7semi INA240 current sensor user manual

Brief description about the product

- The INA240 device is a voltage-output, current-sense amplifier with enhanced PWM rejection that can sense drops across shunt resistors over a wide common-mode voltage range from –4 V to 80 V, independent of the supply voltage.
- It can measure **DC** current with high accuracy. This is possible due to its **low gain error** and **low offset voltage**. It is not designed to measure load voltage directly and you may need additional circuitry to measure the load voltage.

Why does CMRR value matters in current measurement?

In current sensing, the goal is to measure the small voltage drop across a shunt resistor accurately. If the CMRR is low, common-mode voltages (voltages that are present on both the positive and negative inputs of the amplifier) can introduce errors in the measurement. A high CMRR ensures that these common-mode voltages are effectively rejected, leading to more accurate current measurements.

Available Gains for INA240:-

1. INA240A1: 20 V/V
2. INA240A2: 50 V/V
3. INA240A3: 100 V/V
4. INA240A4: 200 V/V

Max Current calculations for different GAIN

Due to its different gain variant you can select the device which will be suitable for your application.

The maximum current for different gain variants of INA240:-

1. **A1 Gain = 20**

   Vs = 5 V *(Supply voltage to the device, Vs range is from 2.7 V to 5.5 V)*
   Maximum analog output voltage = Vs + 0.3 = 5 + 0.3 = 5.3 V
   Voltage across shunt = 5.3/20 = 0.265 V
   Maximum current = Max voltage/ Max resistance = 0.265/ 0.01 = **26.5 A**

2. **A2 Gain = 50**

   Vs = 5 V *(Supply voltage to the device, Vs range is from 2.7 V to 5.5 V)*
   Maximum analog output voltage = Vs + 0.3 = 5 + 0.3 = 5.3 V
   Voltage across shunt = 5.3/50 = 0.106 V
   Maximum current = Max voltage/ Max resistance = 0.106/ 0.01 = **10.6 A**

3. **A3 Gain = 100**

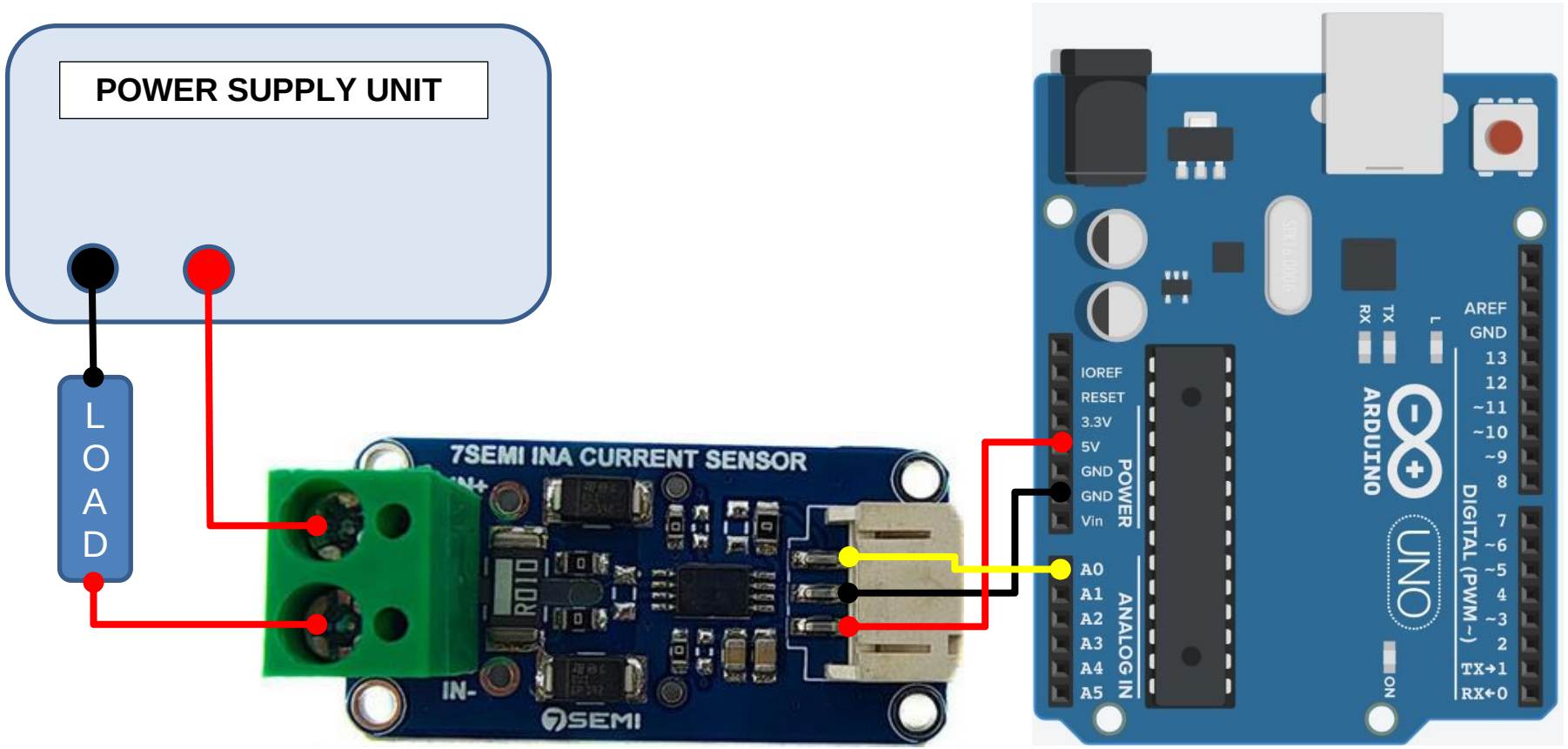
   Vs = 5 V *(Supply voltage to the device, Vs range is from 2.7 V to 5.5 V)*
   Maximum analog output voltage = Vs + 0.3 = 5 + 0.3 = 5.3 V
   Voltage across shunt = 5.3/100 = 0.053 V
   Maximum current = Max voltage/ Max resistance = 0.053/ 0.01 = **5.3 A**

4. **A4 Gain = 200**

Vs = 5 V *(Supply voltage to the device, Vs range is from 2.7 V to 5.5 V)*
Maximum analog output voltage = Vs + 0.3 = 5 + 0.3 = 5.3 V
Voltage across shunt = 5.3/200 = 0.0265 V
Maximum current = Max voltage/ Max resistance = 0.0265/ 0.01 = **2.65 A**

Note:- This calculations are done by taking Vs = 5 V into account and the maximum current value will be different if you use any other reference voltage for your measurement. If you are providing proper 5V supply to the INA240 board then you can go with the above values for your application. One of the most important thing will be the **reference voltage used for the ADC measurement**, more about this will be discussed in the further part.

Connection diagram



Connections of INA240 current sensor with Arduino Uno/ Nano

INA240 board	Arduino Uno/ Nano
VCC	5V
GND	GND
VOUT	A0

- This sensor gives output Analog voltage from its ‘VOUT’ pin. In order to make current measurements we need to convert this analog value to digital. Using Arduino’s ADC pins we can convert the analog values from the sensor to digital.
- **Note:- If you want better accuracy then you must use better reference voltage for the ADC measurement. If your reference voltage is unstable/ noisy then your current readings will also be noisy**.
- By default Arduino uses its supply voltage as reference voltage for ADC measurement (5V or 3.3V). **But these voltages are not exactly 5V or 3.3V all the time**.
- Plug your Arduino board into USB port of your Desktop/ laptop and check voltage at 5V pin using multimeter, note this value for further calculations.

1. Now let's upload a sample code and get some current readings. For testing purposes we have used a heating wire as a load which consumes around 1A at 5V.
2. Sample code link:- INA240 current sensor code
   Copy & paste the code given in the above link and upload it to your Arduino board.
3. With the help of the multimeter measure voltage at the 5V pin of the Arduino board. After measuring the voltage **replace** that value in the code as shown below (5.0)

```
const float referenceVoltage = 5.0;
```

4. Connect the current sensor with your Arduino board as per the connection diagram given.
   Before connecting any kind of load you should see all the readings as **0.00** as shown in the image below.

```
Sensor Value: 0.00      Voltage: 0.0000 V       Shunt Voltage: 0.0000 V Current: 0.0000 A
-------------------------------------------------------------------------------------------
Sensor Value: 0.00      Voltage: 0.0000 V       Shunt Voltage: 0.0000 V Current: 0.0000 A
```

5. Now connect your load as per the connection diagram given.

```
Sensor Value: 149.00    Voltage: 0.4802 V       Shunt Voltage: 0.0096 V Current: 0.9604 A
-------------------------------------------------------------------------------------------
Sensor Value: 151.00    Voltage: 0.4866 V       Shunt Voltage: 0.0097 V Current: 0.9732 A
-------------------------------------------------------------------------------------------
Sensor Value: 151.00    Voltage: 0.4866 V       Shunt Voltage: 0.0097 V Current: 0.9732 A
```