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APPLICATION NOTE 5829

# INSIGHTFUL ELECTRONIC SWITCH BRINGS INTELLIGENCE AND SECURITY TO HOME ENERGY MONITORING

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*Abstract: This application note is a product how-to explanation of the 78M6610 in a smart plug and it is a story of collaboration between the Belkin and Maxim Integrated development teams. Belkin leveraged their technology in packaging and communications by working with Maxim engineers to add the smart energy monitoring. Belkin's WeMo Insight Switch gives consumers an economical, practical solution for monitoring and managing electrical use in the household.*

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Would you pay an extra \$10 (USD) to get some valuable technical insight about the quality of the power delivered to your home? About the actual power consumption of your refrigerator, dehumidifier, and air conditioner? For me, I say, "Maybe."

The decision to invest in this power-monitoring technology really depends on several things. I immediately ask myself how easy is it to install? When can I access it? How robust is it? Is the data accurate? Will I get the granularity in data measurements to draw meaningful conclusions? Does it all come packaged in a user-friendly manner?

So, let me back up for a minute and create some context.

## Security and Peace of Mind with Home Monitoring

As a theft deterrent, I created a low-tech way to turn TVs and lamps on/off at different times of the evening at my lake house when I am not there. I used a \$12 mechanical timer like the one in **Figure 1**. There is a significant limitation in such a basic "network." I get no feedback about whether it is actually working and I get no information about the electrical signal being supplied to the unit. It would not take much time for a thief to figure out that nobody is actually in the house, especially if one of the lamps fails. I'll explain more below why I want that electrical signal information. Fortunately, there is a nifty solution to some of the drawbacks of the mechanical timer.



*Figure 1. Typical mechanical timer.*

Belkin offers their WeMo<sup>®</sup> Switch wall unit (**Figure 2**) as the modern way to introduce variability in turn-on/off times, especially when combined with their motion sensor. Belkin's WeMo Switch and its companion app uses my home's Wi-Fi<sup>®</sup> network to give me control from my smartphone, tablet, or computer of choice. Initially, it struck me as a bit pricey at \$49.99, but let's think about this again.



*Figure 2. The Belkin WeMo Switch wall unit. Provides wireless control of TVs, lamps, stereos, heaters, fans, and more.*

As a platform for building a home network, I don't need to pay for any installation assistance and it is fully modular. Its intuitive, easy setup lets me add one WeMo switch at a time, as budget allows, by connecting to my existing Wi-Fi router. I can put any device plugged into the switch on a schedule that I can modify as often as I'd like. I use my mobile device to set rules for notifying me and rules for the timer on/off cycles. The WeMo Switch acts like the mechanical timer when the Internet is not available.

I now have the ability to do more than a mechanical switch ever could, but...slow down. I have not actually bought one of these yet. Why? Because Belkin has another solution that I prefer.

### **Add Intelligence to Home Energy Monitoring**

I yearn to do more than deter a possible thief from entering my house. After all, with the right "smart" switch every electrical appliance in my house could be fully accessible from the Internet. For example, I want remote feedback if I develop a problem with my sump pump, dehumidifier, freezer chest, or refrigerator. One flooded basement, a mold breakout, or one batch of ruined food would easily surpass \$200 in damages. What investment could help me mitigate the amount of damage and the inconvenience from failed appliances?

I want meaningful, useful information to help me learn more about the behavior of my appliances and the power supplied to them. Did that device fail because it is a poor-quality appliance or was it subjected to an unusually stressful electrical supply? Is the supply of my electricity at my main residence better controlled than the supply from a different utility at my lake house? In my state, New Hampshire, I experience about three power outages per year that exceed 8 hours long. Am I stressing my appliances when I switch to backup power generation during a power outage? Does the electrical characteristics of certain critical appliances such as pumps, dehumidifiers, refrigerators, or freezers change as they age?

How much more could it possibly cost to get more data and enable me to make more intelligent decisions about my electrical connection, my appliances, and my usage patterns? Could I even anticipate a possible failure?

Well, Belkin has a simple, practical solution that takes care of most of my interests. For only \$10 extra, Belkin has literally added “insight” to their basic WeMo Switch. Their WeMo Insight Switch (**Figure 3**) has a miniature utility meter inside its new package that is even smaller than the previous generation. Wahoo! Wouldn't most technology enthusiasts go wild over a \$10 utility meter that sits inside a Wi-Fi node in a switch that is about the size of a deck of playing cards? This thing is brilliant. The user interface (**Figure 4**) is intuitive and sparked a lot of family discussion because it is as easy to understand and control for my 10-year-old daughter as it is for my mother.



*Figure 3. The Belkin WeMo Insight Switch allows you to turn devices on or off, program customized notifications, and change device status—from anywhere.*

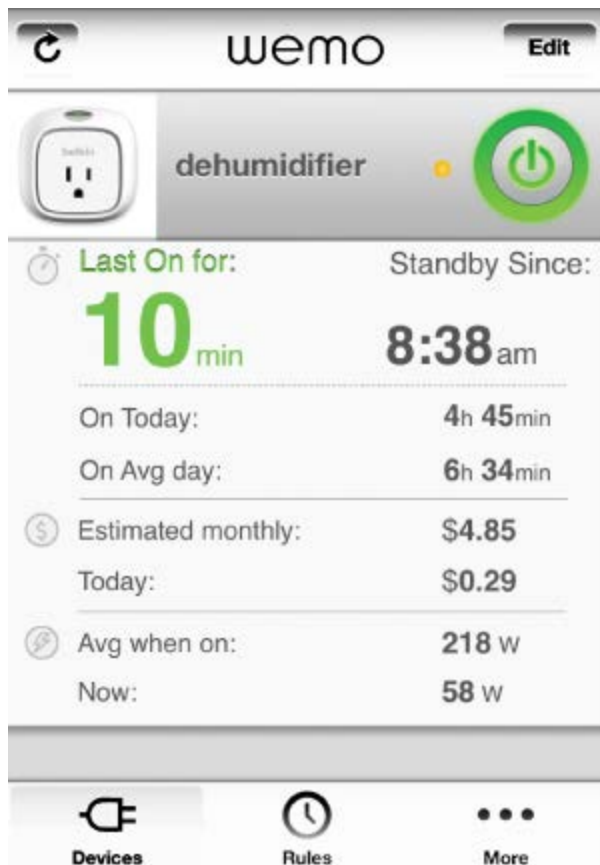


Figure 4. Screen capture of the user interface on my tablet.

The WeMo Insight Switch is so innovative because it uses a chip designed for energy measurement in utility meters. That chip, Maxim's [78M6610+LMU](#) energy-measurement processor, enables measurement values such as current, voltage, power, and harmonic distortion. And, it also does it very precisely. You can't access all that data through the WeMo app, but, for now, I am delighted with the power measurement. Anyone choosing to build such a device using the 78M6610+LMU could enhance their product with all the information available from the 78M6610+LMU.

The 78M6610+LMU has its own RC oscillator and only two low-baud-rate optocouplers to transfer its data to Belkin's communication processor. Here, low speed is actually a really good thing. Typically in designs the higher the baud rate, the more expensive the optocouplers; the higher the number of components, the higher the overall Bill of Materials (BOM) will be. The energy-metering technology in the 78M6610+LMU mitigates those costs. Now the number of optocouplers and their speed requirements are minimized by the 78M6610's autoreporting capability that sends a packet of cumulative data at regular intervals. The host processor can either choose to accept each packet or just monitor the one that it is interested in. No information is ever lost.

The utility metering technology of the 78M6610+LMU is also more accurate and linear than Belkin needs for monitoring home appliances. But still the designer knew exactly how to use that to his advantage. The 78M6610+LMU enables Belkin to meet their design requirements without incurring any additional calibration cost.

Finally, a design concern for such a device is power consumption and space—keep it low and make it fit. Belkin could have used a current transformer to minimize resistive loss, but that would never fit in their switch’s small footprint. The alternative approach was to choose a 2m shunt resistor to sense the current without disrupting the desired accuracy across the entire current range. It would work, but that would be 10x more power consumption than, say, a solution capable of using a 200μ shunt. The 76M6610+LMU enables an incredibly low power consumption solution in a really small footprint. It is the optimal solution to a challenging problem.

The 78M6610+LMU block diagram (Figure 5) illustrates the analog and digital technology integrated in this chip. It is ground referenced, so it shares the same supply as the communications processor.

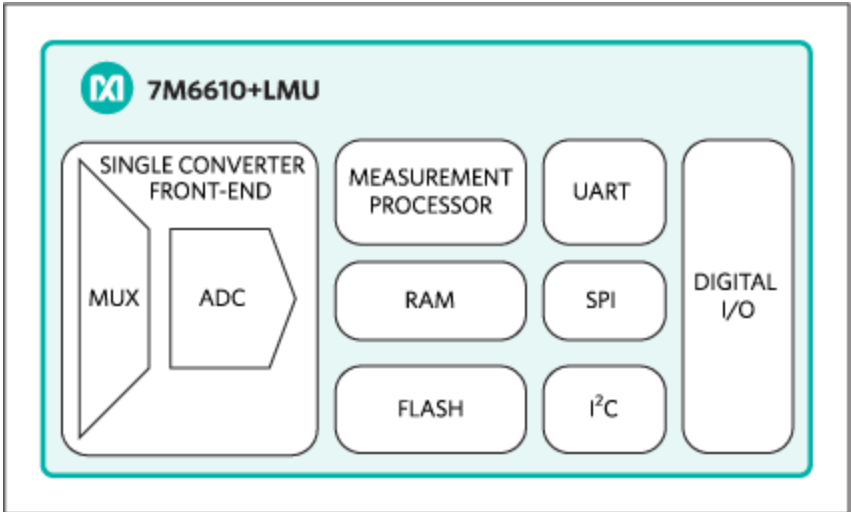


Figure 5. The 78M6610+LMU block diagram illustrates its integrated components: an input multiplexer, 22-bit delta-sigma ADC, a 24-bit RISC processor clocking at 20MHz, RAM and nonvolatile memory, and serial interface options. The chip also has a preamplifier gain stage, temperature-compensated references, an RC oscillator, temperature sensor, and several voltage fault comparators that aren’t shown in the diagram.

**Integration Is Collaboration**

In the end, this is a story of collaboration between the Belkin and Maxim development teams. Belkin leveraged their state-of-the-art technology in packaging and communications by working with Maxim engineers to add the smart energy monitoring. Belkin’s WeMo Insight Switch gives consumers an economical, practical solution for monitoring and managing electrical use in the household. Belkin is, in fact, putting the power of technology into our hands...and electrical outlets. The WeMo Insight Switch can be purchased for \$59.99 and you can start building your network today.

What ways can you foresee using such a tool as the WeMo Insight Switch? Do you have any ideas for embedding a miniature utility meter inside your products? What projects would you like to enhance with Maxim’s energy measurement technology? You can contact us with your comments on [Twitter](#) and [Facebook](#).

WeMo is a registered trademark of Belkin International, Inc.  
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#### Related Parts

[78M6610+LMU](#)

Energy Measurement Processor for Load Monitoring Units

[Free Samples](#)

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#### More Information

For Technical Support: <http://www.maximintegrated.com/en/support>

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Other Questions and Comments: <http://www.maximintegrated.com/en/contact>

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Application Note 5829: <http://www.maximintegrated.com/en/an5829>

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