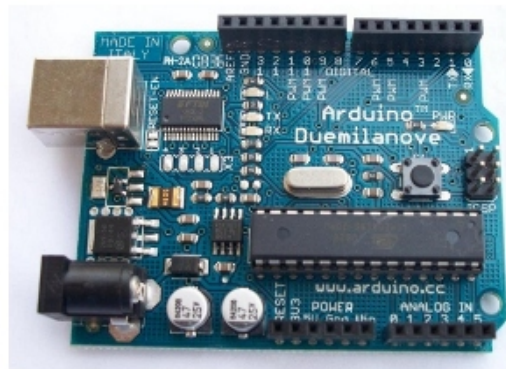


OpenEnergyMonitor

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CT sensors - Interfacing with an Arduino



To connect a CT sensor to an Arduino, the output signal from the CT sensor needs to be conditioned so it meets the input requirements of the Arduino analog inputs, i.e. a positive **voltage** between **0V** and the ADC **reference voltage**.

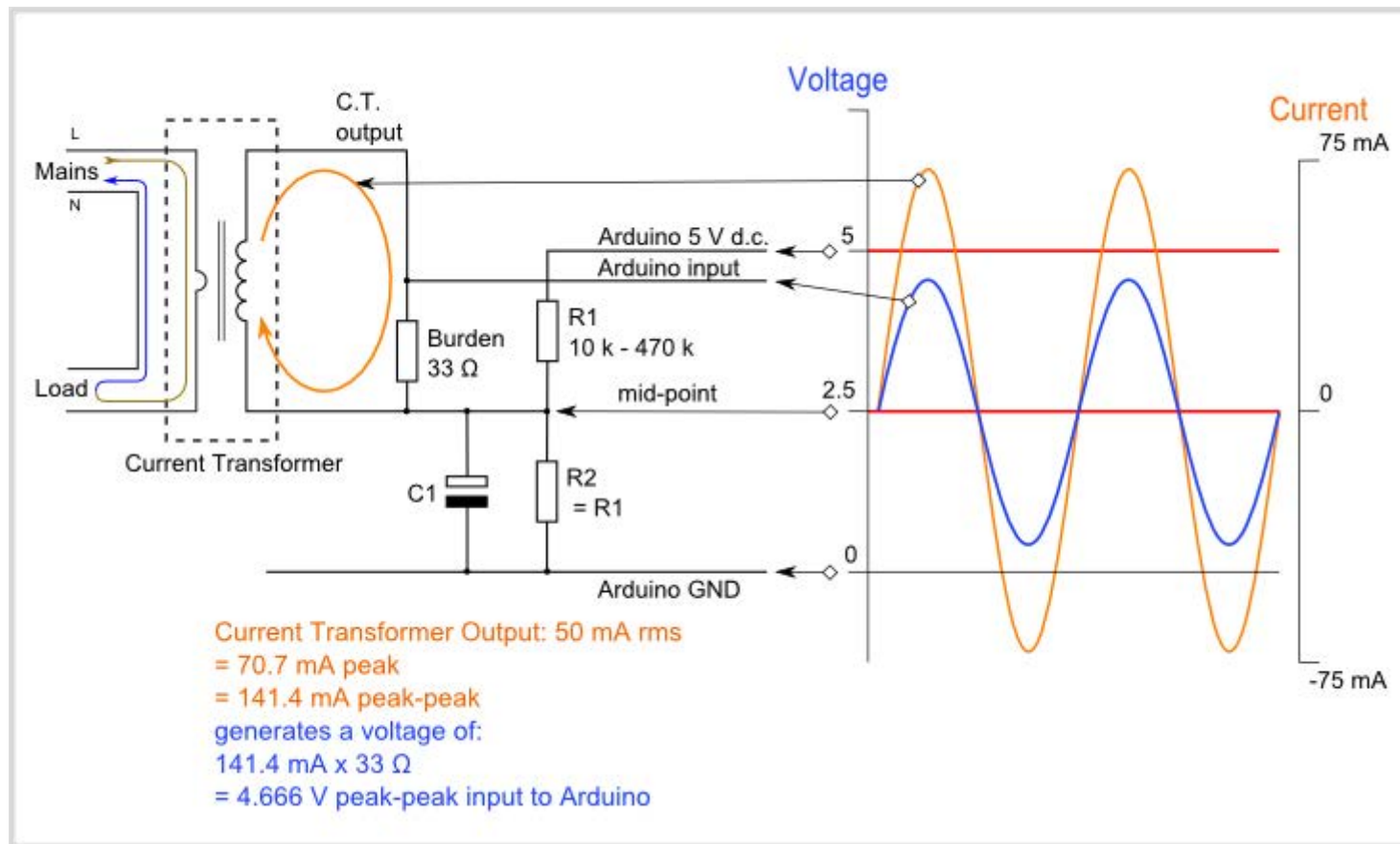
Note: This page give the example of an Arduino board working at 5 V and of the EmonTx working at 3.3 V. Make sure you use the right supply voltage and bias voltage in your calculations that correspond to your setup.

This can be achieved with the following circuit which consists of two main parts:

1. The CT sensor and burden resistor
2. The biasing voltage divider (R1 & R2)

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Calculating a suitable burden resist or size

If the CT sensor is a "current output" type such as the YHDC SCT-013-000, the current signal needs to be converted to a voltage signal with a burden resistor. If it is a voltage output CT you can skip this step and leave out the burden resistor, as the burden resistor is built into the CT.

1) Choose the current range you want to measure

The YHDC SCT-013-000 CT has a current range of 0 to 100 A. For this example, let's choose 100 A as our maximum current.

2) Convert maximum RMS current to peak-current by multiplying by $\sqrt{2}$.

$$\text{Primary peak-current} = \text{RMS current} \times \sqrt{2} = 100 \text{ A} \times 1.414 = 141.4 \text{ A}$$

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3) **Divide** the **peak-current** **by** the **number of turns in the CT** to **give the peak-current in the secondary coil**.

The YHDC SCT-013-000 CT has 2000 turns, so the secondary peak current will be:

$$\text{Secondary peak-current} = \text{Primary peak-current} / \text{no. of turns} = 141.4 \text{ A} / 2000 = 0.0707 \text{ A}$$

4) To **maximise measurement resolution**, the **voltage across the burden resistor at peak-current** should **be equal to one-half of the Arduino analog reference voltage**. (**AREF / 2**)

If you're using an Arduino running at 5V: AREF / 2 will be 2.5 Volts. So the ideal burden resistance will be:

$$\text{Ideal burden resistance} = (\text{AREF}/2) / \text{Secondary peak-current} = 2.5 \text{ V} / 0.0707 \text{ A} = 35.4 \text{ } \Omega$$

35 Ω is not a common resistor value. The nearest values either side of 35 Ω are 39 and 33 Ω . Always choose the smaller value, or the maximum load current will create a voltage higher than AREF. We recommend a 33 $\Omega \pm 1\%$ burden. In some cases, using 2 resistors in series will be closer to the ideal burden value. The further from ideal the value is, the lower the accuracy will be.

Here are the same calculations as above in a more compact form:

$$\text{Burden Resistor (ohms)} = (\text{AREF} * \text{CT TURNS}) / (2\sqrt{2} * \text{max primary current})$$

emonTx V2

If you're using a battery powered emonTx V2, AREF will start at 3.3 V and slowly decrease as the battery voltage drops to 2.7 V. The ideal burden resistance for the minimum voltage would therefore be:

$$\text{Ideal burden resistance} = (\text{AREF}/2) / \text{Secondary peak-current} = 1.35 \text{ V} / 0.0707 \text{ A} = 19.1 \text{ } \Omega$$

19 Ω is not a common value. We have a choice of 18 or 22 Ω . We recommend using an 18 $\Omega \pm 1\%$ burden.

emonTx V3

The emonTx V3 uses a 3.3V regulator, so it's V_{CC} and therefore AREF, will always be 3.3V regardless of battery voltage. The standard emonTx V3 uses 22 Ω burden resistors for CT 1, 2 and 3, and a 120 Ω resistor

types

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for CT4, the high sensitivity channel. See the emonTx V3 technical wiki at:
https://wiki.openenergymonitor.org/index.php?title=EmonTx_V3#Burden_Resistor_Calculations

Tool for calculating burden resistor size, CT turns and max Irms - thanks to Tyler Adkisson for building and sharing this.

(Note: this tool does not take into account maximum CT power output. Saturation and distortion will occur if the maximum output is exceeded. Nor does it take into account component tolerances, so the burden resistor value should be decreased by a few (~5) percent allow some "headroom." There is more info about component tolerances at: [ACAC Component tolerances.](#))

2) Adding a DC Bias

If you were to connect one of the CT wires to ground and measure the voltage of the second wire, relative to ground, the voltage would vary from positive to negative with respect to ground. However, the Arduino analog inputs require a positive voltage. By connecting the CT lead we connected to ground, to a source at half the supply voltage instead, the CT output voltage will now swing above and below 2.5 V thus remaining positive.

Resistors R1 & R2 in the circuit diagram above are a voltage divider that provides the 2.5 V source (1.65 V for the emonTx). Capacitor C1 has a low reactance - a few hundred ohms - and provides a path for the alternating current to bypass the resistor. A value of 10 μ F is suitable.

Choosing a suitable value for resistors **R1 & R2**:

Higher resistance lowers quiescent energy consumption.

We use 10 k Ω resistors for mains powered monitors. The [emonTx](#) uses 470 k Ω resistors to keep the power consumption to a minimum, as it is intended to run on batteries for several months.

Arduino sketch

To use the above circuit to measure RMS current, with an assumed fixed RMS voltage (e.g. 240V) to indicate approximate apparent power, use this Arduino sketch: [Arduino sketch - current only](#)

Attachment	Size
BurdenResistorCalculator.xls	36 KB

Re: **CT sensors - Interfacing with an Arduino**

Submitted by quarbe (not verified) on Mon, 20/02/2012 - 17:05.

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Hi everybody!

I need some help with CSLA2CD Honeywell hall effect. The question is that it's need a minimum of 6V DC to work, recommended 8V and the output is $V_{CC}/2$, incrementing 0,033V for every Amp. So I have connected it to 8V, and the output is 4V without load...



How can I connect to arduino?? Is it necessary to modify the library??

Thanks in advance!

»

Re: CT sensors - Interfacing with an Arduino

Submitted by greenfly (not verified) on Wed, 08/02/2012 - 19:49.



I'm experiencing some Problems with this circuit, meaning I'm not getting any values.

I got the SCT-013-000 and I'm using 320 Ohm Burden Resistor to measure a Current of 10A.

I already checked my circuit (build it 2 times, checked voltages) and now also the SCT. There I noticed, it has got an internal resistance of 100 Ohm. Could that be a problem?

What more can I do?

Sebi

»

Re: CT sensors - Interfacing with an Arduino

Submitted by Robert (not verified) on Wed, 04/01/2012 - 13:55.



I use two of the sct-013-000 on my system. 120 volts with a 3.3volts Arduino. I use a 47 ohms resistor on each. This gives me a 50 amps maximum range on the ct instead of the 100 amps max, but I use them for measuring internal energy on individual breakers (220 volts) and the max one is the clothes dryer at 40 amps. To measure up to 100 amps, you would need 25 ohms resistor or so. I used my alternate method (explained in another comment) to chose the burden resistor since nobody seems to really know the number of turns on this device

»

Re: CT sensors - Interfacing with an Arduino

Submitted by Sergegsx on Fri, 21/10/2011 - 12:15.

wrt this sensors



which one is more convenient to use, not for the whole house monitoring (ive got a efergy there) but for the different sections of the house.

That would be a max of 2000W to 3000W in each.

If i read correctly both will measure up to 5amps ($230V \times 5A = 1150W$??) so thats maximum per sensor?

also, the 100 version would be better cause it outputs 0-5mA so more precise ??

Please any help.

Thanks

TA12L-200

www.ebay.com/itm/0-5A-Input-2-5mA-Output-AC-Current-Transformer-TA12-200-/300609568022

Product Name	AC Current Transformer
Model No.	TA12-200
Ratio	2000:1
Input Current	0-5A
Output Current	0-2.5mA
Sample Resistance	800Ω
Sampling Voltage	2V
Nonlinear Scale	<=0.2%
Phase Drift	<=5'
Working Frequency	20Hz-20KHz

TA12L-100

www.ebay.com/itm/TA12L-100-Epoxy-Resin-Embedding-Current-Transformer-Red-/350497986004

Product Name	Current Transformer
Model No.	TA12L-100
Ratio	1000:1
Input Current	0-5A
Output Current	0-5mA
Sample Resistance	200Ω
Sampling Voltage	1V
Nonlinear Scale	<=0.3%
Phase Drift	<=10'

Working Frequency 20Hz-20KHz

»

Re: CT sensors - Interfacing with an Arduino

Submitted by [Guest](#) (not verified) on Tue, 06/09/2011 - 18:21.



I think you have the example burden values reversed for the 3.3V and 5.0V implementations of the SCT-013-000. If you use the recommended 56 ohms in a 3.3V system, $(33 \text{ mA} * 1.414) * 56 \text{ ohms} = 2.61\text{V}$. Add the 1.65V offset value, and your peak voltage is $2.61 + 1.65 = 4.26\text{V}$ in a 3.3V system. Or are you using a different ADC reference value?

»

Re: CT sensors - Interfacing with an Arduino

Submitted by [glyn.hudson](#) on Wed, 07/09/2011 - 12:16.



Hi, thanks for noticing this. It turns out that the number of turns on the SCT-0130-00 are different to what we initially thought. The number of turns is actually very similar (if not the same) as the efergy CT. The datasheet is not clear on this. I've removed the recommended burden resistor values while we do some more testing. We have been using 15ohm burden resistors in the emonTx running at 3.3V.

»

Re: CT sensors - Interfacing with an Arduino

Submitted by [bellboy.tech](#) (not verified) on Mon, 12/12/2011 - 15:07.



Any luck with testing the SCT-013-000? I'm still having accuracy problems with the two I have?

»

Re: CT sensors - Interfacing with an Arduino

Submitted by [fparaggio](#) (not verified) on Thu, 29/12/2011 - 16:03.



I experienced accuracy problem me too. Any news and testing for SCT-013-000?

»

Re: CT sensors - Interfacing with an Arduino

Submitted by [Robert](#) (not verified) on Wed, 04/01/2012 - 13:58.



They are quite precise. I use a 47 ohms burden resistor at 3.3volts. This means roughly 50 amps max over a 512 range on the Arduinos analog input pin, so about 10 ticks per amp, or 100 ma per tick. This is theoretical. As the sct013-000 outputs 33mA max at 100 amps, spread over 512 steps on the analog pin, don't expect miracles. I do get a final tested resolution of about 50 watts over the entire range, which is not so bad. If I need more precision, I use the sct-013-030 without a burden resistor. On a 3.3 volts system, it's one volt output is precise enough.

»

Open-source tools for energy monitoring and analysis. This project uses the [GNU General Public Licence](#)

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