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Subject:	Traineeship and final year work assignments v12	

Traineeship assignments

Automatic input voltage range-selector

The nominal grid-voltage ranges in the world from 100 Vac to 240 Vac. Most consumer products nowadays incorporate a topology to cover automatically this voltage range (in the past often the input voltage range was selected by a switch). For input power levels higher than 75 W a power factor corrector (PFC) is often used. The PFC can easily operate at the universal grid voltages. However, typical audio applications consume much less than 75 W when in normal listening mode. A PFC is than less cost effective. An automatic voltage selector could is a possibility.

Assignment: Investigate and implement an automatic voltage selector for an input range from 100 Vac to 264 Vac. The power drawn will be about 30 W.

Improved discrete comparator for audio power amplifier

For high performance audio applications it is required that the idle noise of the amplifier is low. The idle noise is the sound you can hear when no audio is applied. The target level for a 3kW amplifier is 50µV or lower (currently the level is 150µV). A source for noise in the amplifier is the comparator. In order to lower the noise level a discrete compactor is a solution.

Assignment: Investigate and implement an discrete comparator in an existing 3kW audio amplifier.

Final year assignments

A compact 10 kW charger for an electrical vehicle battery

Charging a battery fast (say 80% of the full battery capacity within 10 minutes) requires a charger which is capable to deliver enough current (power). For this reason there's a tendency to increase the power from 3.6 kW for a single-phase system to 10 kW or more for three-phase systems. Building the charger into a car requires a compact solution (size/volume). New technologies such as SiC or GaN transistors could be an option to fulfill this requirement.

Assignment: Find a solution for a 10 kW three-phase (400 Vac) powered charger for a battery pack with an output voltage between 300 Vdc and 500 Vdc. The converter should fulfill legal requirements (e.g. safety and mains-harmonic contents) and the maximum size is 340 mm x 220 mm x 50mm.

Digital controlled multiple-phase interleaved power factor corrector

Maximum power can be drawn from the grid when the current and voltage have the same shape and are in phase which each other. In principle the input of a power converter behaves as a resistor load. A common implementation is a so called power factor correction (PFC) circuitry. Often the implementation consists of a boost converter which modulates the current such that the shape of its current is the same as the shape of the input voltage. For high output power (say larger than 1 kW) it's common to parallel several boost converters in order to reduce size of the magnetics. If the phase angle between the several boost converters is changed (180^{o} for 2 boost converters, 120^{o} for 3 boost converters, etc.), the ripple current at the input and output can be reduced compared with one bulky boost converter.

Assignment: Implementation of a multi-phase interleaved PFC control algorithm in a micro control unit (MCU) with DSP possibilities. The firmware should be prepared to be able to at least control 4 phases. For demonstration purposes only two phases will be tested. The two phase power stage will be provided as is.

Series/parallel power converter at global input voltage range

The nominal grid-voltage ranges in the world from 100 Vac to 240 Vac. Most consumer products nowadays incorporate a topology to cover automatically this voltage range (in the past often the input voltage range was selected by a switch). For input power levels higher than 75 W a power factor corrector (PFC) is often used. The PFC can easily operate at the universal grid voltages. However, typical audio applications consume much less than 75 W when in normal listening mode. A PFC is then less cost effective. A solution is to use a topology which consists of two power processing parts. At the low input voltage range the two parts are connected in series and at high input voltage range the two parts are connected in parallel.

Assignment: Study suitable topologies for the power processing parts. Choose a topology and make an implementation. The peak power is 100W and the typical (nominal) power is 12W.

Single-stage isolated PFC

Consumer products with input power higher than 75 W must fulfill some legal requirements (mains harmonic reduction). Often an PFC (power factor corrector) is used. The output voltage of this converter must be higher than the highest input voltage. E.g. at 240 V grid voltage with 10% tolerance, the output voltage of the PFC must be higher than 373 Vdc; often 400 Vdc is chosen. An additional converter is required to decrease this voltage for the application and to have isolation for safety. An isolated PFC is sought for an audio application where this converter fulfills the legal requirement of mains harmonic reduction, incorporates the isolation, and has low output voltage(s) for the amplifier.

Assignment: Find and implement a single-stage isolated PFC for an audio application with a peak output power of 500 W.

Any challenging own ideas are welcomed as well!!