



Features

- High efficiency and excellent thermal performance
- Output remote sense
- Input under-voltage, output over-voltage, over-current, short-circuit and over-temperature protections
- Active current share
- Reinforced insulation, 4,250Vdc input to output isolation
- UL 62368-1 2nd edition recognized
- Qualification/Screening satisfy IPC-9592
- Wide operating temperature range from -40°C to +100°C

Part Numbering System

FYU	EA	□□□	□	□□□	□	□	□	(□)	-	□
Series Name	Input Voltage	Output Voltage	Enabling Logic	Rated Output Current	Pin Length	Options 1	Options 2	Suffix	-	Operating Temperature Grade (°C)*
	EA: 180-400V	Example: 280: 28V	P: Positive N: Negative	Example: 028: 28A	N: 0.130" R: 0.165"	0: Latch off 2: Auto-restart	P: Standard	Variation code		C: -20 to +100 H: -40 to +100

* Operating temperature is the temperature measured at the center of the baseplate.

Available Codes:

Output Voltage	5V	12V*	15V*	28V	48V*	56V
Output Current	100A	67A	54A	24A*, 28A	17A	14A

* Designed to meet UL62368-1 2nd edition.

Absolute Maximum Rating

Excessive stresses over these absolute maximum ratings can cause permanent damage to the converter. Operation should be limited to the conditions outlined under the Electrical Specification section.

Parameter	Min	Max	Unit
Input Voltage (continuous operating)	-0.5	400	V
Input Voltage (continuous, non-operating)	-	450	V
Input Voltage (<100ms, operating)	-	500	V
Storage Temperature	-55	125	°C

Electrical Specifications

These specifications are valid over the converter's full range of input voltage, resistive load, and temperature unless noted otherwise.

Input Specifications

Parameter	Min	Typical	Max	Unit
Input Voltage	180	270	400	V
Input Turn-on Voltage Threshold	173	178	180	V
Input Turn-off Voltage Threshold	165	170	173	V

Output Specifications

Parameter	Min	Typical	Max	Unit
Output Voltage Set Point Accuracy (typical Vin, full load, Ta = 25°C)	-2.0	-	+2.0	%Vo
Output Voltage Set Point Accuracy (over all conditions)	-3.0	-	+3.0	%Vo
Output Regulation: Line Regulation (full range input voltage, 1/2 full load) Load Regulation (full range load, typical Vin) Temperature (Ta = -40°C to 85 °C)	- - -	0.2 0.2 0.1	0.5 0.5 -	%Vo
Output Trim Range in % of typical Vo	80	-	110	%
Output Current Sharing Accuracy (typical Vin, full load, Ta = 25°C)	-	5	10	%

General Specifications

Parameter	Min	Typical	Max	Unit
Remote Enable Logic Low: ION/OFF = 1.0mA VON/OFF = 0.0V	0 -	- -	1.2 1.0	V mA
Logic High: ION/OFF = 0.0μA Leakage Current	3.5 -	- -	15 50	V μA
Isolation Capacitance	-	600	-	pF
Insulation Resistance	10	-	-	MΩ

Module Specific Specifications

5V/100A Module (FYUEA050x100xxx(x)-x)

Parameter	Min	Typical	Max	Unit
Input Current	-	-	2.99	A
Quiescent Input Current (typical Vin)	-	29	39	mA
Standby Input Current	-	5	8	mA
Efficiency (typical Vin, full load, Ta = 25°C)	84.0	89.1	-	%
Output Voltage Set Point	-	5.0	-	V
Output Over Current Protection Set Point	108	114	125	A
Output Power	0	-	500	W
Output Over Voltage Protection Set Point	5.8	6.46	7.8	V
Output Ripple Frequency	235	250	265	kHz
Output Ripple and Noise Voltage RMS	-	7.2	7.3	mVrms
Peak-to-peak (5Hz to 20MHz bandwidth, typical Vin)	-	46	50	mVp-p
External Load Capacitance	-	-	20,000	µF

12V/67A Module (FYUEA120x067xxx(x)-x)

Parameter	Min	Typical	Max	Unit
Input Current	-	-	4.83	A
Quiescent Input Current (typical Vin)	-	39	51	mA
Standby Input Current	-	6	8	mA
Efficiency (typical Vin, full load, Ta = 25°C)	91.0	92.0	-	%
Output Voltage Set Point	-	12.0	-	V
Output Over Current Protection Set Point	74	78	81	A
Output Power	0	-	804	W
Output Over Voltage Protection Set Point	14.0	15.3	17.0	V
Output Ripple Frequency	235	250	265	kHz
Output Ripple and Noise Voltage RMS	-	20	30	mVrms
Peak-to-peak (5Hz to 20MHz bandwidth, typical Vin)	-	75	100	mVp-p
External Load Capacitance	-	-	20,000	µF

15V/54A Module (FYUEA150x054xxx(x)-x)

Parameter	Min	Typical	Max	Unit
Input Current	-	-	6	A
Quiescent Input Current (typical Vin)	-	45	75	mA
Standby Input Current	-	6	8	mA
Efficiency (typical Vin, full load, Ta = 25°C)	91.0	92.3	-	%
Output Voltage Set Point	-	15.0	-	V
Output Power	0	-	810	W
Output Over Current Protection Set Point	58	61	64	A
Output Over Voltage Protection Set Point	16.8	17.8	19.0	V
Output Ripple Frequency	235	250	265	kHz
Output Ripple and Noise Voltage RMS	-	13	14	mVrms
Peak-to-peak (5Hz to 20MHz bandwidth, typical Vin)	-	75	87	mVp-p
External Load Capacitance	-	-	20,000	µF

28V/24A Module (FYUEA280x024xxx(x)-x)

Parameter	Min	Typical	Max	Unit
Input Current	-	-	5.5	A
Quiescent Input Current (typical Vin)	-	40	50	mA
Standby Input Current	-	5	8	mA
Efficiency (typical Vin, full load, Ta = 25°C)	92.0	93.5	-	%
Output Voltage Set Point	-	28.0	-	V
Output Power	0	-	672	W
Output Over Current Protection Set Point	27	29	31	A
Output Over Voltage Protection Set Point	33.0	35.2	37.0	V
Output Ripple Frequency	235	250	265	kHz
Output Ripple and Noise Voltage RMS	-	30	50	mVrms
Peak-to-peak (5Hz to 20MHz bandwidth, typical Vin)	-	100	150	mVp-p
External Load Capacitance	-	-	8,000	μF

28V/28A Module (FYUEA280x028xxx(x)-x)

Parameter	Min	Typical	Max	Unit
Input Current	-	-	6	A
Quiescent Input Current (typical Vin)	-	40	50	mA
Standby Input Current	-	5	8	mA
Efficiency (typical Vin, full load, Ta = 25°C)	92.0	93.5	-	%
Output Voltage Set Point	-	28.0	-	V
Output Power	0	-	800	W
Output Over Current Protection Set Point	32	34	36	A
Output Over Voltage Protection Set Point	33	35.2	37	V
Output Ripple Frequency	235	250	265	kHz
Output Ripple and Noise Voltage RMS	-	30	50	mVrms
Peak-to-peak (5Hz to 20MHz bandwidth, typical Vin)	-	100	150	mVp-p
External Load Capacitance	-	-	8,000	μF

48V/17A Module (FYUEA480x017xxx(x)-x)

Parameter	Min	Typical	Max	Unit
Input Current	-	-	4.715	A
Quiescent Input Current (typical Vin)	-	39	57	mA
Standby Input Current	-	5	8	mA
Efficiency (typical Vin, full load, Ta = 25°C)	93.0	94.7	-	%
Output Voltage Set Point	-	48.0	-	V
Output Power	0	-	816	W
Output Over Current Protection Set Point	17.3	18.4	20.0	A
Output Over Voltage Protection Set Point	56.0	61.5	64.0	V
Output Ripple Frequency	235	250	265	kHz
Output Ripple and Noise Voltage RMS	-	30	50	mVrms
Peak-to-peak (5Hz to 20MHz bandwidth, typical Vin)	-	100	150	mVp-p
External Load Capacitance	-	-	4000	μF



56V/14A Module (FYUEA560x014xxx(x)-x)

Parameter	Min	Typical	Max	Unit
Input Current	-	-	6	A
Quiescent Input Current (typical Vin)	-	35	45	mA
Standby Input Current	-	5	10	mA
Efficiency (typical Vin, full load, Ta = 25°C)	92.0	94.0	-	%
Output Voltage Set Point	-	56.0	-	V
Output Power	0	-	800	W
Output Over Current Protection Set Point	15.0	16.0	18.0	A
Output Over Voltage Protection Set Point	63	70	73	V
Output Ripple Frequency	235	250	265	kHz
Output Ripple and Noise Voltage RMS	-	40	60	mVrms
Peak-to-peak (5Hz to 20MHz bandwidth, typical Vin)	-	300	350	mVp-p
External Load Capacitance	-	-	3,000	μF

Feature Descriptions

Remote ON/OFF

The converter can be turned on and off by changing the voltage between the ON/OFF pin and Vin(-). The FYUEA Series of converters is available with factory selectable positive logic and negative logic.

For the negative control logic, the converter is ON when the ON/OFF pin is at a logic low level and OFF when the ON/OFF pin is at a logic high level. For the positive control logic, the converter is ON when the ON/OFF pin is at a logic high level and OFF when the ON/OFF pin is at a logic low level.

With the internal pull-up circuitry, a simple external switch between the ON/OFF pin and Vin(-) can control the converter. A few example circuits for controlling the ON/OFF pin are shown in Figures 1, 2 and 3.

The logic low level is from 0V to 1.2V and the maximum sink current during logic low is 1mA. The external switch must be capable of maintaining a logic-low level while sinking up to this current. The logic high level is from 3.5V to 15V. The converter has an internal pull-up circuit that ensures the ON/OFF pin at a high logic level when the leakage current at ON/OFF pin is no greater than 50μA.

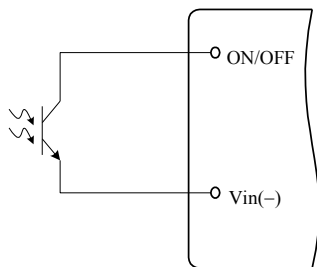


Figure 1. Opto Coupler Enable Circuit

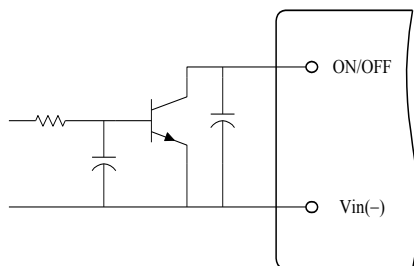


Figure 2. Open Collector Enable Circuit

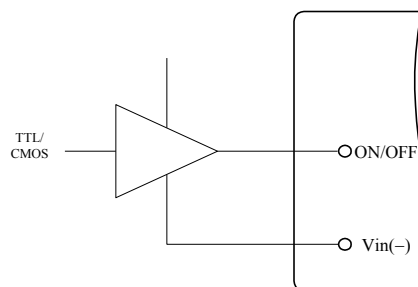


Figure 3. Direct Logic Drive

Remote SENSE

The remote SENSE pins are used to sense the voltage at the load point to accurately regulate the load voltage and eliminate the impact of the voltage drop in the power distribution path.

SENSE (+) and SENSE (-) pins should be connected between the points where voltage regulation is desired. The voltage between the SENSE pins and the output pins must not exceed the smaller of 0.5V or 10% of typical output voltage.

$$[V_{out}(+) - V_{out}(-)] - [SENSE(+)-SENSE(-)] < MIN \{0.5V, 10\%V_o\}$$

When remote sense is not used, the SENSE pins should be connected to their corresponding output pins. If the SENSE pins are left floating, the converter will deliver an output voltage slightly higher than its specified typical output voltage.

Output Voltage Adjustment (Trim)

The trim pin allows the user to adjust the output voltage set point. To increase the output voltage, an external resistor is connected between the TRIM pin and SENSE(+). To decrease the output voltage, an external resistor is connected between the TRIM pin and SENSE(-). The output voltage trim range is 80% to 110% of the specified typical output voltage.

The circuit configuration for trim down operation is shown in Figure 4. To decrease the output voltage, the value of the external resistor should be

$$R_{down} = \left(\frac{205}{\Delta} - 7.16 \right) (k\Omega)$$

Where

$$\Delta = \left(\frac{|V_{nom} - V_{adj}|}{V_{nom}} \right) \times 100$$

And

V_{nom} = Typical Output Voltage
 V_{adj} = Adjusted Output Voltage

The circuit configuration for trim up operation is shown in Figure 5. To increase the output voltage, the value of the resistor should be

$$R_{up} = \left(\frac{2.05V_o(100 + \Delta)}{1.225\Delta} - \frac{205}{\Delta} - 7.16 \right) (\text{k}\Omega)$$

Where

V_o = Typical Output Voltage

As the output voltage at the converter output terminals are higher than the specified typical level when using the trim up and/or remote sense functions, it is important to make sure that the voltage at the output terminals does not exceed the maximum power rating of the converter as given in the specifications table.

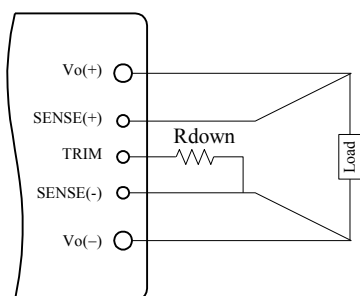


Figure 4. Circuit to Decrease Output Voltage

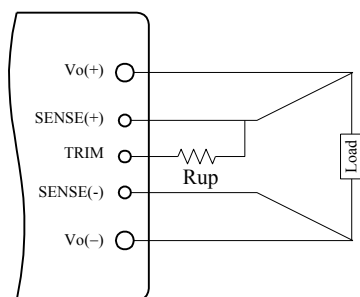


Figure 5. Circuit to Increase Output Voltage

Active Current Sharing (Parallel)

Share pin is designed for active current share among modules in parallel.

The active current share feature allows multiple converters to share load current. For the parallel operation of multiple converters, all Share pins should be connected together. It is suggested to have a copper plane on the system board for Vo(-) to reduce the ground noise impact on the current share accuracy. The loop formed by the trace connecting the SHARE pins and the Vo(-) shall be minimized to avoid noise coupling into the current sharing circuitry. To have synchronized start-up of all modules in parallel operation, the parallel feature should be accompanied by the latch-off protection feature if the output of the modules in parallel will be directly connected together. The FYUEA converter has an internal oring FET at its output. The output pins of the converters in parallel can be directly connected together. A typical current share schemes for the FYUEA series of converters is shown in Figure 6.

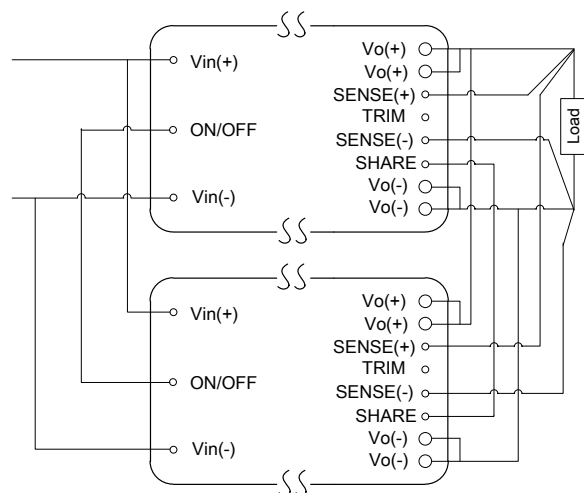


Figure 6. Circuit Configuration for Active Current Sharing

If parallel feature is not needed, just let share pin open.

Up to five FYUEA converters can operate in parallel to share the load current. When the beat frequency of converters in parallel is a concern, synchronization among the converters is often the choice.

Input Under-Voltage Lockout

This feature prevents the converter from starting until the input voltage reaches the turn-on voltage threshold, and keeps the converter running until the input voltage falls below the turn-off voltage threshold. Both turn-on and turn-off voltage thresholds are defined in the Input Specifications table.

Output Over-Current Protection (OCP)

This converter can be ordered in either latch-off or auto-restart version upon OCP, OVP, and OTP.

With the latch-off version, the converter will latch off when the load current exceeds the limit. The converter can be restarted by toggling the ON/OFF switch or recycling the input voltage.

With the auto-restart version, the converter will operate in a hiccup mode (repeatedly try to restart) until the cause of the over-current condition is cleared.

Output Over-Voltage Protection (OVP)

With the latch-off version, the converter will latch off when the output voltage exceeds the limit. The converter can be restarted by toggling the ON/OFF switch or recycling the input voltage.

With the auto-restart version, the converter will operate in a hiccup mode (repeatedly try to restart) until the cause of the over-voltage condition is cleared.

Over Temperature Protection (OTP)

With the latch-off version, the converter will shut down and latch off if an over-temperature condition is detected. The converter has a temperature sensor located at a carefully selected position, which represents the thermal condition of key components of the converter. The thermal shutdown circuit is designed to turn the converter off when the temperature at the sensor reaches 120°C. The module can be restarted by toggling the ON/OFF switch or recycling the input voltage.

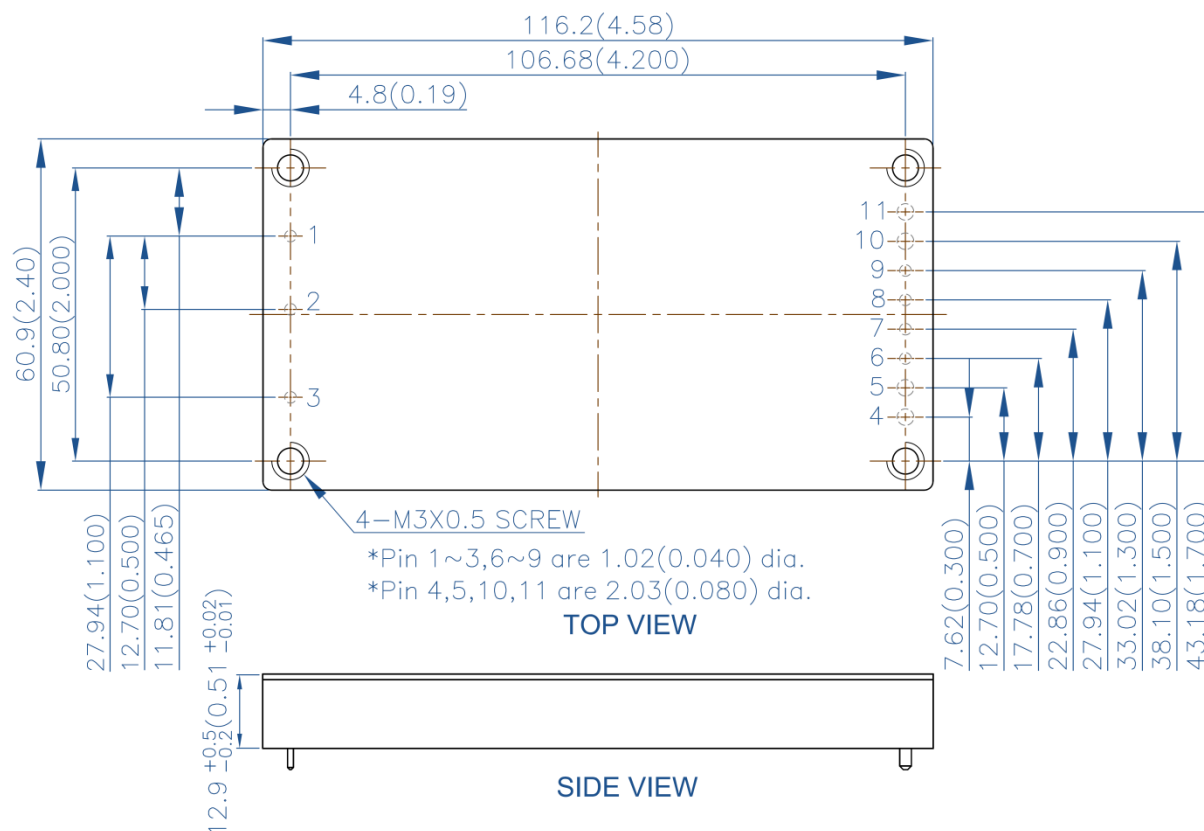
With the auto-restart version, the converter will resume operation after the converter cools down.

Design Considerations

As with any DC-DC converter, the stability of the FYUEA converter may be compromised if the source impedance is too high or inductive. It's desirable to keep the input source ac-impedance as low as possible. Although the converters are designed to be stable without adding external input capacitors for typical source impedance, it is recommended to add 10 μ F low ESR electrolytic capacitors at the input of the converter for each 100W output power, which reduces the potential negative impact of the source impedance on the converter stability. These electrolytic capacitors should have sufficient RMS current rating over the operating temperature range.

The converter is designed to be stable without additional output capacitors. To further reduce the output voltage ripple or improve the transient response, additional output capacitors are often used in applications. When additional output capacitors are used, a combination of ceramic capacitors and tantalum/polymer capacitors shall be used to provide good filtering while assuring the stability of the converter.

Mechanical Drawing



Pin	Name	Function
1	Vin(+)	Positive input voltage
2	ON/OFF	Remote control
3	Vin(-)	Negative input voltage
4	Vout(-)	Negative output voltage
5	Vout(-)	Negative output voltage
6	SHARE	Current share
7	SENSE(-)	Negative remote sense
8	Trim	Output voltage adjustment
9	SENSE(+)	Positive remote sense
10	Vout(+)	Positive output voltage
11	Vout(+)	Positive output voltage

Notes:

- All dimensions in mm (inches)
Tolerances: .x $\pm$.5 (.xx $\pm$ 0.02)
.xx $\pm$.25 (.xxx $\pm$ 0.010)
- Input and function pins are 1.02mm (0.040") dia. with $\pm$ 0.10mm (0.004") tolerance. The recommended diameter of the receiving hole is 1.42mm (0.056").
- Output pins are 2.03mm (0.080") dia. with $\pm$ 0.10mm (0.004") tolerance. The recommended diameter of the receiving hole is 2.44mm (0.096").
- All pins are Copper Alloy, Matte Tin finish with Nickel under plating.
- Typical weight: 310g.
- Workmanship meets or exceeds IPC-A-610 Class II.
- Torque applied on screw should not exceed 6in-lb. (0.7 Nm).
- Baseplate flatness tolerance is 0.10mm (0.004") TIR for surface.