Power Management for IoT SoCs

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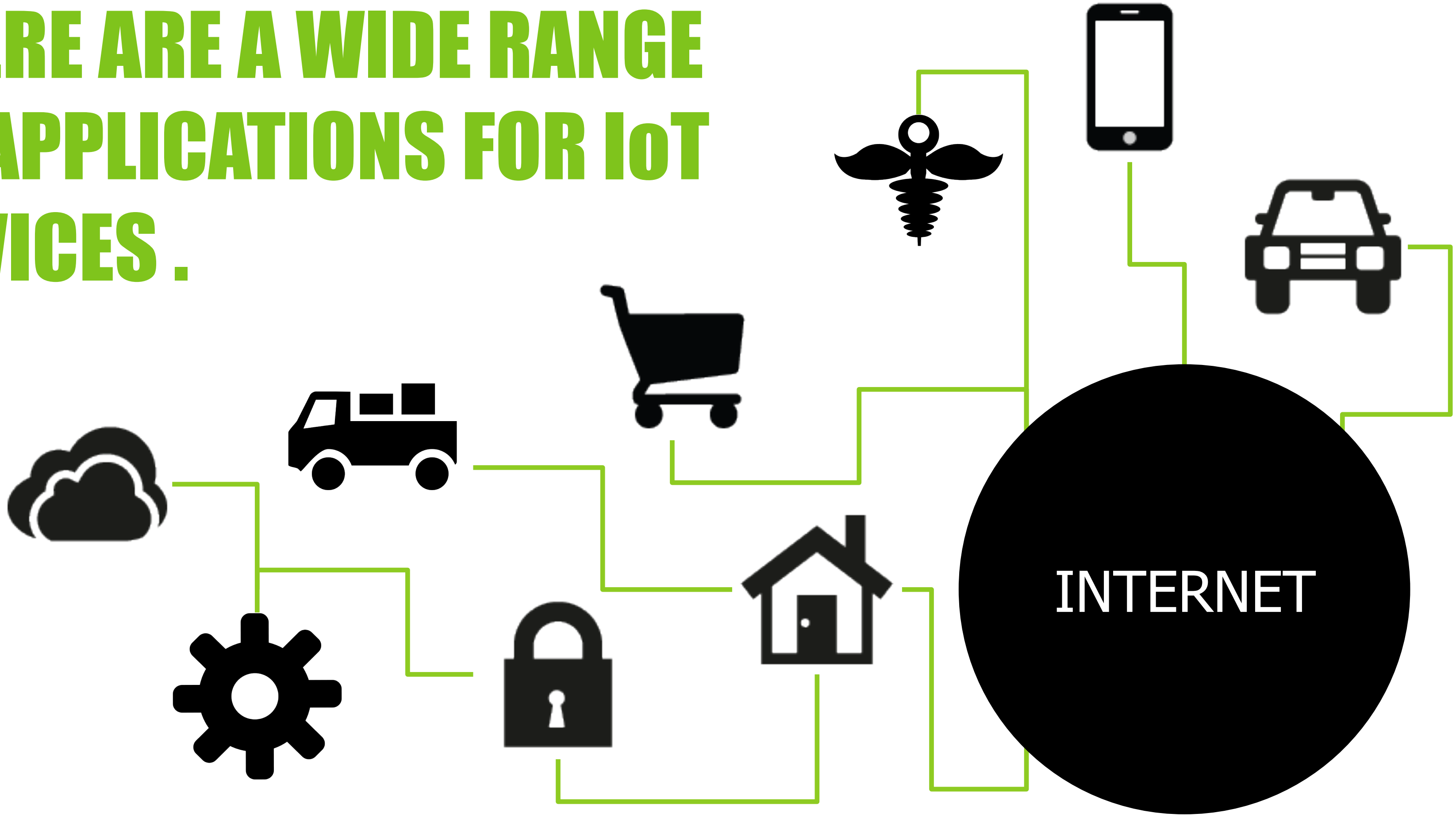
4/16/19

vidatronic

INNOVATION TO POWER™


PROTECTION
LOCATION
WI-FI
HEALTH
MOBILITY
ECOLOGY
ENERGY
WATER
SHOPPING
The interconnection of billions of autonomous devices to the internet is called
THE INTERNET OF THINGS (IoT)

THERE ARE A WIDE RANGE OF APPLICATIONS FOR IoT DEVICES .



MANY NEW IDEAS WILL BE BROUGHT TO THIS FIELD.

BUT A GREAT NUMBER OF THESE WILL COME FROM COMPANIES **WITHOUT BACKGROUND OR EXPERIENCE** IN DEVELOPING HIGH-TECH DEVICES AND EQUIPMENT.

THESE NEW IoT INVENTIONS WILL NEED TO BE IMPLEMENTED WITH A SINGLE SYSTEM ON A CHIP.

THIS WILL PROVIDE THE HIGHEST LEVELS OF INTEGRATION AND CONSERVATION OF AREA.

Integration Trends

Twenty years ago, SERDES analog blocks were completely separate from the ASIC/SoC.

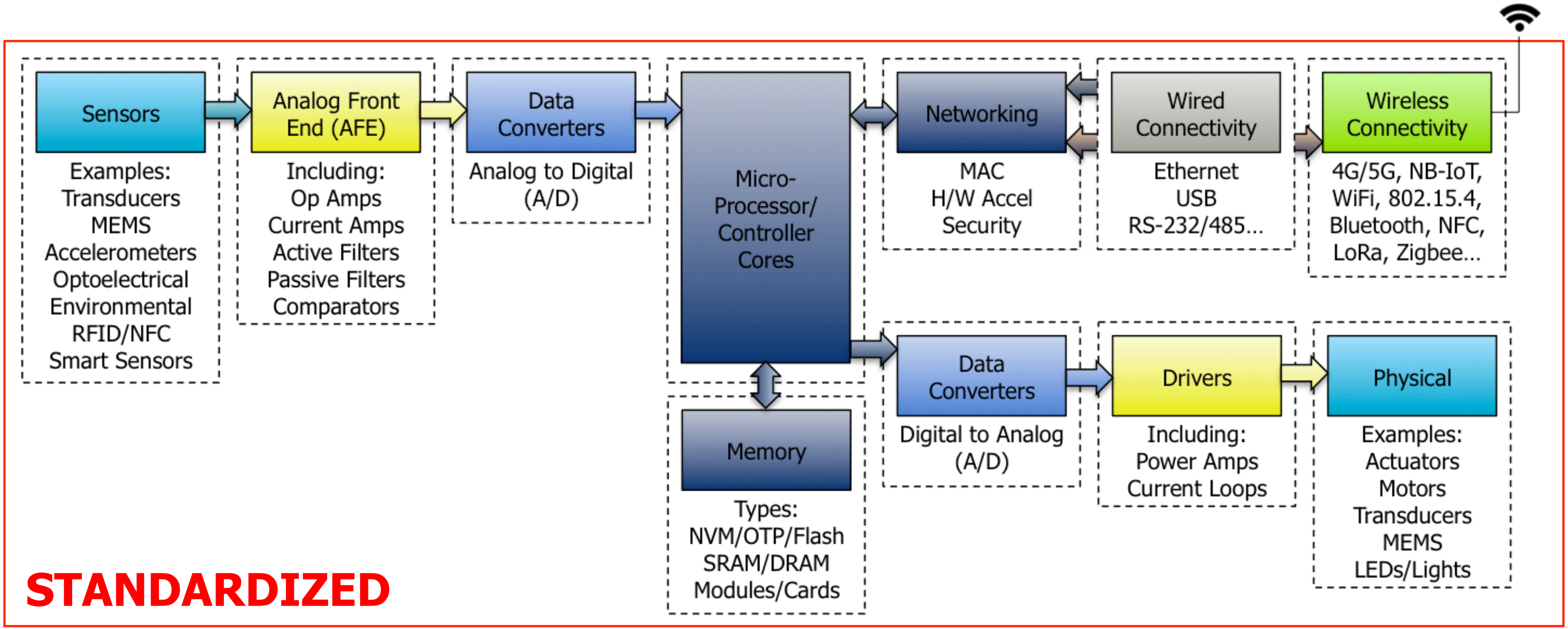
Today, SERDES analog blocks are fully integrated into the ASIC/SoC.

Previously, power management IC (PMIC) analog blocks were separate from the ASIC/SoC.

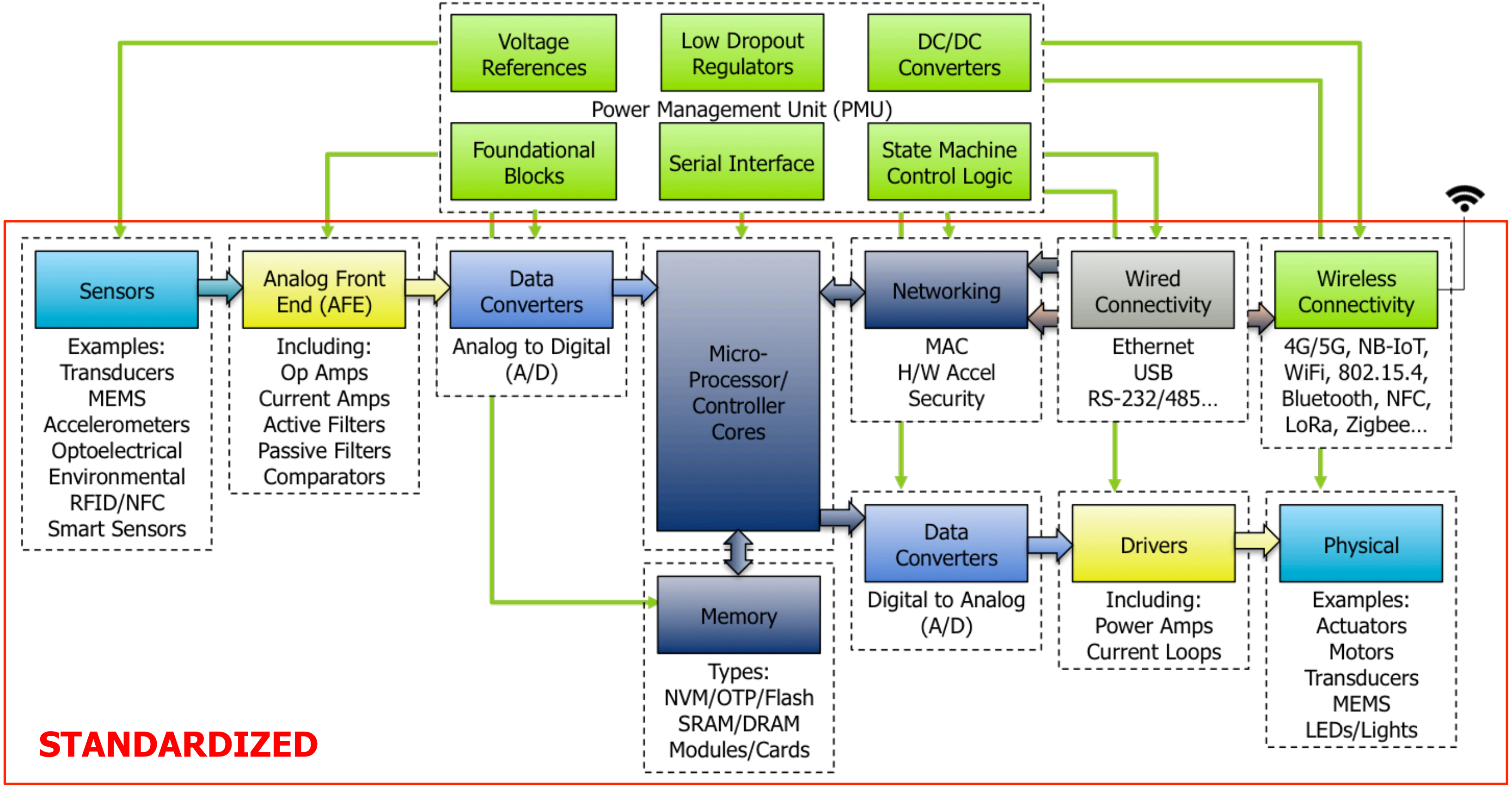
Current trends are to fully integrate the PMU into the ASIC/SoC.

ONE OF THE MOST IMPORTANT ASPECTS OF DEVELOPING A CUSTOM SOC FOR AN IOT APPLICATION IS **DIFFERENTIATING** YOUR PRODUCT FROM OTHER COMPETITORS IN THE MARKET.

MANY OF THE FUNCTIONAL BLOCKS THAT ARE USED IN A TYPICAL SOC ARE EITHER STANDARDIZED OR VERY HIGHLY COMMODITIZED.



THE HIGH-PERFORMANCE ANALOG AND MIXED-SIGNAL BLOCKS IN GREEN, HOWEVER, CAN BE AN AREA FOR **CUSTOMIZATION AND DIFFERENTIATION.**



MOST IOT SOC DESIGNS ARE IMPLEMENTED IN **SMALL-GEOMETRY PROCESSES (55 NM AND SMALLER)**

Advantages of Small-Geometry Processes
✓ Power savings for longer battery life.
✓ Die area savings for smaller devices.

Challenges of Small-Geometry Processes
✓ Transistor mismatch.
✓ Current leakage.

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INNOVATION TO POWER™

We have significant experience in overcoming the difficulties of designs in a variety of advanced-processes, down to 5 nm.

SAMSUNG

tsmc

GLOBALFOUNDRIES

Dongbu HiTek

UMC

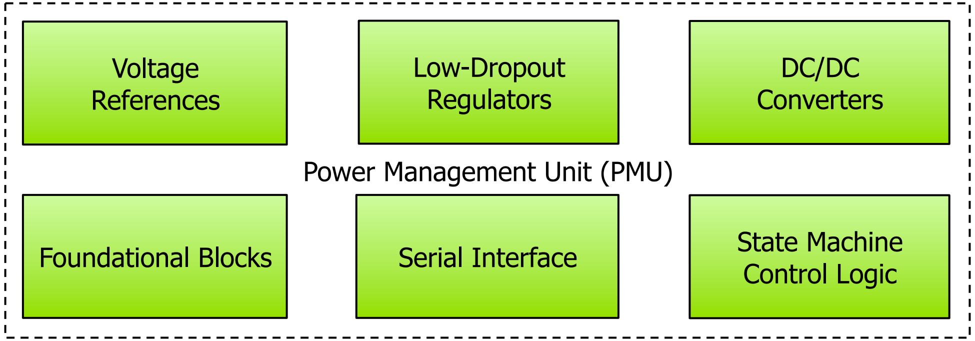
USING VIDATRONIC INTELLECTUAL PROPERTY (IP) WILL HELP YOU:

Reach market faster

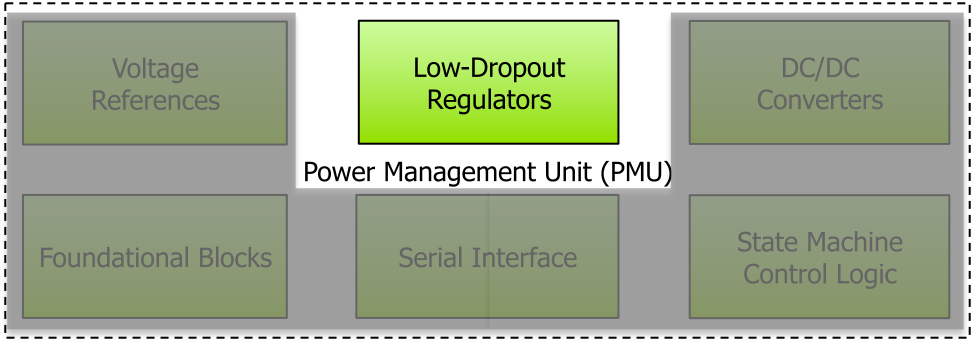
With lower risk

And less cost

Power Management Unit IP Blocks

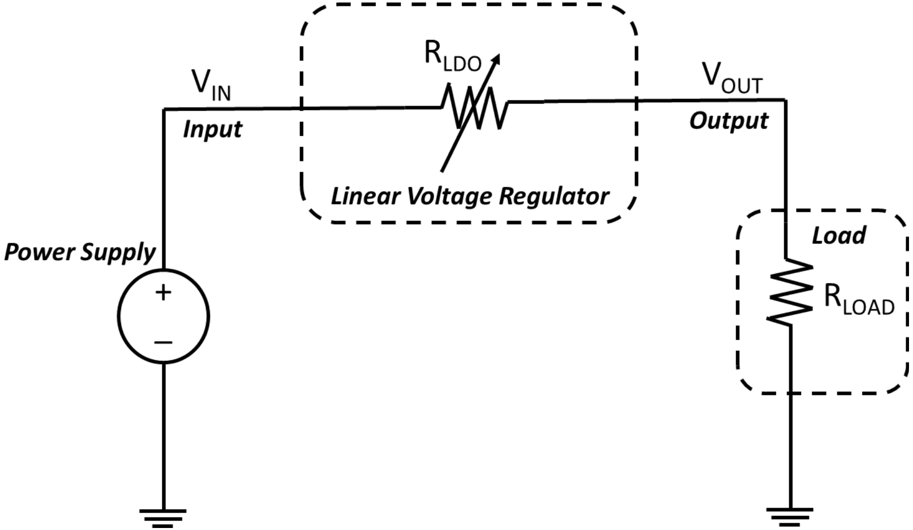


Low-Dropout Regulators (LDOs)



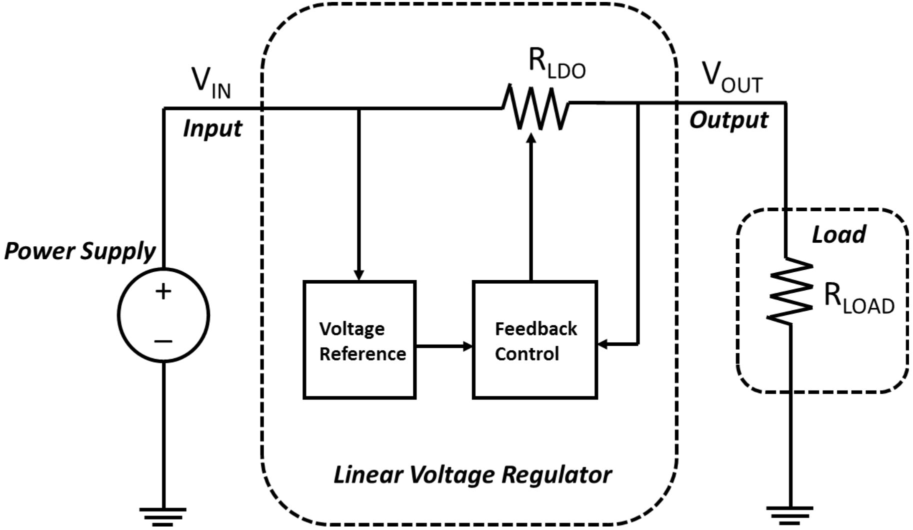
Linear Voltage Regulator Fundamentals

- High input voltage
- Lower output voltage
- Voltage dropped across variable internal resistance
- Power dissipated as heat
- Low input-to-output devices called "Low Drop-Out" or LDO



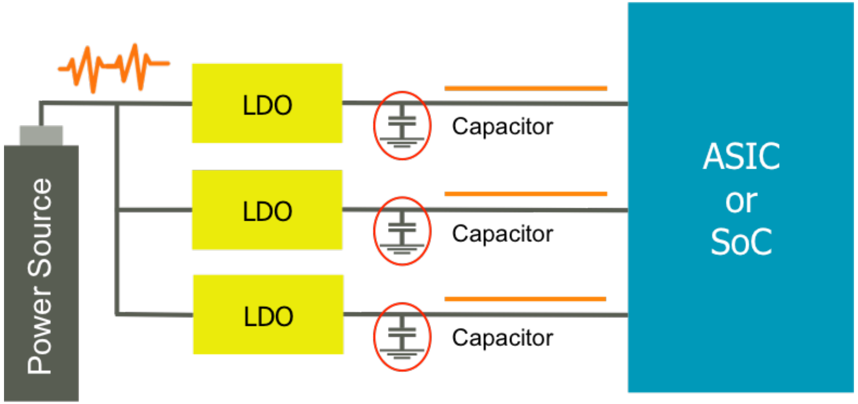
VREG Function

- Varying input voltages
- Varying load currents
- Closed-loop feedback control system
- Loop transfer function & loop stability
- Power-supply noise filtering (PSRR)



Vidatronic's Power Quencher® LDO

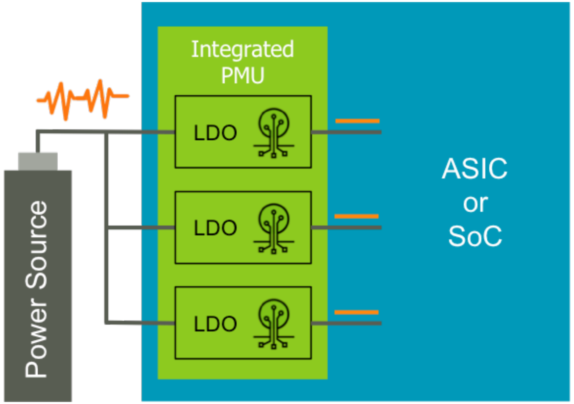
Typical application requiring multiple external LDOs and capacitors.



Vidatronic integrated power management unit (PMU) - inside customer's microchip

No external LDOs.

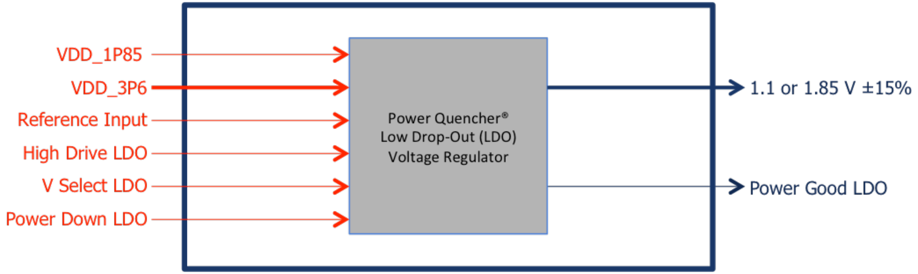
No external capacitors required.



Power Quencher® LDO Voltage Regulator – VLDS0001LNT040

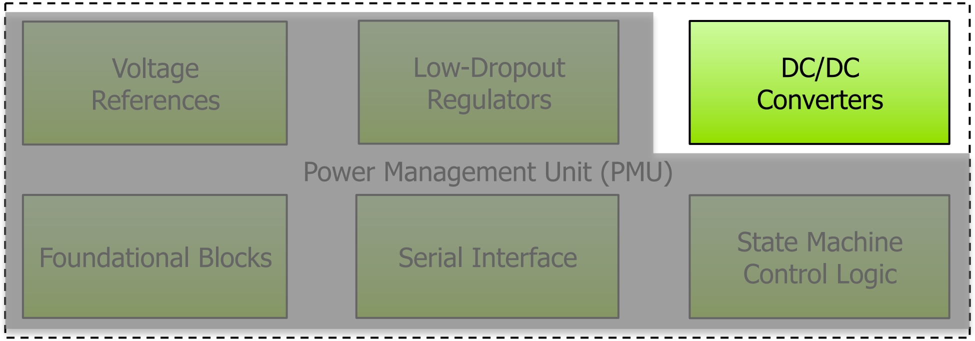
Dual-mode LDO for battery-powered devices where low-power is critical.

Parameters	Specifications
Input Power Supply	2.8 to 4.2 V
Selectable Output Voltages	1.1 or 1.85 V
Output Voltage Accuracy (includes error of the reference input)	± 15%
Maximum Continuous Output Current (high drive mode)	3 mA
Maximum Continuous Output Current (low drive mode)	100 µA
Quiescent Current (at 3 mA output)	< 20 µA
Quiescent Current (at 5 µA output)	< 0.75 µA



- No external capacitors required
- Reference Input: from Vidatronic low-power bandgap
- Achieves a low-noise output voltage without the need for external capacitors, saving package pins and PC board space
- Includes high drive mode select control input, voltage-select control input, power-down control input, soft start, and power-good status output
- Silicon-proven in TSMC 40 nm ULP process

DC-to-DC Converters



DC-to-DC Converters

- Switched-mode voltage conversion
- Input dc is "chopped" to produce an ac voltage which is filtered back to dc
- Very high efficiency
  - Good for battery-powered applications
  - Good thermal
- Noisy

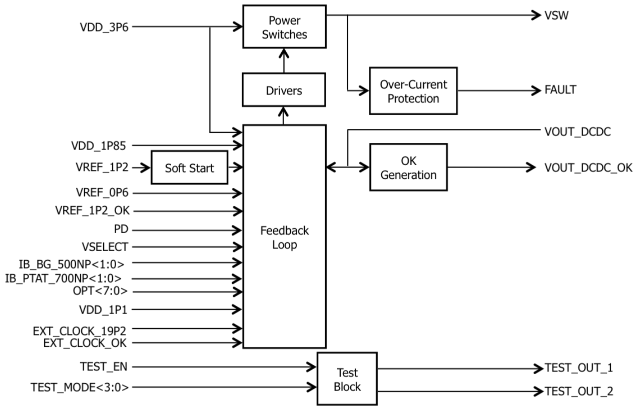
- Voltage Conversions
  - Buck (decrease)
  - Boost (increase)
  - Bypass (pass through)
  - Combinations: Buck/Boost, Boost/Bypass, etc.
- Architectures
  - Traditional inductor-based
    - Requires external inductor and capacitor
  - Switched Capacitor
    - No external components required

DC Voltage-Conversion Comparison

LDOs	DC-DC Converters
High Power/Heat	Low Power/Heat
Low Noise	High Noise
Output always lower than input	Output can be lower or higher than input

Buck DC-DC Converter – VBKS0140T040

Parameters	Specifications
Input Power Supply	2.8 to 4.2 V
Selectable Output Voltages	1.1 or 1.85 V
Output Voltage Accuracy	± 5%
Maximum Continuous Output Current	140 mA
Minimum Load Current	1 mA
Minimum Power Efficiency (5 mA to 140 mA)	> 70%
Minimum Power Efficiency (20 mA to 60 mA)	> 80%
Output Voltage Ripples (at 140 mA)	20 mV

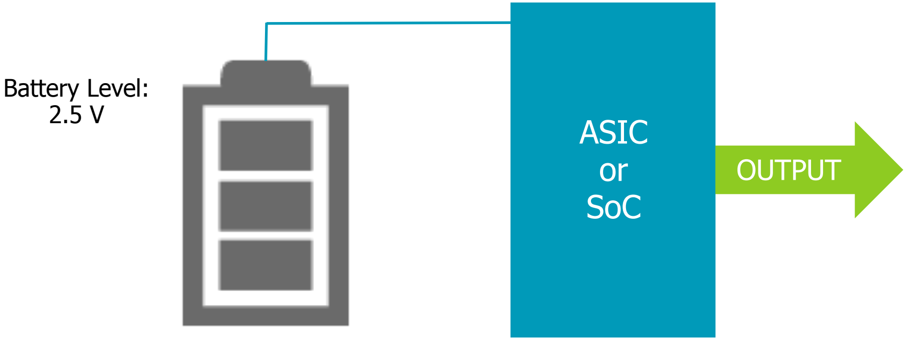


- Selectable output voltages:
  - Nominal low output voltage = 1.1 V
    - Programmable using 4 bits
    - 20 mV programmable steps
  - Nominal high output voltage = 1.85 V
    - Programmable using 4 bits
    - 20 mV programmable steps
- Optimized clocking options eliminate spurious emissions for much lower system noise
- Includes voltage reference, internal oscillator, soft-start, overcurrent protection, and power-good status output
- Silicon-proven in TSMC 40 nm ULP process

Vidatronic's Flexsupply™ IP Cores

Current products designed around a 2.5 V supply function properly when the battery level is high.

When the battery level is low, however, the product stops working entirely.



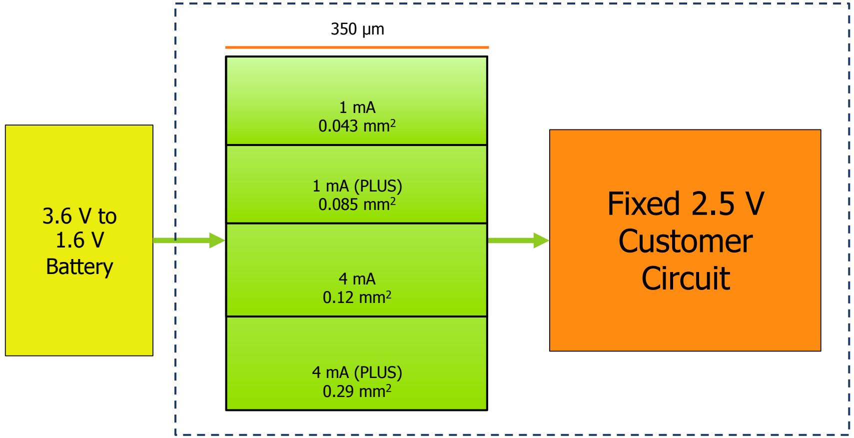
The Flexsupply™ family of switched-capacitor regulated voltage-doubler IP cores are designed to improve current products so that they can function properly at extremely low battery levels.

After integration into the SoC, the Flexsupply™ IP core provides the correct supply voltage to the SoC, even with low battery levels.

Flexsupply™ Available Modules

The die area of each module is based on current requirements.

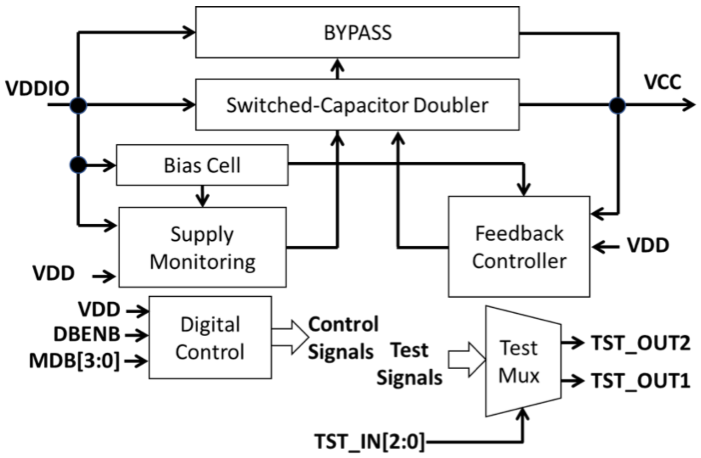
	1 mA Module	1 mA Module PLUS	4 mA Module	4 mA Module PLUS
Product Name	VRDS0002N	VRDS0005N	VRDS0008N	VRDS0020N
DC Drive Capability	1 mA	1 mA	4 mA	4 mA
LONG Write Pulse Magnitude	1.25 mA	3 mA	5 mA	12 mA
LONG Write Pulse Duration	2 µs	2 µs	2 µs	2 µs
SHORT Write Pulse Magnitude	2 mA	5 mA	8 mA	20 mA
SHORT Write Pulse Duration	200 ns	200 ns	200 ns	200 ns
Physical Area (40 nm process)	124 µm by 350 µm	244 µm by 350 µm	350 µm by 350 µm	830 µm by 350 µm



Flexsupply™ Switched Capacitor Regulated Doubler

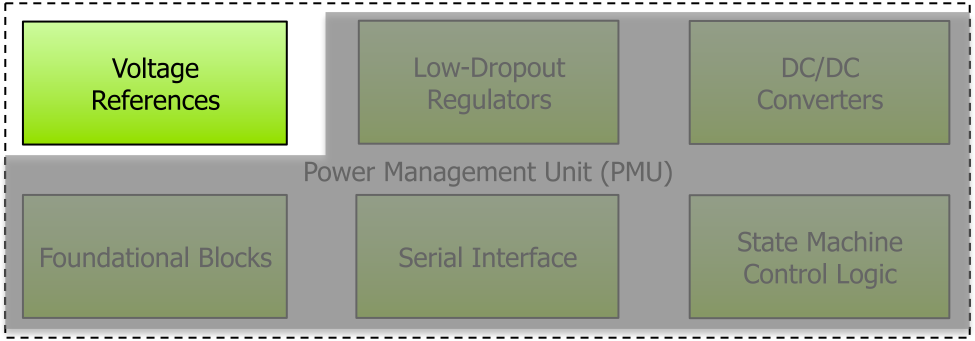
For powering a fixed 2.5 V circuit from variable-voltage battery.

Parameters	Specifications
Input Power Supply	1.6 to 3.63 V
Output Voltage	2.5 V
Maximum Power Efficiency	± 70%



- Die area is based on current requirements
  - Can support 1 mA, 4 mA, 10 mA, etc.
- SLEEP mode supported
- Allows products to continue to perform even at ultra-low battery levels (down to 1.6 V)
- Handles extremely fast/high/long load transients
- Achieves a smooth output voltage with small ripples
- Fully integrated – no external components required
- Silicon-proven in TSMC 40 nm ULP and ULP with embedded flash processes suitable for IoT applications

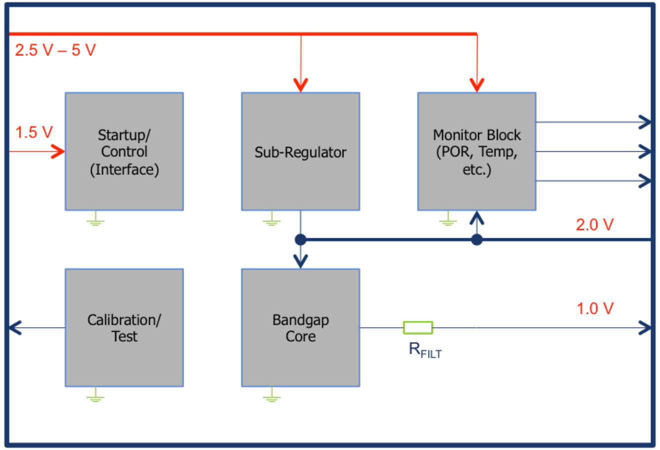
Low-Power Voltage References



ACCUREF™ Voltage and Current Reference IP

For generating a precise, adjustable reference voltage.

Parameters	Specifications
Input Power Supply	2.5 to 5.0 V
Reference Accuracy (HP Mode)	± 0.3%
Reference Accuracy (LP Mode)	± 1.0%
Quiescent Current (HP Mode)	< 20 µA
Quiescent Current (LP Mode)	< 12 µA
Power Supply Rejection Ratio (at 100 KHz)	> 90 dB
Temperature Range	-30 to 125ºC

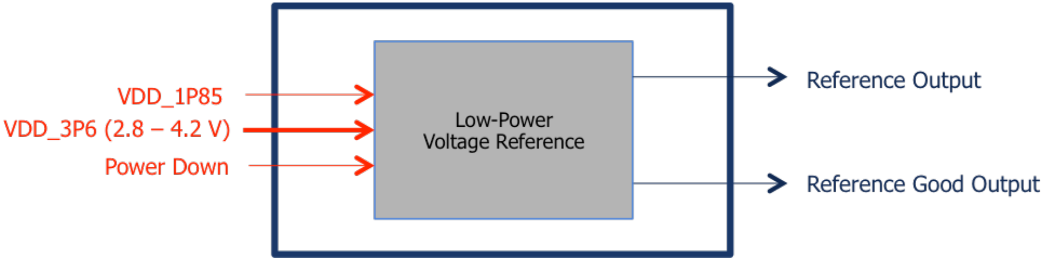


- Silicon-proven in TSMC 130 nm BCD
- Ultra-low levels of power consumption without sacrificing accuracy or noise performance
- Fully integrated – no external components required
- Two modes of operation: High Performance (HP) and Low Power (LP)
- Integrated temperature sensor and current reference
  - Available without integration for increased area savings

Low Power Voltage Reference – VVR060LT040

Parameters	Specifications
Input Power Supply	2.8 to 4.2 V
Output Voltage Accuracy	± 12%
Power Supply Rejection (at < 1 kHz)	> 50 dB
Power Supply Rejection (at < 10 kHz)	> 10 dB
Quiescent Current	< 0.9 μA

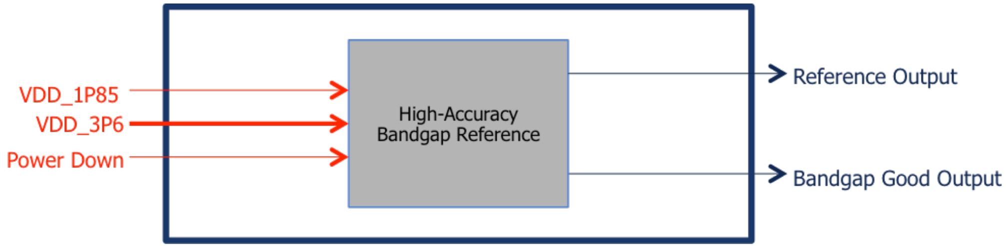
- No external components required
- Includes reference good status output
- Silicon-proven in TSMC 40 nm ULP process



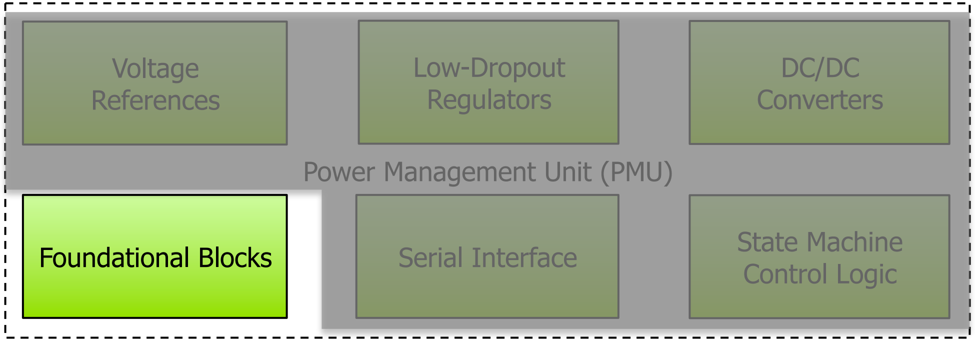
High-Accuracy Bandgap Voltage Reference – VBR120T040

Parameters	Specifications
Input Power Supply	2.8 to 4.2 V
Output Voltage Accuracy (untrimmed)	± 4%
Output Voltage Accuracy (trimmed)	< ± 1%
Power Supply Rejection (at < 1 kHz)	> 60 dB
Power Supply Rejection (at < 10 kHz)	> 20 dB
Quiescent Current	< 40 μA

- No external components required
- Includes bandgap good status output
- Silicon-proven in TSMC 40 nm ULP process



Foundational Blocks



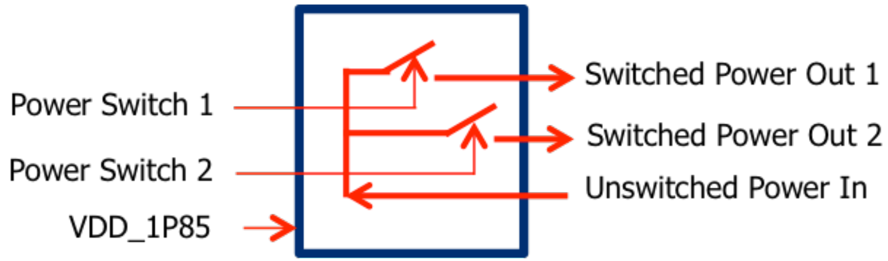
Available Features

- Enable/Disable
- Soft Start/Soft Shutdown
- Over-Current Shutdown
- Over-Temperature Shutdown
- Undervoltage Detection & Lockout (UVLO)
- Overvoltage Detection
- Power-on-Reset
- Power Switch

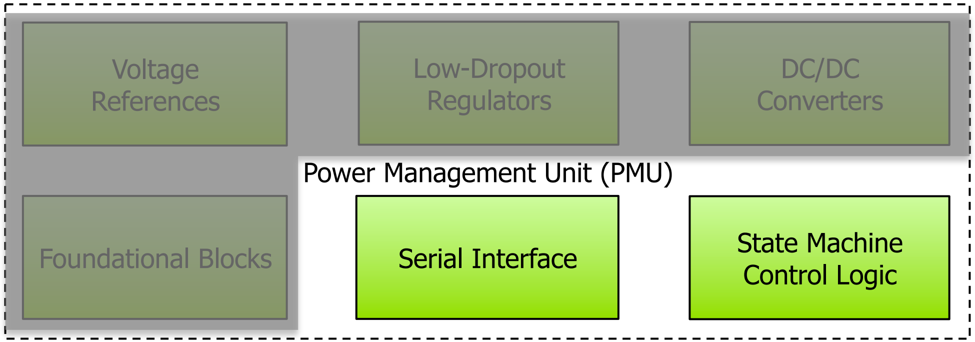
Dual Power Switch – VPS0002T040

Parameters	Specifications
Input Power Supply	1.85 V
Unswitched Power Input	1.85 ± 5%
Maximum Continuous Through-Current (each switch)	30 mA
Maximum Voltage-Drop (at 30 mA each, both switches on)	10 mV

- Includes in-rush current limiting
- Silicon-proven in TSMC 40 nm ULP process



PMU Communication and Control

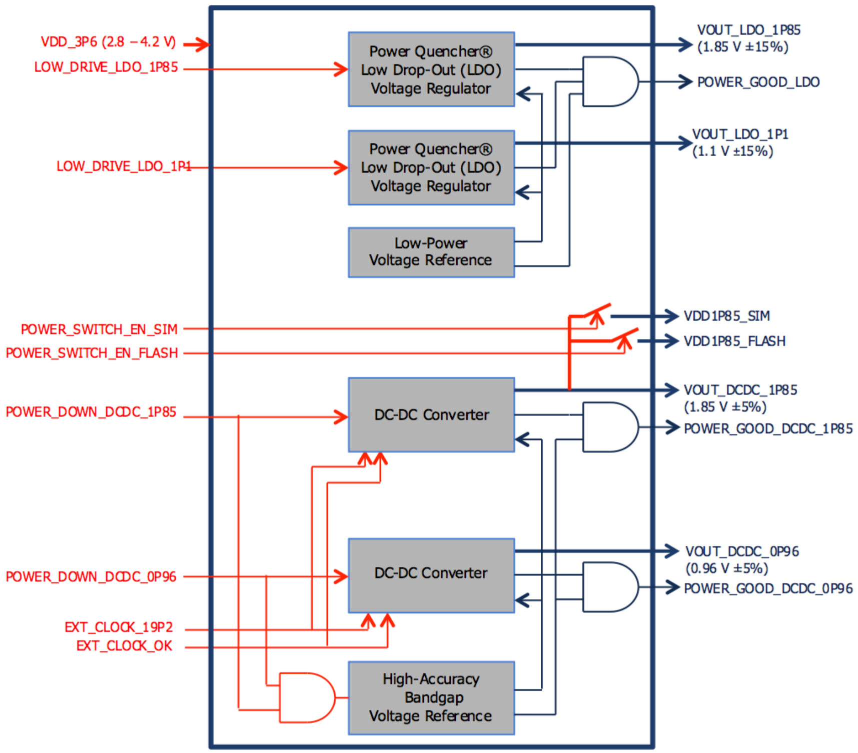


Vidatronic 40 nm Power Management Unit

We can combine several Vidatronic IP blocks into a single power management unit for integration into your SoC.

Silicon-proven in TSMC 40 nm ULP.

Power Management Unit – VPM0140T040
Two Power Quencher® LDOs
One Low Power Voltage Reference
One Dual Power Switch
Two Buck DC-DC Converters
One High-Accuracy Bandgap Reference



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