DATASHEET

CAR1612FP series rectifier

Input: 85V_{AC} to 264V_{AC}; Output: 12V_{DC} @ 1600W; 3.3V_{DC} @ 1A



Description

The CAR1612FP series of Front-End rectifiers provide highly efficient isolated power from worldwide input mains in a compact 1U industry standard form factor in an unprecedented power density of 19W/in^3. These rectifiers are ideal for datacom applications such as enterprise networking, 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^{2}C 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.

Applications

- 12V_{DC} distributed power architectures
- Datacom applications
- Mid to high-end Servers
- Enterprise Networking
- Network Attached Storage
- Telecom Access Nodes
- Routers/Switches
- Broadband Switches
- ATE Equipment

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Features

- Universal input with PFC
- Constant power characteristic
- 2 front panel LEDs: 1-input
  LED 2-[output, fault, over temp]
- Remote ON/OFF control of the $12V_{DC}$ output
- Remote sense on the $12V_{DC}$ output
- No minimum load requirements
- Redundant parallel operation
- Active load sharing (single wire)
- Hot Pluggable
- Efficiency: typically 94.5% @ 50% load
- Standby orderable either as $3.3V_{dc}$ or $5V_{dc}$
- Auto recoverable OC & OT protection
- Digital status & control: I^2C and PMBus serial bus
- UL and cUL approved to UL/CSA†62368-1, TUV (EN62368-1), CE§ Mark
- EMI: class B FCC docket 20780 part 15, EN55032
- Meets EN6100 immunity and transient standards
- Shock & vibration: NEBS GR-63-CORE, level 3
- Compliant to RoHS Directive 2011/65/EU and amended Directive (EU) 2015/863
- Compliant to REACH Directive (EC) No 1907/2006

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Technical Specifications

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.
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Parameter	Device	Symbol	Min	Max	Unit
Input Voltage :Continues	All	V_{IN}	0	264	V_{ac}
Operating Ambient Temperature	All	T_A	-10	60[1]	°C
Storage Temperature	All	T_{stg}	-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}	85	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}			80	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 / 10.5	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_{OUT}= 12V_{DC}, I_O=$I_{O, max}$) [230V_{ac} / 110V_{ac}] 100% load / [230V_{ac} / 110V_{ac}] 50% load / [230V_{ac} / 110V_{ac}] 20% load	All	η		92.5/89 / 94.5/91 / 92.4/88		%
Power Factor (V_{IN}=230V_{AC}, I_O=$I_{O, max}$)	All	PF		0.99		
Holdup time[2] (V_{OUT}= 12V_{DC}, T_{amb} 25°C, I_{OUT}=$I_{O, max}$) V_{in}=230V_{AC} / V_{IN}= 100V_{AC}	All	T		12 / 15		ms
Early warning prior to loss of DC output below regulation	All		2			ms
Ride through	All	T		10		ms
Leakage Current (V_{in}= 250V_{AC}, F_{in} = 60Hz)	All	I_{IN}		3		mA_{rms}
Isolation Input/Output	All		3000			V_{AC}
Input/Frame			1500			V_{AC}
Output/Frame			100			V_{DC}

12VDC MAIN OUTPUT							
Parameter		**Device**	**Symbol**	**Min**	**Typ**	**Max**	**Unit**
Output Power							
High Line Operation	180 – 264 V_{AC}	All	W	0	-	1600	W
Low Line Operation	90 – 132V_{AC}			0	-	1200	W
Set point		All	V_{OUT}	11.9	12.00	12.1	V_{DC}
Overall regulation (load, temperature, aging)		All		-3		+3	%
Ripple and noise[3]		All				120	mV_{p-p}
Turn-ON overshoot		All				+3	%
Turn-ON delay		All	T			2	sec

See footnotes on page no. 7

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Technical Specifications (continued)

Electrical Specifications (continued)

$12V_{DC}$ MAIN OUTPUT (continued)						
Parameter	**Device**	**Symbol**	**Min**	**Typ**	**Max**	**Unit**
Remote ON/OFF delay time	All				40	ms
Turn-ON rise time (10 – 90% of V_{OUT})					50	ms
Transient response 50% step [10%-60%, 50% - 100%] (dI/dt – 1A/µs, recovery 300µs)		V_{OUT}	-5		+5	%V_{OUT}
Programmable range (hardware[4] & software)			10.8		13.2	V_{DC}
Overvoltage protection, latched (recovery by cycling OFF/ON via hardware or software)			13.8	14.8	15.8	V_{DC}
Output current Vi_n – HL V_{in} – LL		I_{OUT}	0		134 100	A_{DC}
Current limit, Hiccup (programmable level)			110		130	% of FL
Active current share			-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		-5		+5	%
Ripple and noise	All				50	mV $_{p-p}$
Output current		I_{OUT}	0		1	A_{DC}
Overload protection -			1.1		2.6	A_{DC}
Overvoltage protection						
Isolation Output/Frame	All		100			V_{DC}

Environmental, Reliability					
Parameter	**Min**	**Typ**	**Max**	**Units**	**Notes**
Ambient Temperature Operating Altitude Operating Power Derating	 -10[5] 	 	 70[6] 2250 2.5	 °C m %/°C	 Air inlet from sea level to 5,000 feet.7400 ft 51°C to 70°C (60°C max where TUV/VDE is required)
Storage Altitude non-operating	-40		85 8200	°C m	30,000 ft
Overload Protection shutdown restart		125 110		°C	
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, minimum 30 minutes
Earthquake Rating	4			Zone	NEBS GR-63-CORE, all floors, Seismic Zone 4 Designed and tested to meet NEBS specifications.
Reliability 25°C		320,000		Hrs	Full load, MTBF per Bellcore RPP
50°C		100,000		Hrs	Full load, MTBF per Bellcore RPP
		200,000		Hrs	Full load, demonstrated MTBF

See footnotes on page no. 7

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Technical Specifications (continued)

Electrical Specifications (continued)

EMC				
Parameter	**Criteria**	**Standard**	**Level**	**Test**
AC input	Conducted emissions	EN55032, FCC Docket 20780 part 15, subpart J EN61000-3-2	A*	0.15 – 30MHz 0 – 2 KHz
	Radiated emissions**	EN55032	A*	30 – 10000MHz
	Voltage dips	EN61000-4-11	B	-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

* Note: Contact the factory for a recommended external EMI filter to meet Class B emissions

** Radiated emissions compliance is contingent upon the final system configuration.

Status and Control

Details of analog controls are provided in this data sheet under Signal Definitions. OmniOn Energy will provide separate application notes on the I^2C protocol. Contact your local OmniOn 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 (Vprog): An analog voltage on this signal can vary the output voltage ± 10% from 10.8V_{dc} to 13.2V_{dc}. The equation of this signal is:

$V_{out} = 10.8 + (V_{prog} * 0.96)$ $0 < V_{prog} < 2.5$

If $2.5 < V_{prog} < 3$, the output is 13.2V. If V_{prog} 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 the presence of the main 12V_{dc} 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 12V_{dc} and the maximum sink current is 4mA. A Logic 1 (TTL HI level) turns ON the 12V_{dc} output, while a Logic 0 (TTL LO level) 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} 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.

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Technical Specifications (continued)

Output signals

Output current monitor (Imon): A voltage level proportional to the delivered output current is present on this pin. 134A = 3V, 100A = 2.25V; accuracy: ± 10%.

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 $12V_{dc}$. 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 $12V_{dc}$. 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 $12V_{dc}$. 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 $3.3V_{dc}$. Open collector (HI) on this signal indicates that no Interrupt has been triggered.

Serial Bus Communications

The I^2C interface facilitates the monitoring and control of various operating parameters within the unit and transmits these on demand over an industry standard I^2C 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 I^2C 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 I^2C 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 I^2C 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 I^2C 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.

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Technical Specifications (continued)

Serial Bus Communications (continued)

Communications Protocol

The I^2C protocol is described in detail by the I^2C and PMBus Serial Communications Protocol for the CAR Family of Power Supplies application note.

LEDs

Two LEDs are located on the front faceplate. The AC_OK 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/FLT provides visual indication of three different states of the power supply. When the LED is GREEN then there are no faults and the DC output is present. When the LED is AMBER then a fault condition exists but the power supply still provides output power. When the LED is RED then a fault condition exists and the power supply does not provide output power.

FOOTNOTES

[1] Derated above 50°C at 2.5%/°C

[2] 12V output can decay down to 10.8V

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

[4] $V_{out}t=10.8 + (V_{prog} * 0.96)$ where $0 < V_{prog} < 2.5$. Unit stays at 13.2V when $2.5 < V_{prog} < 3$. Unit stays at 12V when $V_{prog} > 3V$ or no-connect.

[5] 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.

[6] 60°C max where TUV/VDE is required

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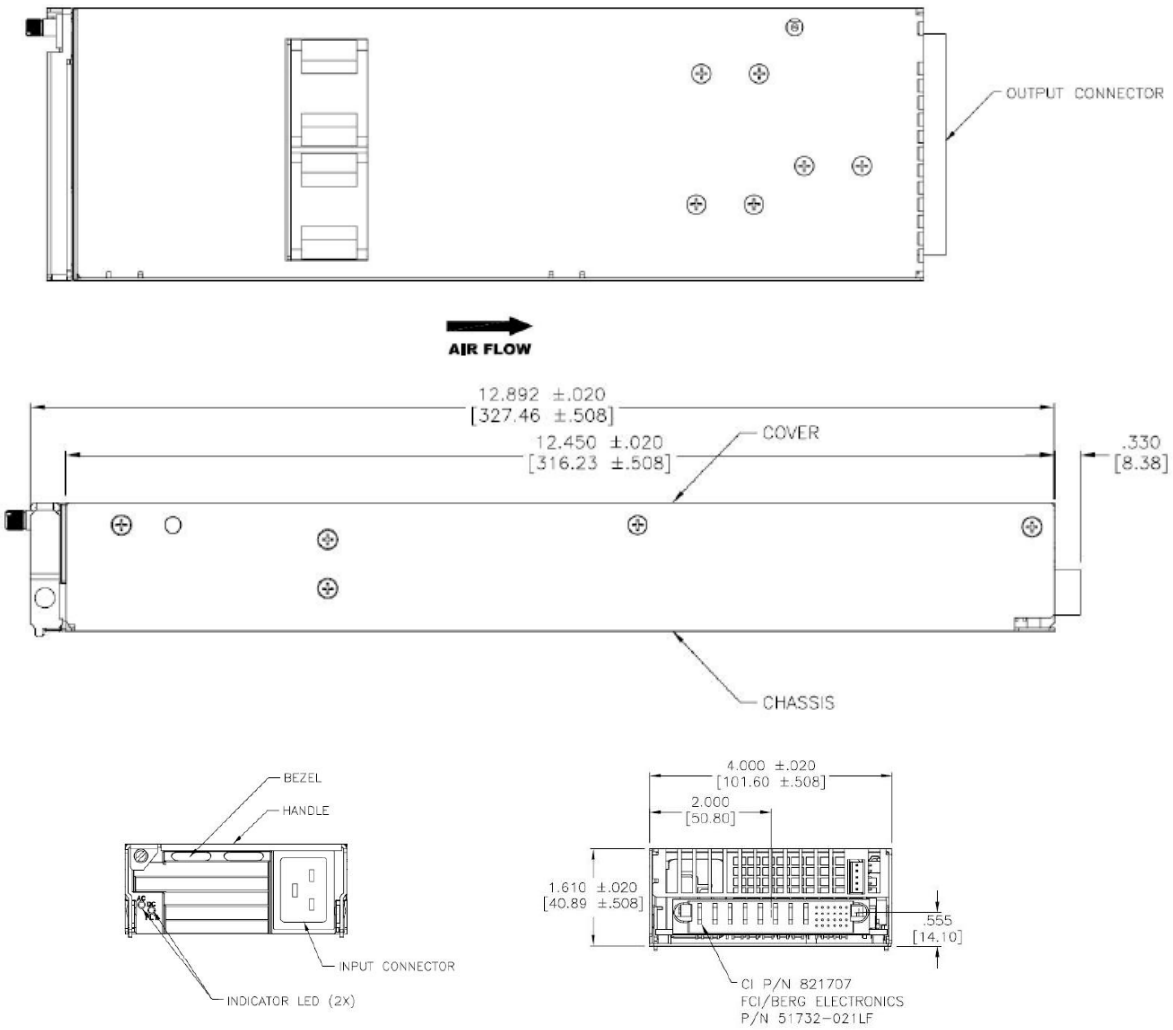
Technical Specifications (continued)

Alarm Table

Test Condition		LED Indicator LED1 AC	LED Indicator Tri-Color LED2 DC / FLT	Monitoring Signals FAULT	DC OK	INPUT OK	TEMP OK
1	Normal Operation	**Green**	**Green**	High	High	High	High
2	Low or NO INPUT	Off	**Red**	Low	Low	Low	High
3	OVP	**Green**	**Red**	Low	Low	High	High
4	Over Current	**Green**	**Red**	Low	Low	High	High
5	Temp Alarm Warning	**Green**	**Orange**	High	High	High	Low
6	Fault Over Temp	**Green**	**Red**	Low	Low	High	Low
7	Remote ON/OFF	**Green**	**Red**	Low	Low	High	High

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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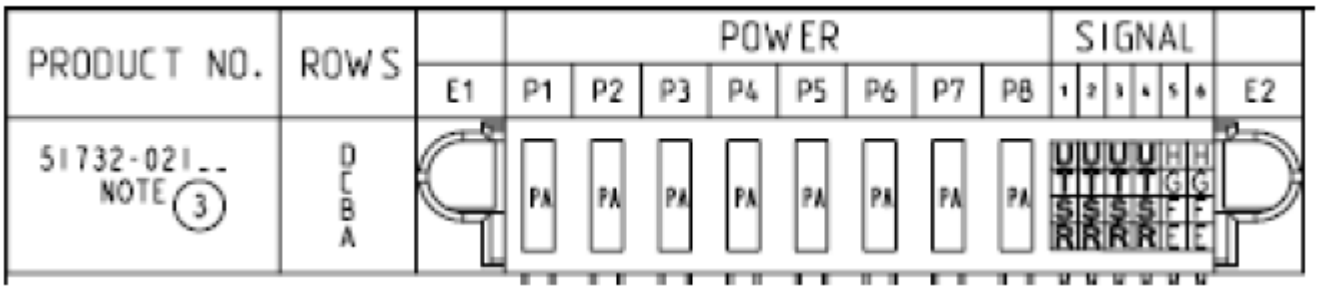
Technical Specifications (continued)

Connector Pin Assignments

Input Mating Connector: IEC320, C19 type

Output Connector: FCI Berg P/N: 51732-021 or equivalent
Mating connector: 51762-10802400ABLF (right angle mount)



Pin	Function	Pin	Function	Pin	Function	Pin	Function
A1	Vstb [3.3V]	B1	Fault	C1	ISHARE	D1	VProg
A2	Vstb [3.3V] Return	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	PS Present	C4	I²C Address (A0)	D4	DC OK
A5	Remote Sense (+)	B5	SDA (I²C bus)	C5	I²C Address (A1)	D5	AC OK
A6	Remote Sense (-)	B6	SCL (I²C bus)	C6	I²C Address (A2)	D6	SMBAlert
P1-P4	Output Return					P5-P8	+12Vout

Ordering Information

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

PRODUCT	DESCRIPTION	PART NUMBER
1600W Front-End	+12Vout Front-End, 3.3Vaux, with bezel and PMBus interface	CAR1612FPBCXZ01A
1600W Front-End	+12Vout Front-End, 5Vaux, with bezel and PMBus interface	CAR1612FPBC5Z01A
1600W Front-End	+12Vout Front-End, 3.3Vaux, reverse airflow, with bezel and PMBus interface	CAR1612FPBRXZ01A
1600W Front-End	+12Vout Front-End, 5Vaux, reverse airflow, with bezel and PMBus interface	CAR1612FPBR5Z01A

Contact Us

For more information, call us at
+1-877-546-3243 (US)
+1-972-244-9288 (Int’l)

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Change History (excludes grammar & clarifications)

Revision	Date	Description of the change
3.3	12/09/2021	Updated as per template
3.4	12/14/2023	Updated as per OmniOn template

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OmniOn Power Inc.
601 Shiloh Rd.
Plano, TX USA

omnionpower.com

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