FTF FREESCALE TECHNOLOGY FORUM 2014

# Design Accessories
## for Smartphones and Tablets

FTF-CON-F0128

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freescale™

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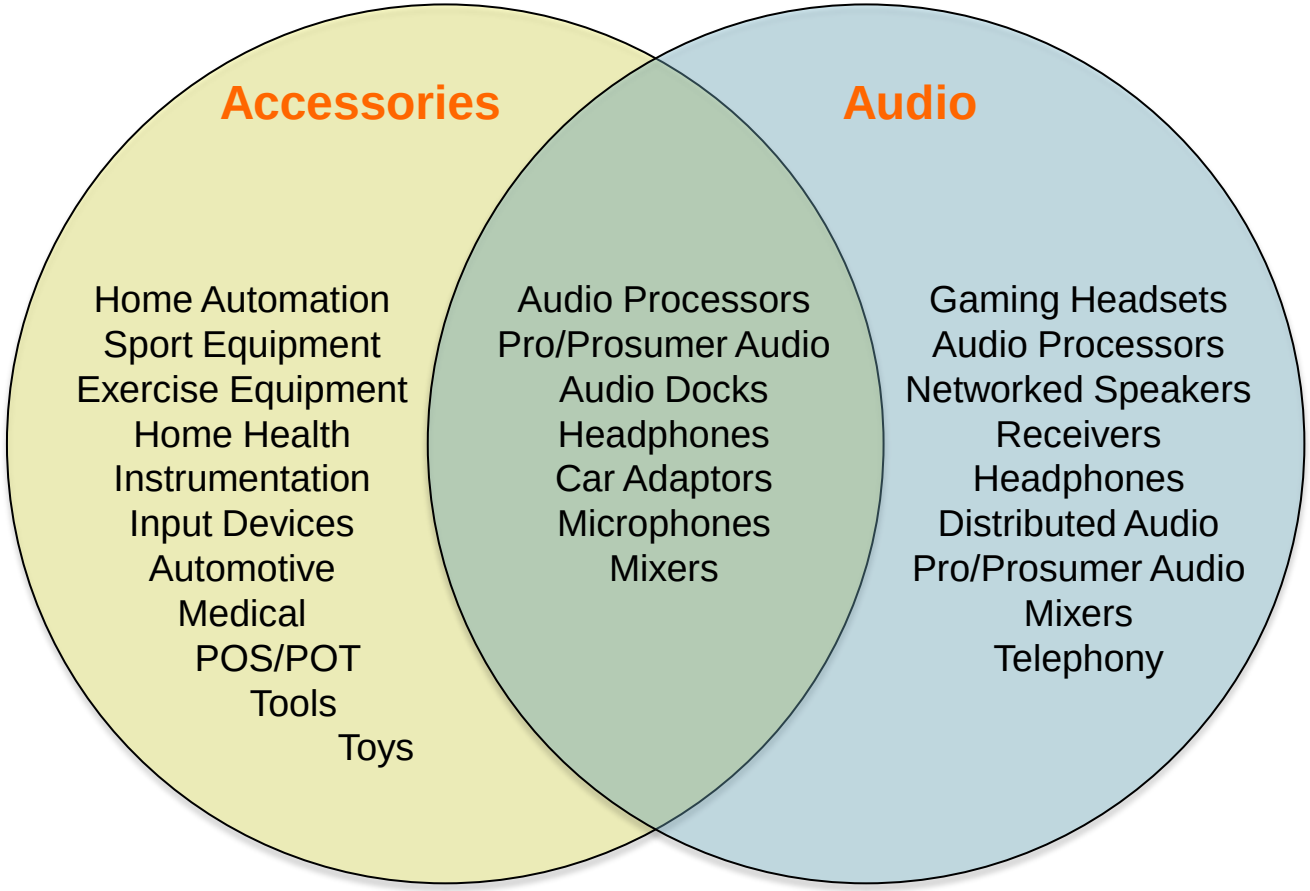
# Agenda

- Introduction
- Made For iPod (MFi) Accessories
- Tower Development and Rapid Prototyping system
- Android Accessories
- Accessory Demos and Examples
- Freescale Audio Solution
- Summary
- Q & A and Demos

# Introduction

# Smartphone and Tablet Accessories & Audio Applications




**Note:** Accessories refers to MFi, Android, Win, other?

# Made For iPod (MFi) Accessories

# Made For iPod (MFi) Program

To develop Accessories or App-based accessories for iPhone®, iPad® or iPod® devices, a company needs an MFi (Made For iPod) license from Apple

Made for iPod iPhone iPad

# https://developer.apple.com/programs/mfi/

Made for iPod iPhone iPad

Developer

Technologies Resources Programs Support Member Center

## MFi Program

Join the MFi licensing program and get the hardware components, tools, documentation, technical support, and certification logos needed to create AirPlay audio accessories and electronic accessories that connect to iPod, iPhone, and iPad.

### Hardware Components and Documentation

Get the hardware connectors and components that are required to manufacture iPod, iPhone, iPad, and AirPlay audio accessories. And access the iPod Accessory protocol specification, the communication protocol used to interact with iPod, iPhone, and iPad.

### MFi Logos

Promote your electronic accessory with MFi logos. Made for iPod, Made for iPhone, Made for iPad, and AirPlay logos communicate to customers that an electronic accessory has been designed to connect specifically to iPod, iPhone, or iPad, and has been certified by the developer to meet Apple performance standards.

**Join the MFi Program**

- Hardware Connectors and Components ✓
- Testing Tools
- Technical Information
- Technical Support ✓
- Product Certification ✓
- MFi and AirP ✓
- iPod, iPhon Compatibility Icons ✓

Apply Now

Click here to apply for an MFi license

# MFi Accessory Connection Options

| Connection | Wired | | Wireless | | | |
|---|---|---|---|---|---|---|
| | Lightning | 30-pin | BLE | BT | BT (MFi) | WiFi |
| | | | Bluetooth 4.0 | Bluetooth | Bluetooth | AirPlay |
| MFi License Required | Yes | Yes | No | No | Yes | Yes |
| Audio | Digital | Analog and Digital | No | Yes | Yes | AirPlay |
| Notes/ Comments | Supports all MFi functions | Some MFi functions not supported | Wearables, Home Automation, iBeacon | A2DP audio, Handsfree | MFi BT Connection, Gaming controllers | Streaming audio |

# Freescale MFi Solution Philosophy

- Develop a flexible solution supporting the full range of possible accessories, including but not limited to audio
- Develop a solution supporting a wide range of existing Freescale MCU and MPU products, and capable of rapidly supporting new Freescale MCU and MPU products at introduction
- Architect the MFi solution to enable fast adoption of any MFi program software or hardware updates
- Make the Freescale MFi solution available to all eligible MFi licensees on the MFi portal

Made for iPod iPhone iPad

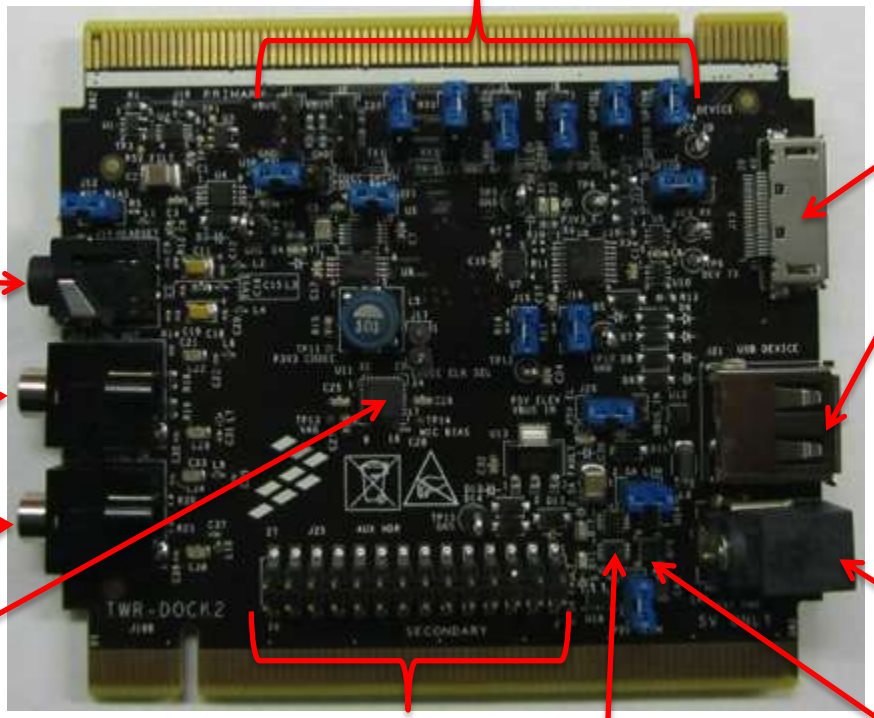
# Made For iPod (MFi) Freescale Solutions

- Freescale's TWR-DOCK2, TWR-DOCK and supporting MFi software allow the Tower System to be used for, iPhone, iPad and iPod Accessory and App-based Accessory development and rapid prototyping, supporting the Lightning and 30-pin dock connectors
  - This provided MFi development support for most MCU and MPU products supported by the Tower System
- Utilize TWR-DOCK2 components and software to support Freescale MPU products not supported by the Tower System

Made for iPod iPhone iPad

# TWR-DOCK2 Tower Module Only

Configuration Jumpers




Custom Dock connector cable Header

USB A Receptacle for standard USB A to dock connector cable

Analog stereo headphones/headset (3.5mm)

Analog stereo audio line in (3.5mm)

Analog stereo audio line out (3.5mm)

SGTL5000 Audio Codec

Signal Access Header

External power supply input (minimum 5V 5A)

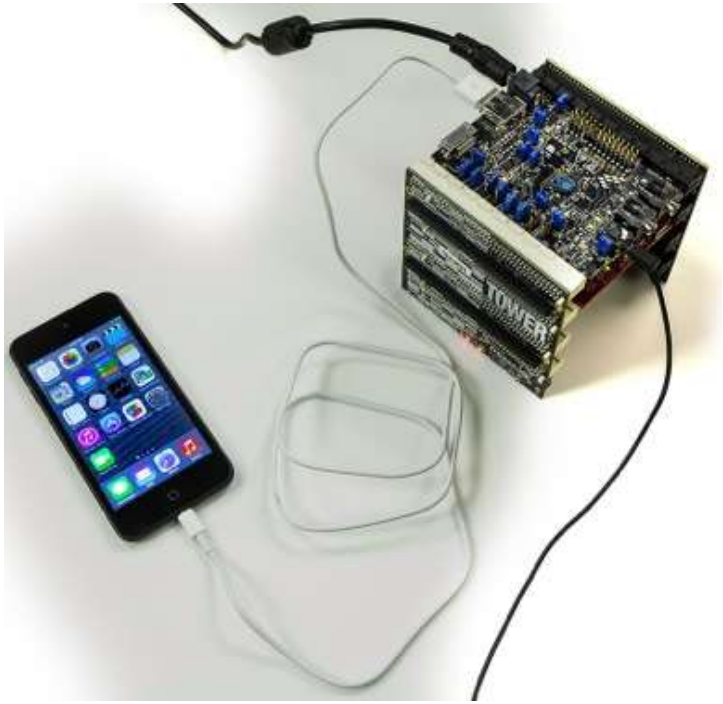
Tower System power current limit circuit (limiter set to 1A)

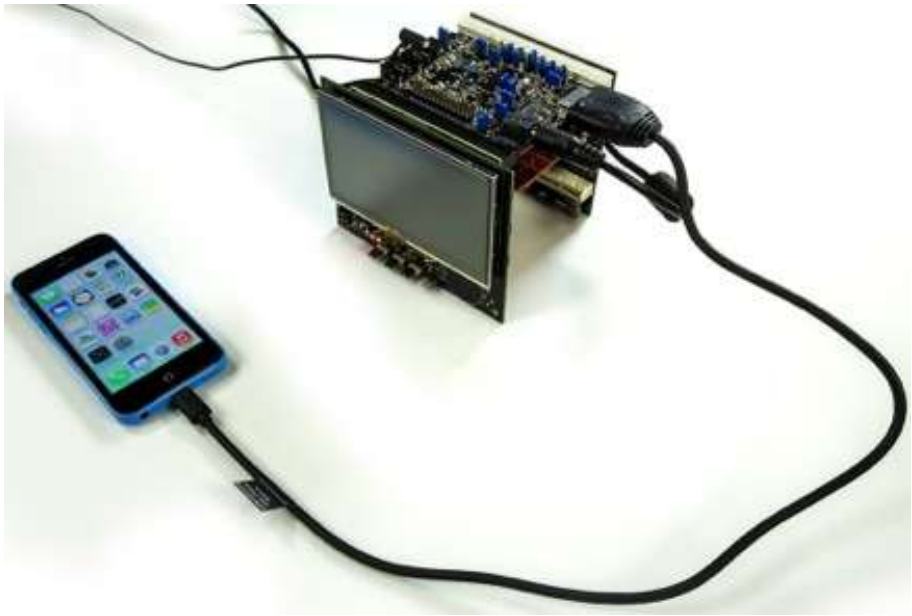
Device charge current limit circuit (limiter set to 2.5A~2.8A)

**Orderable part number ($199):**
MFI-FS-TWR-DOCK2

Made for iPod iPhone iPad

# TWR-DOCK2 Use Examples





iPhone, iPad or iPod connected to Tower system via TWR-DOCK2 and custom Lightning or 30-pin connector cable

Made for iPod iPhone iPad

Custom 30-pin connector cable (USB and Serial connection)

Custom Lightning connector cable

# TWR-DOCK2 Custom Cables

Custom 30-pin connector cable
(USB and Serial connection)

Custom Lightning
connector cable

- The TWR-DOCK2 custom cables use a JAE DD 40-pin connector to connect to the TWR-DOCK2 module
- The 40-pin connector supports all currently required signals, and allows for possible future expansion
- The set of TWR-DOCK2 custom cables support all currently available wired connection options to iPhone, iPad, and iPod devices
- The set of TWR-DOCK2 custom cables support all current iPhone, iPad, and iPod device charging specifications
- The set of TWR-DOCK2 custom cables supports the development of device power accessories

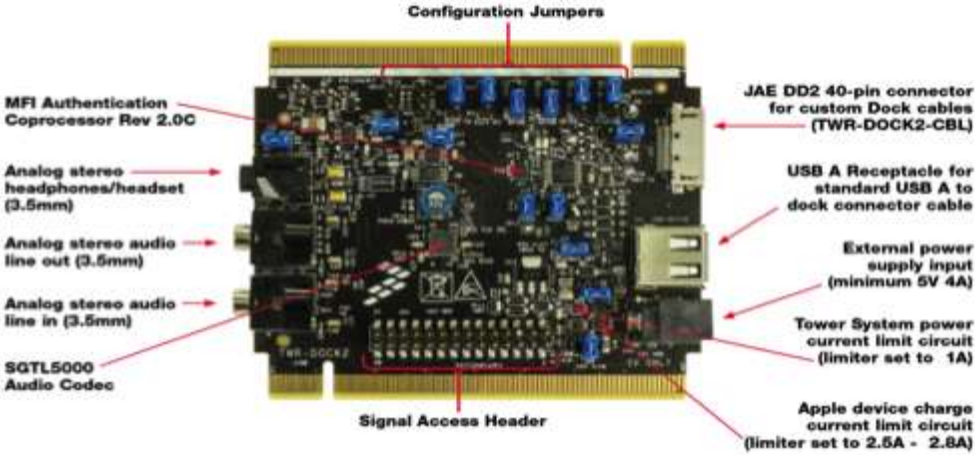
**Orderable part number ($199):** MFI-FS-TWR-DOCK2-CBL

Made for iPod iPhone iPad

# Freescale's Made For iPod (MFi) Solutions

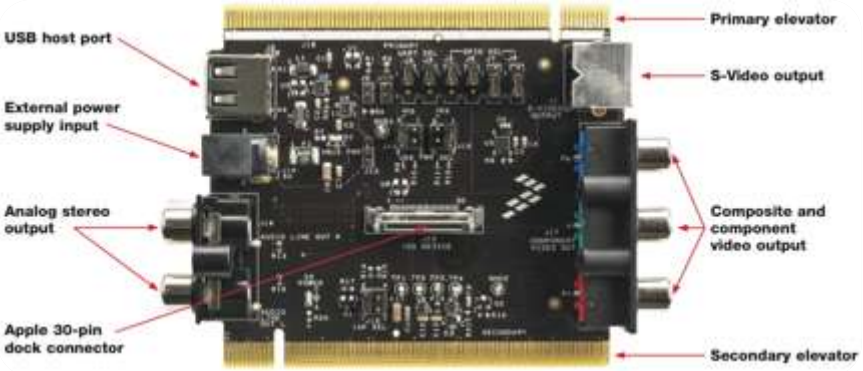
**Freescale's MFi solutions are based on the TWR-DOCK2 and TWR-DOCK peripheral modules**

## TWR-DOCK2




- Custom cables supporting all Lightning and 30-pin dock connector options for smart accessories
- USB A receptacle for standard USB to Lightning™ and to 30-pin dock connector cables
- Digital audio streaming in both directions over USB
- Includes SGTL5000 hardware audio codec for analog audio input and output
- Control and communication with various devices
- Available only on MFi Portal for $199, custom dock connector cable set sold separately for $199

## TWR-DOCK

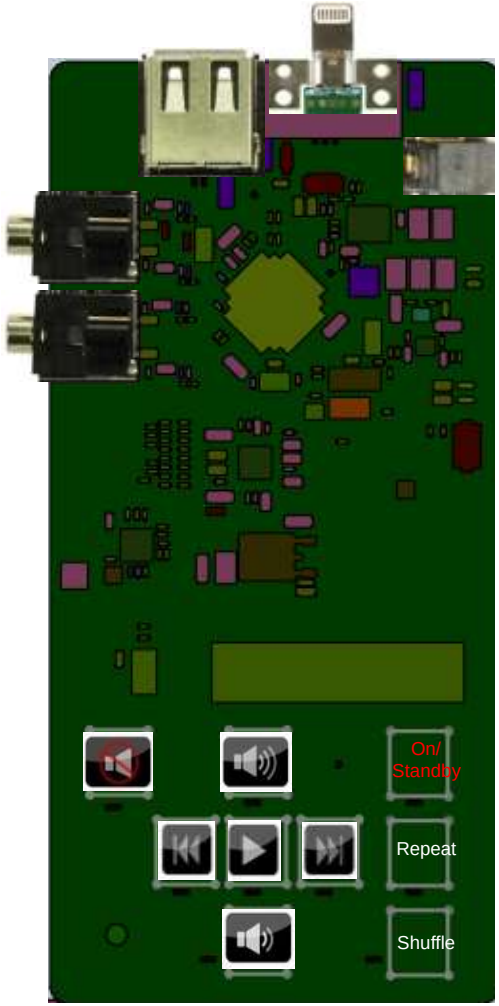



- Direct 30-pin dock connection
- USB A receptacle for standard USB to Lightning™ and to 30-pin dock connector cables
- Analog audio and video signals with standard RCA and S-Video connectors
- Digital audio streaming in both directions over USB (requires hardware audio codec module like TWR-AUDIO-SGTL or TWR-AUDIO-DA7321)
- Control and communication with various devices
- Available only on MFi Portal for $139

- Includes free interface software Kinetis K and Kinetis L MCU families
- May be used with a wide range of Tower System MCU/MPU, peripheral, sensor and communication modules
- Example demos are available
- *i.MX and Vybrid support planned for mid 2014*

# Kinetis KL26 MFi Audio Interface (MFI-KL26-AI) Module

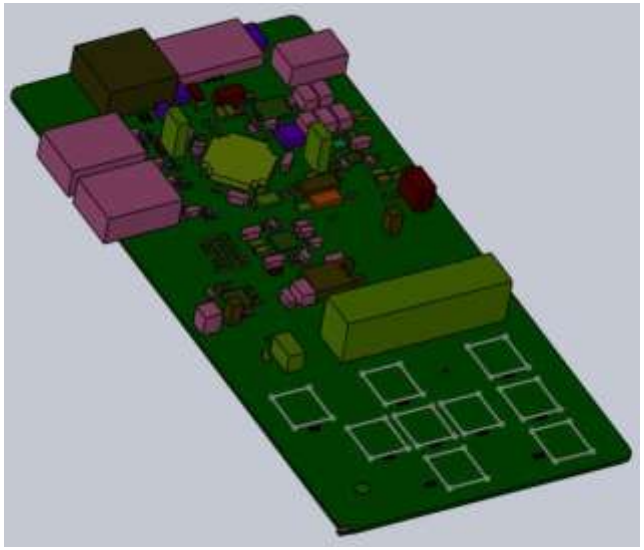
**Audio Interface Module for iPhone, iPad, and iPod devices with Apple Lightning™ connector**

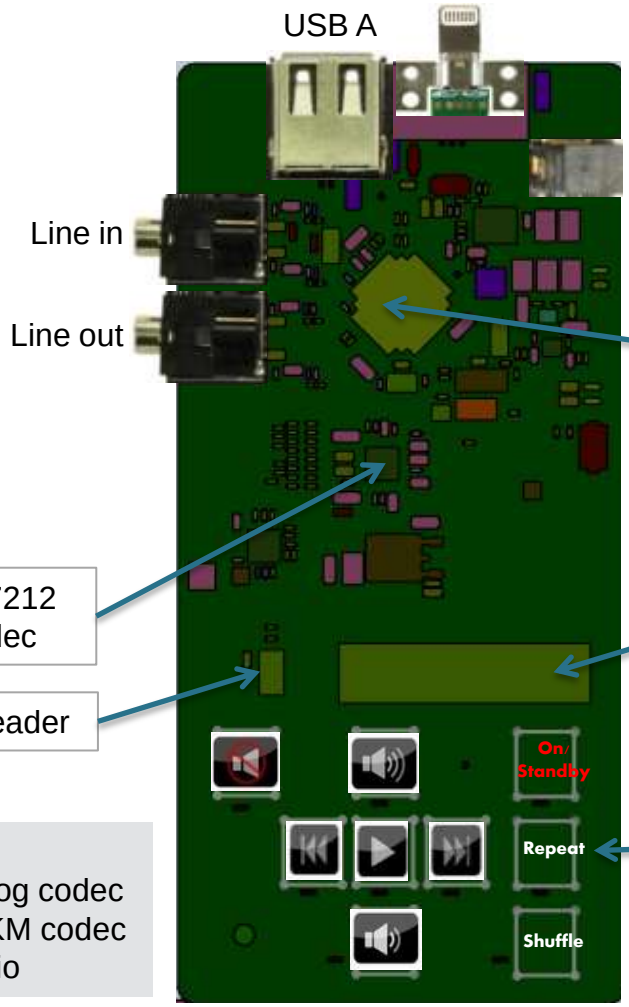



The MFI-KL26-AI provides line level analog audio input and output with basic playback control and charging for iPhone, iPad, and iPod devices with Apple Lightning dock connectors. It may be used as a reference design or basic development system.

- Kinetis KL26 MCU pre-programmed with MFi and Audio Playback control software
- Connectivity;
  - Lighting dock connector
  - USB A receptacle for use with standard USB to Lighting cables
    - Note: Physical design prevents simultaneous use of above dock connector options
  - 3.5mm analog audio line output
  - 3.5mm analog audio line input
  - Barrel receptacle for 6 to 12V power supply
  - Auxiliary header for serial, GPIO and power lines access
  - Debug interface header for use with Kinetis L MCU development tools
- Capacitive touch pads, configured for playback control
- Standard configuration;
  - Analog line audio input and output with Dialog DA7212 audio codec
- Build options;
  - Analog line audio input and output with AKM AK4954A audio codec
  - FM modulated analog audio output with Quintic QN8007B FM transmitter
- Charging current for connected device is limited to 2.4A

# MFI-KL26-AI Module

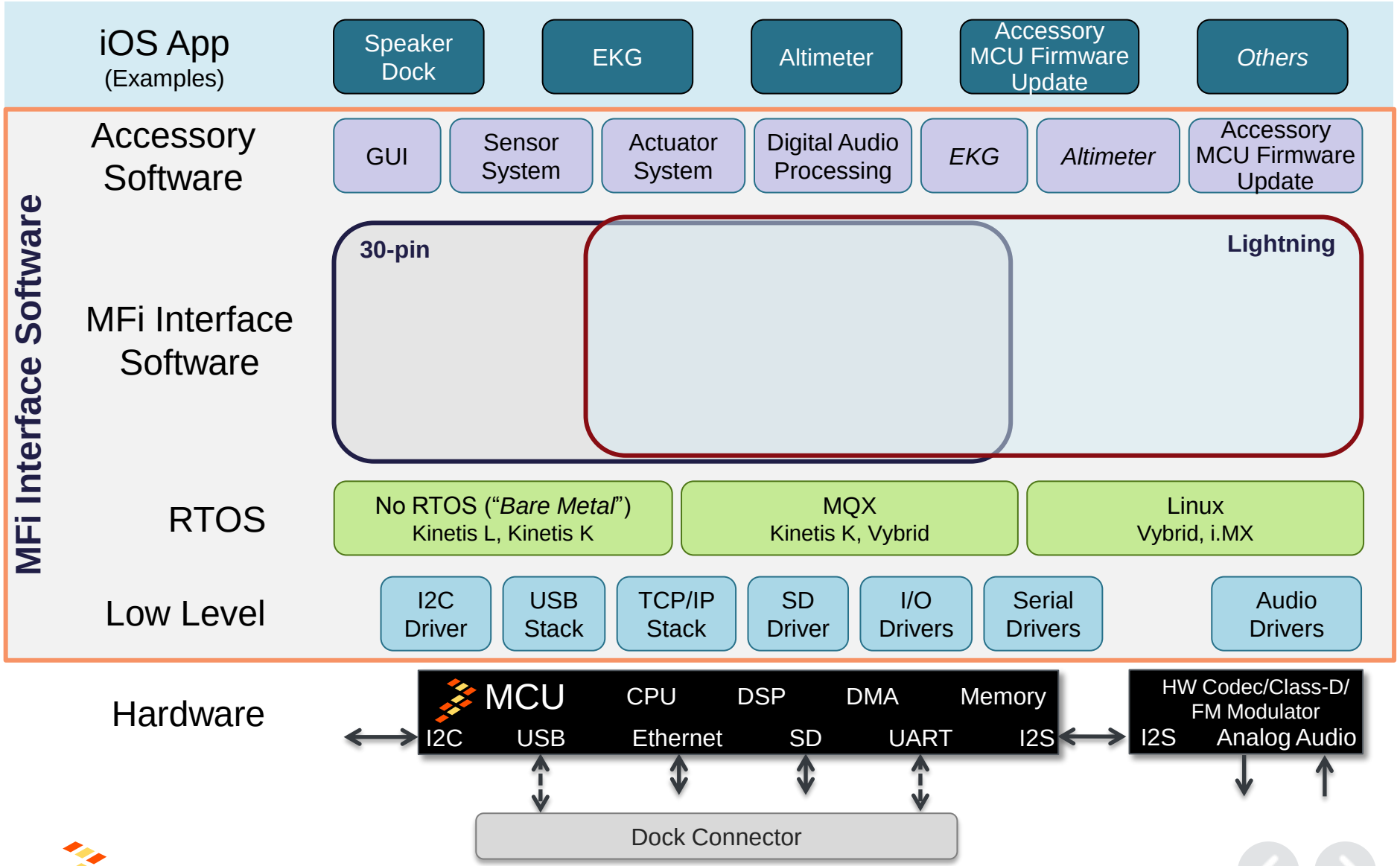




**Planned versions:**

1. MFI-KL26-AI-DA: Analog line audio with Dialog codec
2. MFI-KL26-AI-AKM: Analog line audio with AKM codec
3. MFI-KL26-AI-FM: FM modulated analog audio

# Freescale MFi Software



# Freescale MFi Software Memory Requirements

| **Use Case** (Kinetis MCU, no RTOS ) | **Approximate Memory Requirement** | |
|---|---|---|
| | **Flash (KB)** | **RAM (KB)** |
| All MFi Functions and Features | 100 | 17 |
| Digital Audio Playback for Lightning and 30-pin devices | 80 | 16 |
| Digital Audio Playback for Lightning iOS devices | 45 | 14 |
| Non-Audio Accessory using the standard USB to Lightning or 30-pin connector cables | 70 | 11 |
| Non-Audio Accessory using standard USB to Lightning connector cable for iOS devices | 40 | 9 |
| Non-Audio Accessory using built in Lightning and 30-pin dock connectors | 45 | 8 |
| Non-Audio Accessory using built in Lightning dock connector for iOS devices | 25 | 7 |
| Note: The above are approximate typical memory requirements, actual memory needs will vary depending on the actual MFi features and functions selected, compiler and optimization level used, and the size of user configurable buffers | | |

# MFi Solutions Availability Plan

| Development | Alpha | Beta | General Availability |
|---|---|---|---|

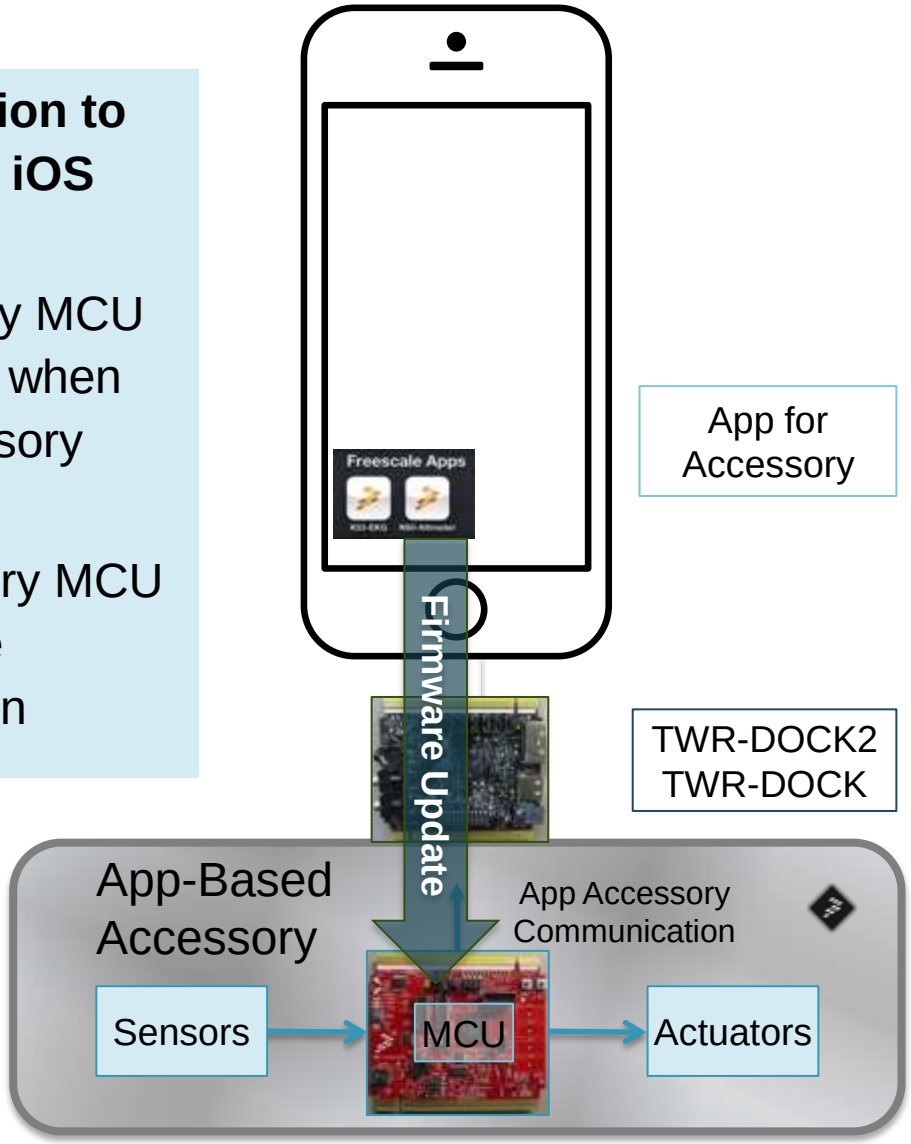
| Software Function and OS | MCU/MPU Family (CPU) | Q4-2013 | Q1-2014 | Q2-2014 | Q3-2014 | Q4-2014 |
|---|---|---|---|---|---|---|
| MFi no OS | Kinetis L | Beta | | | | |
| | Kinetis K | Beta | | | | |
| MFi MQX (integrated in FAS) | Kinetis K | Development | Alpha | Alpha | Beta | |
| | Vybrid (M4) | Development | Alpha | Alpha | Beta | |
| | Vybrid (A5) | Development | Alpha | Alpha | Beta | |
| MFi Linux (integrated in FAS) | Vybrid (A5) | Development | Alpha | Alpha | Beta | |
| | i.MX6 | Development | Alpha | Alpha | Beta | |

Notes: Subject to change

# Accessory Firmware Update

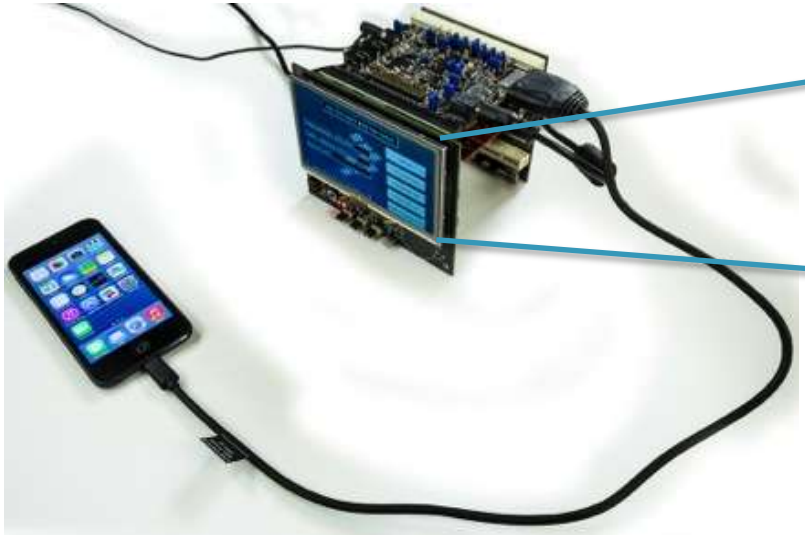
**Freescale MFi Software includes a function to update Accessory MCU firmware via the iOS App:**

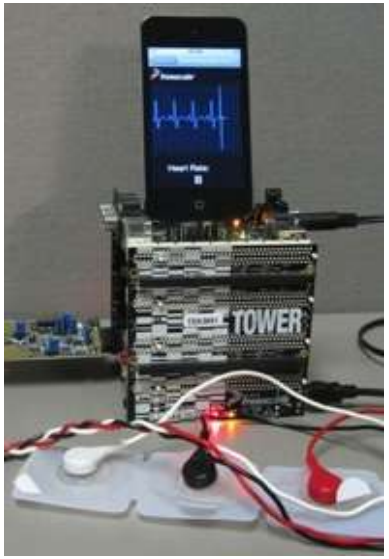
- An App update may include the Accessory MCU firmware update, which will be completed when the iOS device is connected to the Accessory with the App active
- This supports secure method of  Accessory MCU firmware updates without the need for the Accessory to include a network connection




*Available as Beta now, will be included in next release of Freescale MFi software*

# Freescale‘s MFi Demo Software






**Demos:**

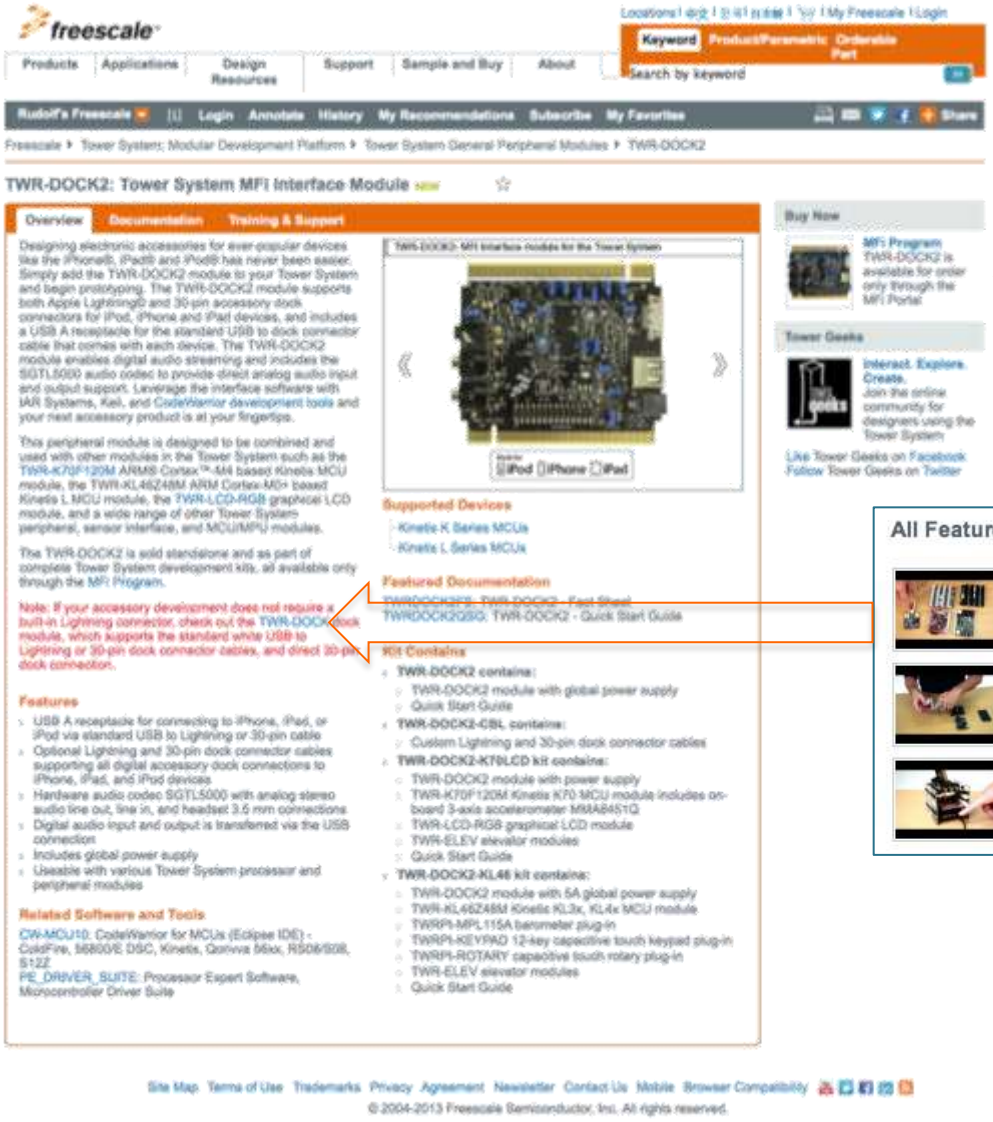
- Simple iPod control with digital audio– *Now*
- iPod control functions with GUI and digital audio – *Now*
- Digital audio streaming with optional post processing, and iOS App control – *Planned*
- iOS App based EKG– *Available with Lightning connector*
- iOS App based Altimeter – *Available with Lightning connector*

***What other demos would you like?***

**Devices:**

- Tested with all iPhone, iPad, and iPod devices introduced since 2009

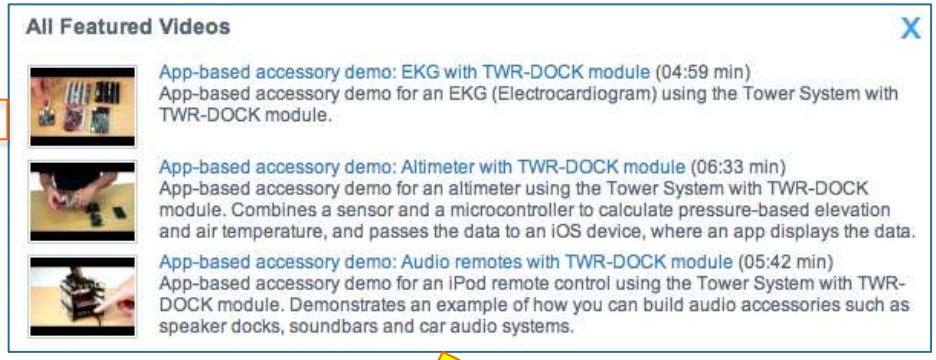
# TWR-DOCK2 Freescale Web Page




For more information and the TWR-DOCK Fact Sheet, visit:

http://www.freescale.com/mfi

Link to Apple MFi developer web page



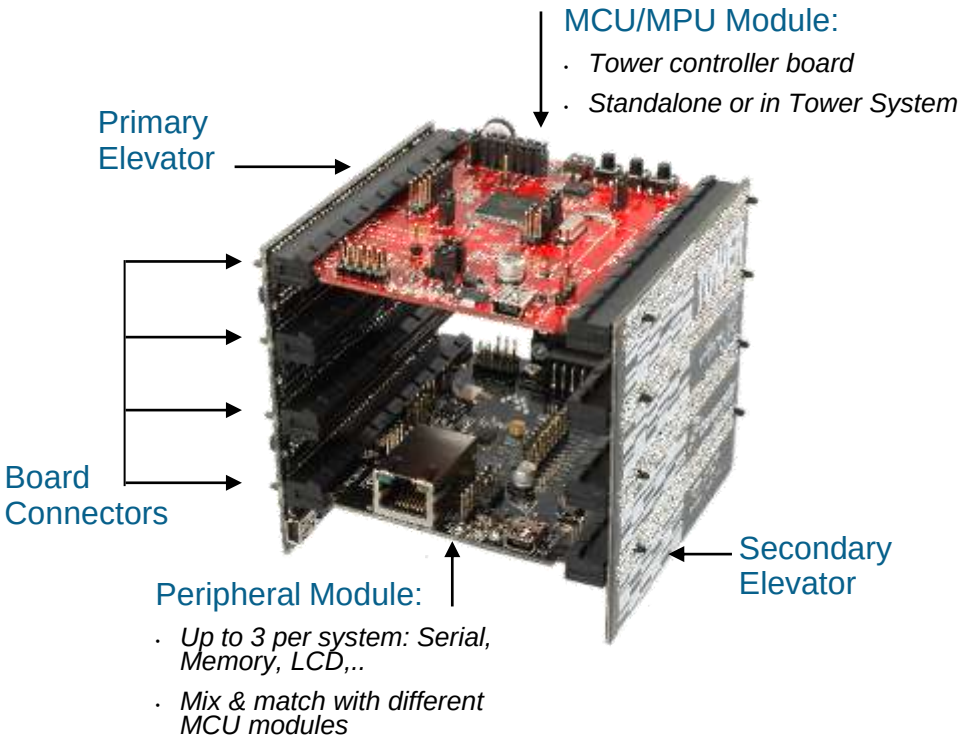

Check out the videos!
(On the TWR-DOCK Web Page)

# Tower System: Development and Rapid Prototyping

# The Freescale Tower System

## A modular development platform for 8-/16-/32-bit MCUs & MPUs

- Quickly combine Tower modules to build a prototype of your application
- Modules sold individually or in kits
- Open Source: Build your own Tower module to integrate your IP
- Cost-optimized hardware
- Software support from Freescale and Third Parties
- Growing community of Third Party hardware support
- On-line community: www.towergeeks.org




Rapidly build a prototype of your end application

Support for all ColdFire+ and Kinetis MCUs!

TWR-MEM

TWR-LCD

TWR-SENSOR-PAK

# Available Tower System Modules

**Processor Modules** (USD $39-$119)

8-bit

TWR-S08LL64
TWR-S08LH64
TWR-S08JE128
TWR-S08MM128
TWR-S08GW64
TWR-S08UNIV

16-bit

TWR-S12GN32
TWR-S12G128

DSC

TWR-56F8257

32-bit - ColdFire

TWR-MCF51JE
TWR-MCF51CN
TWR-MCF51MM
TWR-MCF51QM
TWR-MCF5225X
TWR-MCF5441X

32-bit – Power Architecture

TWR-MPC5125

32-bit Kinetis

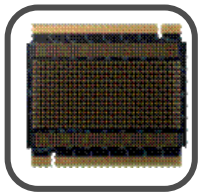
TWR-K60D100M
TWR-K70F120M
TWR-K40X256
TWR-K60N512-IAR
TWR-K60N512-KEIL
TWR-K53N512
KWIKSTIK-K40

**Peripheral Modules** (USD $15 – $149)

Serial

TWR-SER
TWR-SER2

Prototyping



TWR-PROTO

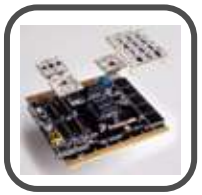
Wi-Fi

TWR-WIFI-RS2101
TWR-WIFI-G1011MI
TWR-WIFI-AR4100

Memory

TWR-MEM

Sensors & Plug-Ins



TWR-SENSOR-PAK
TWR-SENSOR-PAK-AUTO
TWRPI-MMA6900
TWRPI-MPL115A

Displays

TWR-LCD-RGB

Medical

MED-EKG

Analog

TWR-ADCDAC-LTC

Mesh Networking

TWR-RF-SNAP

Audio

TWR-AUDIO-DA7321

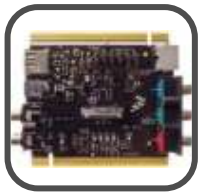
Audio

TWR-AUDIO-SGTL

MFi

TWR-DOCK2

MFi



TWR-DOCK

freescale™

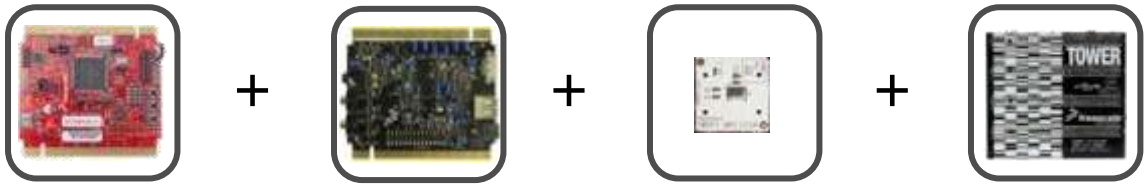


Visit www.freescale.com/tower

# Example Tower System MFi System Configurations

TWR-K60D100M + TWR-DOCK2 + TWR-ELEV = MFi Simple Digital Speaker Dock

TWR-K53N512 + MED-EKG + TWR-DOCK + TWR-ELEV = iOS App Based EKG



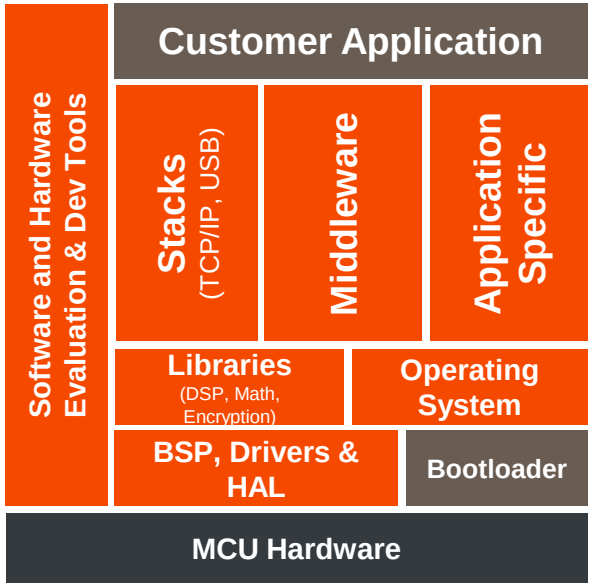

TWR-K60D100M + TWR-DOCK2 + TWRPI-MPL115A + TWR-ELEV = iOS App Based Altimeter

TWR-K70F120M + TWR-LCD-RGB + TWR-DOCK2 + TWR-ELEV = MFi GUI Digital Speaker Dock

# Freescale Processor Expert Software

Create, configure, generate software and drivers for Freescale microcontrollers.

Master complex peripherals with a few mouse clicks, without the need to read thousands of data sheet pages.



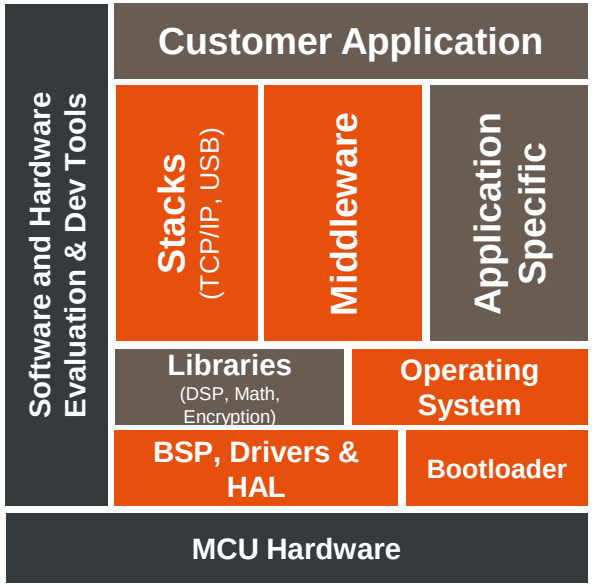

## Product Features

- Standalone or Integrated for
  - Eclipse based IDE's
  - Freescale CodeWarrior
  - IAR Embedded Workbench
  - Keil MDK
- Supports Kinetis, S08, S12, S12Z, ColdFire, DSC and Power Architecture with reusable software components
- Knowledge base of pins, registers, muxing, clocks and dependencies
- Initialization and driver code generation with design time consistency checking
- Bare Metal and RTOS drivers
- On-chip and Off-chip Device Drivers
- Middleware and Stacks: RTOS, TSS libraries and communication stacks
- Component Development Environment (CDE) to create and distribute own components

# Freescale MQX™ Software Solutions

Commercial-grade MCU software platform at no cost with optional support packages

Enabling the development of connected and intelligent applications of the future




## Product Features

- MQX™ Real Time Operating System Kernel
  - Deterministic multi-tasking preemptive scheduler
  - Extensive inter-task synchronization, message passing, and much more
- MQX™ Real Time Communication Suite

  *Now with optional IPv6 add-on package*
  - Broad networking protocol support (TCP,UDP, ICMP, HTTP, DHCP, FTP, Telnet, …)
  - Fully re-entrant, responsive, designed for embedded systems
- MQX™ File System
  - Embedded FAT file system compatible with FAT-12, FAT-16, or FAT-32 file systems
- MQX™ USB Host/Device Stack
  - USB 1.0/2.0; low-/full-/high-speed
- Board Support Packages
  - Pre-configured MQX Kernel, stacks, and peripheral drivers for Freescale HW

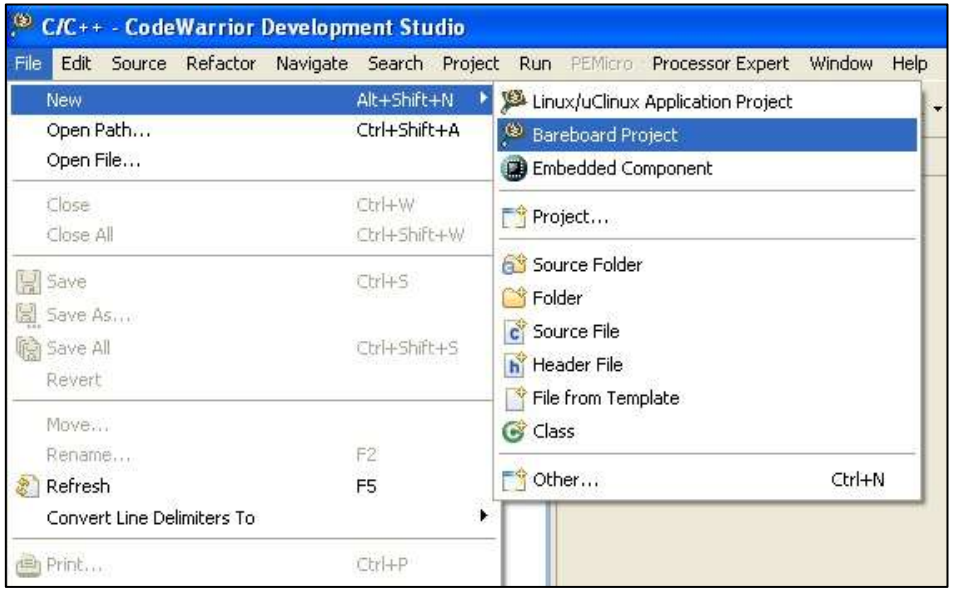
# Creating a New MFi Project 1

The Freescale MFi solution is released for the following development suites:

- CodeWarrior
- IAR
- Keil

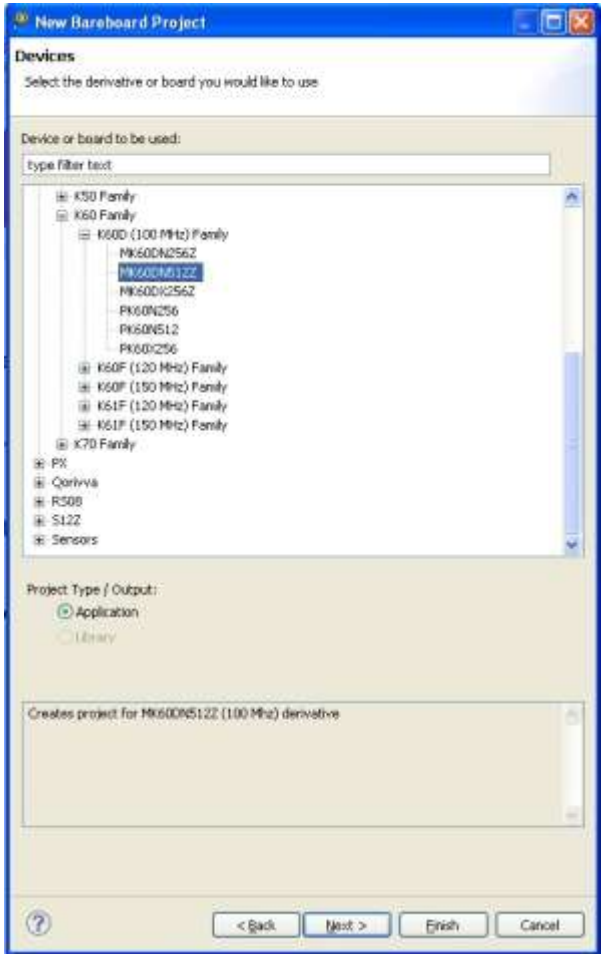
*The following examples are based on CodeWarrior (showing selected steps only)*

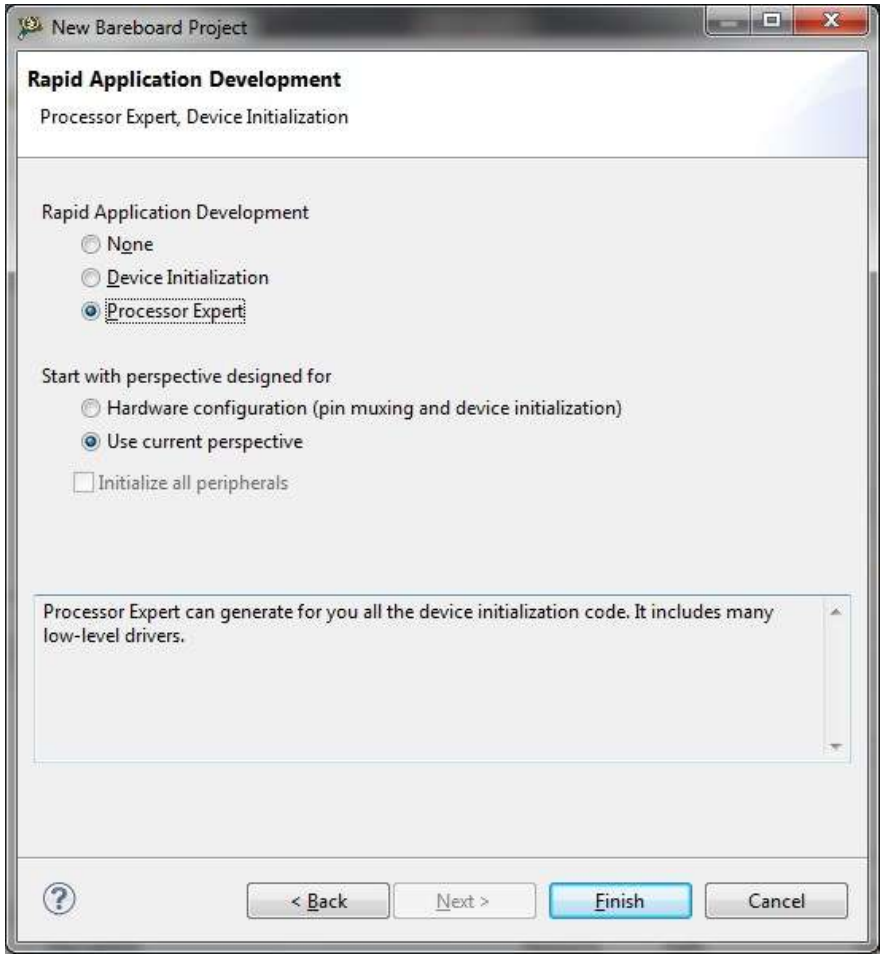
Open CodeWarrior and select the New Project Wizard:



# Creating a New MFi Project 2

Select the target MCU device, and the Processor Expert configuration tool:



# Creating a New MFi Project 3

CodeWarrior Window after Project Creation:

C/C++ - Kinetis PEx Test/Sources/ProcessorExpert.c - CodeWarrior Development Studio

File Edit Search Project Run MQX Tools Processor Expert Window Help

CodeWarrior Projects

| File Name | Size | Type |
|---|---|---|
| ProcessorExpert.pe | 873 KB | Processor Exp |
| Project_Headers | | |
| Project_Settings | | |
| RAM | | |
| Sources | | |
| Events.c | 1 KB | C Source File |
| Events.h | 1 KB | C Header File |
| ProcessorExpert.c | 2 KB | C Source File |

Components Library | Component Inspector - Cpu

Properties | Methods | Events | Build options | Resources

| Name | Value | Details |
|---|---|---|
| CPU type | MK60DN512VLQ10 | |
| Clock settings | | |
| Initialization priority | minimal priority | 15 |
| Watchdog disable | yes | |
| CPU interrupts/resets | | |
| External Bus | Disabled | |
| Clock configurations | 1 | |

Outline

C:\Users\r80267\Documents\EmbeddedSW\
Cpu.h
Events.h
PE_Types.h
PE_Error.h
PE_Const.h
IO_Map.h
main(void) : int

Components - Kinetis PEx Test

Generator_Configurations
RAM
FLASH
OSs
Processors
Cpu:MK60DN512VLQ10
Cpu:MK60DN512VLQ10
Components

ProcessorExpert.c

```
13 **         No public methods
14 **
15 ** ###################################################################*/
16 /* MODULE ProcessorExpert */
17
18
19 /* Including needed modules to compile this module/procedure */
20 #include "Cpu.h"
21 #include "Events.h"
22 /* Including shared modules, which are used for whole project */
23 #include "PE_Types.h"
24 #include "PE_Error.h"
```

Commander

Project Creation: Import project, Import example project, Import MCU executable file, New MCU project

Build/Debug: Build (All), Clean (All), Debug

Problems | Console

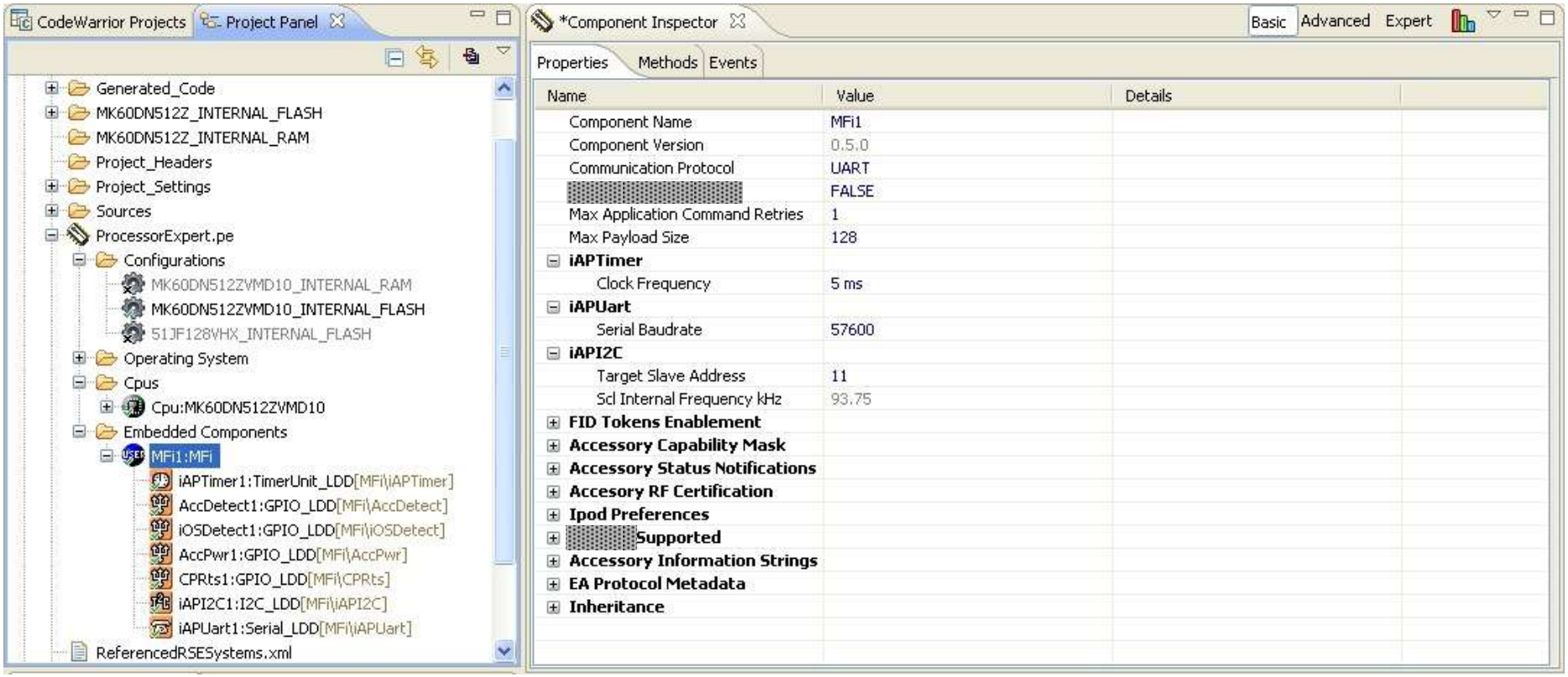
0 items

| Description | Resource | Path | Location | Type |
|---|---|---|---|---|

Writable | Smart Insert | 7 : 32

# Creating a New MFi Project 4

Project Panel and Component Inspector windows:



# Creating a New MFi Project 5

MFi Component Inspector window:

Components Library | *Component Inspector - MFi1 | Components - MFI_iap2

Properties | Methods | Events

| Name | Value | Details |
|---|---|---|
| Component Name | MFi1 | |
| Component Version | 0.6.0 PreBeta Integration 04 | |
| iPod Accessory Protocol selection | | |
| Accessory Communication Protocol | UART | |
| iPod iPhone and iPad Device | FALSE | |
| **iAPTimer** | | |
| Clock Frequency | 5 ms | |
| **iAPUart** | | |
| Serial Baudrate | 57600 | |
| **iAPI2C** | | |
| Target Slave Address | 11 | |
| Scl Internal Frequency kHz | 75.0 | |
| **Accessory Information** | | |
| Vendor ID | 0000 H | |
| Product ID | 0000 H | |
| Accessory Name | Accessory Name | |
| Accessory Manufacturer | Accessory Manufacturer | |
| Accessory Model | Accessory Model | |
| Accessory Serial Number | 000001 | |
| **Firmware version** | | |
| Firmware Major | 00 H | |
| Firmware Minor | 06 H | |
| Firmware Revision | 00 H | |
| **Hardware version** | | |
| Hardware Major | 00 H | |
| Hardware Minor | 00 H | |
| Hardware Revision | 00 H | |
| **External Application Info** | | |
| Preferred App Bundle Seed Identifier | | |
| **External Accessory Protocol** | 1 | |
| **Power options** | | |
| Power Source Type | None | |
| Maximum Current Drawn from Device in mA | 10 D | |

# Creating a New MFi Project 6

MFi interface software, and Digital Audio configuration:

Component Inspector

Properties | Methods | Events

| Name | Value | Details |
|---|---|---|
| Component Name | MFi1 | |
| Component Version | 0.6.0 PreBeta Integration 04 | |
| iPod Accessory Protocol selection | | |
| Accessory Communication Protocol | USB | iPod, iPhone |
| iPod iPhone and iPad Device | FALSE | |
| **iAPTimer** | | |
| **iAPUart** | | |
| **iAPI2C** | | |
| | | |
| | | |
| **Digital Audio Configuration** | | |
| Audio Buffer Size | 1 Kbyte | Buffer can st |
| **Digital Audio Sampling Rates Enablers** | yes | |
| Digital Sample Rate 32kHz | FALSE | |
| Digital Sample Rate 44_1kHz | TRUE | |
| Digital Sample Rate 48kHz | TRUE | |
| Codec Support | SGTL5000 | |
| Sample Size | 16 bits | |
| **SGTL5000 Configuration** | yes | |
| SGTL5000 Slave Address | 0A | |
| System Master Clock | 24.576 | MHz |
| **Digital Audio type selection** | Synchronous | |
| **Sample Rate Compensator usage** | no | |
| **I2S bus configuration** | | |
| I2S mode selection | I2S slave | |
| I2S alligment selection | Left justified | |
| **GPIO usage** | | |
| SGTL5000 I2C address pin | no | |
| Coprocessor I2C address pin | yes | |

Component Inspector - MFi1 | Components Library

Properties | Methods | Events

| Name | Value |
|---|---|
| Component Name | MFi1 |
| Component Version | 0.6.0 PreBeta 05 |
| iPod Accessory Protocol selection | |
| Accessory Communication Protocol | USB |
| iPod iPhone and iPad Device Authentication | FALSE |
| Digital Audio Usage | no |
| **iAPTimer** | |
| Clock Frequency | 5 ms |
| **iAPUart** | |
| Serial Baudrate | 57600 |
| **iAPI2C** | |
| Target Slave Address | 11 |
| Scl Internal Frequency kHz | 75.0 |
| **Accessory Information** | |
| | |
| | |
| enabler | TRUE |
| **Identification Information** | |
| Current Language | English |
| **Supported Languages** | 1 |
| **Transport Component** | USB Host Component |
| **Human Interface Device Component usage** | TRUE |
| **Feature Support** | |
| Accessory | TRUE |
| Accessory | TRUE |
| Comm with iOS App | FALSE |
| Assistive Touch | FALSE |
| **External Accessory Protocol** | FALSE |
| Device | FALSE |
| Bluetooth Pairing and Connection Status | FALSE |
| Human Interface Device | TRUE |
| Location | FALSE |
| **Media Library Access** | FALSE |
| **Now Playing** | TRUE |
| **Power** | FALSE |
| **USB Device Mode Audio** | FALSE |
| Voice Over | FALSE |
| | FALSE |
| **Digital Audio Configuration** | |

# Android Accessories

# Android Accessories Introduction

## Android Accessories do not require licensing from Google, but several interface approaches are used

- Android Open Accessory Protocol (AOAP), version 2.0
  - Optionally supported on Android 4.1 (Jelly Bean) and above
- USB Mass Storage Device (file access only)
  - Requires MP3 etc decoding, and does not support device based playback control
- Some manufacturers use USB OTG, allowing the Android device to act as Host and stream digital audio compatible with USB Audio Class 2.0

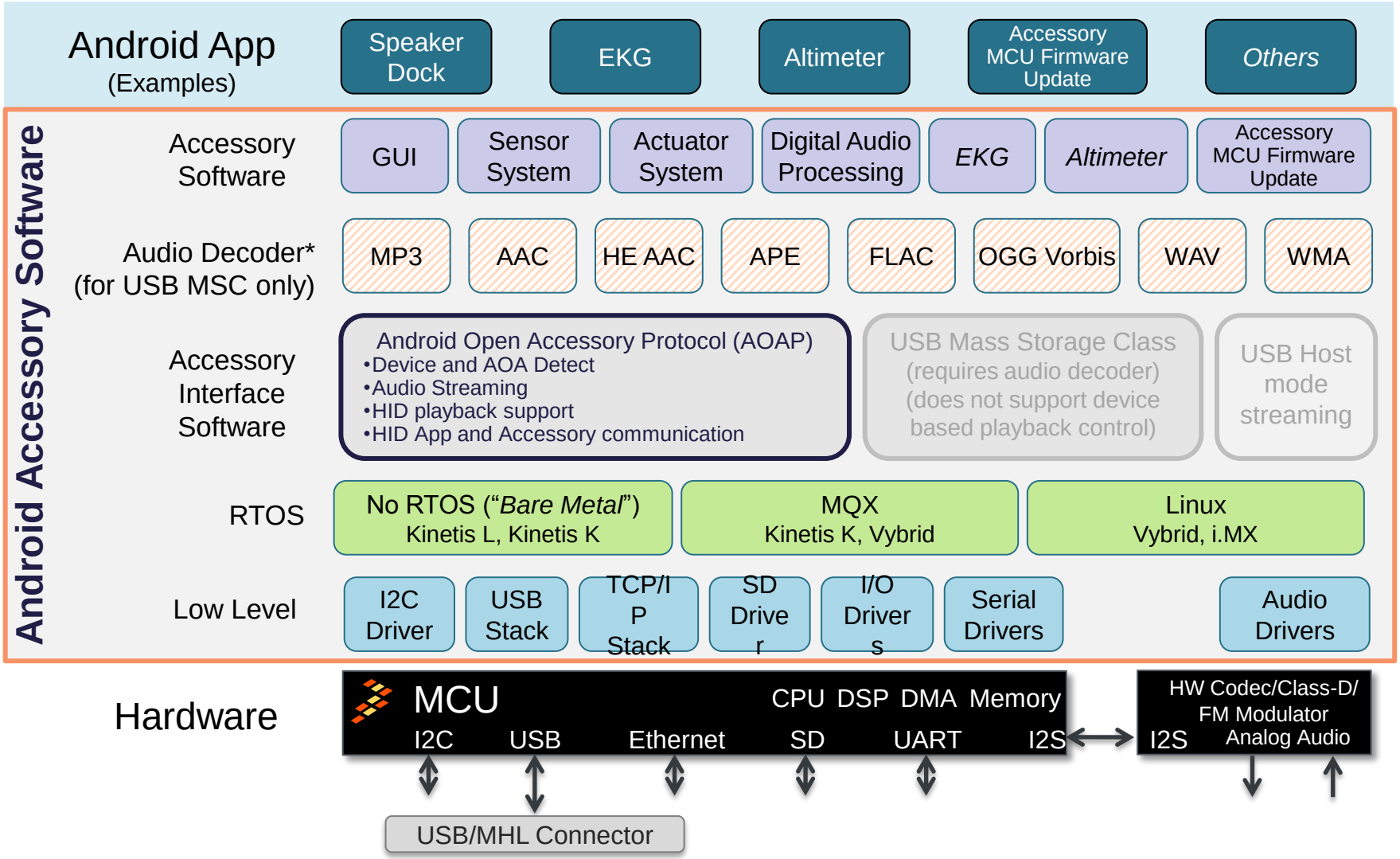
## Connectors

- USB (mini or micro) are the standard connectors, with the Android device generally being the USB Device, although some support USB OTG in order to support USB Audio Class 2.0
- Mobile High-Definition Link (MHL) is a new connector option (5 or 11 pin) that supports “HDMI” video and audio, and USB OTG
- **No special interface hardware is required for Android devices**

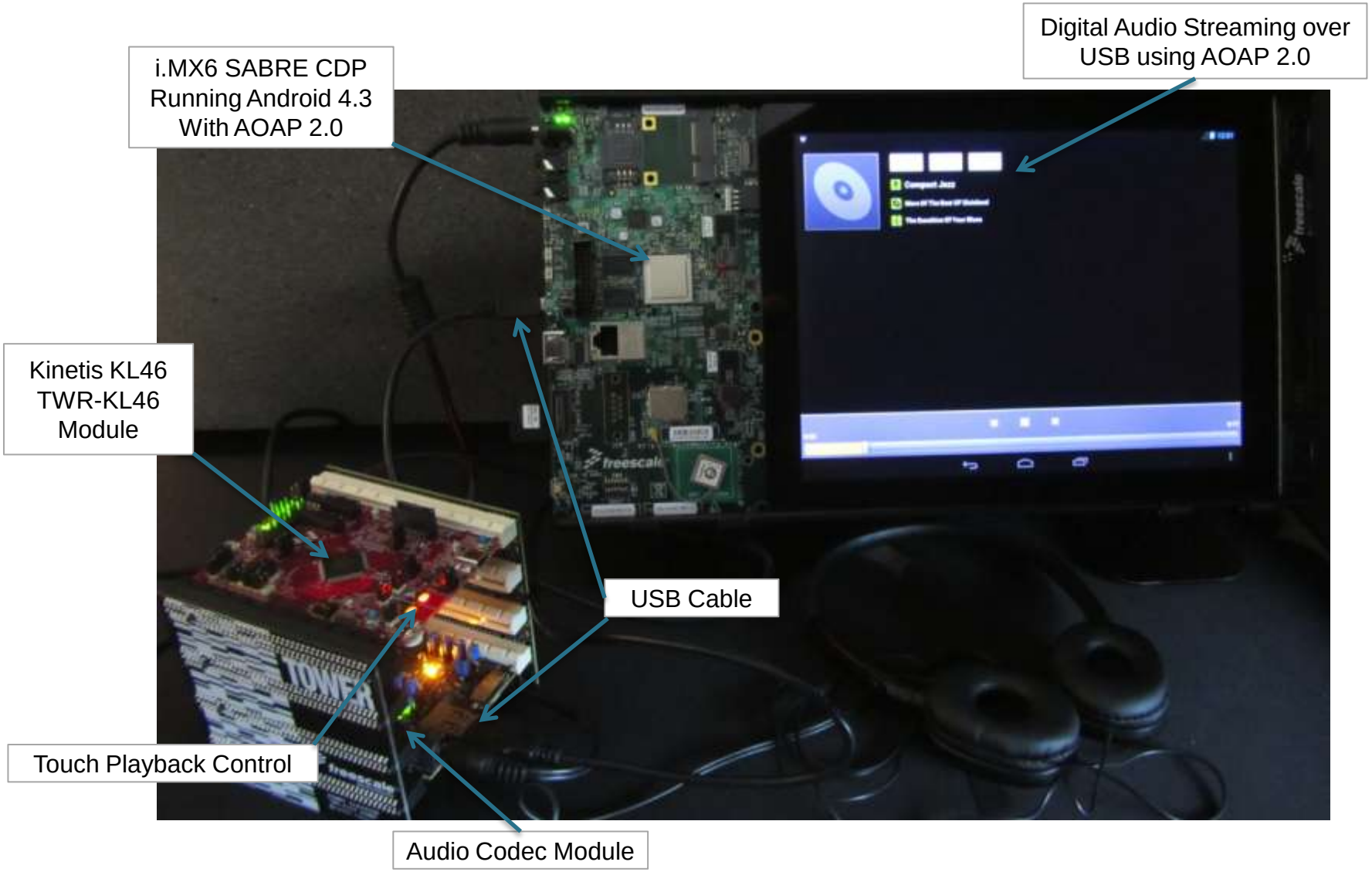
# Android Accessory Connection Options

| Connection | Wired | | | Wireless | | |
|---|---|---|---|---|---|---|
| | USB mini | USB micro | MHL | BLE | BT | WiFi |
| | | | | Bluetooth 4.0 | Bluetooth | |
| Audio Supported | Digital | Digital | Digital | No | Yes | DLNA, WiFi Direct, Miracast |
| Video Supported | No | No | Yes (*"HDMI"*) | No | No | DLNA, WiFi Direct, Miracast |
| Notes/ Comments | AOAP is optional from Android 4.2 | AOAP is optional from Android 4.2 | Video and USB Host mode audio | Wearables and Home Automation | A2DP audio, Handsfree | Requires MirrorLink for control |

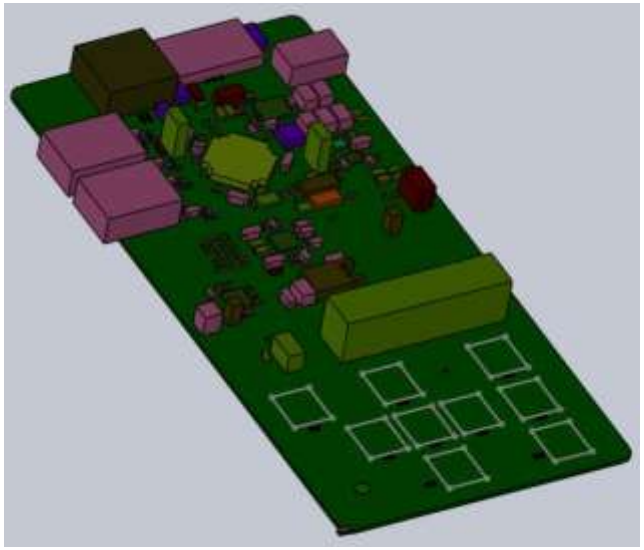
# Freescale Android Accessory Software

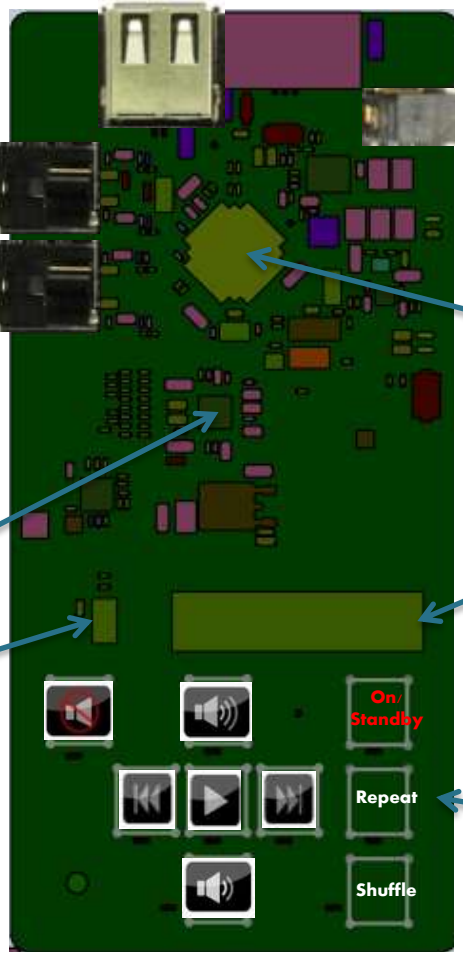


# i.MX6 Android Tablet Streaming Audio to Kinetis KL46



# Audio Interface Reference Design





**Planned versions:**

1. AOAP-KL26-AI-DA: Analog line audio with Dialog codec
2. AOAP-KL26-AI-AKM: Analog line audio with AKM codec
3. AOAP-KL26-AI-FM: FM modulated analog audio

Available in early 2Q2014

# AOAP Solutions Release Plan

| Development | Alpha | Beta | General Availability |
|---|---|---|---|

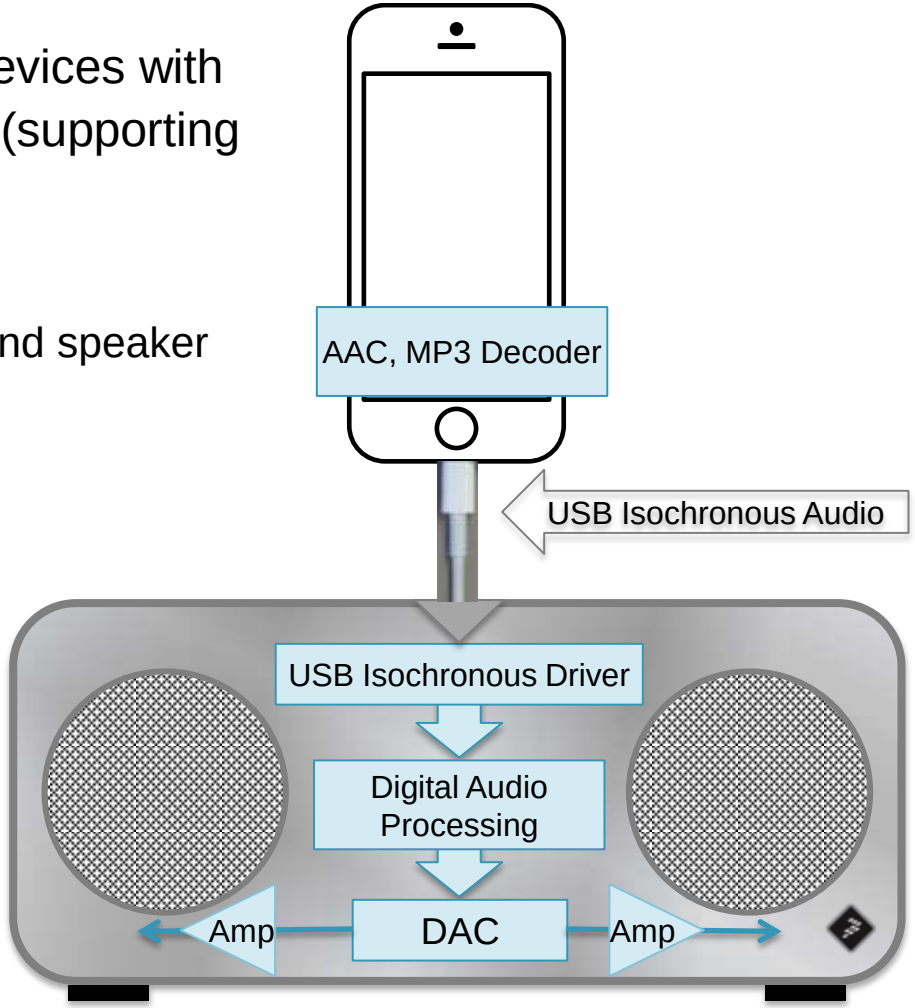
| Software Function and OS | MCU/MPU Family (CPU) | Q4-2013 | Q1-2014 | Q2-2014 | Q3-2014 | Q4-2014 |
|---|---|---|---|---|---|---|
| AOAP no OS | Kinetis L | | ● | ● | | |
| | Kinetis K | | ● | ● | | |
| AOAP MQX (integrated in FAS) | Kinetis K | | ● | ● | ● | |
| | Vybrid (M4) | | ● | ● | ● | |
| | Vybrid (A5) | | ● | ● | ● | |
| AOAP Linux (integrated in FAS) | Vybrid (A5) | | ● | ● | ● | |
| | i.MX6 | | ● | ● | ● | |

Notes:
1. Subject to change
2. FAS is Freescale Audio Solution Framework

# Accessory Demos and Examples

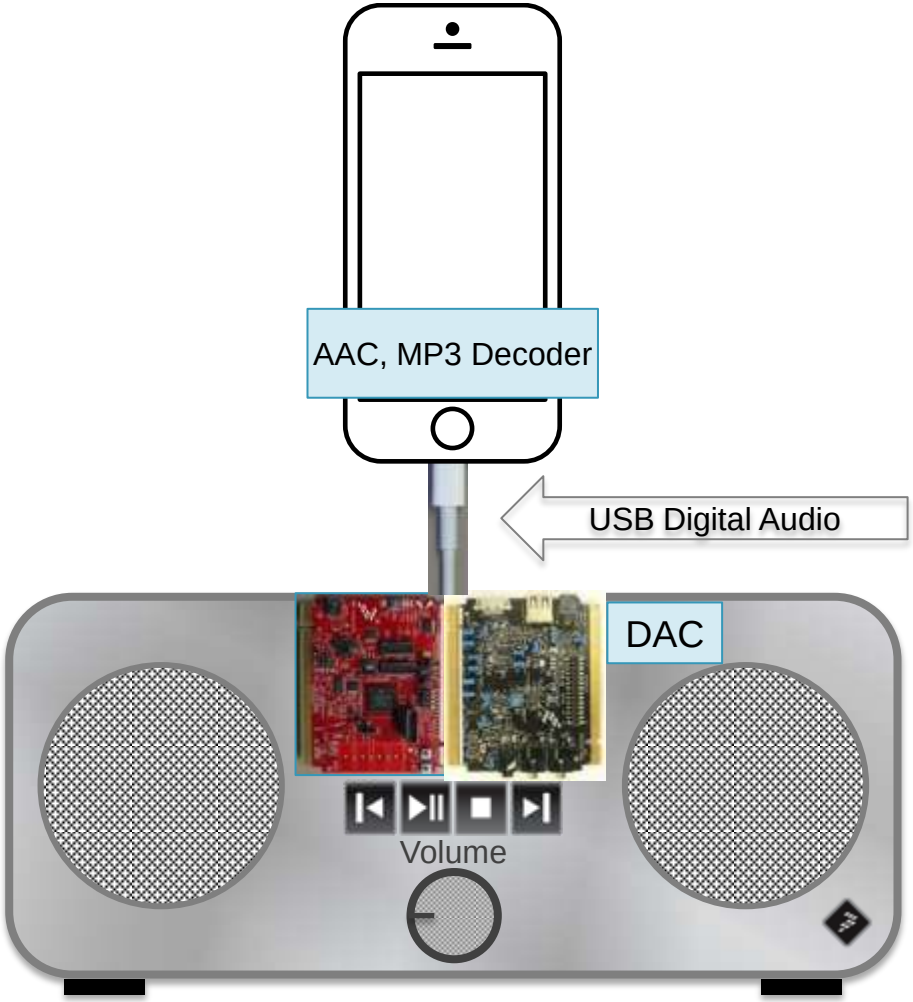
# Fully Digital Speaker Dock

- Required with all iPhone, iPad and iPod devices with Lightning connector, and Android devices (supporting AOAP)
- Best potential audio quality
  - Depends only on quality of source material and speaker dock implementation
- Easy to add digital audio processing



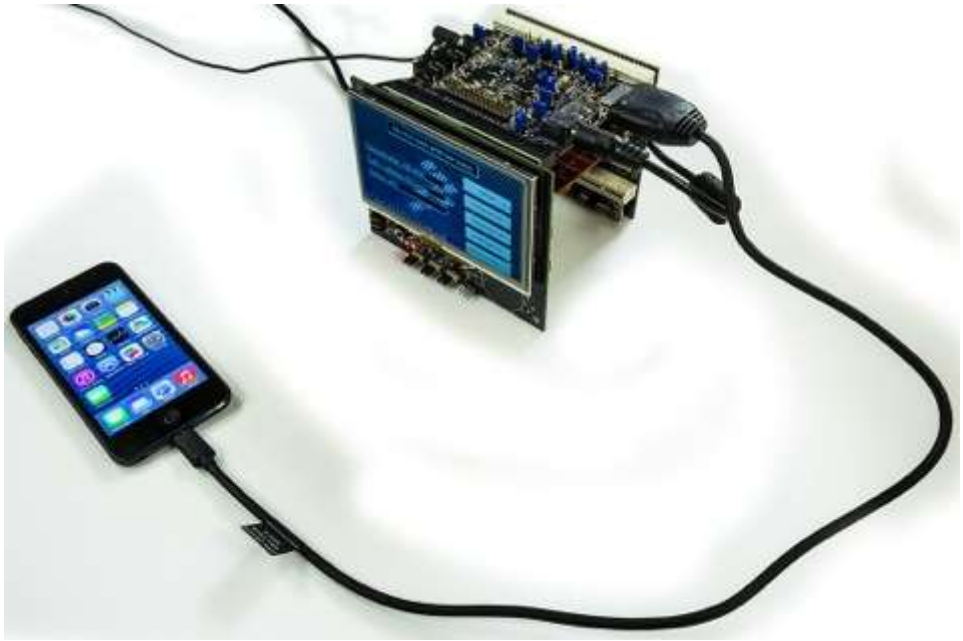
# Demo example: Simple Speaker Dock

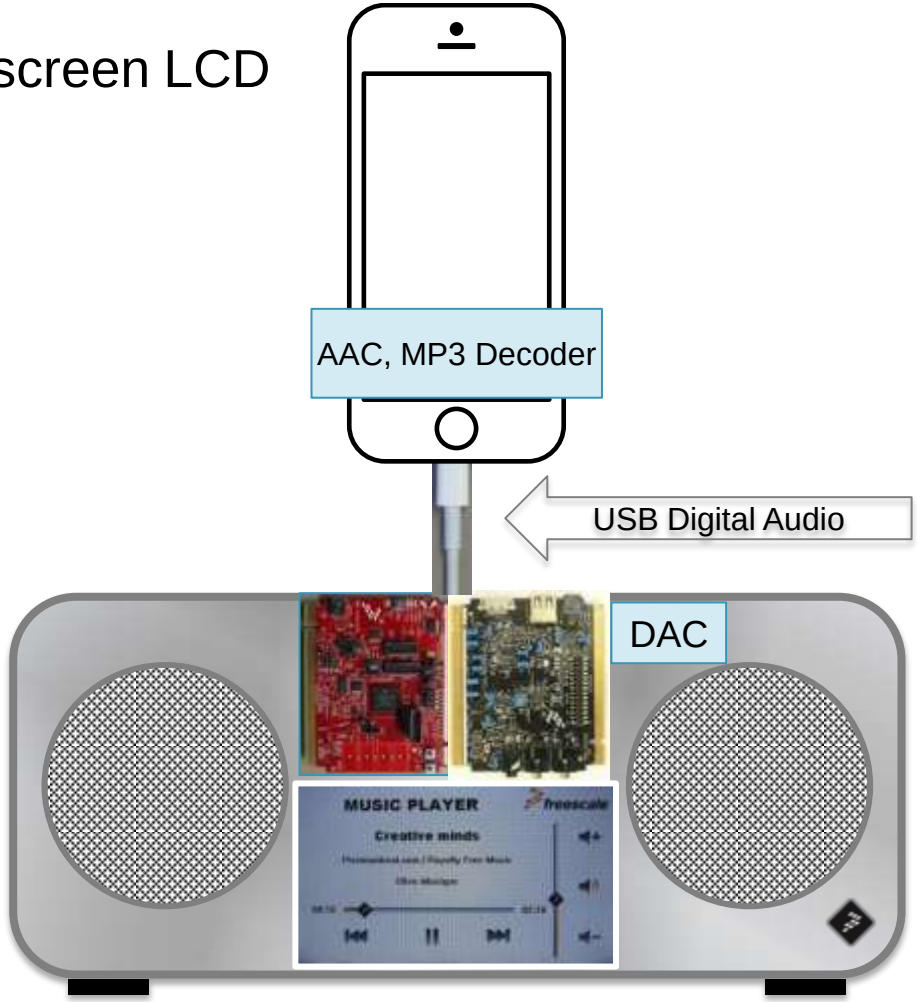
- Simple playback control
- USB digital audio streaming, or
  - Optional analog audio line output
- Optional digital audio processing



# Demo example: GUI Speaker Dock

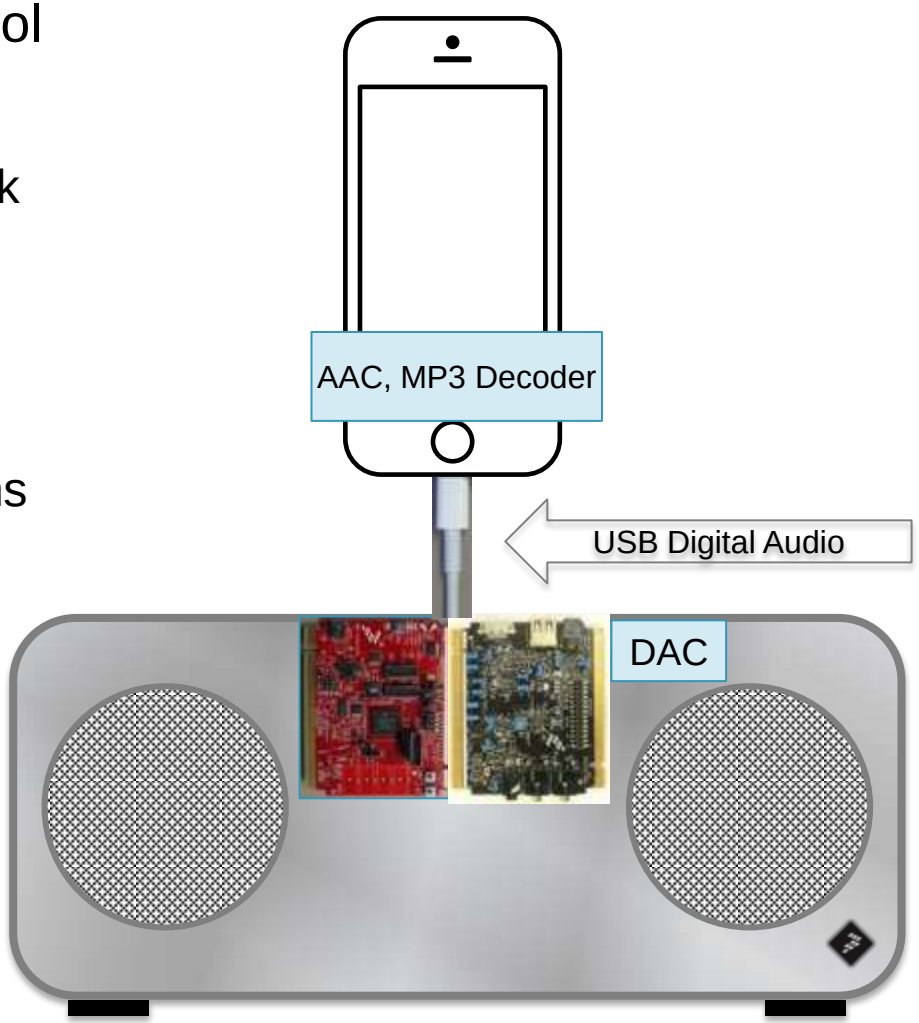
- Playback and audio control via touchscreen LCD
- USB digital audio streaming, or
  - Optional analog audio line output
- Optional digital audio processing





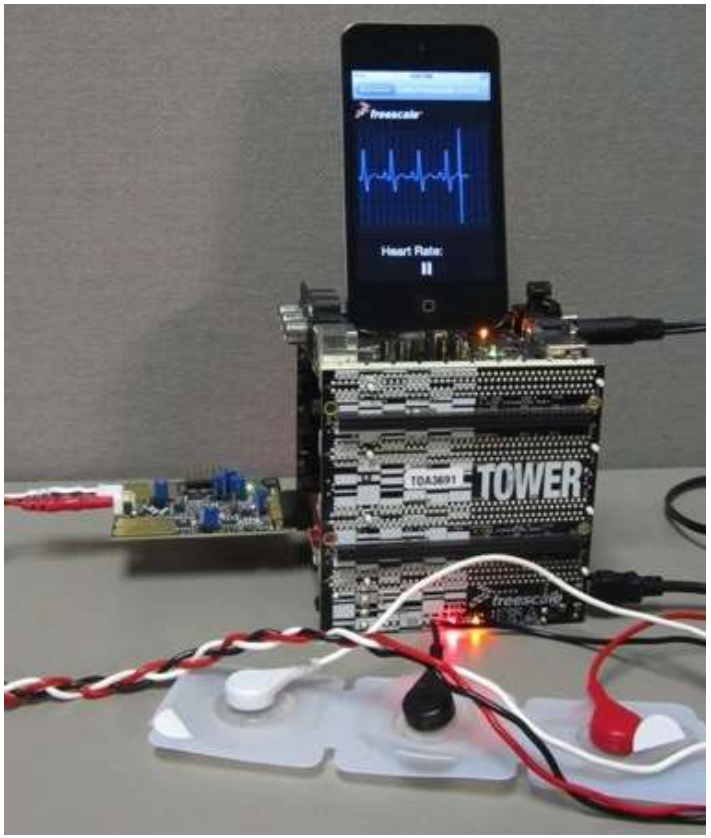
# App-Based Speaker Dock

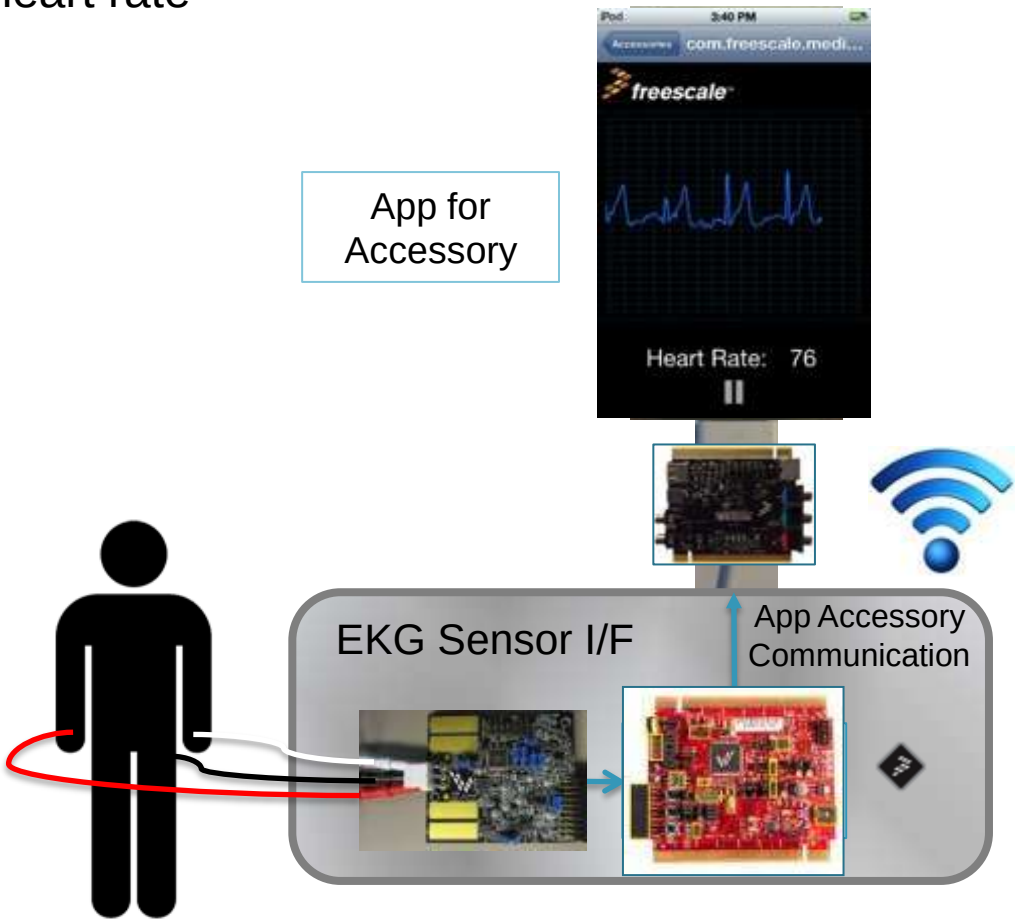
- Uses smartphone based App to control the speaker dock
  - Saves on separate GUI on speaker dock
  - Limited to smartphone or devices that support App-Based Accessories (such as iOS devices)
  - Possible with multiple connection options



# Demo example: EKG - Electrocardiogram

- Kinetis K53 with EKG sensor module
- iOS App to display EKG graph and heart rate



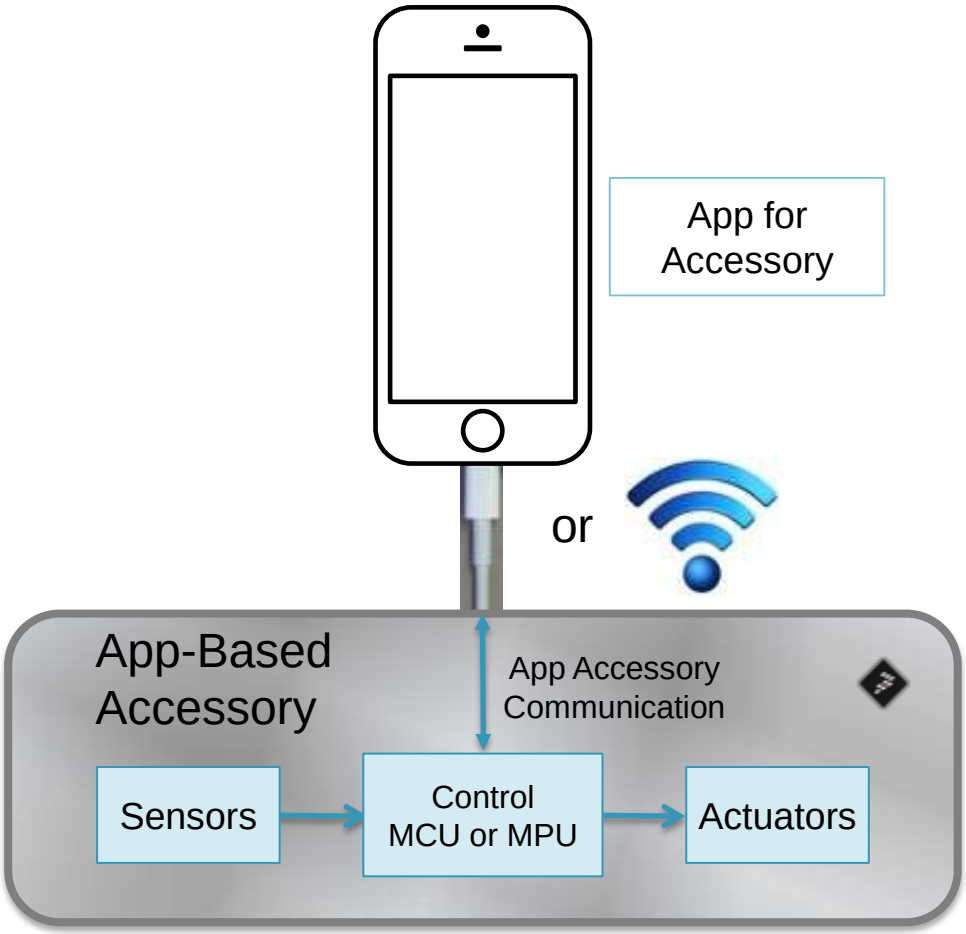



# Demo example: Altimeter

- Air pressure based altimeter
  - High sensitivity: ~ 30 cm (12”)
- Ambient air temperature

# Anatomy Of An App-Based Accessory

- **App provides**
  - User interface
  - Network or Remote access
  - Optional additional processing
- **Accessory provides**
  - Additional sensors
    - E.g. Pressure, Chemical (e.g. Glucose), Level, Light, Voltage, Current
  - Actuators as needed
    - E.g. Motors, Switches, Valves, Lights
  - Local control and processing
    - May be very low power and independent of device
  - Optionally, power for device



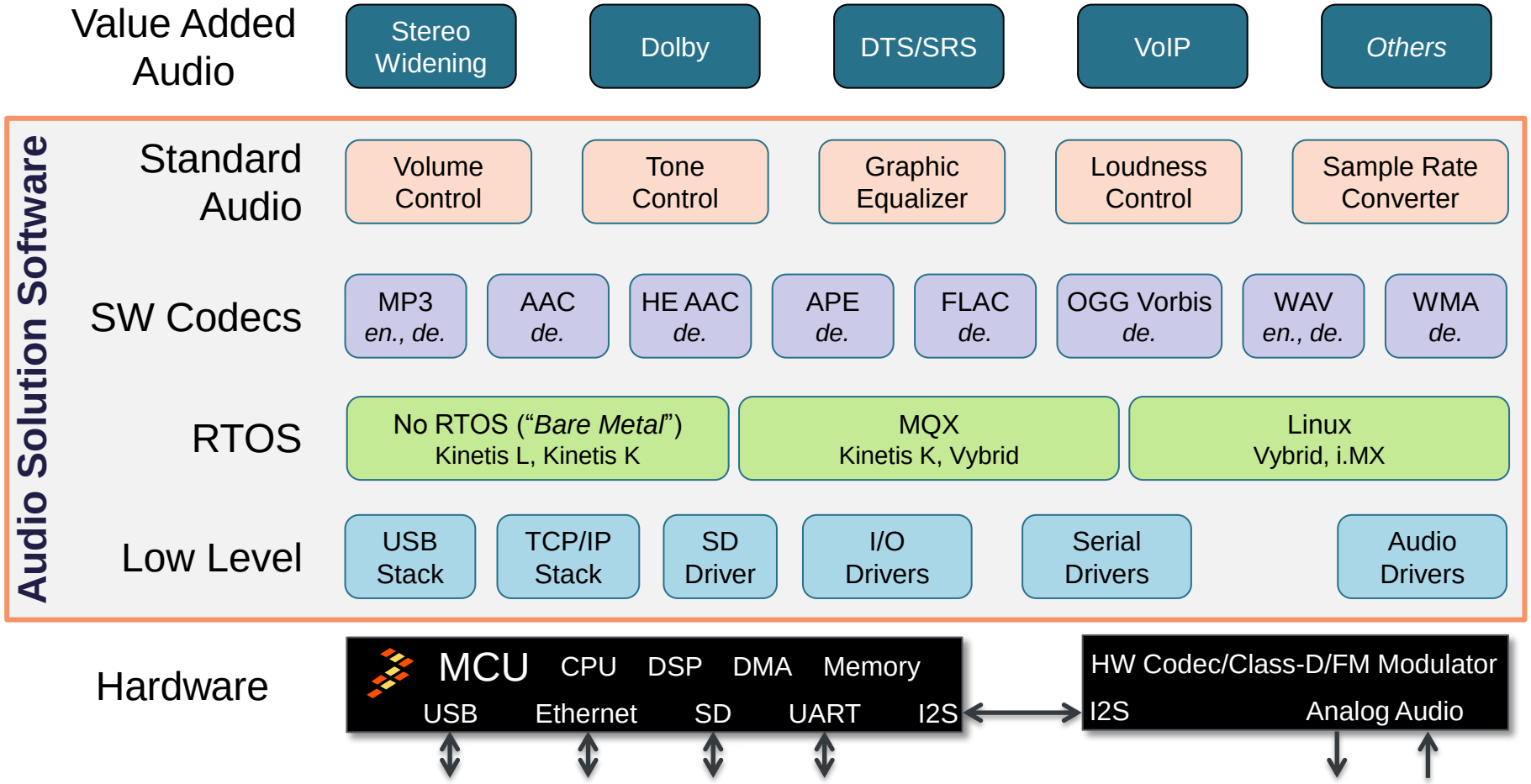
# Freescale Audio Solution

# Freescale Audio Solution Overview

## Focus on Mono and Stereo audio with digital interconnect and processing, and multi-channel audio accessories

- Optimized for ARM Cortex-M4 core and Kinetis K family
  - Wide range of available MCUs with a rich selection of memory, peripheral, and connectivity options
  - Will support ARM Cortex-Ax (Vybrid and i.MX) families later, primarily for multi-channel applications
- Flexible solution framework for easy configuration and customization
- Basic audio software is free for use on Freescale MCUs
  - Premium Audio Functions are subject to a software royalty and possibly to licensing from IP owners
- Tower System support for development and rapid prototyping

# Freescale Audio Solution



# Freescale Audio Solution Resource Requirements

## Current software release data for Kinetis K20

| Component | Total ROM (Flash) | Total RAM | Input Buf | Output Buf | MHz | DMIPS | Test Vector |
|---|---|---|---|---|---|---|---|
| MP3 decode | 21643 | 15276 | | | 12.9 | 10.32 | 320c_48kHz_stereo_test1_44kHz_mp3.mp3 |
| MP3 encode | 23604 | 18494 | | | 20.47 | 16.38 | 320c_48kHz_stereo_test1_44kHz_mp3.wav |
| AAC decode | 32791 | 29014 | | | 12.05 | 9.64 | 320c_48kHz_stereo_test1_44kHz_mp3.aac |
| Ogg Vorbis decode | 59120 | 106510 | | | 17.18 | 13.74 | q4_48000_s_test1_44khz_mp3.wav.ogg |
| Ogg Vorbis decode (low-mem) | 59120 | 52066 | | | | | |
| WAV decoder | 5724 | 208 | 4096 | 16384 | | | |
| WAV encoder | 5720 | 144 | 2048 | 8192 | | | |
| WMA decoder | 74226 | 31312 | 256 | 512 | | | |
| FSRC | 6876 | 9384 | 4096 | 4096 | | | |

Notes: Subject to change

# Freescale Audio Solution Resource Requirements

## Current software release data for Kinetis K20

| Component | .text | .data | .rodata | .bss | Total ROM (Flash) | Total RAM | Input Buf | Output Buf | MHz | DMIPS | Test Vector |
|---|---|---|---|---|---|---|---|---|---|---|---|
| MP3 decode | 14516 | 372 | 6755 | 14904 | 21643 | 15276 | | | 12.9 | 10.32 | 320c_48kHz_stereo_test1_44kHz_mp3.mp3 |
| MP3 encode | 17216 | 298 | 6090 | 18196 | 23604 | 18494 | | | 20.47 | 16.38 | 320c_48kHz_stereo_test1_44kHz_mp3.wav |
| AAC decode | 20768 | 262 | 11761 | 28752 | 32791 | 29014 | | | 12.05 | 9.64 | 320c_48kHz_stereo_test1_44kHz_mp3.aac |
| Ogg Vorbis decode | 35826 | 14 | 23280 | 106496 | 59120 | 106510 | | | 17.18 | 13.74 | q4_48000_s_test1_44khz_mp3.wav.ogg |
| Ogg Vorbis decode (low-mem) | 35826 | 14 | 23280 | 52052 | 59120 | 52066 | | | | | |
| WAV decoder | 5366 | 16 | 342 | 192 | 5724 | 208 | 4096 | 16384 | | | |
| WAV encoder | 5368 | 0 | 352 | 144 | 5720 | 144 | 2048 | 8192 | | | |
| WMA decoder | 48698 | 0 | 25528 | 31312 | 74226 | 31312 | 256 | 512 | | | |
| FSRC | 1756 | 0 | 5120 | 9384 | 6876 | 9384 | 4096 | 4096 | | | |

Notes: Subject to change

# Audio Solution Components Release Plan

Development | Alpha | Beta | General Availability

| Software Function and OS | MCU/MPU Family (CPU) | Q4-2013 | Q1-2014 | Q2-2014 | Q3-2014 | Q4-2014 |
|---|---|---|---|---|---|---|
| MP3 Decoder | ARM Cortex-M4 | | Beta | Alpha | | |
| | ARM Cortex-Ax | Alpha | | | | |
| MP3 Encoder | ARM Cortex-M4 | | Development | Alpha | | |
| | ARM Cortex-Ax | Alpha | | | | |
| AAC Decoder | ARM Cortex-M4 | | Beta | Alpha | | |
| | ARM Cortex-Ax | Alpha | | | | |
| HE AAC Decoder | ARM Cortex-M4 | Alpha | | | | |
| | ARM Cortex-Ax | Alpha | | | | |
| FLAC Decoder | ARM Cortex-M4 | Alpha | | | | |
| | ARM Cortex-Ax | Alpha | | | | |
| OGG Vorbis Decoder | ARM Cortex-M4 | Alpha | | | | |
| | ARM Cortex-Ax | Alpha | | | | |
| WAV Decoder | ARM Cortex-M4 | Alpha | | | | |
| | ARM Cortex-Ax | Alpha | | | | |
| WAV Encoder | ARM Cortex-M4 | Alpha | | | | |
| | ARM Cortex-Ax | Alpha | | | | |
| WMA Decoder | ARM Cortex-M4 | Alpha | | | | |
| | ARM Cortex-Ax | Alpha | | | | |
| ALAC Decoder | ARM Cortex-M4 | Alpha | | | | |
| | ARM Cortex-Ax | Alpha | | | | |
| ALAC Encoder | ARM Cortex-M4 | Alpha | | | | |
| | ARM Cortex-Ax | Alpha | | | | |
| APE Decoder | ARM Cortex-M4 | Alpha | | | | |
| | ARM Cortex-Ax | Alpha | | | | |

Development | Alpha | Beta | General Availability

| Software Function and OS | MCU/MPU Family (CPU) | Q4-2013 | Q1-2014 | Q2-2014 | Q3-2014 | Q4-2014 |
|---|---|---|---|---|---|---|
| OPUS Decoder | ARM Cortex-M4 | Beta | Alpha | | | |
| | ARM Cortex-Ax | Beta | Alpha | | | |
| OPUS Encoder | ARM Cortex-M4 | Beta | Alpha | | | |
| | ARM Cortex-Ax | Beta | Alpha | | | |
| Volume Control | ARM Cortex-M0+ | Alpha | | | | |
| | ARM Cortex-M4 | Alpha | | | | |
| | ARM Cortex-Ax | Alpha | | | | |
| Tone Control | ARM Cortex-M0+ | Alpha | | | | |
| | ARM Cortex-M4 | Alpha | | | | |
| | ARM Cortex-Ax | Alpha | | | | |
| Mixer (many to 1) | ARM Cortex-M4 | Alpha | | | | |
| | ARM Cortex-Ax | Alpha | | | | |
| FSRC (8, 16, 24-BIT) | ARM Cortex-M4 | Alpha | | | | |
| | ARM Cortex-Ax | Alpha | | | | |
| SRC44.1 (8, 16, 24-BIT) | ARM Cortex-M4 | Alpha | | | | |
| | ARM Cortex-Ax | Alpha | | | | |
| SRC48 (8, 16, 24-BIT) | ARM Cortex-M4 | Alpha | | | | |
| | ARM Cortex-Ax | Alpha | | | | |
| SRC96 (8, 16, 24-BIT) | ARM Cortex-M4 | Alpha | | | | |
| | ARM Cortex-Ax | Alpha | | | | |
| Parametric Equalizer | ARM Cortex-M4 | Alpha | | | | |
| | ARM Cortex-Ax | Alpha | | | | |
| Playback Speed Control | ARM Cortex-M4 | Alpha | | | | |
| | ARM Cortex-Ax | Alpha | | | | |

Notes: Subject to change

# TWR-AUDIO-SGTL Overview

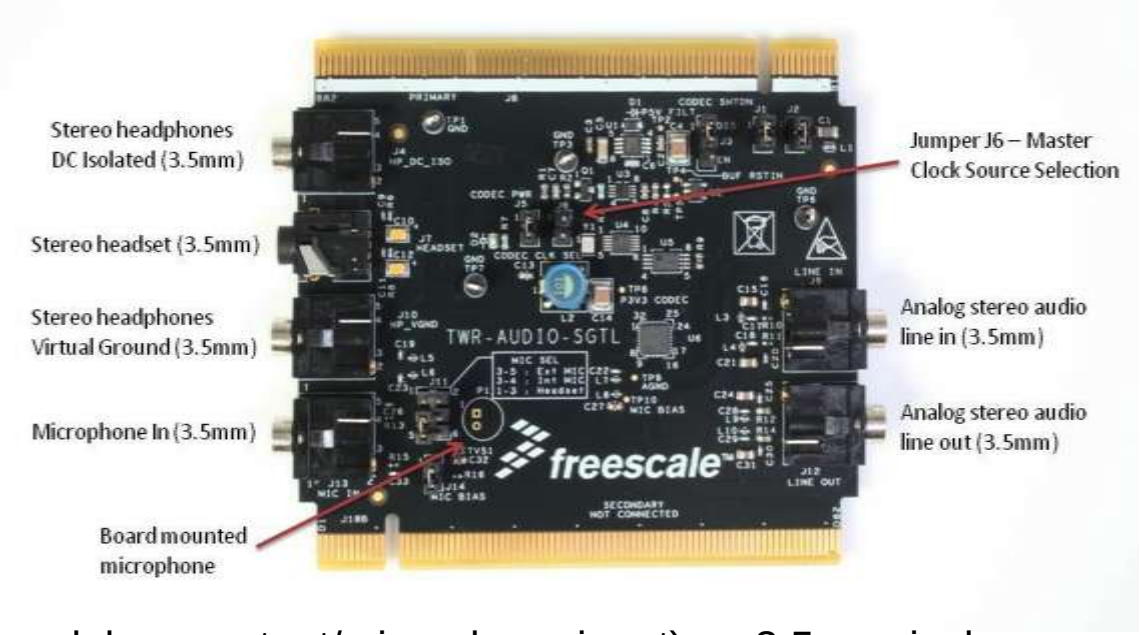
- The TWR-AUDIO-SGTL is a peripheral module compatible with the Freescale Tower System. The TWR-AUDIO-SGTL peripheral module features the SGTL5000 audio codec and provides an audio interface for the Freescale Tower System.

- The SGTL5000 is a low-power stereo codec that includes a headphone amplifier and is designed to provide a comprehensive audio solution for portable products that require line-in, microphone-in, line-out, headphone-out and digital I/O.

- As part of the Freescale Tower System, the TWR-AUDIO-SGTL module may be used with a wide range of Tower System MCU/MPU, peripheral, sensor and communication modules.

# TWR-AUDIO-SGTL

- SGTL5000 low-power stereo codec with headphone amplifier
- Tunable clock generator
- Stereo line-in on 3.5 mm jack
- Stereo line-out on 3.5 mm jack
- Headphone output on 3.5 mm jack
- Capacitor-less headphone output on 3.5 mm jack



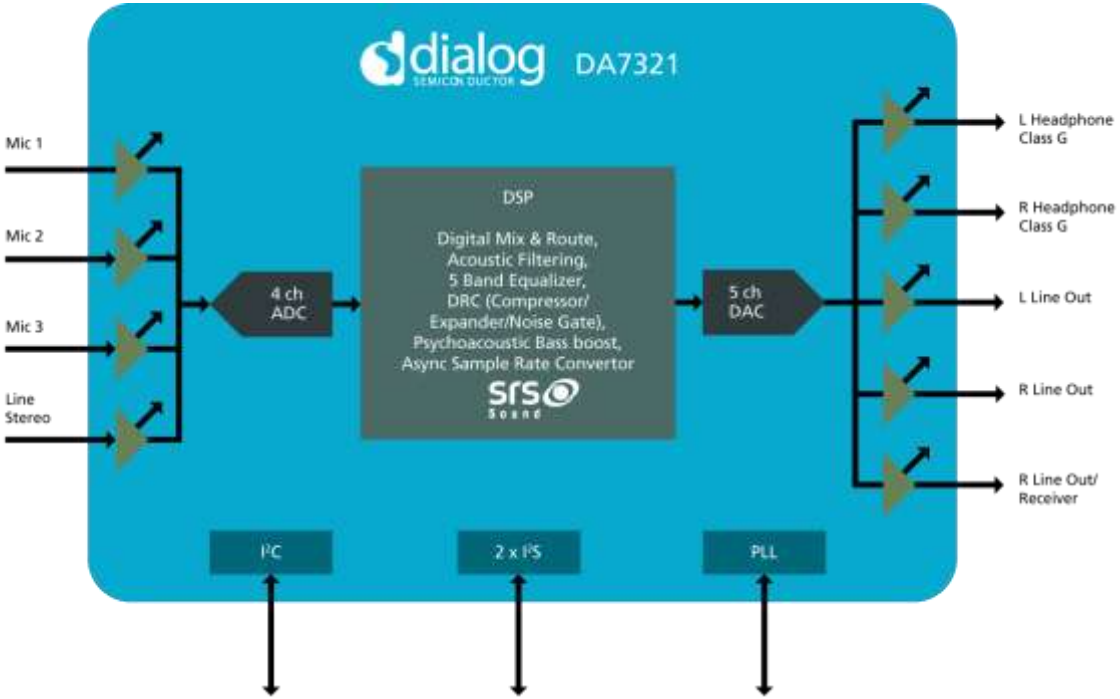

- Smartphone compatible headset (headphone output/microphone input) on 3.5 mm jack
- Microphone input on 3.5mm jack
- Space provided on board to mount an electret microphone
- Compatible with Tower System processor modules using Kinetis, Kinetis L, Vybrid and ColdFire+ microcontrollers
- TWR-AUDIO-SGTL Rev D2 replaces previous module revisions.

# TWR-AUDIO-DA7321 Tower Peripheral Module

- DA7320 multi-channel Audio CODEC processor with adjustable DSP effects
- Dynamic Range Control, Psychoacoustic Bass Boost, n-band Equalization
- SRS Sound support to enhance end user listening for media playback
- Stereo AUX_IN on a 3.5mm jack socket
- MIC input on a 3.5mm jack socket
- MIC input via an on-board mems microphone
- Smartphone compatible HEADSET connection on a 3.5mm jack socket
- Interchangeable GND and MIC routing to the smartphone jack allows multiple headsets to be supported
- Compatible with the Freescale Tower System

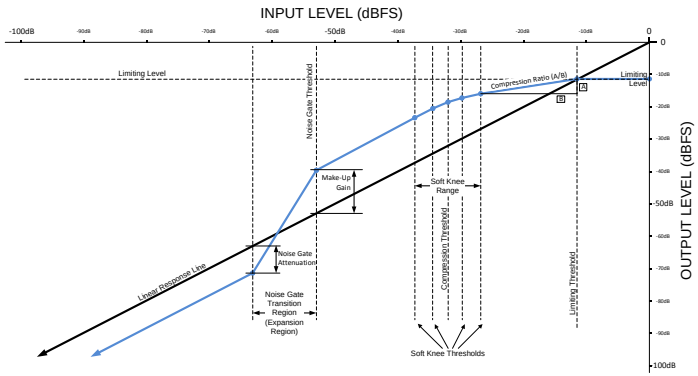
# TWR-AUDIO-DA7321 Tower Peripheral Module

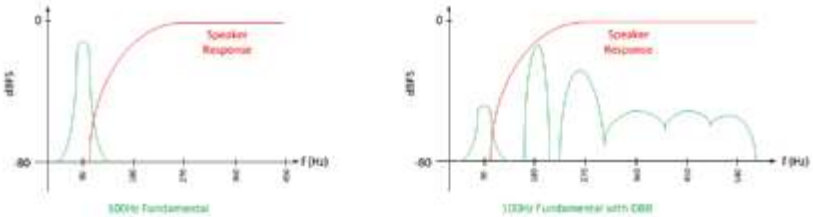
DA7321 Audio Codec



# DA7321 Audio Enhancements

- DRC enables more “perceived” loudness without distortion on headphone and speaker
- Psycho-acoustic bass boost offers improved perceived low frequency performance for low cost speakers
- SRS Sound improves the audio image size, bass sensation and dynamics of an audio system



srs Sound

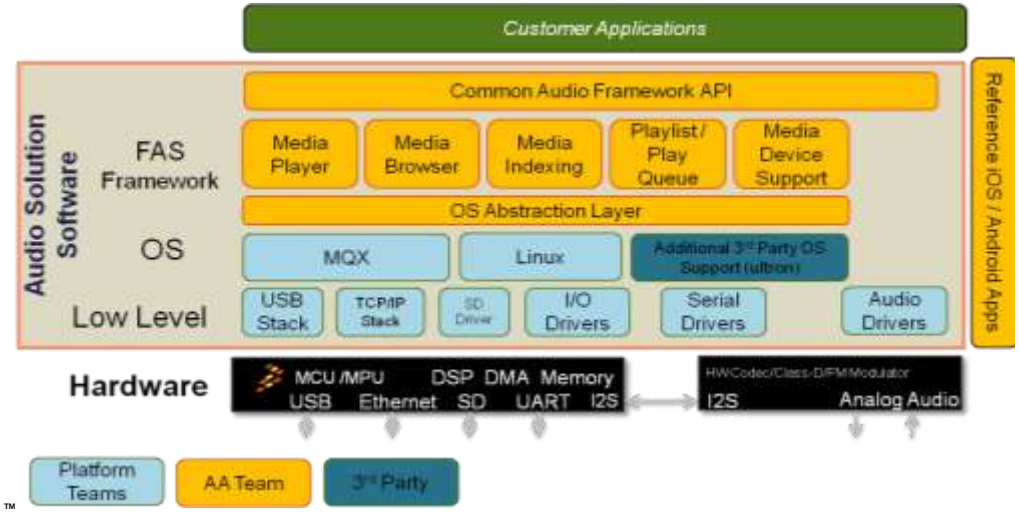
# Target Audio Applications

## Mono and Stereo audio with digital interconnect and processing, and multi-channel audio accessories

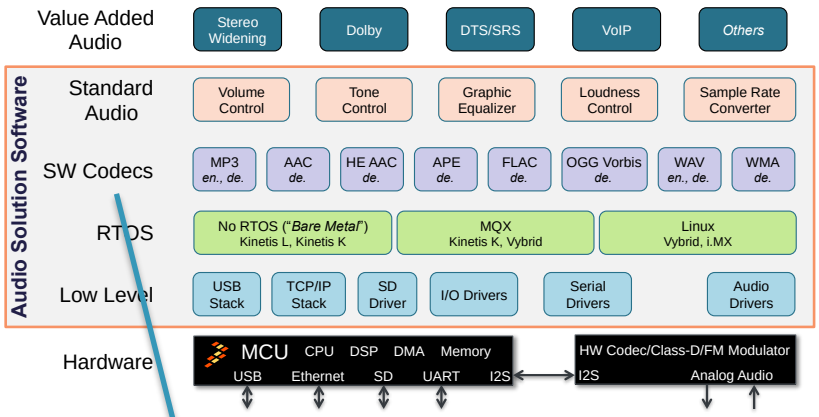
- MFi Speaker Docks
- MFi Accessories
- Android Speaker Docks
- Android Accessories
- SoundBars
- Portable audio recorders
- Gaming Headsets
- Networked audio endpoints
- USB microphones
- USB speakers
- Xbox 360 Accessories
- Musical effects equipment
- Professional audio equipment
- VoIP Intercom systems
- VoIP Public Address (PA) systems
- VoIP telephony
- Automotive after market audio
- *And many more, let your imagination run wild*

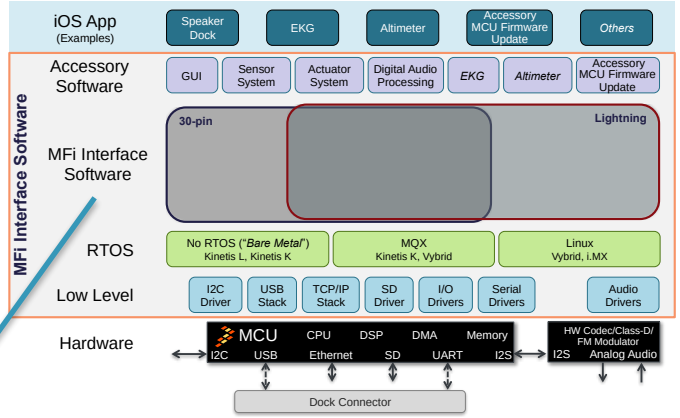
# Freescale Audio Solution (FAS) Framework

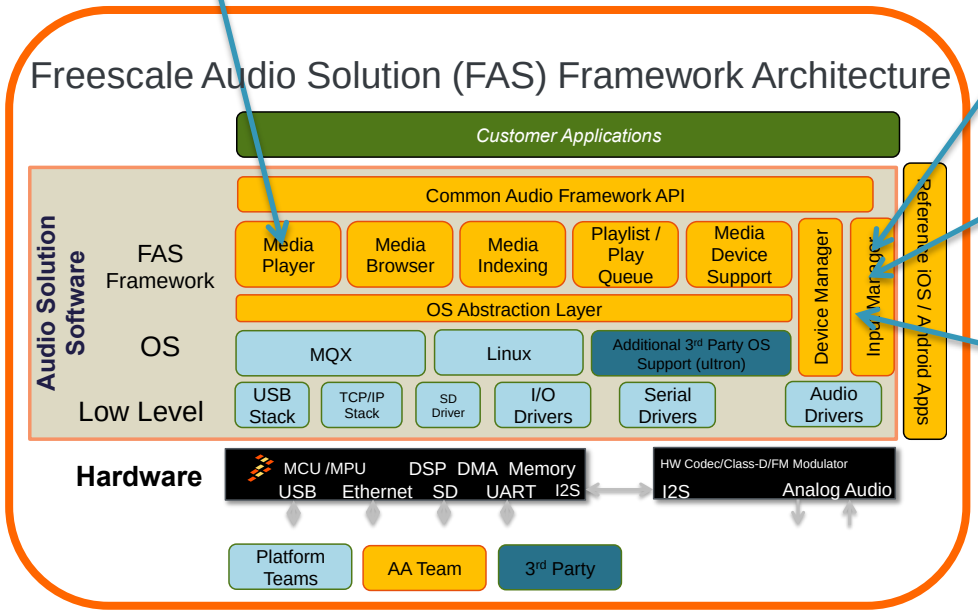
- Freescale Audio Solution (FAS) Framework is being developed for Kinetis, Vybrid, and i.MX processors
- The framework includes functional blocks to deliver media player functionality:
  - Multimedia Framework with Radio Tuner and CD Support.
  - CE Device Connectivity  supporting MFi, USB, SD and AOAP
  - External device management and control.
  - Input management and control for touch screen, buttons and knobs.
  - HMI Framework
  - Bluetooth Stack and Profiles with AEC/NS (HFP, A2DP, AVRCP)
- Using an OS Abstraction provides platform support on MQX and Linux* and can be modified to work with any modern operating system



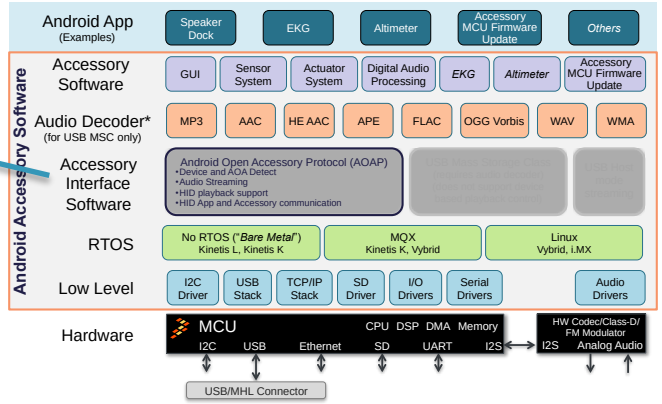
# AA Solutions Framework and Components




Other



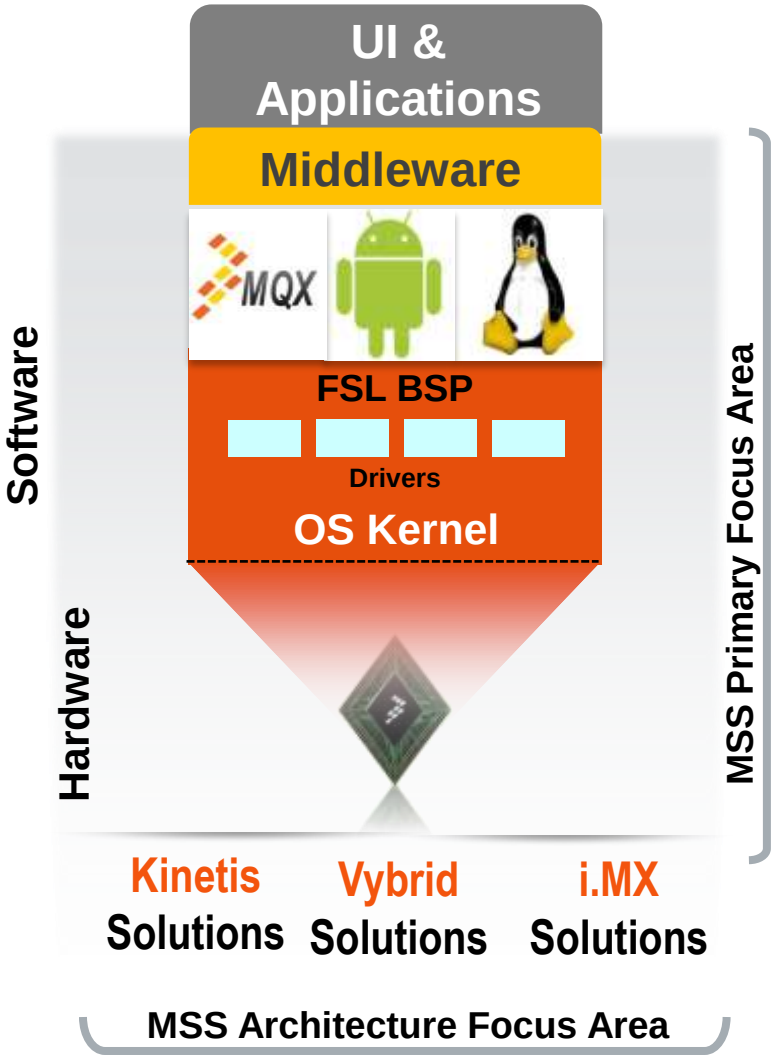
# Freescale Audio Solution (FAS) Framework Release Plan

| Development | Alpha | Beta | General Availability |
|---|---|---|---|

| Software Function and OS | MCU/MPU Family (CPU) | Q4-2013 | Q1-2014 | Q2-2014 | Q3-2014 | Q4-2014 |
|---|---|---|---|---|---|---|
| FAS Framework v1 MQX | Kinetis K | | | ● | ● | |
| | Vybrid (M4) | | ● | ● | ● | |
| | Vybrid (A5) | | ● | ● | ● | |
| FAS Framework v1 Linux | Vybrid (A5) | | ● | ● | ● | |
| | i.MX6 | | ● | ● | ● | |

Notes:
1. Subject to change
2. FAS is Freescale Audio Solution Framework

# Professional Services Focus




## Software Services

- Linux, Android, MQX BSP's, **Audio Framework**
  - Customization
  - Integration
  - Development
  - Porting
  - Testing
  - Optimization
  - Issue analysis, Debug and Fix
- Long-term support on Customer Board

## Hardware Services

- Schematic and layout optimization and review
- Simulation
- On-site board bring-up

# Services Development Methodologies And Quality

## Engineering Discipline

**define**

- Requirements Gathering
- Project Assessments
- IP Selection

**design**

- Design Consulting
- System Consulting
- Architecture

**develop**

- Custom Development
- Porting / Migration
- Integration

**integration and test**

- Testing
- Documentation
- Performance Testing
- Performance Optimization

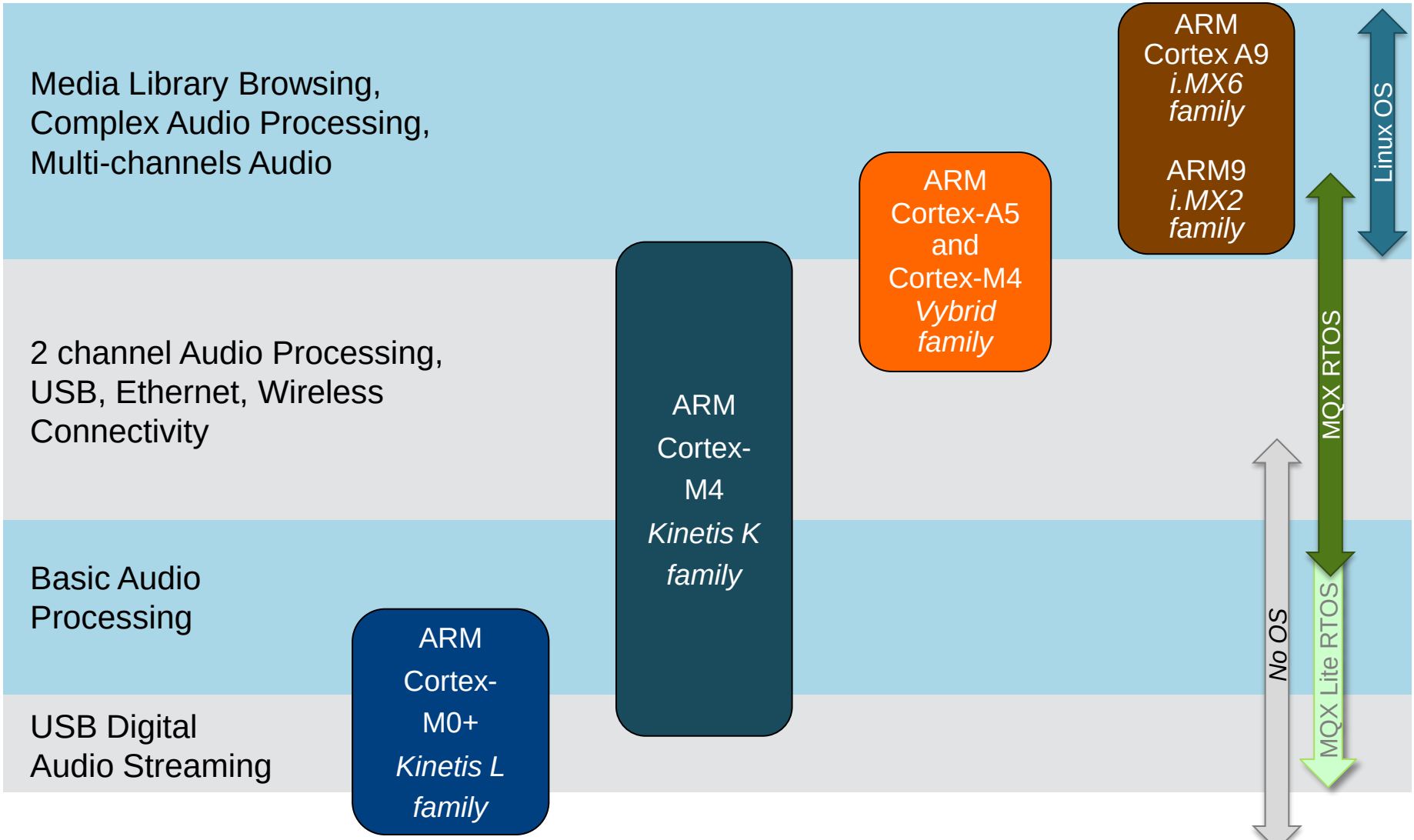
**deploy**

- Knowledge Transfer
- Project Specific Support (3rd Level)
- Maintenance
- Performance Tuning

**Quality Assurance (ISO, CMMI & SPICE Level III)**

# Summary

# Accessories and Digital Audio MCUs and MPUs



# Summary

- The Freescale Audio Solution (FAS) and Framework are designed for a wide range of stereo and mono audio applications
  - Kinetis K, Vybrid and i.MX for audio processing, Kinetis L for streaming only applications
- Freescale MFi software solution and TWR-DOCK2 support Made For iPod (MFi) Accessories and App-Based Accessories development
- Freescale AOAP software supports accessories development for most Android devices

# Q & A

www.Freescale.com

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