is ON. When the LED is GREEN then the DC output is present.

The third LED FLT provides visual indication when a fault is present. When the LED is RED then a fault condition exists and the power supply does not provide output power.

Alarm Table

Test Condition		LED Indicator			Monitoring Signals			
		AC OK	DC OK	FAULT	FAULT	DC OK	INPUT OK	TEMP OK
1	Normal Operation	Green	Green	OFF	High	High	High	High
2	Low or NO INPUT	OFF	OFF	Red	Low	Low	Low	High
3	OVP	Green	OFF	Red	Low	Low	High	High
4	Over Current	Green	OFF	Red	Low	Low	High	High
5	Over Temp Alarm	Green	Green	OFF	High	High	High	Low
6	Over Temp Fault	Green	OFF	Red	Low	Low	High	Low
7	Remote ON/OFF, OFF	Green	OFF	Red	Low	Low	High	High

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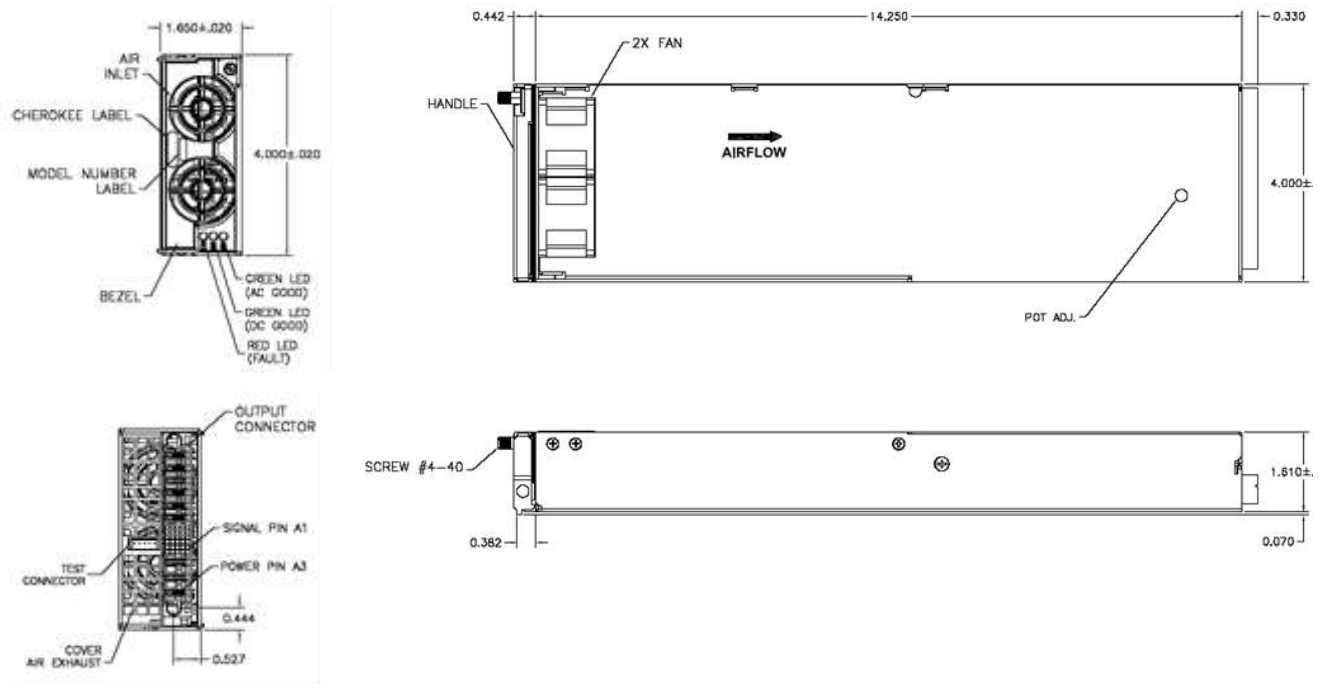
Note: Test condition #2 had 2 modules plug in. One module is running and the other one is with no AC.

Outline Drawing



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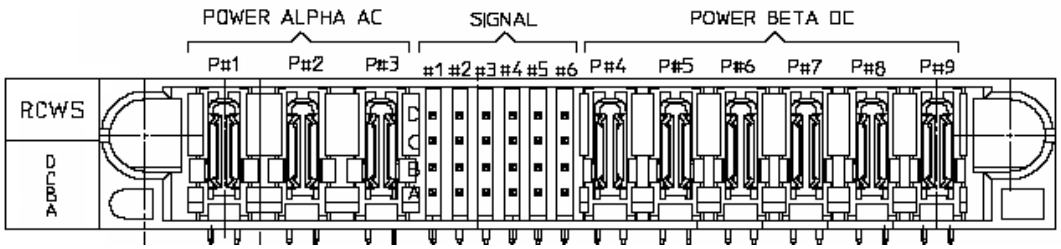
Connector Pin Assignments

Rear of power supply: Molex 87663-4002 or equivalent
FCI 51694-003

Mating connector: Molex P/N 87664-2001
FCI P/N 51810-004LF



Pin	Function	Pin	Function	Pin	Function	Pin	Function
A1	Vstb [3.3V]	B1	Fault	C1	ISHARE	D1	VProg
A2	PS Present	B2	I Monitor (IMON)	C2	N/C	D2	OVP Test Point
A3	Signal Return	B3	Enable: "0" –ON "1" -OFF	C3	Over Temp Warning	D3	Remote ON/OFF
A4	Write Protect (WP)	B4	Vstb Return	C4	I^2C Address (A0)	D4	DC OK
A5	Remote Sense (+)	B5	SDA (I^2C bus)	C5	I^2C Address (A1)	D5	AC OK
A6	Remote Sense (-)	B6	SCL (I^2C bus)	C6	I^2C Address (A2)	D6	SMBAlert
P1	Line	P2	Neutral	P3	Frame		
P4 – P6	+24Vdc					P7 – P9	Return

Ordering Information

Please contact your GE Energy Sales Representative for pricing, availability and optional features.

Contact Us

For more information, call us at

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PRODUCT	DESCRIPTION	PART NUMBER
2000W Front-End	+24Vout Front-End, 3.3Vaux, with face plate and PMBus interface	CAR2024FPBXXZ01A

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Contact Us

For more information, call us at

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