CAR1212DCBLC DC-DC converter

Input: -36V_{DC} to -75V_{DC}; Output: 12V_{DC} @ 1200W; 5 V_{DC} @ 1A



Applications

- Cellular Base Stations
- Satellite Hubs
- Network Equipment
- Network Attached Storage
- Telecom Access Nodes
- Routers/Switches
- Broadband Switches
- ATE Equipment

Features

- Input Or'ing
- Reverse input protection
- 3 front panel LEDs: 1-input;2-output; 3 - fault
- Output programmable from 10.8 – 13.2V_{DC}
- Remote ON/OFF control of the 12V_{DC} output
- Remote sense (up to 0.25V) on the 12V_{DC} output
- No minimum load requirements
- Redundant parallel operation
- Active load sharing (single wire)
- Hot pluggable
- Efficiency: typically 90%
- Standby 5V_{DC}
- 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/UL/CSA C22.2 60950-1 2nd edition +A1
- CE mark§
- EMI: Meets FCC Part 15, EN55022 Class A standards
- Meets EN61000 immunity and transient standards
- Shock & vibration: Meets IPC 9592 Class II standards

Description

This CAR1212DC DC-DC Converter provides highly efficient isolated power from DC input mains in a compact 1U industry standard form factor at a power density of 16.2W/in^3. This converter complements the CAR1212FP rectifier providing comprehensive solutions for systems connected either to commercial AC mains, 48/60V_{DC} power plants or telecom central offices. This plug and play approach offers significant advantages since systems can be reconfigured and repositioned readily by simply replacing the power system assembly. 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 SMBusAlert signal pin alerts customers automatically of any state change within the power supply.

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† *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 *CE* marking procedures 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
† The *PMBus* name and logo are registered trademarks of the System Management Interface Forum (SMIF)

imagination at work

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CAR1212DCBLC -DC converter

Input: -36V_{DC} to -75V_{DC}; Output: 12V_{DC} @ 1200W; 5 V_{DC} @ 1A

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	Symbol	Min	Max	Unit
Input Voltage: Continuous	V_{IN}	0	75	V_{DC}
Operating Ambient Temperature	T_A	-10	70[1]	°C
Storage Temperature	Tstg	-40	85	°C
I/O Isolation voltage (100% factory Hi-Pot tested)			1500	V_{DC}

Electrical Specifications

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

INPUT

Parameter	Symbol	Min	Typ	Max	Unit
Operational Range	V_{IN}	-36	-48/60	-75	V_{DC}
12V_{DC} output turned OFF				-35	
12V_{DC} output turned ON				-36	
Hysteresis between turn OFF and turn ON		2			
Input Overvoltage Protection (surge may last up to 100ms)				100	
Idling Power 12V_{DC} output OFF	W			35	W
12V_{DC} output ON				45	
Maximum Input Current (V_{IN}= -36V_{DC}, V_{OUT}= $V_{O,set}$, I_{OUT}=$I_{O,max}$)	I_{IN}			39	A_{DC}
Cold Start Inrush Current (Excluding x-caps, 25°C, <10ms, per ETSI 300-132)	I_{IN}			40	A_{PEAK}
Efficiency (including fan, T_{amb}=25°C, V_{IN}= -48V_{DC}, V_{OUT}= 12V_{DC}, 60-80% load)	η		90		%
Ride through time (V_{IN}= -48V_{DC}, V_{OUT} ≥ 10.8Vdc, T_{AMB} 25°C, I_{OUT}=$I_{O,max}$)	T		2.5		ms
Isolation Input/Output		1500			V_{DC}
Input/Frame		1500			V_{DC}
Output/Frame		100			V_{DC}

12V_{DC} MAIN OUTPUT

Parameter	Symbol	Min	Typ	Max	Unit
Output power	P_{OUT}	0		1200	W
Set point @ 50% load	V_{OUT}	11.9	12.00	12.1	V_{DC}
Overall regulation (load, temperature)		-2		+2	%
Remote sense (sum of hot & return)				0.25	V_{DC}
Ripple and noise[2]			120		mV_{p-p}

[1] Derated above 50°C at 2.5%/°C

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

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CAR1212DCBLC -DC converter

Input: -36V_{DC} to -75V_{DC}; Output: 12V_{DC} @ 1200W; 5 V_{DC} @ 1A

12V_{DC} MAIN OUTPUT (continued)					
Parameter	**Symbol**	**Min**	**Typ**	**Max**	**Unit**
Turn-ON overshoot	V_{OUT}			3	%
Turn-ON delay	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/µs, recovery 300µs)	V_{OUT}	-5		+5	%
Programmable range (hardware[3] & software)		10.8		13.2	V_{DC}
Programmed voltage accuracy			100		mV_{DC}
Overvoltage protection, latched_OFF (recovery by cycling OFF/ON via hardware or software)		14.5		15.5	V_{DC}
Output current V_{OUT}= 12V_{DC}	I_{OUT}	0		100	A_{DC}
Current limit, Latched_OFF (programmable to auto restart) Short circuit protection Latched_OFF (programmable to auto restart)	I_{OUT}	110		130	A_{DC}
Active current share	I_{OUT}	-5		+5	% of FL

5V_{DC} STANDBY OUTPUT					
Parameter	**Symbol**	**Min**	**Typ**	**Max**	**Unit**
Set point (optional 5Vstb)	V_{OUT}	4.9	5.0	5.1	V_{DC}
Overall regulation (load, temperature, aging)	V_{OUT}	-5		+5	%
Ripple and noise			50	66[4]	mVp-p
Output current	I_{OUT}	0		1	A_{DC}

General Specifications

Parameter	Min	Typ	Max	Units	Notes
Reliability, 25C, full load		250,000		Hrs	MTBF per SR232 Reliability protection for electronic equipment, method I, case III,
Service Life		10		Yrs	Full load, excluding fans
Weight		1.65 (3.7)		Kgs (Lbs)	

Feature Specifications

Unless otherwise indicated, specifications apply over all operating input voltage, resistive load, and temperature conditions. See Feature Descriptions for additional information.

Parameter	Symbol	Min	Typ	Max	Unit
Remote ON/OFF (Pulled HI internally within the module ≈ 40kΩ to 3.3V_{DC})					
Logic High (Module ON) – either N/C or apply V > 3V_{DC}	V_{IH}	2.0	—	3.5	V_{DC}
Logic Low (Module OFF)	I_{IL}	—	—	1	mA
	V_{IL}	0	—	0.8	V_{DC}

[3] Setpoint can be voltage programmable or programmed by a resistor divider. An internal 20kΩ from V_{prog} to 3.3V_{dc} is provided. Add a resistor to complete the divider from V_{prog} to output_return.

[4] Measured at the output with 0.1µf ceramic and a 10µf tantalum capacitor in parallel. 20mHz bandwidth limitation.

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CAR1212DCBLC -DC converter

Input: -36V_{DC} to -75V_{DC}; Output: 12V_{DC} @ 1200W; 5 V_{DC} @ 1A

Feature Specifications (continued)

Parameter	Symbol	Min	Typ	Max	Unit
Output Voltage programming (Vprog)					
Equation: V_{OUT} = 10.8 + (Vprog * 0.96)					
Vprog range	V_{prog}	0	—	2.5	V_{DC}
Programmed output voltage range	Vo	10.8	—	13.2	V_{DC}
Voltage adjustment resolution (8-bit A/D)	Vo	—	10	—	mV_{DC}
Output configured to 13.2V_{DC}	V_{prog}	2.5		3.0	V_{DC}
Output configured to the 12V_{DC} set-point	V_{prog}	3.0	—	—	V_{DC}
Enable (Pulled up internally via a 10kΩ resistor to 3.3V)					
12V output OFF	V_I	2.0	—	3.5	V_{DC}
12V output ON	V_I	0	—	0.8	V_{DC}
Write protect (Wp) (Pulled up internally via a 10kΩ resistor to 3.3V)					
Write protect enabled	V_I	2.0	—	3.5	V_{DC}
Write protect disabled	V_I	0	—	0.8	V_{DC}
INPUT-OK (Pulled up internally via a 10kΩ resistor to 3.3V)					
Logic High (Input within normal range)	V_{OH}	2.0	—	3.5	V_{DC}
Logic Low (Input out of range)	I_{OL}	—	—	20	mA
	V_{OL}	0	—	0.8	V_{DC}
DC-OK (Pulled up internally via a 10kΩ resistor to 3.3V)					
Logic High (Output voltage is present)	V_{OH}	2.0	—	3.5	V_{DC}
Logic Low (Output voltage is not present)	I_{OL}	—	—	20	mA
	V_{OL}	0	—	0.8	V_{DC}
Temperature OK (Pulled up internally via a 10kΩ resistor to 3.3V)					
Logic High (temperature within normal range)	V_{OH}	2.0	—	3.5	V_{DC}
Logic Low (temperature is too high)	I_{OL}	—	—	20	mA
	V_{OL}	0	—	0.8	V_{DC}
Delayed shutdown after Logic Low transition	Tdelay	10			sec
Fault (Pulled up internally via a 10kΩ resistor to 3.3V)					
Logic High (No fault is present)	V_{OH}	2.0	—	3.5	V_{DC}
Logic Low (Fault is present)	I_{OL}	—	—	20	mA
	V_{OL}	0	—	0.8	V_{DC}
PS Present					
Logic High (Power supply is not plugged in)					
Logic Low (Power supply is present)	V_{IL}	0	—	0.1	V_{DC}

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CAR1212DCBLC -DC converter

Input: -36V_{DC} to -75V_{DC}; Output: 12V_{DC} @ 1200W; 5 V_{DC} @ 1A

Feature Specifications (continued)

Parameter	Symbol	Min	Typ	Max	Unit
SMBAlert# (Interrupt) (Pulled up internally via a 10kΩ resistor to 3.3V)					
Logic High (No Alert - normal)	V_{OH}	2.0	—	3.5	V_{DC}
Logic Low (Alert is set)	I_{OL}	—	—	20	mA
	V_{OL}	0	—	0.8	V_{DC}
Output current monitor (Imon)					
Resolution			100		mV/A
Accuracy		-250		+250	mV
Measurement range	I_o	0		100	A_{DC}
Analog output range	V_{mon}	0		10	V_{DC}
Sourced output current	I_o			5	mA_{DC}

Digital Interface Specifications

Parameter	Conditions	Symbol	Min	Typ	Max	Unit
PMBus Signal Interface Characteristics						
Input Logic High Voltage (CLK, DATA)		V_{IH}	2.1		3.6	V_{DC}
Input Logic Low Voltage (CLK, DATA)		V_{IL}	0		0.8	V_{DC}
Input high sourced current (CLK, DATA)		I_{IH}	0		10	µA
Output Low sink Voltage (CLK, DATA, SMBALERT#)	I_{OUT}=3.5mA	V_{OL}			0.4	V_{DC}
Output Low sink current (CLK, DATA, SMBALERT#)		I_{OL}	3.5			mA
Output High open drain leakage current (CLK,DATA, SMBALERT#)	V_{OUT}=3.6V	I_{OH}	0		10	µA
PMBus Operating frequency range	Slave Mode	F_{PMB}	10		400	kHz
Measurement System Characteristics						
Clock stretching		$t_{STRETCH}$			25	ms
I_{OUT} measurement range	Linear	I_{RNG}	0		100	A_{DC}
I_{OUT} measurement accuracy 25°C		I_{ACC}	-10		+10	%
V_{OUT} measurement range	Linear	$V_{OUT(rng)}$	0		14	V_{DC}
V_{OUT} measurement accuracy		$V_{OUT(acc)}$	-5		+5	%
Temp measurement range	Linear	$Temp_{(rng)}$	0		120	°C
Temp measurement accuracy[5]		$Temp_{(acc)}$	-5		+5	%

[5] Temperature accuracy reduces non-linearly with decreasing temperature

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CAR1212DCBLC -DC converter

Input: -36V_{DC} to -75V_{DC}; Output: 12V_{DC} @ 1200W; 5 V_{DC} @ 1A

Environmental Specifications

Parameter	Min	Typ	Max	Units	Notes
Ambient Temperature	-10[6]		70	°C	Air inlet from sea level to 5,000 feet.
Storage Temperature	-40		85	°C	
Operating Altitude			2250/7382	m / ft	
Non-operating Altitude			8200/30k	m / ft	
Power Derating with Temperature			2.5	%/°C	51°C to 70°C[7]
Operating Temperature Derating with Altitude			2.0	°C/305 m °C/1000 ft	Above 2250/7382 m/ft; 3962/13000 m/ft max
Acoustic noise		55		dbA	25°C, half load
Humidity Operating Storage	 30 10		 95 95	 % %	Relative humidity, non-condensing
Shock and Vibration	Meet IPC 9592 Class II, Section 5 requirements				

EMC Compliance

EMC

Parameter	Function	Standard	Level	Criteria	Test
DC input	Conducted emissions	EN55022, FCC Part 15 Telcordia GR1089-CORE	A		0.15 – 30MHz
	Radiated emissions	EN55022	A		30 – 10000MHz
DC input immunity	Voltage dips	IEC 61000-4-29 [V_{IN} start: 50Vdc]		A	-30%, 10ms
				B	-60%, 100ms
				A	-100%, 2.5ms
				B	-100%, 5sec
	Voltage surge	EN61000-4-5	3	A	2kV, 1.2/50µs, common mode
			3	A	1kV, 1.2/50µs, differential mode
	Fast transients	EN61000-4-4	2	A	5/50ns, 1kV (common mode)
Enclosure immunity	Conducted RF fields	EN61000-4-6	A		130dBµV, 0.15-80MHz, 80% AM
	Radiated RF fields	EN61000-4-3, level 3	A		10V/m, 80-1000MHz, 80% AM
		ENV50140	A		
	ESD	EN61000-4-2, level 3	B		6kV contact, 8kV air

Criteria	Performance
A	No performance degradation
B	Temporary loss of function or degradation not requiring manual intervention
C	Temporary loss of function or degradation that may require manual intervention
D	Loss of function with possible permanent damage

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

[7] The maximum operational ambient is reduced in Europe in order to meet certain power cord maximum ratings of 70°C. The maximum operational ambient where 70°C rated power cords are utilized is reduced to 60°C until testing demonstrates that a higher level is acceptable.

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CAR1212DCBLC -DC converter

Input: -36V$_{DC}$ to -75V$_{DC}$; Output: 12V$_{DC}$ @ 1200W; 5 V$_{DC}$ @ 1A

Characteristic Curves

The following figures provide typical characteristics for the CAR1212DC converter at 25°C

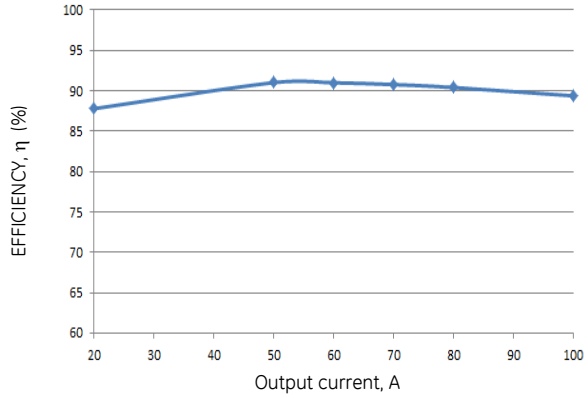


Figure 1. Converter Efficiency versus Output Current.

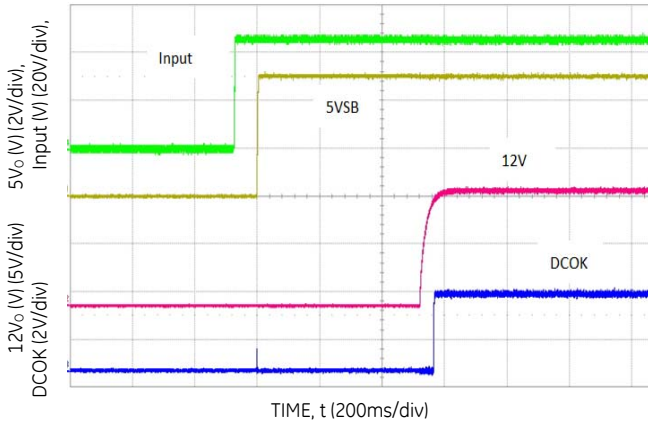


Figure 2. Input start up (Vin: -48V$_{DC}$, full load).

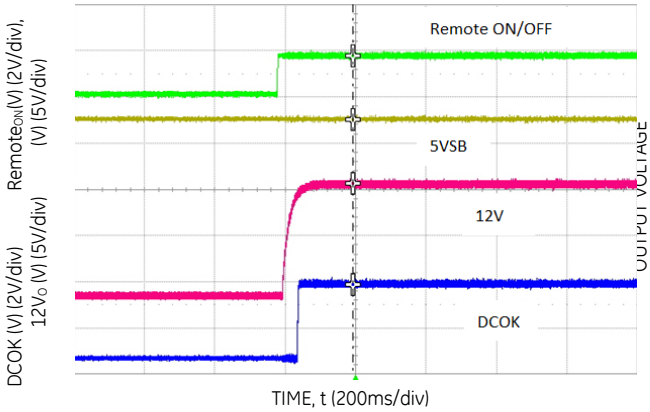


Figure 3. Start-up Using Remote On/OFF (Vin: -48V$_{DC}$, full load)

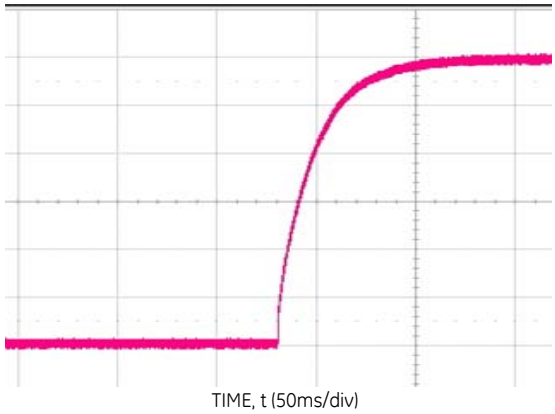


Figure 4. 12V start-up (Vin: -48V$_{DC}$, full load)

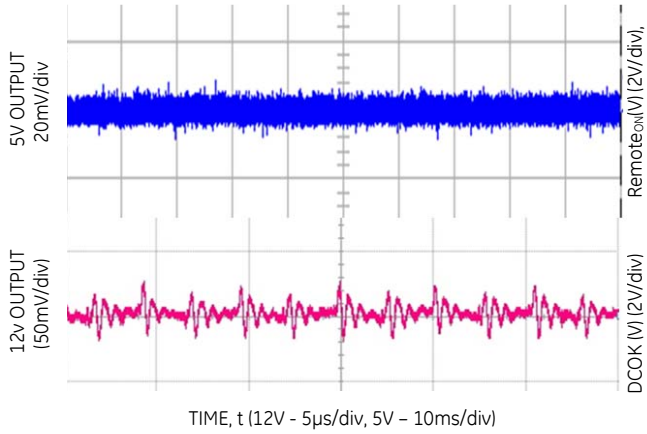


Figure 5. 12V output ripple and noise (Vin: -48V$_{DC}$, full load).

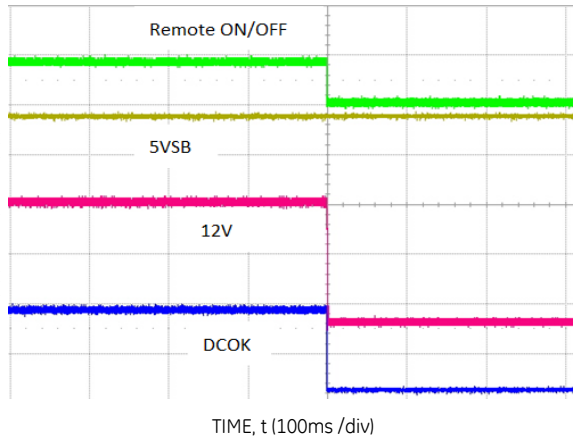


Figure 6. Turn-OFF via Remote ON/OFF (Vin: -48V$_{DC}$, full load)

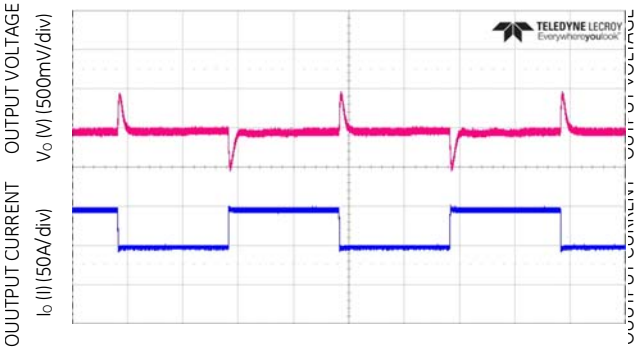
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CAR1212DCBLC -DC converter

Input: -36V$_{D\,C}$ to -75V$_{DC}$; Output: 12V$_{DC}$ @ 1200W; 5 V$_{DC}$ @ 1A

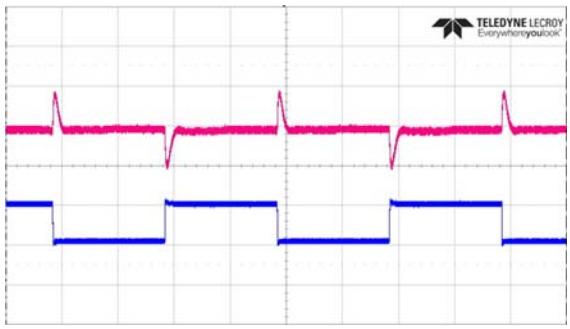
Characteristic Curves (continued)

The following figures provide typical characteristics for the CAR1212DC converter at 25°C.



TIME, t (5ms/div)

Figure 7. Transient response 12V$_{DC}$ output load step 10 – 60A, V$_{IN}$ = -48V$_{DC}$.



TIME, t (5ms/div)

Figure 8. Transient response 12V$_{DC}$ output load step 50 – 100A, V$_{IN}$ = -48V$_{DC}$.

SYSTEM CURRENT STEPS

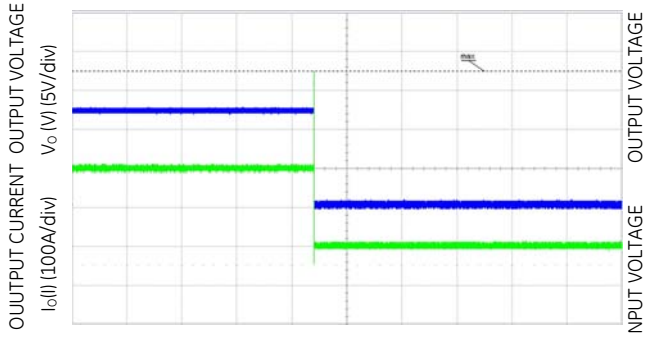
% LOAD	I total(A)	I UNIT #1	I UNIT #2	% I share
100	200	96.89	102.6	**2.8%**
75	150	72.56	78.21	**2.8%**
50	100	47.46	52.64	**2.5%**
30	60	28.41	32.61	**2.1%**
20	40	18.42	21.83	**1.7%**

TOTAL & INDIVIDUAL CURRENT READINGS / %ISHARE

Table 9. Current share between two modules

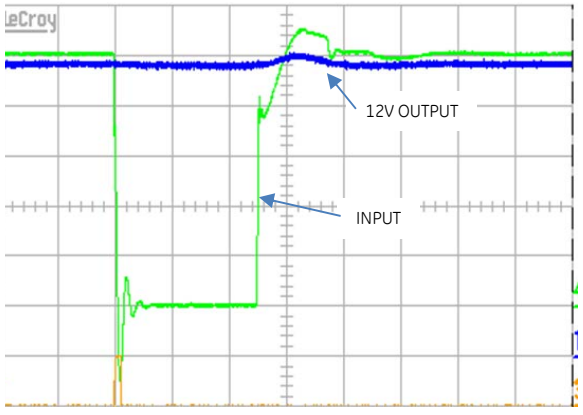
	NO LOAD	FULL LOAD
	25 ℃	25 ℃
Turn on point(V)	34.9	34.9
Turn off point(V)	30.5	30.8
Hysteresis(V)	4.4	4.1

Table 10. Input Turn OFF and Turn ON.



TIME, t (500ms/div)

Figure 11. Overload: output short circuit performance, the unit is in latch_OFF mode. , V$_{IN}$ = -48V$_{DC}$.



TIME, t (1ms/div)

Figure 12. Ride through: full load Vin = -48V$_{DC}$

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CAR1212DCBLC -DC converter

Input: -36V_{DC} to -75V_{DC}; Output: 12V_{DC} @ 1200W; 5 V_{DC} @ 1A

Control and Status

Control hierarchy: Some features, such as output voltage, can be controlled both through hardware and firmware. For example, the output voltage is controlled both by the signal pin (Vprog) and the PMBus command, (Vout_command) .

Using output voltage as an example; the Vprog signal pin has ultimate control of the output voltage until the Vprog is either > 3V_{DC} or a no connect. When the programming signal via Vprog is either a no connect or > 3V_{DC}, it is ignored, the output voltage is set at its nominal 12V_{DC} and the unit output voltage can be controlled via the PMBus command, (Vout_command).

Analog controls: Details of analog controls are provided in this data sheet under Signal Definitions.

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

Control Signals

Voltage programming (Vprog): An analog voltage on this signal can vary the output voltage from 10.8V_{DC} to 13.2V_{DC}. The equation of this signal is:

V_{OUT} = 10.8 + (Vprog * 0.96) where Vprog = 0.1 to 2.5V

Between 2.5 and 3V the output stays at 13.2V_{DC}. If Vprog is > 3V, or left open, the programming signal is ignored and the unit output is set at the setpoint of 12V_{DC}.

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 presence of the main 12V_{DC} output voltage on the output connector. This signal is pulled HI internally. Leaving this pin a no-connect turns ON the 12V_{DC} output. Applying a Logic 0 (TTL LO level) to this pin turns OFF the 12V_{DC} output.

A turn OFF command either through this signal (Remote ON/OFF) or firmware commanded would turn OFF the 12V output.

Enable: This is a short signal pin that controls the presence of the 12V_{DC} on the output connector. 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.

Status signals

Output current monitor (Imon): A voltage level proportional to the delivered output current is present on this pin. The signal level is 0.1V per amp ± 0.25V.

INPUT 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. 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. Open collector (HI) on this signal indicates that the output voltage is present.

Temperature OK: A TTL compatible status signal representing whether an over temperature exists. This signal needs to be pulled HI externally through a resistor. 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 reduce 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. Open collector (HI) on this signal indicates that no Fault is present.

This signal activates for OTP, OVP, OCP, INPUT 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 to detect a missing module.

Interrupt (SMBAlert): A TTL compatible status signal, representing the SMBusAlert# feature of the PMBus compatible I²C protocol in the power supply. This signal needs to be pulled HI externally through a resistor. Open collector (HI) on this signal indicates that no Interrupt has been triggered.

Serial Bus Communications

The I²C interface incorporated within the CAR1212DC modules 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 Bit)							
MCU	0xBx	1	0	1	1	A2	A1	A0	R/W
Broadcast	0x00	0	0	0	0	0	0	0	0
EEPROM	0xAx	1	0	1	0	A2	A1	A0	R/W

The **Global Broadcast** instruction executes a simultaneous ***write*** instruction to all power supplies. A ***read*** instruction cannot be accessed globally. The three programmable address bits are the same for all I²C accessible devices within the power supply.

Address lines (A2, A1, A0): These signal pins allow up to eight (8) CAR1212DC 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.

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CAR1212DCBLC -DC converter

Input: -36V_{DC} to -75V_{DC}; Output: 12V_{DC} @ 1200W; 5 V_{DC} @ 1A

Digital Feature Descriptions

PMBus™ compliance: The power supply is fully compliant to the Power Management Bus (PMBus™) rev1.2 requirements.

Manufacturer specific commands located between addresses 0xD0 to 0xEF provide instructions that either do not exist in the general PMBus specification or make the communication interface simpler and more efficient.

Master/Slave: The 'host controller' is always the MASTER. Power supplies are always SLAVES. SLAVES cannot initiate communications or toggle the Clock. SLAVES also must respond expeditiously at the command of the MASTER as required by the clock pulses generated by the MASTER.

Clock stretching: The 'slave' µController inside the power supply may initiate clock stretching if it is busy and it desires to delay the initiation of any further communications. During the clock stretch the 'slave' may keep the clock LO until it is ready to receive further instructions from the host controller. The maximum clock stretch interval is 25ms.

The host controller needs to recognize this clock stretching, and refrain from issuing the next clock signal, until the clock line is released, or it needs to delay the next clock pulse beyond the clock stretch interval of the power supply.

Note that clock stretching can only be performed after completion of transmission of the 9th ACK bit, the exception being the START command.

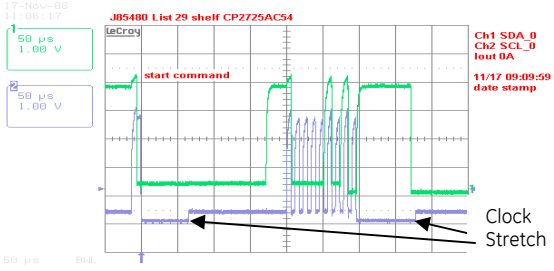


Figure 13. Example waveforms showing clock stretching.

I²C Bus Lock-Up detection: The device will abort any transaction and drop off the bus if it detects the bus being held low for more than 35ms.

Communications speed: Both 100kHz and 400kHz clock rates are supported. The power supplies default to the 100kHz clock rate. The minimum clock speed specified by SMBus is 10 kHz.

Packet Error Checking (PEC): Commands issued without the correct trailing PEC will not be executed. The integrity of communications is compromised if packet error correction is not employed. There are many functional features, including turning OFF the main output, that require validation to ensure that the correct command is executed.

PEC is a CRC-8 error-checking byte, based on the polynomial $C(x) = x^8 + x^2 + x + 1$, in compliance with PMBus™ requirements. The calculation is based in all message bytes, including the originating write address and command bytes preceding read instructions. The PEC is appended to the message by the device that supplied the last byte.

SMBAlert#: The µC driven SMBAlert# signal informs the 'master/host' controller that either a STATE or ALARM change has occurred. Normally this signal is HI. The signal will change to its LO level if the power supply has changed states and the signal will be latched LO until the power supply either receives a 'clear' instruction as outlined below or executes a READ STATUS_WORD. If the alarm state is still present after the STATUS registers were reset, then the signal will revert back into its LO state again and will latch until a subsequent reset signal is received from the host controller.

The signal will be triggered for any state change, including the following conditions;

- VIN and under or over voltage
- IOUT over current
- Over Temperature warning or fault
- Fan Failure
- Communication error
- PEC error
- Invalid command
- Internal faults

The power supply will clear the SMBusAlert# signal (release the signal to its HI state) upon the following events:

- Receiving a CLEAR_FAULTS command
- The main output recycled (turned OFF and then ON) via the ENABLE signal pin
- The main output recycled (turned OFF and then ON) by the OPERATION command

Global broadcast: This is a powerful command because it can instruct all power supplies to respond simultaneously in one command. But it does have a serious disadvantage. Only a single power supply needs to pull down the ninth *acknowledge* bit. To be certain that each power supply responded to the global instruction, a *READ* instruction should be executed to each power supply to verify that the command properly executed. The GLOBAL BROADCAST command should only be executed for write instructions to slave devices.

Read back delay: The power supply issues the SMBAlert # notification as soon as the first state change occurred. During an event a number of different states can be transitioned to before the final event occurs. If a read back is implemented rapidly by the host a successive SMBAlert# could be triggered by the transitioning state of the power supply. In order to avoid the triggering of successive SMBAlert# s and thus reading a transitioning state, it is prudent to wait more than 2 seconds after the receipt of an SMBAlert# before executing a read back. This delay will ensure that only the final state of the power supply is captured.

Successive read backs: Successive read backs to the power supply should not be attempted at intervals faster than every one second. This time interval is sufficient for the internal processors to update their data base so that successive reads provide fresh data.

PMBus™ Commands

Standard instruction: Up to two bytes of data may follow an instruction depending on the required data content. Analog data is always transmitted as LSB followed by MSB. PEC is optional and includes the address and data fields.

1	8		1	8	1
S	Slave address	Wr	A	Command Code	A

8	1	8	1	8	1	1
Low data byte	A	High data byte	A	PEC	A	P

Master to Slave Slave to Master

SMBUS annotations; S – Start , Wr – Write, Sr – re-Start, Rd – Read, A – Acknowledge, NA – not-acknowledged, P – Stop

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CAR1212DCBLC -DC converter

Input: -36V_{DC} to -75V_{DC}; Output: 12V_{DC} @ 1200W; 5 V_{DC} @ 1A

Standard READ: Up to two bytes of data may follow a READ request depending on the required data content. Analog data is always transmitted as LSB followed by MSB. PEC is mandatory and includes the address and data fields. PEC is optional and includes the address and data fields.

1	7	1	1	8	1
S	Slave address	Wr	A	Command Code	A

1	7	1	1	8	1
Sr	Slave Address	Rd	A	LSB	A

8	1	8	1	1
MSB	A	PEC	No-ack	P

Block instruction: When writing or reading more than two bytes of data at a time BLOCK instructions for WRITE and READ commands must be used instead of the Standard Instructions.

Block write format:

1	7	1	1		8	1
S	Slave address	Wr	A		Command Code	A

8	1	8	1	8		1
Byte count = N	A	Data 1	A	Data 2		A

8	1	8	1	8	1	1
.....	A	Data 48	A	PEC	A	P

Block read format:

1	7	1	1		8	1
S	Slave address	Wr	A		Command Code	A

1	7	1	1
Sr	Slave Address	Rd	A

8	1	8	1	8		1
Byte count = N	A	Data 1	A	Data 2		A

8	1	8	1	8	1	1
.....	A	Data 48	A	PEC	NoAck	P

Linear Data Format The definition is identical to Part II of the PMBus Specification. All standard PMBus values, with the exception of output voltage related functions, are represented by the linear format described below. Output voltage functions are represented by a 16 bit mantissa. Output voltage has a E=9 constant exponent.

The Linear Data Format is a two byte value with an 11-bit, two's complement mantissa and a 5-bit, two's complement exponent or scaling factor, its format is shown below.

	Data Byte High								Data Byte Low							
Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
	Exponent (E)					Mantissa (M)										

The relationship between the Mantissa, Exponent, and Actual Value (V) is given by the following equation:

$$V = M * 2^{E}$$

Where:

V is the value

M is the 11-bit, two's complement mantissa

E is the 5-bit, two's complement exponent

PMBus™ Command set:

Command	Hex Code	Data Byte	Write	Function / Default
Operation	01	1	W	0 x 80
ON_OFF_config	02	1		0 x 1F
Clear_faults	03	0		Clear Status
Write_protect	10	1	W	0 x 80
Store_default_all	11	0	W	Store permanently
Restore_default_all	12	0		Reset defaults
Vout_mode	20	1		0 x 17
Vout_command	21	2	W	Set Vout
Fan_config_1_2	3A	1	W	RPM or duty cycle
Fan_speed_control	3B	2	W	Set fan speed
Vout_OV_fault_limit	40	2	W	14
Vout_OV_fault-response	41	1		0 x 80
Vout_OV_warn_limit	42	2	W	13.5
Iout_OC_fault_limit	46	2	W	115
Iout_OC_fault_response	47	1	W	0x41
Iout_OC_warn_limit	4A	2	W	105
OT_fault_limit	4F	2	W	115
OT_fault_response	50	1	W	0 x C0
OT_warn_limit	51	2	W	112
Vin_OV_fault_limit	55	2	W	80
Vin_OV_fault_response	56	1		0 x C0
Vin_OV_warn_limit	57	2	W	77
Vin_UV_warn_limit	58	2	W	35
Vin_UV_fault_limit	59	2	W	32
Vin_UV_fault_response	5A	1		0 x C0
Status_byte	78	1		
Status_word	79	2		
Status_Vout	7A	1		
Status_Iout	7B	1		
Status_input	7C	1		
Status_temperature	7D	1		
Status_CML	7E	1		
Status_mfr_specific	80	1		
Status_fan_1_2	81	1		
Read_Vin	88	2		Read input voltage
Read_Vout	8B	2		Read output voltage
Read_Iout	8C	2		Read output current
Read_temperature_1	8D	2		Read temperature
Read_Pin	97	2		Read input power
PMBus revision	98	1		
Read fan_speed	90	2		Reads in RPM
Mfr_ID	99	5		FRU_ID
Mfr_model	9A	15		
Mfr_revision	9B	4		
Mfr_location	9C	4		
Mfr_date	9D	6		
Mfr_serial	9E	15		
Mfr_Vin_min	A0	2		36V (linear format)
Mfr_Vin_max	A1	2		75V (linear format)
Mfr_Iin_max	A2	2		40A (linear format)
Mfr_Pin_max	A3	2		1400W (linear format)
Mfr_Vout_min	A4	2		10V (linear format)
Mfr_Vout_max	A5	2		15V (linear format)
Mfr_Iout_max	A6	2		100A (linear format)
Mfr_Pout_max	A7	2		1200W (linear format)
Mfr_Tambient_max	A8	2		70C (linear format)
Mfr_Tambient_min	A9	2		-10C (linear format)
FRW_revision	D0	1		

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CAR1212DCBLC -DC converter

Input: -36V_{DC} to -75V_{DC}; Output: 12V_{DC} @ 1200W; 5 V_{DC} @ 1A

Command	Hex Code	Data Byte	Write	Function
Fan_duty_cycle_ I²C	D6	1		Duty_cycle read in %
DCOKHI_ I²C	E6	2		(1/512V)
DCOKLO_ I²C	E7	2		(1/512V)

Status Register Bit Allocation:

Register	Hex Code	Data Byte	Function
Status_Byte [0 – normal 1 – fault]	78	7	Busy
		6	DC_ OFF
		5	Output OV Fault
		4	Output OC Fault
		3	Input UV Fault
		2	Temp Fault/warning
		1	CML (communication fault)
		0	None of Below
Status_word (includes Status_byte) [0 – normal 1 – fault]	79	7	V_{OUT} Fault/Warning detected
		6	OC Fault/Warning detected
		5	Input Fault/Warning
		4	Mfr_specific register change
		3	nPower_Good
		2	Fan Fault or Warning
		1	Other fault
		0	Unknown
Status_Vout [0 – normal 1 – fault]	7A	7	Vout OV Fault
		6	Vout OV Warning
		5	Vout UV Warning
		4	Vout UV Fault
		3	N/A
		2	N/A
		1	N/A
		0	N/A

Register	Hex Code	Data Byte	Function
Status_Iout [0 – normal 1 – fault]	7B	7	IOUT OC Fault
		6	N/A
		5	IOUT OC Warning
		4	N/A
		3	N/A
		2	N/A
		1	N/A
		0	N/A
Status_input [0 – normal 1 – fault]	7C	7	Vin OV Fault
		6	Vin OV Warning
		5	Vin UV Warning
		4	Vin UV Fault
		3	N/A
		2	N/A
		1	N/A
		0	N/A
Status_temperature [0 – normal 1 – fault]	7D	7	OT Fault
		6	OT Warning
		5	N/A
		4	N/A
		3	N/A
		2	N/A
		1	N/A
		0	N /A
Status_cml [0 – normal 1 – fault]	7E	7	Invalid/Unsupported Command
		6	Invalid/Unsupported Data
		5	Packet Error Check Failed
		4	Memory Fault Detected
		3	Processor Fault Detected
		2	Reserved
		1	Other Communications Fault
		0	Other Memory or Logic Fault
Status_mfr_specific [1 – normal 0 – fault]	80	7	5V_fault
		6	OVSD
		5	Interrupt
		4	Fault detected
		3	PS_remote_OFF
		2	DC_fault
		1	INPUT_fault
		0	N/A
Status_fan_1_2 [0 – normal 1 – fault]	81	7	Fan 1 Fault
		6	Fan 2 Fault
		5	N/A
		4	N/A
		3	Fan 1 Speed Overridden
		2	Fan 2 Speed Overridden
		1	N/A
		0	N/A

Command Descriptions

Operation (01) : By default the Power supply is turned **ON** at power up as long as *Power ON/OFF* signal pin is active HI. The Operation command is used to turn the Power Supply ON or OFF via the PMBus. The data byte below follows the OPERATION command.

FUNCTION	DATA BYTE
Unit ON	80
Unit OFF	00

To **RESET** the power supply cycle the power supply OFF, wait at least 2 seconds, and then turn back ON. All alarms and shutdowns are cleared during a restart.

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CAR1212DCBLC -DC converter

Input: -36V_{DC} to -75V_{DC}; Output: 12V_{DC} @ 1200W; 5 V_{DC} @ 1A

Clear_faults (03): This command clears all STATUS and FAULT registers and resets the SMBAlert# line.

If a fault still persists after the issuance of the clear_faults command the specific registers indicating the fault are reset and the SMBAlert# line is activated again.

WRITE_PROTECT register (10): Used to control writing to the PMBus device. The intent of this command is to provide protection against accidental changes. All supported command parameters may have their parameters read, regardless of the write_protect settings. The contents of this register can be stored to non-volatile memory using the Store_default_code command. The default setting of this register is disable_all_writes except write_protect 0x80h. This default cannot be changed.

FUNCTION	DATA BYTE
Enable all writes	0 x 00
Disable all writes except write_protect	0 x 80
Disable all writes except write_protect and OPERATION	0 x 40

Vout_Command (21) : This command is used to change the output voltage of the power supply. Changing the output voltage should be performed simultaneously to all power supplies operating in parallel using the Global Address (Broadcast) feature. If only a single power supply is instructed to change its output, it may attempt to source all the required power which can cause either a power limit or shutdown condition.

Software programming of output voltage permanently overrides the set point voltage configured by the **Vprog** signal pin. The program no longer looks at the '**Vprog** pin' and will not respond to any hardware voltage settings. If power is removed from the µController it will reset itself into its default configuration looking at the **Vprog** signal for output voltage control. In many applications, the **Vprog** pin is used for setting initial conditions, if different that the factory setting. Software programming then takes over once I²C communications are established.

Vout_OV[OT]_fault_limit (40[4F]): Provides the capability to change the OV[OT] shutdown limit. The unit ensures that the changed value is within adjustable levels and within the max/min limits. If the requested value is not within max/min limits the change should not take place and a CML error should be issued.

Vout_OV[OT]_warn_limit (42[51]): **OV[OT]_warning** is extremely useful because it gives the system controller a heads up that the output voltage/temperature is drifting out of regulation and the power supply is close to shutting down. Preemptive action may be taken before the power supply would shut down and potentially disable the system.

OC and OT_fault_ response (47, 50): The default response for OC and OT is shown in the tables. Each register, individually, can be reconfigured into the opposite state. Latched_OFF and hiccup are the only supported states.

Restart after a latch_OFF: Either of four restart possibilities are available. The hardware pin **Remote ON/OFF** may be turned OFF and then ON**.** The unit may be commanded to restart via i2c through the *Operation* command by first turning OFF then turning ON . The third way to restart is to remove and reinsert the unit. The fourth way is to turn OFF and then turn ON ac power to the unit. Each of these commands must keep the power supply in the OFF state for at least 2 seconds, with the exception of changing to **restart**.

A power system that is comprised of a number of power supplies could have difficulty restarting after a shutdown event because of the non-synchronized behavior of the individual power supplies. Implementing the latch_OFF mechanism permits a synchronized restart that guarantees the simultaneous restart of the entire system.

A synchronous restart can be implemented by;

1. Issuing a GLOBAL OFF and then ON command to all power supplies,
2. Toggling OFF and then ON the **Remote ON/OFF** signal
3. Removing and reapplying input commercial power to the entire system.

The power supplies should be turned OFF for at least 20 – 30 seconds in order to discharge all internal bias supplies and reset the soft start circuitry of the individual power supplies.

Auto_restart: Auto-restart is the default configuration for recovering from over-current and over-temperature shutdowns.

An overvoltage shutdown is followed by three attempted restarts, each restart delayed 1 second, within a 1 minute window. If within the 1 minute window three attempted restarts failed, the unit will latch_OFF If less than 3 shutdowns occur within the 1 minute window then the count for latch_OFF resets and the 1 minute window starts all over again.

Vin_UV_warn_limit (58): This is another warning flag indicating that the input voltage is decreasing dangerously close to the low input voltage shutdown level.

Status_word (79): returns two bytes of information. The upper byte bit functionality is tabulated in the Status_word section. The lower byte bit functionality is identical to Status_byte.

Fan_speed (D7): This register can be used to 'read' the fan speed in adjustment percent (0 – 100%) or set the fan speed in adjustment percent (0 – 100%). The speed of the fan cannot be reduced below what the power supply requires for its operation. The register value is the percent number, it is not in linear format.

FRU_ID all in ASCII except mfr_revision

Mfr_ID (99): 5 characters: **GE-CP** (General Electric - Critical Power)

Mfr_model (9A): product name example: **CAR1212DCBLCZ1A**

Mfr-revision (9B): Total 4 hex bytes

Each byte is partitioned into high and low nibbles.

Example: 99 is read as 9.9 [numerical digits only]
11 is read as 1.1

Series	Hardware Rev	Primary µC	Secondary µC

Mfr_location (9C): up to 4 bytes identifying country of manufacture.

Mfr_date (9D): Follows standard PMBus format YYMMDD

Mfr_serial (9E): Product serial number includes the manufacturing date, manufacturing location in up to 15 characters. For example:

13KZ51018193xxx, is decoded as;

13 – year of manufacture, 2013

KZ – manufacturing location, in this case Matamoros

51 – week of manufacture

018193xxx – serial #, mfr choice

note: if the additional xxx space is not utilized then_'s (spaces) are filled in, (i.e. 018193___), ensuring that the actual serial number is clearly identified.

Note: The actual data in the FRU_ID registers may deviate from the above representation at the discretion of the manufacturing location.

Invalid commands or data: The power supply notifies the MASTER if a non-supported command has been sent or invalid data has been received. Notification is implemented by setting the appropriate STATUS and ALARM registers and setting the SMBAlert# flag. An invalid command always returns a value of 0 x 00.

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CAR1212DCBLC -DC converter

Input: -36V_{DC} to -75V_{DC}; Output: 12V_{DC} @ 1200W; 5 V_{DC} @ 1A

Control and Read accuracy:

The estimates below are believed to be reasonable under most operating conditions. However, these are typical numbers and not hard bound values that cannot be exceeded. In most nominal operating conditions the returned values are significantly better than these estimates.

FUNCTION	ACCURACY
Vout_command	± 2%
Vout_OV_fault_limit	± 3%
Iout_OC_warn_limit	± 4% of FL
OT_warn_limit (see note below)	± 5°C
Vin_UV_warn_limit	± 3%
Vin_UV_fault_limit	± 3%
Read_Vout	± 2%
Read_Iout	± 4% of FL
Read_temperature (see note below)	± 5°C

Note: Temperature accuracy is estimated near the shutdown point around 100°C. At lower temperatures the accuracy is much reduced

Fan speed: Speed control can vary from 0 – 100% duty cycle, where 100% is 16,000 RPM. Internal control is designed to minimize fan speed to that level that is required, thereby ensuring quiet operational levels.

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. This EEPROM is only for customer.

LEDs

Three LEDs are located on the front faceplate. When the LEDs are ON GREEN then input and output are normal.

When the FAULT_LED is RED, then a fault condition exists and the power supply may not provide output power. The following ALARM table further defines these states:

Alarm Table

Test Condition		LED Indicator			Monitoring Signals			
		INPUT 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 Fault	**Green**	OFF	**Red**	Low	Low	High	Low

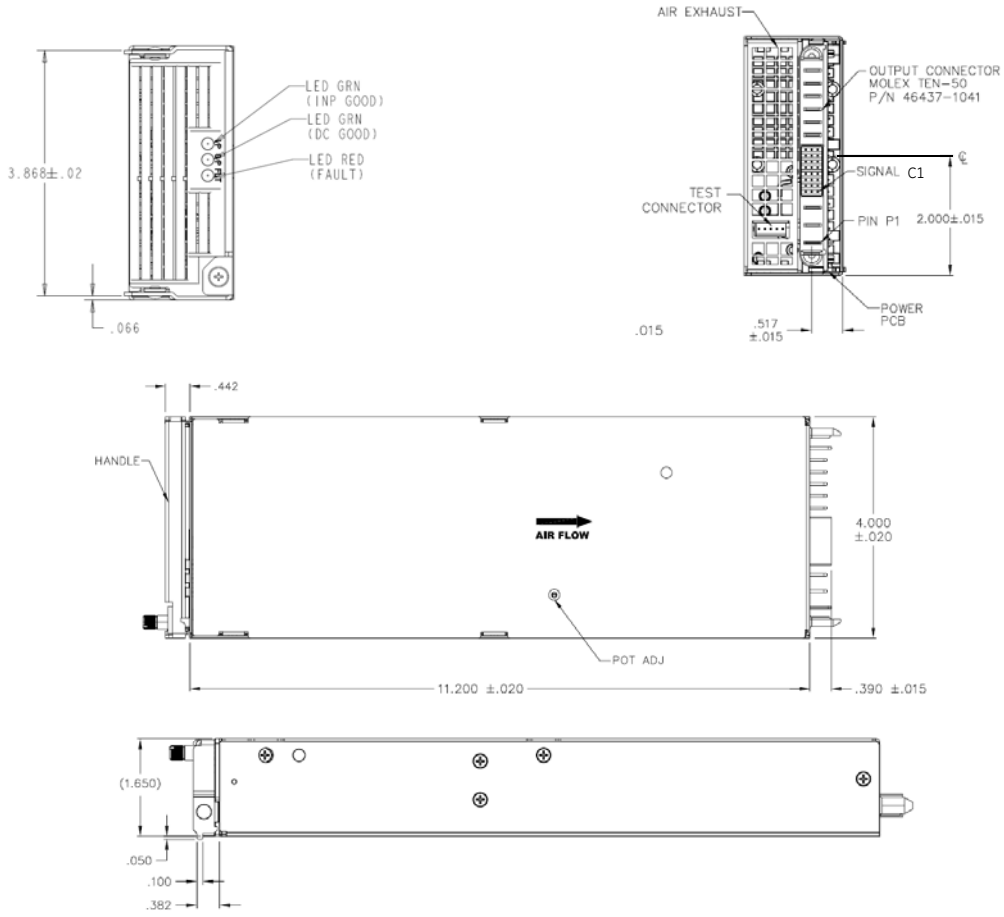
Note: Test condition #2 has 2 modules working in parallel. One module is running and the other has no input.

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CAR1212DCBLC -DC converter

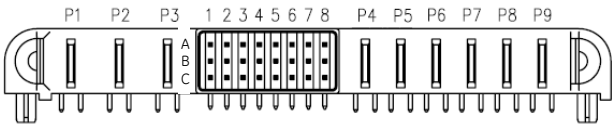
Input: -36V_{DC} to -75V_{DC}; Output: 12V_{DC} @ 1200W; 5 V_{DC} @ 1A

Outline Drawing



Connector Pin Assignments

Input/Output



Molex P/N: 46437-1041
Mating connector: Molex P/N: 46436-1041

Pin	Function	Pin	Function	Pin	Function	Pin	Function
A1	Vprog	B1	Write Protect (WP)	C1	Remote ON/OFF	P1	V_{IN} (+)
A2	PS Present	B2	DC OK	C2	SDA (I^2C bus)	P2	V_{IN} (-) [return]
A3	OVP Test Point	B3	INPUT OK	C3	SCL (I^2C bus)	P3	GND
A4	Fault	B4	V_{STDBY} return	C4	Vstb return		
A5	Remote Sense (+)	B5	SMBAlert (Interrupt)	C5	I^2C Address (A2)	P4 – P6	+12V_{DC}
A6	Temperature OK	B6	I Monitor (IMON)	C6	I^2C Address (A1)	P7 – P9	Power Return
A7	N/C	B7	V_{STDBY} [5V]	C7	I^2C Address (A0)		
A8	Remote Sense (-)	B8	Enable (short pin)	C8	Ishare		

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CAR1212DCBLC -DC converter

Input: -36V_{DC} to -75V_{DC}; Output: 12V_{DC} @ 1200W; 5 V_{DC} @ 1A

Ordering Information

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

PRODUCT	DESCRIPTION	PART NUMBER
1200W converter	12V_{DC} DC-DC converter w/Bezel, 5Vaux	CAR1212DCBLCZ01A
1200W converter	12V_{DC} DC-DC converter w/Bezel, 3.3Vaux	CAR1212DCBLCZ02A

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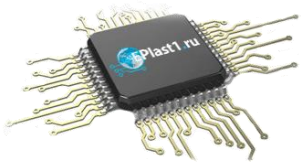
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- Оперативные поставки широкого спектра электронных компонентов отечественного и импортного производства напрямую от производителей и с крупнейших мировых складов;
- Поставка более 17-ти миллионов наименований электронных компонентов;
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- Лицензия ФСБ на осуществление работ с использованием сведений, составляющих государственную тайну;
- Поставка специализированных компонентов (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Aeroflex, Peregrine, Syfer, Eurofarad, Texas Instrument, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits,General Dynamics и др.);

Помимо этого, одним из направлений компании «ЭлектроПласт» является направление «Источники питания». Мы предлагаем Вам помощь Конструкторского отдела:

- Подбор оптимального решения, техническое обоснование при выборе компонента;
- Подбор аналогов;
- Консультации по применению компонента;
- Поставка образцов и прототипов;
- Техническая поддержка проекта;
- Защита от снятия компонента с производства.



Как с нами связаться

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