CURRENT SENSOR

CURRENT SENSOR – POWER LINE MONITORING FOR ENERGY DEMAND CONTROL

29 July 2026

Observe precautions! Electrostatic sensitive devices!

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REVISION HISTORY

The following major modifications and improvements have been made to this document:

Version	Author	Reviewer	Date	Major Changes
1.0	CB		2010.01	Original version
1.1	CB		2020.01	Updated component values, added VDDLIM protection.
2.0	AZ	JB	2026.07	Document maintenance

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1 Introduction

Based on EnOcean's self-powered STM wireless sensor modules, this application note describes a simple concept for a self-powered, galvanically isolated current sensor for monitoring AC current. The basic requirements are:

- Autonomous, isolated measurement
- Measurement range: 1 to 60 A (AC)

An STM module cannot continuously monitor line current the way a conventional ammeter does, because it can only sample the signal at discrete, periodic intervals. Reading the exact instantaneous current at a random sampling moment therefore provides little useful information — it could coincide with a transient peak, a zero crossing, or anything in between. A more meaningful approach is to read the average effective current value, or simply to detect whether current is flowing at all.

2 Challenge

An AC line typically operates at 50/60 Hz, so the sinusoidal voltage swings between zero and its peak roughly every 10 ms. However, the current drawn by the load rarely follows a clean sinusoidal waveform: modern switch-mode power supplies, electronic ballasts, and other nonlinear loads draw current in pulses, and external interference can distort the waveform further. Aside from the usual phase shift and power factor, this pulsed current generates harmonics and sub-harmonics of the line frequency — so, except for very simple resistive loads, the current waveform rarely resembles the voltage waveform.

The STM module can sample the current only periodically, and for energy-budget reasons the measurement window is typically limited to under 2 ms. Neither the module nor its analog front end has time to compute a true average over a full mains cycle (about 20 ms at 50 Hz). Sampling at different points within that cycle would therefore yield randomly different readings.

One way around this is to measure an average effective value provided by a self-powered current transducer. The same monitored line should also be able to safely supply the small amount of power the sensor itself needs. As described in the following sections, a current transducer can both power a wireless transmitter and supply it with a measured current value every time the current flows.

3 Solution: Using a Self-Powered Current Transducer

The only passive, ultra-low-power sensor well suited to this task is the current transducer (CT). CTs are widely used to measure AC amperage in electrical circuits: they are accurate, safe, straightforward to install, and reliable across a wide range of environmental and thermal conditions. A CT is installed around an energized conductor without breaking the circuit, and senses the magnetic field generated by the primary current. Unlike other transducer types, the primary-side current in a CT is entirely independent of the secondary-side load — it depends only on the circuit into which the primary conductor is connected. The principle itself is not new.

For example, a self-powered CT can drive an LED as a discrete current indicator for a remote circuit. When current flows, the CT harvests enough energy to light the LED, and the LED turns off once the current stops. Commercial products based on this idea already exist, such as the ABB LCS10T12 AC Current Go/No-Go Indicator.

4 Designing a Discrete, Line-Powered Energy Harvester

In a typical wall distribution box, direct access to the monitored wire is available, but there is no ambient light for a solar panel to power the STM module. Instead, the circuit shown in Figure 1 uses a second, low-cost 50/60 Hz CT as an energy source. A burden resistor converts its output current into a voltage, followed by a voltage limiter and rectifier that produce a continuous, filtered supply voltage of roughly 3 to 4 V — enough to power the transmitter module whenever the monitored (primary) current exceeds about 1 A.

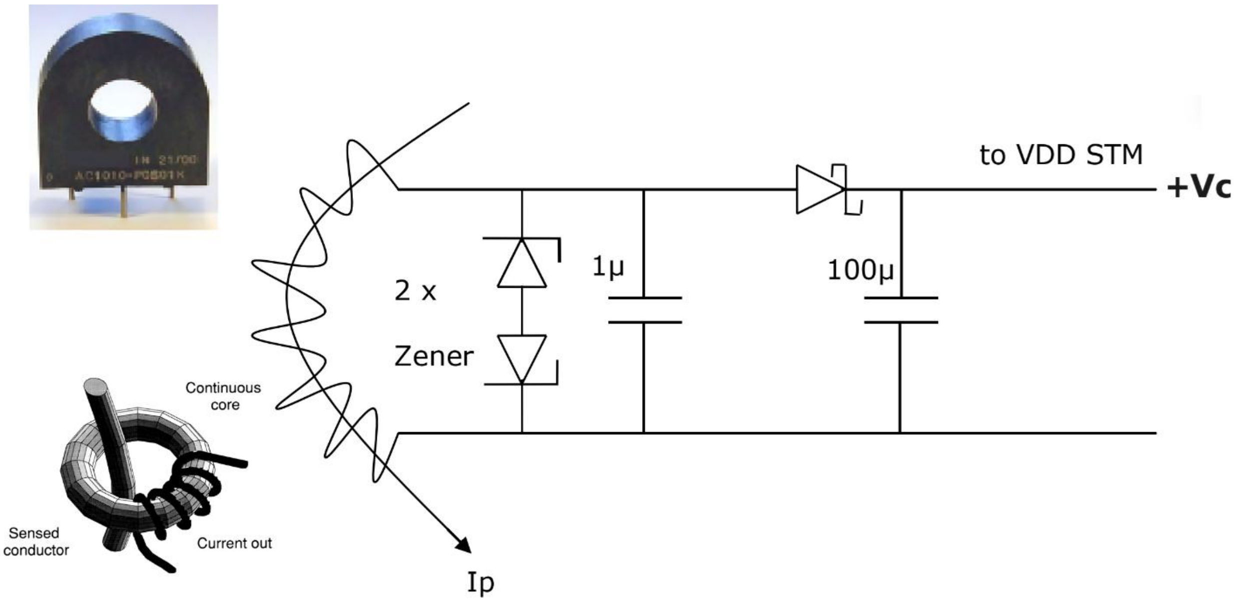

Figure 1: Energy harvester concept

Choose a CT with an opening large enough for the monitored wire and a sensitivity of at least 2 V/A into a 5 kΩ load — for example, the AC1005 from Talema. The CT's output (V/A) can be scaled up or down over a wide range simply by adjusting the burden resistor.
Because a CT behaves as a current source, a burden resistor is needed to convert its output current into a usable voltage. The rectified output voltage (+Vc) should be limited to around 4 V, which is below the STM module's maximum rated supply voltage. Assuming a minimum secondary DC voltage of about 2.6 V at the minimum primary current of 1 A, the burden resistor works out to roughly 5–10 kΩ. Low-drop Schottky diodes are recommended for the rectifier. To guard against overcurrent damage, add overvoltage protection — for example, the two 3.3 V / 0.5 W Zener diodes shown in Figure 1. Alternatively, on modules such as the STM 300, the VDDLIM pin can be tied to VDD; it can sink up to 50 mA and limits overvoltage internally, which makes the burden resistor unnecessary.
If only a Go/No-Go signal is required, this harvester circuit alone is enough to power the STM module and have it report a message whenever the primary current exceeds, for example, 1 A. Monitoring the actual current value, however, requires a second CT acting as the measurement sensor, as described next.

5 Current Measurement: First Approach (Plug & Play, Preferred Solution)

A convenient way to obtain a calibrated current reading is to use a ready-made device such as the H922 from Flex-Core (Figure 2). The H922 is a low-cost, self-powered current transducer with switch-selectable 30 A, 60 A, or 120 A ranges and built-in signal-conditioning electronics. Its swing-open jaws clamp around a single current-carrying wire — only one wire should ever pass through the sensor. Further specifications are available from the manufacturer at https://www.flex-core.com

Figure 2: Current Transducer (CT) — Flex-Core H922

5.1 Current Transducer Specifications

The H922 requires no external power; it is parasitically powered from the monitored line current through its internal current transformer. Key manufacturer specifications are summarized in Table 1.

Table 1: H922 current transducer — manufacturer specifications

Parameter	**Value**
Range	0 to 30, 60, or 120 A (switch-selected)
Output	0 to 5 Vdc, proportional to primary current
Accuracy	Better than ±2% or ±1% FS
Size	2.9 × 2.58 × 1.04 in (L × W × H)
Approvals	UL listed E150462

The H922's 0–5 Vdc output, proportional to primary current, only needs to be scaled down (dividing by 3, giving roughly 0–1.7 V) before being applied to the STM module's analog input. This lets the module detect both the presence and magnitude of current and transmit that information. Overvoltage protection — for example, two 3.3 V Zener diodes between the analog input and ground — is recommended to guard against damage; devices in the STM 3xx family can alternatively provide this protection internally by tying VDDLIM to VDD.

6 Principle of the Current Sensor

Figure 3 shows the two CTs combined into a complete current-sensing circuit: the AC1005 CT supplies power to the STM module through the rectifier and limiting stage, while the H922 CT — scaled by a 1:3 voltage divider — feeds the measured current value to the analog input.

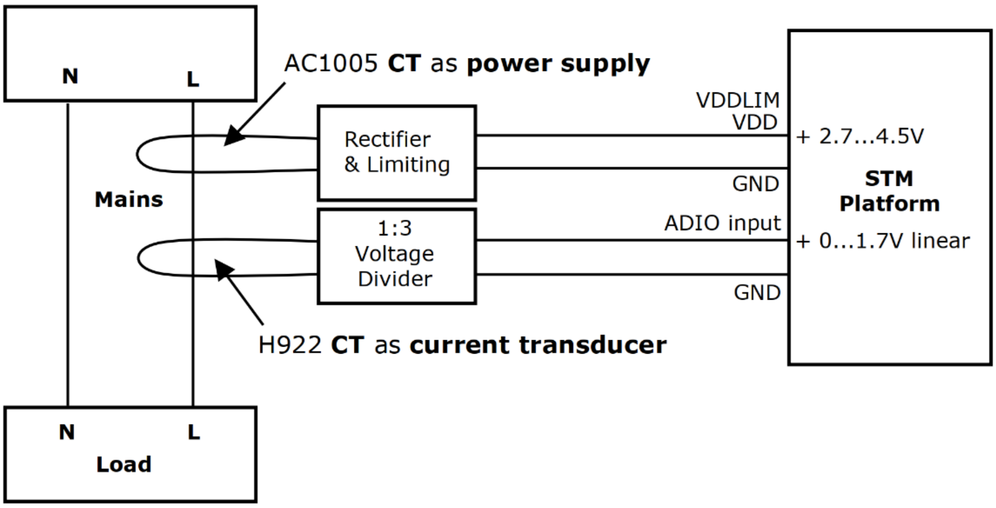

Figure 3: Principle of the current sensor

7 Safety Precautions for Current Transducers

Caution: A CT must never be open-circuited while primary current is flowing. If the secondary load (burden resistor or overvoltage protection) is disconnected while current flows through the primary winding, the magnetic flux in the core rises sharply, producing a very high voltage across the open secondary terminals. Given the high turns ratio typical of these transformers — often around 1:1000 — this voltage can reach dangerous levels: enough to break down insulation, damage the circuitry, and pose a hazard to personnel. Always place a short circuit or another overvoltage-limiting device across the secondary winding before disconnecting the secondary load while primary current is flowing.

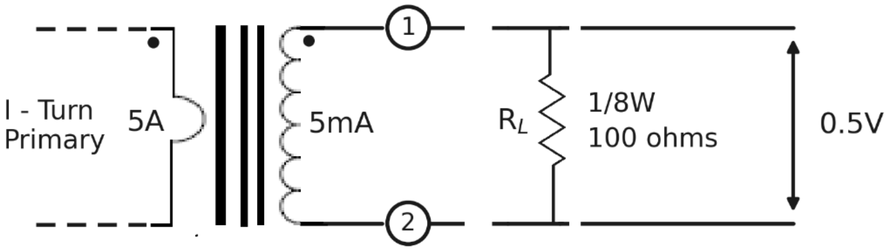

Figure 4: CT equivalent schematic

8 Notes on CT Core Types

Current transducers offer a simple, low-cost, yet accurate way to sense current in power conductors. They are generally available in two core configurations:

- Ring-core CTs, with a fixed opening sized to the conductor hole that the wire has to pass through
- Split-core CTs, with one section removable so the conductor or bus bar doesn't need to be disconnected during installation

Ring-core CTs are the most common geometry: because the core has no air gap, magnetizing current stays low, and the core material is used efficiently, keeping both core size and core losses small. This makes ring-core CTs the preferred choice for new installations. Split-core CTs, on the other hand, are smaller and less expensive than clamp-on probe-style CTs, and their easy installation makes them well suited for retrofits — especially in crowded electrical panels where space is limited.

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