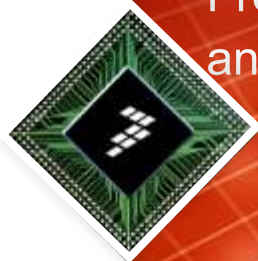




Anand Balakrishnan
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Company Overview

- **Semiconductor design and manufacturing company established in 1953**
- Focused on the automotive, consumer, industrial, networking, and enabling technologies
- Engaged with **10,000+ customers** globally; more than **100 of the top electronic manufacturers**
- Headquartered in **Austin, Texas**
- **19,500** employees in over **30** countries



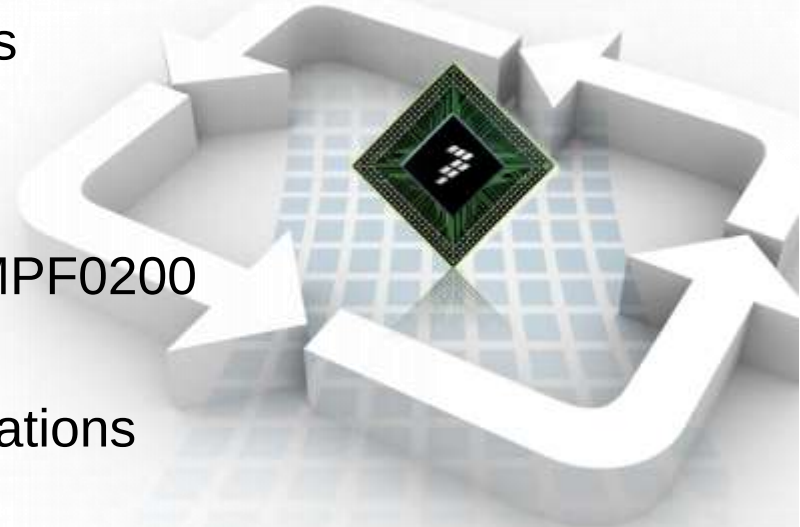
- *The Warm-up*

- *The Race*

- Introducing MMPF0100 and MMPF0200
- Features
- Evaluation Tools and Demonstrations
- Schedule
- Other Freescale analog power management products

- *The Finish*

- Q & A



- *The Warm-up*

- Switching and Linear Regulators

- *The Race*

- Introducing MMPF0100 and MMPF0200

- Features

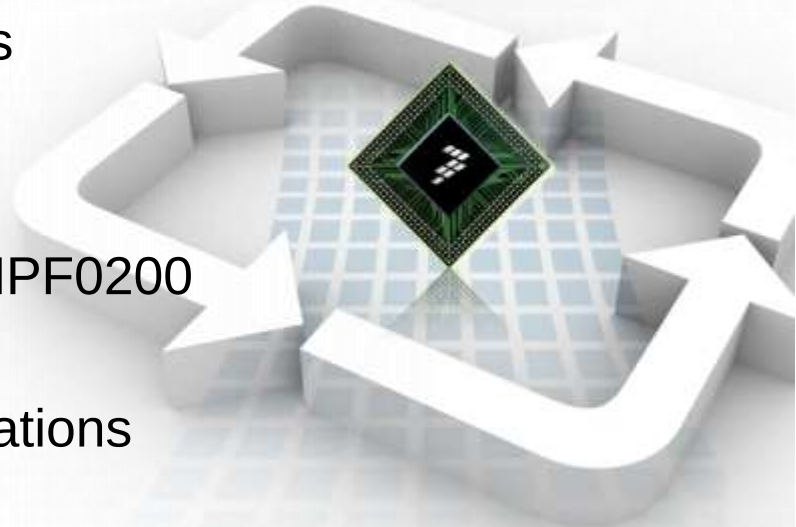
- Evaluation Tools and Demonstrations

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- *The Finish*

- Q & A



Role of a Power Management Integrated Circuit

- Typical system consists of large number of ICs each requiring power to operate. Each has varying power requirements
- 'Power Management' broadly refers to meeting these requirements
- Considerations include:
 - **Conversion** – What is the optimal way to convert power from source to destination
 - **Distribution** – How to generate different voltage rails for the system requirement while lowering cost, increasing efficiency
 - **Control** – What flexibility is needed in controlling voltage, general performance (efficiency, quiescent current etc.) and how to achieve it
 - **Regulation** – What tolerance is required during various operating conditions
 - **Monitoring/reporting** – What features are required to monitor regular operation. How should faults be reported and what actions should be taken
- A PMIC performs the above functions to provide a one-stop solution for system power needs

Power Conversion

- Loads (ICs) require tightly controlled voltage at their inputs for proper operation



- There are different types of 'Power Converters' that can do this task
- It is important to use the correct type of converter for the given power requirements
 - Considerations: Cost, efficiency, size
- To understand the tradeoff, let us look at two popular types of DC-DC converters
 - Linear Regulators
 - Switching Regulators

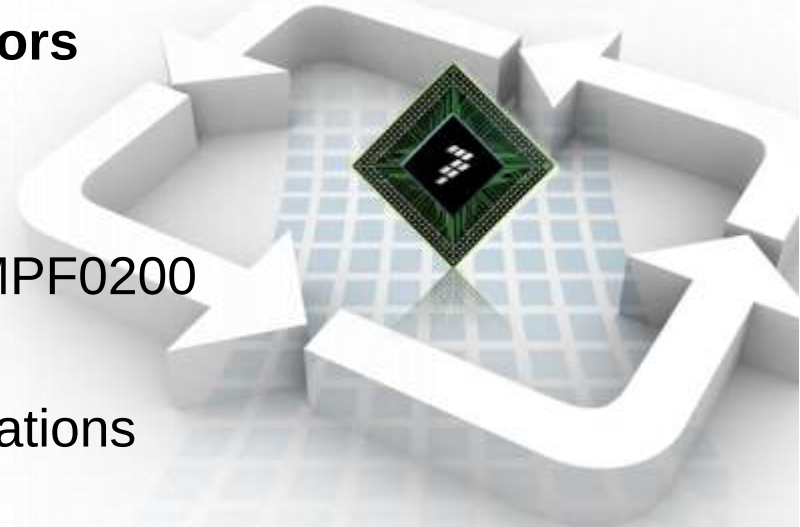
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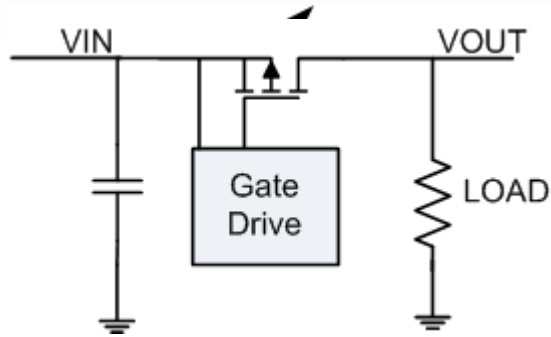
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Linear Regulator (LDO)



$$V_{out} = \frac{V_{in} * R_{LOAD}}{R_{LOAD} + R_{PASS}}$$

- When load current changes (R_{LOAD} changes), the control loop adjusts R_{PASS} so that V_{out} remains in regulation
- In reality, R_{PASS} is realized by a low-dropout MOSFET
- Control loop varies V_{GS} of the pass-device to keep V_{out} in regulation

Advantages:

- Very low number of components, low complexity and cheap
- No ripple, low noise, better noise rejection
- High bandwidth design possible without impact on efficiency
- Small quiescent current for modern LDOs

Disadvantages:

- Efficiency decreases with input-output voltage difference
- Heat dissipation has to be managed if load and input/output voltage difference are high
- Only $V_{out} < V_{in}$ can be achieved

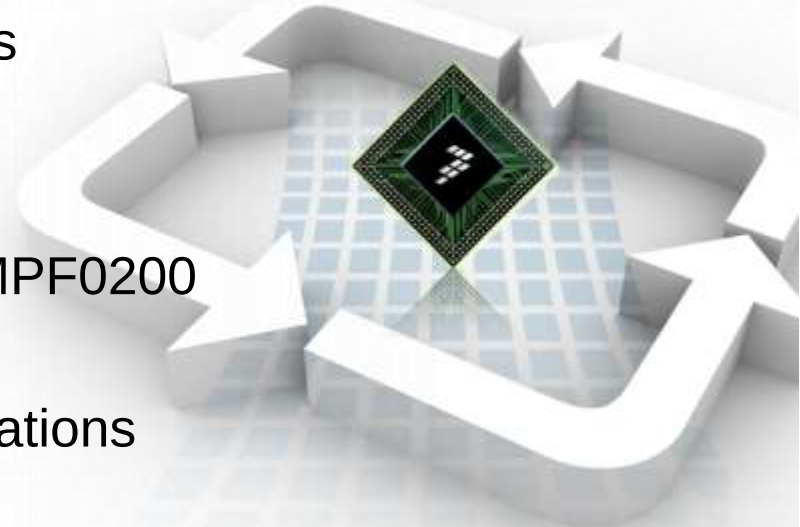
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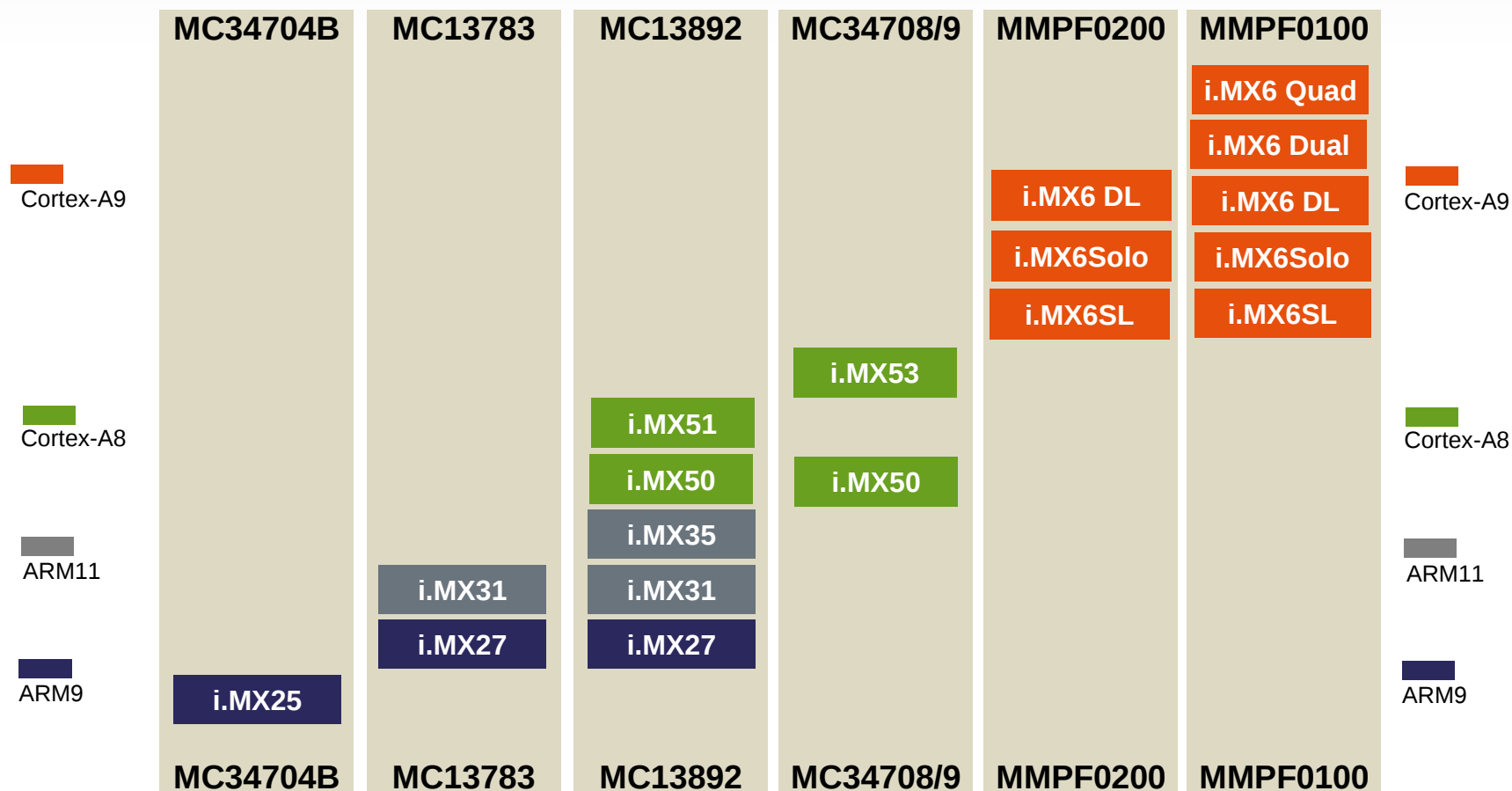
- *The Finish*

- Q & A





Freescal PMICs for i.MX Processors



Introduction to MMPF0100

- **Highly integrated power management ICs designed to support today's advanced multi-core processing solutions**
 - Designed primarily for use with i.MX6x series of multimedia applications processors
 - Minimal external components
 - Internal compensation simplifies use
- **PF0100 used in Freescale's i.MX 6 Series reference designs to provide a faster time to market with fewer resources**
- **Fully supported in i.MX 6 Series BSPs**
 - Linux, Android supported directly by Freescale
 - Other OS (inc. WinCE) supported by Freescale partners
- **Available in two versions:**
 - Consumer with operating range -40°C to + 85°C
 - Industrial with operating range -40°C to + 85°C
 - Automotive AEC-Q100 Grade 3 with operating range -40°C to + 85°C

- *The Warm-up*

- *The Race*

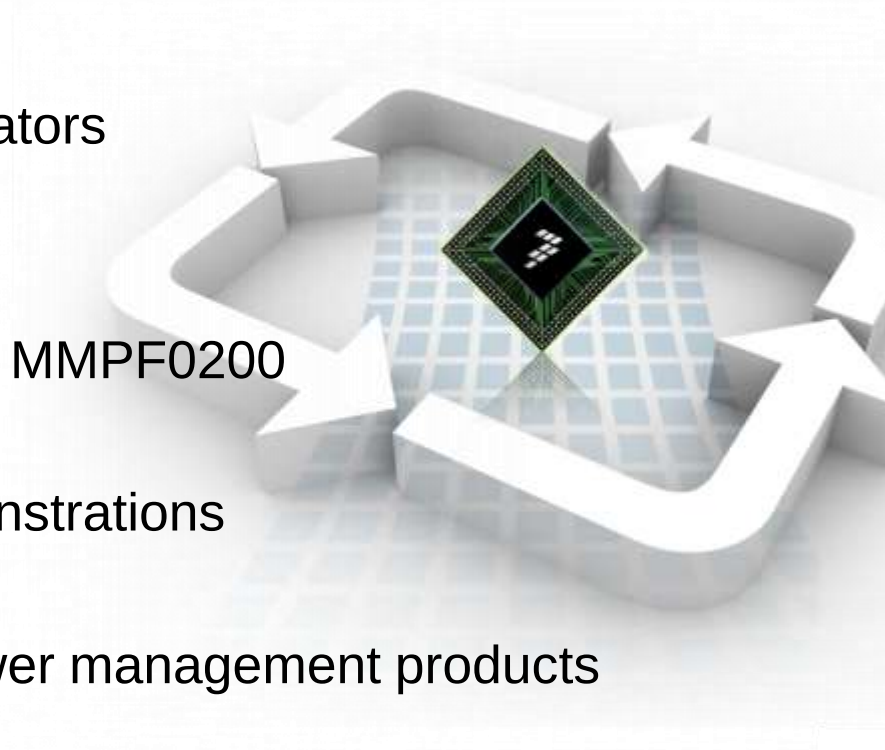
- ## - Introducing MMPF0100 and MMPF0200

- Evaluation Tools and Demonstrations

- Other Freescale analog power management products

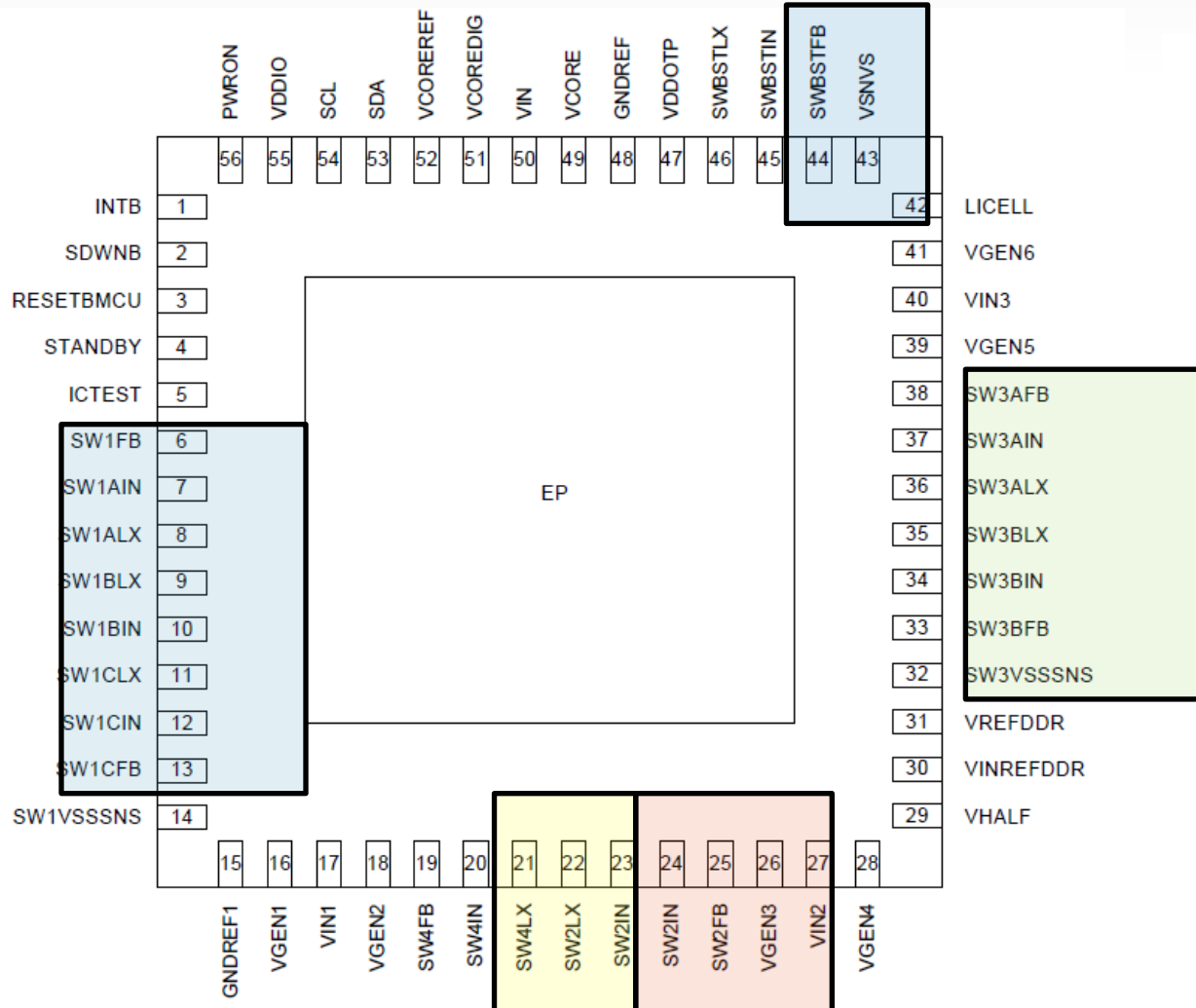
- *The Finish*

- Q & A



MMPF0100/Z Pin-out and Packages

Consumer/Industrial
EP SUFFIX (E-TYPE)
56 QFN 8X8
0.5MM PITCH



AUTOMOTIVE
ES SUFFIX (WF-TYPE)
56 QFN 8X8
0.5MM PITCH

MMPF0100 Features

Input voltage range to PMIC: 2.8V-4.5V

Buck regulators (4-6 channel configurable)

- **SW1A/B/C** (single 0.3 to 1.875V, 4.5A)
- **SW1A/B** (single/dual 0.3 to 1.875V, 2.5A), **SW1C** (single 0.3 to 1.875V, 2A)
- **SW2** (0.4 to 3.3V, 2A)
- **SW3A/B** (single/dual 0.4 to 3.3V, 2.5A)
- **SW3A** (single 0.4 to 3.3V, 1.25A) **SW3B** (single 0.4 to 3.3V, 1.25A)
- **SW4** (0.4V to 3.3V, 1.0A), VTT mode provides DDR termination at 50% of SW3A
- Dynamic voltage scaling
- Modes: PWM, PFM, APS
- **Programmable:** output voltage, current limit, soft start, PWM switching frequency, OCP with fault interrupt, power stages

Boost regulator

- **SWBST** (5.0 to 5.15V,600mA) OTG support
- Modes: PFM, Auto
- OCP fault interrupt

LDOs (6 user programmable LDO)

- **VGEN1** (0.80 to 1.55V, 100mA) **VGEN2** (0.80 to 1.55V, 250mA)
- **VGEN3** (1.8 to 3.3V, 100mA) **VGEN4** (1.8 to 3.3V, 350mA)
- **VGEN5** (1.8 to 3.3V, 100mA) **VGEN6** (1.8 to 3.3V, 200mA)
- Soft start

LDO/Switch supply

- VSNVS (1.0/1.1/1.2/1.3/1.5/1.8/3.0), 400μA

DDR memory reference voltage

- VREFDDR, 10mA

16MHz internal master clock

Coin cell charger

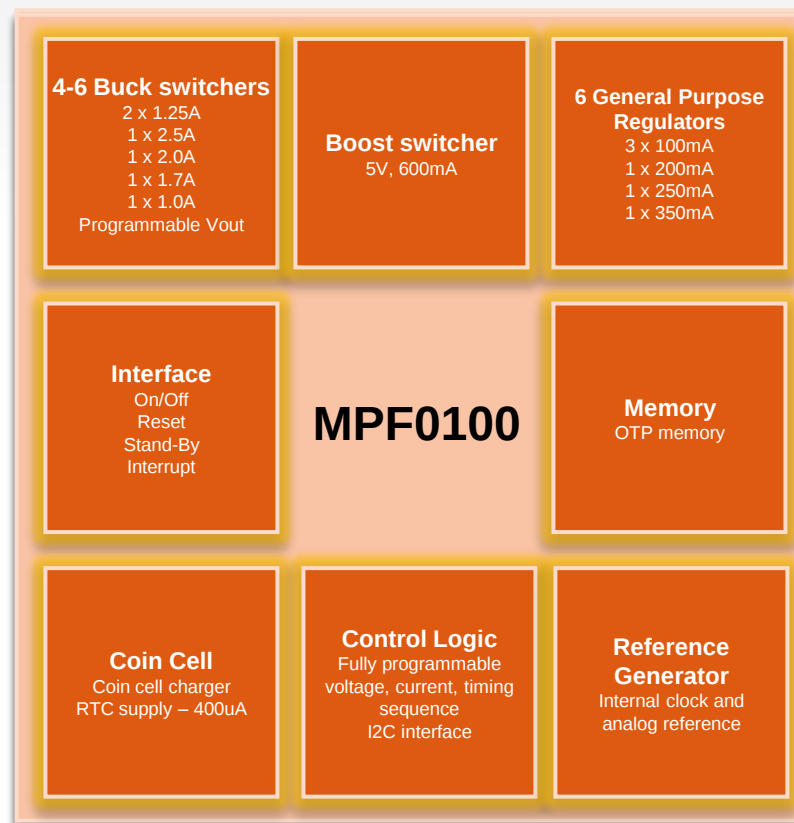
OTP(One time programmable) memory for device configuration

- User programmable start-up sequence and timing

Battery backed memory

I²C Interface

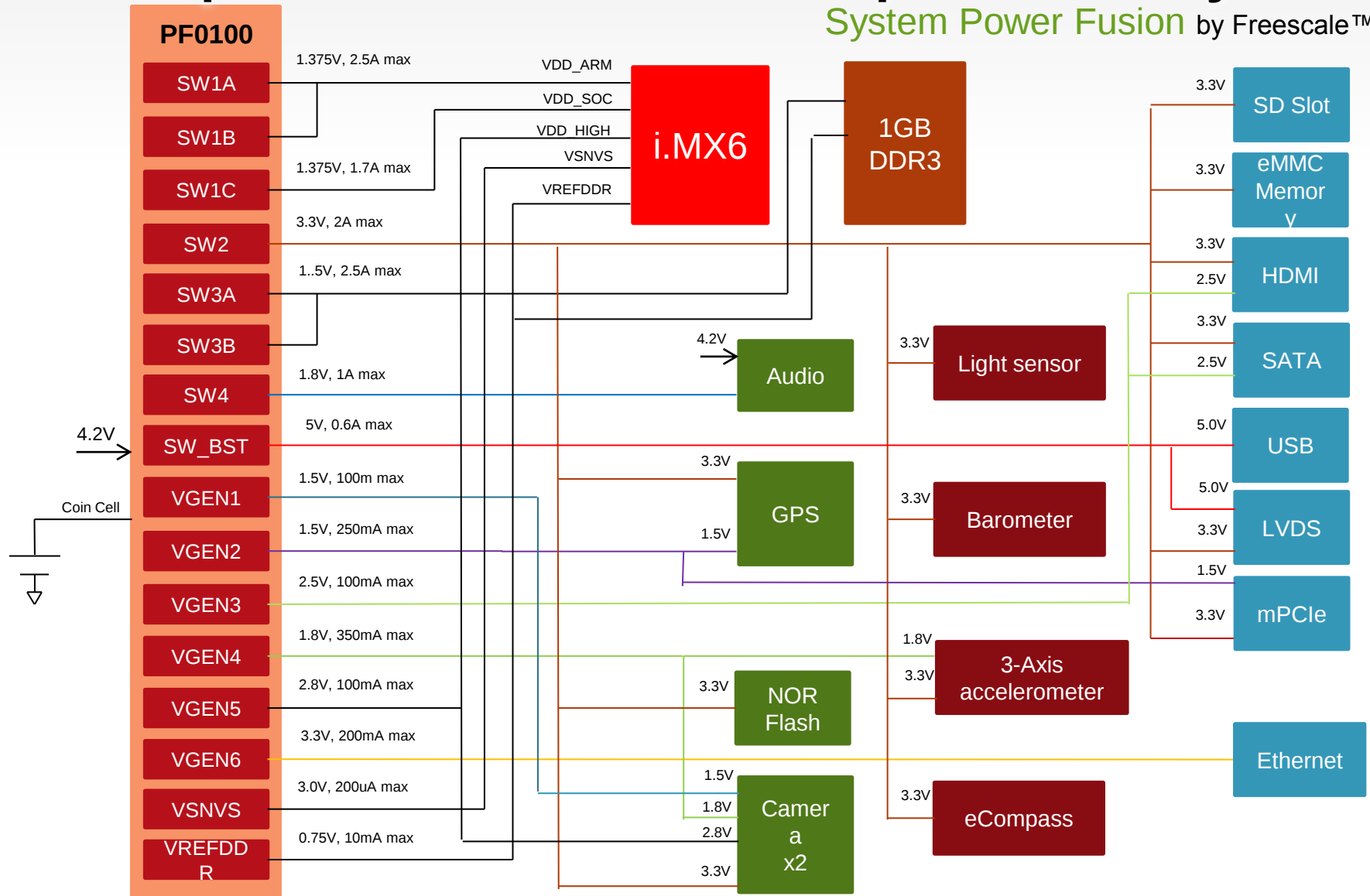
User programmable standby and Off modes



MMPF0200 is
MMPF0100 minus
SW1C and SW4

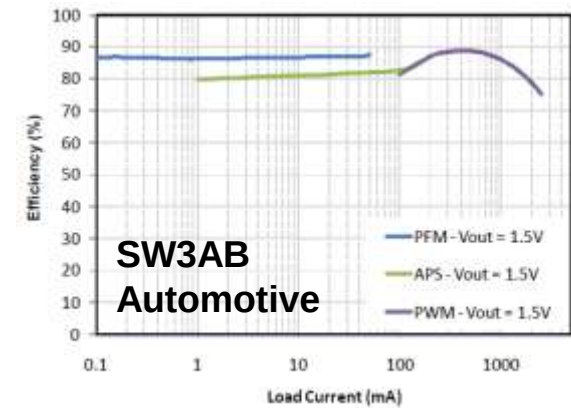
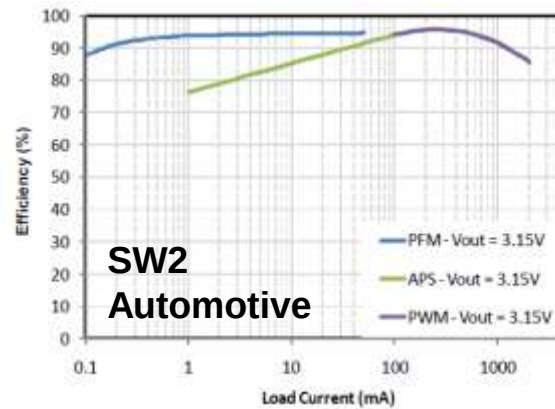
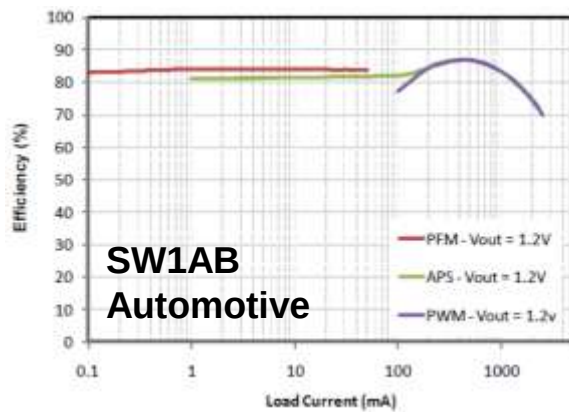
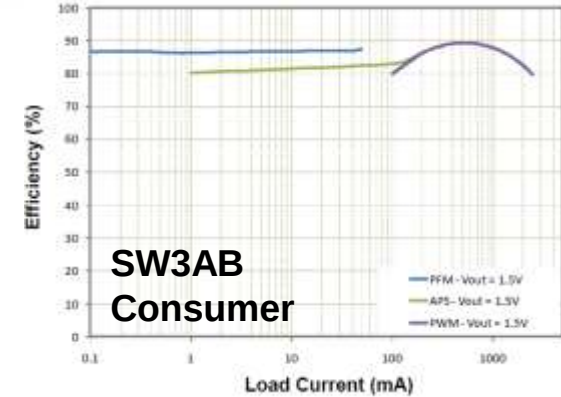
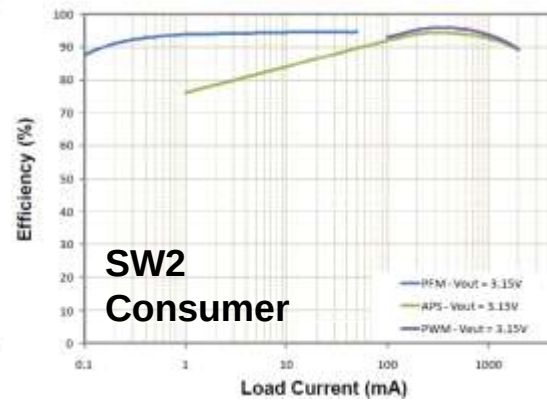
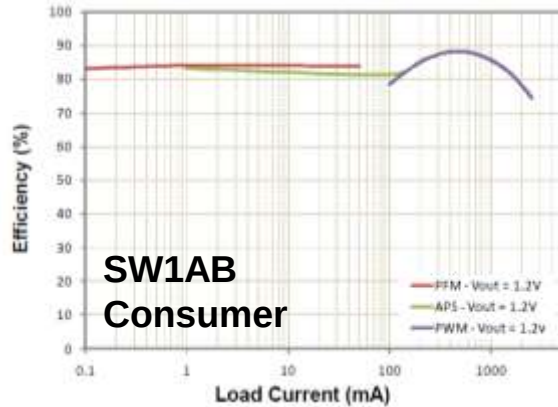
Example: PF0100 Power to Complete i.MX6 System

System Power Fusion by Freescale™



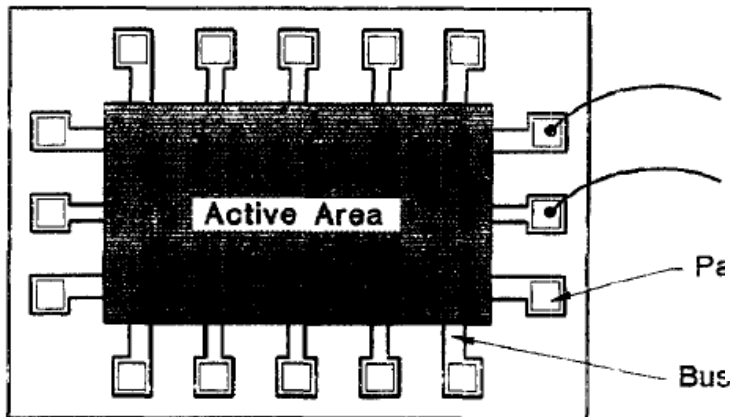
Complete system power solution in 1 IC

Typical Buck Regulator Efficiency

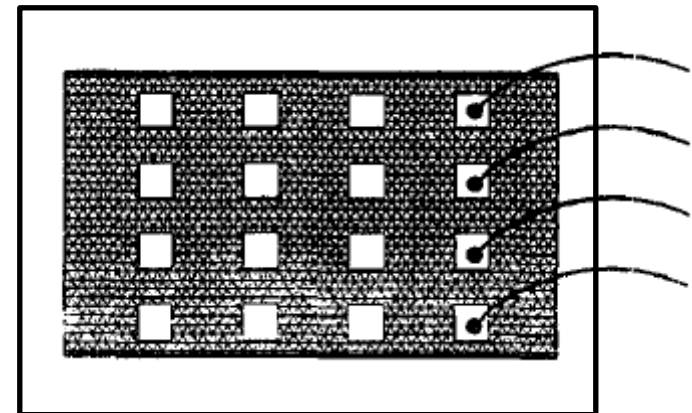


PF0100/N/Z Bond Over Active Technology

- **Bond Over Active Circuitry** Technology is a method to eliminate bond-pad associated resistances
- High quality bonds achieved over active circuit area reduce effective path resistance and increase reliability
- Automotive (Z) and Industrial (N) versions of PF0100 use BOAC
- BOAC provides significantly higher efficiency (5-10%)



Conventional Bonding



Bond Over Active Circuit

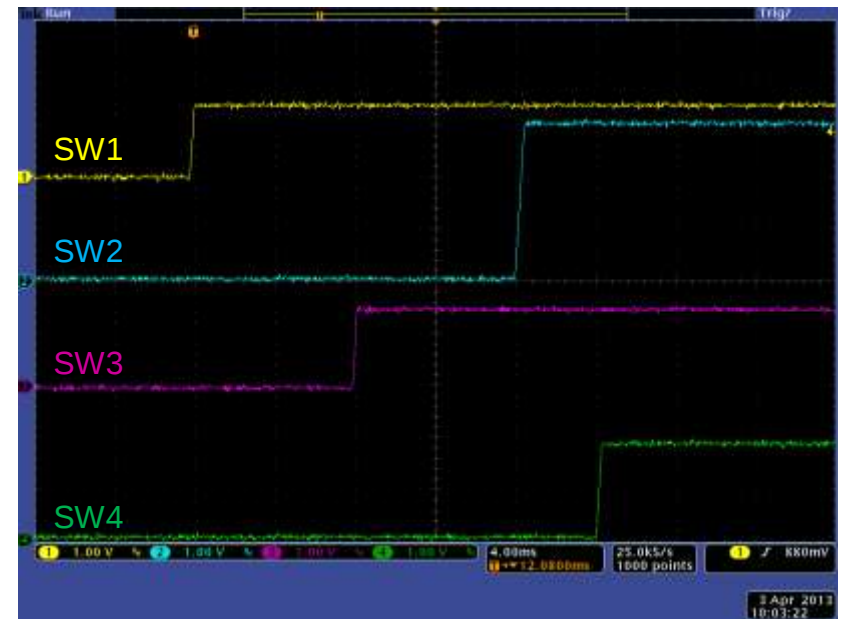
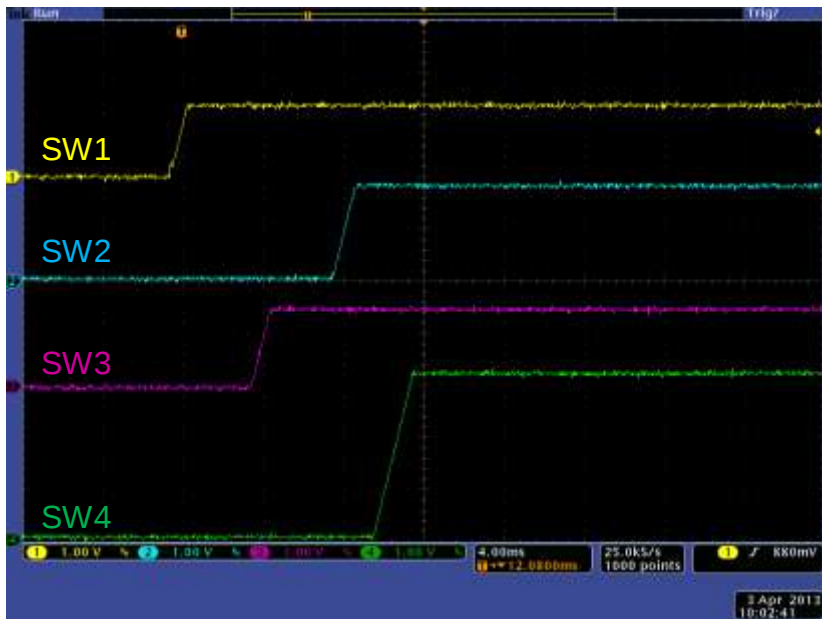
PF Series Advantages

- **Unique, Configurable Switching Regulator Architecture**
 - Multiple outputs with lower current, or single output with higher current
 - Adjustable power stages for best overall performance
- **Programmable Output Voltages**
 - Supports broad range of system power requirement
- **Fully Programmable Startup Sequence and Timing**
 - OTP Memory to store key power-on parameters
- **System Power Control**
 - For maximum system flexibility
- **High Efficiency Conversion** across output range
- **Reduced External Components**
 - Overall BOM cost reduction

Why OTP?

The PF0100 has been designed with flexibility to adapt itself to every i.MX6 application

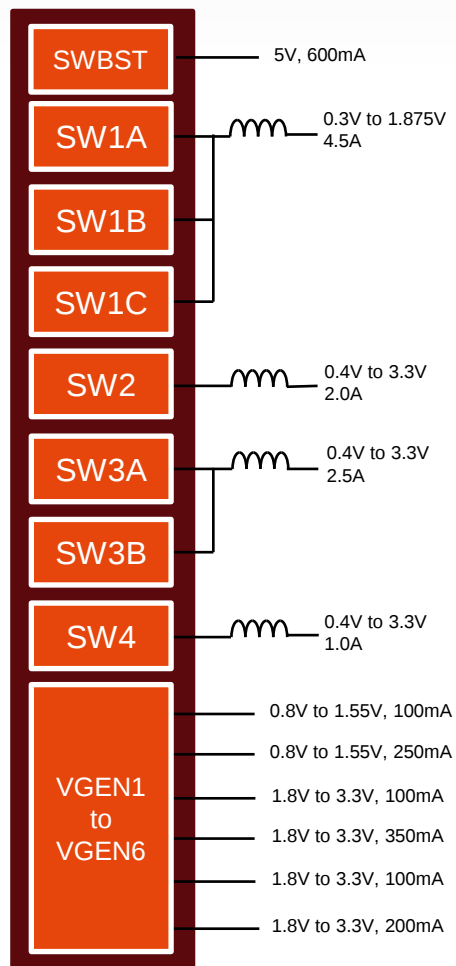
OTP is used to exercise this flexibility



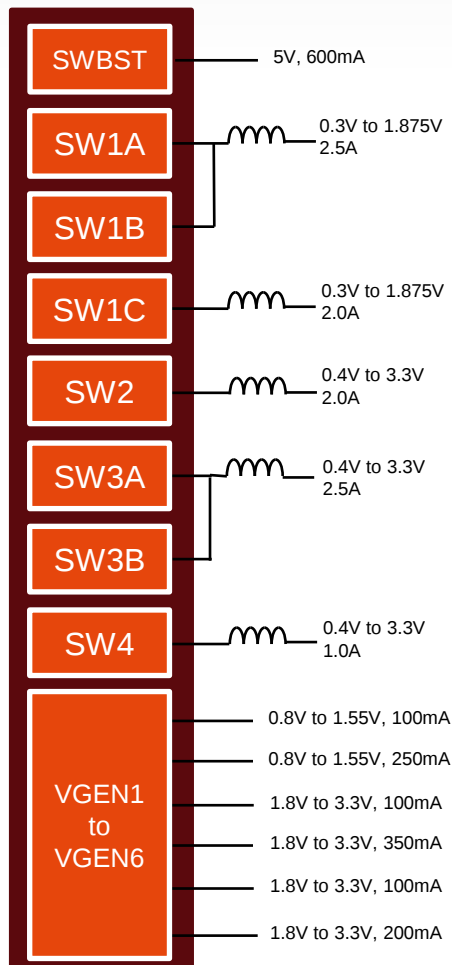
Example of PF0100's with different startup voltage, timing and slew rate

Why OTP?

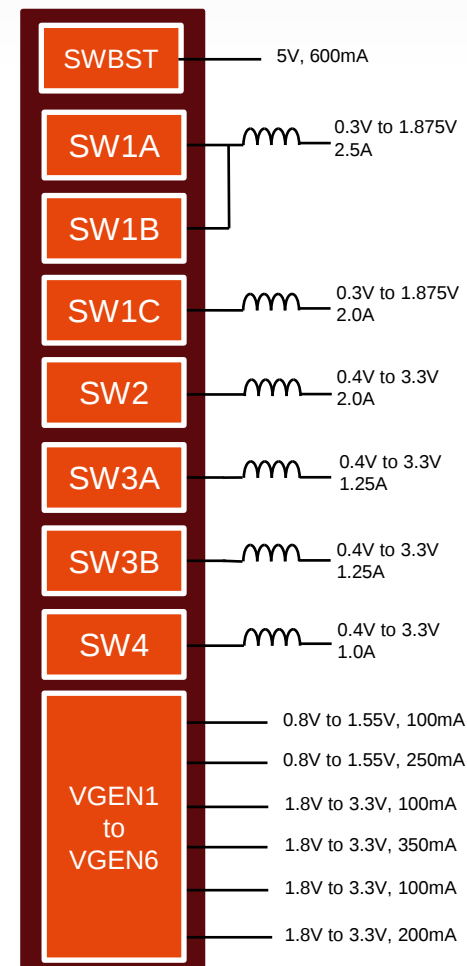
Unique and optimal PF0100 for every application



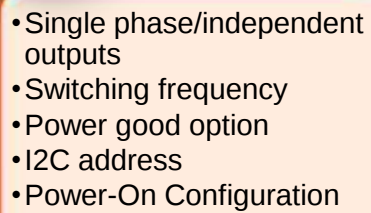
4 buck, 6 LDO, 1 Boost



5 buck, 6 LDO, 1 Boost



6 buck, 6 LDO, 1 Boost



Overall Configuration

Output voltage

- Output voltage of all regulators at startup
- VTT mode option

Startup timing

- Precise control of startup sequence, timing and slew rate



- *The Warm-up*

- *The Race*

- Introducing MMPF0100 and MMPF0200
- Features
- **Evaluation Tools and Demonstrations**
- Schedule
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- *The Finish*

- Q & A



SABRE Platform for Automotive Infotainment (AI)

Powered by MMPF0100NPZES

CPU Card Details

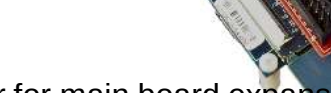
Power and Memory

- 2 GB DDR3 memory (i.MX 6Dual/Quad)
- 1GB DDR3 memory (i.MX 6Solo)
- 32GB Parallel NOR Flash
- NAND Socket

Display

- LVDS connector
 - compatible with MCIMX-LVDS1
 - Parallel RGB display interface
 - HDMI output connector
 - Analog Video Input
 - LVDS Input
- 

Connectivity and Expansion

- SD Card Slot
 - High Speed USB OTG
 - Ethernet
 - SATA
 - MIPI CSI
 - PCIe
 - MLB150 INIC connector
 - 281-pin MXM card edge connector for main board expansion
- 
- A close-up photograph of the bottom edge of a blue printed circuit board (PCB). Several connectors are visible, including a large multi-pin connector (likely the MXM connector mentioned in the text), a smaller connector with a red latch, and various other pins and components. Orange arrows point from the text labels to specific connectors on the board.

Part Numbers

Base Board: MCIMXABASEV1 (\$699)

CPU Cards: MCIMX6SAICPU1 (\$799)
MCIMX6OAICPU1 (\$799)

Display: MCIMX-LVDS1 (\$499)

Base Board Details

Can be reused from i.MX53 SABRE AI

Connectivity and Expansion

- SD card slot (WiFi module or SD)
- Bluetooth or Bluetooth+WiFi header
- AM/FM tuner header
- Sirius XM Module header (de-pop'd)
- GPS (UART) module connector
- 2x CAN
- Dual High Speed USB Host connectors
- MLB 25/50 INIC connector
- SPI NOR flash

Debug

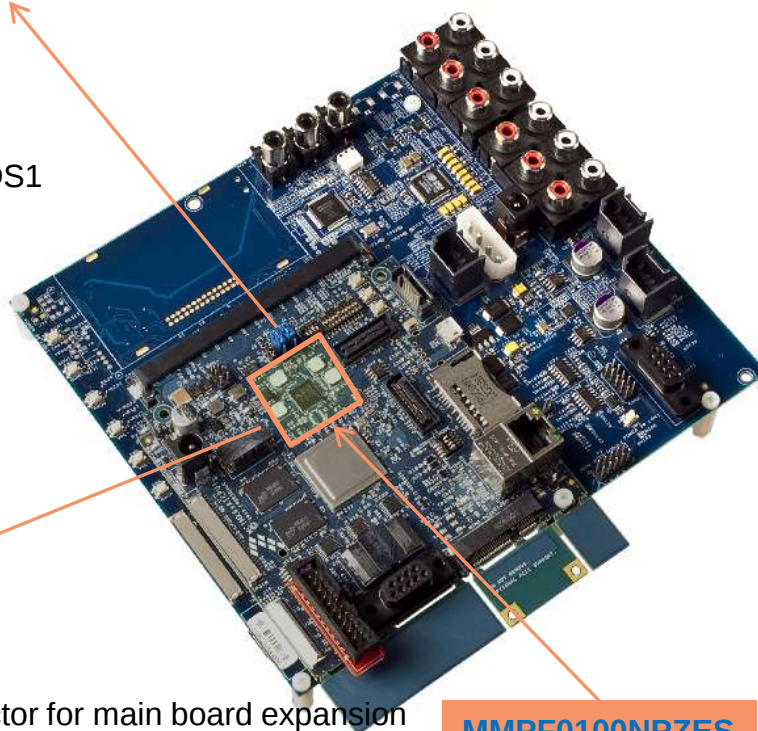
- JTAG connector
- Debug UART connector

Audio

- Multichannel audio codec
 - Up to 8 outputs
 - Dual microphone inputs
 - Stereo Line Level Input
- SPDIF receiver

OS Support

- Linux
- Others: future support by 3rd parties



MMPF0100NPZES

SABRE AI boards will only be supported at automotive customers

SABRE Board for Smart Devices (SDB)

Powered by MMPF0100F0EP

**i.MX 6Quad 1GHz Cortex-A9
Processor**

- Can be configured as i.MX 6Dual
- 1 GB DDR3 memory (non terminated)
- 3" x 7" 8-layer PCB

Display connectors

- 2x LVDS connectors
- Connector for 24 bit 4.3" 800x480 WVGA with 4-wire touch screen
- HDMI Connector

Audio

- Audio Codec
- Microphone and headphone jacks

Expansion Connector

- Camera CSI port signals
- I²C, SSI, SPI signals

Part Numbers:

MCIMX6Q-SDB (\$399)

Display (9.7"):

MCIMX-LVDS1 (\$499)

Display (4.3"):

MCIMX28LCD (\$199)

Connectivity

- 2x Full-size SD/MMC card slot
- 22-pin SATA connector
- 10/100/1000 Ethernet port
- 1x high-speed USB OTG port
- mPCI-e connector

Debug

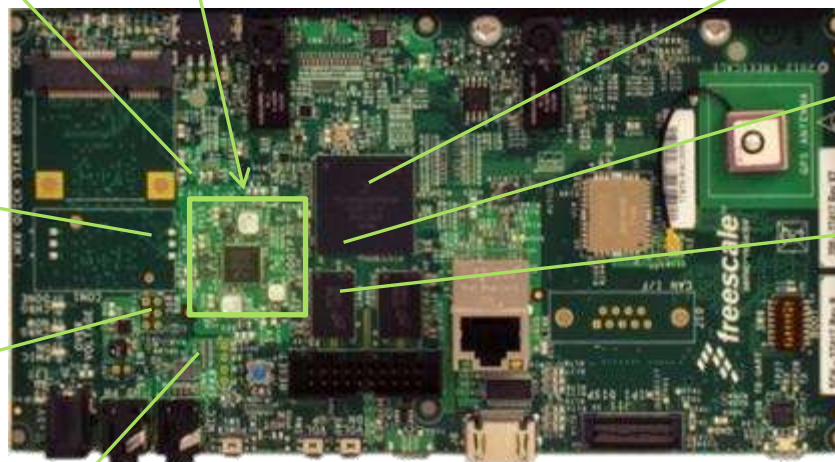
- JTAG connector
- Serial to USB connector

Additional Features

- 3-axis Freescale accelerometer
- eCompass
- Power supply

OS Support

- Linux and Android IceCream Sandwich from Freescale;
- Others: support by 3rd parties



Tools Support

- Lauterbach, ARM (DS-5), Macraigor debug/IDE tool chain

SABRE Platform for Smart Devices (SDP)

Powered by MMPF0100F0EP

i.MX 6Quad 1GHz Cortex-A9 Processor
i.MX 6DualLite 1GHz Cortex-A9 Processor

- 1 GB DDR3 memory (non terminated)
- 3" x 7" 8-layer PCB

Display connectors

- Native 1024x768 LVDS display (comes with kit)
- 2nd LVDS connector
- Connector for 24 bit 4.3" 800x480 WVGA with 4-wire touch screen
- HDMI Connector
- MIPI DSI connector

Audio

- Audio Codec
- Microphone and headphone jacks
- Dual 1W Speakers

Expansion Connector

- Enables parallel LCD or HDMI output
- Camera CSI port signals
- I²C, SSI, SPI signals

Part Numbers:

MCIMX6Q-SDP (\$999)
MCIMX6DL-SDP (\$999)

Display (4.3''):
Wi-Fi:

MCIMX28LCD (\$199)
Silex Wi-Fi module

Connectivity

- 2x Full-size SD/MMC card slot
- 22-pin SATA connector
- 10/100/1000 Ethernet port
- 1x high-speed USB OTG port
- mPCI-e connector

Debug

- JTAG connector
- Serial to USB connector

Additional Features

- 3-axis Freescale accel
- GPS receiver
- Ambient Light Sensor
- eCompass
- Dual 5MP Cameras
- Power supply
- Battery Charger
- Battery connectors

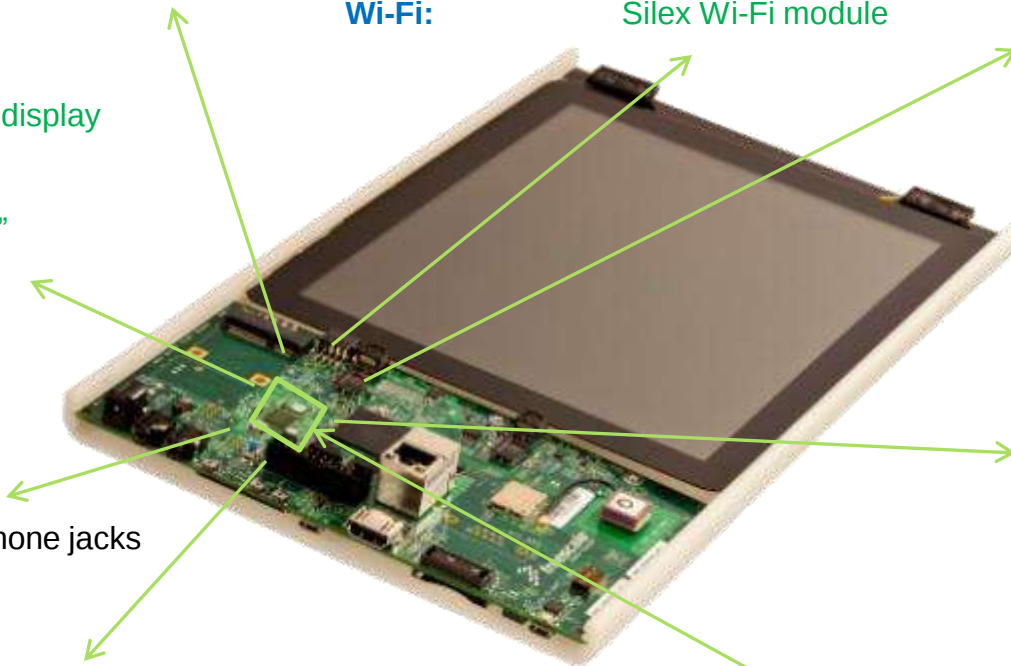
OS Support

- Linux and Android IceCream Sandwich from Freescale;
- Others: support by 3rd parties

Tools Support

- Lauterbach, ARM (DS-5), Macraigor debug/IDE tool chain

MMPF0100F0EP



MMPF0100 Evaluation Board

KITPF0100EPEVBE is the evaluation board for the MMPF0100 Power Management Integrated Circuit (PMIC) in a standalone environment. The board allows the user to evaluate the MMPF0100 device. Communication is achieved through the integrated USB to I²C communication and the graphical user interface (GUI) software. The GUI software enables easy communication between a user's PC and the MMPF0100 evaluation board and it allows the user to configure and control the regulators and to program the one-time programmable (OTP) registers.

For latest documentation and GUI go to:

http://www.freescale.com/webapp/sps/site/prod_summary.jsp?code=KITPF0100EPEVBE&fsrch=1&sr=2

Features

- GUI software allows user to:
 - Configure regulator voltages and start up sequences
 - Save and recall MMPF0100 configuration files
 - Develop configuration macros with a powerful scripting tool
- Onboard boost supply generates the voltage for programming the OTP registers
- Embedded USB to I²C interface to access device registers
- LED indicators for easy monitoring of PMIC and programming status
- Standard Mini-USB connector for communication with PC
- Terminal block connectors with 2.5 mm screws allow easy connections for bench evaluation
- Numerous test points provide easy access for monitoring all power and signal nodes
- Push button to cycle PMIC power ON
- Four layer board layout supports standard design rules
- Top side board component placement for MMPF0100



Kit Contains

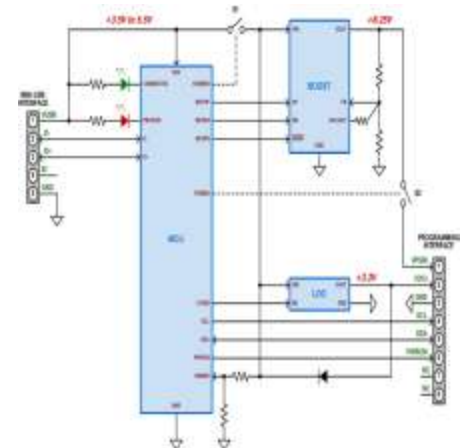
- MMPF0100 Evaluation Board
- Li-Ion coin cell battery
- Quick Start Guide

PF Series Programmer

A development tool designed to provide easy configuration of the PF Series devices and to facilitate the device's (OTP) one-time programmable registers directly on the target application board.

The PF series programmer features:

- GUI software that allows user to
 - Configure regulator voltages and start up sequences
 - Save and recall user defined configuration files
 - Develop configuration macros with a powerful scripting tool
- Generates voltage for programming the OTP registers
- USB to I²C interface to access device registers
- LED indicators for easy monitoring of programming status
- Standard Mini-USB connector for communication with PC



Part Number	Available	MSRP \$USD Each
KITPFPGMEVME	Now	\$49.99

KIT Contents

- PF Series Programmer
- Flat Ribbon Cable
- Quick Start Guide



Qualification Levels



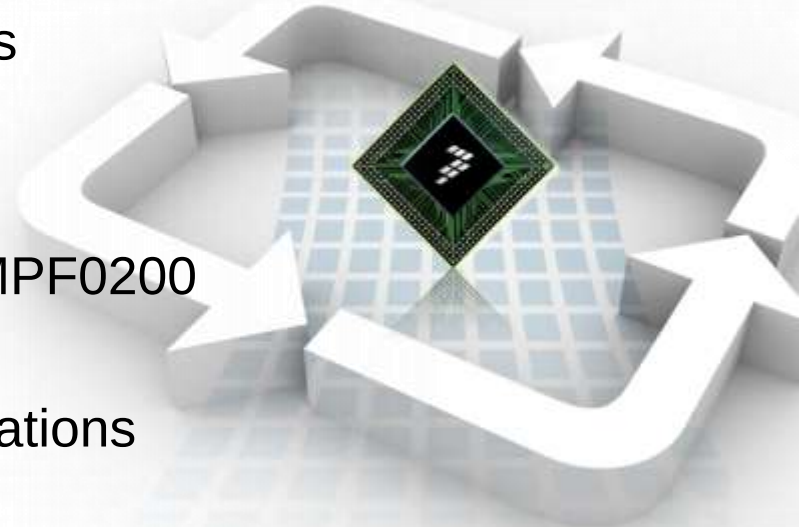
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- *The Finish*

- Q & A



- Complete system lineup with highly integrated Power Management & User Interface features
- Switching and linear regulators with coordinated sequencing for system power tree
- Boost, 4 adjustable buck regulators and 12 adjustable LDOs
- Battery charging with backup cell
- 10-bit ADC for monitoring battery and other inputs plus Coulomb Counter support module
- Real time clock / calendar / alarm
- Serial WLED backlighting / flashlight
- Touch screen interface and GPADC

- Saves design time
- Optimized for Freescale's i.MX family
- Highly integrated, cost effective solution
- Reduces system costs & board space
- EBOM efficiency, software simplicity and product scalability



- Tablets
- eBooks
- Smartphones
- Portable Navigation Devices
- Ultrasound Medical Equipment
- Other Embedded Hand-held Devices

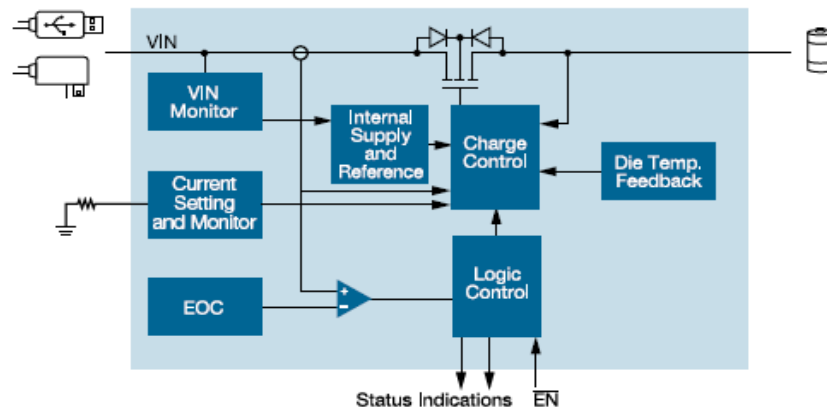
Industry's Most Flexible Battery Charger Solution

- **FEATURES**

- +/-0.7% voltage accuracy over -20°C to +70°C (-20°C to +70°C for MC34675)
- +/- 5% charge current accuracy over -40°C to +85°C (+/- 6% for MC34673 and MC34675)
- 28V maximum input voltage rating – 11V OVP for MC34671 and 6.8V for MC34673
- Up to 1.2A of programmable charge current
- No External FETs, blocking diodes or current sense resistors required
- Trickle charge for fully discharged batteries
- Low-profile, compact 2 mm x 3 mm x 0.65 mm UDFN thermally enhanced package

- **BENEFITS**

- Complete charger for single-cell Li-ion and Li-polymer batteries
- Feature-rich and easily modified to meet the needs of a wide variety of applications
- Factory-configurable parameters for faster time to market and lower system cost
- Output voltage, Input overvoltage protection, EOC & CC current, Trickle charge current & voltage threshold, Recharge threshold, Thermal fold back threshold, Timeout, Verification filter timing
- Low external component count
- Meets AC/DC adapter standard YD/T 1591-2006 in the Chinese cell phone market



- APPLICATIONS

- Any Li-ion or Li-polymer battery powered, handheld, portable applications
- Bluetooth® headsets
- Cell phones
- GPS
- MP3 players
- PDAs
- Portable media players

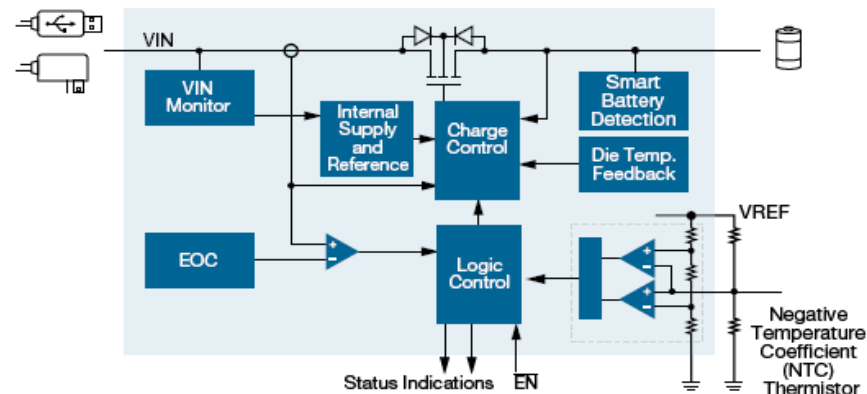
Industry's Most Flexible Battery Charger Solution

- **FEATURES**

- $\pm 0.4\%$ voltage accuracy over -20°C to $+70^{\circ}\text{C}$ and $\pm 2\%$ at room temperature
- $\pm 8\%$ charge current accuracy over -40°C to $+85^{\circ}\text{C}$
- 28V maximum input voltage rating – 11V OVP
- Up to 1.05A of programmable charge current
- No External FETs, blocking diodes or current sense resistors required
- Trickle charge for fully discharged batteries
- Low-profile, compact 2 mm x 3 mm x 0.65 mm UDFN thermally enhanced package

- **BENEFITS**

- Complete charger for single-cell Li-ion and Li-polymer batteries
- Feature-rich and easily modified to meet the needs of a wide variety of applications
- Factory-configurable parameters for faster time to market and lower system cost
- Output voltage, Input overvoltage protection, EOC & CC current, Trickle charge current & voltage threshold, Recharge threshold, Timeout, Indicator pin functions, ISET pin, NTC Thermistor option, Battery connection verification, EOC flow, remote sense
- Low external component count
- Meets AC/DC adapter standard YD/T 1591-2006 in the Chinese cell phone market



- **APPLICATIONS**

- Cradle chargers
- Travel chargers
- Digital still cameras

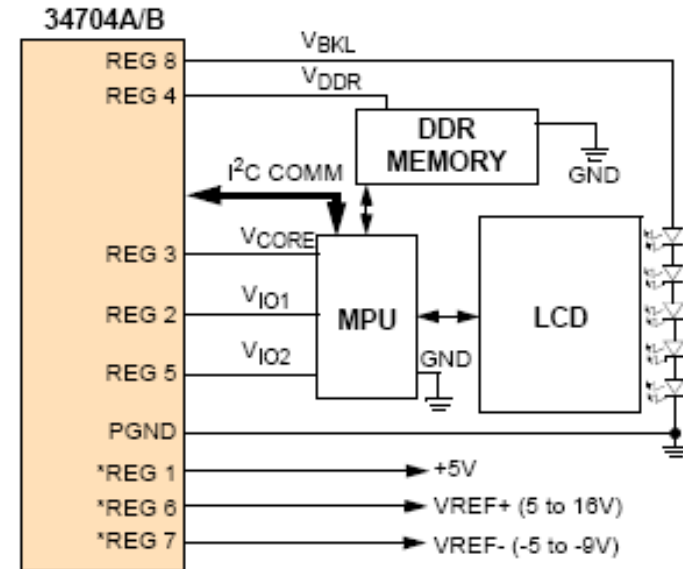
...C34704A/B

- **FEATURES**

- Eight DC/DC (34704A) or five DC/DC (34704B) switching regulators with up to ± 2 percent output voltage accuracy
- 2.7 to 5.5 input voltage range
- Dynamic voltage scaling on all regulators
- Selectable voltage mode control or current mode control on REG8
- I2C programmability
- Output under-voltage, over-voltage, over-current detection and short circuit protection for each regulator
- Thermal limit detection for each regulator except REG7
- Integrated compensation for REG1, REG3, REG6, and REG8
- 5 μ A maximum shutdown current
- True cutoff on all of the boost and buckboost regulators

- **BENEFITS**

- Ideal for portable devices powered by Li-Ion or Li-Polymer batteries or USB powered devices
- Up to 2 MHz switching frequency
- Space efficient due to reduced external components



* Available only in 34704A device

Figure 1. 34704 Simplified Application Diagram

- **APPLICATIONS**
- Portable media players
- Smart phones
- Portable navigation devices
- Security or digital still cameras
- Remote controls
- Laser printers or fax machines
- Mobile gaming consoles
- Small appliances
- Point-of-sale terminals

- **FEATURES**

- **BENEFITS**

-
- The diagram illustrates the system architecture of the iMX Apps Processor. At the center is the **iMX Apps Processor**. It is connected to several components:
- Audio IC**: Receives input from **Stereo Loudspeakers** and **Mic Input** (which includes **Stereo headphones**). It outputs to the **iMX Apps Processor** via **SSI**.
 - BT (+FIR)**: A wireless module connected to the **iMX Apps Processor** and an external antenna.
 - Memory Stack**: Consists of **DRAM**, **NVR**, **TV Out**, and **MMC**, all connected to the **iMX Apps Processor**.
 - Camera**: Connected to the **iMX Apps Processor** and the **Display**.
 - Display**: Shows a colorful image of a flower.
 - 34709 PMIC**: A Power Management Integrated Circuit that provides **Power** to the **iMX Apps Processor** and manages **SPB/I2C** communication. It is powered by an **External Charger** and a **Li Ion Battery**.
 - RTC** (Real Time Clock) and **CALENDAR**: Connected to the **34709 PMIC**.
 - Touch Screen**: Connected to the **34709 PMIC**.
 - Coin Cell Battery**: Connected to the **34709 PMIC** for backup power.

- Tablets
- Smart Mobile Devices
- Digital Signage / Kiosks
- Telehealth
- Connected TV

- 

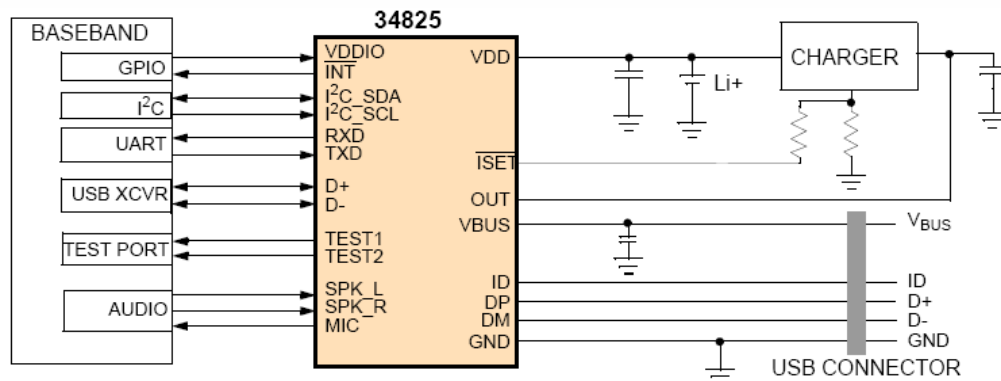
Micro-USB Interface IC Supporting UCS and Wired Accessories

- **FEATURES**

- Automatic accessory identification
- Support Universal Charging Solution (UCS) recommended by OMTP
- Internal power switch with up to 28V OVP
- USB2.0 (480Mbps) compliant
- Support USB or UART firmware download
- Internal 5-bit ADC to support 32 ID resistors
- Accessory attachment and detachment detection
- I2C interface
- 10uA quiescent current in standby mode
- 3x3 UQFN package

- **BENEFITS**

- Flexible input such as ac/dc adapter or USB port
- Sets high or low charging current based on power supply capability
- Supports stereo/mono headsets with or without microphone and remote control with pure passive components



- APPLICATIONS

- Cell Phones
- MP3 / MP4 Players
- Portable Voice Recorders
- USB Universal Charging solution (UCS-OMTP)
- Supports Mini/Micro – USB connector
- UART and USB High Speed communication
- Remote Control/Accessories IDs

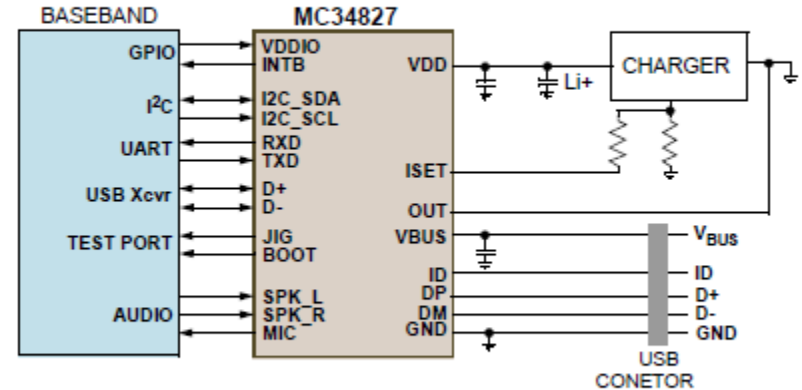
...C34827

• FEATURES

- Internal Power Switch Protects the Phone System against 28V Power Supply Input
- Supports USB or UART Test and R/D cables
- High-Speed USB 2.0 Compliant
- Supports 32 ID resistance values with a High-Accuracy 5-bit ADC
- I2C Interface with Interrupt to the Host
- 10 μ A Quiescent Current in Standby Mode
- 4mm X 3mm 20 Ld. UTQFN and 3mm X 3mm 20 Lead UTQFN Packaging

- **BENEFITS**

- Flexible input such as ac/dc adapter or USB port
- Sets high or low charging current based on power supply capability
- Supports stereo/mono headsets with or without microphone and remote control



- **Applications**

- Cell Phones
- MP3/MP4 Players
- Portable Voice Recorders
- USB Universal Charging Solution (UCS-OMTP)
- Supports Mini/Micro - USB Connector
- UART and USB High Speed Communication
- Remote Control/Accessories IDs

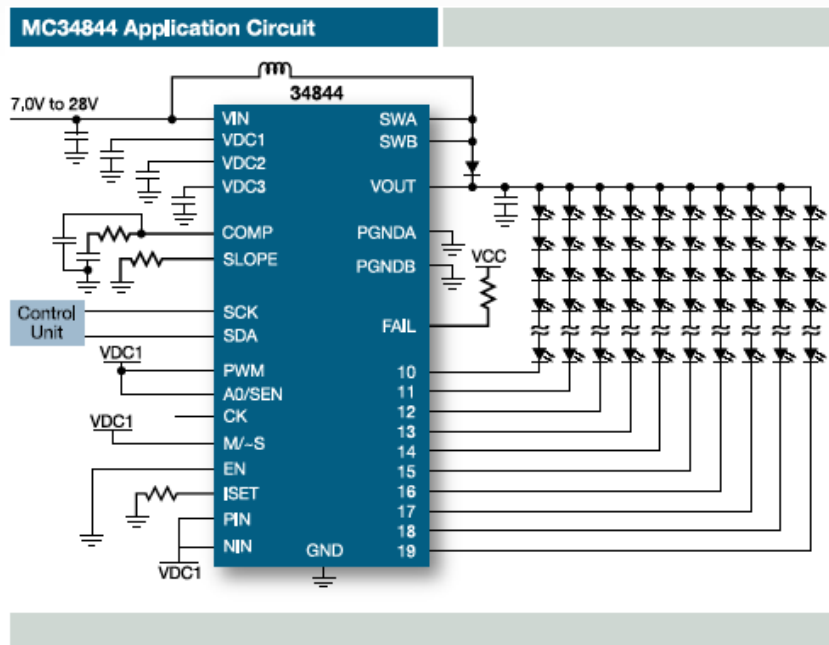
10-ch LED backlight driver w/ integrated Power Supply

- **FEATURES**

- Input voltage of 7.0V to 28V
- Output voltage up to 60V
- 2.5A integrated boost FET
- Up to 80 mA LED current per channel
- 90 percent efficiency (DC:DC)
- 10-channel current mirror with ± 2 percent current matching
- I2C/SM-bus interface
- 8-bit programmable LED current and dimming resolution
- PWM frequency programmable or synchronizable from 100 Hz to 25 kHz
- User-programmable Boost OVP
- LED open failure detection and OTP/OCP/UVLO lockout

- **BENEFITS**

- High flexibility and integration
- Highly accurate LED current matching
- LED dimming via integrated PWM generator
- Optical/temperature closed loop operation
- Ambient light compensation for improved battery life in portable devices
- Drive up to 160 LEDs in 10 parallel strings – up to 30 W
- Small footprint 32 pin 5 mm x 5 mm TQFN package



- **Applications**

- Monitors up to 27 inches
- PC notebooks
- GPS screens
- Smaller screen televisions
- Gaming consoles
- Industrial instrumentation displays
- Health care device displays

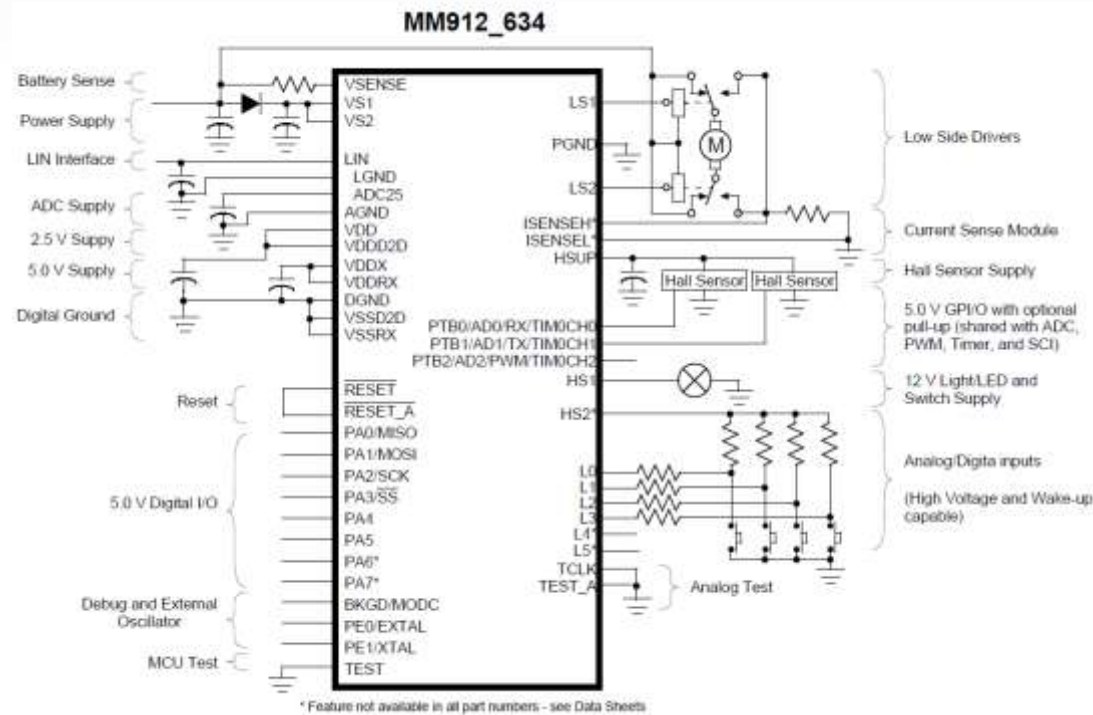
Integrated S12 Based Relay Driver with LIN

- **FEATURES**

- High performance 16-bit S12 CPU
- 32/48/64kByte FLASH, 2/4 kByte RAM
- Two autonomous window watchdogs with dedicated oscillator
- LIN 2.1 Physical Layer Interface, fast mode capable
- Serial Communication Interface (SCI)
- Configurable cyclic sense & forced wake-up feature
- Current sense with selectable gain
- Two protected Low Side outputs to drive inductive loads
- Two protected high side outputs
- Battery voltage sense with low battery warning (IRQ), reverse battery protected
- Chip temperature sensor
- Hall sensor supply implemented as switchable 18 V voltage regulator

- **BENEFITS**

- Microcontroller and analog features in one space saving package
- Easy control of high-current motors using relays and current sense features
- Reduced space, resulting in enhanced reliability
- Internal protection features provide full protection for output stages (with status reporting)
- Low-power mode flexibility and wake-up options, including 7 wake-up sources



- **APPLICATIONS**

- Window Lift
- Seat Control
- Sun Roof Control
- Fan Control
- Key Pad Interface
- Switch Panel Interface

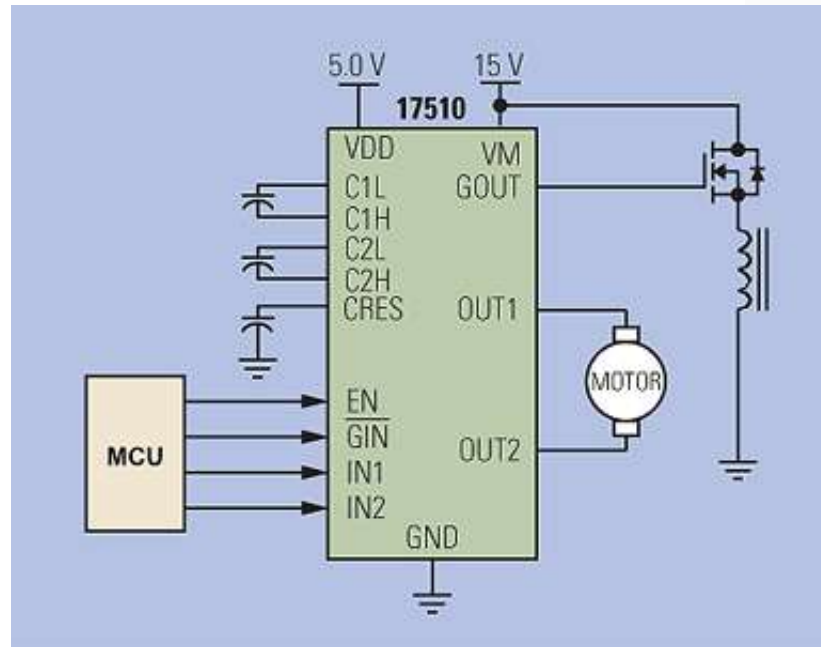
...PC17510

• FEATURES

- 2.0V to 15V continuous operation
- Low RDS(ON) 450 mΩ (typ)
- Output current 1.2 A (DC), 3.8 A (peak)
- Cross-conduction suppression
- PWM control input frequency 200 kHz
- Built-in charge pump circuit

- **BENEFITS**

- Simple MCU Interface
- Under voltage detection to prevent erratic operation
- TSWITCH output for driving an external MOSFET
- Low quiescent current
- Low profile package for portable designs
- Reduces design time



- **APPLICATIONS**

- Portable Electronics
- Single Lens Camera
- Digital Still Camera

- **FEATURES**

- **BENEFITS**

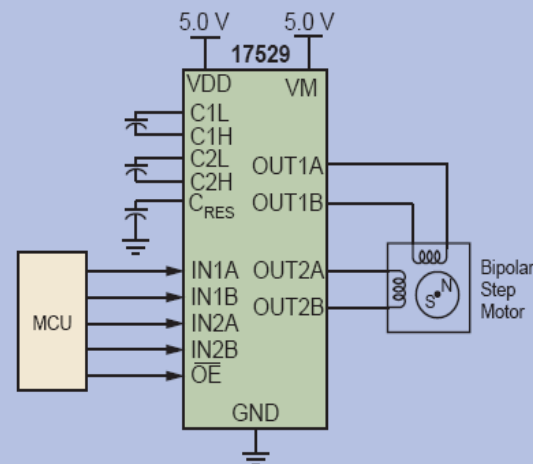
-

- Portable Electronics
- Single Lens Camera
- Digital Still Camera

• FEATURES

- **BENEFITS**

- ## 17529 SIMPLIFIED APPLICATION DIAGRAM

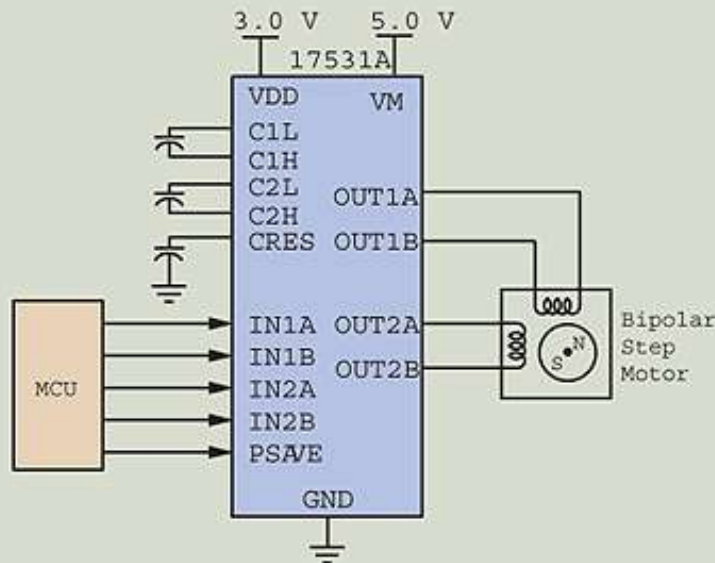


- Portable Electronics
- SLR Lens Shutter Control
- Optical Disc Drive (MO, DVD, and CD)
- DSC, DVC

- **FEATURES**

- Motor power supply - 2 to 8.6 V
- Low RDS(ON) 0.8 Ω (typ)
- Output current 700 mA (DC), 1.4 A (peak)
- Shoot through current protection circuit
- PWM control input frequency 200 kHz
- Built-in charge pump circuit

- Simple MCU Interface
- Single or parallel H-Bridge outputs
- Under voltage detection to prevent erratic operation
- Low quiescent current
- Low profile package for portable designs
- Reduces design time



- Portable Electronics
- SLR Lens Shutter Control
- Optical Disc Drive (MO, DVD, and CD)
- DSC, DVC

Monolithic Dual H-Bridge for Portable Applications

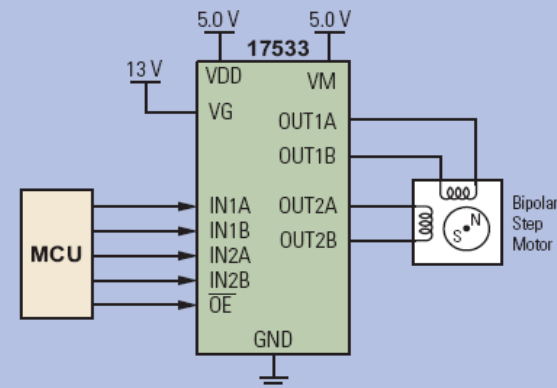
- **FEATURES**

- Motor power supply - 2 to 6.8 V
- Low RDS(ON) 0.8 Ω (typ), 1.4 Ω (Peak)
- Output current 700 mA (DC), 1.4 A (peak)
- 3.0V/5.0V CMOS-Compatible Inputs
- Shoot through current protection circuit
- PWM control input frequency 200 kHz
- Charge pump circuit

- **BENEFITS**

- Simple MCU Interface
- Single or parallel H-Bridge outputs
- Under voltage detection to prevent erratic operation
- Low quiescent current
- Low profile package for portable designs
- Reduces design time

17533 SIMPLIFIED APPLICATION DIAGRAM



- APPLICATIONS

- Portable Electronics
- Lens Shutter Camera
- Optical Disc Drive

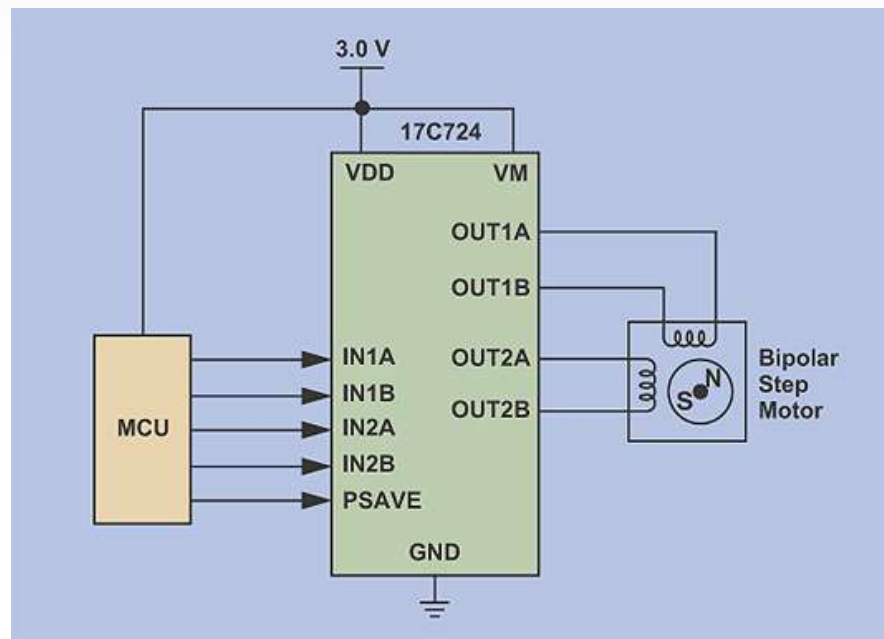
Monolithic Dual H-Bridge for Portable Applications

- **FEATURES**

- Motor power supply – 2.7 to 5.5 V
- RDS(ON) 1.0 Ω (typ), 1.5 Ω (Peak)
- Output current 400 mA (DC)
- 3.0V/5.0V CMOS-Compatible Inputs
- Shoot through current protection circuit
- Low-Voltage Shutdown
- PWM control input frequency 200 kHz
- Charge pump circuit

- **BENEFITS**

- Simple MCU Interface
- Single or parallel H-Bridge outputs
- Low quiescent current
- 3x3mm 16-pin QFN package for small footprint
- Reduces design time



- APPLICATIONS

- Portable Electronics
- Lens Shutter Camera
- Optical Disc Drive

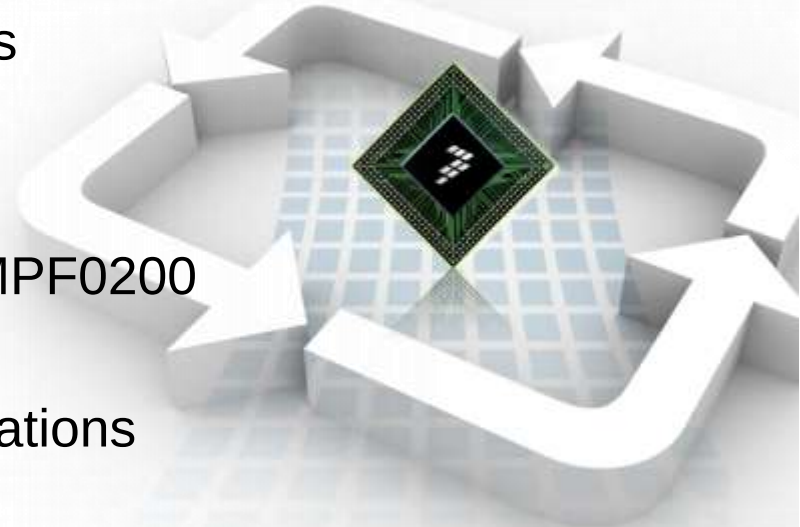
- *The Warm-up*

- *The Race*

- Introducing MMPF0100 and MMPF0200
- Features
- Evaluation Tools and Demonstrations
- Schedule
- Other Freescale analog power management products

- *The Finish*

- Q & A

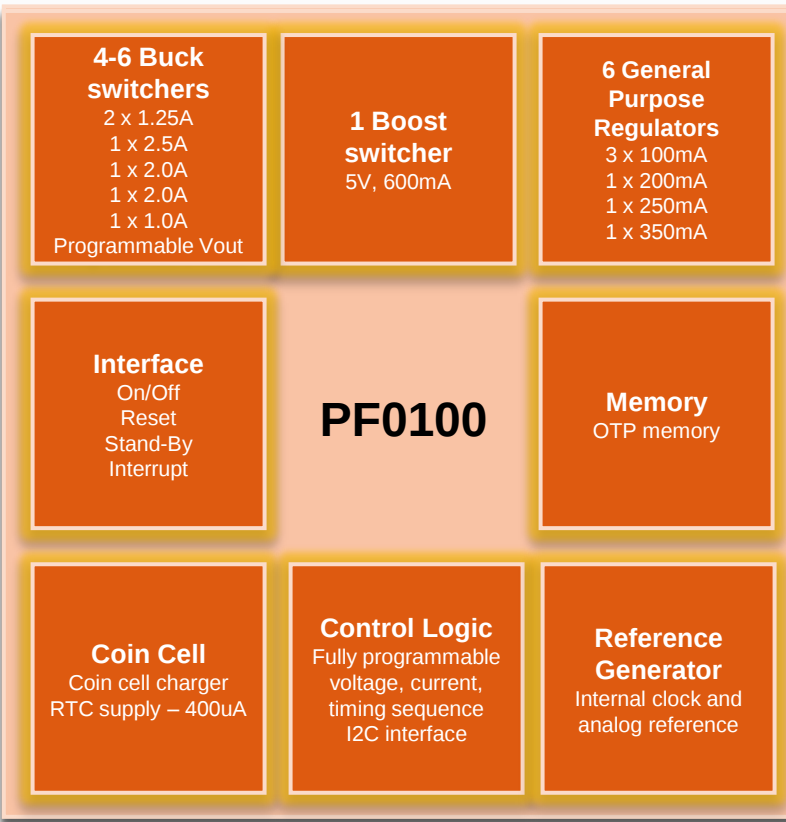




BACKUP

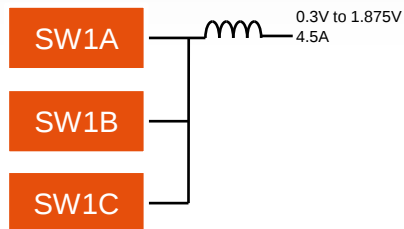


MMPF0100 Buck Regulators

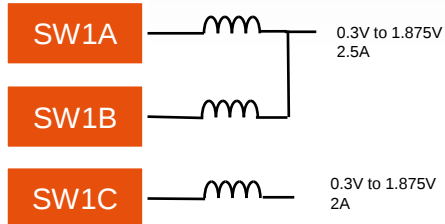


- Input voltage range: 2.8V to 4.5V
- 4 to 6 buck converters
 - (2 x 1.25A, 1 x 2.5A, 1 x 2.0A, 1 x 2.0A, 1 x 1.0A)
 - Single/Multi-phase configurable
- Programmable MOSFET stages to facilitate using smaller inductor
- Programmable current limit (1.5x or 2x rated)
- High light-load efficiency modes (APS/PFM)
- Adjustable switching frequency (1/2/4 MHz options as well as finer frequency margining for EMC)
- High efficiency across entire load range
- Internally compensated thus requiring minimum external components

MMPF0100 Output Configuration & Phase Options

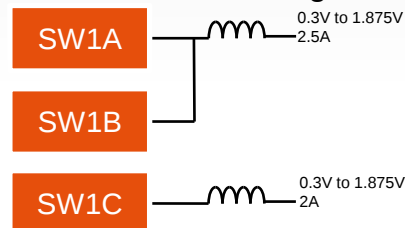


Single Phase

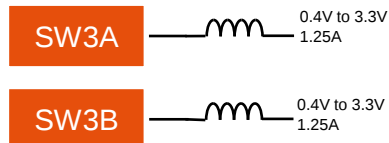


Dual Phase A/B + Independent output C

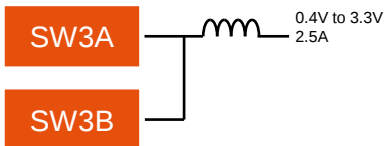
SABRE-SDB/AI Configuration



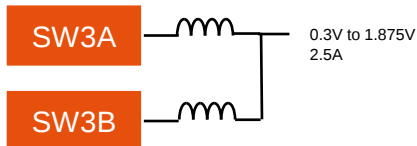
Single Phase A/B + Independent output C



Independent



Single Phase



Dual Phase

- 6 – 8 Buck Output Voltages
- Optimized BOMs available with application specific reference designs

Using MOSFET Power Stages

- Inside the IC, each MOSFET is composed of multiple paralleled stages of smaller MOSFET.
- The PF0100 gives flexibility to reduce the number of power stages for a given application. But why?
 - The overall current rating of the buck converter is reduced. For example, SW1AB is rated for 2.5A. If in a given application, maximum expected load is only 1.5A, the converter can operate with only 60% of the internal MOSFETs. This allows use of an inductor of smaller current rating. Current limit is reduced proportionally.

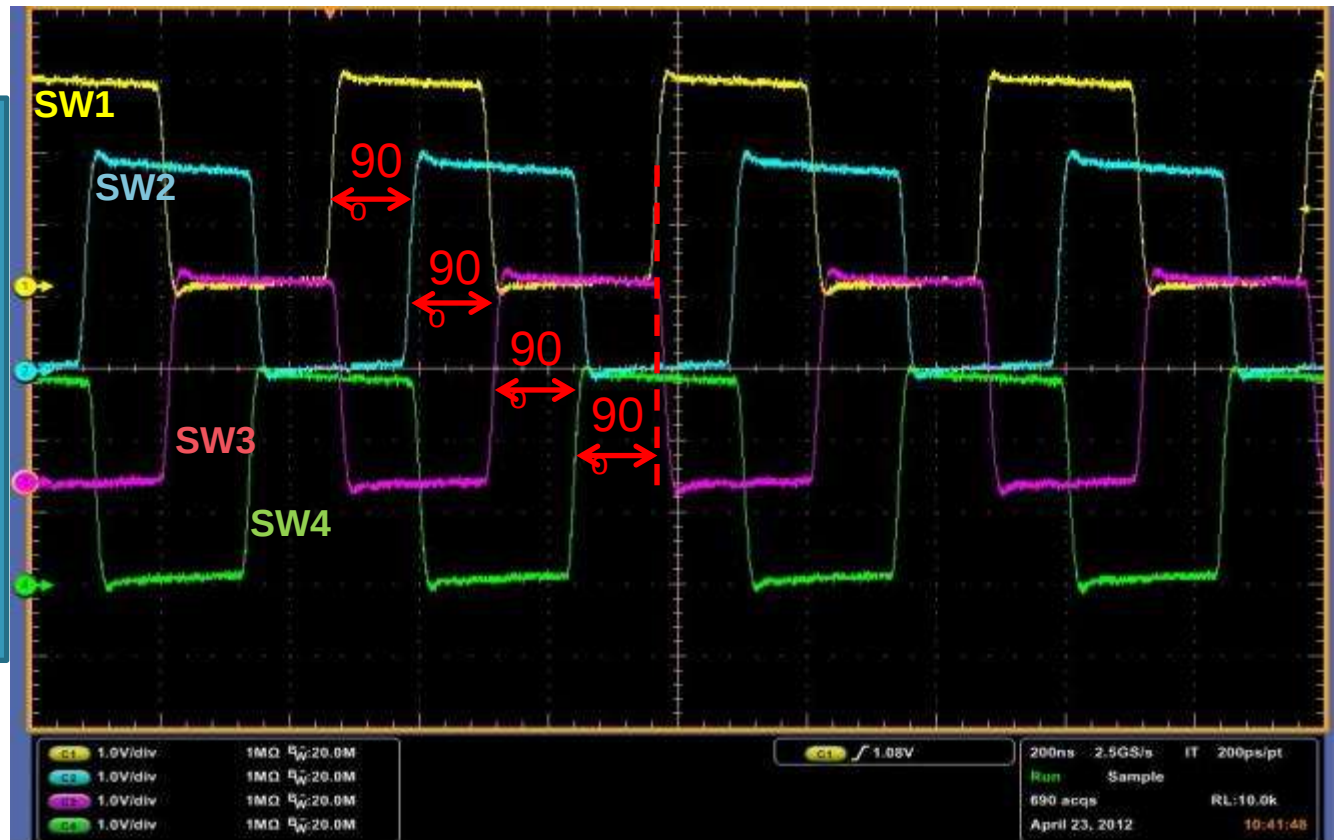
Regulators	Control Bits			% of Power Stages Enabled	Rated Current (A)
SW1AB	SW1AB_PWRSTG[2:0]				ISW1AB _{MAX}
	0	0	1	40%	1.0
	0	1	1	80%	2.0
	1	0	1	60%	1.5
	1	1	1	100%	2.5

Switching Modes and Phase Clock

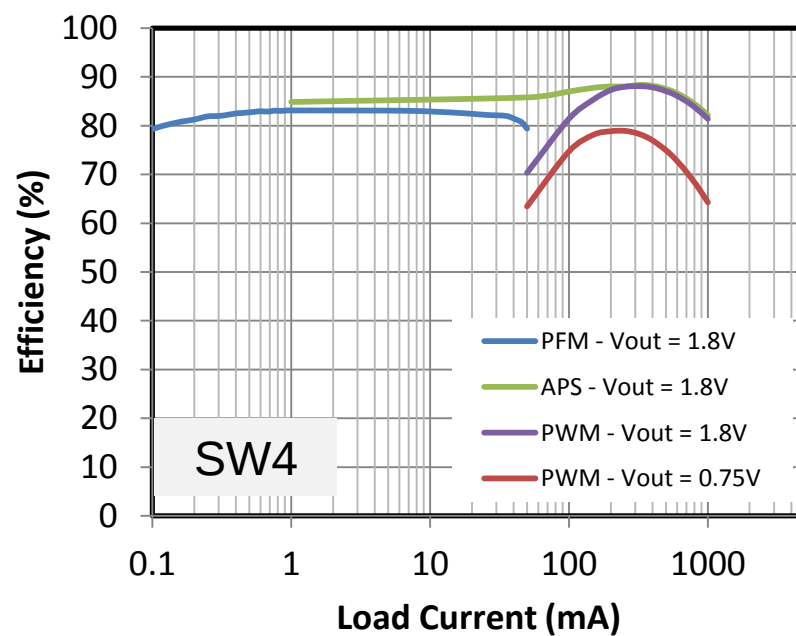
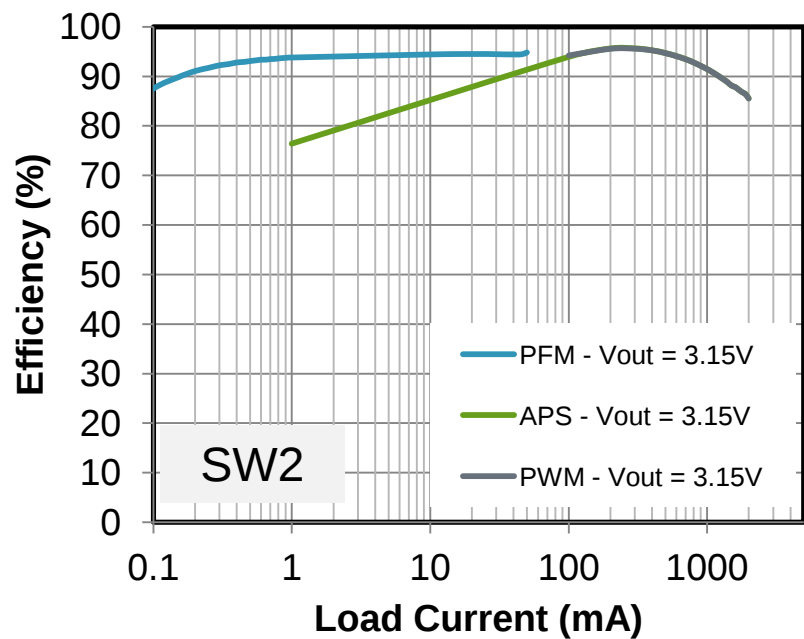
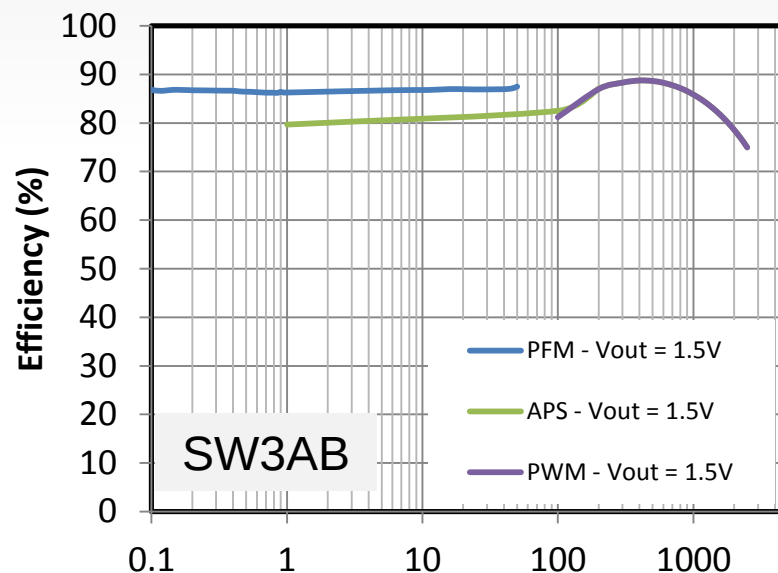
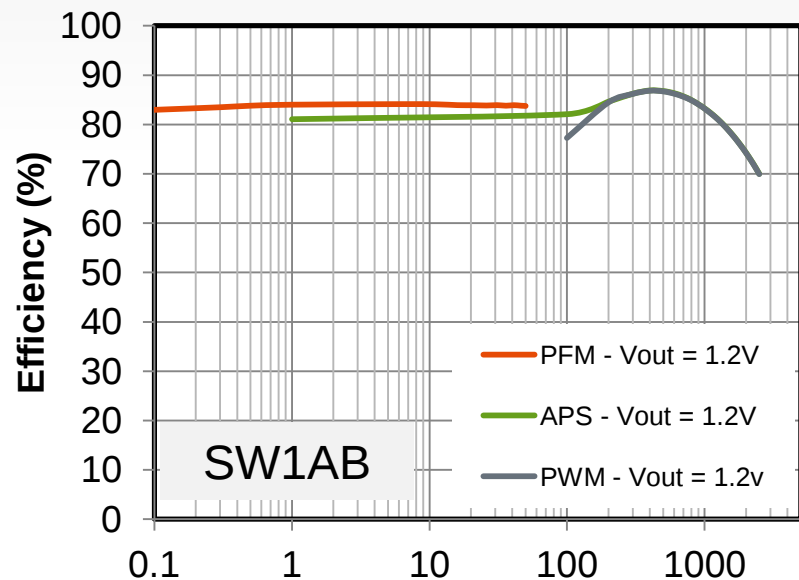
Operation Modes	Description	Efficiency @ light load	Efficiency @ heavy load
PFM	The regulator is always in PFM mode	high	mid
PWM	The regulator is always in PWM mode	low	high
APS	The regulator moves automatically between Pulse Skip and PWM modes depending on load conditions	high	high

Phase Interleaving:

When the top FET in a buck converter turns on, input capacitor sees sudden discharge. By interleaving the different switching converters, **input ripple is minimized**. This interleaving is also programmable.

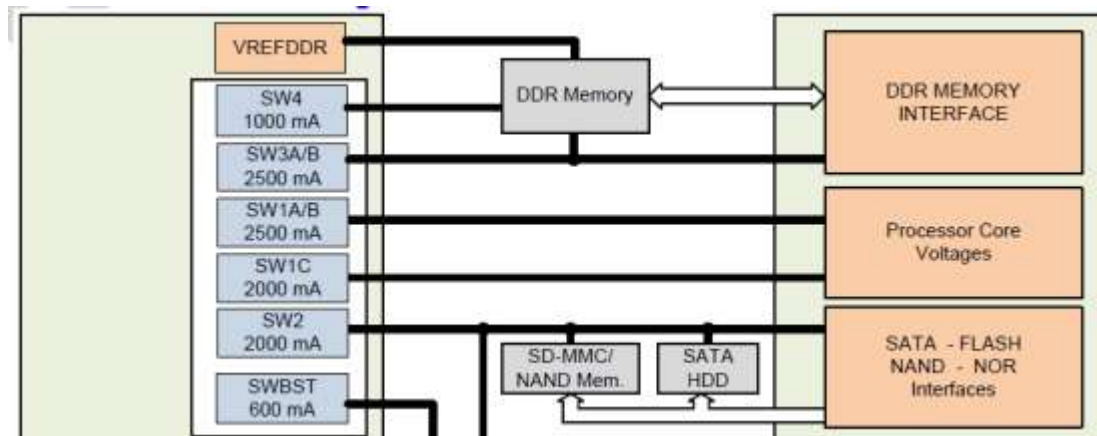


Typical Buck Regulator Efficiency

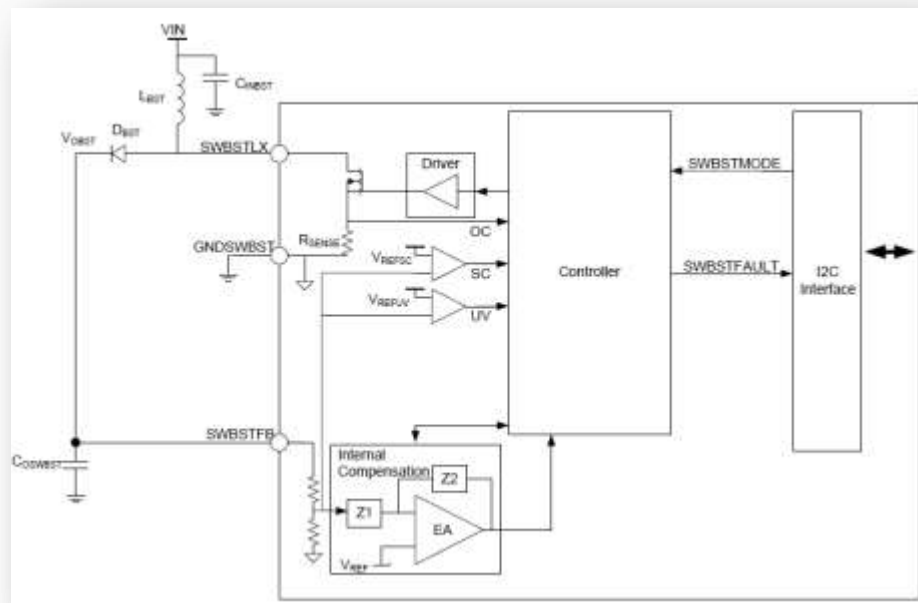
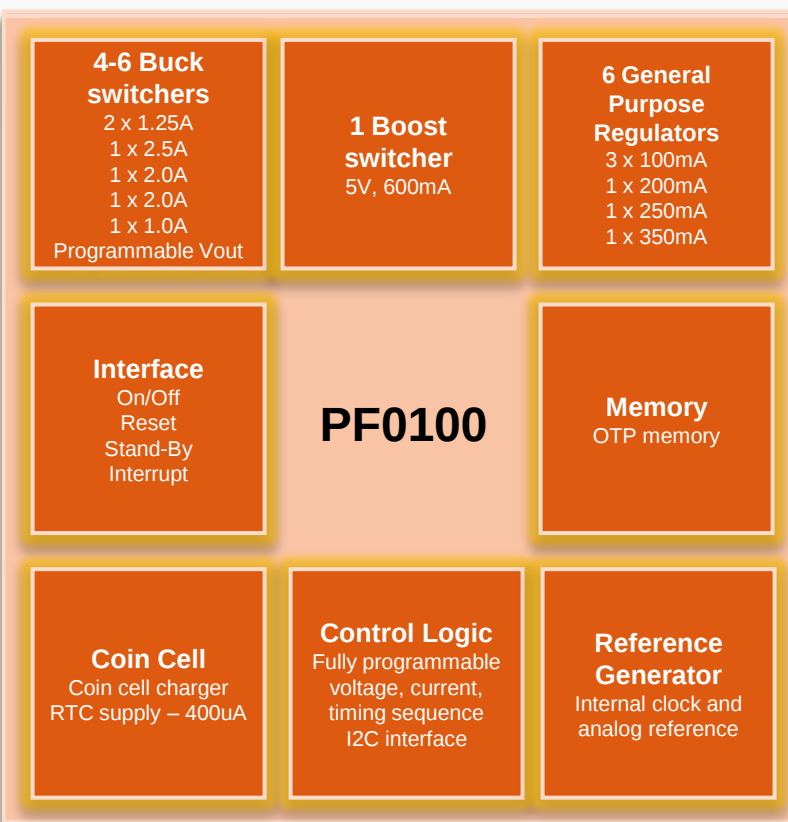


SW4 in VTT Mode

- If system requires DDR memory termination, SW4 can be used in VTT mode
- In the VTT mode, its reference voltage will track ($0.5 * \text{SW3A voltage}$)
- Only PWM switching is allowed in VTT mode to allow current sinking
- The VTT mode can be configured by use of VTT bit in the OTP_SW4_CONFIG register



MMPF0100 Boost Regulator



Programmable output voltage

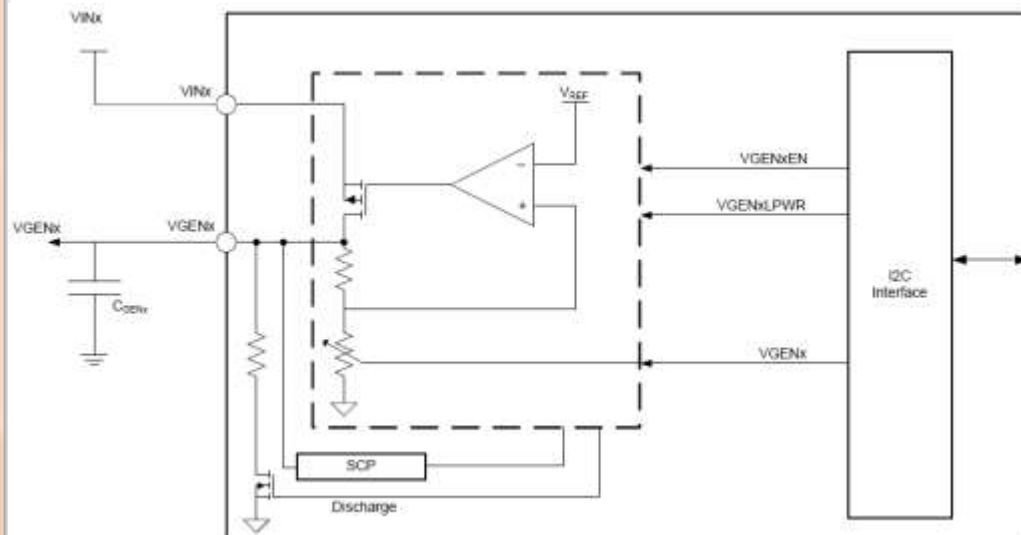
5.0V/5.05V/5.10V/5.15V

600mA

2MHz Switching Frequency

Modes: PWM, PFM, AUTO

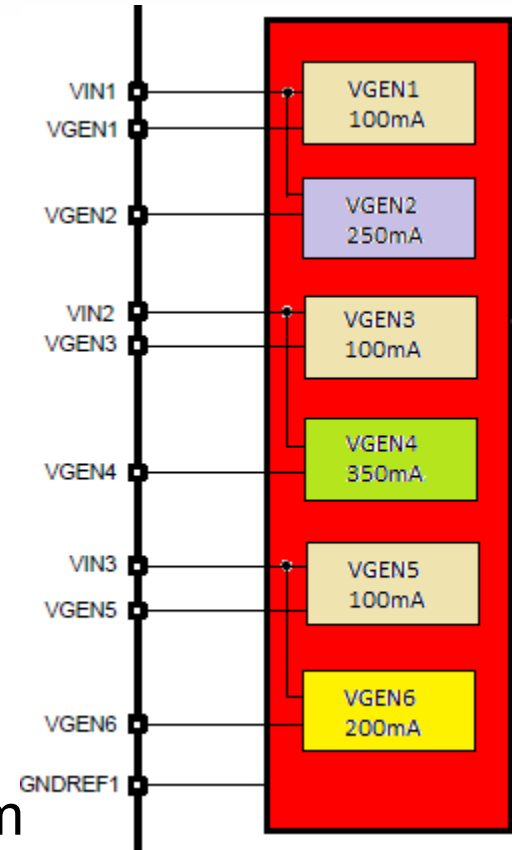
OCP fault interrupt



VGENx LDO Block Diagram

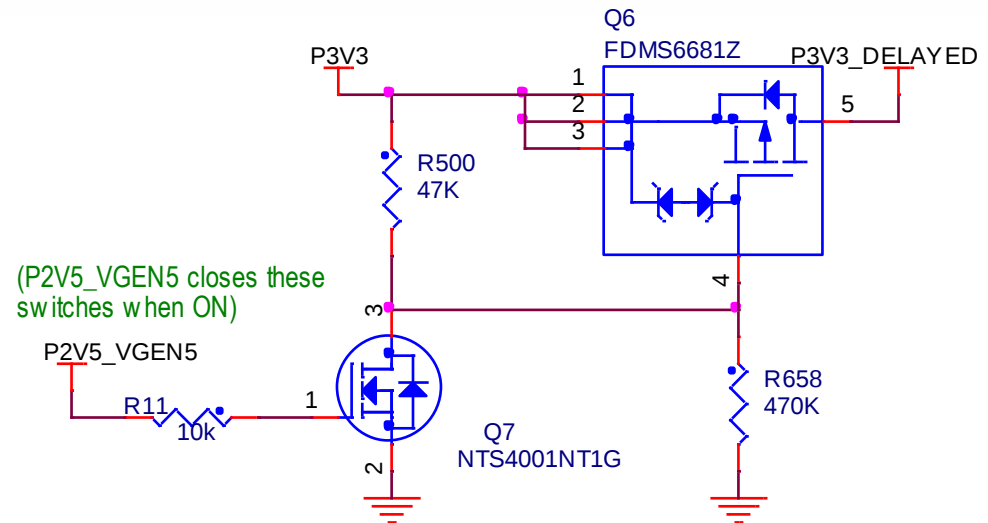
VGENx LDO Specifications

- Programmable output voltage
 - VGEN1, 0.80V - 1.55V, 100mA
 - VGEN2, 0.80V - 1.55V, 250mA
 - VGEN3, 1.8V - 3.3V, 100mA
 - VGEN4, 1.8V - 3.3V, 350mA
 - VGEN5, 1.8V - 3.3V, 100mA
 - VGEN6, 1.8V - 3.3V, 200mA
- Soft start – output slew rate control
- Low power mode, automatically or setting by the VGENxLPWR bit
- Short circuit/Over current protection
- Unused LDO's can be used for general system sequencing!



Using Unused LDOs for Sequencing

- The PF0100 has 6 general purpose low dropout linear regulators
- The startup sequence of these LDO's can be OTP programmed
- Output of these LDOs can be used to drive an external bypass FET to control the sequence of other power rails in the system



Optional Circuit for using VGEN5 as a sequencer. P3V3 and P3V3_DELAYED are shown for example. The concept can be used for other system rails.

Control Logic

- **PWRON**
 - Input signal to generate a turn-on event. It can be OTP configured to detect a level, or an edge depending on the PWRON_CFG bit
- **STANDBY**
 - Input signal to control the PF0100 to enter standby mode and exit standby mode
- **RESETBMCU**
 - Open drain, active low. Can also act as a PGOOD pin
- **SDWNB**
 - Open drain, active low. Notifies the processor of an imminent PMIC down
- **INTB**
 - Open drain , active low. Interrupt the processor in the event of a fault

Turn On Events

- **PWRON_CFG=0**
 - The PWRON signal is high, the PMIC will turn on; the interrupt and sense bits, PWRONI and PWRONS respectively, will be set.
- **PWRON_CFG =1**
 - The PWRON signal is low, the PMIC will turn on; the interrupt and sense bits, PWRONI and PWRONS respectively, will be set. The sense bit will show the real time status of the PWRON pin.
- **From SLEEP mode to ON mode**
 - Any regulator enabled in the SLEEP mode will remain enabled when transitioning from SLEEP to ON, i.e., the regulator will not be turned off and then on again to match the start-up sequence.

Turn Off Events

- **PWRON pin**
 - PWRON_CFG bit =0, SWxOMODE bit =0 and PWRON pin is low
 - PWRON_CFG bit=1, SWxOMODE bit =0, PWRONRSTEN = 1 and PWRON is held low for longer than 4 seconds. Alternatively, the system can be configured to restart automatically by setting the RESTARTEN bit.
- **Thermal protection**
 - 140°C
 - Warning interrupt
 - THERM110I, THERM120I, THERM125I, and THERM130I
- **Under voltage detection**
 - Falling edge of the UVDET, 2.65V

MMPF0100 State Machine Modes of Operation

- **On mode.**
 - When the PF0100 is in the On mode, all functionality is available. RESETBMCU is high.
- **Off mode.**
 - Only VCOREDIG and the coin cell module are powered. A valid turn-on event can exit the OFF mode.
- **Standby mode**
 - Pin on PMIC: STANDBY
 - Enter Standby mode: STANDBY is asserted high when the SOC enters low power mode .
 - Exit Standby mode: STANDBY is de-asserted. Supply is expected to regulate to previous voltage.
- **Sleep mode**
 - Pin on PMIC: PWRON
 - Enter sleep mode: PWRON is de-asserted low when the SOC enters sleep mode.
 - Exit sleep mode: PWRON is asserted high.
- **Coin cell mode**
 - VIN=0V and the coin cell is the only valid power source to the PF0100.
 - No turn-on event is accepted.
 - RESETBMCU is low.
 - VCOREDIG is at ~1.3V.

