

ANTI-THEFT SYSTEM FOR CATALYTIC CONVERTER

Team: Theft-Away

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ELECTRICAL ANALYSIS

Power Consumption

CP2102 USB to UART Bridge Controller:

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Product ID: 0xea60
Vendor ID: 0x10c4 (Silicon Laboratories, Inc.)
Version: 1.00
Serial Number: 0001
Speed: Up to 12 Mb/s
Manufacturer: Silicon Labs
Location ID: 0x01120000 / 7
Current Available (mA): 500
Current Required (mA): 100
Extra Operating Current (mA): 0
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Figure 1. Current measurement obtained from Mac Terminal

From the figure above, the ESP-32 and detection system, which draws power from ESP-32 to operate, requires 100 mA of current from the computer. As specified in Apple specifications, USB port outputs 5V voltage, thus the total power to ESP-32 in normal operating mode is:

$$P_{normal} = 5V * 100mA = 500mW$$

A car battery outputs 12V of power, thus the required current for ESP-32 board is:

$$I_{ESP32} = \frac{P_{normal}}{12V} = \frac{500mW}{12V} \simeq 42mA$$

A car starter motor typically draws a maximum current of 225A [1] over 15 seconds to start the engine, thus it requires a battery capacity of:

$$Minimum\ capacity = 225A * \frac{15s}{3600 \frac{s}{h}} \simeq 0.9375Ah$$

Using a safety factor of 1.5, the required capacity to safely start a car is:/

$$Require\ capacity = 0.9375Ah * 1.5 \simeq 1.4Ah$$

A typical car battery has battery capacity of 55Ah [2]. When excluding the capacity requires to safely start a car, the remaining battery is:

$$Remain\ capacity = 55Ah - 1.4Ah = 53.6Ah$$

Suppose only half of the remain capacity can be used for ESP-32, the total running time of ESP-32 when operating in normal mode is:

$$Running\ time = \frac{Remain\ capacity/2}{I_{ESP32}} = \frac{53.6Ah/2}{42 * 10^{-3}A} \simeq 638\ hours = 26.5\ days$$

Thus, even when operating in normal mode, ESP-32 can still operate up to 26.5 days without draining all the car battery.

