Standby Power Management of Microwave-Oven

Poshavoni Vikas Yadav, Prof. N Umaheshwar Rao

***Abstract*— at present electronic appliances play a vital role in day-to-day activities of human life. These activities increase the electric power consumption. The proposed design is to reduce the standby power consumption of the electronic appliances like touch panel microwave oven, TV and etc. As an example the touch panel microwave oven which is turned off does not mean that it is not consuming electric power. Although it is in non-heating state but it still consumes 1 to 3 W when it is plugged into an AC socket. It is aimed to reduce such unwanted electric power consumption which greatly increases the power consumption on a whole. An effective circuit design concept based on ARM processor is proposed to reduce standby power consumption of a touch panel microwave oven by means of a latching relay which is also easy to apply to future products. In the stand by state some power is consumed for internal functions these power is called standby power. The standby power is realized by the proposed scheme should be lower than that of others and not only simple but also should be inexpensive.**

Index Terms*— Microwave Oven, Relay Standby Power Consumption.

I. INTRODUCTION

The touch panel microwave-oven has three power states they are Cutoff state, Standby state and Heating state. In cutoff state there is no power consumption because the power is switched off in this state and in heating state the power is consumed because the oven does its main heating operation. In standby state also power is consumed but compared to heating state it is very less but most of the time the oven will be in the standby state and it will be heating state when it is used for heating. When single microwave oven taken in to consideration the standby power consumption will be less and if we take all the ovens in the country in to account we will get much power consumption and these will affect the total power in the country.

In our proposed project work, we have reduced the standby power consumption by means of latching relay. In this section, the microcontroller will be activated with a start button along with dc power module. Then the controller will check for an external interrupt from door open unit. The user has to set the time for oven heating and other activities. After receiving these inputs, the controller will wakes up from power down mode and power is supplied for internal functions. After setting the timer for heating press start button on the touch screen the controller will give signal to the latching relay circuit to connect to the AC supply to the load i.e. microwave-oven. The oven will start its heating operation and ends when the timer comes to zero. By latching relay circuit we are reducing standby power consumption.

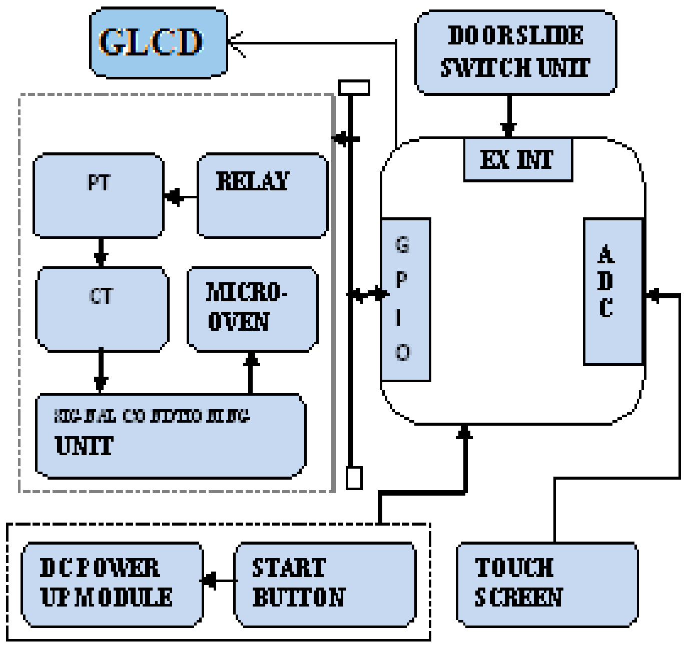


Fig. 1.Block diagram

This project work consists of a Processor using ARM7 core, touch screen and alert unit and control unit. As hardware parts and an effective in this project initially the oven power consumption should be found out by the load applied from the home. In the existing system we have to consider some set points and if the power consumption levels will equal the set point then automatically oven will coming to on condition. In the proposed design the system will operate based on the event i.e. when we want to heat the food at that time the oven will comes to ON and Heating state.

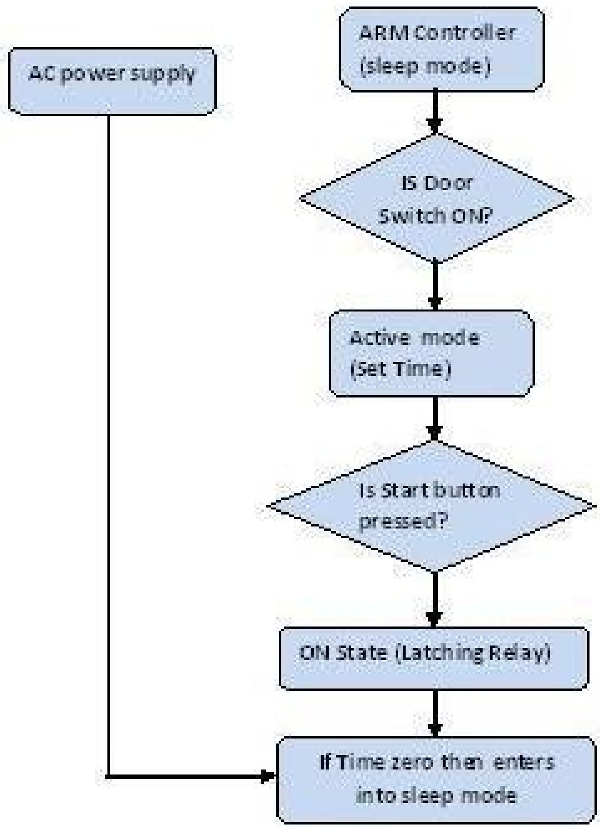
II. DESIGN AND IMPLEMENTATION

This project uses two important power supplies. 1. DC (direct current) and 2.AC (alternating current). These paths are discussed below

Manuscript received September, 2014.
***Poshavoni Vikas Yadav**, Electronics and Communication Engineering, Vardhaman College of Engineering, Hyderabad, India, 09640488646.*
***Prof. N Umamaheshwar Rao** Electronics and Communication Engineering, Vardhaman College of Engineering, Hyderabad, India, 09440158596.*

ISSN: 2278 – 7798

In this project a power consumption system is used which will do the key role in the entire operation. For the oven system, we are using the relay circuit and Processor power down mode.



Flowchart. 1. Design Process

The flowchart consists of two power supply 1.DC power supply. 2. AC power supply. The dc power supply connects to the ARM7 controller. The arm board consists of door switch module and touch screen and start button. Normally when dc supply connects to controller it is in sleep mode and when door switch is ON the Arm7 processor will enters into the active mode will display the touch screen for operation. By using touch screen set time for heating and press start button after pressing start button the controller will give signal to the latching circuit to connect to the AC supply to the micro-oven and if the timer is zero then the controller will enter into the sleep mode. The Latching relay circuit is placed in between ARM7 processor and microwave-oven.

The ARM7 board requires 3.3v DC supply and the process of converting to 3.3v DC is explained clearly in the next section. In the proposed design we are using the LPC2148 arm7 processor. The LPC2148 ARM7 controller has some special features which are more useful for our proposed design they are low power consumption and power down mode and other features are explained in the section IV. In the proposed system the door switch is connected high priority interrupt i.e. fast interrupt request. The door switch module consists of switch which is connected to fast interrupt request. The LPC2148 includes four External Interrupt Inputs as selectable pin functions. The External Interrupt Inputs can be used to wake up the processor from Power-down mode. In the proposed design External Interrupt Input 0 is used, 1.An active low or high level, 2. Falling or Rising edge general purpose interrupt input, any section from 1 and can be taken based on the requirement, in the above design we have selected active high rising edge. This pin may be used to wake up the processor from Idle or Power-down modes. Pins P0.1 and P0.16 can be selected to perform EINT0 function. There are four register which are used for external interrupt function they are EXTINT, EXTWAKEUP, EXTMODE and EXTPOLAR registers. The EXTINT register contains the interrupt flags, and the EXTWAKEUP register contains bits that enable individual external interrupts to wake up the microcontroller from Power-down mode. The EXTMODE and EXTPOLAR registers specify the level and edge sensitivity parameters.

When the door is opened this interrupt is executed and wakes up from power down mode this process is set up by programming using software. In the active mode the touch and GLCD gets in to ON condition, when touch screen gets ON the four lines passes voltage through it, as we touch it restrict the flow of voltage and it gets detected, With the help of touch screen we set time for heating and the heating process starts when the start button is pressed and it will ends the heating process when timer becomes to zero. The status of heating process will be known by red and green led. When the red led in thus states that oven is in heating state. The touch screen works on the principle of potentiometer. To determine the touch position we have to find out the X and Y positions and the touch screen has four pins. They are x1, x2, y1 and y2. The pins x1 and y2 should be connected to both ADC and GPIO multiplexed pin and this pins does the multi functionality. Other pins x2 & y1 should be connected to GPIO pin.

The latching relay plays an important role in the proposed system, we are using DPDT (double pole double terminal) relay and it is used to switch the both AC & DC, here AC connection is switched to the load by DC supply with the help of ARM processor.

In the proposed design the 95% standby power is reduced and in the standby state there is only DC power consumption.

Some critical situation like after setting the timer if didn’t press the start button in the program we set up some time like 20/30 sec and the button is within this time then automatically the processor goes to the sleep mode. In this situation also we are reducing the power consumption.

III. DC POWER SUPPLY

All electronic circuits’ works only in low DC voltage, so we place DC power supply unit for their proper functioning .This unit consists of transformer, rectifier, filter & regulator. AC voltage of typically 230volts rms is connected to a transformer voltage down to the level to the desired ac voltage. A diode rectifier that provides the full wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation . A regulator circuit can use this dc input to provide dc voltage that not only has much less ripple voltage but also remains the same dc value even the dc voltage varies

ISSN: 2278 – 7798

somewhat, or the load connected to the output dc voltages changes

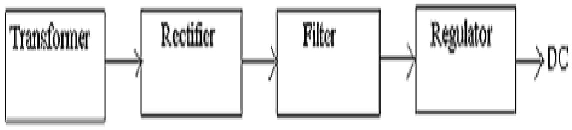


Fig. 2. Power Supply.

IV. ARM7 (LPC2148) PROCESSOR

In the proposed design LPC2148 arm7 processor is used.LPC2148 works on 3.3 V power supply. LM 117 regulator is used for generating 3.3 V supply and other peripherals like LCD; ULN 2003 (Motor Driver IC) etc. requires 5V for functioning. So DC power supply unit is placed for converting 230V AC to 5V DC by using above mentioned circuit and after that LM 117 is used to convert 5V into 3.3V.

The ARM7TDMI-S is a general purpose 32-bit microprocessor, which offers high performance and very low power consumption. The ARM architecture is based on Reduced Instruction Set Computer (RISC) principles, and the instruction set and related decode mechanism are much simpler than those of micro programmed Complex Instruction Set Computers (CISC). This simplicity results in a high instruction throughput and impressive real-time interrupt response from a small and cost-effective processor core. Pipeline techniques are employed so that all parts of the processing and memory systems can operate continuously. Typically, while one instruction is being executed, its successor is being decoded, and a third instruction is being fetched from memory. The ARM7TDMI-S processor also employs a unique architectural strategy known as Thumb, which makes it ideally suited to high-volume applications with memory restrictions, or applications where code density is an issue. Thumb is that of a super-reduced instruction set. Essentially, the ARM7TDMI-S processor has two instruction sets:

- The standard 32-bit ARM set.
- A 16-bit Thumb set.

The Thumb set's 16-bit instruction length allows it to approach twice the density of standard ARM code while retaining most of the ARM's performance advantage over a traditional 16-bit processor using 16-bit registers. This is possible because Thumb code operates on the same 32-bit register set as ARM code. Thumb code is able to provide up to 65% of the code size of ARM, and 160% of the performance of an equivalent ARM processor connected to a 16-bit memory system.

V. DISPLAY UNIT

A touch screen is a display that can detect the presence and location of a touch within the display area, when we touch or contact the display screen by a finger or hand. So touch screen acts like an input device. The touch screens are sensitive to pressure;

In the proposed design resistive touch is used. A resistive touch screen panel is composed of several layers, there are two important thin, metallic, electrically conductive layers separated by a narrow gap. When an object, example finger, presses down on a particular point on the panel's of display surface the two metallic layers become connected at that point: the panel then behaves as a pair of voltage dividers with connected outputs. This causes a change in the electrical current which is noticed as a touch event and sent to the controller for processing. In another way the resistive system consists of a normal glass panel which is covered with a resistive metallic and a conductive layer. The spacers separate these two layers, and on top of whole setup a scratch-resistant layer is placed. When monitor or display is ON an electrical current flows through the two layers. When a user touches the screen or display, the two layers make contact in that exact spot. The change in the electrical field is noted and the coordinates of the point of contact are calculated by the processor.

A. GLCD

The CFAG12864B is a 128 x 64 pixel graphical LCD with backlight. It is driven by 2 64 x 64 pixel Samsung KS0108 drivers. Figure 3 shows an image of what the LCD looks like with a sample output of a tractor. The actual view area of the LCD is 60 mm x 32.6 mm.

Fig. 3 GLCD.

VI. LATCHING RELAY

A relay is an electrically operated switch. It creates a magnetic field when Current flowing through the coil of the relay circuit which attracts a lever and changes the switch contact points. The current flowing in the coil can be on or off so relays have two switch positions and they are double throw (changeover) switches.

Relays allow one circuit to switch a second circuit which can be completely separate from the first. For example a low voltage battery circuit can use a relay to switch a 230V AC mains circuit. There is no electrical connection inside the relay between the two circuits; the link is magnetic and mechanical.

ISSN: 2278 – 7798

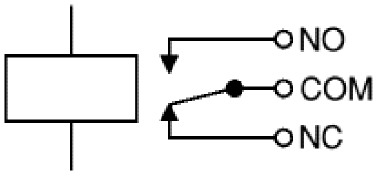


Fig. 4 Circuit symbol of a relay.

VII. POTENTIAL TRANSFORMER

PTs or VTs are the most common devices used. These devices are conventional transformers with two or three windings (one primary with one or two secondary). They have an iron core and magnetically couple the primary and secondary. The high side winding is constructed with more copper turns than the secondary, and any voltage impressed on the primary winding is reflected on the secondary windings in direct proportion to the turns ratio or PT ratio.

VIII. CURRENT TRANSFORMER

A **current transformer** (**CT**) is a type of instrument transformer designed to provide a current in its secondary winding proportional to the alternating current flowing in its primary. They are commonly used in metering and protective relaying in the electrical power industry where they facilitate the safe measurement of large currents, often in the presence of high voltages. The current transformer safely isolates measurement and control circuitry from the high voltages typically present on the circuit being measured.

VII. CONCLUSION

This paper introduces a new circuit design which substantially reduces the standby power to much less than that of other touch panel microwave ovens. This new ultra-low standby power microwave oven, which consumes 3 mW, is both easy to set up and inexpensive. In the long run this oven saves more power while at the same time the performance of the oven is unchanged. Furthermore, this design could be made into a socket connected to the existing touch panel microwave oven. Although the standby power of a touch panel microwave oven is not great, it not only affects the electricity bill in the long run, but because this power is converted into heat it also increases the indoor temperature.

REFERENCES

[1] Cheng-Hung Tsai, Ying-Wen Bai, Ming-Bo Lin, *Senior Member*, IEEE, Roger Jia Rong Jhang and Chih-Yu Chung " Reduce the Standby Power Consumption of a Microwave Oven" IEEE Transactions on Consumer Electronics, Vol. 59, No. 1, February 2013

[2] Kim, D.S., Cho, G.Y., Kwon, W.H., Kwan, Y.I. and Kim, Y.H., "Home network message specification for white goods and its applications, "*IEEE Trans. Consumer Electron.*, vol. 48, no. 1, pp. 1-9, Feb. 2002.

[3] Kwan Joo Myoung, Jae Min Lee, Dong-Sung Kim and Wook Hyun Kwon, "Home network control protocol for networked home appliances," *IEEE Trans. Consumer Electron.*, vol. 52, no. 3, pp. 802-810, Aug. 2006.

[4] Chia-Hung Lien, Ying-Wen Bai and Ming-Bo Lin, "Remote-Controllable Power Outlet System for Home Power Management," *IEEE Trans. Consumer Electron.* vol. 53, no. 4, pp. 1634-1641, Nov. 2007.

[5] Joon Heo, Choong Seon Hong, Seok Bong Kang and Sang Soo Jeon "Design and Implementation of Control Mechanism for Standby Power Reduction," *IEEE Trans. Consumer Electron.* vol. 53, no. 1, pp. 179-185, Feb. 2008.C.-H. Tsai et al: Reduce the Standby Power Consumption of a Microwave Oven 61

[6] Ying-Wen Bai, and Yi-Te Ku, "Automatic room light intensity detection and control using a microprocessor and light sensors," *IEEE Trans. Consumer Electron.*, vol. 54, no. 3, pp. 1173-1176, Aug. 2008.

[7] Jinsoo Han, Haeryong Lee and Kwang-Roh Park, "Remote-controllable and energy-saving room architecture based on ZigBee communication," *IEEE Trans. Consumer Electron.*, vol. 55, no. 1, pp. 264-268, Jan. 2009.

[8] Minsoo Lee, Yoonsik Uhm, Yong im, Gwanyeon Kim and Sehyun Park, "Intelligent Power Management Device with Middleware based Living Pattern Learning for Power Reduction," *IEEE Trans. Consumer Electron.* vol. 55, no. 4, pp. 2081-2089, Nov. 2009.

[9] Vb Hyun Sang Cho, Tatsuya Yamazaki, and Minsoo Hahn, "I Determining location of appliances from multi-hop tree structures of power strip type smart meters," *IEEE Trans. Consumer Electron.*, vol. 55, o. 4, pp.2314-2322, Nov. 2009.

[10] Young-Sung Son, Topi Pulkkinen, Kyeong-Deok Moon and ChaekyuKim, "Home Energy Management System based on Power Line Communication," *IEEE Trans. Consumer Electron.*, vol. 56, no.3, pp.1380-1386, Aug. 2010.

[11] Dong-Sun Kim, Byung-Soo Kim, Kwang-Ho Won and Min-Soo Kang, "A Wireless Sensor Node SoC with a Profiled Power Management Unit for IR Controllable Digital Consumer Devices," *IEEE Trans. Consumer Electron.*, vol. 56, no. 4, pp. 2282-2287, Nov. 2010

[12] Ying-Wen Bai, Zi-Li Xie, and Zong-Han Li, "Design and Implementation of a home embedded surveillance system with ultra-low alert power," *IEEE Trans. Consumer Electron.*, vol.57, no.1, pp.153-159, Feb. 2011.

[13] Jinsoo Han, Chang-Sic Choi, and Ilwoo Lee, "More Efficient Home Energy Management System Based on ZigBee Communication and Infrared Remote Controls," *IEEE Trans. Consumer Electron.*, vol. 57, no. 1, pp. 85-89, Feb. 2011.

[14] Stefan Mozar, "Intelligent standby concept," *IEEE Trans. Consumer Electron.*, vol. 46, no. 1, pp. 179-182, Dec. 2000.

[15] Ying-Wen Bai and Ming-Yuan Yang, "An Improved Design of a Wireless Keyboard Powered by Solar Cells and a Large Capacitor,"*IEEE Trans. Consumer Electron.* vol. 54, no. 3, pp. 1355-1359, Aug.2008.

[16] Cheng-Hung Tsai, Ying-Wen Bai, Wang Hao-Yuan and Ming-Bo Lin, "Design and Implementation of a Socket with Low Standby Power", *IEEE International Symposium on Consumer Electron.*, Kyoto, Japan,pp. 119-123, May 2009.

[17] Cheng-Hung Tsai, Ying-Wen Bai, Wang Hao-Yuan and Ming-Bo Lin,"Design and Implementation of a Socket with Low Standby Power", *IEEE Trans. Consumer Electron.*, vol. 55, no. 3, pp. 1558-1565, Aug.2009.

[18] Cheng-Hung Tsai, Ying-Wen Bai, Chun-An Chu, Chih-Yu Chung and Ming-Bo Lin, "PIR-sensor-based Lighting Device with Ultra-low Standby Power Consumption," *IEEE Transactions on Consumer Electron.*, vol. 57, no. 3, pp. 1157-1164, Aug. 2011.

[19] Cheng-Hung Tsai, Ying-Wen Bai, Chun-An Chu and Ming-Bo Lin, "Design and Implementation of a Socket with Zero Standby Power using a Photovoltaic Array," *IEEE Trans. Consumer Electron.*, vol. 56, no. 4,pp. 2686-2693, Nov. 2010

[20] Cheng-Hung Tsai, Ying-Wen Bai, Chun-An Chu, Chih-Yu Chung and Ming-Bo Lin, "PIR-sensor-based Lighting Device with Ultra-low Standby Power Consumption," *2011 IEEE International Instrumentation and Measurement Technology Conference,* Binjiang, Hangzhou, China,pp. 1524-1529, 10-12 May 2011.

[21] U.S. Department of Energy, "Energy Saver Booklet: Tips on Saving Energy & Money at Home," May 2009.

[22] Sungmuk Kang, Kyungjin Park, Seunghwan Shin, Keunsu Chang and Hoseong Kim, "Zero standby power remote control system using light power transmission," *IEEE Transactions on Consumer Electron.*, vol.57, no. 4, pp. 1622-1627, Nov. 2011.

[23] IEA, "Fact Sheet: Standby Power Use and the IEA "1 Watt Plan," Apr.2007.

[24] Hidenori Kako, Tatsuya Nkagawa and Ryuho Narita,"A universal power supply integrated circuit for TV and monitor applications," *IEEE Trans.Consumer Electron.*, vol. 36, no. 1, pp. 10-17, Feb. 1990.

[25] Hidenori Kako, Tatsuya Nkagawa and Ryuho Narita, "Development of compact inverter power supply for microwave oven," *IEEE Trans. Consumer Electron.*, vol. 37, no. 3, pp. 611-616, Aug. 1991.

ISSN: 2278 – 7798

First Author:

P Vikas Yadav is pursuing M.Tech in Embedded system in the Department of Electronics and Communication Engineering from Vardhaman College of Engineering at Hyderabad and B.Tech in Electronics and Communication Engineering from Vijaya Krishna Institute of Technology and Sciences. Participated in the "IEEE section student congress and All India student project contest". Event organizer in college fest conducted at Vijaya Krishna Institute of Technology & Sciences. Participated in the school level games and secured second prize in cricket.

Second Author

N Umamaheshwar Rao is a Professor in the Department of Electronics and Communication Engineering from Vardhaman College of Engineering and M. Tech in Communication & Radar Engineering from Indian Institute of Technology (IIT), Delhi and B.E. in Electronics & Communication Engineering Sree Venkateswara University, Tirupati. Participated in an International conference on "MOBILE SATELLITE COMMUNICATIONS" held by International Maritime Satellite Organization (INMARSAT), LONDON and conducted type approval tests for 406 MHz EPIRB at French Govt. Space Agency (CNES-Centre National d'etudes spatiales) Toulouse, France. He is a life – member of IETE and ISTE.

He also published the following papers

- Temperature compensation circuits for Data Transmitters Published in RF Technology Expo 1986, Coloredo, USA.
- S-Band exciter for uplink Transmitter – Published in Asia-Pacific Conference held in New Delhi, in February 1986.
- Strategic Human Resource Management (SHRM) – Presented at 37^{th} Annual Convention of IETE held at Netaji Subhas Institute of Technology, New Delhi in 2005.
- Design Of Integrated Multi-Band Antenna For Wireless Communication Networks---- Presented at International Conference On Photonics, VLSI & Signal Processing,28-29 March 2014,Kakatiya University ,Warangal-506 009,A.P,INDIA.

ISSN: 2278 – 7798