

HIGH-ACCURACY MEASUREMENT USING KINETIS M SERIES MCUS

NXP TECH DAY WARSZAWA

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EXTERNAL USE



SECURE CONNECTIONS
FOR A SMARTER WORLD

Session Objectives

- Familiarize with Kinetis M series MCUs
- Learn how Kinetis M series MCUs can be used for high-accuracy measurement applications including: power meters, data acquisition systems, pressure and temperature sensing
- Get overview about hardware and software tools

Agenda

- Kinetis M Series MCUs for Legal Metrology
- Basics and Parameters of Analogue Subsystem
- Application Examples
 - Power Meters
 - Data Acquisition Systems
 - Pressure Sensing
 - Temperature Sensing
- Hardware and Software Tools
- References

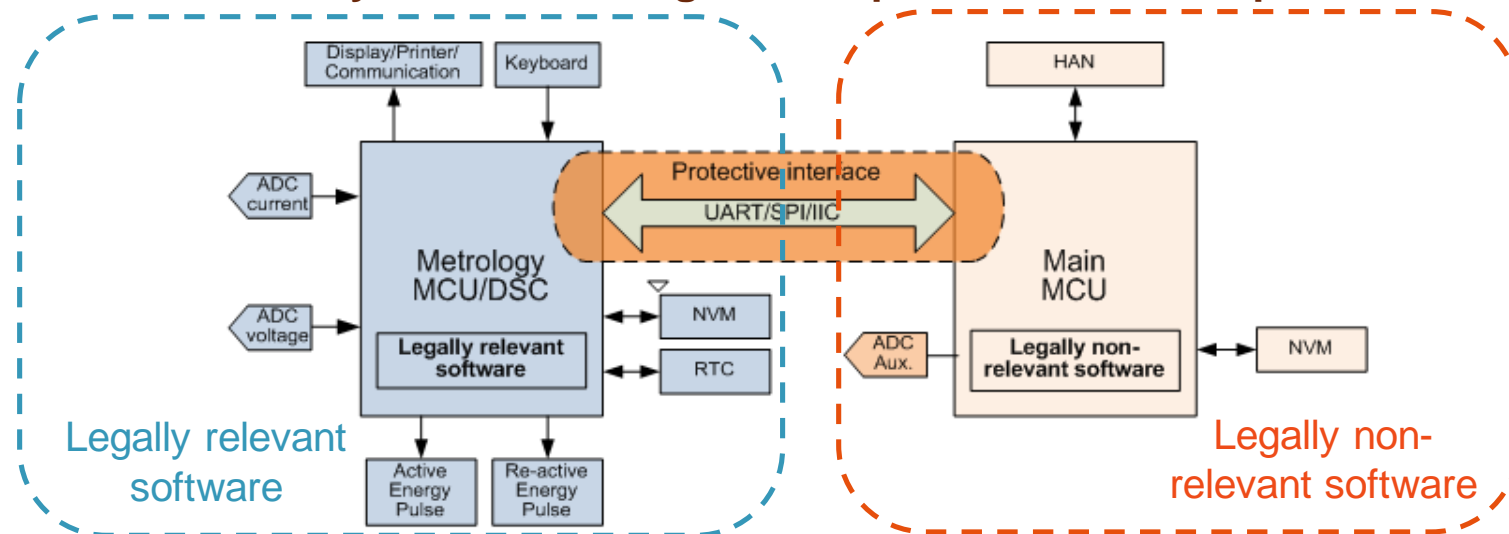
KINETIS M SERIES MCUS FOR LEGAL METROLOGY



Code Separation Technique in Metrology Applications

- **Legally relevant** software shall run in privileged mode exclusively preventing other software functions to influence its execution.
- Memory sections for **legally relevant** software, parameters and variables storage shall be protected against reading, writing and execution (R/W/E) from other software routines.
- On-chip peripherals controlled by the **legally relevant** software shall not be influenced by other software routines.

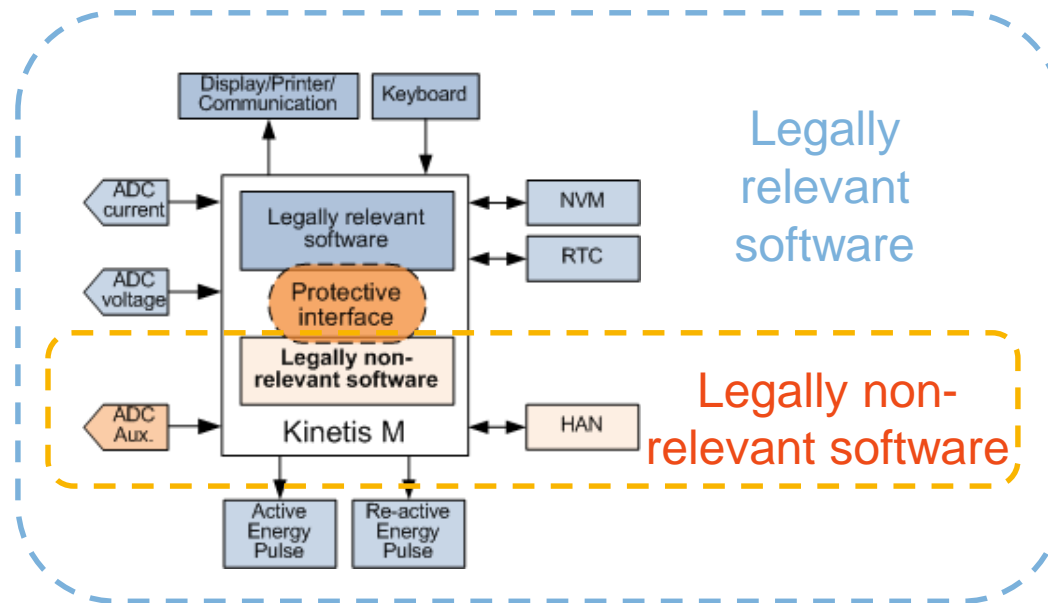
Traditional ways of maintaining code separation → two chip solution:



Literature: OIML D31, "General Requirements for Software Controlled Measuring Instruments", edition 2008: http://www.oiml.org/en/files/pdf_d/d031-e08.pdf
- WELMEC 7.2, "Software Guide (Measuring Instruments Directive 2004/22/EC)": http://www.welmec.org/fileadmin/user_files/publications/7-2_Issue4.pdf

Kinetis M Series MCUs a Single Chip Solution for Metrology Applications

- **Kinetis M platforms** support access permissions for privileged secure, user secure and user non-secure mode
- Read, write and execute accesses to on-chip memories are protected by the **Memory Protection Unit (MPU)**
- Read and write accesses to on-chip peripherals including GPIO are handled by **Peripheral Bridge (AIPS-Lite)**



Legal Metrology Applications

- Active Electrical Energy Meters
- Water Meters
- Gas Meters
- Volume Conversion Devices
- Heat Meters
- Measuring Systems for the Continuous and Dynamic Measurement of Quantities of Liquids Other than Water
- Weighing Instruments
- Taximeters

Core

- **CM0+ core up to 75MHz**
- **HW arithmetic unit** (MMAU - 64-bit multiply, multiply accumulate, divide and square root)
- Separate FLL post-scalers for Flash & Core clocks
- Dedicated PLL for $\Sigma\Delta$ modulator clock
- 4ch DMA
- Memory Protection Unit
- Single 32kHz Crystal operation
 - MHz Crystal optional

Security & Encryption

- Programmable 16/32-bit CRC
- IRTC w/ tamper detection
 - 3 Tamper pins (operating on battery)
- Random Number Generator (NIST: SP800-90)
- **HW encryption** (MMCAU – DES, 3DES, AES, MD5, SHA-1/SHA-256)
- Memories
 - Up to **256 KB Program Flash**
 - **32 KB SRAM**

Analog

- **4x24 bit $\Sigma\Delta$ after averaging (4xPGA)** highly accurate supporting EN 50470-1, EN 50470-3, IEC 62053-21, IEC 62053-22 and IEC 62053-23, optimized for shunt sensor ($\geq 50\mu\text{Ohm}$).
- 0.1% error in active and reactive energy over a dynamic range of 2000 to 1
- Internal 1.2V reference voltage (10 ppm/°C)
- 16-ch 16-bit SAR for auxiliary measurement
- **3x analog comparator**

Serial Communications

- 2x SPI
- **5x UART**
 - All combined with Quad Timer & HSCMP for IR
 - 2 support ISO7816
- 2x I2C

Peripheral XBAR

- **Up to 52x44 signal interconnections**
- Remapping peripheral IOs
- UART selection for IR
- 16-bit SAR ADC triggering

Timer/PWM/Clock

- Quad Timer (total 4 universal timers)
- 2x PIT
- 1x Watchdog Timer (windowed, independently clocked)
- 1x EWM (External Watchdog Monitor)
- 1x LPTimer
- **1x PDB**

LCD Display

- **Up to 448 segments LCD with 8 backplanes.**
- **Up to 336 segments LCD with 6 backplanes.**
- **Up to 240 segments LCD with 4 backplanes.**

Wakeup Unit

- **Up to 30 wakeup sources**; 24 GPIOs, LPTMR, RTC (+tamper pins) and HSCMP.

GPIO

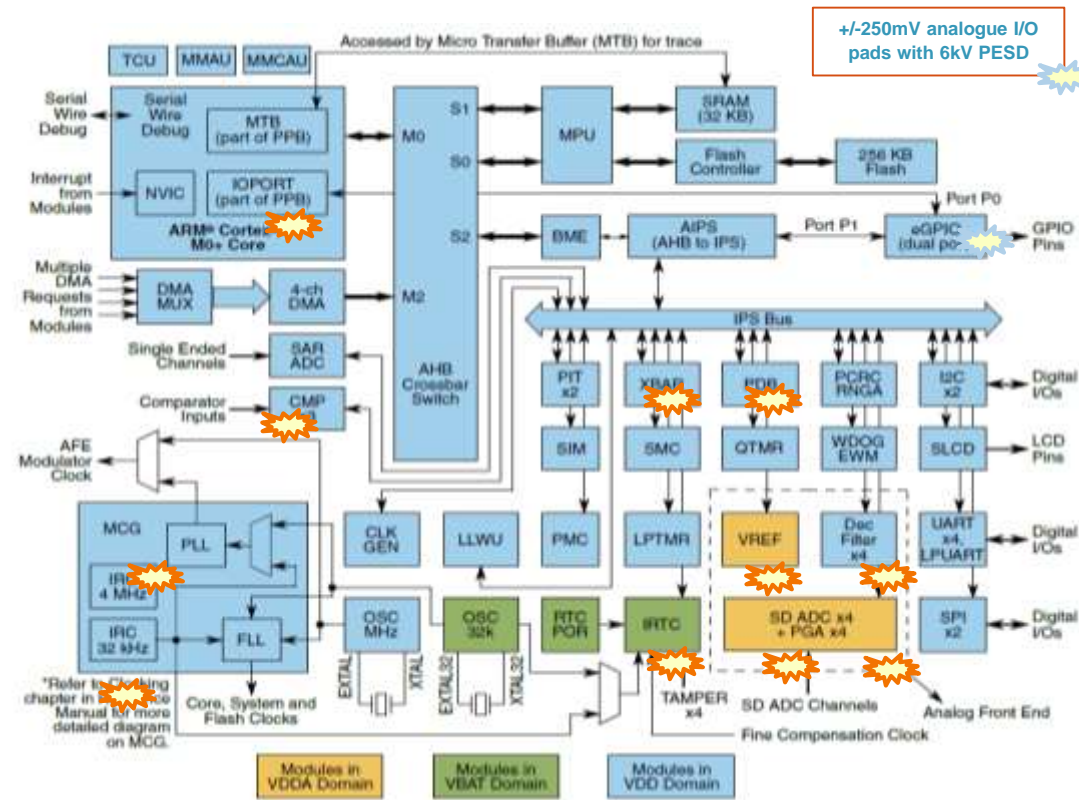
- **Up to 99** with push pull, open-drain select
- Support for interruption on any edge
- Single cycle access for all GPIOs (Rapid GPIO)

Power Modes & Clock

- Many low power modes supported
- 2.7V to 3.6V Operating voltage with AFE
- 1.71V to 3.6V Operating voltage without AFE
- 1.71V-3.6V IRTC VBAT supply
- 32kHz or 4 MHz internal clock source
- 32.768kHz crystal oscillator

Package

- 144LQFP and 100 LQFP
- -40°C ~ +85°C Temp



IPs with functionality specific to metering



Kinetis M Series MCUs, 256KB Series Package Options & Device Features



144 LQFP
20 x 20 mm²
 MKM34Z256VLQ7



100 LQFP
14 x 14 mm²
 MKM34Z256VLL7

Configuration/Module	Packages	
	144 LQFP (20 x 20 mm ²)	100 LQFP (14 x 14 mm ²)
Core, Platform and Debug		
Maximum CPU frequency (MHz)	75 MHz	
MMAU	yes	
MMCAU	yes	
DMA	4 ch	
MPU	yes	
Peripheral XBAR (VO supported)	11	9
Single Wire Debug (SWD)	yes	
System Security and Integrity		
Cyclic redundancy check (CRC)	yes	
RNGA (Random Number Generator)	yes	
Watchdog timer	yes	
External Watchdog Monitor	yes	
Passive Tamper Pins	3 (one pair)	1 (NA)
Embedded Memory		
Flash memory (KB)	256	
RAM (KB)	32	
Clock Generator		
MCG	FLL, Internal OSC (32 kHz or	
Real Time Clock (32 kHz OSC)	yes	
Timer/PWM		
QuadTimer	4 ch	
Low power timer (LPTMR)	1	
Periodic Interrupt Timer (PIT)	2	
Programmable Delay Block (PDB)	4 ch	
Communication Interfaces		
UART (LPUART)	4 (1)	
SPI 16-bit	2	
I2C	2	2
Analog		
24-bit Analog Front End (PGA)	4	
16-bit SAR ADC	16 ch	12 ch
1.2V VREF	yes	
CMP (Number of Channels)	3 (18)	
Human Machine Interface		
Segmented LCD	4x60 (8x56)	4x40 (8x36)
Total GPIO pins	99	72

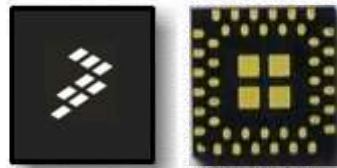
Kinetis M Series MCUs, 128KB Series Package Options & Device Features



64 LQFP
10 x 10 mm²
 MKM33Z64ACLH5
 MKM33Z128ACLH5
 MKM33Z64ACLL5
 MKM33Z128ACLL5



100 LQFP
14 x 14 mm²
 MKM33Z128ACLL5
 MKM34Z128ACLL5



44 LGA
5 x 5 mm²
 MKM14Z64ACHH5
 MKM14Z128ACHH5

Configuration/Module	Packages		
	100 LQFP (14 x 14 mm ²)	64 LQFP (10 x 10 mm ²)	44 LGA (5 x 5 mm ²)
Core, Platform and Debug			
DMA	4 ch		
MPU	yes		
Peripheral XBAR (I/O supported)	yes		
Single Wire Debug (SWD)	yes		
System Security and Integrity			
Cyclic redundancy check (CRC)	yes		
RNGA (Random Number Generator)	yes		
Watchdog timer	yes		
External Watchdog Monitor	yes		
Passive (Active) Tamper Pins	3 (one pair)	1 (NA)	1 (NA)
Embedded Memory			
Flash memory (KB)	128/64		
RAM (KB)	16		
Clock Generator			
MCG	FLL, Internal OSC (32 kHz or 4/2 MHz), PLL		
Real Time Clock (32 kHz OSC)	yes		
Timer/PWM			
QuadTimer	4 ch		
Low power timer (LPTMR)	1		
Periodic Interrupt Timer(PIT)	2		
Communication Interfaces			
UART	4	4	2
SPI	2		
I2C	2	2	1
Analog			
24-bit Analog Front End (PGA)	4 (2)	3 (2)	4 (2)
16-bit SAR ADC	12 ch	6 ch	5 ch
1.2V VREF	yes		
CMP (Number of Channels)	2 (12)	2 (8)	2 (6)
Human Machine Interface			
Segmented LCD	4x40 (8x36)	4x24 (8x20)	NA
Total GPIO pins	68	38	20



Kinetis M Series MCUs Comparison

Configuration/Module	MKMxxZxxACxx5	MKM34Z256VLxx7
Maximum CPU frequency (MHz)	50 MHz	75 MHz
Flash memory (KB)	64-128	256
RAM (KB)	16	32
Memory Mapped Arithmetic Unit (MMAU)	No	Yes
Memory Mapped Cryptographic Unit (MMCAU)	No	Yes
Programmable Delay Blocks (PDB)	No	Yes
UART (LPUART)	4	4 (1)
24-bit Analog Front End (PGA)	4 ch (2)	4 ch (4)
Peripheral XBAR (I/O supported)	33x33	51x44
Comparators	2	3
Segmented LCD	288 (8x36)	448 (8x56)
Total GPIO pins	Up to 68	Up to 99
Packages	144 LQFP 64 LQFP 44 LGA	144 LQFP 100 LQFP



100 LQFP
14 x 14 mm²
 MKM33Z128ACLL5
 MKM34Z128ACLL5

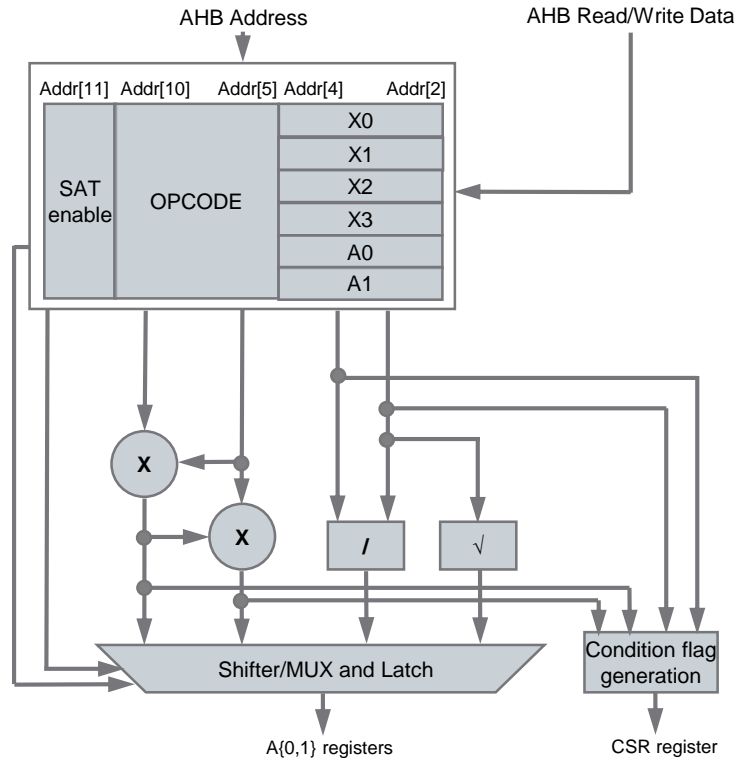


Pin-to-pin compatible



100 LQFP
14 x 14 mm²
 MKM34Z256VLL7

Memory Mapped Arithmetic Unit



VLPR	VLPW	STOP	VLPS	VLLSx
Optionally active				OFF

• Features

- Supports 32x32, 64x32 **multiply** on signed, unsigned integer and Q0.31 or Q0.63 fractional number
- Supports 32x32, 64x32 **multiply with accumulation** on signed, unsigned integer and Q0.31 or Q0.63 fractional number
- Supports 32/32, 64/32, 64/64 **divide** computation on signed, unsigned integer and Q0.31 or Q0.63 fractional number
- Supports 32-bit and 64-bit **square root** calculation on unsigned integer and Q0.31 or Q0.63 fractional number
- Optional to saturate the result if overflow occurs
- 32x32, 64x32, 64+64x32 operations in single cycle
- Pipelined divide and square root design processes 2 bits per cycle with early termination for minimum execution time
- Programming model implements “decorated storage” on read/writes for simple software interface
- DMA support to provide fast calculation launching and result fetching

Memory Mapped Arithmetic Unit – Operations

Return type [register]	Saturation	Unsigned UMUL	Unsigned UMAC	Unsigned UDIV	Unsigned USQR	Unsigned Read/Load	Signed SMUL	Signed SMAC	Signed SMSU	Signed SDIV	Signed Read/Load	Fractional MUL	Fractional MAC	Fractional MSU	Fractional DIV	Fractional SQR	Fractional Read/Load	
uint16 [A0]	No				s_usqr_l													
uint32 [A0]	No			l_udiv_ll	l_usqr_d l_usqra	l_urda												
uint64 [A10]	No	d_umul_ll d_umul_dl d_umula_l	d_umac_ll d_umac_dl d_umaca_dl	d_udiv_dl d_udiva_l	d_udiv_dd d_udiva_d	d_urda												
	Yes	d_umuls_dl d_umulas_l	d_umacs_ll d_umacs_dl d_umacas_dl															
int32 [A0]	No									l_sdiv_ll	l_srda							
	Yes									l_sdivs_ll								
int64 [A10]	No						d_smul_ll d_smul_dl d_smula_l	d_smac_ll d_smac_dl d_smaca_l	d_smsu_ll d_smsu_dl d_smsua_l	d_sdiv_dl d_sdiva_l d_sdiva_d	d_srd							
	Yes						d_smuls_dl d_smulas_l	d_smacs_ll d_smacs_dl d_smacas_dl	d_smsus_ll d_smsus_dl d_smsusa_dl	d_sdivs_dl d_sdivas_l d_sdivas_d								
frac16 [A1]	No																s_sqr_l	
frac32 [A1]	No											l_mul_ll l_mul_dl l_mula_l	l_mac_ll l_mac_dl l_maca_l	l_msu_ll l_msu_dl l_msua_l	l_div_ll l_diva_l l_diva_d	l_sqr_ll l_sqr_dl l_sqra_l	l_rda	
	Yes											l_muls_ll l_muls_dl l_mulas_l	l_macs_ll l_macs_dl l_macas_dl	l_msus_ll l_msus_dl l_msuas_l	l_divs_ll l_divas_l l_divas_d			
frac64 [A10]	No											d_mul_ll d_mul_dl d_mula_l	d_mac_ll d_mac_dl d_maca_l	d_msu_ll d_msu_dl d_msua_l	d_div_dl d_diva_l d_diva_d			d_rda
	Yes											d_muls_ll d_muls_dl d_mulas_l	d_macs_ll d_macs_dl d_macas_dl	d_msus_ll d_msus_dl d_msuas_l	d_divs_dl d_divas_l d_divas_d			
void* [A10]	No	umul_ll umul_dl umula_l	umac_ll umac_dl umaca_l	udiv_ll udiv_dl udiva_l udiv_dd udiva_d	usqr_l usqr_d	ulda_d	smul_ll smul_dl smula_l	smac_ll smac_dl smaca_l	smsu_ll smsu_dl smsua_l	sdiv_ll sdiv_dl sdiva_l sdiv_dd sdiva_d	slda_d	mul_ll mul_dl mula_l	mac_ll mac_dl maca_l	msu_ll msu_dl msua_l	div_ll div_dl diva_l	sqr_ll sqr_dl sqra_l	lda_d lda_l	
	Yes	umuls_dl umulas_l	umacs_ll umacs_dl umacas_dl				smuls_dl smulas_l	smacs_ll smacs_dl smacas_dl	smsus_ll smsus_dl smsuas_l	sdivs_ll sdivs_dl sdivas_l sdivs_dd sdivas_d		muls_ll muls_dl mulas_l	macs_ll macs_dl macas_dl	msus_ll msus_dl msuas_l	divs_ll divs_dl divas_l			

```

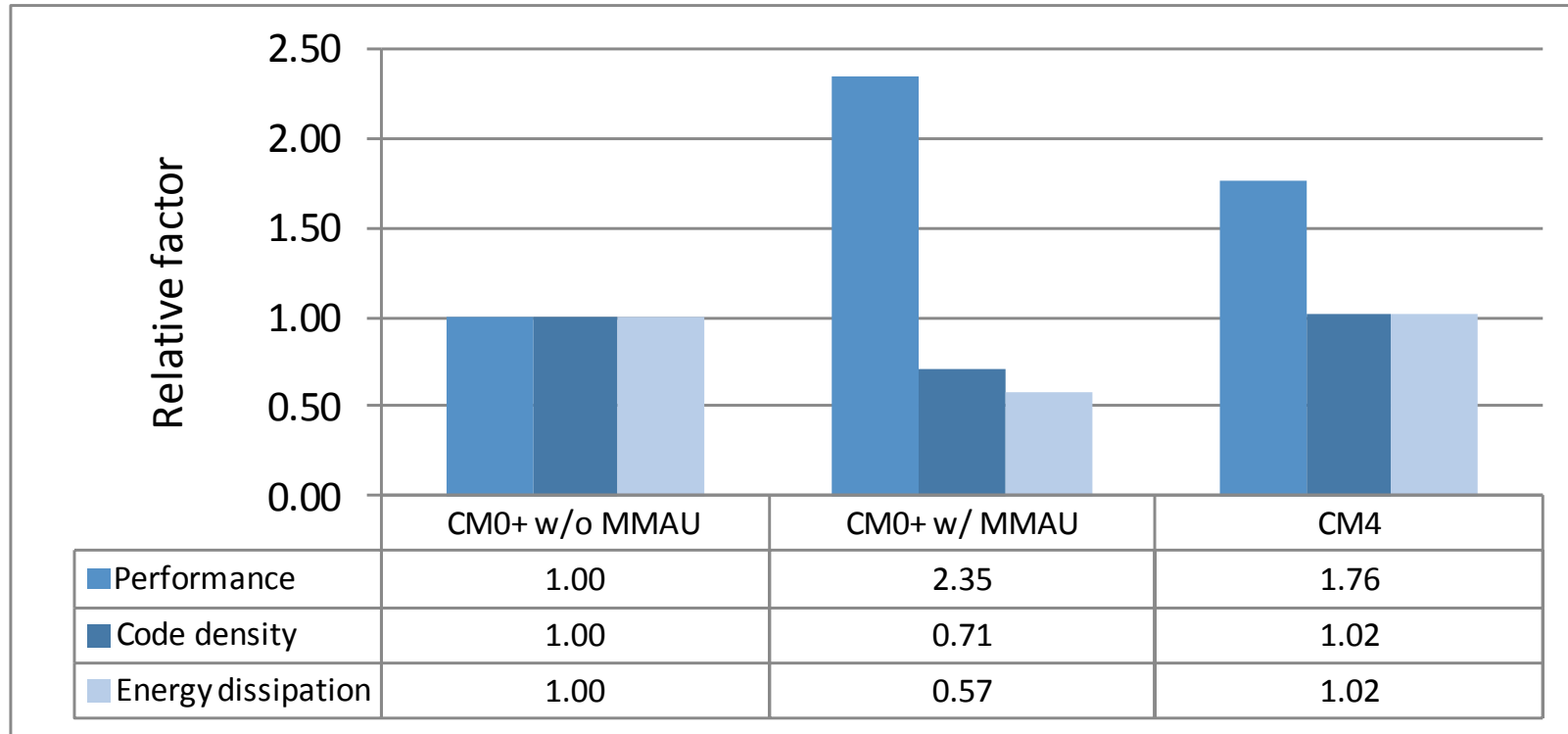
GNU Inline Assembler
/*****
 * @brief Divide two 64-bit integer values returning a 64-bit integer
 *        quotient.
 * @details The @ref d_sdiv_dd function divides two 64-bit integer values
 *          returning a 64-bit integer quotient.
 * @param dnum @ref int64 integer value.
 * @param dden @ref int64 integer value.
 * @return @ref int64 integer value.
 * @note Quotient is stored in A10 register of the MMAU for next computation
 *****/
#define d_sdiv_dd(dnum, dden)
({
  register uint32 addr = (MMAU_SDIVDD|MMAU_X0);
  register int64 out = (dnum);
  register int64 inp = (dden);
  asm volatile
  (
    "stm %0!,{%Q1,%R1}\n"
    "stm %0!,{%Q2,%R2}\n"
    "ldm %0!,{%Q1,%R1} :":="1"(addr),"=1"(out):"1"(inp),"0"(addr),"1"(out)
  );
  (int64)out;
})

```

Function pre- and post fixes: s-16bit, l-32-bit and d-64-bit input and output operands.



Memory Mapped Arithmetic Unit - Performance

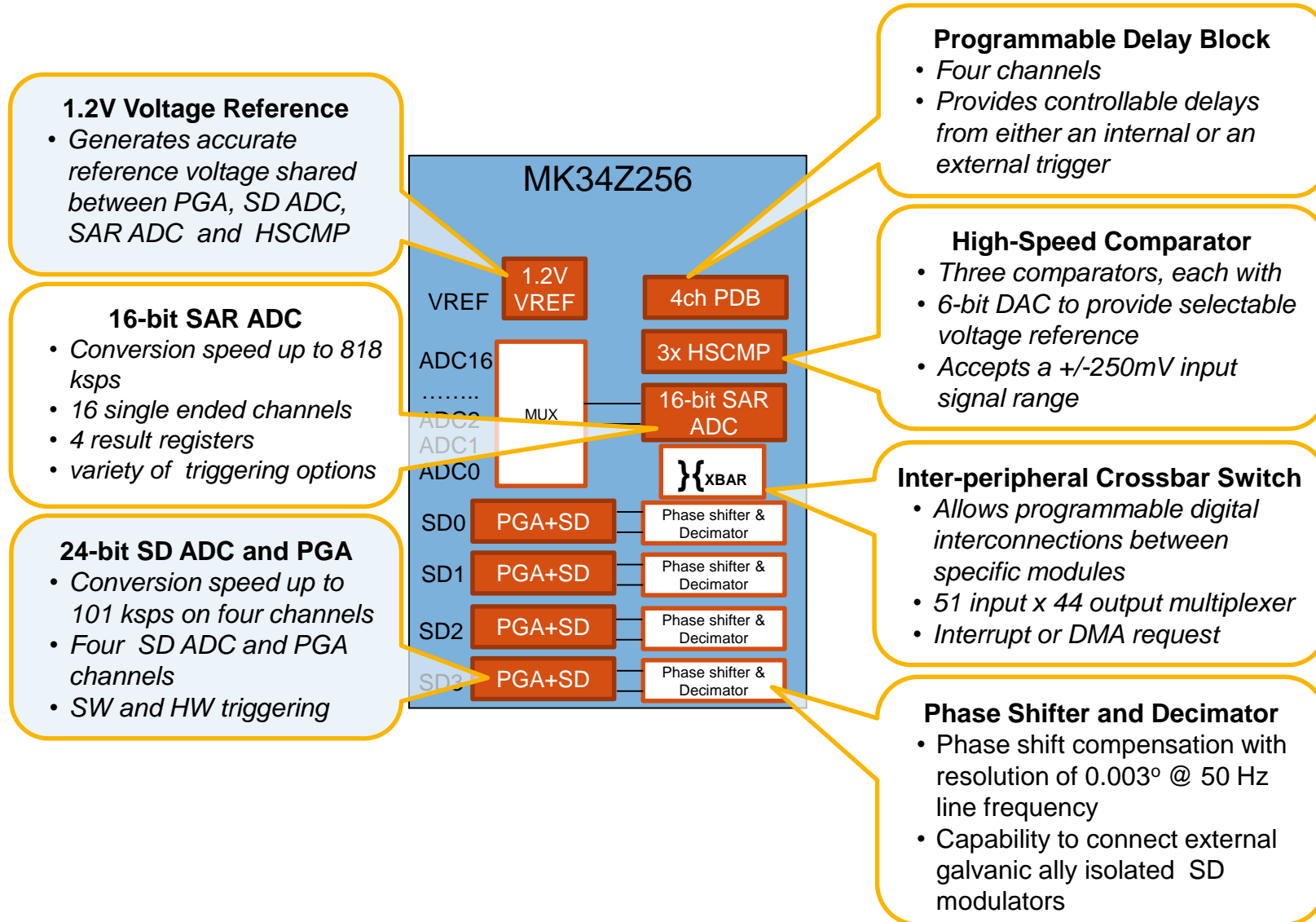


Measured on execution 32-bit filter-based metering algorithms [AN4265](#)

BASICS AND PARAMETERS OF ANALOGUE SUBSYSTEM



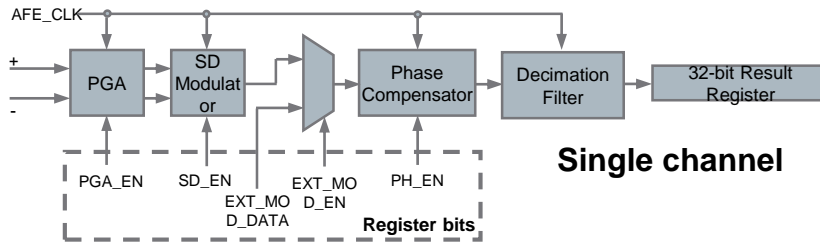
Analogue Subsystem



Analogue Subsystem (SD ADC and PGA)

- **Blocks**

- **Four channels with 24-bit SD ADC & PGAs**
- Phase Shifter & Decimator
- CPU/DMA Interface



- **Electrical parameters**

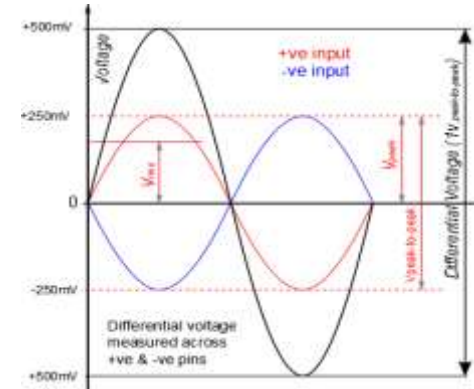
- Full operating voltage range: 2.7V to 3.6V
- **±250 mV** (1 V_{P-P} differential, 0.5 V_{P-P} single ended) input range for both single ended and differential inputs
- Common mode voltage range of 0 to 0.8V
- SD modulator Signal-to-Noise Ratio:
 - Normal mode: 92dB @ (Fs=6.144MHz, OSR=2048)
 - Low power mode: 82dB @ (Fs=0.768MHz, OSR=256)

Operation Mode	PGA	Signal range (mV peak-peak)	SNR (dB @ OSR=2048)	Current (mA)
Normal	ON	31 (gainx32)	64 (74)	4.0
Low Power	ON	31 (gainx32)	52 (62)	3.1
Normal	OFF	1000	92	1.4
Low Power	OFF	1000	82	0.5

- **Features**

- Supports single and continuous conversions
- Support both software and hardware triggering
- Output sampling rates: 3 kHz, 6 kHz, 12 kHz, 24 kHz, 48 kHz, and 96 kHz
- Gain programmable from 1x to 32x
- **Dynamic phase shift compensation**
- Synchronized start operation
- Option to generate interrupt or DMA request on conversion complete

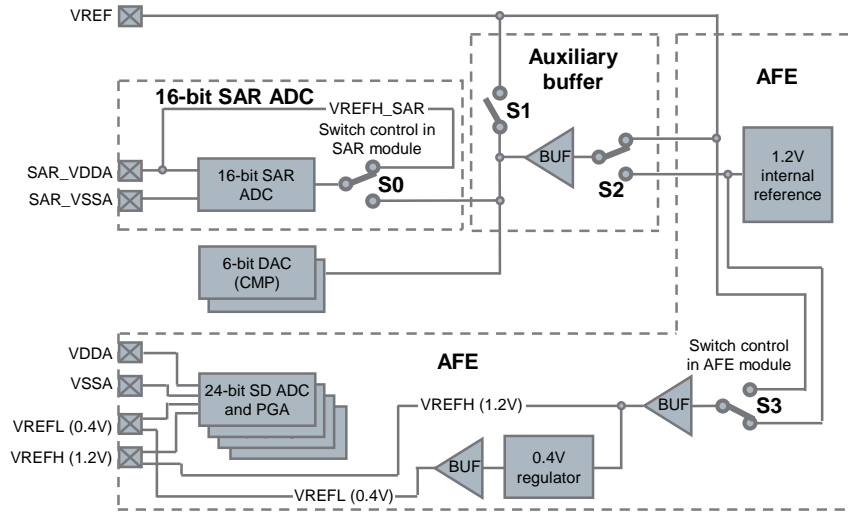
- **SD ADC measurement range**



VLPR	VLPW	STOP	VLPS	VLLSx
FF			FF (PLL disabled)	OFF



Analogue Subsystem (Voltage Reference)



Switch **S1** is meant for outputting 1.2V VREF on the device pin.
When using externally supplied VREF, this switch should be open.

• Features

- Option to use internal or external voltage reference source
- Generates accurate reference voltage shared between 24-bit SD ADCs, PGAs, 16-bit SAR ADC, and CMPs
- Generates 1.195V and 0.4V voltages
- Low VREF gain drift over temperature of 6 ppm/C° (ICOMP=1)
- Programmable trim register with 0.5 mV steps
- Programmable mode of operation
 - Off
 - Bandgap enabled/standby (output buffer disabled)
 - Low power buffer mode (output buffer enabled)
 - High power buffer mode (output buffer enabled)

• Reference control switches

Switch Position				16-bit SAR ADC Reference	6-bit DAC (CMP) Reference	24-bit SD ADC and PGA Reference	VREF Pin Output
S0	S1	S2	S3				
UP	ON	DOWN	DOWN	3.3V SAR_VDDA	1.2V VREF Internal	1.2V VREF Internal	1.2V VREF Internal
UP	OFF	DOWN	DOWN	3.3V SAR_VDDA	1.2V VREF Internal	1.2V VREF Internal	-
DOWN	ON	DOWN	DOWN	1.2V VREF Internal	1.2V VREF Internal	1.2V VREF Internal	1.2V VREF Internal
DOWN	OFF	DOWN	DOWN	1.2V VREF Internal	1.2V VREF Internal	1.2V VREF Internal	-
UP	OFF	DOWN	UP	3.3V SAR_VDDA	1.2V VREF Internal	1.2V VREF External	-
UP	OFF	UP	DOWN	3.3V SAR_VDDA	1.2V VREF External	1.2V VREF Internal	-
DOWN	OFF	UP	UP	1.2V VREF External	1.2V VREF External	1.2V VREF External	-

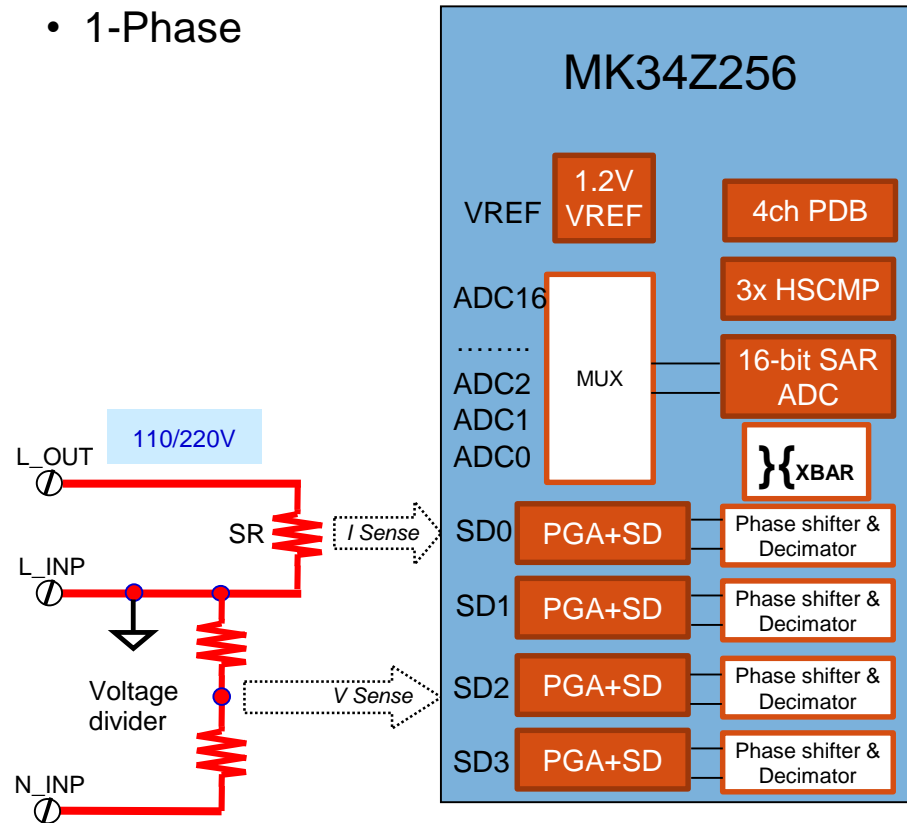
VLPR	VLPW	STOP	VLPS	VLLSx
FF (low power buffer mode)				OFF

POWER METERS

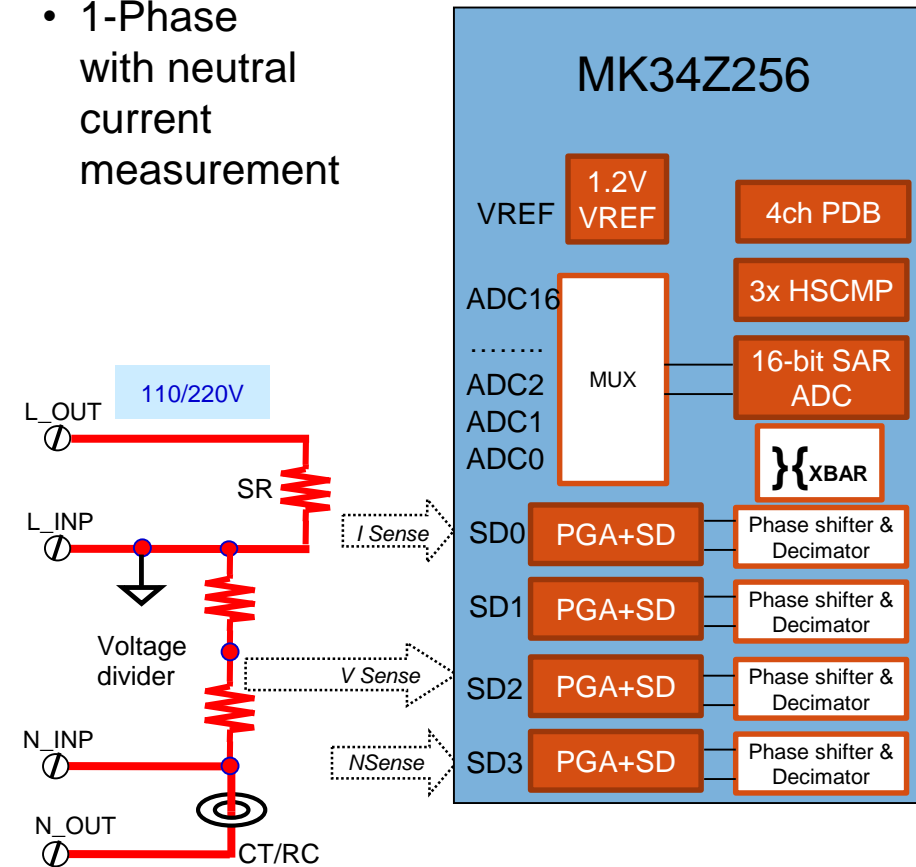


Power Meters

- 1-Phase



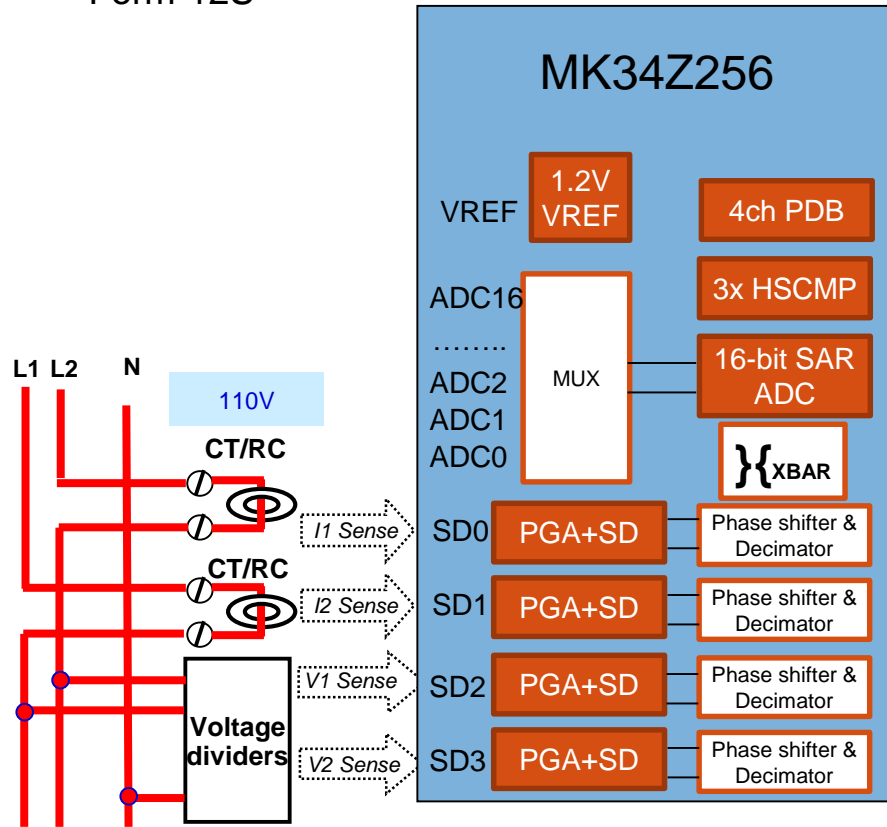
- 1-Phase with neutral current measurement



- All measurements performed by SD ADC
- Shunt resistor measurements amplified by Programmable Gain Amplifier (PGA)
- Phase shift between phase voltage and phase current measurements compensated by Phase Shifter block

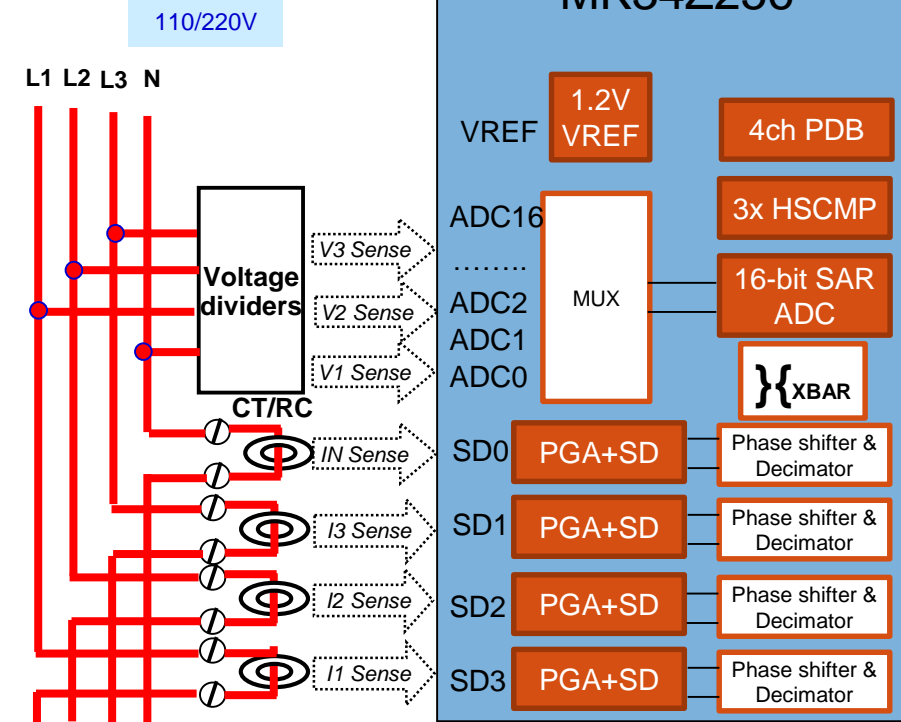
Power Meters - Cont'd

- Form-12S



- All measurements performed by SD ADC
- Rogowski coil measurement optionally amplified by Programmable Gain Amplifier (PGA)
- Phase shift between phase voltage and phase current measurements compensated by Phase Shifter block.

- 3-Phase with neutral current measurement



- Phase and neutral current measurement performed by SD ADC
- Phase voltage measurement performed by 16-bit SAR ADC
- Phase shift between phase voltage and phase current measurements compensated either numerically a FIR filter or by hardware using PDB channels.

1-Phase Power Meter Reference Design with Shunt Resistor

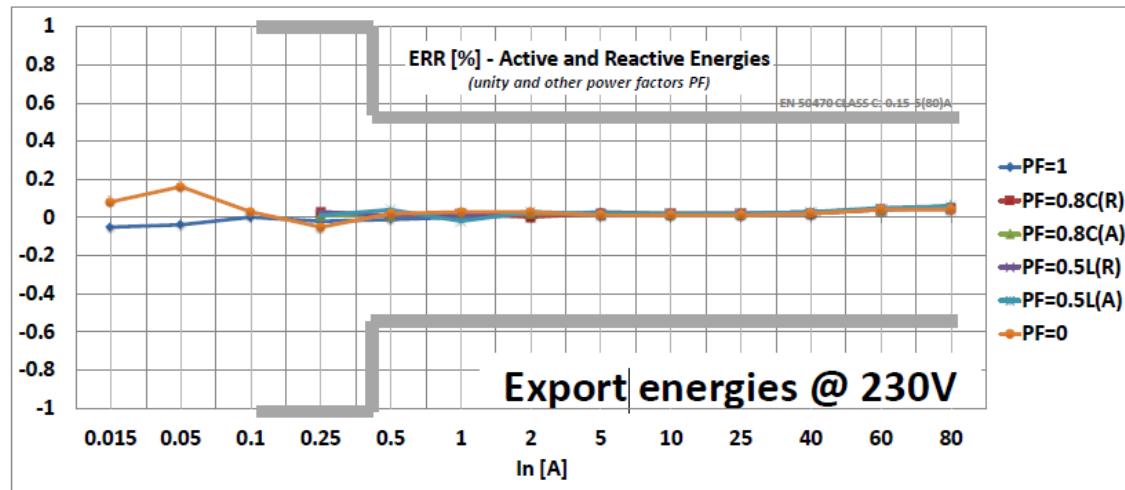
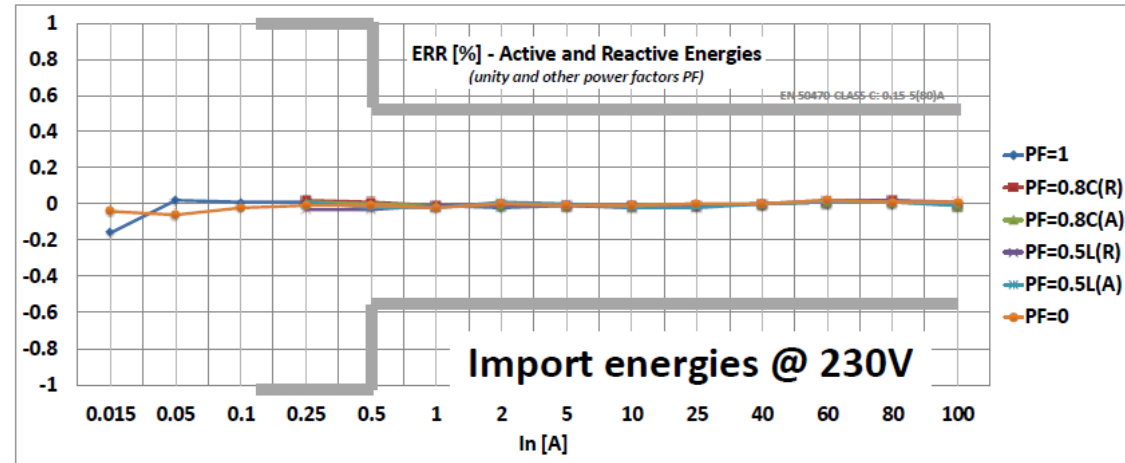


Features

- Complies with active energy EN50470 Class C: 0.15-5(120)A
- **Current range 5 to 120A**
- Voltage range 85 to 264V, 50/60 Hz
- MCU clocked by 12.288MHz
- Uses 140 $\mu\Omega$ shunt resistor

Software Provided

- Application framework, Filter-based metering algorithms



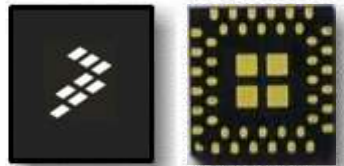
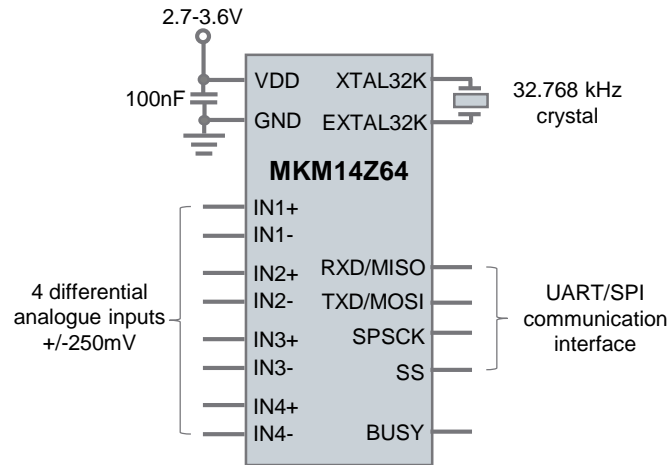
Refer to: Kinetis-M One-Phase Power Meter Reference Design (document [DRM143](#))

DATA ACQUISITION SYSTEMS



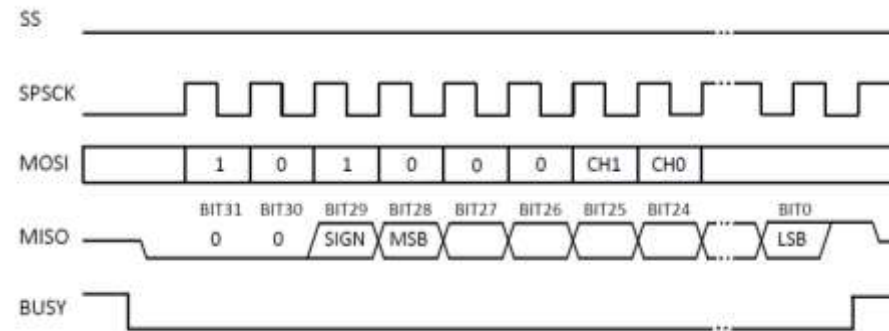
High-Performance Data Acquisition Systems

- Measurement ASIC emulation



44 LGA
5 x 5 mm²
 MKM14Z64ACHH5
 MKM14Z128ACHH5

- The Kinetis-M microcontroller series can be programmed to acquire analogue signals at sampling rates from 24 sps up to 96 ksps, communicate measured values through a variety of communication buses; and hence to emulate functionalities of many popular 24-bit SD ADCs
- For example, firmware that emulates high-performance LTC2440/5 measurement devices has been developed (requires 3 KB Flash and 388 Bytes of RAM).
- Firmware communication protocol:



The channel input whose result will be read on the next communication transfer is selected based on decoding bits 25 (CH1) and 24 (CH0)

Parameter	Value	Unit
Output data rate	2.8	ksps
SNR	92	dB
SINAD	78	dB

Refer to: The High-Performance Data Acquisition Circuit (document [AN5101](#))

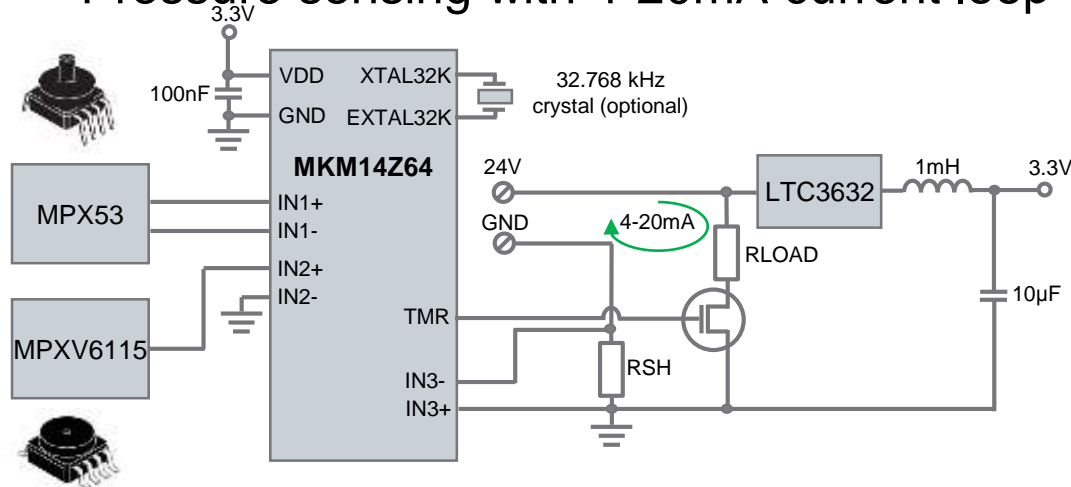


PRESSURE SENSING



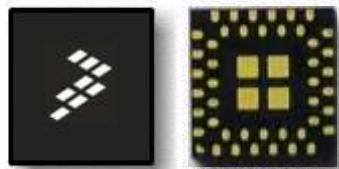
Pressure Sensing

- Pressure sensing with 4-20mA current loop



Signal conditioning circuitry and 3.3V LDO not shown

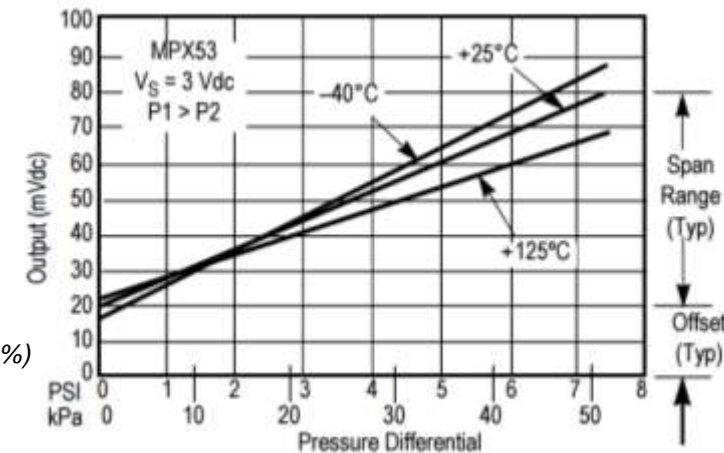
- The MKM14 device can be used in **pressure sensing applications**.
- For example, a small board including firmware for interfacing Freescale's pressure sensor with differential output (MPX53) and single ended output (MPXV6115) has been developed (uses 4 KB Flash and 28 Bytes of RAM).
- The MKM14 device enables implementing compensation technique, which is required for low-cost uncompensated pressure sensor devices (like MPX53 series) - see below:



44 LGA
5 x 5 mm²
 MKM14Z64ACHH5
 MKM14Z128ACHH5

Power consumption	Value	Unit
MKM14Z64	8.5mA @ 21 MHz core clock	mA
MPX53	6	mA
TOTAL	14.5	mA

Electronics power budget = 56.29 mW (LTC3632 efficiency 85%)
 Power budget restriction = 96.00 mW (4mA * 24 V)



Refer to: MKM14 Pressure Sensor with 4-20mA Current Loop (document [AN4853](#))

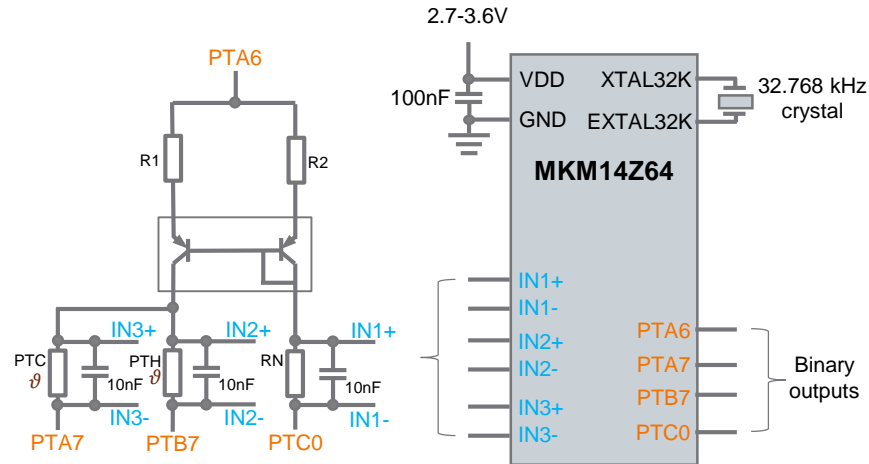


TEMPERATURE SENSING

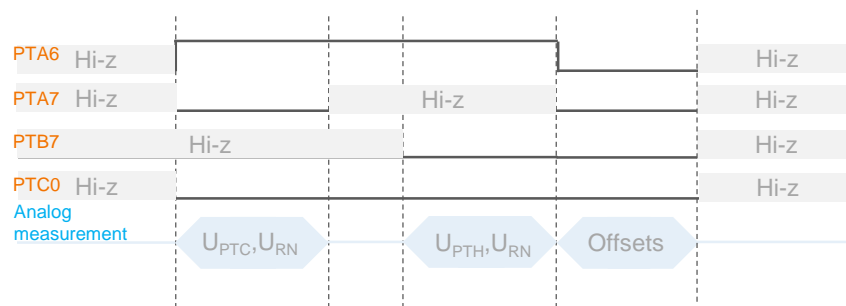


Temperature Sensing

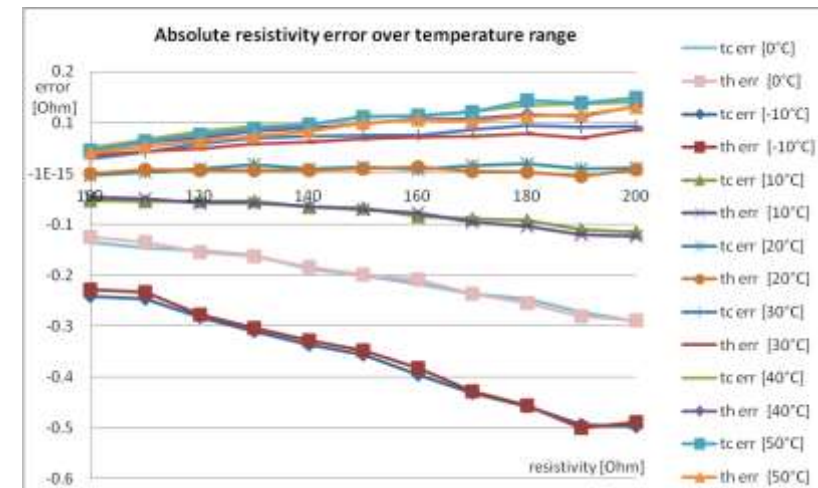
- Hot & Cold Water Temperature Measurement



Measurement diagram



- The Kinetis-M microcontroller series can be used for **precise temperature difference measurement between two PT100 sensors**.
- The heating meter design requires very precise temperature sensing in the range of 0°C to 200°C of absolute temperature where a temperature difference error for low temperature difference (~3°C) may be measured with an error below 1.5%.



Resistors with known value (R_{real}) were used instead of the PT100 sensors. Resistivity ($R_{measured}$) was then calculated from the measured voltages and the resistivity error (Y-axis) was calculated as $R_{measured} - R_{real}$.

Refer to: Kinetis KM3x MCU PT100 Sensing (document [AN4904](#))

HARDWARE AND SOFTWARE TOOLS







TWR-KM34Z75M Tower System Module



- Tower-compatible microcontroller module
- MKM34Z256VLQ7 MCU (75 MHz, 256 KB Flash, 32 KB RAM, low power, LQFP144 package)
- USB interface with Mini-B USB connector
- Large 160-seg. glass LCD
- On-board debug circuit: open source JTAG/SWD (OpenSDA) with virtual serial port
- Three-axis accelerometer/anti tamper tilt sensor (MMA8451Q)
- Four user-controllable LEDs
- Two user pushbutton switches for GPIO interrupts
- One user pushbutton switch for tamper detection
- One user pushbutton switch for MCU reset
- Potentiometer
- Headers for direct GPIO and ADC access
- External Tamper pins
- Independent, battery-operated power supply for Real Time Clock (RTC) and tamper detection modules
- IRDA support
- NTC temperature sensor
- General-purpose Tower Plug-in (TWRPI) socket

Kinetis KM34Z256 MCUs: Broad Software Support

	Keil (MDK) 	IAR (EWARM) 	Atollic (TrueSTUDIO) 	CrossWorks for ARM 
Kinetis MCU Basic Device Support	Yes v5.14	Yes V7.40.2	Yes V3.3	Yes V3.4.0
MKM34Z256 Bare Metal Driver Support	Yes	Yes	Yes	in preparation
MQX Task Awareness	Yes	Yes	No	No
MTB Trace	Yes – with CMSIS-DAP and ULINK2	Yes – with J-jet and CMSIS-DAP	Yes	Yes
Free Version Limitations	Lite 32KB	KickStart 16KB	Lite 8KB	No
Download Size	~355MB	~916MB	~652MB	~164MB

References

- Kinetis M Series MCUs, available on [freescale.com](https://www.freescale.com)
- Kinetis M Support for Distinct Separation of Legally Relevant Software (document [KINETISMWP](#))
- Filter-Based Algorithm for Metering Applications (document [AN4265](#))
- FFT-Based Algorithm for Metering Applications (document [AN4255](#))
- Using an FFT on the Sigma-Delta ADCs (document [AN4847](#))
- Kinetis-M One-Phase Power Meter Reference Design (document [DRM143](#))
- Kinetis M series MCUs One-Phase Power Meter Reference Design Introduction, available on [youtube.com](https://www.youtube.com).
- FreeMASTER Data Visualization and Calibration Software, available on [freescale.com](https://www.freescale.com).
- Kinetis M Bare-metal Software Drivers (document [KMSWDRVAPI](#))
- TWR-KM34Z50 Tower Module (document [TWRKM34Z50M](#))
- The High-Performance Data Acquisition Circuit (document [AN5101](#))
- Kinetis KM3x MCU PT100 Sensing (document [AN4904](#))
- MKM14 Pressure Sensor with Current Loop (4-20ma) Output (document [AN4853](#))





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