

Eaton Switched Combiner

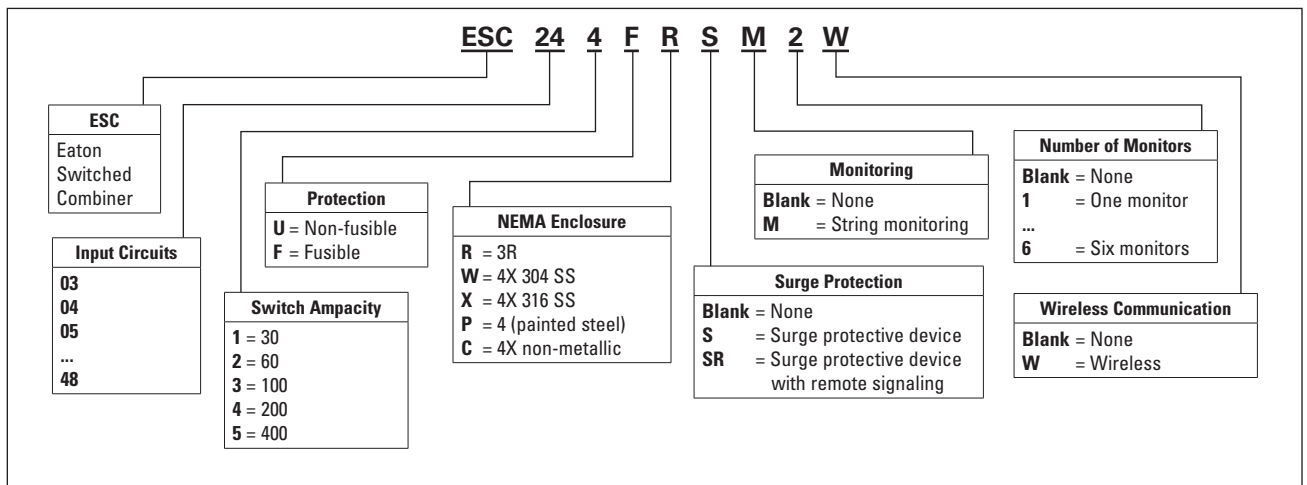


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Catalog numbering system

Table 1. ESC Ordering Information



Danger and warning labels

⚠ DANGER

HAZARDOUS VOLTAGE WILL CAUSE SEVERE INJURY OR DEATH. WORKING ON OR NEAR ENERGIZED CIRCUITS POSES A SERIOUS RISK OF ELECTRICAL SHOCK. DE-ENERGIZE ALL CIRCUITS BEFORE INSTALLING OR SERVICING THIS EQUIPMENT AND FOLLOW ALL PRESCRIBED SAFETY PROCEDURES.

⚠ IMPORTANT

THESE PROCEDURES DO NOT CLAIM TO COVER ALL POSSIBLE DETAILS OR VARIATIONS ENCOUNTERED WITH THE EATON SWITCHED COMBINER BOX. NOR DO THEY PROVIDE FOR ALL POSSIBLE CONDITIONS THAT MAY BE ENCOUNTERED. IF FURTHER INFORMATION IS DESIRED OR NEEDED TO ADDRESS ANY PARTICULAR ISSUE NOT COVERED IN THIS DOCUMENT, CONTACT YOUR EATON REPRESENTATIVE. THE INFORMATION IN THIS DOCUMENT DOES NOT RELIEVE THE USER FROM EXERCISING GOOD JUDGMENT, NOR FROM USING SOUND SAFETY PRACTICES.

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⚠ IMPORTANT

FOR THE PURPOSE OF THIS INSTRUCTION LEAFLET, A QUALIFIED PERSON:

- (A) IS FAMILIAR WITH THE SUBJECT EQUIPMENT AND THE HAZARDS INVOLVED WITH THEIR APPLICATION, USE, ADMINISTRATION, AND MAINTENANCE.**
- (B) IS TRAINED AND AUTHORIZED TO DE-ENERGIZE, CLEAR, GROUND, AND TAG CIRCUITS AND EQUIPMENT IN ACCORDANCE WITH ESTABLISHED SAFETY PRACTICES.**
- (C) IS TRAINED IN THE PROPER CARE AND USE OF PERSONAL PROTECTIVE EQUIPMENT SUCH AS RUBBER GLOVES, HARD HAT, SAFETY GLASSES OR FACE SHIELDS, ARC-FLASH CLOTHING, ETC., IN ACCORDANCE WITH ESTABLISHED SAFETY PRACTICES.**
- (D) IS TRAINED TO RENDER FIRST AID.**
- (E) HAS RECEIVED SAFETY TRAINING TO RECOGNIZE AND AVOID THE HAZARDS INVOLVED.**
- (F) HAS THE SKILLS AND KNOWLEDGE PERTAINING TO THE CONSTRUCTION AND OPERATION OF THIS EQUIPMENT AND ITS INSTALLATION.**

⚠ DANGER

TERMINALS ON BOTH THE LINE AND LOAD SIDES MAY BE ENERGIZED IN THE OPEN POSITION. DO NOT TOUCH TERMINALS. ELECTRIC SHOCK HAZARD POTENTIAL.

⚠ CAUTION

LINE SHIELD (BARRIER) MUST BE INSTALLED AT ALL TIMES. IF IT IS REMOVED FOR WIRING OR SERVICING, IT MUST BE REINSTALLED PRIOR TO PUTTING THE DEVICE BACK INTO SERVICE.

Signal words

The signal words “DANGER,” “WARNING,” “CAUTION,” and “NOTICE” (along with their assigned symbol) throughout this manual indicate the degree of hazard the user may encounter.

These symbols and words are defined as:

⚠ DANGER

DANGER: Indicates a hazardous situation that, if not avoided, will result in death or serious injury.

⚠ WARNING

WARNING: Indicates a hazardous situation that, if not avoided, could result in death or serious injury.

⚠ CAUTION

CAUTION: Indicates a hazardous situation that, if not avoided, could result in minor or moderate injury.

NOTICE

NOTICE: Indicates a hazardous situation that, if not avoided, could result in property damage.

Safety concerns

The following are important safety precautions that Eaton Switched Combiner users should observe at all times. This summary is not comprehensive. It is assumed that the Eaton Switched Combiner user will follow standard safety precautions for working in an electrical environment. For more information on safety precautions and procedures, consult the following sources:

Web sites

National Fire Protection Association (NFPA®): www.nfpa.org.

Underwriters Laboratories (UL®): www.ul.com.

National Electrical Manufacturers Association (NEMA®): www.nema.org.

International Electrotechnical Commission (IEC): www.iec.ch.

Overview

The Eaton Switched Combiner (ESC) is designed for solar photovoltaic (PV) applications and systems, which require source-circuit (array) combining, overcurrent protection, and some means of disconnect. This product is designed to be placed in circuits between the PV source and the inverter or recombiner. Putting a 600 Vdc disconnect in a source-circuit combiner provides a single-point location to safely isolate the DC side of a PV system closer to the modules and combine the incoming arrays.

The product comes completely assembled for quick installation, eliminating the labor and the time needed to assemble individual components. Using the catalog numbering system (**Table 1**) ensures that you get all the right components, with the right ratings, properly constructed.

The ESC uses the standard Eaton DC disconnect, which is a UL 98 Listed unit (meets requirements of CSA C22.2 No. 4-04). It can be configured with the main fuse as a fusible (Class R) or non-fusible device. The input (source) fuse holders are 30A rated and DIN rail mounted.

The ESC is designed to accommodate 3–48 source-circuit inputs. It meets ANSI/ASME, NEC®, and NFPA 72 requirements. The product is UL 1741 Listed, and is also marked cUL (in compliance with CSA requirement specified in CSA 22.2 No.107.1-01). It is marked suitable for NEC 690 PV applications up to 600 Vdc. It comes in NEMA 3R, 4, 4X 304 SS, 4X 316 SS, and 4X non-metallic enclosures. It is available in 30, 60, 100, 200, or 400A configurations.

Figure 2 provides an example of the product design and the layout of major components. This is an example only—additional modifications and options are available.

Features

Standard features

- 30–400A, 600 Vdc, fusible (Class R) or non-fusible main disconnect
- NEMA 3R, 4, 4X 304 SS, 4X 316 SS, and 4X non-metallic
- 3–48 input source-circuits
- Touch-safe input fuse holders with blown fuse indication, (fuses not included)
- Isolated block for the grounded conductors
- Equipment ground
- Draw-pull latches (some restrictions apply)

Optional features

- Surge protective device (SPD)
 - 35 mm DIN rail mounted
 - UL 1449 recognized
- String monitoring (100–400A only)
- Wireless communication (100–400A only)
- Viewing window
- Oversized lugs, see **Table 7b**
- Input PV fuses
- Heyco®-Tite cordgrips
- Prewired style connectors

Circuit configurations

- 30A: 3–4 circuits
- 60A: 3–6 circuits
- 100A: 6–12 circuits
- 200A: 12–24 circuits
- 400A: 24–48 circuits

Note: Refer to **Table 3** and **Figure 1** for ampacity and circuit details, as well as enclosure dimensions.

Standards and certifications

- UL 1741 Listed—File E328440
- Suitable for NEC 690 PV applications
- Meets requirements of CAN/CSA 22.2 No.107.1-01)
- cUL (in compliance with CSA requirement specified in CSA 22.2 No. 107.1-01)

Fusing and ratings

Full nameplate ampere rating shall be used when the input/source circuits are sized per NEC 690.8 unless shown different in the “Rated Output Current” column of **Table 2**. All ratings based on 50°C operation temperature.

Table 2. Fusing and Ratings

ESC Number	Number of Circuits	Maximum Fuse Rating (A)	Rated Output Current (A)	Maximum Input Short-Circuit Current per Circuit (A), I _{sc}
ESC031*	3	10	30	6.4
ESC041*	4	8	30	4.8
ESC032*	3	20	60	12.8
ESC042*	4	15	60	9.6
ESC052*	5	12	60	7.7
ESC062*	6	10	60	6.4
ESC063*	6	20	100	10.7
ESC073*	7	15	100	9.2
ESC083*	8	15	100	8.0
ESC093*	9	12	100	7.1
ESC103*	10	10	100	6.4
ESC113*	11	10	100	5.8
ESC123*	12	10	100	5.3
ESC124*	12	15	172	9.2
ESC134*	13	15	186	9.2
ESC144*	14	15	200	9.2
ESC154*	15	15	200	8.5
ESC164*	16	15	200	8.0
ESC174*	17	12	200	7.5
ESC184*	18	12	200	7.1
ESC194*	19	12	200	6.7
ESC204*	20	12	200	6.4
ESC214*	21	10	200	6.1
ESC224*	22	10	200	5.8
ESC234*	23	10	200	5.6
ESC244*	24	10	200	5.3
ESC245*	24	15	343	9.2
ESC255*	25	15	358	9.2
ESC265*	26	15	372	9.2
ESC275*	27	15	386	9.2
ESC285*	28	15	400	9.2
ESC295*	29	15	400	8.8
ESC305*	30	15	400	8.5
ESC315*	31	15	400	8.3
ESC325*	32	15	400	8.0
ESC335*	33	15	400	7.8
ESC345*	34	12	400	7.5
ESC355*	35	12	400	7.3
ESC365*	36	12	400	7.1
ESC375*	37	12	400	6.9
ESC385*	38	12	400	6.7
ESC395*	39	12	400	6.6
ESC405*	40	10	400	6.4
ESC415*	41	10	400	6.3
ESC425*	42	10	400	6.1
ESC435*	43	10	400	6.0
ESC445*	44	10	400	5.8
ESC455*	45	10	400	5.7
ESC465*	46	10	400	5.6
ESC475*	47	10	400	5.5
ESC485*	48	10	400	5.3

Dimensions

Table 3. ESC Dimensions and Ratings

Ampere Rating	Source/Input Circuit Range	Available With Monitoring	Enclosure Dimensions, Exterior—Inches (mm)			
			Height (H)	Width (W)	Depth (D ₁)	Depth (D ₂)
Metallic Enclosures						
30	3–4	N/A	19.27 (489.5)	14.33 (364.0)	11.54 (293.1)	6.37 (161.8)
60	3–6	N/A	19.27 (489.5)	14.33 (364.0)	11.54 (293.1)	6.37 (161.8)
100	6–12	No	23.27 (591.1)	16.33 (414.8)	11.54 (293.1)	6.37 (161.8)
		Yes	27.27 (692.7)	20.44 (519.2)	11.54 (293.1)	6.37 (161.8)
200	12–24	No	31.27 (794.3)	19.97 (507.2)	11.54 (293.1)	6.37 (161.8)
		Yes	36.27 (921.3)	24.97 (634.2)	11.54 (293.1)	6.37 (161.8)
400	24–48	Yes	50.08 (1272.0)	38.53 (978.7)	12.35 (313.7)	7.23 (183.6)
Non-Metallic Enclosures						
30	3–4	N/A	22.75 (577.9)	17.46 (443.5)	12.31 (312.7)	9.94 (252.5)
60	3–6	N/A	22.75 (577.9)	17.46 (443.5)	12.31 (312.7)	9.94 (252.5)
100	6–12	No	22.75 (577.9)	17.46 (443.5)	12.31 (312.7)	9.94 (252.5)
		Yes	27.00 (685.8)	21.84 (554.7)	12.31 (312.7)	9.94 (252.5)
200	12–24	No	32.84 (834.1)	21.59 (548.4)	12.31 (312.7)	9.94 (252.5)
		Yes	33.41 (848.6)	26.50 (673.1)	11.31 (287.3)	8.93 (226.8)
400	24–48	Yes	51.28 (1302.5)	37.65 (956.3)	16.46 (418.1)	14.08 (357.6)

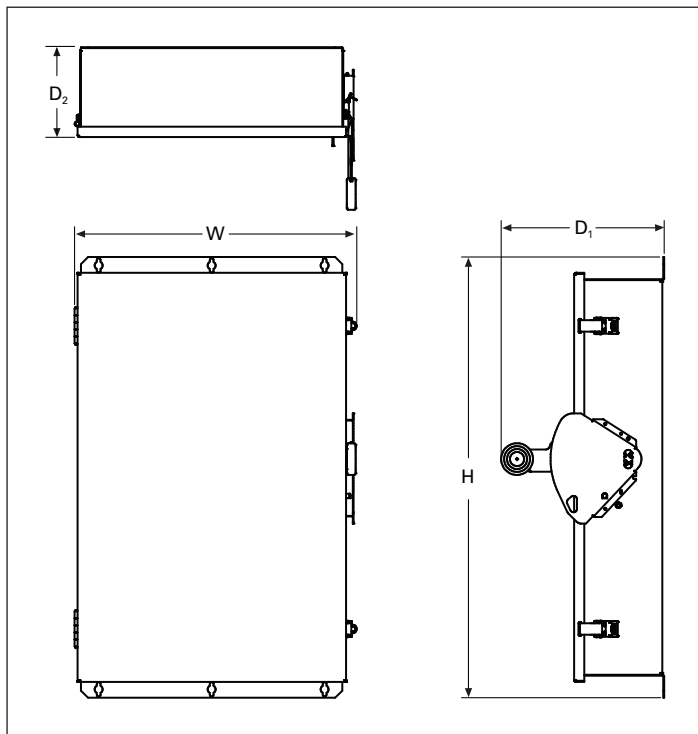


Figure 1. ESC Dimensions

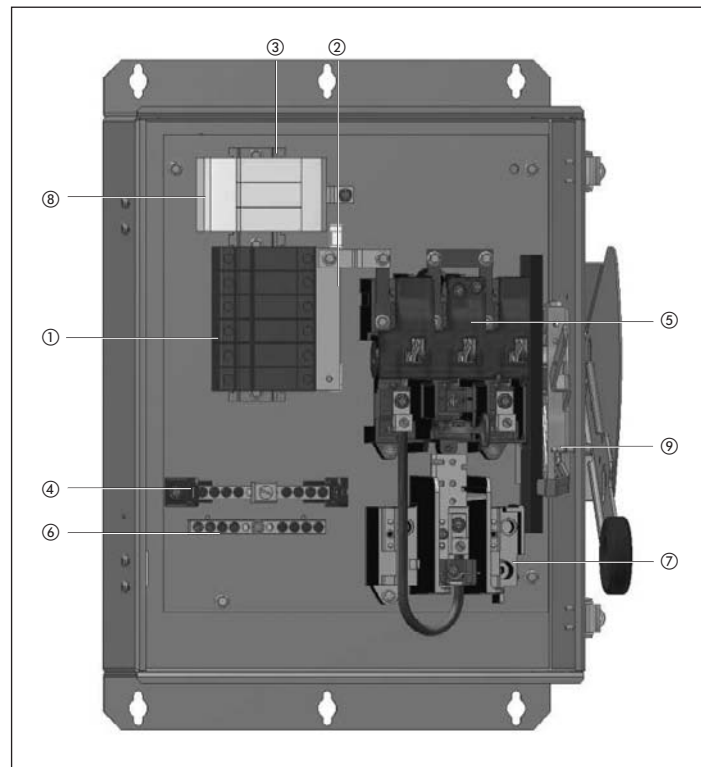


Figure 2. ESC Component Details

- ① Input fuse holders
- ② Comb busbar
- ③ DIN rail
- ④ Return block
- ⑤ Main switch available fusible (shown) or non-fusible
- ⑥ Ground block
- ⑦ Output fuse block
- ⑧ Surge protective device (SPD)
- ⑨ Mechanism and handle

Note: For illustration purposes only. Modification and other optional items are available.

Wiring instructions/details

Standard wiring

Use 90°C wire and size all current-carrying conductors according to the 75°C ampacity table, per NEC 310.

Table 7a shows the range of input and output conductor sizes.

Input wiring

The ESC is designed to be wired from the sides, top, and/or bottom of the enclosure. The incoming ungrounded conductors are wired into the fuse holders, which are connected to the switch via a comb busbar. Ungrounded conductors fed from strings, panels, or an upstream device must be Cu and sized a minimum of 14 AWG except 400A products, which require a minimum of 12 AWG wire.

Grounded conductor and equipment ground blocks have provisions for #14–4 AWG Cu/Al wires.

Output wiring

The ESC has the necessary wire bending space per NEC to allow the maximum output conductors. Refer to **Table 4** to correctly size the conductors.

Note: Refer to UL 98 or NEC 310 standards to size the input and output wires. Lugs contained in the ESC may be oversized.

Surge protective device (SPD)

SPD comes pre-wired from the factory, eliminating any need for wiring or assembly.

The negative side wire is connected to the grounded conductor block and can be removed for ease of wiring or installation. However, the wire must be reconnected prior to operation of the unit.

The positive side wire is connected to one of the bus connectors and shall not be altered unless the equipment is being serviced.

Table 4. Output Conductor Sizing, AWG or kcmil

Ampere Rating	Copper					Aluminum or Copper-Clad Aluminum				
	26–30°C	31–35°C	36–40°C	41–45°C	46–50°C	26–30°C	31–35°C	36–40°C	41–45°C	46–50°C
30	10	10	10	8	8	10	8	8	8	8
60	6	6	4	4	4	4	4	3	3	2
100	3	2	2	1	1/0	1	1/0	1/0	2/0 ③	2/0 ③
200	3/0	4/0	4/0	250	300	250	300	300	350 ③	400 ③
400	600	700	700	800 ①	1000 ①	1000 ①	1250 ①	1500 ①	1500 ③	1750 ③
400 ②	3/0 (2)	4/0 (2)	4/0 (2)	250 (2)	300 (2)	250 (2)	300 (2)	300 (2)	350 ③ (2)	400 ③ (2)

① Must use two conductors.

② Two conductors.

③ Standard lug can not handle this range; refer to **Table 7b** for alternate lugs.

String monitoring

String monitoring is provided by an Obvius A89DC-08 DC Current Monitor. The incoming ungrounded conductors shall be routed through the non-contact Hall effect sensors prior to being connected to the input fuseholders. All of the wiring from and to the string monitor, including the power input, shall be supplied by the customer. Power supply must be provided by the customer, external to the Eaton Switched Combiner, and shall satisfy the power input requirements per **Table 5**.

The Obvius DC monitor can monitor up to 50A DC per channel. It is possible to route multiple strings per one channel (Hall effect sensor); however, the number of strings per channel can be limited by the incoming conductor type and size. **Table 8** shows the most commonly used wires for solar applications and their approximate outer diameters. **Table 9** through **Table 14** give cross-references of the Hall effect sensor opening (aperture) vs. number of wires per channel with respect to wire type and size. The opening of each Hall effect sensor is 0.49 x 0.35 inches.

Note: Wire diameters, types, and sizes are shown for customer reference ONLY; refer to specific solar application requirements for wire type and size.

The Obvius DC monitor has the ability to daisy-chain up to 32 devices via the RS-485 port. The string monitor or the last one in the system shall be connected to an external Data Acquisition Unit or a PC with the necessary software using either the RS-485 or the RS-232 ports. Obvius has a free monitoring software (OCC) that can be downloaded from www.obvius.com. Obvius also offers a compact data acquisition server, AcquiSuite EMB A8810, allowing users to collect data from the string monitors. It is designed to connect to IP-based applications, eliminating the need for a software, where the information can be accessed through ANY Web browser.

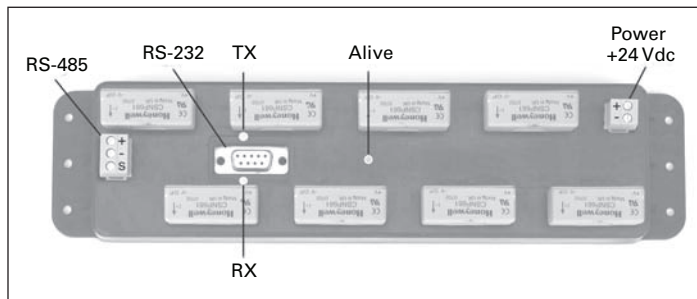


Figure 3. Obvius DC Monitor

The Obvius monitor may generate a fair amount of heat depending on the total current load being monitored. Care should be taken to ensure that the device does not overheat. In situations where high load current is to be monitored, forced air cooling will be required. **Figure 4** shows this requirement.

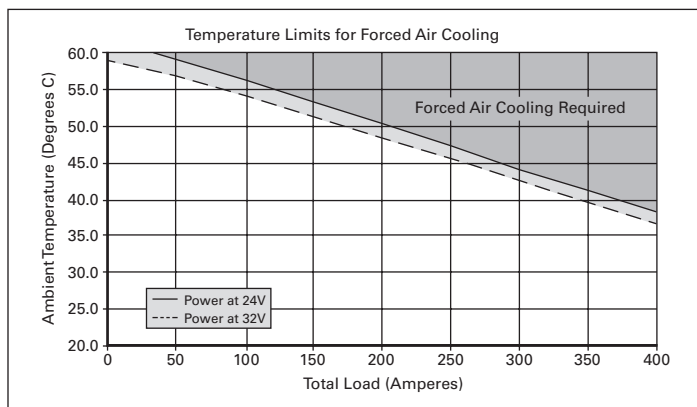


Figure 4. Temperature and Load Chart

When using the chart in **Figure 4**, the total current being monitored on all 8 channels should be used averaged over a 1-minute period. The chart assumes long-term current levels at a steady state. Infrequent peaks lasting less than 30 seconds (such as inrush current) should not be used for this calculation.

For example, if the power being monitored is a maximum of 200A (total of all channels) and the ambient air exceeds 50°C, forced air cooling will be required.

To provide forced air cooling, a minimum of 10 CFM across the narrow width of the monitor is required.

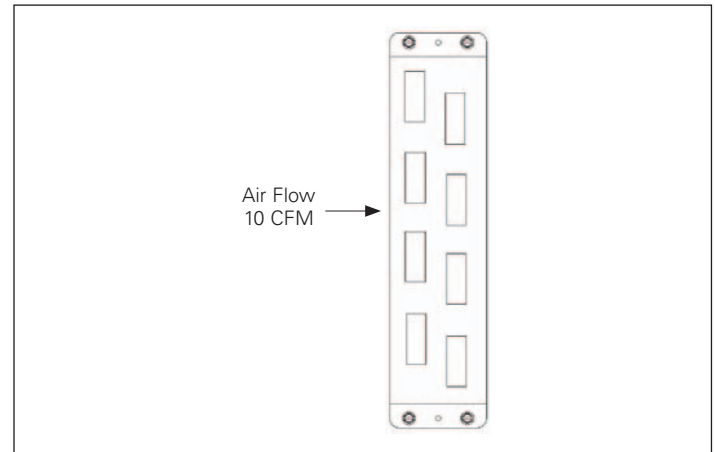


Figure 5. Forced Air Cooling

Note: Ambient air temperature refers to the air immediately surrounding the monitor. This is not the outdoor air temperature.

Table 5. Current Monitor Specifications

Description	Specifications
Processor	ARM 7 embedded CPU
LEDs	Alive (green), RS-485 RX, RX (yellow)
Power input	24 Vdc, 382 mA
Protocols	Modbus®/RTU
CTs	8 DC Hall effect sensors, non-contact CAT I measurement device
Range	Maximum +50A to -50A DC at 600 Vdc
CT aperture	0.49 inch x 0.35 inch opening for load wire
Accuracy	±1% of scale (±0.5A)
Safety	UL® 61010 Recognized (File No.E320540), EN61010
Temperature range	-30°C to +60°C at 0-95% RH, noncondensing
Measurements	DC current per channel, instantaneous and average Total DC current (sum of 8 channels), instantaneous and average Average DC current (of 8 channels), instantaneous and average
Alarming	Low alarm may set as a percent of DC average of other channels Alarms may be disabled below a minimum average current level Minimum time for alarm may be set to prevent alarms on brief events Unused channels may be disabled to exclude them from total and average calculation
Voltage rating	600 Vdc
Baud rate	9600 baud, fixed

Wireless communication—ModHopper®

Wireless communication is provided by an Obvius R9120-3 ModHopper. All of the wiring from and to the ModHopper, including the power input (9–30 Vdc, 200 mA maximum), shall be supplied by the customer; however, one class 2 wall brick transformer (110–120 Vac, 60 Hz) is included as an alternate. **Table 6** shows the specifications for the Obvius ModHopper.

The ModHopper is wired to the Obvius string monitor via RS-485 port. It is not necessary to have a ModHopper per each Eaton Switched Combiner as it can accommodate up to 32 devices daisy-chained in the system as long as the last string monitor is connected to the ModHopper. Outdoor antenna provided with the Eaton Switched Combiner shall be connected to the ModHopper using the cable provided.

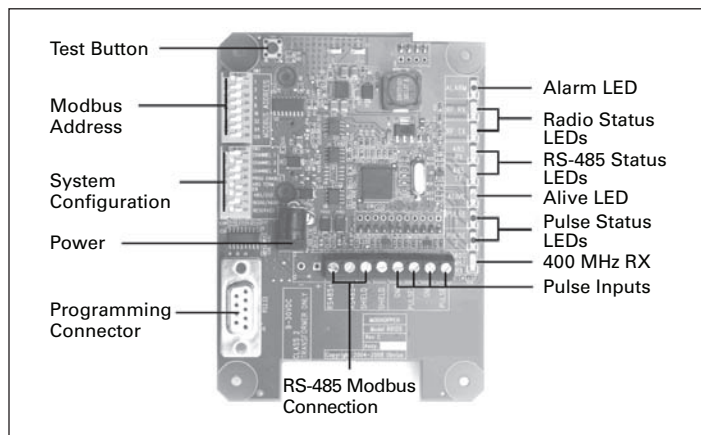


Figure 6. Obvius ModHopper

Table 6. Wireless Communication Specifications

Description	Specifications
Processor	60 MHz ARM 7 embedded CPU
LEDs	3 x RF, 2 x RS-485, 2 x Pulse, Alive, Alarm
Power input	9–30 Vdc, 200 mA max., class 2 wall brick transformer included
Protocols	Modbus/RTU
Baud rate	9600/19200 baud, N, 8, 1
Range	900 MHz, 100 mW, 1500 ft (450m) indoor, 7 miles (11 km) line of sight
RF	Frequency hopping, spread spectrum (FHSS), ISM band
Pulse rate	User selectable to 10 Hz, 50 Hz, 100 Hz, and 250 Hz
Accuracy	±1% of scale (±0.5A)
Safety	UL 61010 Recognized (File #E320540), EN61010
Temperature range	–30°C to 70°C at 0–90% RH, noncondensing
FCC ID	OUR-9XTREAM
Voltage rating	600 Vdc

Wiring for monitoring option

All of the internal and external wiring shall be provided by the customer if the String Monitoring and/or Wireless Communication options are selected. Shielded twisted pair wire shall be used for all of the RS-485 connections.

Table 7a. Terminal/Lug Wire Range for Input and Output Conductors

Ampere Rating	Ungrounded Conductor		Grounded Conductor		Equipment Ground	
	Input	Output	Input	Output	Input	Output
30	14–6 AWG ①	14–2 AWG	14–4 AWG ①	14–4 AWG	14–4 AWG	14–4 AWG
60	14–6 AWG ①	14–2 AWG	14–4 AWG ①	6–2/0 AWG	14–4 AWG	14–4 AWG
100	14–6 AWG ①	14–1/0 AWG	14–4 AWG ①	6–2/0 AWG	14–4 AWG	14–4 AWG
200	14–6 AWG ①	6 AWG–300 kcmil	14–4 AWG ①	6 AWG–300 kcmil	14–4 AWG	14–4 AWG
400	12–6 AWG	1/0 AWG–750 kcmil or (2X) 1/0 AWG–300 kcmil	14–4 AWG ①	1/0 AWG–750 kcmil or (2X) 1/0 AWG–300 kcmil	14–4 AWG	14–1/0 AWG

① 90°C rated wire required—ampacity based on the 75°C ratings shown in NEC 310.

Table 7b. Alternate Lugs

Ampere Rating	Option	Alternate Lugs	
		Grounded and Ungrounded Conductor	Equipment Ground
100	A	2/0–14 AWG	No alternate
200	A	(2) 300 kcmil–6 AWG	250 kcmil–6 AWG
	B	350 kcmil–6 AWG	No alternate
	C	500 kcmil–4 AWG	No alternate
400	A	(1) 750 kcmil–1/0 AWG	250 kcmil–6 AWG
	A	(1) 600 kcmil–2 AWG	250 kcmil–6 AWG

Note: Consult factory for all alternate lug options.

Table 8. Commonly Used Wire Types and Sizes for Solar Applications, Applicable to Wiring from PV String to Input Fuse Holders

Wire Type	OD Inches/Wire Gauge (AWG)				Material	Comments
	14	12	10	8		
600V USE-2/RHW-2	0.173	0.192	0.212	0.271	XLPE	Flame retardant, oil, abrasion, chemical, and sunlight resistant
600V THWN-2/THWN/THNN	0.115	0.137	0.171	0.220	Nylon	Flame retardant and oil resistant
600V USE-2/PV, RHW-2	—	0.218	0.238	0.299	XLPE	Flame retardant and sunlight resistant
2 kV, PV RHH/RHW-2, Flexible Tinned Cu	0.240	0.258	0.282	0.351	CPE	Flame retardant, oil, abrasion, chemical, and sunlight resistant
2 kV PV, RHH/RHW-2, Class B Bare Cu	0.243	0.262	0.282	0.331	CPE	Flame retardant, oil, abrasion, chemical, and sunlight resistant
2 kV PV, 600V USE-2, RHW-2, Class B Bare Cu	0.231	0.250	0.270	0.320	XLPE	Flame retardant and sunlight resistant

Common wire sizes and types for monitoring option

Table 9. 600V Type USE-2/RHW-2

Number of Wires/Channel	AWG			
	14	12	10	8
1	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	No
3	Yes	Yes	No	No

Table 10. 600V Type THWN-2/THWN/THNN

Number of Wires/Channel	AWG			
	14	12	10	8
1	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes
3	Yes	Yes	Yes	No

Table 11. 600V Type USE-2/PV, RHW-2

Number of Wires/Channel	AWG			
	14	12	10	8
1	No	Yes	Yes	Yes
2	No	Yes	Yes	No
3	No	No	No	No

Table 12. 2 kV Type PV, RHH/RHW-2 Class B Bare Cu

Number of Wires/Channel	AWG			
	14	12	10	8
1	Yes	Yes	Yes	Yes
2	Yes	No	No	No
3	No	No	No	No

Table 13. 2 kV Type PV, RHH/RHW-2 Flexible Tinned Cu

Number of Wires/Channel	AWG			
	14	12	10	8
1	Yes	Yes	Yes	Yes
2	Yes	No	No	No
3	No	No	No	No

Table 14. 2 kV Type PV, 600V USE-2, RHW-2, Class B Bare Cu

Number of Wires/Channel	AWG			
	14	12	10	8
1	Yes	Yes	Yes	Yes
2	Yes	Yes	No	No
3	No	No	No	No

Installation

Enclosure

NEMA 3R enclosure may only be installed in the vertical orientation.

NEMA 4, 4X 304 SS, 4X 316 SS, and 4X non-metallic enclosures may be installed either in vertical or horizontal, or on an inclined plane.

ESC shall be mounted using all of the provisions (teardrop-shaped key holes) located on the top and bottom flanges, per the following:

- 30A through 200A use 1/4-inch x 1-inch-long minimum bolts or 2-inch-long concrete anchors or lag bolts
- 400A use 3/8-inch x 1-inch-long minimum bolts or 2-inch-long concrete anchors or lag bolts

Washers must be used with all anchors and bolts during installation. ESC shall not be directly mounted to drywall.

Normal operation temperature for the ESC is -30°C (-22°F) to +50°C (+122°F). It is recommended to take necessary precautions, such as installing the ESC in a shaded area, if the ambient temperatures exceed the 50°C limit.

Input fuses

Use PV rated 10 x 38 mm size, 600 Vdc, fuses only.

Table 2 shows the maximum recommended fuse ratings.

Wireless Communication—ModHopper

If the Wireless Communication option is chosen, the customer shall install the wireless antenna (supplied as a kit inside the enclosure) to the outside of the enclosure at either the recommended or the user-preferred location. Recommended location will be marked on the right side of the enclosure above the switch handle (metallic enclosures only). All of the necessary hardware is provided with the ESC to assist antenna installation and wiring.

ModHopper supplied with an ESC is used to transmit the wireless signal only. A separate ModHopper is required at the receiving end to intercept and receive the signal.

Wiring

See **page 6** for wiring instruction.

Lug torque specifications

Turn down all terminal and lug pressure screws per **Table 15** and **Table 16**.

Table 15. Incoming and Outgoing Conductor Torque Specifications

Ampere Rating	Ungrounded Conductor (Lbs-in)		Grounded Conductor (Lbs-in)		Equipment Ground (Lbs-in)	
	Input	Output	Input	Output	Input	Output
30	14.75	35-50	35-45	35-45	35-45	35-45
60	14.75	35-50	35-45	45-50	35-45	35-45
100	14.75	35-50	35-45	45-50	35-45	35-45
200	14.75	275	35-45	275	35-45	35-45
400	14.75	550	35-45	550	35-45	120

Preventive maintenance

Under normal use, the ESC is virtually maintenance-free.

Should a customer want to take additional measures to evaluate the condition of the ESC, the following steps should be considered. To properly maintain the ESC, the operation of all components should be tested on an annual basis by a qualified person.

- Take the necessary precautions to notify the surroundings that the Eaton Switched Combiner is under maintenance and the solar grid has been taken out of service
- Bring the latch handle down to OFF position to disconnect the ESC
- Lock out the switch appropriately for inspection per industry standards
- Inspect the blades on the switch and make sure they are greased. There should be no need to grease the blades for the life of the product
- Inspect all connections to ensure that the conductors are in tact
- Check all lug torques and compare to the torque specifications shown in **Table 15** and **Table 16**. Tighten lugs per specification if necessary
- Conduct a thermal scan to uncover any portion generating excessive heat that indicates an underlying problem
- Any unexpected temperature increase, not related to load variations or ambient temperature could signal a lug torque issue
- Maximum temperature at any lug should never exceed 90°C under any operating condition or load
- Keep switch exterior and interior clean. Always follow prevailing safety rules when servicing this product throughout the year

Table 16. Alternate Lug Torque Specifications

Ampere Rating	Option	Alternate Lug Torques (Lbs-in)	
		Grounded and Ungrounded Conductor	Equipment Ground
100	A	80	No alternate
200	A	275	275
	B	275	No alternate
	C	450	No alternate
400	A	550	275

Frequently asked questions

For more information or if there are additional questions, please contact EatonCare at 877-ETN-CARE (877-386-2273).

1. What UL Listings and Agency Standards does the ESC have and/or comply by?
 - UL 1741
 - NEC 690
 - UL 98 (switch)
 - cUL (in compliance with CSA requirement specified in CSA 22.2 No. 107.1-01)

All work shall be performed in accordance with the latest edition of applicable standards, codes, and laws.

2. What kind of input fuses does Eaton recommend?

Fuses that are designed and manufactured specifically for PV applications and systems.

3. What is I_{sc} and how is it used for the ESC?

I_{sc} is referred to as the short-circuit current within an electrical circuit that travels along a path where there is essentially no or very low electrical impedance. I_{sc} rating of a PV module is used in compliance with NEC 690.8 to calculate the maximum current for a specific PV source circuit. All input (source) I_{sc} ratings must be multiplied by 1.56 per NEC 690.8. See **Table 2**.

4. What type of wire should be used during installation?

Most of the solar applications in the industry use 600V Type USE-2, THWN-2, or PV conductors. NEC or UL standards (ambient temperatures, location, current/string, etc.) shall be followed while choosing a conductor type and size. Please be aware that the insulation thickness varies between different types of wire. See the "Wiring" section for examples of common industry conductors.

5. Does the ESC require any periodic maintenance?

While no specific maintenance is called for, it is always a good practice to annually inspect the unit for any loose fuse clips, connections, or accumulation of foreign material. See "Preventive Maintenance" in this document for more details.

6. If an ESC is ordered with a wrong component, can the component be changed in the field?

Yes. As long as the component swap complies with the UL listing.

7. Is it OK to swap the grounded and ungrounded conductors?

No, the ungrounded conductor shall always be wired into the input fuse holders. The grounded conductor shall always be wired into the Return Bar.

8. Is it possible to install the ModHopper antenna inside the enclosure?

Eaton recommends that it be installed outside of the box to provide the necessary reception unless a non-metallic enclosure is used.

9. What enclosures are available for the ESC?

NEMA 3R, 4, 4X 304 SS, 4X 316 SS, and 4X non-metallic.

10. Do I have to have the ModHopper for the string monitoring?

No, string current information can be received from the String

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Monitor via an RS-485 or an RS-232 serial cable.

11. What is RS-485 and RS-232?

RS-485 and RS-232 are traditional names for a series of standards for serial signals connecting electronic devices.

12. What is the difference between RS-485 and RS-232?

RS-485 uses a shielded three-wire communication, whereas RS-232 uses a standard 9-pin serial cable.

13. What are the distance limitations of RS-485? And is that between each monitor or from the first in a daisy chain to the last?

An RS-485 daisy chain is limited to 4000 ft from the first device to the final connection at the data acquisition system (first to last).

14. Is it possible to run more than one string/circuit per channel on the String Monitor?

Yes, a maximum of 50A DC can be monitored through each channel. The number of strings per channel is dependent on the total current and overall wire size of the respective string(s). See **Table 9** through **Table 14** for more information.

15. Does DC power have to be brought to each 8-channel monitor?

Yes, each 8-channel DC current monitor requires 24 Vdc. You can daisy chain the power, but will need to account for line loss, and each device will draw 382 mA. Even though you can implement this method of powering the devices, the installer must be aware of the local electrical code requirements before doing this.

16. What are the distance limitations of 24 Vdc power?

24 Vdc distance is limited by the wire size and distance. The electrical contractor or design engineer should be able to calculate the line loss.

17. Are the String Monitor and/or ModHopper ready to use once the ESC is installed?

No. Customer shall provide all of the required power and other inter-connections to these devices as outlined under the "Wiring" section of this manual.

18. What are the locations for the input and output conductors entering and exiting the enclosure?

The ESC is designed to allow input and output conductors to enter and/or exit from the sides, top, or bottom of the enclosure to ease the PV system installation.

19. What program, software, or device do I need to monitor the current?

Once the monitoring option is selected for the ESC, the customer will need the necessary equipment and software (DataAq., PC, and so on) that can communicate with the Modbus communication protocol. Refer to the Obvius Web site for details.

20. What is Modbus?

Modbus is a serial communications protocol that is used to connect industrial electronic devices.

21. What is the regular operating temperature range for ESC?

-30°C (-22°F) to +50°C (+122°F)

22. Can the ESC accommodate 90°C wire?

Yes, the ESC is designed to use 90°C wire; however, the conductor sizes must be calculated per 75°C ampacity table in NEC 310.

23. Are the lugs rated for 90°C wire?

Yes, all of the field wiring terminals (lugs, fuse holders, ground bar, return block) are 90°C wire capable.

24. How is the Modbus address determined and/or set?

String monitor is set from factory and the address is labeled on the device; however, it can be changed via Modbus register.

ModHopper has an incorporated DIP switch that can be configured from 1 to 247.

25. Is the plastic barrier, line shield, critical to the operation and safety of the product?

Yes, the line shield must be attached at all times to the product, while in service, to be compliant with the UL listing.

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