Industrial, Connectivity

Kinetis KM3x MCU Two-Phase Metering Reference Design

Based on high-performance, 24-bit sigma-delta ADC

Overview

With the growing consumption of energy worldwide, particularly in the residential market, utility providers need increasingly accurate and cost-effective energy metering solutions. The Kinetis M series two-phase electricity meter reference design addresses high accuracy and low cost needs by providing a high-performance analog front-end (24-bit AFE) combined with an embedded programmable gain amplifier (PGA) to increase the accuracy of energy measurement. The design is targeted especially for the U.S. and Japan regions.

The two-phase power meter reference design is used for measurement and registration of active and reactive energy in single-phase three-wire networks for direct connection. It is precertified according to ANSI C12.20, class 0.2. The integrated switched mode power supply (buck converter) enables efficient operation of the meter electronics and provides enough power for optional modules such as NVM memories for data logging and firmware storage, the Xtrinsic 3-axis low-power tilt sensor in cooperation with the Xtrinsic 3-axis magnetometer (both for electronic tamper detection), a built-in optical readout port (infrared) for a handheld terminal reading with ANSI C12.18 protocol support, and an expansion header for an RF communication module (sub-GHz or 802.15.4g/e with 6LoWPAN/IPv6 connectivity).

The backup battery is used to power the meter electronics in case of a power absence. This battery will activate the meter when a tamper event occurs. There are two types of electronic tamper detection circuits inside the meter. The first tamper event may be generated by the Xtrinsic 3-axis low-power tilt sensor. With the tilt sensor populated, the meter electronics become powered when coordinates of the installed meter unexpectedly change. The tilt sensor not only prevents physical tampering but it can detect an earthquake and trigger the MCU to power down the meter electronics. The second tamper event may be generated by the Xtrinsic 3-axis low-power magnetometer. This sensor can measure magnetic fields in three dimensions and it is primarily used for tamper detection of the current transformer current sensors by an external strong magnet.

The 32-bit Kinetis MKM34Z128 MCU based on the ARM® Cortex®-M0+ core is at the heart of the reference design. This efficient processor core with support for 32-bit math enables fast execution of FFT-based metering algorithm.

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Two-Phase Metering Reference Design Features

- Kinetis MKM34Z128 MCU built on the Cortex-M0+ core
- 200 A current range (CL200, TA 30A)
- 85 to 264 V, 50/60 Hz voltage range
- Two types of installation: Form 2S or Form 12S
- Accuracy class: ANSI C12.20-2002 Class 0.2
- Line frequency measurement (for precision zero-cross detection)
- Current transformer sensing circuit implementation for each phase
- Low-power modes, including the use of built-in RTC (lithium battery backup)
- 8 x 20 segment LCD, including charge pump
- Isolated (4 kV) RS232 port for monitoring, parameterization and firmware upgrade (optional)
- LED pulse outputs (kWh, kVARh)
- Infrared optical port according to ANSI C12.18-2006 (optional)
- Supports two types of RF daughter cards: sub-GHz or IEEE® 802.15.4g/e with 6LoWPAN/IPv6 connectivity for an AMR, and remote control or HAN/NAN communication in the smart grid.
- Xtrinsic 3-axis ultra-low-power tilt sensor for electronic tamper detection
- Xtrinsic 3-axis low-power magnetometer for electronic tamper detection
- Cost-effective bill of materials

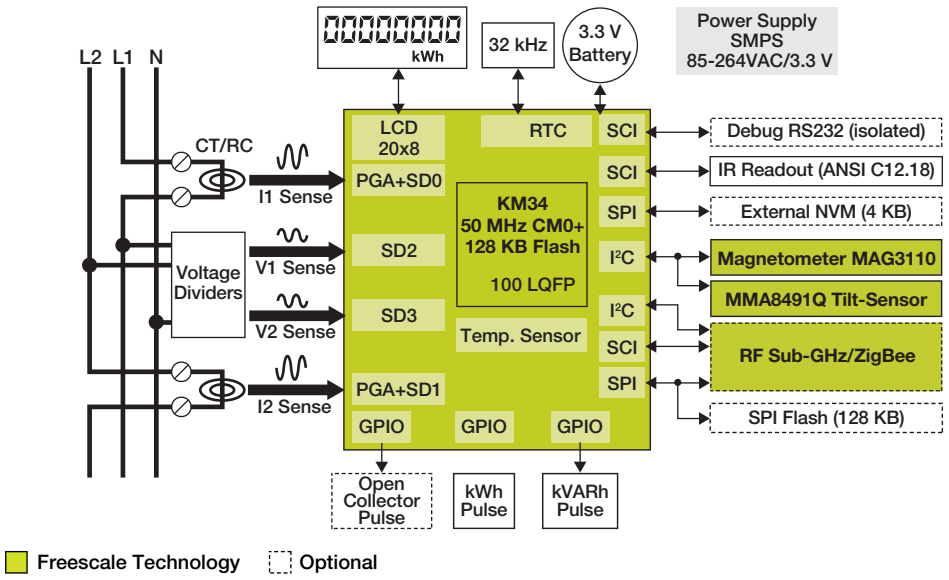
Software Provided

- Multiple advanced metering algorithms
  - Filter-based
  - FFT method
- MQX™ real-time operating system
- Comprehensive peripheral library drivers

KM34Z128 MCU Features

- Up to 50 MHz Cortex M0+ core with up to 128 KB flash and 16 KB RAM
- Highest resolution AFE with 4 x 24-bit SD ADC with 94 dB SNR

Kinetis M Series Two-Phase Power Meter Reference Design



- Built-in VREF and PGA with low drift over temperature
- Four UART, two SPI and two I²C with IRDA and 7816 support
- Two analog comparators
- Single low-cost 32 kHz crystal for MCU and RTC
- Auto-compensated RTC with high-speed calibration with high accuracy and 0.88 PPM resolution (1 Hz output pulse)
- Security with active tamper and memory protection unit
- Up to 4 x 40 and 8 x 36 segment LCD

Documentation

- Design reference manual (DRM149)
- Filter-based algorithm for metering application (AN4265)
- FFT-based algorithm for metering applications (AN4255)
- Using an FFT on the sigma-delta ADCs (AN4847)
- Low-level on-chip peripheral drivers
- Hardware schematic diagram
- Reference design Quick Start Guide

Related Products

KW20 Wireless 2.4 GHz MCUs (Optional)

- Efficient Cortex-M4 CPU with up to 512 KB flash
- Low RF power consumption TX (0 dBm) 15 mA and RX 15 mA
- Dual PAN and antenna diversity support with +10 dBm output power and –102 dBm sensitivity
- Support IEEE 802.15.4-compliant radio with ZigBee®, 6LoWPAN, WirelessHART and ISA 100.11a stacks

KW01 Wireless Sub-GHz MCUs (Optional)

- Efficient Cortex-M0+ CPU with up to 128 KB flash
- Ultra-low-power mode with 1.7 µA/4.3 µs wake-up time
- High RF budget link up to +137 dBm
- Support of WM bus, 802.15.4g/e

MMA8491Q Xtrinsic 3-Axis MEMS Tilt Sensor (Optional)

- Miniature 3 mm x 3 mm QFN
- Ultra-low current consumption: 400 nA at 1 Hz sample rate
- 14-bit accelerometer data

For more information, visit freescale.com/metering and freescale.com/Kinetis/Mseries

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