Maxim > Design Support > Technical Documents > Application Notes > Energy Measurement & Metering > APP 5752

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APPLICATION NOTE 5752

Comparing OMU and HPL Solutions to the 78M6610+LMU

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Abstract: This application note provides a comparison between the single-phase OMU and HPL firmware solutions available for the 78M6612 and 78M6613 programmable systems-on-chips (SoCs) and the new 78M6610+LMU energy measurement processor. Engineers using these previous solutions can use this application note to help consider design conversion to the 78M6610+LMU.

Introduction

This application note provides a comparison between the single-phase OMU and HPL firmware solutions available for the 78M6612 and 78M6613 programmable systems-on-chips (SoCs) and the new 78M6610+LMU energy measurement processor. The intended audience is an engineer already familiar with the previous solutions who is considering to a design conversion to the 78M6610+LMU.

Terminology

SoC	The 78M6612 and 78M6613 system-on-chip products from Maxim with a programmable 80515 core, a dedicated 32-bit metrology compute engine (coprocessor), and single converter analog front-end. One or more firmware libraries are available for customer modification of application firmware.
OMU	*Outlet Monitoring Unit firmware* (SoC) library for monitoring of two single-phase (2-wire) AC loads using a single line voltage and two currents.
HPL	High Power Load firmware (SoC) library for monitoring any single-phase (2-, 3-wire) AC load using two line voltage and two line current inputs.
EMP	*Energy Measurement Processor* platform with Maxim's single converter analog front-end. Multiple embedded firmware options are available as different end part numbers such as the 78M6610+LMU.
LMU	*Load Monitoring Unit* firmware on the 78M6610 with two voltage and two current sense inputs for monitoring any single-phase input.
CLI	An ASCII-based *Command Line Interface* protocol for use over the serial UART interface (available with SoC and EMP platforms). Used with demonstration code.
SLIP	A binary *Serial Line Interface Protocol* for use over the serial UART interface (available with

SoC platforms using MAPI or SDK 1.0 libraries). SAI A binary *Serial Asynchronous Interface* for use over a serial UART interface (available with SoC platforms using SDK 2.0 libraries).

SSI A binary *Simple Serial Interface* for use over a serial UART unavailable with EMP products.

CT A *Current Transformer* is an isolated sensor placed in series with the load for measuring AC current.

VT A *Voltage Transformer* is an isolated sensor placed across a load for measuring AC voltage.

Sensor Interface

The configurable LMU firmware supports all the sensor interface configurations offered with the OMU and HPL firmware solutions. The 78M6610+LMU, however, improves on the 78M6612/13 hardware by offering differential inputs for easier layout of current sense inputs and a faster effective sample rate for each of the four sense input slots. See **Figure 1**.

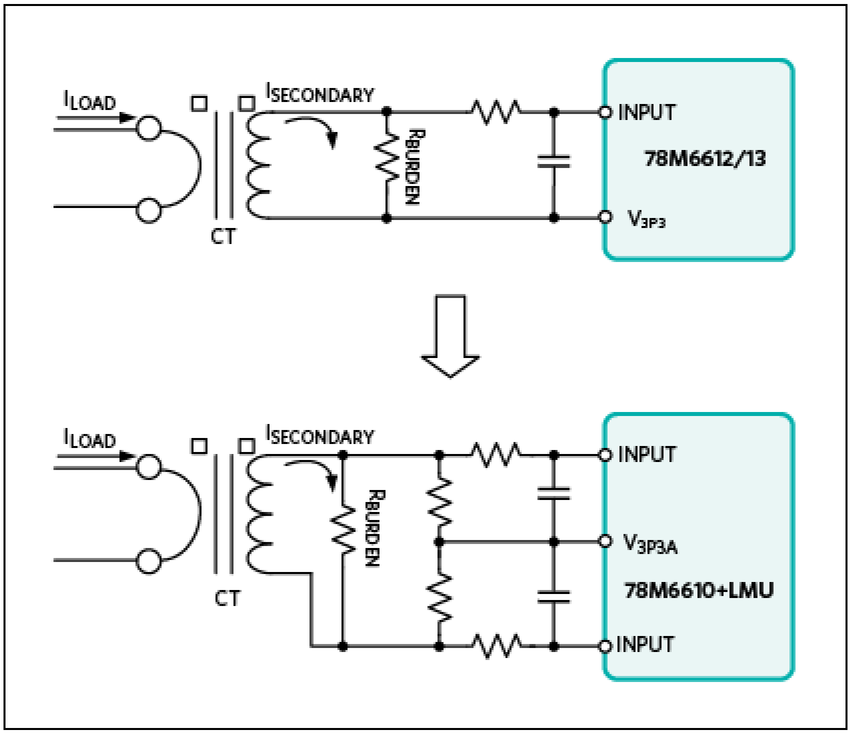


Figure 1. 78M6610+LMU sensor interface vs. 78M6612/78M6613 sensor interface.

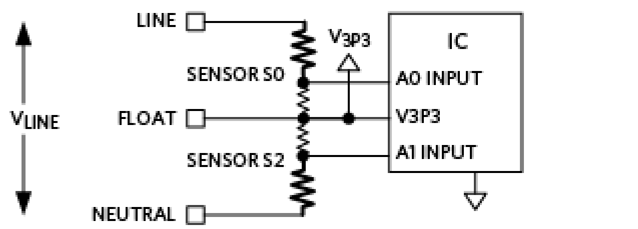
With the 78M6612 or 78M6613, the available sensors configurations were selected by 1 or 2 bits in the compute engine (CE) configuration registers. The 78M6610+LMU uses multiplier bits in the CONFIG register for flexible mapping of each sensor slot (S0 through S3) to the reported measurement outputs (V_A, I_A, I_B, etc.). This section summarizes the equivalent 78M6610+LMU device settings for each of the sensor configurations supported by OMU and HPL firmware, along with any scaling considerations for the 78M6610+LMU measurement output registers.

Register type notations used in this document (S.23, S.22, etc.) are further described in the 78M6610+LMU IC data sheet. It should be noted that notations are not fixed for all sensor configuration options. For example, the data sheet may describe a power output register as an S.23 register type while this document may describe power as S.22 (a register with twice the full-scale magnitude of S.23) for some configurations.

For simplicity, in the following diagrams, filtering components and differential connections are not shown. Only single-ended sense inputs and the 3.3V high-side reference (V3P3) are presented.

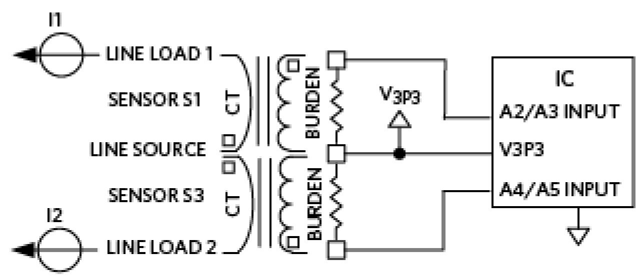
Mode 1: Line Voltage + Two Currents from OMU

This **pseudo-isolated** sensor configuration for 2-wire applications utilizes two independent voltage sense inputs with resistive dividers for a single line voltage measurement. This voltage sense configuration, when combined with isolated current sensors like a CT, maintains a high impedance (pseudo-isolated) path between AC mains and the measurement sub system allowing a common ground with the rest of the system.



- Set the multiplier bits for V_A, V_B, and V_C all equal to 'S0-S2' to report V_{Line} for all voltage measurement outputs.

Voltage Inputs



- Set the multiplier bits for I_A to S1 to report I_1.
- Set the multiplier bits for I_B to S3 to report I_2.

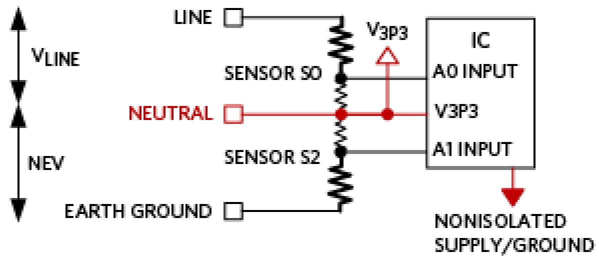
Current Inputs

Scaling Considerations

All voltage measurement outputs and derived power measurements are subsequently shifted one digit to the right, resulting in an S.22 register type. Total Power outputs for channel C are subsequently an S.21 register type. Current measurement outputs remain an S.23 register type.

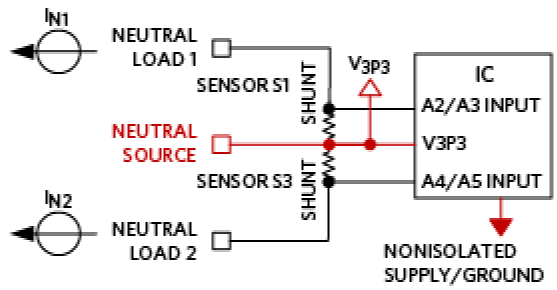
Mode 2: Line Voltage, NEV Voltage, and Two Currents from OMU

This **non-isolated** sensor configuration for 2-wire applications also uses resistive sensors for sensing voltage, but utilizes the second voltage-sense input to monitor the neutral to earth ground voltage (NEV) for fault conditions. It can be used with any current sensor type, but remains non-isolated due to the direct connection of AC mains to the measurement IC.



- Set the multiplier bits for V_A and V_B equal to S0 to report V_{LINE}.
- Set the multiplier bits for V_C equal to S2 to report NEV.

Voltage Inputs



- Set the multiplier bits for I_A to S1 to report IN1.
- Set the multiplier bits for I_B to S3 to report IN2.

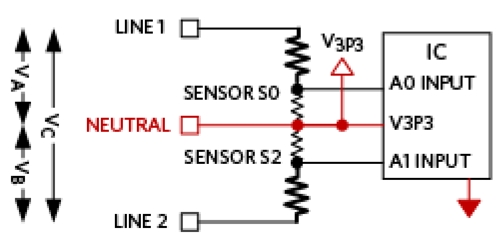
Current Inputs

Scaling Considerations

All register types remain as documented in the IC data sheet.

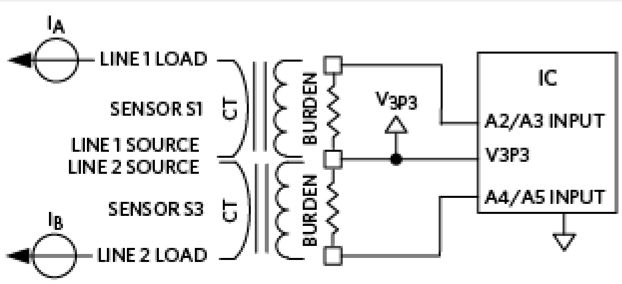
Mode 3: Fixed Reference Split-Phase Mode from HPL

This non-isolated sensor configuration for 3-wire applications uses resistive sensors for sensing two line voltages and isolated sensors for sensing current of each phase.



- Set the multiplier bits for V_A to S0.
- Set the multiplier bits for V_B to S2.
- Set the multiplier bits for V_C to S0-S2.

Voltage Inputs



- Set the multiplier bits for I_A to S1.
- Set the multiplier bits for I_B to S3.

Current Inputs

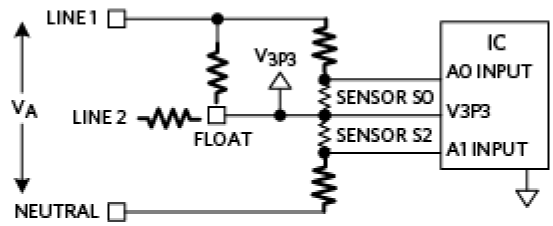
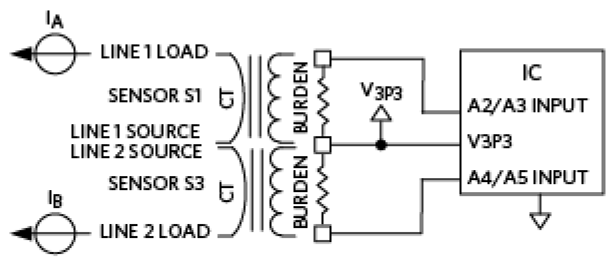
Scaling Considerations

All register types remain as documented in the IC data sheet.

Mode 4: Floating Reference Split-Phase Mode from HPL

The **pseudo-isolated** sensor configuration for 3-wire split-phase systems utilizes two voltage-sense inputs with resistive sensors for a single line voltage measurement, but with matched bleeding resistors to each line. This configuration assumes 180-degree offsets between phases and uses of an inverted copy of the measured Line 1 voltage as the Line 2 voltage. Target systems should be installed close to the service entry to minimize NEV and imbalances between V_A and V_B. When combined with one or two isolated current sensors like a CT, this configuration maintains a high-impedance (pseudo-isolated) path between AC mains and the measurement IC, allowing a shared isolated power supply with the rest of the system.

VC cannot be measured or reported by the 78M6610+LMU in this configuration. Mathematical formula for calculating the missing voltage VB is different in 78M6613 HPL firmware than with 78M6610+LMU.

	• Set the multiplier bits for V_A to S0-S2. • Set the multiplier bits for V_B to '-S0+S2'.	**Voltage Inputs**
	• Set the multiplier bits for I_A to S1. • Set the multiplier bits for I_B to S3.	**Current Inputs**

Scaling Considerations

All voltage measurement outputs and derived power measurements are shifted one digit to the right, resulting in an S.22 register type. Total Power outputs for channel C are subsequently an S.21 register type. Current measurement outputs remain an S.23 register type.

Measurement Parameters

Nearly all the measurement capabilities found in the OMU and HPL solutions are preserved in the 78M6610+LMU. If using the SPI interface, one can now access raw data at sampling rates for external post processing if necessary. Notable differences in measurement outputs, parameters, or terminology include:

- Elimination of phase angle measurement outputs that were used for phase calibration purposes in sinusoidal conditions. Routines for adjusting the internal phase compensation parameter are now handled by the host as needed.
- A reduced number of min/max value tracking registers. The user now has six configurable sets of register outputs that track the min/max value of any selectable address.

- Modified alarm/status outputs and eliminated alarm counters.
- Improved harmonic measurement capabilities replacing fixed frequency ‘narrowband’ measurements with configurable ‘fundamental’ measurements that can report either the carrier frequency or a selected harmonic. Total harmonic distortion outside the selected harmonic is reported as well.
    - Wideband measurements containing the sum of all harmonics are still provided as well.
- Added instantaneous and peak outputs for voltage and current.
- Replaced QUANT terminology with offset terminology: IxRMS_OFF, Px_OFFS, Qx_OFFS.
- Simplified calibration settings by replacing tolerance and avg/max interval count inputs with a single CALCYCS input that selects the number of accumulation intervals to average during calibration routines.

The 78M6610+LMU presents the host with unscaled 24-bit values and a configurable energy counter for greater flexibility with LSB sizes and load ranges. By contrast, the SoC solutions provided scaled 32-bit measurement outputs using predetermined LSB sizes such as mV, mA, and mW.

Host Interface

There are minor differences in the host interfaces between the programmable SoC devices, which include plenty of DIOs and a programming interface, and the 78M6610+LMU EMP devices that do not. This section summarizes the key differences between the SoC solutions and the 78M6610+LMU.

Serial Interface Protocols

The original OMU and HPL (SPL) solutions were initially introduced with an ASCII-based CLI interface over the UART port. In addition to a set read and write commands, this legacy CLI protocol contained several unique control commands for specific device controls such as resets, initiating calibration routines, and updating flash. For users that prefer this terminal interface, a simplified CLI implementation is available with the 78M6610+LMU that only supports read and write commands in the decimal format.

For binary protocols more suitable for chip-to-chip communications and efficient processing by the host, the 78M6610+LMU offers I^2C, SPI, or an SSI protocol for the UART interface that is comparable to the SLIP or SAI protocols found with the SoC solutions. Refer to the 78M6610+LMU documentation for full details on the SSI protocol.

Commands and Control

Device controls such as flash access, reset, and calibration routines are now initiated with simple write commands to a COMMAND register in the 78M6610+LMU allowing the same functionality for I^2C, SPI, or UART interfaces. Notable differences in controls include:

- Relay control timing with SoCs was based on both voltage and current crossing information. Only voltage crossing info is used with 78M6610+LMU relay control on/off functions.
- The integrated “Calibrate Phase” routine is not implemented in the 78M6610+LMU. This parameter is often fixed for a given bill of materials and determined during design. Refer to calibration application note(s) for equations on calculating phase offset values.

Rest of Circuit

Reference timing has changed from 32kHz reference to a 20MHz reference with the 78M6610+LMU. Startup times are significantly reduced with the addition of an internal RC oscillator. For applications that do not require precision time-base calculations (energy and line frequency), the external crystal can be eliminated from the bill of materials by using the internal RC oscillator. Otherwise, the device automatically switches to the external reference as described in the respective 78M6610 IC data sheet.

External reset requirements for 78M6613 are eliminated further reducing the minimum bill of materials. An external reset can still be applied as needed.

With a smaller package, the 78M6610+LMU offers fewer DIOs and no programming interface. The same 5V tolerant I/Os are used with all mentioned products. Interface select pins (IFC0/IFC1) are now required to select which serial interface (I^2C, SPI, UART) to enable upon startup.

Related Parts		
78M6610+LMU	Energy Measurement Processor for Load Monitoring Units	Free Samples
78M6612	Single-Phase, Dual-Outlet Power and Energy Measurement IC	Free Samples
78M6613	Single-Phase AC Power-Measurement IC	Free Samples

More Information
For Technical Support: http://www.maximintegrated.com/support
For Samples: http://www.maximintegrated.com/samples
Other Questions and Comments: http://www.maximintegrated.com/contact

Application Note 5752: http://www.maximintegrated.com/an5752
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