The invention relates to a device and a method for operating a low power switch mode power supply, where OC input power is converted to AC power by an oscillator, which AC power is transformed to an AC voltage and AC current, which output power is converted into DC power, where the DC voltage is used as a feedback signal for controlling the oscillator. It is the object of the invention to reduce a standby power consumption of power consuming devices. The oscillator comprises a first and a second current loop, which first current loop generates an activation current for the second current loop, where the primary coil of a transformer is part of the second current loop, and where the second loop comprises a current/voltage measuring system and generates increasing current in the second current loop and closes the current flow in the second current loop.
Low power switch mode power supply

Field of the Invention
The present invention relates to a low power switch mode power supply comprising a primary oscillating circuit, which primary oscillating circuit is connected to a DC power source, which primary oscillating circuit is connected to a first primary coil of a transformer, which transformer comprises at least a first secondary coil, which secondary coil is connected through a rectifier to an output circuit, which output circuit comprises at least a first capacitor for forming a mostly DC output voltage, the switch mode power supply further comprises a feed back circuit, which feed back circuit uses the actual output voltage for control of the primary switching circuit.

The present invention also relates to a method for operating a low power switch mode power supply, where a mostly DC input power is converted to AC power by an oscillator, which AC power is transformed to a AC voltage and AC current, which output power is converted into DC power, where the output DC voltage is used as a feed back signal for controlling the oscillator.

Background of the Invention
EP 1798845 A1 concerns a multi-output switched-mode power supply has an AC/DC converter with an AC input voltage at its input, a DC/AC converter and a transformer, which provides a Vac3 voltage at its output, which is coupled to a plurality of output blocks. Each output block consists of a switch, a filter and a controller. The switch of each output block has its input connected to the Vac3 voltage and provides at its output a rectified switch output voltage when turned on and high impedance when turned off. In turn, the filter of each output block has its input coupled to an output of the corresponding switch and provides at its output a smoothed output voltage Vout1, Vout2, Voutn, whereas the controller, which has its first input connected to the output voltage, its second input connected to a reference voltage, and its third input connected to the Vac3 voltage, provides at its output a switch control signal to the corresponding switch. The switch control signal turning the corresponding switch on is generated when the output voltage drops below the reference voltage and the Vac3 voltage is
zero, and the switch control signal turning the corresponding switch off is generated when the output voltage increases above the reference voltage.

Object of the Invention

It is the object of the invention to reduce a stand by power consumption of power consuming devices. A further object of the invention is to reduce a stand by power consumption for protecting the global environment.

Description of the Invention

The object of the invention can be fulfilled by the preamble to claim 1 if a feedback circuit comprises an opto coupler, which input LED of the opto coupler is connected through a current an voltage limiting circuit to the output voltage, which low power switch mode power supply comprises a first current loop in form of a voltage divider, which voltage divider is connected to the DC power source through at least one large resistor, which large resistor is connected to the basis of a first transistor, which voltage divider is connected to the collector of a second transistor, which emitter of the second transistor is connected to ground, which low power switch mode power supply further comprises a second current loop in form of the primary coil of the transformer which first end is connected to the DC power source and the second end of primary coil is connected to the collector/emitter of the first transistor, which second current loop further comprises a resistor, which resistor is connected to ground, which basis of the first transistor is further connected to an output transistor of the opto coupler.

Hereby it can be achieved that the oscillator is controlled by a feedback signal over the opto coupler dependent of the output voltage at the secondary side of the circuit. By controlling the oscillator on demand at the output, the number of oscillations can be limited to only one oscillation and then no activity for a relatively long time period. If no power is used at the secondary side of the switch mode transformer, maybe only one oscillation per second is performed. If there is any demand then more oscillations take place and even a relative high power demand can be achieved if the oscillator is operating continuously. By controlling the oscillation based on the actual output voltage it is possible to read a stand-by power consumption of this switch mode power supply that is nearly impossible to measure.
The oscillator is operating in the way where the oscillation automatically stops after each single oscillation. Due to the start of the oscillation on demand then the single oscillation automatically stops when the current flowing in the transformer has reached a certain level. Thereby, it is achieved that the current flowing through the oscillator is very limited both in the actual flowing current when activated but also in that there is a long period between each single activation. The switch mode power supply can be designed in a way where there is a galvanic isolation between the input side and the output side. In that way, the input to the switch mode power supply could be a traditional connection to an AC grid with a voltage approximately 110-230 volts AC. Because a transformer is used for the power transmission and the feed back is performed by an opto coupler, it is possible to perform the galvanic isolation.

In a preferred embodiment of the invention can the transformer comprise a second primary coil, which coil is by one end connected to ground, and the second end of the coil is connected to the voltage divider of the first current loop. By using a second primary coil, it is possible to start the activation by a relative limited current and then let this limited current generate a weak current pulse in the second primary coil and use the energy of this pulse to increase the activation current for a transistor and then first afterwards increase the current up to a higher level. The circuit is constructed so that as soon as the current is increasing to a certain level, the circuit as such is closed. The use of the second primary coil also leads to a reduction in the time period in which current is flowing through the primary coil. Hereby it can be achieved that the power demand on the primary side is further reduced.

It is preferred that the single switching sequence of the oscillator in standby situation is performed at a rate as long as once per second. Hereby is received that only once per second there is a power consumption, in the resting period current is only flowing through very large resistors. Therefore the power in the resting periods for the oscillator is as low as a few mW. Only in the short switching period is the power consumption higher. Therefore, the power consumption in standby condition can be reduced to less than 10 mW. Many electronic devices have standby power consumption above one W.
A low power relay unit can receive power for operation from the low power switch mode power supply, which relay unit comprises a bi-stable relay, which bi-stable relay has a coil connected to a control circuit, which control circuit comprises a first and a second current loop, which first and second current loop each comprises two electronic switches for forming a electronic bridge, which coil of the relay unit is connected between the switches of the bridge, where at least one electronic switch is connected to a processor, which processor generates activation pulses for the electronic switches, which processor further is connected to a input device. Hereby it can be achieved that a bi-stable relay can be switched between two stable positions with a very low power demand. The bi-stable relay could be part of a power switch in any electric or electronic devices. The relay unit could have switches that can be used by normal electric net connections with up to several amperes and a voltage up to 230 volts. If this unit has to be used with a much larger power demand, it is possible by using further a relay for switching e.g. a three-phase connection to an electronic or electric device. The combination of the switch mode power supply and the relay unit can lead to an extremely low standby power in all kinds of electric or electronic devices. Nearly all lands of electric or electronic devices are today connected to the grid and have a standby power consumption that typically has a value of some W. The pending invention can be used in several ways but one way of using this invention is to build this invention into the electronic or electric devices as part of a power supply. Further possible use of this invention is the use of the switch mode power supply and the relay unit for the supply of a row of sockets which can be connected to electronic devices. All these devices can power up immediately, and in fact the relay unit can be coded in a way in where a normal infra red communication device is switching on the relay unit.

Use of a low power switch mode power supply as described previously, whereby the low power switch mode power supply is used to supply a relay unit, which relay unit control the position of a bi-stable relay, which relay unit change the position of the bi stable relay based of an input signal. The use of the switch mode power supply together with the relay unit will in a standby situation be nearly no power consumption from the relay unit because the relay is bi-stable. Only a small processor is in operation in order to have the input device active. The power consumption in that circuit
can be extremely low. The low power consumption can result in that the oscillator in the switch mode power supply is only switching perhaps once per second. Therefore, the power supply in a standby situation is so low that the actual power demand is reduced to a few mW. By use of this power supply and the relay unit activation by sending an input for the relay unit will only in a very short period give an increasing power demand because as soon as the relay unit is switched to the opposite position, the power consumption will again return to the very low state. Only in the very short time period, when the switching of the relay is performed, there will be a more or less continuous switching of the oscillator in the power supply. This continuous oscillation only takes place for a few milliseconds. Therefore, the power consumption spread over a period is extremely low and difficult to measure.

The relay unit can receive an input signal from a communication device. The communication device could be e.g. an infra red communication device used for controlling a television. The communication device could be designed so that a number of different input commands to the infra red communication device all will result in a power on of the device. One disadvantage by using this invention could be that it will be necessary to at first switch on the power supply and then as the next give further one command before the television switches on.

The power supply and the relay unit can be part of the power supply in a power consuming device. Hereby can be achieved that the standby power supply e.g. in a washing machine or a dishwasher can be reduced to a very low level. Also in many computer devices there is relatively high power consumption when these computer systems are in a standby situation. The use of this invention can reduce this power consumption in the standby situation to a power consumption that is close to zero.

The object of the invention can be fulfilled by the preamble to claim 6 if the oscillator comprises a first and a second current loop, which first current loop generate an activation current for a second current loop, were the primary coil of a transformer is part of the second current loop, where the second loop comprises a current/voltage measuring system and generates increasing current in the second current loop and closes the current flow in the second current loop.
Hereby it can be achieved that the first current loop is generating the control signal for opening the second current loop if the signal is undisturbed from to opto coupler. In this way, the oscillator can start automatically because if no input signal occurs the current in the first loop will automatically open a transistor in the second loop. That will lead to built up a current during the second loop but there is a serial resistor which is connected to the basis of the transistor in the first loop and increasing the current during that resistor will lead to increasing collector voltage in that transistor which is connected to the basis of the transistor in the second loop which transistor thereby is closed. Hereby is a very short pulse is generated. But this short pulse is transmitted over the transformer and is forming a current that is flowing to a diode onto an electrolytic capacitor where the output DC is generated. Hereby is achieved a very effective switch mode power supply for small power consumptions.

**Description of the Drawing**

Figure 1 shows a possible embodiment for a switch mode power supply.

Figure 2 shows a possible embodiment for a relay unit.

Figure 3 shows a combination of figures 1 and 2.

**Detailed Description of the Invention**

Figure 1 shows a possible embodiment for a switch mode power supply. An AC input having a voltage 80-230 volts is at first sent through fuses F1 and further through a resistor R2 to one of the input terminals of a diode bridge. The other input line is connected through a resistor R1 to the other side of the diode bridge. The output of the diode bridge is in one end forming a negative voltage and the other end forming a positive voltage. The capacitor C1 is connected between the positive and the negative part of the circuit for forming a mostly DC voltage. Starting from the positive terminal a first current loop 1 is formed by relatively big resistors R3 and R4. Furthermore, the first current loop contains a diode D1 and a resistor R5. Further is the first current loop connected to the collector of a transistor Q2 where the emitter is further connected to the negative power terminal. Further is a second current loop 2 starting from the positive terminal connected to the primary side of a transformer where this primary side on the opposite side of the coil is connected to the collector of the transistor Q1. The emitter of the transistor Q1 is connected through a resistor R6 to the negative terminal.
The basis of the transistor Q1 is connected to the resistor R5 and the collector of the transistor Q2. Further the basis of the transistor Q2 is connected to the emitter of the Q1 and to the resistor R6. The secondary side of the transformer is connected through a diode D2 to a capacitor C3. Furthermore the diode D2 is connected through a resistor R7 to a zenerdiode Z1 to the transmitting part of an opto coupler ISOl. The receiving part of the optocoupler which is a photo transistor has its emitter connected to the negative voltage and the collector is connected to the first current loop between the collector of Q2 and the resistor R5 which is also the connection to the basis of the Q1. The output is further connected to a regulation unit U1 which can perform a power regulation to a voltage which is reduced in the shown example to 6 volts.

In operation, there will be a continuous DC voltage at the positive side of the diode bridge. Therefore, a current is flowing through the first current loop to the R3 R4, the diode D1 and the resistor R5. Probably, the Q2 is in a closed situation. Therefore, a basis current is generated for the transistor Q1. But if the opto coupler is active because the current is flowing to the opto coupler no basis current for the Q1 is generated. As soon as the opto coupler is no longer activated, the basis current for the Q1 is generated and the Q1 starts opening and the current is flowing through the second current loop. The primary side of the transformer comprises a further coil 4, 5 which coil at one end is connected to the negative terminal and which other end through a capacitor C2 is connected to the second current loop. Hereby is a further opening current generated for the transistor Q1, if the Q1 transistor has started opening for current flowing through the second current loop. Hereby a two-step activation of the current through the transformer can be achieved. As soon the current is starting to flow through the primary side of the transistor and through the Q1, the resistor R6 has an increasing voltage which generates basic current into the transistor Q2 which is then opened. Opening of the transistor Q2 is also removing the basis current from the Q1 which is then closed. Thereby, the current flowing through the R6 is decreasing, and the basis current for the Q2 decreases as the Q2 stops conducting. The switching as such stops after each single oscillation. Next oscillation starts only in a situation of low output voltage. As long as the output voltage is able to send a sufficient current through the Z1 Zener diode and the light emitting diode of the opto coupler ISOl and hereby bring the transistor in the opto coupler to conduct. Hereby the basis current of
the Q1 is reduced, and the Q1 is not able to start conducting before the current in the opto coupler is stopped.

Hereby is achieved a highly effective switch mode power supply.

Figure 2 shows the relay circuit which could be connected to the switch mode power supply as indicated in figure 1. The relay circuit comprises an electronic switching bridge in which bridge four transistors are forming legs and where the midpoint of the bridge both are connected to each side a relay coil in a bi-stable relay LSI. The first leg in the bridge is formed of two transistors Q11 and Q9. Basis of the Q11 is connected to the positive power supply to a resistor R1O and through a transistor Rl1 to one part of the relay coil. The other leg of the bridge is formed of the transistor Q12 and the transistor Q10. Furthermore, is the basis of the Q12 connected to the positive power supply through a resistor R11 and through a resistor R13 to the opposite side of the relay coil. Both the transistors Q9 and Q10 of the bridge have an emitter connected to the ground. The midpoint of the bridge is also a collector connection from both sides of the bridge. These midpoints are connected to each side of the relay coil. The relay coil is further over resistor R11 and R13 connected to the basis of the transistors Q11 and Q12. The basis of both the transistors Q9 and Q10 are by resistors R14 and R15 connected to a processor ICl. This processor ICl is further connected to a memory IC2. The ICl is also connected to a crystal Y1 for internal generating a clock frequency. The processor ECl has an input lines connected to an input device which could be cable or other communication means for connection to any kind of input means.

Figure 3 shows a combination of figures 1 and 2.
CLAIMS

1. Low power switch mode power supply comprising a primary oscillating circuit, which primary oscillating circuit is connected to a DC power source, which primary oscillating circuit is connected to a first primary coil of a transformer, which transformer comprises at least a first secondary coil, which secondary coil is connected through a rectifier to an output circuit, which output circuit comprises at least a first capacitor for forming a mostly DC output voltage, the switch mode power supply further comprises a feedback circuit, which feedback circuit uses the actual output voltage for control of the primary switching circuit, characterized in that the feedback circuit comprises an opto coupler, which input LED of the opto coupler is connected through a current limiting circuit to the output voltage, which low power switch mode power supply comprises a first current loop in form of a voltage divider, which voltage divider is connected to the DC power source through at least one large resistor (R3,R4), which large resistor (R3,R4) is connected to the basis of a first transistor (Q1), which voltage divider is connected to the collector of a second transistor (Q2), which emitter of the second transistor (Q2) is connected to ground, which low power switch mode power supply further comprises a second current loop in form of the primary coil of the transformer which first end is connected to the DC power source and the second end of primary coil is connected to the collector/emitter of the first transistor (Q1), which second current loop further comprises a resistor (R6), which resistor (R6) is connected to ground, which basis of the first transistor (Q1) is further connected to an output transistor of the opto coupler.

2. Low power switch mode power supply according to claim 1, characterized in that the transformer comprises a second primary coil, which coil is by one end connected to ground, and the second end of the coil is connected to the voltage divider of the first current loop.

3. Low power switch mode power supply according to one of the claims 1-2, characterized in that the single switching sequence of the oscillator in standby situation is performed at a rate as long as once per second.
4. Use of a low power switch mode power supply as described in claims 1-3, characterized in that a low power relay unit receives power for operation from the low power switch mode power supply, which relay unit comprises a bi-stable relay, which bi-stable relay has a coil connected to a control circuit, which control circuit comprises a first and a second current loop, which first and second current loop each comprises two electronic switches for forming a electronic bridge, which coil of the relay unit is connected between the switches of the bridge, where at least one electronic switch is connected to a processor, which processor generates activation pulses for the electronic switches, which processor further is connected to an input device.

5. Use of a low power switch mode power supply according to claim 4, characterized in that the low power switch mode power supply is used to supply a relay unit, which relay unit control the position of a bi-stable relay, which relay unit change the position of the bi-stable relay based on an input signal.

6. Use of a low power switch mode power supply according to claim 5, characterized in that the relay unit is receiving an input signal from a communication device.

7. Use of a low power switch mode power supply according to one of the claims 4-6, characterized in that the power supply and the relay unit is part of the power supply in a power consuming device.

8. Method for operating a low power switch mode power supply, where mostly DC input power is converted to AC power by an oscillator, which AC power is transformed to a AC voltage and AC current, which output power is converted into DC power, where the output DC voltage is used as a feedback signal for controlling the oscillator, characterized in that the oscillator comprises a first and a second current loop, which first current loop generate an activation current for a second current loop, were the primary coil of a transformer is part of the second current loop, where the second loop comprises a current/voltage measuring system and generates increasing current in the second current loop and closes the current flow in the second current loop.
INTERNATIONAL SEARCH REPORT

International application No.
PCT/DK2010/050205

A. CLASSIFICATION OF SUBJECT MATTER
H02M 3/335 (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H02M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

DK, NO, SE, FI

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
WPI, EPODOC, TXTE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
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<td>US 4654771 A (STASCH et al.) 31 March 1987 Figure.</td>
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<td>A</td>
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D. Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents
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Date of the actual completion of the international search
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Date of mailing of the international search report
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