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Introduction to Low-potential Electrotechnical System of Power Efficient Conversion of Electrical Energy Using SMPS

The negative impact generated from conventional energy sources has been continually increasing over the last century, and new types of energy sources must be found. All energy sources can be divided into two types: high-potential and low-potential. High-potential sources when the level of energy is higher than the level which customer has, and low-potential sources when the level of environment energy is lower than the level of customer energy. The energy level is temperature, pressure, an electric voltage value, etc. Environment has inexhaustible stocks of renewable low-potential energy such as heat, electromagnetic, gravitational energy etc. Energy extraction from low-potential environment demands much higher scientific knowledge and volume of research.

The idea of this project is to develop electrotechnical system of power efficient conversion of Earth currents potential for low-power customers. This paper presents a brief description of typical Switched Mode Power Supply topology (SMPS), used as the starting point for the development of the novel system.

Switched Mode Power Supplies are considerably more complex that the linear regulated power supplies. The main advantage of this added complexity is that switched mode operation gives greater efficiency because the switching transistor dissipates little power when acting as a switch and provides regulated DC supplies that can deliver more power for a given size, cost and weight of power unit.

A number of different design types are used [1, 2]. Hence a SMPS can be used as an AC to DC converter, or DC to DC converter, either stepping the DC voltage up or down as required in battery powered systems.

Typical SMPS block diagram is shown on Fig. 1. The output rectification and filter are electrically isolated from the High Frequency switching section by a high frequency transformer, and voltage control feedback is isolated via an optoisolator. The control circuit block contains the high frequency oscillator, pulse width modulation, voltage and current control and output shut down sections. The high frequency AC produced during the conversion process is a square wave, which provides a means of controlling the output voltage by means of pulse width modulation. This allows the regulation of the output to be much more efficient than possible in linear regulated supplies. In most switched mode supplies, regulation of both input voltage and output voltage is normally available. To provide a well-regulated output, a sample of the DC output voltage is normally fed back to the control circuitry and compared with a stable reference voltage. Any error is used to control the output voltage. Using high frequency switching gives several advantages:

1. The transformer will be of a HF type, which is much smaller than a standard mains transformer.

2. The ripple frequency will be much higher than a linear supply, so it needs a smaller value of smoothing capacitor.

3. Using a square wave to control the switching transistors ensures that they dissipate much less power than a conventional series regulator transistors. So, smaller and cheaper transistors can be used for a given amount of output power.

4. Using smaller transformers and capacitors makes SMPS lighter and less bulky.

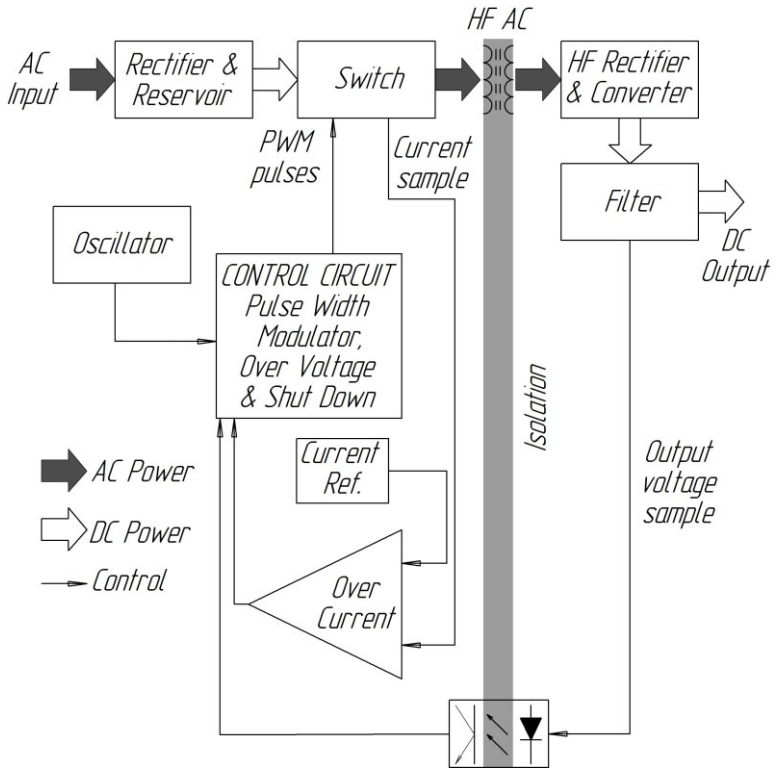

Figure 1 – Typical SMPS Block Diagram

Although linear supplies can provide better ripple rejection and regulation at low power levels than SMPS, the above advantages make SMPS the most common choice for any equipment. A disadvantage is that many powerful high frequency harmonics can be created so that without very effective RF screening and filtering there is a danger of creating RF interference by SMPS.

Basic types of dc-dc converter topologies that are used in SMPS circuits are the object for further investigation [3]. Their characteristics will be compared and principles of operation will be studied.

References

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