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Rev. 1.0, 11/2015

Intelligent Sensing Framework Version 2.1 for Kinetis Release Notes

Contents

1 Introduction

This document describes the Freescale Intelligent Sensing Framework version 2.1 (ISF v2.1) middleware, released for Kinetis E Series platforms. ISF v2.1 consists of Processor Expert components that take advantage of Processor Expert's capability to configure the Kinetis E series processors supported by logical device drivers in Processor Expert.

2 Requirements

ISF v2.1 middleware for Kinetis has several requirements for tools, development systems and deployment targets.

2.1 Development tools

The ISF v2.1 release was compiled and tested with the following development tools with built-in support for Kinetis using Freescale's Processor Expert technology:

Kinetis Development Studio (KDS) Version 3.0

2.2 System requirements

The ISF implementation for the Kinetis platforms accommodates a wide variety of host system configurations.

Table 1. System requirements for ISF v2.1

Parameter	Minimum PC configuration	Recommended PC configuration
Operating system	Windows 7	
Communications to target hardware	USB port	
Processor speed (GHz)	1.8	2.6
RAM (GB)	2	4
Free disk space (GB)	20	400

2.3 Generic support of Kinetis and sensors

The ISF v2.1 executes on a Kinetis E Series MCU and supports sensor types with analog output.

2.3.1 Tested implementations

The ISF v2.1 release supports the Freescale Freedom Development platforms for Kinetis E Series MCUs, in particular, the FRDM-KE06. There are existing and future sensor shield boards that can be used in conjunction with the Freescale Freedom boards including:

- FRDMKE06DP5004, a Freescale Freedom demonstration kit containing the Freescale differential pressure sensor (MPXV5004DP) development board (FRDMSTBCDP5004) kitted with a modified FRDM-KE06Z to accommodate the 5 V capability of the sensor.
- FRDMSTBCxxxx, future development boards containing various Freescale sensors supporting a variety of applications.
- The Freescale Sensor MPXV5004DP is supported in this release.

3 Release content

Table 2 provides a summary of the contents of the ISF v2.1 installer. These items are also included on the ISF website located at freescale.com/ISF-2.1-KINETIS

Table 2. ISF downloads

Run time software	Status
Middleware-Framework	
ISF2P1_Installer Installer for ISF v2.1 documentation, tools, and project files. There is an uninstall feature included with the installer, located in the Start menu with the other ISF 2.1 artifacts.	Updated
ISF2P1_PEx.PEupd	Updated
Application Specific-Apps, also known as, Example Applications	
ISF2P1_KE06_MQX_ ANALOG5V PROJ Basic KDS Project using ISF v2.1 with a KE06Z MCU. Register level interface capability is included.	New

The ISF Processor Expert component is contained within the ISF2P1_PEx.PEupd file loaded from the ISF website into Processor Expert via KDS. The component library contains the components listed in Table 3:

Table 3. ISF component status

Implicit Processor Expert components contained within ISF_Core component	***Status***
ISF_CommChannel_UART	*Updated*
ISF_CommChannelConfig	*Updated*
ISF_Core	*Updated*
ISF_Protocol_Adapter	*Updated*
ISF_Sensor_Generic_Analog	*New*
ISFBusManager	*Updated*
Explicit Processor Expert Component	***Status***
ISFEmbApp	*Updated*

In addition, the ISF v2.1 installer includes the following documentation, which is also available individually from the Documentation tab of the freescale.com/ISF-2.1-KINETIS website.

Table 4. ISF documentation status for ISF v2.1

Documentation	Status
ISF2P0_KINETIS_SW_REFERENCE_RM Software Reference Manual for the Intelligent Sensing Framework v2.0	Minimal updates
ISF2P1_KINETIS_API_REFERENCE_RM API Reference Manual for the Intelligent Sensing Framework (Unzip and open ISF_2.1_API_Reference.html)	Updated
ISF2P1_KINETIS_RELEASE_RN Software Release Notes for the Intelligent Sensing Framework v2.1	Updated

Furthermore, there is an ISF v2.1 training video available from the Training tab of the freescale.com/ISF-2.1-KINETIS website.

Table 5. ISF training resources status

Training Resources	Status
ISF2.1_Hardware and Software Setup Training Video showing how to get started with ISF 2.1 using CodeWarrior	New
ISF2.1 FRDM-KEO6Z Example Project (uses KDS)	New
KIT V2 Tool Usage – Data Analysis (KIT V2 Tool is included in Freedom Sensor Toolbox GUI)	New

4 What is new for ISF v2.1 release – November 2015

All ISF 2.1 functionality in addition to support for Kinetis MCUs other than the Kinetis E-Series is now supported in ISF v2.2.

Most Freescale motion sensors are now supported by ISF v2.2. See the ISF v2.2 Release Notes on the freescale.com/ISF-2.2-KINETIS website for additional information.

CodeWarrior support by ISF has been eliminated in this release. Only Kinetis Design Studio (KDS) is used in the creation and support of this release.

ISF v2.1 has been modified to support devices with analog outputs and are supported only by Kinetis E-Series MCUs. This means that only UART communication protocol is provided, the I^2C and SPI communication protocols have been eliminated.

- RLI feature has been removed.
- The updated list of sensor adapters are:
- Sensor Adapters using generic APIs based upon sensor types:
- Sensors with analog output
- MPXV5004DP, differential pressure sensor

All previous sensor adapters have been removed. Use ISF v2.2 for all other sensors.

4.1 ISF v2.1 features

In addition to some ease of use items, the core libraries have been replaced with public source code.

The KIT V2 is now included as one of two options that may be invoked from the Freedom Sensor Toolbox Launcher. The Freedom Sensor Toolbox Launcher incorporates both the KIT V2 Tool and the Freescale Sensor Fusion Toolbox. Once invoked, the KIT V2 Tool operates exactly the same as for ISF v2.0. This allows all the materials from the ISF v2.0 videos to apply directly to ISF v2.1. The Freedom Sensor Toolbox Launcher can also optionally invoke the Freescale Sensor Fusion Toolbox, which displays sensor fusion output for the sensor fusion projects associated with the FRDM-K22F and FRDM-K64F boards.

Sensor Fusion is available through the virtual orientation sensor, which combines data from an available and configured accelerometer, magnetometer, or gyroscope. This is an ISF implementation of the Freescale Sensor Fusion library.

Additional sensors supported include the MMA8652, MMA8653, FXLS8471Q, and MPL3115A2. The updated list of sensor adapters using generic APIs is:

Accelerometer

- FXLS8471
- FXOS8700
- MMA8652
- MMA8653

Gyroscope

- FXAS21002C

Magnetometer

- FXOS8700
- MAG3110

Pressure

- MPL3115

Orientation (virtual)

- Sensor Fusion

4.2 ISF v2.0 features

The middleware is integrated into the Freescale Processor Expert technology. This allows the middleware to be autogenerated for specific hardware configurations.

By using Processor Expert, ISF is abstracted from the specific MCU hardware. ISF can be configured for almost all of the Kinetis processors, those with a PIT timer. Implementations for two Kinetis processors, the KL25Z and the K64F, have been tested and verified for this release.

The middleware includes a set of Processor Expert components downloadable from the Freescale ISF website.

The ISF_Core component is a library of components. Some of the components of interest within the ISF_Core library are:

Protocol Adapters

- I^2C for sensor communication
- SPI for sensor communication
- UART for host communications

Sensor Adapters using generic APIs based on sensor types

Accelerometer

- FXOS8700
  - MMA865x

Gyroscope

- FXAS21002C

Magnetometer

- MAG3110
- FXOS8700

Streaming protocol allows wider options for communicating sensor data back to the host. CRC error checking is included as an optional feature.

DSA-Direct API replaces the functionality of the Sensor Manager and can manage sensor data directly. Register-level access to the sensors is provided. Optimization of memory usage is implemented.

4.3 ISF v1.1 features

The following features from ISF v1.1 are available in the new release.

- The middleware acts as a sensor hub, providing sensor data from external sensors.
- CodeWarrior project files are available allowing users to begin with a working project.
- Automated installation is provided to enable ease-of-use.
- Synchronization is now provided during framework initialization to ensure that initialization is complete prior to executing application code.
- Application-specific commands are supported by the Command Interpreter.

5 Installation instructions

A single, unified installer is provided for installing the documentation, training and example projects. ISF artifacts can be installed by going to freescale.com/ISF-2.1-KINETIS website and clicking on the Download button.

The Processor Expert PEupd file is a separate download as it may be updated with new sensor adapters between releases. This file can be downloaded from the homepage or the Featured Downloads tab. Once downloaded, install the Processor Expert PEupd file within the Kinetis Design Studio (KDS) by using the Processor Expert pull down menu, selecting Import Component, choose the peupd package and clicking Open.

Refer to the Freescale Processor Expert website to learn about Processor Expert and how to add components, including the ISF components, to a project. The example projects provided may be used as examples to provide a starting point to users.

6 Release overview

This is the Intelligent Sensor Framework (ISF) release by Freescale Semiconductor. It targets the Freescale Kinetis platforms that use a PIT timer. ISF is built on the Freescale MQX™Lite RTOS and supported by KDS.

6.1 Using and modifying the ISF source, project and template files

The ISF release makes source, project, and template files available. All of the ISF2P1 projects are provided as user applications, sample code for users to adapt and modify.

NOTE: Freescale is not responsible for the support of any modified examples or templates.

7 Memory footprint for target: Kinetis KE06Z

Table 6. ISF memory requirements

Component	Code size (bytes)				Description
	Flash		SRAM		
	DEC	HEX	DEC	HEX	
Required ISF Components					
MQXLite RTOS	14124	372C	32	20	Minimum MQX kernel
Processor Expert LLD components	3418	D5A	854	356	Logical device drivers used by Processor Expert
ISF_Core	1979	7BB	22	16	ISF initialization and configuration functions
Optional ISF Core Features					
ISFBusManager	1490	5D2	116	74	Component
			1024	400	Task Stack Space
ISF_Core (Command Interpreter)	5797	16A5	238	EE	Component
			1024	400	Task stack space

Component	Code size (bytes)				Description
	Flash		SRAM		
	DEC	HEX	DEC	HEX	
ISF_Core (Power Manager)	120	78	26	1D	Component
			512	200	Task stack space
Optional ISF Components					
ISFEmbApp	942	3AE	232	E8	Basic Application
			1280	500	Task stack space
Protocol adapter components					
ISF_CommChannel_UART	1212	4BC	0	0	Component
Sensor adapter components					
ISF_Sensor_Generic_Analog	1488	5D0	29	1D	Analog Sensor
Minimum and maximum ISF configuration sizes					
Minimum ISF configuration, including MQX™ RTOS	19521	4C41	908	38C	This is the minimal required configuration of ISF.
Maximum space available for customer	111551	1B3BF	15476	3C74	This is the maximum memory available to customers for application development.

NOTE: Optimization is set to –Os to optimize for code size.

8 CPU load

The computational load imposed on a system by different applications that use ISF components may be different it is not possible to measure every instance or configuration. To estimate the CPU load demanded by an application that uses ISF on the KE06Z Freescale Freedom board, the time required for ISF to process one sensor data sample is used. The measurement of computational load begins when the ISF Bus Manager (BM) PIT timer generates an interrupt. The measurement stops when the user-embedded application receives notification that sensor data is available. Key aspects of the measurement include KDS 3.0 and the following ISF components:

- DSA Direct, Bus Manager (BM), and the Generic Analog sensor adapter
- MQXLite RTOS embedded in KDS 3.0 as a Processor Expert component
  - The source code was compiled with optimization set for size in order to provide the smallest code size.

A key peripheral of the KE06Z hardware that is actively running is the PIT timer, used by the BM. Each timer count is 1 µsec, as configured by the BM during initialization. ISF must be configured to run at 48 MHz core and 24 MHz bus in order for the PIT timer to run at 1 µsec per timer count. The PIT timer is considered to be the most accurate method for measurement because the Bus Manager establishes the PIT timer, creating interrupts at the sample rate requested by the user. It restarts at a count of zero, after an interrupt is generated. After the sensor data is retrieved by the user's task, the PIT counter value reflects the time required for ISF to perform the following activities:

- The BM includes processing the PIT interrupt
- The BM task is switched and the sensor adapter callback is invoked.
- The sensor adapter callback retrieves the sensor data and includes serial communication with the sensor and sets an event flag, which notifies the application.
- Task switches to the user-embedded application after a notification of the availability of sensor data.

The test application is generated using the standard ISFEmbApp PEx component with an MPXV5004DP subscription. The initialization section of the embedded application is modified to configure the application to subscribe to sensor data and start running. A sample counter was added to the application loop, and increments with the receipt of each new sensor sample. Finally, a time stamp variable stores the PIT counter value with the receipt of each new sensor sample.

In addition, a test task was created to run at the lowest priority of all other tasks. It runs as a loop that blocks on the Wait-for-Interrupt (WFI) instruction. This test task unblocks when an interrupt for the TPM timer or the MQX systick timer occurs. It then checks the sample counter to determine if a new sample has been received. If a new sample has been received, the time stamp value is added to an accumulator variable. Otherwise, the WFI instruction is executed. The loop runs for a specified number of times before exiting. The test setup ran for 2000 samples.

Table 7. CPU load test parameters

Speed (MHz)	Sample count	Total time in (µsec)	Average (µsec/sample)	Average latency for I^2C (µsec/sample)	Average latency for ISF (µsec/sample)
48 MHz ARM® Cortex®core frequency	2000	327560	164	128	36
24 MHz bus clock frequency					
24 MHz flash clock frequency					

The average latency time is the accumulated time divided by the sample counter value.

A limitation of the method used is that the sample rate cannot be set faster than the time it takes for ISF and the user application to retrieve sensor data.

The measured time for both the ISF components and the user task to retrieve sensor data and be ready for algorithm processing averaged 164 µsec. Out of the 164 µsec latency, 128 µsec were due to ADC conversion. Therefore, ISF code latency is 36 µsec.

Table 8. Measured CPU Load

Frequency (Hz)	Period (msec)	ISF CPU load (%)	CPU load total (%)
1.56	640	0.01	0.03
6.25	160	0.02	0.10
12.5	80	0.05	0.20
50	20	0.19	0.80
100	10	0.38	1.6
200	5	0.77	3.2
400	2.5	1.54	6.4
800	1.25	3.1	12.8

9 Known issues and limitations

9.1 Compiler/IDE issues

With KDS, there are no known compiler or IDE issues.

9.2 Known software issues

- Each embedded application is limited to accessing each specific sensor in a single subscription.
- Embedded applications may require up to 5 seconds to initialize before sending the first command.

9.2.1 Open defects

There are no open defects.

9.2.2 Closed defects

Table 9. Closed defects

Defect ID	Ticket Summary	Ticket Closure Date	Priority
SSDSW-99	The response packet for the Command Interpreter does not match the ISF 2.0 Software Reference Manual. The offset and command echo are eliminated for the response, and the number of bytes transferred is duplicated.	27 July 2015	L3

Table 10. Closed defects – ISF 2.1 PEupd.PE (Rev 2) (21 April 2015)

Defect ID	Ticket Summary	Ticket Closure Date	Priority
CR340662[1]	In order for the CI Streaming feature to work properly, the user must manually type in the following into the Protocol component methods: ci_stream_init ci_protocol_CB_stream	14 April 2015	L3
SSDSBOX-30[2]	Some internal tasks using floating point calculations do not enable MQX_FLOATING_POINT_TASK properly.	2 April 2015	L3
SSDSBOX-49[3]	There are numerous typographical errors in the generic sensor type definitions.	16 April 2015	L5
SSDSW-3	There are remnants of the MAG3110 embedded app appearing in the code generated in App1.c.	2 April 2015	L5
SSDSW-9	The fixed point conversion factors in FXOS8700 and FXAS21002C sensor adapters are incorrect. The fixed-point acceleration data has 15 fraction bits rather than 16. It is suspected that a similar situation exists for the magnetometer and gyroscope data as well.	16 April 2015	L3
SSDSW-79	Orientation Sensor does not include pressure data, the 10th axis.	10 April 2015	L2
SSDSW-97	Cycling the Orientation Sensor through STARTED_SUBSCRIBED to STOPPED_UNSUBSCRIBE and back does not work. The isf_fifo_init routine was called inside the sensor adapter configuration API instead of the initialization API.	10 April 2015	L3
SSDSW-98	The stack size for the main task of ISFEmbApp cannot be modified.	2 April 2015	L3
SSDSW-101	A request to steam data for the FXAS21002 at 800 Hz results in only 480–500 Hz stream data.	10 April 2015	L3
SSDSW-104	The FXAS21002 sensor adapter Processor Expert component does not allow the user to set sample rates of either 400 or 800 Hz.	10 April 2015	L3
SSDSW-105	The default task priorities for ISF were not correct and some could not be changed in the Processor Expert components.	10 April 2015	L3
SSDSW-106	The sensor adapter conversion tables are swapped for the FXAS21002C and the FXAS21000.	15 April 2015*	L3
CR340211	ISF R2.0 depends upon an update to the MQXLite_task PEx component in order to compile properly. Users must use the most recent version of CW10.6.1.	18 November 2014	L2
CR340214[4]	ISF Sensor Adapter PEx Components sometimes fail to offer I2C_CH1 Communications Channel to User.	18 November 2014	L3

1. Also known as SSDSW-6
2. Also known as SSDSW-4
3. Also known as SSDSW-8
4. Also known as SSDSW-10

Table 11. Closed defects – ISF 2.1 PEupd.PE (Rev 1) (20 March 2015)

Defect ID	Ticket Summary	Ticket Closure Date	Priority
SSDSW-2	FXAS21002C Sensor Adapter reports incorrect response to WHOAMI command.	20 March 2015	L2
SSDSW-64	The floating point conversion factors in MPL3115 sensor adapter are incorrect.	20 March 2015	L3
TabSSDSW-98	The stack size for MainTask of ISFEmbApp cannot be modified.	20 March 2015	L3

Table 12. Closed defects – ISF 2.1 (6 March 2015)

Defect ID	Ticket Summary	Ticket Closure Date	Priority
CR340207[1]	The installation shows unit test information released in the core library.	6 March 2015	L3
CR345614	The CI mailbox protocol does not use 2 bytes for offset as specified in the SWRM.	30 January 2015	L3
CR345907	If the Component name for the ISFEmbApp component is changed, the compilation fails.	2 February 2015	L3
CR345910	The FXOS8700CQ sensor adapter does not properly support accelerometer only usage at frequencies other than 400 Hz.	30 January 2015	L3
CR346036	The Device ID Command does not consistently return the expected 18 bytes of data.	30 January 2015	L2
SSDSBOX-81	Timestamp resolution has only 5 µsec resolution by default and may create duplicate timestamps.	9 February 2015	L3

[1]. Also known as SSDSW-5

Table 13. ISF 2.0 release (December 2014)

Defect ID	Ticket Summary	Ticket Closure Date	Priority
CR312443	The Device info command returns incorrect values for legacy data fields.	30 September 2014	L4
CR318202	CW 10.6 build fails due to code duplication.	28 September 2014	L5
CR325403	Incomplete Error Handling in the DSA.	1 December 2014	L2
CR339505	Bus Manager appears to run out of tokens in the Newton sensor adapter.	1 December 2014	L3
CR340065	When the host writes an incorrect sample period data to the MAG310, the incorrect value is saved in memory even though an error message is sent to the user.	8 December 2014	L3
CR340212	Remove compilation warnings (Warnings generated by MQX remain.)	4 December 2014	L4
CR340215	Improve the error handling in the Embedded Application goto-state.	25 November 2014	L3
CR340217	Lack of error handling in Sensor Adapters.	25 November 2014	L3

10 ISF Software change log

Table 14. ISF version changes

Version 2.1 (Updated November 2015)
All sensors removed. Support for MPXV5004DP added. KDS support only
Version 2.1 (March 2015)
Sensor Fusion incorporated as a virtual Orientation sensor.
Version 2.0 (December 2014)
ISF integrated with Processor Expert with hardware abstraction for entire Kinetis platforms supporting PIT timers.
Version 1.1 (April 2014)
This is the initial ISF release supporting Kinetis KL25Z.

11 References

Resource	Description	Link
ISF2P1 website	Tool Summary Page	freescale.com/ISF-2.1-Kinetis
ISF2P2 website	Tool Summary Page	freescale.com/isf-2.2-KINETIS
ISF v2.1 installer	Tool Summary Page	freescale.com/ISF-2.1-Kinetis
MPXV5004DP	Product Summary Page	freescale.com/MPXV5004DP
ISF v2.1 Training	Tool Summary Page	freescale.com/ISF-2.1-Kinetis (see training tab)
ISF v2.2 Release	Tool Summary Page	freescale.com/isf2P2
Processor Expert	Tool Summary Page	freescale.com/processorexpert

12 Revision history

Rev. No.	Date	Description
0	3/2015	Initial public release
1	11/2015	Public release of ISF v2.1, updated November, 2015.

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