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APPLICATION NOTE 5864

INNOVATIVE CHINESE ELECTRICAL METERING TECHNOLOGY TO SAVE CHINESE METER

MANUFACTURERS \$25M ANNUALLY¹

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Abstract: An innovative Chinese electricity meter design uses the MAX71315 ZON M3 SoC to dramatically reduce the size and cost of an electricity meter.

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Introduction

Suppose that you were about to purchase a new DVD player for \$60 (USD) in your favorite electronics shop, and you knew that you would save 40 cents by buying it from another shop 10 miles away. Would that cost savings affect your decision? Personally, no. I would still buy it in that shop and happily spend 40 cents more, knowing that I would be saving gas and time by doing so.

Now suppose you were about to buy 62.5 million units of the same DVD player. How would that change your decision, knowing that those same 40 cents would save you a stunning \$25M?

The story above is fictionalized and anecdotic. But if you told it to the CEO of a Chinese electricity meter manufacturer, he or she would recognize the significance immediately. "Keep your costs as low as possible." Most of us have heard that sometime, and it is exactly the challenge that Suzhou Galaxy Camphol Technology Co. Ltd.² is about to take on for electric utility meters. They now can save this 40 cents on each meter and will save their national utility \$25M annually. I am going to relate their story. This is a story about innovation, integration, and perhaps most importantly here, collaboration.

The "China Effect" on the Cost of Electricity Meters

The Chinese electricity meter market is by far the largest in the world due to China having the biggest population on earth, approximately 1.4 billion people. China has one (quasi-single)³ state-owned utility called State Grid Corporation of China, arguably the biggest state-owned utility in the world. With revenues close to \$300B (1.860B ¥), State Grid was ranked as the seventh largest company in the world in Fortune 500 for 2013.⁴ We estimate that 60 to 65 million electricity meters (**Figure 1**) were produced in China for the local market in 2013, a number that is going to grow more than 10% annually in the coming years.⁵



Figure 1. Chinese State Grid meters. Each typically sells below \$20 per unit.

During my many trips to China, I was told several times that more than 200 Chinese companies are in this utility meter business. Is this true, or not? I will leave this for you to verify, but I can easily list more than 30 major companies manufacturing meters for State Grid.

In this competitive environment, the Chinese electricity meter manufacturers struggle daily to provide products with higher performance and even better cost optimization. Here each penny saved definitely means “*big business.*”

When Solution Rhymes with Innovation

Suzhou Galaxy Camphol Technology Co. Ltd. is no newcomer to the meter business and thoroughly understands the requirements and specifications of State Grid.

In 2009, State Grid released the specifications for electricity meters, moving away from mechanical meters to solid-state meters and setting a standard for the entire country. Galaxy immediately saw an opportunity for success as they had been working with new meter designs in the Beijing region since 2003, a time when most other meter manufacturers’ expertise was only with mechanical technology. Galaxy’s highest priority was to learn about microcontrollers, how to implement them and how to program them.

In 2010 Galaxy introduced a new solid-state electronic meter that was certified by the China Electric Power

Institute (CEPRI), a research institute and subsidiary of State Grid.⁶ The CEPRI is the only body who can approve a meter for the State Grid biddings. Thanks to their outstanding technical skills and armed with that certified meter, Galaxy started promoting their reference design to all the Chinese meter manufacturers.

They rapidly became very successful.

Specifications for electricity meters in China require the meter to isolate the metrology from the data processing. This mandate means that most meters in the country use a similar architecture (**Figure 2**).

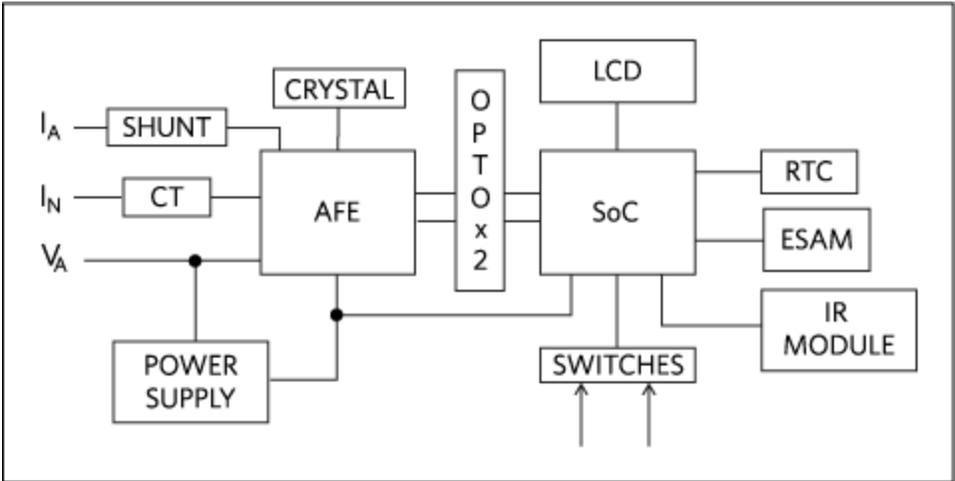


Figure 2. Block diagram for a traditional Chinese electricity meter.

From this typical national design, we return to the \$25M question for Galaxy: how could they reduce the Bill of Materials (BOM) for their device and still comply with the state requirements? I am sure that most of your first answers would point to the microcontroller or the AFE. Not bad, but believe me, considering the high volumes in this market, there is not much that can be done at that level to reduce their price.

Galaxy spoke with Maxim Integrated engineers and we began examining their existing meter architecture. We concluded that the only way to reduce the cost of their electricity meters was to change the architecture of the entire meter. It was time to innovate and integrate.

A Cost-Saving Meter Design

Galaxy now has a new reference design for their electricity meter. They made several adjustments, but their most important change was the inclusion of a Maxim high-performance ZON™ M3 electricity metering (the MAX71315) system-on-chip (SoC) and the MAX710714 isolated sensors (**Figure 3**).

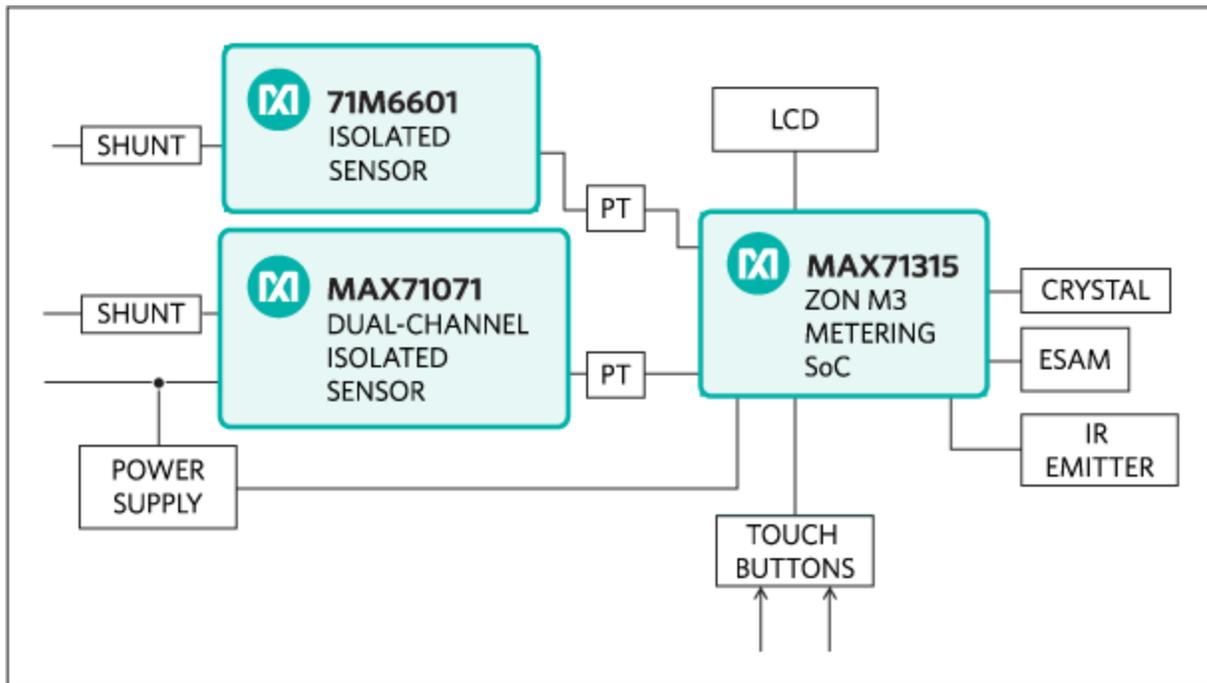


Figure 3. Block diagram for a Galaxy meter, featuring the ZON M3 electricity metering SoC.

The new Galaxy design is so novel and cost saving because of the highly integrated ZON M3 SoC. This new Galaxy implementation does not require a current transformer (CT) or expensive copper bus bars. Isolation is provided by low-cost pulse transformers that form a bidirectional digital communication link between ZON M3 and the MAX71071 ADC and 71M6601 isolated sensor. The new design shaves more than 40 cents off their prior BOM (Table 1).

Table 1. Cost Savings for Galaxy Meter Design vs. Traditional Design

Components	Traditional Design	Galaxy Design	Cost Savings by Design (%)
Microcontroller	Half-SoC + AFE	Integrated electricity metering SoC (ZON M3)	Traditional (10%)
Clock	1 RTC + 1 crystal	1 crystal (integrated RTC)	Galaxy (65%)
Touch buttons (2)	Switches	Touch sensors (no cost)	Galaxy
Infrared (IR)	External module	Fully integrated	Galaxy (30%)
Power supply	Dual (AFE + SoC)	Single (SoC only)	Galaxy (10%)
Current and voltage sensors	Shunt + CT + bus bars	Shunt + isolated sensors* + pulse transformers	Galaxy (30%)
Isolation	Optocouplers (2)	Ensured by the isolated sensors (no cost)	Galaxy

*Note that the “isolated sensor” component here comprises the 71M6601 sensor and MAX71071, a dual 24-bit delta-sigma ADC with integrated amplifier and differential inputs, a precision voltage reference, a temperature sensor, and a supply voltage generator energized by power pulses provided by the ZON M3. This isolated sensor design offers immunity to magnetic tampering, and enhanced reliability.

Is That All?

To this point we have discussed how even small BOM cost savings can quickly add up to a significant savings on these meters. Good, but in reducing those costs Galaxy also had to meet the specifications defined by the CEPRI. So, while collaborating with Galaxy, Maxim optimized the ZON M3 SoC for the Chinese market. Because ZON M3 was already a flexible platform, it was easily customized for the Chinese CEPRI requirements.

Timing in the meter. The CEPRI requires that the timing accuracy variation must be less than 0.5s per day at room temperature and rated operating voltage. Consequently, the meter’s real-time-clock (RTC) is another big piece of the equation. The ZON M3 metering SoC integrates an RTC with temperature compensation. Its accuracy across the whole temperature range of operation complies with the CEPRI specification. With the RTC integrated in the SoC, the solution saves on implementation, size and, of course, BOM costs.

Integrated security. ZON ensures the security of the meters by connecting to an embedded security access (ESAM) module. That module is interfaced with the ISO7816 protocol. That protocol is well known to the smartcard industry and operates with a specific UART. ZON integrates two of those dedicated UARTs.

Reliable data collection. To comply with this requirement, ZON integrates an infrared (IR) encoder and decoder that eliminate the typical extra IR receiver module needed to retrieve and collect the measured data from the meter.

Switching reliability. The CEPRI mandates two switch sensors on electricity meters. Mechanical switches generate reliability issues and require the casing of the meter to be drilled opened. ZON has two touch sensors that replace the obsolete and old-fashioned switch sensors and improve the user’s experience.

Collaboration + Integration = Higher Performance + Cost Reduction

Galaxy has already completed their reference design based on ZON M3 and will start promoting the design to the Chinese meter manufacturers in mid-2014.

This project has demonstrated how important it is for major semiconductors companies like Maxim to collaborate with local companies to understand the market and optimize the specifications of their products. I am very excited to be part of that initiative and to see how, together, we will change the landscape of the Chinese metering market. After all, it is not that often in your life that you are given the opportunity to save \$25M.

References

1. Estimated volume is based on 62.5M units, and growing, forecasted for China. See “[China Powers Up Domestic Smart Meter Market](#),” **IHS Technology**, December 08, 2011.
2. For more information about Suzhou Galaxy Camphol Technology Co. Ltd., go to <http://www.szgc.com.cn/>. Note that there is no English version of this website.
3. I use this term carefully and with all due respect to all utilities in China. In fact, besides the State Grid Corporation of China, there are actually two other minor utilities called South Grid and Rural Grid, both of which tend to follow the rules of State Grid.
4. See http://money.cnn.com/magazines/fortune/global500/2013/full_list/.
5. See **IHS Technology**, *op. cit.*
6. For more information, see www.epri.sgcc.com.cn/en/.
7. For information on the ZON M3 electricity SoC, go to www.maximintegrated.com/MAX71315; for the MAX71071 and 71M6601 isolated sensors, go to www.maximintegrated.com/MAX71071 and www.maximintegrated.com/71M6601.

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Related Parts		
71M6601	Isolated Sensor ICs	Free Samples
MAX71071	Dual-Channel Isolated Metrology ADCs	Free Samples
MAX71315	ZON M3 Single-Phase Electricity Meter SOC	Free Samples

More Information

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

For Samples: <http://www.maximintegrated.com/en/samples>

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

Application Note 5864: <http://www.maximintegrated.com/en/an5864>

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