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Release Notes for Xtrinsic Intelligent Sensing Framework 1.1

on the FXLC95000 Intelligent Motion-Sensing Platform

Contents

1 Introduction

This document describes the Freescale Xtrinsic Intelligent Sensing Framework (ISF) version 1.1 firmware, released for the FXLC95000 intelligent motion-sensing platform.

2 Requirements

Xtrinsic Intelligent Sensing Framework (ISF) version 1.1 firmware for the FXLC95000 system has several requirements for tools, development systems and deployment targets.

2.1 Development tools

The ISF v1.1 Release was compiled and tested with the following development tool:

- CodeWarrior Development Studio for Microcontrollers Version 10.4 for Windows with built-in support for Coldfire V1 and FXLC95000. ISF v1.1 is compatible with CodeWarrior 10.5 and is expected to be compatible with future versions of CodeWarrior.

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2.2 System requirements

The system requirements are defined by the product requirements. The ISF implementation on the FXLC95000CL platform accommodates a wide variety of host system configurations and does not require special host system requirements.

Minimum PC configuration:

- As required by CodeWarrior 10.4 and above

Recommended PC configuration:

- 2 GHz processor
- 2 GB RAM
- 4 GB free disk space

Recommended Operating System:

- Windows 7

2.3 Target requirements

The ISF v1.1 release supports the evaluation boards listed in the kits below.

KITFXLC95000EVM (ISF 1.0 release)	
Baseboard	KITFXLC95000EVM
DIP board	FXLC95000 • MCU with onboard 3-axis accelerometer (FXLC95000)
FXLC95000MAG	
Baseboard	KITFXLC95000EVM
DIP board	FXLC95000MAG • MCU with onboard 3-axis accelerometer (FXLC95000) • 3-axis magnetometer (MAG3110)
FXLC95000-10AXIS (Expected availability is 2nd quarter, 2014)	
Baseboard	KITFXLC95000EVM
DIP board	FXLC95000-10AXIS • MCU with onboard 3-axis accelerometer (FXLC95000) • 3-axis gyroscope (FXAS21000) • 3-axis accelerometer and 3-axis magnetometer (FXOS8700) • Pressure sensor (MPL3115) • 3-axis magnetometer (MAG3110)

There is an updated version of the Intelligent Sensor Mailbox Tool which supports the bridge code on these evaluation boards for the ISF 1.1 release as well as the ISF 1.0 release.

3 Release Content

With the ISF 1.1 release, an automated installer is provided. Within the installer, all the items in the tables below are included and are also available individually from www.freescale.com/ISF, Downloads tab. This section gives an overview about the release content, file locations and status.

Run-time Software	Status
Operating System Software - Operating Systems	
Freescale MQX RTOS 3.7 modified for the FXLC95000	Updated
Middleware–Framework	
ISF1P195K_Installer Installer for ISF 1.1 and all associated materials	New
ISF1P195K_INSTALL_INS Instructions for installing ISF on a Windows system	Updated
Middleware - Sensor Adapters	
ISF1P195K_MAG3110_ADAPTER_LIB Optional Xtrinsic ISF component to manage the Freescale MAG3110 magnetometer from the FXLC95000	Updated
ISF1P195K_ECOMPASS_ADAPTER_LIB Optional Xtrinsic ISF component to provide virtual eCompass data from the FXLC95000 and the MAG3110	Updated
ISF1P195K_FXAS21000_ADAPTER_LIB Optional Xtrinsic ISF component to manage the Freescale FXAS21000 gyroscope from the FXLC95000	Updated
ISF1P195K_FXOS8700_ADAPTER_LIB Optional Xtrinsic ISF component to manage the Freescale FXOS8700 combination accelerometer and magnetometer from the FXLC95000	New
ISF1P195K_MMA865X_ADAPTER_LIB Optional Xtrinsic ISF component to manage the Freescale MMA865X family of accelerometers from the FXLC95000	New
ISF1P195K_VIRTUALGYRO_ADAPTER_LIB Optional Xtrinsic ISF component to manage a virtual gyro using the internal accelerometer of the FXLC95000 and the MAG3110 magnetometer	New
Application Specific–Apps, also known as Example Applications	
ISF1P195K_ACCELMAG_PROJ CodeWarrior project with source code for an application using an accelerometer (FXLC95000CL) and a magnetometer (MAG3110) on the FXLC95000	Updated
ISF1P195K_DSA_SNSR_ADAPTER_TMPL Digital Sensor Abstraction Template useful for writing sensor adapters	Updated
ISF1P195K_GETACCELDATA_PROJ CodeWarrior project with source code for an application using the accelerometer on the FXLC95000	Updated
ISF1P195K_ECOMPASS_PROJ CodeWarrior project with source code for an application using the eCompass on the FXLC95000	Updated
ISF1P195K_FXAS21000_PROJ CodeWarrior project with source code for an application with a gyroscope (FXAS21000)	Updated
ISF1P195K_FXOS8700_PROJ CodeWarrior project with source code for an application using an accelerometer and magnetometer combination (FXOS8700) on the FXLC95000	New

Table continues on the next page...

ISF1P195K_MMA865X_PROJ CodeWarrior project with source code for an application using an accelerometer from the MMA865X family on the FXLC95000	New
ISF1P195K_VIRTUALGYRO_PROJ CodeWarrior project with source code for an application using a virtual gyroscope created from accelerometer (FXLC95000CL) and magnetometer (MAG3110) data managed by ISF	New
ISF1P195K_APPS_TMPL_PG Instructions for using the provided application-specific apps with CodeWarrior and the KITFXLC95000EVM/MAG/10AXIS	Updated
Application Specific - Reference Applications	
ISF1P195K_ACCELMAG_S19 Precompiled binary image used for demonstrating a reference application for an accelerometer (FXLC95000CL) and a magnetometer (MAG3110) on the FXLC95000	New
ISF1P195K_ECOMPASS_S19 Precompiled binary image used for demonstrating a reference application for a virtual eCompass using an accelerometer (FXLC95000CL) and a magnetometer (MAG3110) on the FXLC95000	New
ISF1P195K_FXAS21000_S19 Precompiled binary image used for demonstrating a reference application for a gyroscope (FXAS21000) on the FXLC95000	New
ISF1P195K_FXOS8700_ACCELMAG_S19 Precompiled binary image used for demonstrating a reference application for the accelerometer and magnetometer combination (FXOS8700) on the FXLC95000	New
ISF1P195K_MMA865X_ACCEL_S19 Precompiled binary image used for demonstrating a reference application for an accelerometer (MMA865X) on the FXLC95000	New
ISF1P195K_S19_INSTALL_INS Instructions for using the provided Reference Applications with CodeWarrior and the KITFXLC95000EVM/ma/MAG/10AXIS	New
ISF1P195K_GETACCELDATA_S19 Project with precompiled binary image used for demonstrating a reference application for an accelerometer on the FXLC95000	New

With the ISF 1.1 release, an automated installer is provided. Within the installer, all the items in the tables below are included and are also available individually from www.freescale.com/ISF, Documentation tab. This section gives an overview about the release content, file locations and status.

Documentation	
ISF1P195K_SW_REFERENCE_RM Software Reference Manual for the Intelligent Sensing Framework on the FXLC95000 - Reference Manual	New
ISF1P195K_API_REFERENCE_RM IAPI Reference Manual for the Intelligent Sensing Framework on the FXLC95000 (Unzip and open ISF_1.1_API_Reference.html)	New
ISF1P195K_CORE_LIB_RELEASE_RN Software Release Notes for the Intelligent Sensing Framework on the FXLC95000	New

The following table indicates which sample applications can be demonstrated on the various evaluation boards provided by Freescale. Any of these sensor adapters and embedded applications could be used on a user-developed platform containing the appropriate hardware.

Table 2. FXLC95000 Evaluation Boards vs. Projects Compatibility

CW project or S19 file	KITFXLC95000EVM	FXLC95000MAG	FXLC95000-10AXIS
ISF1P195K_GETACCELDATA	X	X	X
ISF1P195K_ACCELMAG		X	X
ISF1P195K_ECOMPASS		X	X
ISF1P195K_VIRTUALGYRO		X	X
ISF1P195K_FXOS8700			X
ISF1P195K_FXAS21000			X

4 What is New?

Freescale has previously provided standalone intelligent sensors with embedded firmware in the MMA955xL series. ISF provides significantly new functionality for the FXLC95000 in the following ways:

4.1 ISF 1.0 Release

- The firmware is downloadable from the Freescale website, allowing customers to select the version of firmware to be used with their product.
- The firmware is provided as a library allowing customers to select those components required for their application.
- The firmware provides components for bus management, command interpretation, device message supporting I^2C communication, direct communication with the host via the host proxy, power management, and sensor management.
- The firmware acts as a sensor hub providing sensor data from external sensors as well as the internal accelerometer on the FXLC95000.
- CodeWarrior project files are available allowing users to begin with a working project.

4.2 ISF 1.1 Release

- Automated installation is provided to enable ease of use.
- Additional temperature output is provided in the FXLC95000 internal accelerometer, fsl_fxlc95000_mmap_3D_accel, sensor adapter and associated example application.
- The PC tool, called the Intelligent Sensor Mailbox Tool, allows for automatic loading of S19 executables as another ease-of-use feature.
- New virtual sensor adapters and associated example applications, eCompass and Virtual Gyro, are provided to demonstrate the sensor fusion capabilities of the FXLC95000.
- New external sensor adapters and associated applications provided for a gyroscope (FXAS2100), a combination magnetometer and accelerometer (FXOS8700), and a family of accelerometers (MMA865X).
- Enhancements made to the Freescale MQX™ RTOS related to memory management.
- ISF issues an event when initialization is complete requiring updates to embedded applications.
- Application specific commands are supported by the Command Interpreter.

5 Installation Instructions

There is one step required to properly build and install ISF on the FXLC95000 platform. Click the "Download the latest version" link on the Freescale Xtrinsic ISF website. The installer is also located under Downloads/Middleware-Framework. If users opt to do specific installation without the automated installer, they must follow the instructions in the corresponding documents.

5.1 Installing the ISF core library

A single, unified installer is provided for installing the ISF Core Libraries, Sensor Adapters, Example Projects, Documentation, and Binaries. Installation instructions are located with the **ISF1P195K_Installer** file on the Freescale Xtrinsic ISF website under Downloads/Middleware-Framework or Documentation.

5.2 Importing precompiled binary images onto the FXLC95000

The available precompiled binary images may be installed via the ISF1P195K_Installer, but are also available individually on the Freescale Xtrinsic ISF website under Downloads/Reference Applications The installation instructions are located on the Xtrinsic ISF website under the Documentation tab.

5.3 Importing sample user application projects into CodeWarrior

The available sample user application projects may be installed via the ISF1P195K_Installer, but are also available individually on the Freescale Xtrinsic ISF website under Downloads/Application Specific-Apps. The installation instructions are available on the Freescale Xtrinsic ISF website under Documentation.

6 Release Overview

This is the Xtrinsic Intelligent Sensor Framework (ISF) release by Freescale Semiconductor. It targets the Freescale Xtrinsic FXLC95000CL Intelligent, Motion-Sensing Platform.

ISF is built upon the Freescale MQX™ RTOS version 3.7.

The ISF includes the following components:

- Bus Manager
- Command Interpreter
- Device Messaging Communications supporting I^2C
- Host Proxy
- Power Manager
- Sensor Manager
    - Digital Sensor Abstraction (DSA)

6.1 Reference applications

There are fully supported example embedded applications provided as S19 binary images to demonstrate ISF functionality. They showcase how the FXLC95000 system manages data obtained from the sensors. These files are produced by the corresponding sample embedded user applications.

6.2 Sensor adapters supported

ISF acts as a sensor hub, capable of managing sensor data from sensors, both internal and external to the FXLC95000CL device. This release provides the following sensor adapters:

- FXLC95000CL Internal Accelerometer Adapter included in the ISF1P195K_CORE_LIB library
- MAG3110 Magnetometer Adapter
- FXAS21000 Gyroscope Adapter
- FXOS8700 Combined Accelerometer and Magnetometer Adapter
- MMA865X Accelerometer Family Adapter
- eCompass Virtual Adapter using the MAG3110 and the internal accelerometer of the FXLC95000
- VirtualGyro Adapter using the MAG3110 and the internal accelerometer of the FXLC95000

Additional sensor adapters may be provided on the ISF web site independent of ISF releases of the core library.

6.2.1 FXLC95000CL internal accelerometer adapter

ISF includes a set of functions for the FXLC95000CL accelerometer. These functions provide the following capabilities:

- Configuring/initializing the sensor
- Starting the transmission of requested sensor data to the host or embedded application
- Providing accelerometer and temperature data
- Stopping the transmission of requested sensor data to the host or embedded application

6.2.2 MAG3110 magnetometer adapter

ISF includes a set of functions for a magnetometer external to the FXLC95000CL device, specifically the Freescale MAG3110 using the I^2C protocol. These functions are contained in the **ISF1P195K MAG3110 ADAPTER LIB**. The MAG3110 sensor adapter provides the following capabilities:

- Configuring/initializing the magnetometer
- Starting the transmission of magnetometer data to the host or embedded application
- Providing magnetometer data
- Stopping the transmission of magnetometer data to the host or embedded application

6.2.3 Additional adapters

Each of the sensor adapters provided with and after the release have similar functions as the MAG3110 magnetometer sensor adapter, as described above. Each adapter is provided with a sample CodeWarrior project to demonstrate how the sensor is configured and initialized as well as starting and stopping sensor data to the host or embedded application.

6.3 Changing the ISF source files

ISF is provided as a set of libraries to allow users flexibility in utilizing the features desired for their specific applications. Some source code has been provided to allow users to expand the capabilities provided within ISF to include additional sensors connected to the FXLC95000CL device.

Note

Freescale is not responsible for the support of any modified code.

6.4 Using and modifying the ISF source, project or template files

The ISF release makes source, project, and template files available. The ISF template, **ISF1P195K_GETACCELDATA_PROJ**, is provided as user application 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

Target: FXLC95000					
	Code Size (bytes)				
	Flash		SRAM		
Component/Application	DEC	HEX	DEC	HEX	Description
Base ISF Components					
ISF MQX	8096	1FA0	336	150	MQX Operating System
ISF Core	761	2F9	20	14	ISF initialization and configuration functions
Optional ISF Components					
Sensor Manager	4530	11B2	72	48	Sensor Manager component
			640	280	Sensor Manager task stack
Bus Manager	2440	988	137	89	Bus Manager component
			512	200	Bus Manager task
I^2C	2347	92B	0	0	I^2C component memory usage
Command Interpreter	1830	726	139	8B	Host communications interface
			1024	400	Command Interpreter task stack
Power Manager	1294	50E	56	38	Power Management component
Host Proxy	550	226	46	2E	General Host Interface for Embedded Applications
Adapter for FXLC95000CL accelerometer	680	2A8	37	25	DSA Adapter for internal accelerometer
Device Messaging	652	28C	0	0	Device Messaging component

Table continues on the next page...

Target: FXLC95000					
	Code Size (bytes)				
	Flash		SRAM		
Component/Application	DEC	HEX	DEC	HEX	Description
The sum of the bytes above (Base ISF Components and Optional ISF Components) are displayed in the row below					
Minimum ISF Configuration (including MQX)	23180	5A8C	3019	BCB	Minimum consumed by ISF (including MQX)
Maximum available for customer	107892	1A574	13365	3435	Maximum memory available for customer code
The next two components are required to create a virtual eCompass					
eCompass Sensor Adapter and Algorithm	21964	55CC	4468	1174	
	10582	2956	0	0	
Adapter for Freescale Magnetometer 3110	1190	4A6	47	2F	DSA Adapter for Freescale Magnetometer 3110
The sum of the Minimum ISF Configuration and the two rows above are displayed in the row below					
Maximum Total ISF Configuration	56916	DE54	7534	1D6E	Includes the Corelib and the other components from the previous page
Minimum Available for Customer	74156	121AC	8850	2292	
The following components may be added to the minimum build if the required memory space is available					
FXAS21000 Sensor Adapter	1815	717	26	1A	
FXOS8700 Sensor Adapter	2465	9A1	41	29	
MMA865X Sensor Adapter	4495	118F	27	1B	
Virtual Gyro Sensor Adapter	4216	1078	34	22	Requires use of eCompass algorithm

While the table above provides the minimum available and the maximum available memory sizes, the figure below depicts the range of memory sizes available for any custom code that needs to be accomodated in flash in addition to required ISF components. The available memory is generally based upon the configuration of ISF, the number of sensor adapters, and the complexity of the algorithms involved.

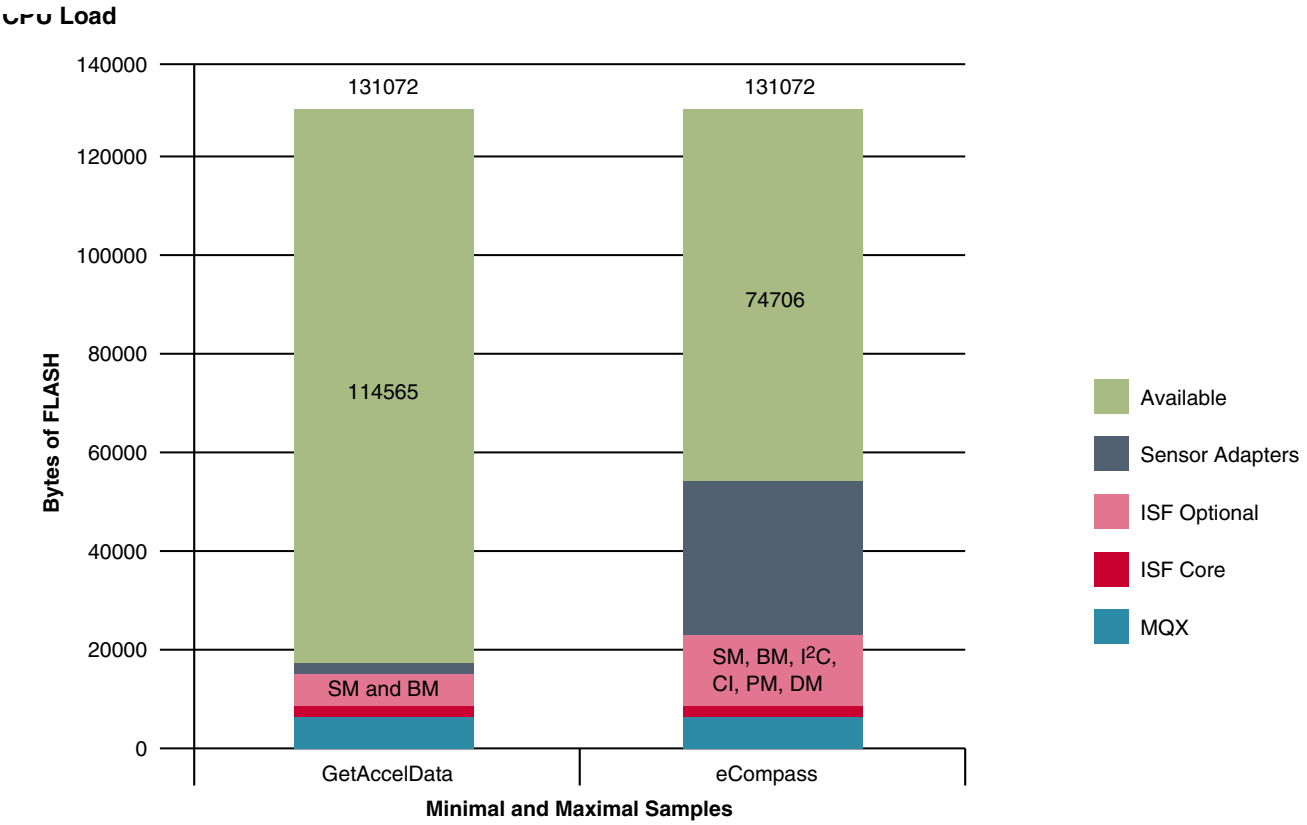

Figure 1. Sample ISF Memory Footprint Ranges

8 CPU Load

Computational load imposed by different applications that use ISF components may be different and it is not possible to measure it for every given situation. To get an idea about the CPU Load demanded by an application that uses ISF on FXLC95000, the time required for ISF to service a sensor data event from the start of a frame to the time a user application retrieves the sensor data was measured. Key aspects of the measurement include:

- CodeWarrior v10.4 and the following ISF components were used:
  - Sensor Manager (SM), Bus Manager (BM), and the internal accelerometer sensor adapter
- Two tasks were running during the measurement:
  - The first was a user-application task to wait for and receive sensor data
  - The second was a CPU-load task running at the lowest priority level in order to measure the timing
- A key peripheral of the FXLC95000 hardware actively running was the MTIM timer used by the Bus Manager. Each timer count is 1 µsec as configured by the Bus Manager during initialization. The MTIM timer is considered to be the most accurate method for measurement because the Bus Manager establishes the MTIM timer creating interrupts at the frame rate requested by the user. It restarts at count of zero after an interrupt is generated. After the sensor data is retrieved by the user's task, the MTIM counter value reflects the time required for ISF to perform the following activities:
  - The Bus Manager services the MTIM interrupt and sets an event
  - The Bus Manager task awakens due to the event and invokes the callback
  - The sensor adapter is invoked starting an AFE conversion as well as the time for the conversion
  - The sensor adapter services the AFE interrupt and sets an event
  - The event wakes the Sensor Manger, which collects the sensor data and sets an event to notify the user task that the sensor data is available
  - The user task awakens and retrieves the sensor data. The sensor data is retrieved but not used by any specific algorithm
- The PDB timer used by MQX was turned off during the measurements to exclude the RTOS activities

- ColdFire STOP Fast Clock mode was used during idle mode when all tasks are blocked, waiting for sensor data
- The CPU was running at 16 MHz (62.5 nanoseconds period)

A limitation of the method used is that the frame 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 is **433 µsec**. The 433 µsec remains the same, regardless of the sample—only the percentage of the frame taken varies with the sample frequency as shown in the table below.

Table 3. Measured CPU load

Frequency Rate (Hz)	Period (ms)	CPU Load
10	100.00	0.43%
50	20.00	2.17%
100	10.00	4.33%
200	5.00	8.66%
400	2.50	17.32%
800	1.25	36.64%

The CPU loading is derived from the frame rate used by dividing the measured time by the frame period. The percentage value represents the amount of time of the specified frame rate that is required for ISF and the user application to retrieve sensor data.

9 Known Issues and Limitations

9.1 Compiler/IDE issues

By default, CodeWarrior uses unsigned 8-bit integers for its char data type. This may not be the expected behavior. This may be changed by unchecking the “Use Unsigned Chars” compiler configuration option in the **Project Properties->C/C++Build->Settings->Coldfire Compiler->Language Settings** page.

9.2 Known software issues

9.2.1 MQX PDB Timer and STOP Modes

The MQX timer functionality depends on OS clock ticks driven by the PDB hardware timer. MQX was not designed to be aware of the FXLC95000’s processor slow clock or stop modes. As a result, if these modes are used while an MQX timer is active or while the PDB timer is stopped, the MQX timer behavior will be incorrect. Therefore, MQX timer usage should be confined to single contiguous periods of processor RUN mode. If the application requires timers for proper operation, then the user should not stop the PDB or put the processor into STOP mode.

The FXLC95000 MQX BSP uses the PDB timer. If the user stops the PDB timer or puts the processor into STOP mode, then the MQX timer subsystem does not receive timer interrupts and all timers stop counting.

9.2.2 Sensor Manager notes and limitations

The following limitations have been identified in the Sensor Manager:

- Using the Sensor Manager, an application can assign up to three signal taps to the AFE. Each tap represents a different notification rate. Only one function can be assigned to each signal tap. Each tap must be a multiple of the tap with the shortest registered period.

Table 4. Correct and incorrect data sampling periods

Incorrect Data Sampling Periods		Correct Data Sampling Periods	
256 µs	This set returns an error message because 500 and 1000 are not multiples of 256.	250 µs	This set works because 500 and 1000 are multiples of 250.
500 µs		500 µs	
1000 µs		1000 µs	
666 µs	This set returns an error message because 666 and 999 are not multiples of 300.	666 µs	This set works because 666 and 999 are multiples of 333.
300 µs		333 µs	
999 µs		999 µs	
5000 µs	This set returns an error message because 5000 and 10,000 are not multiples of 4000.	8000 µs	This set works because 8000 and 12,000 are multiples of 4000. Note: If the third subscription drops, leaving 8000 µs and 12000 µs as the ongoing subscription periods, an error message is returned because 12000 is not an even multiple of 8000.
10,000 µs		12,000 µs	
4000 µs		4000 µs	

- Only one subscriber is permitted for each signal tap. If two subscribers request data at the same frequency, they must use two signal taps. It is more efficient if they could both obtain results from the same taps. In such a situation, more subscribers could be serviced within the existing maximum number of signal taps.

9.2.3 Open defects

Table 5. Correct and incorrect data sampling periods

Ticket Summary	Ticket Submission Date	Priority
Error messages generated by ISF are suppressed by the Sensor Manager.	22 January 2014	3

10 Change Log

Version 1.0 (June 2013)
This is the initial ISF release (containing MQX v3.7) supporting the FXLC95000 platform.
Version 1.1 (February 2014)
Small enhancements to the Sensor Manager and sensor adapter interfaces.

Table continues on the next page...

Update to the Software Reference Manual to notify users about a FXLC95000 hardware feature. The AFE manual trigger bit inhibits frame interrupt causing the Power Manager to spin waiting for the Start of Frame IRQ.
Sensor Adapters were required to be in the STATE_STARTED state before unregistering callbacks from the Bus Manager. This was an unnecessary condition for unregistering callbacks and has been removed in all of the sensor adapters.
DSA Template Documentation updated.
Task synchronization added to the DSA sample code by using a locking semaphore to protect sensor data during asynchronous access.
Update "driver" terminology to “adapter” in the code.
fxlc95000_util.c & .h files removed from the ISF Sensor Manager library. Processor specific header files isolated from the component libraries.
The MAG3110 files were removed from the core library.
ISF issues an event when initialization is complete. Sample embedded applications updated to respond to the event.
Freescale MQX™ 3.7 now returns allocated memory to the memory pool when the allocating task is destroyed.
The FXOS8700 sensor adapter updated to include a 1 millisecond delay after reset.

11 Release History

Version number	Release date	Description
ISF v1.0	7 June 2013	• Initial Release
ISF v1.1	Feb 2014	• Automatic installation, Sensor Manager API, and new sensor adapters

How to Reach Us:

Home Page:
freescale.com

Web Support:
freescale.com/support

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