UPS Compliant with Department of Energy Efficiency Requirements

schneider-electric.us

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PROJECT MOTIVATION:

APC by Schneider Electric Uninterruptible Power Supplies (UPS) are known for their efficiency in power conditioning, and providing power backup in case of a grid power outage. The Energy Star® program for UPS products provides information so consumers can easily select more efficient models to save energy and operating costs. The Department of Energy (DoE) plans to release new efficiency regulations for these types of products. The efficiency requirements the DoE intends to release are more stringent than the current Energy Star® program. If the regulation is approved, products that are sold in the United States must comply or be removed from the market. With new Department of Energy efficiency regulations being placed into effect, Schneider Electric must revise and improve their already efficient UPS systems. To achieve this new level of efficiency, it means the redesign of several different sub-systems within the UPS.

ANTICIPATED BEST OUTCOME:

The team will have to identify several sub-circuits can be redesigned to lower power consumption. Once identified, the team will analyze the circuits and improve them without affecting the interaction with the overall system. The goal is to reduce power consumption of the UPS by several watts. In addition, the team will work on software that provides analytical data on the UPS operation. This includes analysis of cloud data as well as analysis of data from direct communication with the UPS. The analysis of the UPS data will result in dashboards to show statistics on loading, self-test results, and customer configurations.

IMPLICATIONS FOR COMPANY AND INDUSTRY:

If the team is successful in this project, Schneider Electric could apply the changes to improve the efficiency of the UPS product. The changes could be applied to several different models. This will help Schneider Electric meet the new DoE requirements when they come into effect. The combination of the data analysis and improved efficiency could put Schneider Electric at a competitive advantage, potentially gaining market-share from key competitors in a multibillion-dollar market.

PROJECT OUTCOME:

The Anticipated Best Outcome was not achieved: A few sub-circuits were designed to reduce power consumption by a couple of hundred milliwatts.

KEY ACCOMPLISHMENTS:

Modification of IC 412 Comparator Circuit: For this particular circuit a mathematical derivation of a transfer function was performed to understand the frequency response of the circuit. A simulation and frequency sweep were performed for comparison with transfer function's Bode Plot. This was done using PSPICE. Using the mathematical transfer function, resistor and capacitor values were maximized for minimal power consumption. For this circuit, there was a limitation in one resistor value. As a result of this limitation, the ratio between resistor increase and capacitor decrease could not be maintained equal. Adjustments were made to maximize values and retain the circuits response as close as possible to the original response. This result can be seen in fig. 4.

Vout Error Amplifier: For this circuit, a simulation was performed to understand circuit parameters and operational purpose. A frequency sweep was done in PSPICE in order to visualize the circuits response. A mathematical transfer function was derived using circuit components. The transfer function was then plotted in MATLAB and compared with the simulated PSPICE frequency response. This was done to ensure that the mathematical transfer function was correct. Using the transfer function, resistor and capacitor values were adjusted and determined to minimize circuit power consumption and retain original circuit functionality. Since there was no limitation on resistor values, all resistors were increased to 4 times their original value, and capacitors were reduced accordingly. The response can be seen in fig. 3.

Charger Disconnect Switch: High power consumption was identified in the battery charging circuit. A way to turn off the circuit when the battery charging cycle was completed was devised. A MOSFET driven Optocoupler switch that was powered from AC conditioned input was implemented. Leakage current protection was built into the circuit as well as overvoltage protection for MOSFET. Resistor Values were maximized for optimal power conservation. The designed circuit can be seen in fig. 1.

Updating firmware: Used Eclipse to update firmware files in collaboration with firmware engineer. The team also used programs such as BitBucket and SourceTree to share files in collaboration with the firmware engineer.

Data Analysis: Created repositories and exchanged information with the firmware engineer regarding data analysis. This included obtaining telemetry data that was logged to Schneider's digital service platform and doing analysis on the collected data.

QR Generator: The team created a QR code generator that can be used to test error messages that occur in each device. When scanning the QR code, the user is sent to a web page with relevant information regarding the error and the device. This includes the device serial number, the MAC address of the device, the error code, and a description of the error. A sample of the webpage can be seen in fig. 2.

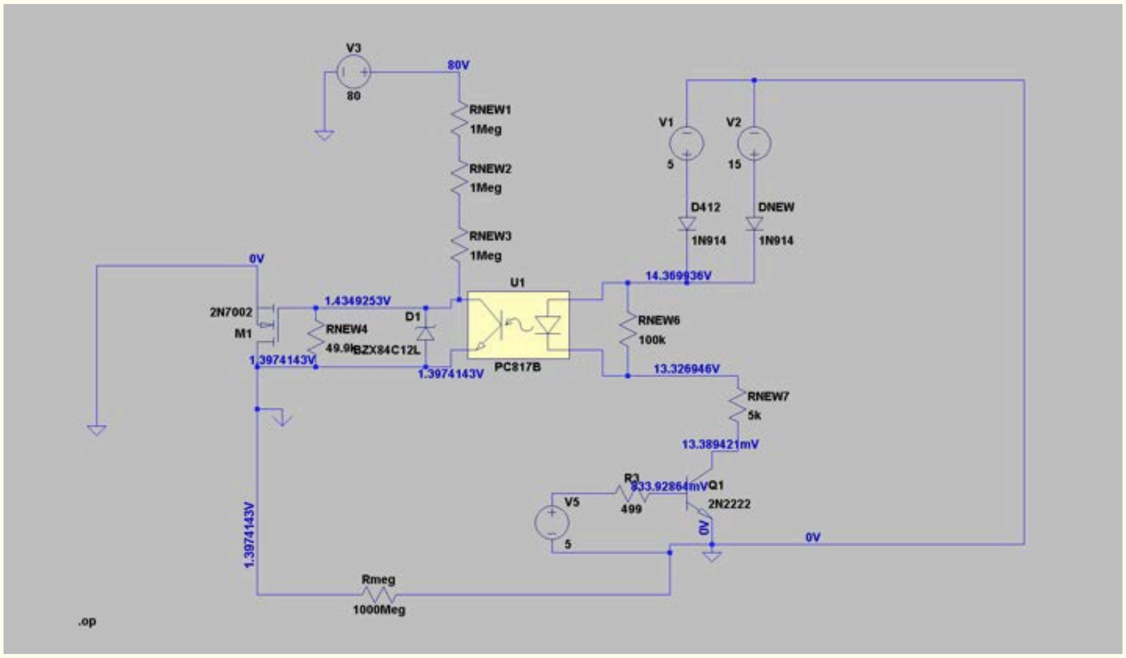

Fig 1: Charger Disconnect Switch

Fig 2: Example QR-Redirected Error Page

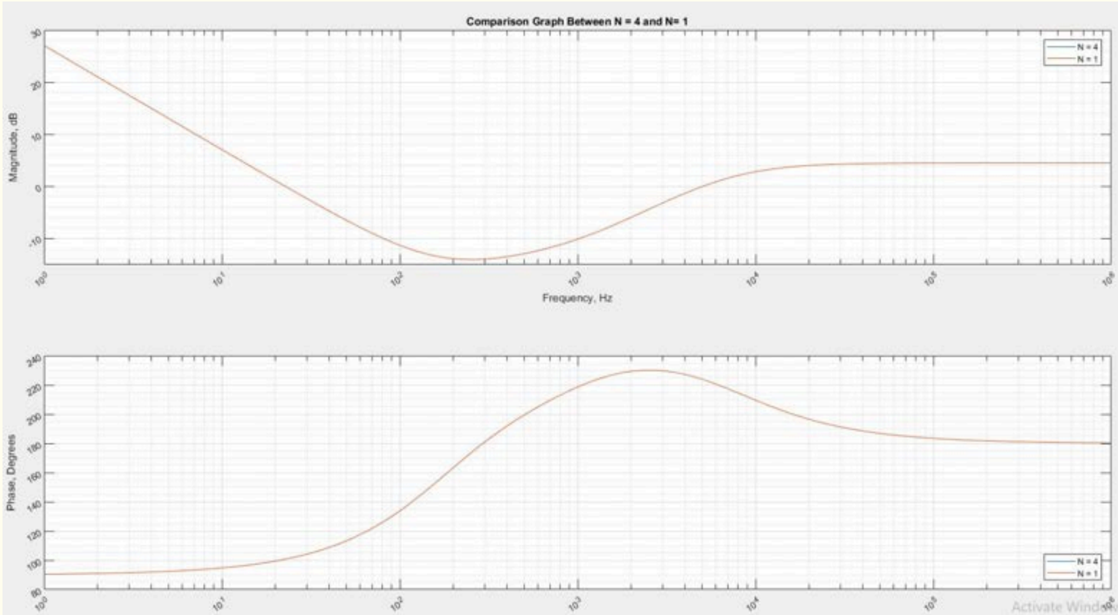

Fig 3: Adjusted Frequency Response Comparing Different Circuit Scale Parameters

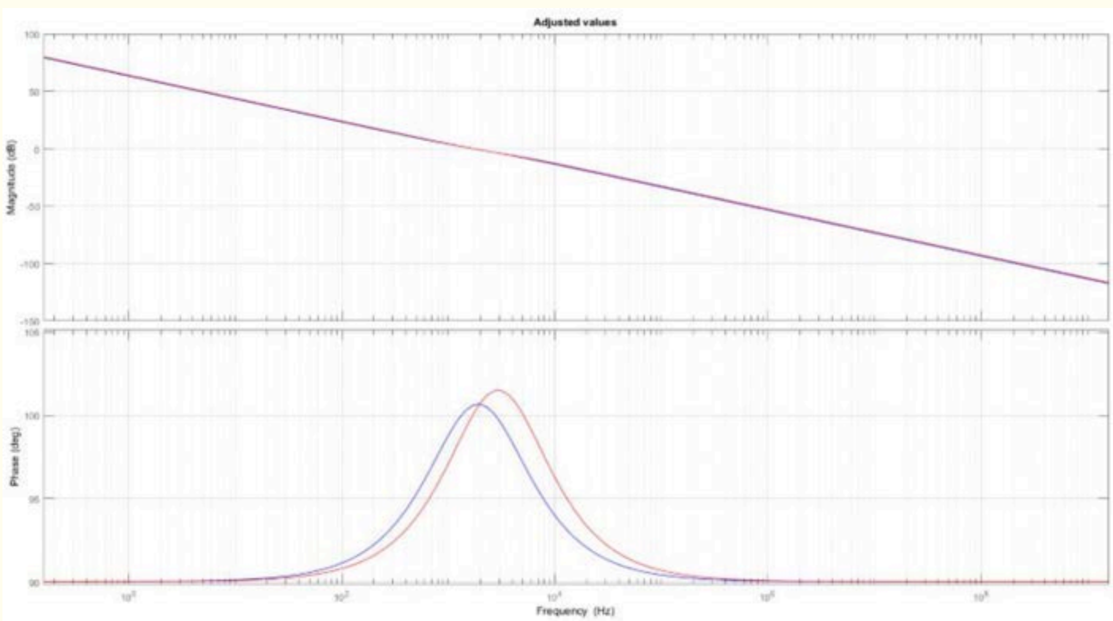

Fig 4: IC 412 Adjusted Frequency Response