EC5051 – POWER ELECTRONICS AND DESIGN

MINI PROJECT

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2018/E/016

SEMESTER 5

06/02/2022

FACULTY OF ENGINEERING, UNIVERSITY OF JAFFNA
EC5051 – POWER ELECTRONICS AND DESIGN
MINI PROJECT – 2022

DESIGN REQUIREMENTS OF THE DC POWER SUPPLY

1) Main supply with switch: 230V, 50Hz

2) Over current protection (fuse)

3) Dual output

4) Operation mode

- Independent
- Series
- Parallel

5) Output voltage range: 0-30V

6) Output current rate: 0-3A

7) Over current indicator

DESIGN CONSIDERATIONS AND CALCULATIONS

- The flow diagram of the Designed power supply is as follows,

AC Power → Step Down Transformer → Full wave bridge rectification → Filtering (smoothing) → Voltage regulation → Overcurrent Detection → Load

- The AC Section requires a switch and Fuse for safety considerations. So that according to the max output current 5A fuse is selected for AC power section.
- For the step Down transformer,

Peak primary voltage $= \sqrt{2} * 230\ V = 325.26\ V$

Maximum DC voltage = 30 V

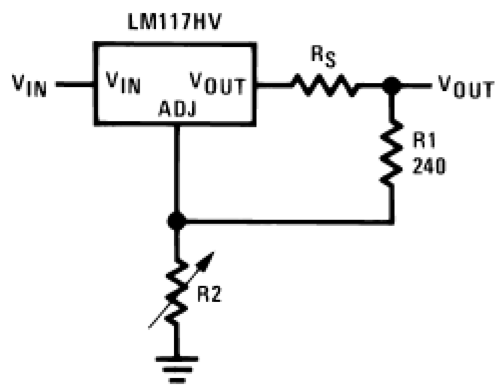
Average voltage drop through the 3N246 rectifier = 1.15 V (Datasheet), Rounded up = 2V

Ripple voltage = 3V (nearly)

Peak secondary voltage = 30 + 2 + 3 = 35V

Turn ratio of the Transformer = $\frac{N_1}{N_2} = \frac{325}{35}$

- Therefore the turn ratio is selected as 325:25 for the step down transformer.
- For the bridge rectifier, 3N246 Bridge is selected.
- The smoothing capacitor is selected as 2.2mF for better smoothing effect.
- For The Voltage regulator, LM117HVKSTL/883 is selected .



For the calculations of the R1 and R2 (Potentiometer); R1 selected as 450 ohms.

From the datasheet,

$$V_{OUT} = V_{REF}\left(1 + \frac{R2}{R1}\right) + I_{ADJ}R2$$

The IC is designed for a constant I_{Adj} = 100µA,

So for the max voltage, the equation as follows,

$$30 = 1.25 * \left(1 + \frac{R2}{450}\right) + R2 * 100 * 10^{-6}$$

Solving the equation gives R2 = 9990 Ω s. So a close - valued Standard valued potentiometer is selected as 10kΩs.

For safety considerations of the IC, Two general purpose 1N4002 Diodes are used for surge current preventions

- For the overcurrent indication, a shunt current monitor circuit for overcurrent detection is used. INA301 current sensing amplifier is used for over current detection and the output of the IC is directly fed to a LED for indication purposes. Pin configurations and calculations for shunt resistor and Limit resistor as follows,
    - Vs is supplied by 4.5 DC voltage(separate)
    - GND is connected to ground
    - RESET is also grounded as stated in the data sheet in order to operate in the transparent condition.
    - As stated in the datasheet the shunt resistor Rs = 7m Ωs,(Imax = 3.1 A, Gain = 20V/V)
    - So the Limiting resistor,

$$RL = (Ioc * Rs * gain)/(80 * 10^{-6})$$
$$RL = (3 * 7/1000 * 20)/(80 * 10^{-6})$$

This gives RL = 5250 Ω and a standard valued resistor is selected for RL as 5.23kΩ.

- The Alert pin is kept floating condition and Out pin is connected to the indicator LED.

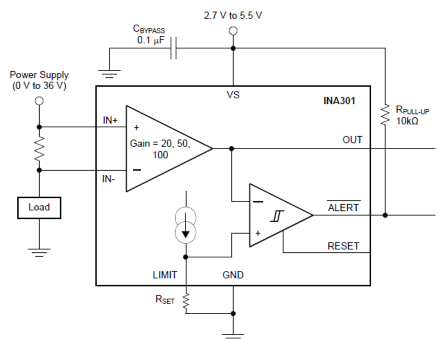


Figure 1: Functional Diagram of the INA301 current sensing amplifier

- Since the Max current of the Power supply doesn't exceed 2.5 A . The Indicator circuit is tested separately. Following are the results of the tests.

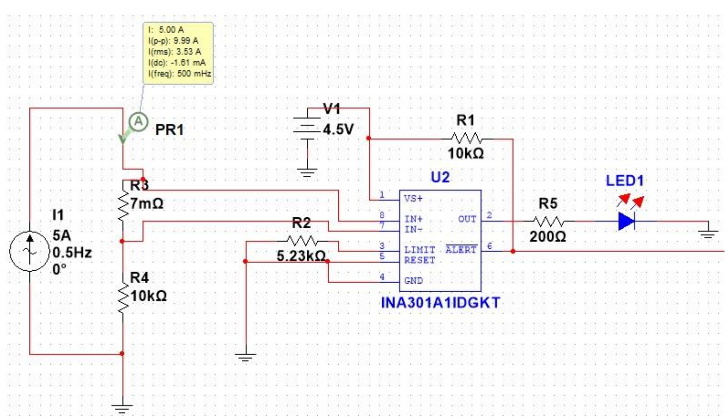


Figure 2: When the current is greater than slightly 3.3 A, The LED is on

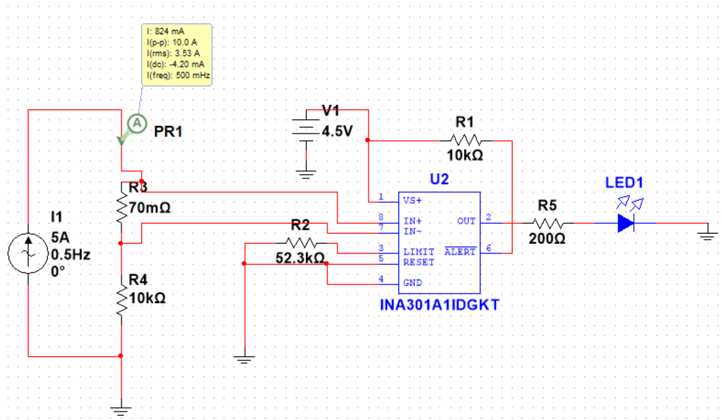


Figure 3: When the current is lower than 3A the LED is OFF

DESIGN SIMULATIONS AND RESULTS

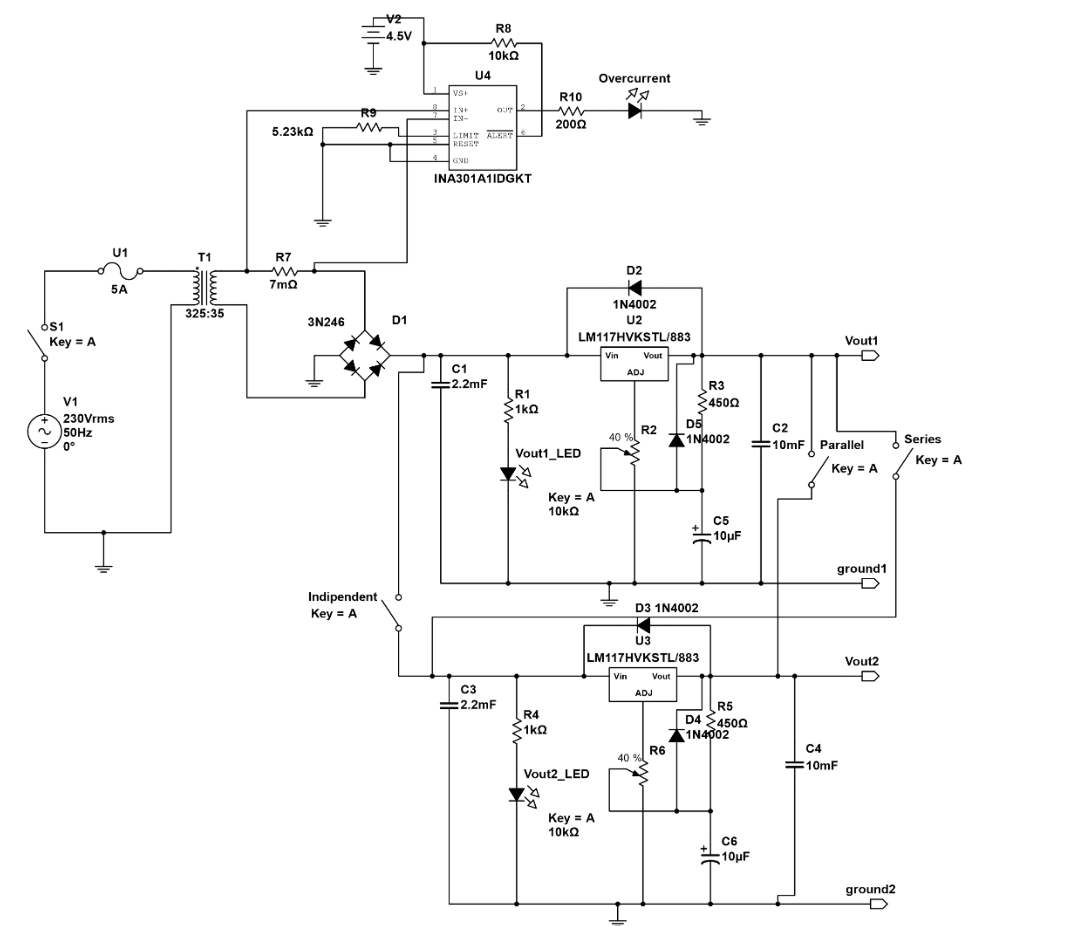


Figure 4: Final printed design of the DC power supply

1. INDEPENDENT OPERATION MODE

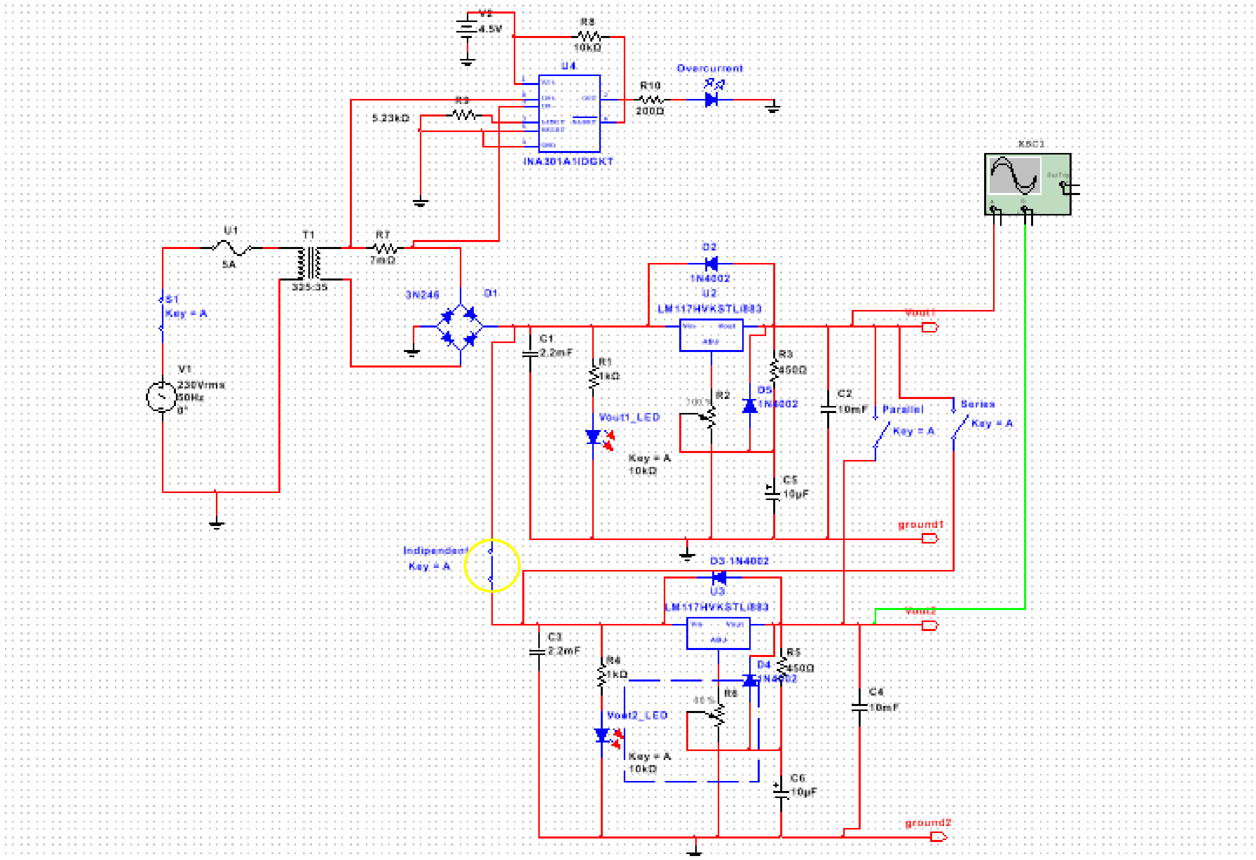


Figure 5: Independent operation of the Circuit

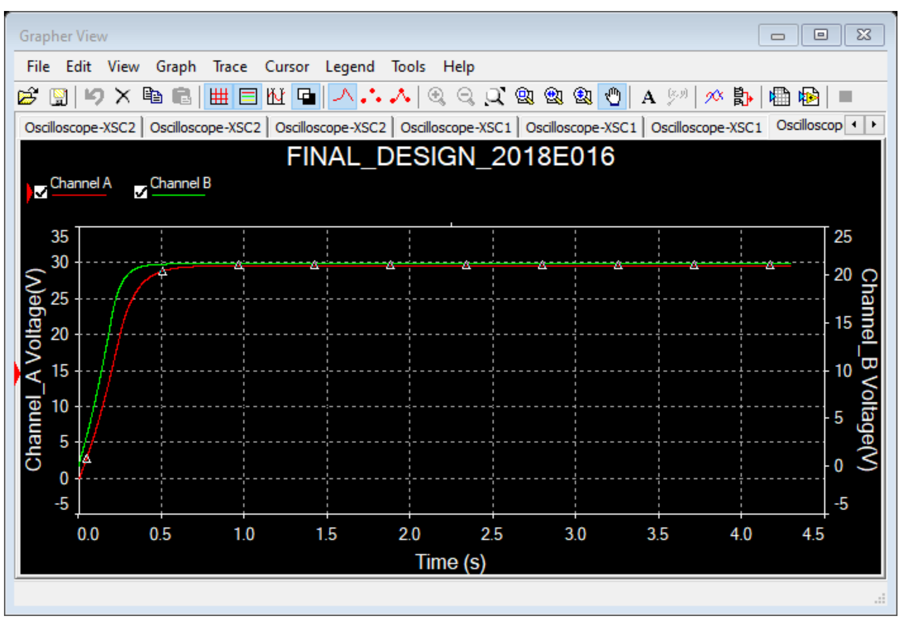


Figure 6: Oscilloscope output for the Independent mode

2. PARRALLEL OPERATION MODE

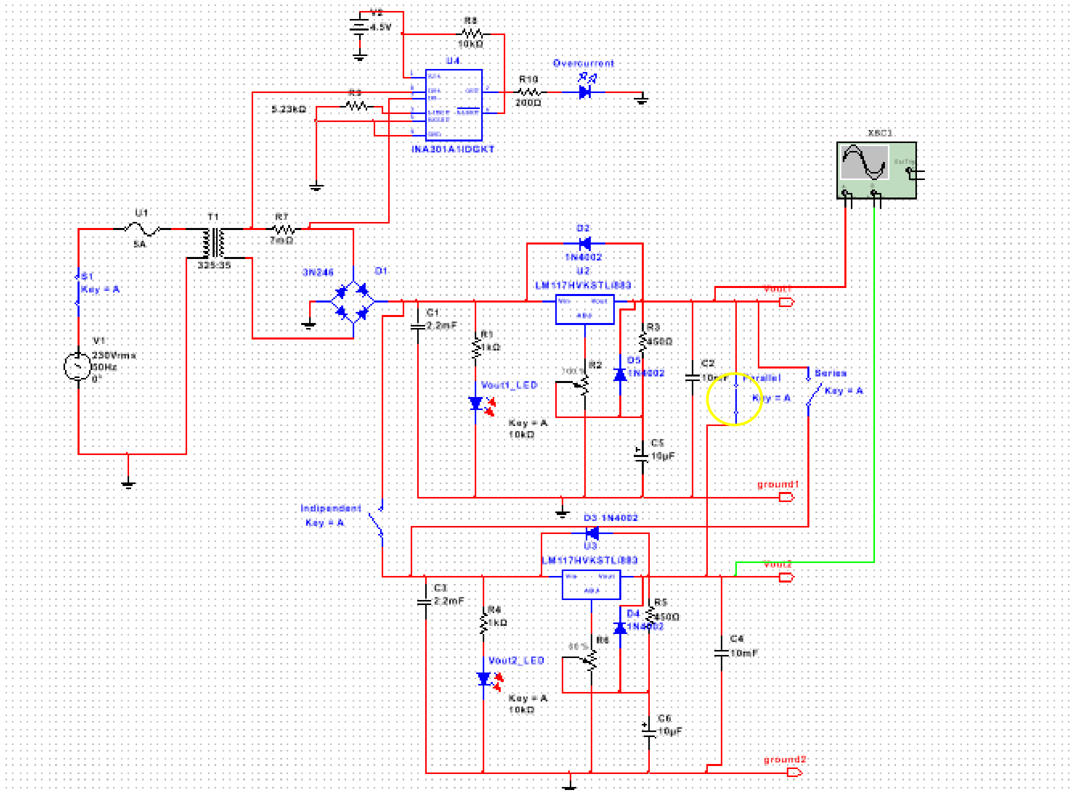


Figure 7: The Circuit on Parallel operation

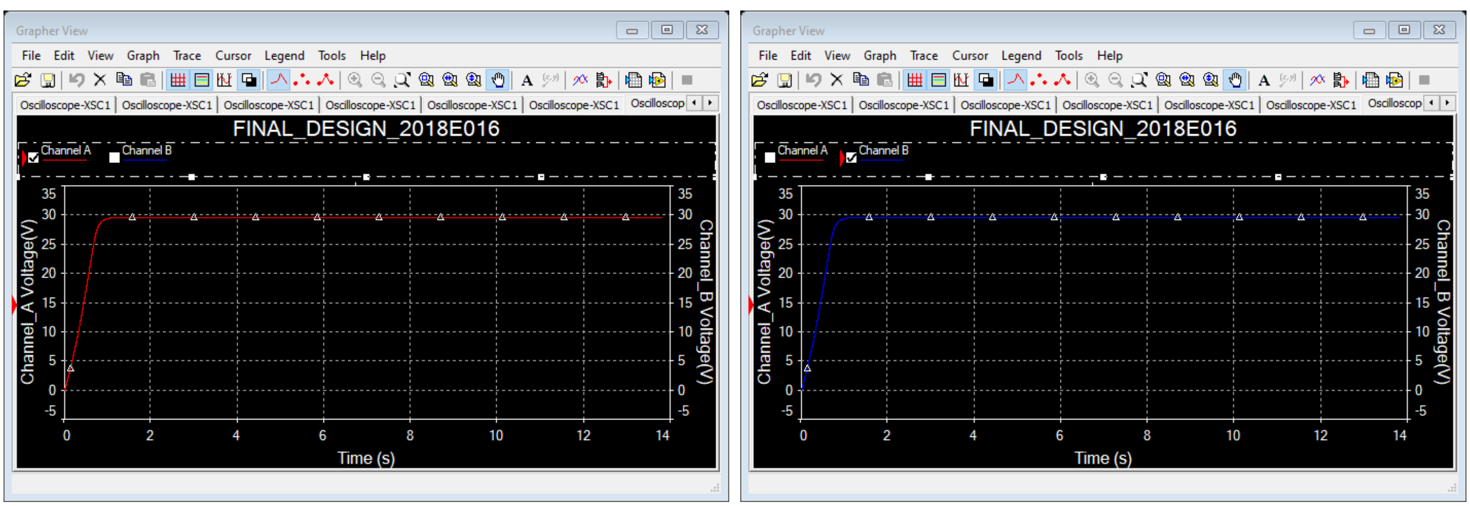


Figure 8: Oscilloscope outputs for the parallel operation

3. SERIES OPERATION MODE

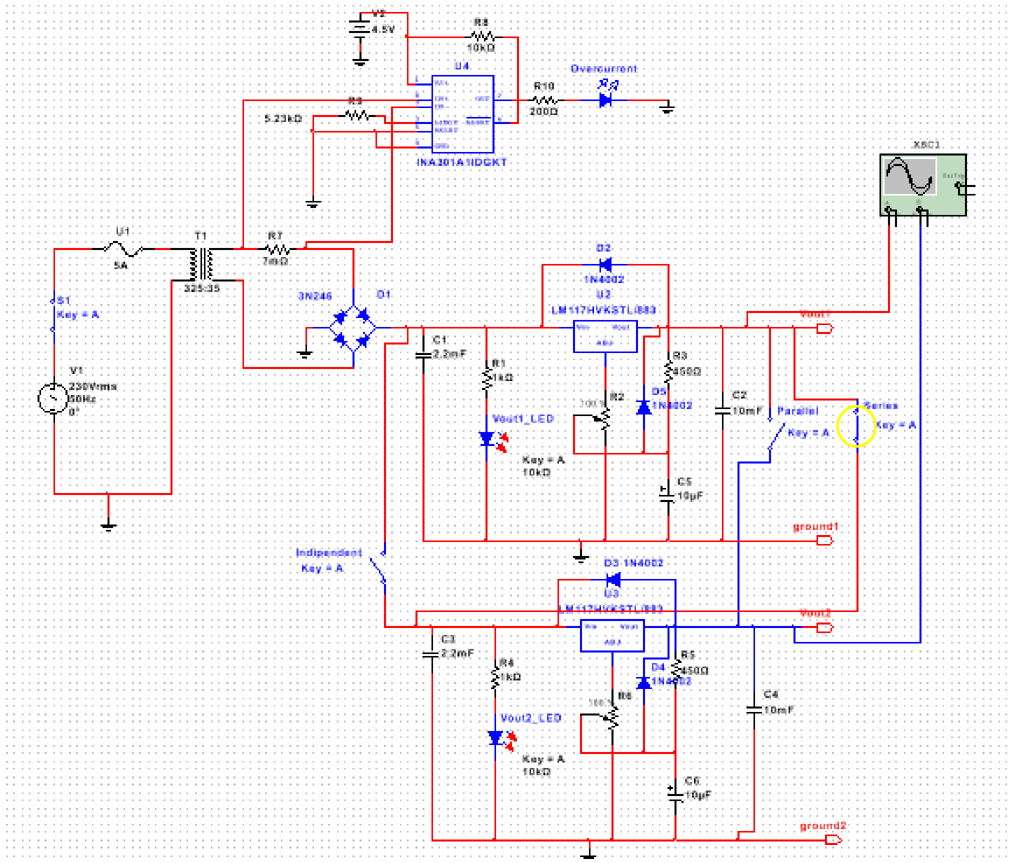


Figure 9: Series operation of the circuit

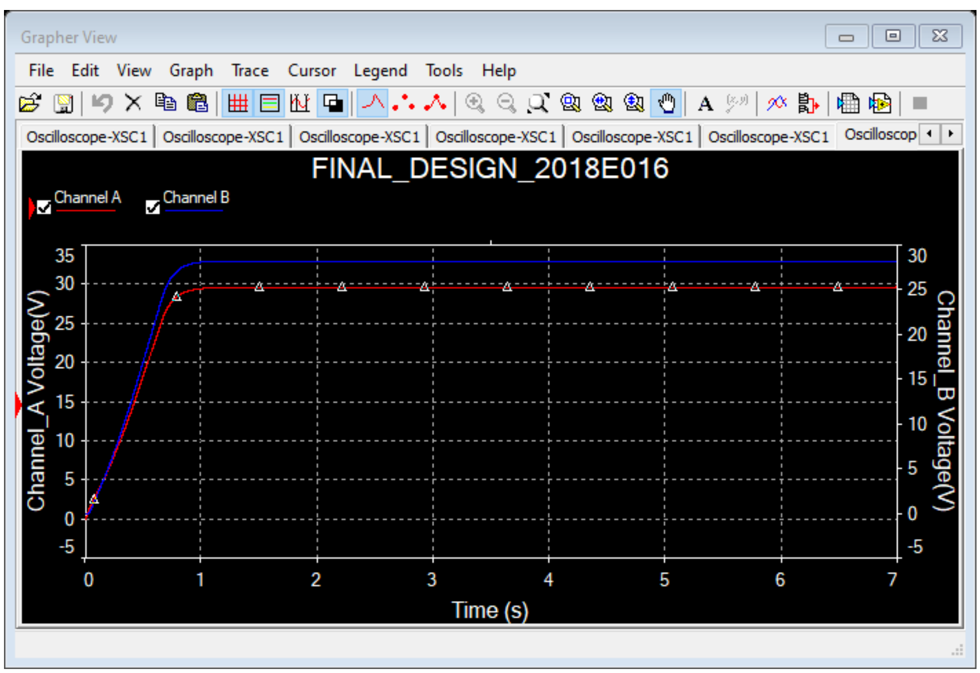


Figure 10: Oscilloscope output for the series operation