



APPLICATION NOTE 5048

Frequently Asked Questions about Energy-Measurement SoCs

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Abstract: This application note answers many of the common questions about the Maxim/Teridian 78M6612/78M6613/78M6618 energy- and power-measurement SoCs and their embedded software.

Introductory Questions

1. What are Maxim's energy-measurement SoCs?
2. What are the differences between the 78M6618, 78M6612, and 78M6613?
3. Do you have evaluation boards for these products?
4. What is the difference between a Maxim energy-measurement device and a Maxim metering device?
5. What is the accuracy of a 78M6612-, 78M6613-, or 78M6618-based system?
6. What is the clock source for these parts?
7. Do you have any lower-cost alternatives that offer less accuracy?
8. I have an on-board 32.768kHz clock that I would like to use to drive the 78M6612, 78M6613, or 78M6618 device and save the cost of an additional crystal and board real estate. My clock is a square wave with amplitude of 3.3V. How can I drive your parts with this clock?
9. What is the calibration time?
10. Which current sensors do the 78M6612/78M6613/78M6618 support?
11. What is the power consumption?
12. What is the sampling rate?
13. Can the sampling rate be changed?
14. What is the effective bandwidth of the signals that the 78M6612/78M6613/78M6618 can accommodate?
15. How fast is the device clocking?
16. How can I power up the 78M6612 or 78M6613 Evaluation Board when installed in an AC-DC power supply?
17. I notice there is an 80515 MPU core in addition to the metrology processor. Is the entire MPU core available to the user for my application?
18. Are your packages lead-free?

Programming Questions

1. Are the 78M6612, 78M6613, and 78M6618 programmable?
2. Given the multiple communication interfaces that these parts provide, do I need to install any special drivers in order to control the device?
3. Can I get sample code to leverage in building my own code?
4. What is M-API?
5. Can I program the 32-bit CE?
6. What tools do I need to program the 78M6612, 78M6613, and 78M6618?

Support Questions

1. What application notes do you have to assist me?
2. Where do I go if I have a question?
3. I am designing a board using the 78M6612, 78M6613, or 78M6618, and I want to make sure that the layout is correct. Do you have Gerber files of your evaluation boards that I can download and use in my design?
4. How can I select appropriate voltage and current sensors for my application?
5. Where can I purchase the 78M6612, 78M6613, and 78M6618 devices and evaluation boards?

Introductory Questions

1. What are Maxim's energy-measurement SoCs?

Maxim's energy-measurement SoCs let you easily embed accurate AC power- and energy-measurement functionality into grid-friendly electronic equipment and intelligent power-distribution systems. These devices provide highly accurate, cost-effective alternatives to multichip implementations. Our single device solutions are easier to design into your system and are programmable to satisfy changing standards worldwide. A full suite of development tools eases programming efforts, reduces testing and prototyping needs, and shortens design cycles.

2. What are the differences between the 78M6618, 78M6612, and 78M6613?

The [78M6618](#) provides 10 analog inputs for independent measurement of up to eight single-phase AC outlets. The 78M6618 is ideal for metered power distribution units (PDUs) and rack enclosures for the data center, as well as intelligent power strips and subpanels in the grid-friendly digital home. The device provides 19 digital I/O pins and includes 4KB MPU XRAM and 128KB flash.

The [78M6612](#) provides four analog inputs and can measure each outlet of a duplex receptacle with a single IC. The device includes up to 18 pins (available in a 68-pin QFN package) or 16 pins (in a 64-pin LQFP package) of digital I/O. It includes 2KB MPU XRAM and 32KB flash, and its integrated LCD controller can drive up to 140 segments (offered in a 64-pin QFN package) or up to 152 segments (in a 68-pin QFN package).

The small-package option [78M6613](#) also has four analog inputs. The device is designed for implementation into power supplies, smart appliances, and other applications. It is available in a small 5mm x 5mm 32-pin QFN package for optimal space saving. The 78M6613 provides 10 digital I/O pins and includes 2KB MPU XRAM and 32KB flash.

This summary includes major differences but does not address minor differences. For more information, refer to the individual data sheets.

3. Do you have evaluation boards for these products?

Maxim offers an extensive set of evaluation boards complete with demonstration builds for common applications. Demonstration code is shipped preprogrammed into evaluation boards and is also available in preprogrammed ICs for in-system evaluation. For a complete summary of the available evaluation boards and firmware options, see application note 4982, "[Getting Started with 78M661x Energy Measurement SoCs.](#)"

4. What is the difference between a Maxim energy-measurement device and a Maxim metering device?

The metering device differs from the energy-measurement device in that its main function is to measure the aggregate energy load for the purpose of revenue collection by the utility. The metering device typically measures an entire building's energy consumption, while the energy-measurement device usually measures a subset of loads inside a building, or even within a specific piece of equipment. The hardware and firmware features (LCD, battery, RTC, EEPROM) of the metering device are consistent across customers. Contrastingly, the hardware and firmware of the energy-measurement device may or may not have all the features of the metering device, depending on the customer base and different application requirements. Also, the metering device is typically the master host, while the energy-measurement device is typically a slave.

5. What is the accuracy of a 78M6612-, 78M6613-, or 78M6618-based system?

When calibrated by the customer, the 78M6612/78M6613/78M6618 provide 0.5% Wh accuracy over a 2000:1 current range and over a 40°C to +85°C operating range. When the measurements are over a more limited dynamic range (for example, from 100mA to 20A), the devices can be capable of up to a 0.1% Wh measurement error. If not calibrated by the customer, the accuracy is typically 2.5% for a shunt sensor. The accuracy degrades at the low end of the measurement range, due to the noise in the system.

6. What is the clock source for these parts?

The clock source is a standard low-cost 32.768kHz watch crystal.

7. Do you have any lower-cost alternatives that offer less accuracy?

There is negligible material cost difference between an IC that can measure with up to a 2.5% accuracy versus a sub-1% accuracy. Provided the IC design is optimized for AC measurement (as it is in the 78M6612/78M6613/78M6618), the optional cost adder for achieving precision AC measurement resides in the selection of voltage/current sensors and the respective calibration of each sensor's tolerances at the time of manufacturing.

With that said, an uncalibrated 78M6612/78M6613/78M6618 will typically deliver approximately 2.5% accuracy for the lowest

possible solution cost. Introducing variable amounts of calibration (and cost) would increase accuracy levels up to 0.5% or better. The flexibility of the devices can also help to significantly reduce the BOM cost for isolation of the host interface.

8. I have an on-board 32.768kHz clock that I would like to use to drive the 78M6612, 78M6613, or 78M6618 device and save the cost of an additional crystal and board real estate. My clock is a square wave with amplitude of 3.3V. How can I drive your parts with this clock?

It is possible to use an external oscillator or a generic 32.768kHz clock to drive the 78M6612, 78M6613, and 78M6618. It can be directly connected, if the level of the clock signal is 2.5V_{p-p}.

In this case, the best way would be to use a voltage divider having a ratio of 3:4, so that the voltage at the input pin would not exceed 2.5V peak.

Another consideration using digital clocks is with regards to the rise and fall time. The clock is low frequency; however, the rise and fall times could be very steep. In this case, ringing caused by an unbalanced clock line can cause a malfunction. The clock line needs to be terminated accordingly, usually with a simple resistor. Note that the voltage divider can itself act as termination.

9. What is the calibration time?

It takes approximately 15 seconds for a full calibration of a single socket of the 78M6612/78M6613/78M6618, and approximately 7.5 seconds for the current-only calibration. This represents the fastest calibration in the industry for similar products.

10. Which current sensors do the 78M6612/78M6613/78M6618 support?

The devices support current transformers (used primarily for high currents) and resistive shunt sensors (for low cost and lower currents). In some firmware options, Rogowski sensors are supported. See application note 5027, "[78M661x Sensor Selection Guide](#)."

11. What is the power consumption?

The power consumption is typically between 20mW and 30mW, not counting I/O loads.

12. What is the sampling rate?

The effective sample rate can range from 2.52ksps to 6.5ksps per input, depending on the number of ADC inputs being sampled through the multiplexer. In the case of the 78M6612, the ADC measures one or two voltages (VA, VB) and up to two currents (IA, IB). It also measures the temperature and battery voltage. These measurements are accumulated based on the settings of compute engine (CE) so that the contents of the MPU measurement registers are an average of separate measurements during a measurement cycle. The outlet measurement unit (OMU) demo accumulates and can report one set of measurements per second, but other versions of the CE code can accumulate and output measurements in as quickly as four 60Hz AC cycles.

13. Can the sampling rate be changed?

The CE code is not user-programmable and the user does not have control of the sample rate, but Maxim can provide one of three different rates for the CE at which to run, according to the customer's needs. This requires the CE code to be changed, which is not something that can be done by the user.

14. What is the effective bandwidth of the signals that the 78M6612/78M6613/78M6618 can accommodate?

The typical sample rate is sufficient to measure out to the 19th harmonic or 1120Hz.

15. How fast is the device clocking?

The internal processors run at approximately 5MHz, even though the external crystal is 32.768kHz.

16. How can I power up the 78M6612 or 78M6613 Evaluation Board when installed in an AC-DC power supply?

Use an isolated DC-DC power supply, an independent auxiliary winding configured for 3.3V output, or a dedicated cap-drop supply.

17. I notice there is an 80515 MPU core in addition to the metrology processor. Is the entire MPU core available to the user for my application?

While the embedded CE performs much of the computation or calculation of AC-measurement parameters, resources from the MPU are required to service the CE, further process the data into a usable format, and manage the IC's hardware resources. The MPU resources available for the user application are suitable for AC-measurement subsystem functionality like data formatting, managing host interface protocols, and intelligent relay control. For running secure COM stacks for wireless or

wireline network interfaces on the MPU, consult a Maxim representative.

18. Are your packages lead-free?

All 78M6612, 78M6613, and 78M6618 packages are RoHS-compliant (6/6)/lead-free.

Programming Questions

1. Are the 78M6612, 78M6613, and 78M6618 programmable?

The 78M6612/78M6613/78M6618 provide the user with flexibility and programmability, even though in most cases, it will not be necessary to program the device. Maxim is continually creating different turnkey builds to accommodate different user interfaces (UART/RS-232, I²C, or SPI™) and measurement configurations for the energy-measurement market. One such build is the Command Line Interface (CLI). This firmware facilitates communication via UART between the device and the host processor. The CLI provides a set of commands that are used by the host to configure and to obtain information from the 78M6612/78M6613/78M6618.

The host processor requires an interpreter to communicate according to the given protocol and communications interface. This should be the only programming required for most applications.

For customers who wish to add functionality or modify an existing turnkey application, Maxim provides the top-level source code to customers to perform this customization as they see fit. This source code is written using the Maxim M-API libraries to perform all measurement related functions. See the [What is M-API?](#) section.

2. Given the multiple communication interfaces that these parts provide, do I need to install any special drivers in order to control the device?

No. Depending on the firmware selected, the driver for either UART/RS-232, I²C, or SPI (78M6618 only) is embedded in the object code.

3. Can I get sample code to leverage in building my own code?

Yes, but this is generally not necessary. If a customer requires some functionality beyond that provided by the CLI, a determination can be made between the customer and Maxim to best accommodate this additional functionality. In some cases, Maxim may decide to add this functionality or allow the customer to do this customization themselves. If the customer performs this task, then the sample application source code, along with the Maxim M-API library, can be provided.

4. What is M API?

The Metrology Application Programming Interface (M-API) provides customers who want to develop their own code or to add functionality to an existing application a straightforward software development platform. M-API is a set of metrology libraries that configure the measurement front-end, perform calculations on the CE output data, provide simplified access to measurement output data, and manage device resources via API calls. The M-API allows customers to create/modify applications without needing to meddle with the metrology functionality, which reduces any chance of breaking the code or introducing a performance degradation. The M-API libraries are thoroughly validated to ensure proper operation and are considered proprietary. As a result, the source code of M-API is not available to customers.

5. Can I program the 32-bit CE?

No. Normally there is no need to program the CE, as the existing CE code performs all necessary tasks. Most customization can be done at the application level and does not require modification of the CE. The CE code is considered proprietary and is not released to customers.

6. What tools do I need to program the 78M6612, 78M6613, and 78M6618?

M-API is built using the Keil® Compiler version 8.02, although any Keil version 7.00 or higher is also compatible. You will need a Keil Compiler for compiling.

For software debugging, you will most likely need the Signum Systems® ADM-51, which can be ordered online through [Maxim Direct](#) (order number DB6510-ADM51) or through Signum Systems. This can be used for both emulation and flash programming.

In-circuit programming is accomplished using the Signum ICE or the TFP2. Alternatively, preprogrammed parts are available.

Support Questions

1. What application notes do you have to assist me?
The 78M6618, 78M6612, and 78M6613 documentation is available on Maxim's website. Enter 78M6618, 78M6612, or 78M6613 in the search box in the upper right. Then click on the IC name and click on the Technical Documents tab.
2. Where do I go if I have a question?
Go to www.maxim-ic.com/support and select the appropriate topic.
3. I am designing a board using the 78M6612, 78M6613, or 78M6618, and I want to make sure that the layout is correct. Do you have Gerber files of your evaluation boards that I can download and use in my design?
Yes, the design files for the evaluation boards, such as schematics (OrCAD and PDF format), BOM, and PCB Gerber fabrication files are available for download from the Maxim website.
4. How can I select appropriate voltage and current sensors for my application?
See application note 5027, "[78M661x Sensor Selection Guide](#)."
5. Where can I purchase the 78M6612, 78M6613, and 78M6618 devices and evaluation boards?
The devices and evaluation boards can be purchased from [Maxim Direct](#) or from the following distributors: [Avnet](#) or [Mouser Electronics](#).

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Related Parts

78M6612	Single-Phase, Dual-Outlet Power and Energy Measurement IC	Free Samples
78M6613	Single-Phase AC Power-Measurement IC	Free Samples
78M6618	Octal Power and Energy Measurement IC	Free Samples

More Information

For Technical Support: <http://www.maxim-ic.com/support>

For Samples: <http://www.maxim-ic.com/samples>

Other Questions and Comments: <http://www.maxim-ic.com/contact>

Application Note 5048: <http://www.maxim-ic.com/an5048>

APPLICATION NOTE 5048, AN5048, AN 5048, APP5048, Appnote5048, Appnote 5048, FAQ_661x_079

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