***Initial Project Outline***

**Smart AC Monitor** – An AC (mains) device capable of accurately measuring and logging RMS Power, Voltage, Current, and Energy, and reporting these results wirelessly to a connected device (smartphone).

Such a device would be extremely useful for simply and intuitively auditing power consumption of any household electrical device, from a smartphone charger (5 - 20 W) to a desktop PC setup (200 – 800 W).

It would also touch on a huge range of electrical engineering topics, including, but not limited to:

* Safe AC design
* Mixed design (analogue/digital)
* High speed design & transmission line effects (USB, Wireless comms)
* ECAD software & PCB layout/routing
* Design-For-Manufacturing & Component procurement
* Low-level embedded firmware (in C)
* High-level, responsive, web programming (HTML, JavaScript, Python?)

***Initial Minimum requirements***

Power range: 1 W – 1 kW

AC Voltage range to suit Australian electrical grid (~230 Vrms)

Logging capability: 1 Hz logging for at least 24 hrs  
 Australian AC connectors for inline insertion (female/male “AS/NZS 3112”)

***Design goals***

Low-cost (project is self-funded)  
Assemble-able by hand, where possible  
< 1 W measurement accuracy

***Initial Research***

Device will require a microcontroller with either Wi-Fi (and the ability to run a simple HTTP server), or Bluetooth (and a companion app on any smartphone). The current most popular microcontroller that is capable of both is the ESP32, [available in a SMD module for $6 AUD from Digikey](https://www.digikey.com.au/product-detail/en/espressif-systems/ESP32-WROOM-32D/1904-1023-1-ND/9381732).

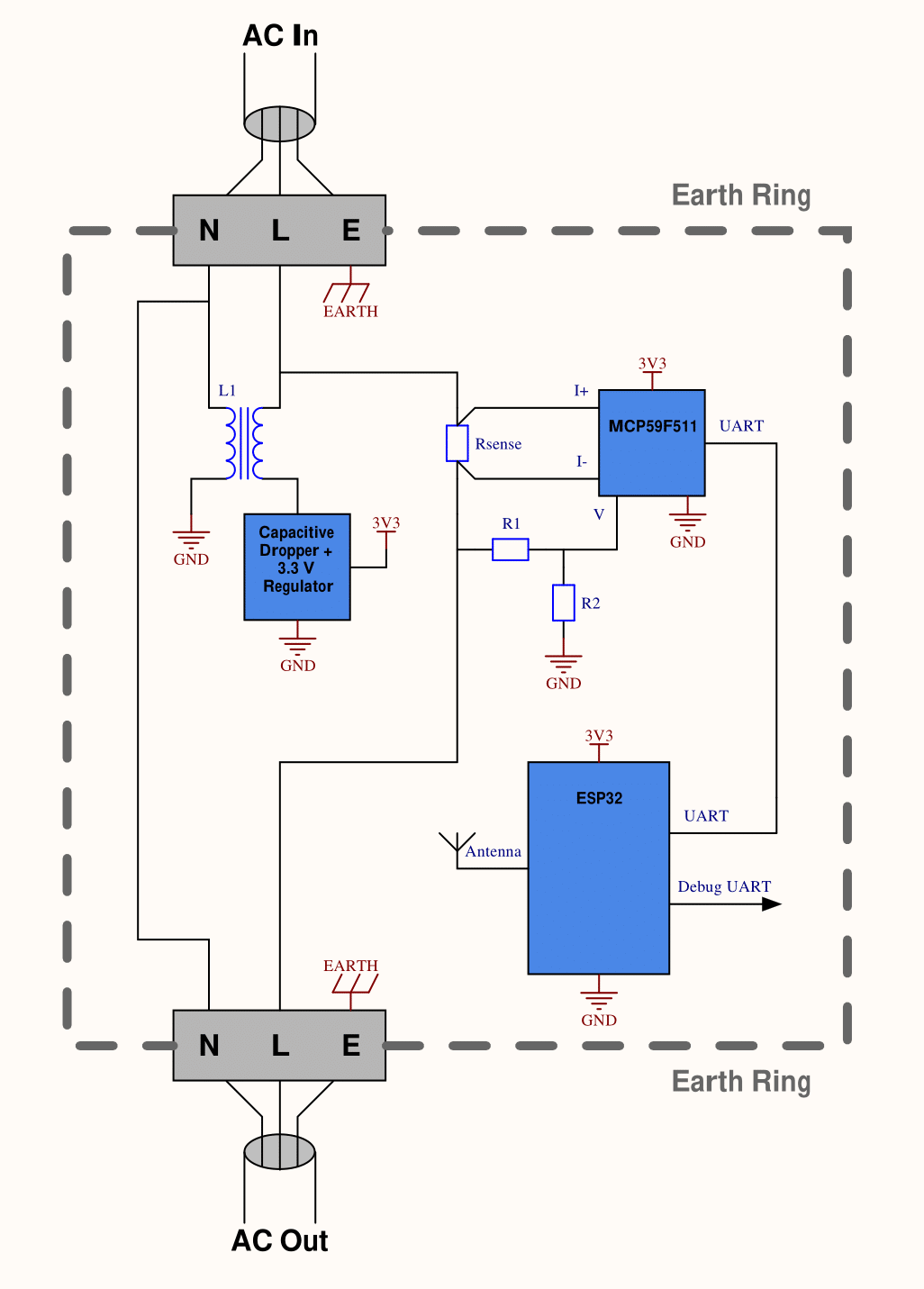
For monitoring AC lines, there are a few options: current and voltage transformers, or a current shunt and voltage divider setup. The second is simpler, cheaper, and more analogous to low-voltage (digital) DC power measurement, so this is probably the best choice. One could definitely design the entire analogue section themselves, but there is a lot of signal processing that would need to be done to the AC measurements to convert them into RMS values, so I’d prefer a dedicated IC with this built-in.

Checking the “ICs > Energy Metering” product category on Digikey shows that the cheapest candidate with good availability is the Microchip MCP39F511, [available in a SMD package (QFN 5x5) for $4 AUD from Digikey.](https://www.digikey.com.au/product-detail/en/microchip-technology/MCP39F511-E-MQ/MCP39F511-E-MQ-ND/5323591)

The MCP39F511 has 4000:1 dynamic range, more than enough to measure the 1 W – 1 kW range with less than 1 W resolution, and also a PGA with up to 32x gain, to further extend measurement range. It can also measure RMS current, voltage, power and energy using just a current shunt resistor, and voltage divider, so is perfect for our needs.

Both the ESP32 and MCP39F511 are capable of running from a 3.3 V DC power supply, so the simplest 3.3 V DC power supply derived from the AC input is probably best – as long as the device is totally enclosed while energised, a capacitive-dropper circuit, with any suitable 3.3 V LDO, should be appropriate.

***Initial Concept Sketch***

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