Masters 2015, Russia
Analog Overview

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October 2015
Microchip Analog Product Portfolio Growth
Expanding Solutions

- Temperature Management
- Linear Products
- Power Management
- CAN/LIN Interface Products
- Motor Controllers
- A/D Converters
- Smoke Detectors
# Analog & Interface Products

**THERMAL MANAGEMENT**
- Temperature Sensors
- Fan Control and Hardware Management

**LINEAR**
- Op Amps/INAs
- Comparators
- RF Power Amplifiers, PGA, SGA

**SAFETY AND SECURITY**
- Smoke Detector ICs
- Piezoelectric Horn Drivers

**POWER MANAGEMENT**
- Linear Regulators
- Switching Regulators
- Digitally-Enhanced & PWM Controllers
- Charge Pump DC/DC Converters
- Battery Management
- USB Port Power Controller
- System Supervisors Voltage Detectors
- Power MOSFET Drivers
- Power MOSFETs

**MIXED SIGNAL**
- Pipelined A/D Converters
- Delta-Sigma & SAR A/D Converters
- Energy Measurement ICs
- Current/DC Power Measurement ICs
- Dual Slope / Display A/D Converters
- D/A Converters
- Digital Potentiometers
- Voltage References

**INTERFACE**
- CAN/LIN
- USB and I/O Expanders
- Ethernet
- Wireless
- Real Time Clock/Calendar

**MOTOR DRIVER**
- Stepper, DC and 3Φ Brushless
- Supertex

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Click on boxes to navigate.
Microchip offers complete, competitive product portfolio

Ambient Sensors

- Digital Output: I²C and SPI (MIC280)
- Analog Output
- Temp Switch

Multi-point Remote Temperature Monitoring

Fan Speed Control
Temperature Sensors

Logic Output
- TC6501/2/3/4
- TC620/1/2/3/4
- MCP9501/2/3/4
- MCP9509/10

Voltage Output
- TC1046
- TC1047/47A
- MCP9700/1/A

Remote Monitors with Alerts
- EMC1412/3/4
  2-4ch, Alert/Therm
- EMC1422/3/4
  2-4ch, Alert/Shdn
- EMC1182/3/4
  2-4ch, 1.8V Comm
- EMC1186/7/8
  2-4 ch, 1.8V Comm
- EMC1428
  8 ch, Alert/Shdn

Ambient Monitors with Alerts
- TC74
- TCN75A
- MCP9800/1/2/3
- MCP9804
- MCP9805
- MCP9808
- MCP9843
- MCP9844
- EMC1001

Serial Output

SMBus/I^2C™

SPI
- TC72
- TC77

With EEPROM
- MCP98243 w/EEPROM for SPD
- MCP98244 w/EEPROM for SPD

Multi-Temp Polling
- EMC1043/53/63
  3 channel
- EMC1046/7
  6/7 channel
World’s First Integrated Thermocouple Electromotive Force to Degrees Celsius Converter From Microchip Saves Design Effort, Space and Cost
MCP9600
Thermocouple to °C Converter

- Fully integrated thermocouple EMF to I^2C converter
  - Provides 1°C temperature accuracy
  - Reduces required expertise in analog, mixed signal, thermal management, and microcontroller design.
  - Integrated features simplify design, reduce development time and improve system performance.

- Applications
  - Boilers, furnaces, kilns, smelters
  - Ovens, refrigerators, freezers, water heaters
  - Temp. monitor of exhaust, cylinder head, general temperature monitoring
  - Thermal monitoring of motors, chemicals, furnaces
High Level of Integration

**Integrates:**
- Precision Instrumentation
- Precision Temperature Sensor
- Precision, High-Resolution ADC
- Math Engine with Firmware to Support:
  - Type K, J, T, N, S, E, B and R Thermocouples
What is an Temperature Switch?

- A temperature switch is a device that monitors ambient temperature and signals the system if the temperature is above or below a set temperature limit.

  - The temperature limit can be set by the factory (MCP9501/2/3/4, TC6501/2/3/4)
  - The temperature limit can be set by the customer via an external resistor (MCP9509/10)
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MCHP: Lowest current for given GBWP

Legend:
- Precision Op Amps
- General Purpose Op Amps

- MCP65x
- MCP66x
- MCP62x
- MCP66x
- MCP602x
- MCP6491
- MCP6H0x
- MCP6001
- MCP601
- MCP6L01
- MCP624x
- MCP6V31
- MCP6V0x
- MCP605x
- MCP623x
- MCP642x
- MCP603x
- MCP604x
- MCP614x
- MCP644x
Linear Products

- **Low Power MCP64xx family**
  - Low Quiescent Current (450 nA), 1-1.5mV Offset, low Bias Current (up to 125°C)

- **Zero-Drift Amplifier:**
  - The #1 Key spec (Input Offset Drift) improved by 2-5 times
  - Beats the competition parts

- **INA portfolio**
  - MCP6N16 - Higher performance MCP6N11
Hot Product Update
Zero-Drift Amplifiers
MCP6Vxx
What Problem Does the MCP6Vxx Solve?

• Applications Requiring Ultra High Precision
  • Zero-Drift architecture provides superior performance
    • Ultra low initial offset, low offset drift, eliminates 1/f noise, superior common mode and power supply rejection

• Space Constrained Applications
  • Small packaging including SOT-23, SC-70, TDFN, MSOP and TSSOP
Microchip’s Zero-Drift Op Amp Portfolio

- **MCP6V0x**
  - 1.3 MHz GBWP, industry leading offset performance, 2x3 TDFN smallest package

- **MCP6V2x**
  - 2 MHz GBWP, industry leading offset performance, available in popular MSOP

- **MCP6V1x**
  - 80 kHz GBWP, lowest power ZD amplifier on the market, SC-70 and SOT-23 singles

- **MCP6V3x**
  - 300 kHz GBWP, SC-70 and SOT-23 singles
Zero-Drift Design Win Examples

- Weight Scales
- Oxygen Sensor
- Temperature Transmitter
- Methane Detector
- Fire Detection
- Lighting
- Flow Meters

- Alcohol Tester
- Thermocouple Isolator
- Current Sensor
- Appliances
- Cryogenics
- Power Supplies
- Gas Meters
MCP6V1x High Performance Amplifiers

The Lowest Current per GBWP for a Zero-Drift Amplifier on the Market!

- **Zero-Drift Architecture**
  - Low voltage offset, 8 µV maximum
  - Low offset drift, 50 nV/°C
  - No 1/f noise
  - High CMRR/PSRR (~120 dB minimum)

- **Low Power**
  - 11 uA max (per amplifier) for 80 kHz GBWP

- **Small Packages**
  - SOT-23, SC-70, MSOP, TDFN, TSSOP
MCP6V91/1U Package/Pinout Offerings

- **Zero-Drift Architecture**
  - Low voltage offset, 9 µV maximum
  - Low offset drift, 17 nV/°C
  - No 1/f noise
  - High CMRR/PSRR (~117 dB minimum)

- **Low Power for Given Bandwidth**
  - 1.1 mA max for 10 MHz GBWP

- **Enhanced EMI Rejection**
  - EMIRRR at 1.8 GHz: 93 dB

- **Small Packages**
  - 5-pin SOT-23 and 5-pin SC-70
Instrumentation Amplifiers

- Specialized version of an op amp but w/o a feedback loop
  - Closed loop makes them better for differential gain and common mode rejection applications
  - Extraction of small signals in presence of large voltage or noise

- Target Applications
  - Products that interface to real-world sensors like: Temperature, Pressure, Bio-Sensors, Strain Gauges and Photodiodes

- Microchip solutions
  - MCP6N11 utilize mCal and provide low operating voltage and small packaging
  - MCP6N16 are Zero-Drift and provide better performance and enhanced EMI rejection
MCP6N11 Instrumentation Amp

- Rail to rail input/output
- Gain set by 2 ext resistors
- GBWP of 500kHz (typical)
- Supply current: 800 uA
- Calibration/Enable Pin
  - Featuring mCal Technology
  - Offset voltages from 350uV up to 3mV, depending on Gmin
- Op voltage: 1.8 to 5.5V
Hot Product Update
MCP642x
EMI Hardened Amplifiers
What Problem Does the MCP642x Solve?

- **Power savings**
  - Low quiescent current helps extend battery life

- **Low leakage current helps keep the input error voltage low**
  - Sensors with high output impedance, end applications that go through accelerated life tests at high temperature

- **Enhanced EMI Rejection**
  - Reduces the input offset voltage error due to EMI signals at the input
## MCP64xx Op Amps

<table>
<thead>
<tr>
<th>Product</th>
<th># per Package</th>
<th>GBWP (kHz)</th>
<th>Iq Max (uA)</th>
<th>Vos Max (uV)</th>
<th>Operating Voltage Range (V)</th>
<th>Temp. Range</th>
<th>Rail-To-Rail</th>
<th>Packages</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCP644x</td>
<td>1/2/4</td>
<td>9</td>
<td>0.65</td>
<td>4500</td>
<td>1.4 - 6.0</td>
<td>E Temp</td>
<td>In/Out</td>
<td>SC-70, SOT-23, MSOP, SOIC, TDFN, TSSOP</td>
</tr>
<tr>
<td>EMI Hardened</td>
<td>1/2/4</td>
<td>90</td>
<td>5.5</td>
<td>1000</td>
<td>1.8 - 5.5</td>
<td>E Temp</td>
<td>In/Out</td>
<td>SC-70, SOT-23, MSOP, SOIC, TSSOP</td>
</tr>
<tr>
<td>MCP640x</td>
<td>1/2/4</td>
<td>1000</td>
<td>70</td>
<td>4500</td>
<td>1.8 - 6.0</td>
<td>E &amp; H Temp</td>
<td>In/Out</td>
<td>SC-70, SOT-23, SOIC, TDFN, TSSOP</td>
</tr>
<tr>
<td>MCP647x</td>
<td>1/2/4</td>
<td>2000</td>
<td>200</td>
<td>1500</td>
<td>2.0 - 5.5</td>
<td>E Temp</td>
<td>In/Out</td>
<td>SC-70, SOT-23, MSOP, SOIC, TDFN, TSSOP</td>
</tr>
<tr>
<td>MCP648x</td>
<td>1/2/4</td>
<td>4000</td>
<td>400</td>
<td>1500</td>
<td>2.2 - 5.5</td>
<td>E Temp</td>
<td>In/Out</td>
<td>SC-70, SOT-23, MSOP, SOIC, TDFN, TSSOP</td>
</tr>
<tr>
<td>MCP649x</td>
<td>1/2/4</td>
<td>7500</td>
<td>800</td>
<td>1500</td>
<td>2.4 - 5.5</td>
<td>E Temp</td>
<td>In/Out</td>
<td>SC-70, SOT-23, MSOP, SOIC, TDFN, TSSOP</td>
</tr>
</tbody>
</table>
Performance degradation Caused by EMI

The pink waveform shows the output of a standard amplifier without external filtering, when a cell phone signal is used to introduce EMI.

With external filtering, the output of the standard amplifier shows some improvement.

EMI hardened amplifier (MCP6424), (without external filtering), shows significant improvement and predictable EMI rejection at the output.
For Whom Does It Solve It?

- **Battery powered Systems**
  - Security Systems
    - Contact Sensors, IR Detectors, Smoke/CO Detectors, Alarm Systems
  - Temperature Sensing
  - Assets Protection systems
    - Shock Detections, Portable Tracking Systems
  - Toys/ Gaming devices

- **Metering**
  - Flow meters, Gas Meters, Water Meters

- **Data loggers**

- **RFID Readers**

- **Medical**
  - Insulin Pumps, Blood Pressure Meters with wireless comm.,
# MCP642x Key Features

<table>
<thead>
<tr>
<th>Feature</th>
<th>MCP642x</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Vos (max., mV)</td>
<td>1</td>
</tr>
<tr>
<td>PSRR (typ., dB)</td>
<td>90</td>
</tr>
<tr>
<td>Low Ibias (typ., pA)</td>
<td>1</td>
</tr>
<tr>
<td>CMRR (typ., dB)</td>
<td>90</td>
</tr>
<tr>
<td>Supply Voltage Range (V)</td>
<td>1.8 - 5.5</td>
</tr>
<tr>
<td>Low Supply Current (max., µA)</td>
<td>5</td>
</tr>
<tr>
<td>GBWP (kHz)</td>
<td>90</td>
</tr>
<tr>
<td>Slew Rate (V/µs)</td>
<td>0.05</td>
</tr>
<tr>
<td>EMIRR @ 1.8 GHz (typ., dB)</td>
<td>97</td>
</tr>
<tr>
<td>Packages</td>
<td>SC70, SOT23, MSOP, TDFN, TSSOP, SOIC</td>
</tr>
</tbody>
</table>
The Evaluation Board is intended to support EMIRR measurements and show the capability of the MCP6421 EMI enhanced operational amplifier.

It can be used for signal acquisition from sensors. Example: Pressure sensor
Design Win Examples

- **Application:** Headphones
  - **Function:** Current Sensing
  - **Device:** MCP6421
  - **Location:** Americas
  - **Reason for win:** Low offset voltage with EMI Rejection
Design Win Examples

• Application: Smoke Detector with wireless communication
  • Function: Sensor signal amplification
  • Device: MCP6422
  • Location: Americas
  • Reason for the win: Overall low current consumption and EMI rejection
Micrel Addition

General Purpose Operational Amplifiers

- MIC7300
- MIC6211
- LMC7101A/B
- MIC7122
- MCP6H8x
- MCP6H9x
- MCP6H7x
- MCP627x, MCP647x, MCP660x
- MCP6H0x
- MIC7111
- MCP624x
- MCP640x
- MCP623x
- MIC8664
- MIC864
- MIC860
- MIC862
- MCP643x
- MIC863
- MIC861
- MCP604x
- MCP614x
- MCP644x
- MCP664x
- MCP629x
- MCP649x
- MCP648x
- MCP628x
- MIC913/4
- MIC910/5/6
- MIC922
- MIC912
- MIC923
- MIC911
- MIC918
- MIC920
- MIC919
- MIC921
How do these fit within our current portfolio?

- All Micrel devices fit in the general purpose Op Amp portfolio. They are high speed (up to 410MHz) and high voltage (up to 32V) devices
- Mostly singles, some duals, a triple

Are these considered proprietary or commodity?

- Commodity
Comparators

- **MCP654x**
  - Both push-pull and open-drain outputs
  - Slow comparators
  - Low power

- **MCP65R4x**
  - Adds a bandgap reference to the MCP654x comparator

- **MCP656x**
  - Both push-pull and open-drain outputs
  - 100x faster than the MCP654x
Micrel’s Comparators
Comparators

- How do these fit within our current portfolio?
  - Considerable overlap with existing portfolio
  - One higher voltage device (36V), various Vref options

- Are these considered proprietary or commodity?
  - Commodity
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**Updates**

**Demo & Eval Boards**

**Overview**

**End Equipments**
Power Management from Microchip Originally

- **Linear Regs**
  - MCP1703A
  - MCP1711
  - MCP1754/5
  - MCP1790

- **Integrated Switching Regulators**
  - MCP16301
  - MCP16311/2
  - MCP16331
  - MCP164x
  - MCP162xx

- **MCU8 → Power Conversion**
  - Standalone, + MCP163x
  - or
  - MOSFET Drivers

- **PWM CONTROLLER + External MOSFETs**
  - MCP19110/1/8/9 – Sync Buck w/ Integrated MCU
  - MCP19035 – Sync Buck
  - + MCP87xxx - HIGH SPEED MOSFETs

- **dsPIC® DSC + MOSFET Drivers**

**Input Voltage (V)**
- 60V
- 40V
- 30V
- 4.5V

**Power (Watts)**
- <1W
- <10W
- <50W
- <150W
- 300W<
Microchip Power management with Micrel

**Integrated Switching Regs, Controllers and Modules**

- **60V**
  - Linear and Switching Regs
    - MAQ5282
    - MIC5283
  - Integrated Switching Regs
    - MCP16301/H
    - MCP16311/2
    - MCP16331
  - DEPA or (MCU + PWM CONTROLLERs) + External MOSFETs
    - + MCP87xxx - HIGH SPEED MOSFETs

- **120V**
  - Linear Regs
    - MCP1703A
    - MCP1754/5
  - Integrated Switching Regs
    - MCP1754/5
  - DEPA or (MCU + PWM CONTROLLERs) + External MOSFETs
    - + MCP87xxx - HIGH SPEED MOSFETs

- **300W<**
  - Linear Regs
    - MCP87xxx
  - Integrated Switching Regs
    - MCP1703A
    - MCP1754/5
  - DEPA or (MCU + PWM CONTROLLERs) + External MOSFETs
    - + MCP87xxx - HIGH SPEED MOSFETs

**Future Expansion Will Fill Gaps**

- **30V**
  - Linear Regs
    - MAQ5282
    - MIC5283
  - Integrated Switching Regs
    - MCP16301/H
    - MCP16311/2
    - MCP16331
  - DEPA or (MCU + PWM CONTROLLERs) + External MOSFETs
    - + MCP87xxx - HIGH SPEED MOSFETs

- **40V**
  - Linear Regs
    - MCP1703A
    - MCP1754/5
  - Integrated Switching Regs
    - MCP16301/H
    - MCP16311/2
    - MCP16331
  - DEPA or (MCU + PWM CONTROLLERs) + External MOSFETs
    - + MCP87xxx - HIGH SPEED MOSFETs

- **60V**
  - Linear Regs
    - MAQ5282
    - MIC5283
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    - MCP16311/2
    - MCP16331
  - DEPA or (MCU + PWM CONTROLLERs) + External MOSFETs
    - + MCP87xxx - HIGH SPEED MOSFETs

- **600V**
  - Linear and Switching Regs
    - MAQ5282
    - MIC5283
  - Integrated Switching Regs
    - MCP16301/H
    - MCP16311/2
    - MCP16331
  - DEPA or (MCU + PWM CONTROLLERs) + External MOSFETs
    - + MCP87xxx - HIGH SPEED MOSFETs

**Power (Watts)**

- **<1W**
- **<10W**
- **<50W**
- **<150W**
- **300W<**

**Input Voltage (V)**

- **4.5V**
- **30V**
- **40V**
- **60V**
- **120V**
- **600V**

**Future Expansion Will Fill Gaps**
Key IPs that makes the difference!
What Micrel do better than others?

- **Ripple Blocker™**
  - Unique, Awarded noise filter and Ultra Low Drop LDO
  - Applications: RF, Analog, GPS, Camera etc...

- **Hyper Speed Control™**
  - Unique DCDC Architecture => Small passives, low EMI, Ultra High Speed regulation, High Voltage Drop regulation
  - Applications: Industrial, Telecom

- **Hyper Light Load™**
  - Unique DCDC Architecture => High Efficiency at any load, Low current consumption
  - Applications: Everything that needs low standy consumption

- **Complex Power Sequencing**
  - Unique DCDC Architecture => allows any type of power-up/down sequencing
  - Applications: FPGA, CPUs, DDRx Memories

- **High Efficiency LDO (HeLDO™)**
  - Unique DCDC Architecture with internal ultra low noise LDO => allows ultra fast, low noise, high efficiency power. As easy as an LDO to use!
  - Applications: FPGA, CPUs, RF, Analog, GSM/GPRS/3G modems etc...

- **Integrated Inductor**

- **High Voltage LDO (up to 120V)**
  - LDO with 120V input capability with ultra low current consumption!
  - Applications: Automotive, High input voltage applications (such as 48V) etc...

- **Ultra Low Input LDO**
  - Ultra Low Input LDO with Ultra Low drop for high-speed systems.
  - Applications: FPGA, CPUs, DDRx Memories

- **Ultra Precise Current Limiting Switches**
  - Ultra precise current limiting protection
  - Applications: USB, hotswap, Power ORing
LDO Product Line Summary

- **Micrel LDO strength**
  - Up to 120V LDO regulators
  - Cost effective high current LDOs
  - Known for its 1A, 2A, 3A and 5A LDOs
  - Multi-channel LDOs
  - Ripple Blockers

- **Classic APID LDO strength**
  - Family of low power LDOs
  - Broad range of automotive qualified LDOs
  - Excellent high performance products
LDO Operating Voltage and Load Current

120V

7.5 A

30V

AUTOMOTIVE QUALIFIED
Switching Regulators
Switching Regular Product Line Summary

- Micrel switching regulator strength
  - Higher voltage (up to 75V) and current capability (up to 12A)
  - Higher switching frequency (8 MHz) allows small inductor designs
  - Multi-phase and Multi-channel switching regulators

- Classic APID switching regulator strength
  - Built-in Intelligence
  - Optimized, High-efficiency power conversion
  - Low power, low start-up boost regulators
  - Q100 Qualified
## MCP16331 MCP16301/H MCP16311/2

<table>
<thead>
<tr>
<th>Feature</th>
<th>MCP16331</th>
<th>MCP16301/H</th>
<th>MCP16311/2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mode</strong></td>
<td>PWM</td>
<td>PWM</td>
<td>PWM/PFM or PWM</td>
</tr>
<tr>
<td><strong>Architecture</strong></td>
<td>Non-Synchronous</td>
<td>Non-Synchronous</td>
<td>Synchronous</td>
</tr>
<tr>
<td><strong>Input Voltage Range (V)</strong></td>
<td>4.4 - 50V</td>
<td>4 – 30 4.7 – 36</td>
<td>4 – 30</td>
</tr>
<tr>
<td><strong>Output Voltage Range (V)</strong></td>
<td>2-24</td>
<td>Adjustable 2 – 15</td>
<td>Adjustable 2 – 24</td>
</tr>
<tr>
<td><strong>Current Output (mA)</strong></td>
<td>500</td>
<td>600</td>
<td>1000</td>
</tr>
<tr>
<td><strong>Quiescent Current (µA)</strong></td>
<td>1700</td>
<td>2000</td>
<td>44 (PFM)</td>
</tr>
<tr>
<td><strong>Switching Frequency (kHz)</strong></td>
<td>500</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td><strong>Features</strong></td>
<td>Shutdown</td>
<td>Shutdown</td>
<td>Shutdown</td>
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<tr>
<td><strong>Packages</strong></td>
<td>SOT23-6 2x3 TDFN-8</td>
<td>SOT23-6</td>
<td>MSOP-8 2x3 TDFN-8</td>
</tr>
<tr>
<td><strong>AEC-Q100 Qualified</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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## MCHP Boost Regulator Highlights

<table>
<thead>
<tr>
<th></th>
<th>MCP1623/4</th>
<th>MCP16251/2</th>
<th>MCP1640/B/C/D</th>
<th>MCP1642B/D</th>
<th>MCP1661</th>
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<tr>
<td><strong>Architecture</strong></td>
<td>Synchronous</td>
<td>Synchronous</td>
<td>Synchronous</td>
<td>Synchronous</td>
<td>Non-Synchronous</td>
</tr>
<tr>
<td><strong>Mode</strong></td>
<td>PWM or PWM/PFM</td>
<td>PWM/PFM</td>
<td>PWM or PWM/PFM</td>
<td>PWM</td>
<td>PWM</td>
</tr>
<tr>
<td><strong>Start-up Voltage</strong></td>
<td>0.65V</td>
<td>0.82V</td>
<td>0.65V</td>
<td>0.65V</td>
<td>2.3V</td>
</tr>
<tr>
<td><strong>Input Voltage</strong></td>
<td>0.35V – 5.5V</td>
<td>0.35V – 5.5V</td>
<td>0.35V – 5.5V</td>
<td>0.5V – 5V</td>
<td>2.4V – 5.5V</td>
</tr>
<tr>
<td><strong>Output Voltage</strong></td>
<td>2V – 5.5V</td>
<td>1.8V – 5.5V</td>
<td>2V – 5.5V</td>
<td>1.8V – 5.5V</td>
<td>5.5 – 32V</td>
</tr>
<tr>
<td><strong>Peak Input Current Limit</strong></td>
<td>425 mA</td>
<td>650 mA</td>
<td>850 mA</td>
<td>1.8A</td>
<td>1.3A</td>
</tr>
<tr>
<td><strong>Quiescent Current (µA)</strong></td>
<td>19/220</td>
<td>4</td>
<td>19/220</td>
<td>400</td>
<td>250</td>
</tr>
<tr>
<td><strong>Switching Frequency</strong></td>
<td>500 kHz</td>
<td>500 kHz</td>
<td>500 kHz</td>
<td>1 MHz</td>
<td>500 kHz</td>
</tr>
<tr>
<td><strong>Shutdown</strong></td>
<td>True Load Disconnect</td>
<td>Input to Output Bypass or True Load Disconnect</td>
<td>Input to Output Bypass or True Load Disconnect</td>
<td>Input to Output Bypass or True Load Disconnect</td>
<td>Input to Output Bypass</td>
</tr>
<tr>
<td><strong>Packages</strong></td>
<td>SOT23-6*</td>
<td>SOT23-6*</td>
<td>SOT23-6*</td>
<td>MSOP-8</td>
<td>SOT23-5</td>
</tr>
<tr>
<td><strong>2x3 TDFN-8</strong></td>
<td>SOT23-6*</td>
<td>2x3 TDFN-8**</td>
<td>2x3 DFN-8**</td>
<td>2x3 DFN-8</td>
<td>2x3 TDFN-8</td>
</tr>
<tr>
<td><strong>Key Attributes</strong></td>
<td>Lowest Cost</td>
<td>Lowest Quiescent</td>
<td>Highest Performance</td>
<td>High Current Output</td>
<td>High Output Voltage</td>
</tr>
</tbody>
</table>

* Ideal for Single Cell Alkaline/Lithium Applications

** - Pin-to-pin compatible packages
MCP1642 synchronous boost

- Synchronous Architecture
- Up to 96% Typical Efficiency
- 1MHz PWM Operation
- 1.8A Typical Peak Input Current
  - $I_{\text{OUT}} > 175 \text{ mA} @ 3.3V \text{ VOUT}, 1.2V \text{ VIN}$
  - $I_{\text{OUT}} > 600 \text{ mA} @ 3.3V \text{ VOUT}, 2.4V \text{ VIN}$
  - $I_{\text{OUT}} > 800 \text{ mA} @ 5.0V \text{ VOUT}, 3.3V \text{ VIN}$
- Low Start-up Voltage: 0.65V @1mA load

- Low Operating Input: Down to 0.35V
- Adjustable Output Voltage: 1.8V to 5.5V
  - Fixed options: 1.8V, 3V, 3.3V, 5V
- Shutdown Options
  - True Load Disconnect Option (MCP1642B)
  - Input to Output Bypass Option (MCP1642D)
- 2x3 DFN or MSOP-8
Hybrid Controllers

- **UNIQUE**: Analog Performance with Digital Flexibility!
- Excellent Transient Performance
  - Responds quickly to step-changes in current
- Digital Interface
  - Offering COMMUNICATION and CONFIGURABILITY!
- Wide Input Voltage Operating Range
- Integration ➔ Small & Standalone
  - Analog PWM Controller, MCU, Synchronous MOSFET Driver, and bias LDO
Simplified Block Diagram
MCP19119

MCP19118 Digitally Enhanced Power Converter

8-bit MCU
- 12 Channel, 10-bit ADC
- GPIO
- Comm Interface

Analog Control and Power Stage
- VREF
- Slope Compensation
- Error Amp
- PWM Generator
- Adjustable Compensation Network
- Internal Bias Supply
- Current Sense
- Synchronous MOSFET Driver

Synchronous Buck Topology

VIN
VOUT
# MCP19118/9 and the Digitally Enhanced Power Analog Portfolio

<table>
<thead>
<tr>
<th>Feature</th>
<th>MCP19114/5</th>
<th>MCP19110/1</th>
<th>MCP19118/9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrated PIC™ MCU</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Power Topologies Supported</td>
<td>Boost, SEPIC, Ćuk, Sync Flyback</td>
<td>Sync Buck</td>
<td>Sync Buck</td>
</tr>
<tr>
<td>Input Operating Voltage</td>
<td>4.5 – 42V</td>
<td>4.5 - 32V</td>
<td>4.5-40V</td>
</tr>
<tr>
<td>Output Voltage</td>
<td>1V – 200V*</td>
<td>0.6V – 90%*V&lt;sub&gt;IN&lt;/sub&gt;</td>
<td>0.6V – 90%*V&lt;sub&gt;IN&lt;/sub&gt;</td>
</tr>
<tr>
<td>Compensation Network</td>
<td>External</td>
<td>Internal</td>
<td>Internal</td>
</tr>
<tr>
<td>Switching Freq</td>
<td>32kHz – 2MHz, Quasi-Resonant Mode</td>
<td>100kHz – 1.6MHz</td>
<td>100kHz – 1.6MHz</td>
</tr>
<tr>
<td>Flash Memory</td>
<td>4kW</td>
<td>4kW</td>
<td>4kW</td>
</tr>
<tr>
<td>Communication Interface</td>
<td>I²C</td>
<td>I²C, PMBus™ Compliant</td>
<td>I²C, PMBus™ Compliant</td>
</tr>
<tr>
<td>GPIO Available</td>
<td>Yes (10 / 12)</td>
<td>Yes (10 / 14)</td>
<td>Yes (10 / 14)</td>
</tr>
</tbody>
</table>

* With resistive divider network for voltage feedback signals
Typical Applications

- Power Supplies, Point-of-Load
- Power Supply Modules
- USB Power
- Battery Chargers
- LED Drivers
Embedded Power Conversion

• **Embedded Power Conversion**
  - $V_{IN} = 12V_{DC}$
  - $V_{OUT} = 1.2V_{DC} @ \sim 25A$
  - Target Market: Networking/Server

• **Core Value:**
  - Configurability over $I^2CTM/PMBusTM$ communication interface
    - Supports late-stage design changes, manufacturability, and adjustments due to field-reliability data
  - Adjustable, on-the-fly, compensation supports component aging.

*Off-line AC/DC* \(\xrightarrow{V=12V}\) **MCP19111 Programmable DC/DC** \(\xrightarrow{\text{Programmable Vout, Iout, Adjustable Compensation, and Protection Thresholds}}\)
USB Power Port

**USB Power → MCP19111 + UCS1002**

- **$V_{IN} = 12V_{DC}$**
- **$V_{OUT} = 5V @ ~5A$**
- **Target Market:**
  - Automotive, USB-Charging

**Core Value:**

- UCS1002 offers USB Charger Emulation, including a programmable Emulation profile for solution ‘future-proofing’
- MCP19111 generates USB-compliant 5V supply, and its fully-programmable MCU can store additional Charger Emulation Profiles which are communicated to the UCS1002 via SMBus interface
Battery Charging

- **Battery Charging**
  - Chemistry: NiMH
  - $V_{\text{IN}} = 12$ or $24\, V_{\text{DC}}$
  - $V_{\text{OUT}} = 8 - 12\, V_{\text{DC}}$ (8 Cells), Adj. Current
  - Target Market: Radio-Controlled Vehicles

- **Core Value:**
  - Standardized Battery-Charger architecture that’s scalable to support wide portfolio of battery configurations and charging profiles. Includes battery detection and adjustable protection features.

### Typical Operating Range

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{\text{IN}}$</td>
<td>12-24V</td>
</tr>
<tr>
<td>$V_{\text{OUT}}$</td>
<td>3 – 20V</td>
</tr>
<tr>
<td>$I_{\text{OUT}}$</td>
<td>Adj.</td>
</tr>
<tr>
<td>Chem</td>
<td>NiMH, Li-Ion</td>
</tr>
</tbody>
</table>

---

**Programmable** Vout, Iout, and Protection Thresholds

**Battery Detection**

**Offline**

**AC/DC**

*Wall Wart*

$V=12V$ or $24\, V_{\text{dc}}$

**MCP19111**

*Battery Charger*

*In Cradle*
LED Lighting

**LED Lighting**

- $V_{IN} = 12V_{DC}$ (from Battery)
- $V_{OUT} = 3-6V_{DC}$ (~1-2 LEDs)
- $I_{OUT} = \text{Adj., } 350mA-1.5A$ (typ)
- Target Market: Automotive, Headlamp (Fog-light)

**Core Value:**

- LED loads are complex, requiring advanced power conversion functions, including PWM Dimming and LED Binning capability.
- Standardized architecture, used across multiple end-customers
- Rapid support of changing standards and technologies (LEDs)
- Excel-based Design Guide!

- Define application inputs to define passive component (L’s & C’s) and refine the compensation
Power Supply Evaluation
MCP19111

- GUI available to simplify programming for a standard power supply applications
  - GUI resides in MPLABX (plugin)
  - Supports PICKIT3 and ICE3 Program/ Debug

- **Standard Firmware** for Power Supply application
Unique Strengths

- Supports “special” application, load, and operating behavior requirements
- Multiple power conversion topologies including boost, flyback, synchronous flyback, SIPC and Cuk-based topologies supported
- Supports both fixed-frequency and quasi-resonant mode switch to improve EMI performance
- On-board MCU may be used as a general purpose controller after initial setup of Analog Power Controller

MCP19114 Evaluation Board
PN: ADM00578 US$49.99
DC/DC Power Conversion

Input Voltage (V)

0.35 V

3.0 V

5.5 V

16 V

40 V

Switch Current, A

1.5A

Boost Portfolio Product Positioning

New!
MCP1642
I_{IN} = 1.8A

Low-VIN, Sync Boost
MCP1623/4
I_{IN} = 425mA, 500Khz
MCP16251/2
I_{IN} = 650mA, 500Khz
MCP1640
I_{IN} = 800mA, 500Khz
MCP1643
I_{IN} = 1.6A LED Driver
V_{OUT} \leq 5.5V
MCP1661
I_{IN} = 1.3A, V_{OUT} < 32V
MCP1662
LED Driver

MCP1630
PIC™-Attach, Low-Side PWM Controller with Integrated MOSFET Driver

MCP1632 + External MOSFET
Standalone, Low-Side PWM Controller with Integrated MOSFET Driver

MCP1631 + External MOSFET
PIC™-Attach, Low-Side PWM Controller with Integrated MOSFET Driver

MCP19114/5 + External MOSFETs
Sync Low-Side with Integrated MCU and MOSFET Drivers
# Low Voltage Boost Family

<table>
<thead>
<tr>
<th></th>
<th>MCP1623/4</th>
<th>MCP16251/2</th>
<th>MCP1640/B/C/D</th>
<th>MCP1643</th>
<th>MCP1642B/D</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mode</strong></td>
<td>PWM or PWM/PFM</td>
<td>PWM/PFM</td>
<td>PWM or PWM/PFM</td>
<td>PWM</td>
<td>PWM</td>
</tr>
<tr>
<td><strong>Start-up Voltage (V)</strong></td>
<td>0.65</td>
<td>0.82</td>
<td>0.65</td>
<td>0.65</td>
<td>0.65</td>
</tr>
<tr>
<td><strong>Input Voltage (V)</strong></td>
<td>0.35 – 5.5</td>
<td>0.35 – 5.5</td>
<td>0.35 – 5.5</td>
<td>0.35 – 5.5</td>
<td>0.35 – 5.5</td>
</tr>
<tr>
<td><strong>Peak Switch Current (mA)</strong></td>
<td>425</td>
<td>650</td>
<td>850</td>
<td>1600</td>
<td>1800</td>
</tr>
<tr>
<td><strong>Quiescent Current (µA)</strong></td>
<td>19</td>
<td>4</td>
<td>19</td>
<td>-</td>
<td>400</td>
</tr>
<tr>
<td><strong>Switching Frequency (kHz)</strong></td>
<td>370 - 630</td>
<td>425 - 575</td>
<td>425 - 575</td>
<td>850 - 1150</td>
<td>850 - 1150</td>
</tr>
<tr>
<td><strong>Shutdown</strong></td>
<td>True Load Disconnect</td>
<td>Input to Output Bypass or True Load Disconnect</td>
<td>Input to Output Bypass or True Load Disconnect</td>
<td>True Load Disconnect</td>
<td>Input to Output Bypass or True Load Disconnect</td>
</tr>
<tr>
<td><strong>Packages</strong>*</td>
<td>SOT23-6*</td>
<td>SOT23-6*</td>
<td>SOT23-6*</td>
<td>MSOP-8</td>
<td>MSOP-8</td>
</tr>
<tr>
<td></td>
<td>2x3 TDFN-8**</td>
<td>2x3 DFN-8**</td>
<td>2x3 DFN-8</td>
<td>2x3 DFN-8</td>
<td>2x3 DFN-8</td>
</tr>
<tr>
<td><strong>Key Attributes</strong></td>
<td>Lowest Cost</td>
<td>Lowest Quiescent Current</td>
<td>Highest Performance</td>
<td>LED Driver $V_{REF} = 120$</td>
<td>Highest Current Capability</td>
</tr>
</tbody>
</table>

*,** Packages are pin-to-pin compatible
For Higher output voltages, consider MCP1661/2
Fully Integrated Modules
High Power Density and Space Saving

Simple Land Patterns Optimized for Thermal Performance and Eliminates Assembly Issues

Total Area: 496mm$^2$
Excellent Thermal Performance

Competitor “I”

Competitor “L”

Competitor “T”

Operating Conditions:
Vin=12V, Vout=1.2V, f=600kHz, Iout=10A, Ta = 25°C,
Based on standard evaluation board by each vendor (size varies)

Micrel’s Module Offers Superior Thermal Performance versus the Competition

MIC45212
Excellent EMI Performance (CISPR22, Class B)

12V_3.3V_1A  With Snubber

12V_3.3V_8A  With Snubber
## POWER MODULES Family (Integrated Inductor)

<table>
<thead>
<tr>
<th>Part Number</th>
<th>I&lt;sub&gt;OUT&lt;/sub&gt; Max</th>
<th>V&lt;sub&gt;IN&lt;/sub&gt;</th>
<th>V&lt;sub&gt;OUT&lt;/sub&gt;</th>
<th>F&lt;sub&gt;SW&lt;/sub&gt;</th>
<th>Topology</th>
<th>IQ&lt;sub&gt;TYP&lt;/sub&gt; Non switching</th>
<th>Power Good Output</th>
<th>Duty Cycle Max</th>
<th>Package</th>
<th>Comments/Other Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIC33030</td>
<td>0.4A</td>
<td>2.7-5.5V</td>
<td>0.7V-3.6V</td>
<td>8MHz</td>
<td>Hyper Light Load™</td>
<td>21uA</td>
<td>-</td>
<td>85%</td>
<td>2.5x2x1.1mm</td>
<td>Low IQ</td>
</tr>
<tr>
<td>MIC33050</td>
<td>0.6A</td>
<td>2.7-5.5V</td>
<td>0.4V-89%*V&lt;sub&gt;IN&lt;/sub&gt;</td>
<td>4MHz</td>
<td>Hyper Light Load™</td>
<td>20uA</td>
<td>-</td>
<td>89%</td>
<td>3x3x0.9mm</td>
<td>Low IQ</td>
</tr>
<tr>
<td>MIC3385</td>
<td>0.6A</td>
<td>2.7-5.5V</td>
<td>1V-5V</td>
<td>8MHz</td>
<td>LOWQ™ Mode</td>
<td>19uA</td>
<td>-</td>
<td>100%</td>
<td>3x3.5x0.9mm</td>
<td>LOWQ™ mode driven by input pin</td>
</tr>
<tr>
<td>MIC33153</td>
<td>1.2A</td>
<td>2.7-5.5V</td>
<td>0.65V-3.6V</td>
<td>4MHz</td>
<td>Hyper Light Load™</td>
<td>22uA</td>
<td>•</td>
<td>80%</td>
<td>3x3.5x1.1mm</td>
<td></td>
</tr>
<tr>
<td>MIC38150</td>
<td>1.5A</td>
<td>3-5.5V</td>
<td>1V VIN-1.2V</td>
<td>2.5MHz max</td>
<td>HeLDO™</td>
<td>1mA</td>
<td>-</td>
<td>1.2V&lt;sub&gt;DROP&lt;/sub&gt; max</td>
<td>4x6x0.9mm</td>
<td>High Efficiency LDO™ for Low EMI, High-Speed regulation, Low Noise</td>
</tr>
<tr>
<td>MIC38300</td>
<td>3A</td>
<td>3-5.5V</td>
<td>1V VIN-1.2V</td>
<td>2.5MHz max</td>
<td>HeLDO™</td>
<td>1mA</td>
<td>-</td>
<td>1.2V&lt;sub&gt;DROP&lt;/sub&gt; max</td>
<td>4x6x0.9mm</td>
<td>High Efficiency LDO™ for Low EMI, High-Speed regulation, Low Noise</td>
</tr>
<tr>
<td>MIC28304-1</td>
<td>3A</td>
<td>4.5-70V</td>
<td>0.9V-24V</td>
<td>200-600kHz</td>
<td>Hyper Light Load™</td>
<td>0.4mA</td>
<td>•</td>
<td>85%</td>
<td>12x12x3mm</td>
<td>AnyCap™ stable, no compensation, Low EMI EN55022,ClassB</td>
</tr>
<tr>
<td>MIC28304-2</td>
<td>3A</td>
<td>4.5-70V</td>
<td>0.9V-24V</td>
<td>200-600kHz</td>
<td>Hyper Speed Control™</td>
<td>2.1mA</td>
<td>•</td>
<td>85%</td>
<td>12x12x3mm</td>
<td>AnyCap™ stable, no compensation, Low EMI EN55022,ClassB</td>
</tr>
<tr>
<td>MIC28303-1</td>
<td>3A</td>
<td>4.5-50V</td>
<td>0.9V-24V</td>
<td>200-600kHz</td>
<td>Hyper Light Load™</td>
<td>2.1mA</td>
<td>•</td>
<td>85%</td>
<td>12x12x3mm</td>
<td>AnyCap™ stable, no compensation, Low EMI EN55022,ClassB</td>
</tr>
<tr>
<td>MIC28303-2</td>
<td>3A</td>
<td>4.5-50V</td>
<td>0.9V-24V</td>
<td>200-600kHz</td>
<td>Hyper Light Load™</td>
<td>2.1mA</td>
<td>•</td>
<td>85%</td>
<td>12x12x3mm</td>
<td>AnyCap™ stable, no compensation, Low EMI EN55022,ClassB</td>
</tr>
<tr>
<td>MIC45205-1</td>
<td>6A</td>
<td>4.5-26V</td>
<td>0.8V-5.5V</td>
<td>200-600kHz</td>
<td>Hyper Light Load™</td>
<td>0.35A</td>
<td>•</td>
<td>85%</td>
<td>8x8x3mm</td>
<td>No compensation, CISPR22,ClassB compliant</td>
</tr>
<tr>
<td>MIC45205-2</td>
<td>6A</td>
<td>4.5-26V</td>
<td>0.8V-5.5V</td>
<td>200-600kHz</td>
<td>Hyper Speed Control™</td>
<td>2.1mA</td>
<td>•</td>
<td>85%</td>
<td>8x8x3mm</td>
<td>No compensation, CISPR22,ClassB compliant</td>
</tr>
<tr>
<td>MIC45208-1</td>
<td>10A</td>
<td>4.5-26V</td>
<td>0.8V-5.5V</td>
<td>200-600kHz</td>
<td>Hyper Light Load™</td>
<td>0.4mA</td>
<td>•</td>
<td>85%</td>
<td>10x10x4mm</td>
<td>No compensation, CISPR22,ClassB compliant</td>
</tr>
<tr>
<td>MIC45208-2</td>
<td>10A</td>
<td>4.5-26V</td>
<td>0.8V-5.5V</td>
<td>200-600kHz</td>
<td>Hyper Speed Control™</td>
<td>2.1mA</td>
<td>•</td>
<td>85%</td>
<td>10x10x4mm</td>
<td>No compensation, CISPR22,ClassB compliant</td>
</tr>
<tr>
<td>MIC45212-1</td>
<td>14A</td>
<td>4.5-26V</td>
<td>0.8V-5.5V</td>
<td>200-600kHz</td>
<td>Hyper Light Load™</td>
<td>0.37mA</td>
<td>•</td>
<td>85%</td>
<td>12x12x4mm</td>
<td>No compensation, CISPR22,ClassB compliant</td>
</tr>
<tr>
<td>MIC45212-2</td>
<td>14A</td>
<td>4.5-26V</td>
<td>0.8V-5.5V</td>
<td>200-600kHz</td>
<td>Hyper Speed Control™</td>
<td>2.1mA</td>
<td>•</td>
<td>85%</td>
<td>12x12x4mm</td>
<td>No compensation, CISPR22,ClassB compliant</td>
</tr>
</tbody>
</table>
# Analog & Interface Products

## THERMAL MANAGEMENT
- Temperature Sensors
- Fan Control and Hardware Management

## LINEAR
- Op Amps/INAs
- Comparators
- RF Power Amplifiers, PGA, SGA

## SAFETY AND SECURITY
- Smoke Detector ICs
- Piezoelectric Horn Drivers

## POWER MANAGEMENT
- Linear Regulators
- Switching Regulators
- Digitally-Enhanced & PWM Controllers
- Charge Pump DC/DC Converters
- Battery Management
- USB Port Power Controller
- System Supervisors Voltage Detectors
- Power MOSFET Drivers
- Power MOSFETs

## MIXED SIGNAL
- Pipelined A/D Converters
- Delta-Sigma & SAR A/D Converters
- Energy Measurement ICs
- Current/DC Power Measurement ICs
- Dual Slope / Display A/D Converters
- D/A Converters
- Digital Potentiometers
- Voltage References

## INTERFACE
- CAN/LIN
- USB and I/O Expanders
- Ethernet
- Wireless
- Real Time Clock/Calendar

## MOTOR DRIVER
- Stepper, DC and 3Φ Brushless
- Supertex

---

**Click on boxes to navigate**

---

81
## USB Bridge Family
UART, SPI, I2C/SMBus

<table>
<thead>
<tr>
<th>Feature</th>
<th>MCP2200</th>
<th>MCP2210</th>
<th>MCP2221</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCU Interface</td>
<td>UART</td>
<td>SPI</td>
<td>I2C/SMBus/UART</td>
</tr>
<tr>
<td>USB Speed</td>
<td>Full Speed</td>
<td>Full Speed</td>
<td>Full Speed</td>
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<tr>
<td>Max Recommended UART Rate</td>
<td>1Mbps</td>
<td>N/A</td>
<td>115.2kbps</td>
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<tr>
<td>Hardware Flow Control Pin</td>
<td>Yes</td>
<td>N/A</td>
<td>No</td>
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<tr>
<td>UART Pin Polarity Inversion Capable</td>
<td>Yes</td>
<td>N/A</td>
<td>No</td>
</tr>
<tr>
<td>Internal Oscillator</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>TX Buffer Size</td>
<td>128</td>
<td>64</td>
<td>64</td>
</tr>
<tr>
<td>RX Buffer Size</td>
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<td>64</td>
<td>64</td>
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<tr>
<td>GPIO</td>
<td>8</td>
<td>9</td>
<td>4</td>
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<tr>
<td>256 bytes EEPROM</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>ADC/DAC Peripheral</td>
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<td>No</td>
<td>Yes</td>
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<tr>
<td>Package Options</td>
<td>20 Lead QFN, SOIC, SSOP</td>
<td>20 Lead QFN, SOIC, SSOP</td>
<td>14 Lead PDIP, SOIC, TSSOP 16 Lead QFN</td>
</tr>
</tbody>
</table>
Pipelined A/D Converters

Standard Pipelined ADCs

16-bit

MCP37231-200
200 Msps, 8-ch mux

14-bit

MCP37221-200
200 Msps, 8-ch mux

12-bit

MCP37211-200
200 Msps, 8-ch mux

ADC with Integrated Digital Down-converter

MCP37D31-200
200 Msps, 16-bit, 8-ch mux
Digital Down-converter

MCP37D21-200
200 Msps, 14-bit, 8-ch mux
Digital Down-converter

MCP37D11-200
200 Msps, 12-bit, 8-ch mux
Digital Down-converter
MCP372x1-200
Standard ADCs

• Lowest power 16-bit ADC at 200Msps
  • <500mW compared to >1W of other suppliers

• Among highest accuracy
  • ~74dB SNR, ~90dB SFDR

• On-chip decimation filters
  • Gives 2-3dB SNR improvement per filter

• 8-ch mux with fractional delay recovery

• Noise-shaping requantizer (12-bit)

• VTLA & small 8x8 BGA* packages

*Coming 2015
# MEMS Oscillators

<table>
<thead>
<tr>
<th>mm x mm</th>
<th>7.0 x 5.0</th>
<th>5.0 x 3.2</th>
<th>3.2 x 2.5</th>
<th>2.5 x 2.0</th>
<th>1.6 x 1.2</th>
</tr>
</thead>
</table>

## Low Power Oscillators
**DSC10xx**
- **LVCMOS**, up to 150MHz
- -40 to 105°C

## Low Jitter Oscillators
**DSC11xx**
- Differential or LVCMOS, up to 460MHz
- -55 to 125°C

## Clock Generators
**DSC2x/DSC4x/DSC5x**
- 2 to 4 Outputs Differential and LVCMOS, up to 460MHz
- -40 to 105°C

All MEMS products are AEC-Q100 Capable, PPAP package ready for selected parts.
Benefits of MEMS over Traditional Quartz

Performance: Stability & Jitter
- Up to 10ppm frequency stability
- Temperature grades up to -55 to 125°C
- Less than 0.5 ps phase noise jitter

Higher Reliability
- Full AEC-Q100, JEDEC qualification
- 1.2 FIT rates vs. 20 FIT for crystal
- 50 000G shock and 70G vibration

Cost Effective
- Semiconductor supply chain, without mechanical handling steps of crystal
- On CMOS pricing trend, scaling with chip geometry

Faster Time to Market
- 2-4 weeks production lead time
- Engineering samples programmable in 1 sec with full production performance
Intermission - Timeflash Demonstration Video
System Challenges with Crystal Based Solution

77GHz Long Range Radar

- Frequency drift at high temperature
- Limited board space
- Higher failure rate than other semiconductor components on board
- Higher cost for small package
- Long product lead time
MEMS Solution Advantage

• ±25ppm from -55°C to 125°C, AEC-Q100 grade 1 qualified.
• Space saving 2.5x2.0mm 6-pin DFN replacing two crystals/oscillators
• Semiconductor grade reliability. 50K G Shock, 50G vibration
• Cost competitive
• 4 weeks production lead time
Frequency Range: 1 to 150MHz
Exceptional Stability over Temperature
±10 PPM, ±25 PPM, ±50 PPM
Operating voltage of 1.7V to 3.6V
Operating Temperature Range
   Ext. Industrial -40°C to 105°C
   Industrial -40°C to 85°C
   Ext. Commercial -20°C to 70°C
   Commercial 0°C to 70°C
Low Operating and Standby Current
   5mA Operating (40MHz)
   15µA Standby
Ultra Miniature Footprint
   2.5mm x 2.0mm x 0.85mm
   3.2mm x 2.5mm x 0.85mm
   5.0mm x 3.2mm x 0.85mm
   7.0mm x 5.0mm x 0.85mm
MIL-STD 883 Shock and Vibration Resistant
Pb-Free, RoHS, Reach SVHC Compliant
AEC-Q100 Reliability Qualified
FUSION
Ultra-low Jitter Oscillators and Clocks

Integrated crystal and multiple outputs offer a complete clock tree in a single package

<table>
<thead>
<tr>
<th></th>
<th>MX55/57</th>
<th>MX68</th>
<th>MX85</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Logic</td>
<td>LVDS, LVPECL, HCSL, LVCMOS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jitter (fs)</td>
<td>180fs</td>
<td>47</td>
<td>200</td>
</tr>
<tr>
<td>Outputs</td>
<td>1</td>
<td>1</td>
<td>Up to 5</td>
</tr>
<tr>
<td>Frequency</td>
<td>Programmable to 850MHz</td>
<td>156.25/125/100/50MHz</td>
<td>Programmable to 850MHz</td>
</tr>
<tr>
<td>Size (mm)</td>
<td>5x3.2</td>
<td>5x7</td>
<td>5x7</td>
</tr>
</tbody>
</table>

![Diagram of circuit and package](image)
Benefits of MEMS over Traditional Quartz

Quartz Crystal Oscillator in Metal+Ceramic Package

MEMS Oscillator in Plastic Package

Performance: Stability & Jitter
- Up to 10ppm frequency stability
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- Full AEC-Q100, JEDEC qualification
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- Engineering samples programmable in 1 sec with full production performance
Motion Monitor and Sensor Hub

Motion Solutions
Wide Range of Target Applications

This creates an opportunity to take this technology into many different products:

- Laptops/Tablets
- Gaming
- Remotes
- Robots
- Wearables
- Physical Therapy
- Toys
- Stabilization/Positioning
- Transportation
- Smart Farms
Motion Application Development Not Trivial!

- Complex algorithms req’d to filter, compensate, and fuse the raw sensor data
  - This requires specialized knowledge
  - Is also resource intensive
- Most vendors focused on large OEMs
  - Difficult to get support from some
  - Harder to get samples, technical support, distribution, etc.
MM7150 Motion Module

- Powered by the SSC7150 Motion Coprocessor
  - Filter, compensate and fuse raw 9-axis sensor data
- Comes pre-populated with 3-axis accelerometer, 3-axis magnetometer, and 3-axis gyroscope from Bosch
- Small size 17mm x17mm
- Single sided – can be soldered down
- Factory programmed and calibrated
- Self-calibrating during operation
- Suitable for battery powered applications
  - Consume 13ma active – 70ua sleep
- Outputs position & motion data over standard I²C™ connection
  - Works with most MCU/MPUs with I²C

The MM7150 Motion Module makes it easy to add motion & position capability
MM7150 Motion Module

- **Motion Coprocessor (SSC7150)**
- **I²C™ Clk**
- **I²C Data**
- **3-Axis Accelerometer / 3-Axis Magnetometer Bosch (BMC150)**
- **Reset**
- **3.3 V (range 2.3v – 3.6v)**
- **Gnd**
- **3-Axis Gyroscope Bosch (BMG160)**
- **Wake**
- **I²C Interrupt**
Easy to Develop

MM7150 PICtail™ Plus Daughter Board
(Part Number: AC243007)

- Plugs directly into Explorer16 board
- Outputs raw sensor data, compensated sensor data, and positioning data
- Standardized API for most MCUs with I²C® to communicate with MM7150 Motion Module
- MPLAB project with sample code to communicate with the PICtail
- $50 USD, quantity 1, available now

Explorer 16 Board
(Part Number: DM240001)

- Large installed base
- Interface with various PIC® MCUs by swapping Plug-In-Modules (PIMs)
  - PIC MCU demo code provided
- C Reference Code provided (on Savo)
- Works with MPLAB® IDE, Programmer, Debugger, Compiler
- $129.99 USD, quantity 1, available now
GestIC Technology Basics

- Utilizes Electrical Near Field (E-field) sensing for advanced proximity sensing
- E-Field generated by electrical charges
- Field distortion by a user translated into 3D tracking and gestures
- Very low power consumption since nearly no energy is transferred
Battery Efficiency

- **lowest power consumption** of any 3D sensing technology
- **up to 90% lower** than camera systems
- **always-on** 3D sensing
  ...even for mobile devices

- 150µW to max 100mW!*

*GestIC® Other

*@ 3.3V
Key Features

- 0 to 15cm detection range
- fast data sampling at 200Hz
- 32-bit signal processing unit
- mouse-like resolution of 150dpi
- 70-130kHz range - no RF interference
- no environmental influences
- self wake-up at 150µW – Low Power!
- Colibri Gesture Suite on-chip

fast
precise
robust
On-Chip Colibri Suite Features

Colibri Suite of GestIC features that are *pre-processed* on MGC3130

- **Approach Detection**
- **Flick Gestures (8)**
- **Position Tracking** *(xyz)*
- **Single Touch** *(5 positions on electrodes)*
- **Circle Gestures (4)** *(NEW)*
- **Symbol Gestures (TBD)** *(NEW)*
- **Electrode Signals** *(NEW)*

*Requires MGC3130*
Topology

1. Electrodes sense user action
2. MGC3030 processes signals
3. Gesture output to Application/Host

... or MGC3130

Gestures done right. MGC3x30.
GestIC Roadmap
2D Multi-Touch and 3D Gesture

3D Gesture Controller

**MGC3130**
*3D Positioning and Gestures*
5RX, 1TX channels
32bit MCU @ 22.5 MHz
32k Flash, 12k RAM
I²C, QFN28

**MGC3030**
*Gestures Only*
5RX, 1TX channels
I²C, SSOP28

New

2D Multi-Touch & 3D Gesture Controller

**MGC3430** (2015)
3D: 5RX + TX
2D: 48 RX/TX
32bit MCU @ 40 MHz
128k Flash, 32k RAM
I²C, USB
64L/48L QFN

**Aurea v1.3**
New Gestures
Gesture enhancements

- More cost efficient product
- Lower cost of manufacturing
  - SSOP28L

- For real-time positioning use MGC3130

In development

In production
It’s all about gestures

- **I²C + EIO interface**
  - Gesture Port = mapping of gestures to EOIs
  - Gesture Port enables gestures for **ALL products**.

- utilizes GestIC design-in tool set
  - [www.microchip.com/gesticgettingstarted](http://www.microchip.com/gesticgettingstarted)
  - AUREA SW suite (V1.2 or later)
  - Reference designs / Electrode Design Guide
  - Interface Manual
  - Reference Host codes

- **SSOP28L package**
  - Cost efficient manufacturing
GestIC Development Kits

MGC3x30 Unit

5” Reference Electrode
Frontside view

USB
I²C

I²C to USB Bridge
Connection to PC / Aurea GUI / MGC3x30 / System Paramterization

5” Reference Electrode
Backside view
(no components)

Each Kit contains
1 physical 5” Reference Electrode and
design / gerber files for
6 additional Reference Electrodes

MGC3130 Hillstar Development Kit
PN: DM160218
Price: $179.99

MGC3030 Woodstar Development Kit
PN: DM160226
Price: $139
Low Power Touch Pads & Screens

TOUCH PADS [&] SCREENS
Proximity, Keys, and Sliders
mTouch and RightTouch

PIC Microcontroller Solutions  Firmware Framework

MTCH102
2 channel
Active Guard
Digital I/O

MTCH112
2 channel
Active Guard
Digital I/O

MTCH105
5 channel
Active Guard
Digital I/O

MTCH108
8 channel
Active Guard
Digital I/O

CAP1133
3 channel
3 LED drivers
I²C

CAP1166
6 channel
6 LED drivers
I²C

CAP1188
8 channel
8 LED drivers
I²C

CAP1126
6 channel
2 LED drivers
I²C

CAP1128
8 channel
2 LED drivers
I²C

CAP1114
14 channel
11 LED drivers
I²C

MTCH101
1 channel
Low Cost
Digital I/O

MTCH108
8 channel
Active Guard
Digital I/O

MTCH105
5 channel
Active Guard
Digital I/O

CAP1105/6
5/6 channel
I²C

CAP1126
6 channel
2 LED drivers
I²C

CAP1128
8 channel
2 LED drivers
I²C

CAP1188
8 channel
8 LED drivers
I²C

CAP1114
14 channel
11 LED drivers
I²C

RightTouch Demo

Return to Topics
USB Keypad w/ mTouch™

- All features driven by PIC16F1459
  - Crystal free USB operation
- 18 touch buttons using Capacitive Voltage Divider (CVD) technique
- LED backlight with proximity sensing ON and auto power OFF
- USB HID interface
- Plug and play
- Development Made Easy
- Low-cost development experience
- Start with the FREE download
  - Schematics & ‘C’ source code
- Easily modified to your specific application needs
New MTCH102, MTCH105 and MTCH108
What is the MTCH10x family?

The MTCH10x are the easiest Capacitive Touch Controller for direct Mechanical Buttons Replacement.
Product Highlights

Product:
- Up to 8 buttons
- Buttons and Proximity with Guard Option
- One Input – One Output
- No SW – Only HW configuration
- No Host SW as Digital Outputs
- High Noise Performance: Passed 10V RMS
- Water Resistance
Very Simple Configuration

- MTSA: Sensitivity level – VSS biggest
- MTPM: Power Mode – VSS lowest Power
- GC: VSS = Guard Active
Digital outputs for Direct Mechanical buttons replacement

MTCH101
1 x Input
1 x Output
Adjustable Sensitivity
Low Power Mode

MTCH102
2 x Input / Guard Option
2 x Output
Adjustable Sensitivity
Low Power Mode

MTCH105
5 x Input / Guard Option
5 x Output
Adjustable Sensitivity
Low Power Mode

MTCH108
8 x Input / Guard Option
8 x Output
Adjustable Sensitivity
Low Power Mode

Supports Water Resistance

DM160229 @ $29.95
Available Nov 15
Block Diagram
Demo Board

- Use MTCH108 with Guard On
  - So MTI2 is inactive
- Print for MTCH102 and MTCH105
- $29.95, available in November
Water Resistance

- No Trigger when Drop of water

- Cannot work if covered with Water
  - Metal Over Cap
Hot Product Update
DN2470

Depletion-Mode N-Channel MOSFET for High Voltage Linear Regulation

October 2015
Customer Problem Solved

For: LDO Front-End Requiring HV Input

- Problem: LDOs Can’t Naturally Interface to Offline Input
  - Input Voltage Range, Transient Issues Prevent Offline Function
  - Step-Down Requires a Lot of Parts for Simple Line Interface Applications
DN2470 Solution and Benefits

- Normally-On MOSFET, Voltage Drop Dictated by Zener Voltage
  - Limits Input Voltage to LDO to Acceptable Level
  - Provides High Voltage and Transient Survivability to LDO
- Suitable for Applications Seeking Low Part Count, Low Noise, High Accuracy Offline Regulation with Linear Power
Depletion Mode MOSFETs

- Switches Providing Low Voltage to High Voltage Interface for Protection and Start-Up Circuits
- Normally On Device, Require a Negative Gate-Source to Turn-Off
# Depletion MOSFET Family

<table>
<thead>
<tr>
<th>Part Number</th>
<th>BVDSX Min (V)</th>
<th>RDS(ON) Max (Ω)</th>
<th>VGS(OFF) Min (V)</th>
<th>VGS(OFF) Max (V)</th>
<th>IDSS @ VGS = 0V Min (mA)</th>
<th>IDSS @ VGS = 0V Max (mA)</th>
<th>Package Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>DN1509</td>
<td>90</td>
<td>6</td>
<td>-1.8</td>
<td>3.5</td>
<td>300</td>
<td>-</td>
<td>SOT-23 SOT-89</td>
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<tr>
<td>DN2450</td>
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<tr>
<td>DN2470</td>
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<td>42</td>
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<td>500 (Typ.)</td>
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<td>3.5</td>
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<td>120</td>
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<td>6</td>
<td>-1.5</td>
<td>3.5</td>
<td>300</td>
<td>-</td>
<td>SOT-89</td>
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<td>350</td>
<td>10</td>
<td>-1.5</td>
<td>3.5</td>
<td>200</td>
<td>-</td>
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<td>DN3765</td>
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<tr>
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<td>3.0</td>
<td>300</td>
<td>-</td>
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<tr>
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<td>100</td>
<td>-1.0</td>
<td>3.0</td>
<td>1</td>
<td>3</td>
<td>SOT-23 TO-92</td>
</tr>
</tbody>
</table>
Description
The DN2470 is a linear friendly depletion-mode (typically ON) switch. This device is free from thermal runaway and thermally induced secondary breakdown.

Features
- High Voltage Rating=700V, Linear Capable
- Avalanche Tolerant (Evaluation System Survives Lighting Strike Test to 2kV)
- $R_{DS(ON)} = 42\, \Omega$ - Supports 10-50mA Offline Load Current
- Thermally Friendly TO-252 (D-Pak)
- $R_{TH,JC} = 2.4^\circ C/W$
• Features
  • Absolute Max Input Voltage: 700V
  • 120 & 230 VAC Offline Regulator
    • Minimum output current: 10mA
    • Maximum output current thermally limited
    • Transient survivability: 2.5kV
  • Over-temperature protection
  • Output voltage range 3-5V
  • 3 different selectable LDOs
  • Good thermal impedance (27.4 °C/W, junction to ambient) enables offline function
DN2470 Based Linear Regulator
Input Voltage Range Extender

BLOCK DIAGRAM:
What is EERAM?

EERAM is an SRAM with a shadow EEPROM in one package

- 4Kb, 16Kb I2C (1MHz)
- 3.0V, 5.0V Options
- Unlimited Writes to SRAM
- Automatically Stores Data at power down
- No Battery Needed (needs ext. capacitor)
- Data auto recalled to SRAM on Power-Up

Combines Two Proven Technologies

“Reliability of an EEPROM with the Performance of an SRAM”
EERAM Market Position
Where does it fit?

**Floating Gate**
- Broad Market
- Lower Costs
- Limited Endurance
- Drop-ins

**RAM Based**
- Niche Market
- Zero Write Times
- Infinite Endurance
- Sole-Sourced

---

- **EEPROM**
  - ~1.2B
- **NOR Flash**
  - 100 K
- **NAND Flash**
  - 10 K
- **EEPROM**
  - ~600M
- **MRAM**
  - SAM: ~$700M+
- **NVS RAM**
- **FRAM**
  - 140M

EERAM Fits here

---

EERAM

1. Significantly Less Expensive
2. No need of external battery
3. Low Power

---

**Cost/ bit**

- $$$
- $$
- $
Product Highlights

Product:
- 4Kb, 16Kb I2C Interface
- 2.7V-3.6V; 4.5V-5.5V
- 1MHz Max Clock

Read/Write and Modes:
- Infinite Read and Writes to SRAM Array
- 1M+ Store Cycles to EEPROM
- Automatic Store to EEPROM on power down
- Automatic Recall to SRAM array on power up

Other Features:
- Event Detect Flag/Pin
- Write Protection from 1/64\textsuperscript{th} of array to whole memory
- Industrial and Automotive Temps (Automotive Qualified)
Where is EERAM Useful?

Applications Needing:

- Ultra Fast Writes, Random Access
- Unlimited Endurance
- Preserve Data Reliably through Power Loss
## Comparing NVSRAM technologies

<table>
<thead>
<tr>
<th>Attribute</th>
<th>EERAM</th>
<th>FRAM</th>
<th>NVSRAM</th>
<th>MRAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer</td>
<td>Microchip (47XXX)</td>
<td>Cypress (CY15XX),</td>
<td>Cypress (CY14XX)</td>
<td>Everspin (MR25XX)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fujitsu (MB85xx)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Density</td>
<td>1Kb - 16Kb</td>
<td>4Kb - 2Mb</td>
<td>64Kb -1Mb</td>
<td>256Kb - 4Mb</td>
</tr>
<tr>
<td>Bus (Max Speed)</td>
<td>I2C (1MHz)</td>
<td>I2C (1MHz), SPI</td>
<td>I2C (3.4MHz), SPI</td>
<td>SPI (40MHz)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(20MHz)</td>
<td>(40MHz)</td>
<td></td>
</tr>
<tr>
<td>Voltage</td>
<td>2.7-3.6V, 4.5-5.5V</td>
<td>2.7-3.6V, 4.5-5.5V</td>
<td>2.7-3.6V, 4.5-5.5V</td>
<td>2.7V-3.6V</td>
</tr>
<tr>
<td>Max Temp Range</td>
<td>-40C to 125C</td>
<td>-40C to 85C</td>
<td>-40C to 85C</td>
<td>-40C to 125C</td>
</tr>
<tr>
<td>Data Retention</td>
<td>200+ Years</td>
<td>151 Years</td>
<td>20 Years</td>
<td>20 Years</td>
</tr>
<tr>
<td>AECQ-100</td>
<td>Grade 1</td>
<td>Grade 3</td>
<td>NA</td>
<td>Grade 1</td>
</tr>
<tr>
<td>Endurance</td>
<td>Unlimited</td>
<td>1 trillion +</td>
<td>Unlimited</td>
<td>Unlimited</td>
</tr>
<tr>
<td>Cost</td>
<td>$</td>
<td>$$</td>
<td>$$$</td>
<td>$$$$$</td>
</tr>
<tr>
<td>Min Capacitor</td>
<td>15uF</td>
<td>Not needed</td>
<td>270uF</td>
<td>Not needed</td>
</tr>
<tr>
<td>Standby Current</td>
<td>40uA</td>
<td>3uA</td>
<td>250uA</td>
<td>115uA</td>
</tr>
</tbody>
</table>
Applications

Metering – Energy, Gas, Water
- Secure, Continuous logging of consumption data
- In field updates of features and pay scale tables

Automotive
- Black Box Data Recorder, Data Logging
- Last Set Point Recorder (Seat Position, Wiper etc)
- ABS, Air Bags, Sensors, Seats, Black Box, Transmission

Printers, ATM, Kiosks, POS
- Log Printer Head Position, Record Ink Details
- Buffer Memory
- Record Number of Prints, Start Up Configuration

Any application that needs unlimited writes, instant writes, and data stored securely during power loss is a good fit for EERAM
EERAM in Metering

EERAM allows meters to write consumption data 1000x more frequently than EEPROMs

More accurate consumption data

Real Time Data Logging – Modern meters need data to be written as frequently as ~2 times per second.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fast data-writing speed</td>
<td>Protects against data loss in the event of a power failure</td>
</tr>
<tr>
<td>Read/write Cycle Endurance</td>
<td>Permits Data Collection at frequent intervals</td>
</tr>
<tr>
<td>Back-up via Capacitor</td>
<td>Eliminates the need for a battery back-up to preserve data</td>
</tr>
</tbody>
</table>

EERAM allows users to write to it continuously
EERAM Tools and Support

- **EERAM PICtail™ Plus Board** – Dec’ 15
  - Evaluate EERAM quickly
  - PICtail™ Plus connector allows you to connect to Explorer 16 Board.

- **EERAM Driver Code** with PIC – Jan’16

- **PM3 Support** – Dec’ 15

- **App Note:** Choosing the right capacitor for your design (type, size, tolerance, etc.) – Jan’ 16

- **App Note:** Recommended Usage of I2C EERAM – Dec’ 15
Enables Re-Use Coax

- Extends...
  - Ethernet and HD-SDI out to nearly 500m
  - Firewire up to 50m
  - Machine Vision up to 100m

... All using existing Coax
USB Power Delivery
UTC2000 USB Type-C™ Controller

- **Transition:**
  - Existing USB Type-A ➔ USB Type-C DFP
  - Existing USB Type-B ➔ USB Type-C UFP

- USB 2.0, USB 3.0, or USB3.1 compliant
- Supports up to 3.0A Charging profiles
- 3x3mm QFN-16
- Integrated ADC for Voltage monitoring on CC Pins
- Minimal external components
- Works with Microchip’s USB Controller Hubs
Typical UFP Applications

- **Mobile Devices Are Typically UFP**
  - Smartphone and Tablets

- **Default USB Type-C Charging Currents Do Not Require Controller (on UFP)**
  - USB2.0 500mA and USB3.0 900mA

- **UFP Responsible to Detect Higher Current Levels Above Default**
  - 1.5A and/or 3A of Current
  - Per USB Type-C Standard Specification
  - Some Controller Required to Support
UTC2000 UFP w/ Full Charging

BOM Cost Reduction!
Application Examples

- Notebook
- Monitor/Dock
- Devices (UFP only)
- USB Wall Charger
- Industrial Charging Cart
- Automotive
EVB-UTC2000

- NEW Evaluation Kit Available NOW
  - DFP Board
  - UFP Board
  - USB Type-C Cable

Plug Into Host

DFP Board

UFP Board

UTC2000 on backside
Wired Connectivity

Ethernet and USB
Ethernet - What’s New

- **EtherCAT for Industrial Applications (now)**
  - Industrial protocol developed by Beckhoff
  - Target applications for motor / motion control

- **Next generation 2&3 Port Switches (now)**
  - 1588v2 Precision Time Stamp Protocol
  - Cable diagnostics
  - 100FX Fiber support
  - WoL & Energy Efficient Ethernet

- **Gigabit Ethernet solutions**
  - LAN7800 – USB3.0 to 10/100/1000 Ethernet - mid 2016
  - KSZ9031 – GigE PHY – available now!
    - GMII/RGMII
    - Cable Diagnostics
    - Voltage driven for low power
    - WoL & Energy Efficient Ethernet
LAN7800
USB3.0 to Gigabit Enet

Target Applications
- PC Docking
- Port Replicators
- USB to eNet Dongle
- Digital Signage
- Networked Printers

- Netbook/Tablet
- PVR, STB
- Digital TV
- SoC Reference Platforms

Commercial (0 to +85C) and Industrial (-40 to +85C) temperature supported

- Single-chip, USB 3.0 to 10/100/1000
- Fully supports IEEE 802.3/802.3u
- Implements NetDetach™ and WoL support for reduced system power consumption
- Supports PCI-like PME Wake up
- Supports Win8’s Connected Standby with flexible address filtering modes, Wakeup packet support, ARP and NS offload
- Supports EEPROM-less operation for reduced BOM costs
- UniClock Technology requires single 25 MHz crystal for both USB and Ethernet
- Energy Efficient Ethernet 802.3az
- Cable Diagnostics

Microchip Confidential
KSZ9031
Next Gen GigE PHY

- 802.3az EEE and WoL
- Cable Diagnostics
- Low Power
  - Voltage mode line driver
- Built in switching and LDO regulator
  - Operates from single 1.2, 2.5 or 3.3 volt supply
  - Variable I/O voltage support
    - 1.8V, 2.5V or 3.3V
- Programmable LEDs (4)
- HP Auto-MDIX support with IEEE 802.3ab specs at 10/100/1000 Mbps operation
- Power Down modes
- 64-pin or 48-pin QFN

Target Applications
- Industrial PC
- VoIP gateway
- SOHO/SMB router
- Industrial Networks
- Security/Inspection
- MFP Printers
- STB

Commercial (0 to +85C), Industrial (-40 to +85C)
LAN9250
10/100 Enet Controller

- IEEE 1588-2008 Compliant
  - Supports UDP/IPv6 and layer 2
  - Transparent clocks
  - Smaller packet size
  - Increased update rate
- IEEE 802.3u 100Base-FX Fiber Interface
- IEEE 802.3az EEE and WoL
- Cable Diagnostics
- Optional EEPROM support via \( I^2C \)
- Integrated regulator enables single 3.3V supply

Target Applications
- Industrial PC
- VoIP gateway
- SOHO/SMB router
- Telecom
- Financial Transactions
- Industrial Networks
- Power Grid/Meter
- Security / Surveillance
- Transportation
- Mill/Aero

Commercial (0 to +70C) Industrial (-40 to +85C) and Extended temp. (-40 to +105C) supported
LAN9352/53/54/55
2/3 Port Switches

- IEEE 1588-2008 Compliant
  - UDP/IPv4/IPv6 and layer 2
  - Transparent and Boundary clocks,
  - Smaller packet size
  - Increased update rate
- IEEE 802.3u 100Base-FX Fiber Interface
- IEEE 802.3az EEE and WoL
- Cable Diagnostics
- Optional EEPROM or external SoC serial management support via I²C
- Virtual PHY support to simplify s/w development
- Integrated regulator enables single 3.3V supply

Target Applications
- Industrial PC
- VoIP gateway
- SOHO/SMB router
- Telecom
- Financial Transactions
- Industrial Networks
- Power Grid/Meter
- Security / Surveillance
- Transportation
- Mill/Aero

Commercial (0 to +85C) Industrial (-40 to +85C) and Extended (-40 to +105C) temp supported
What is EtherCAT®

● **Industrial Ethernet**
  ● Ethernet for Control and Automation Technology

● **Advantages**
  ● Uses standard Ethernet cabling
  ● Requires only low-cost slave controller
    ● No dedicated card or co-processor
  ● Flexible topologies w/ or w/o switches or hubs
    ● Switch/Hub req’d if not only EtherCAT devices on network
  ● Lower cost and easier to implement
Why EtherCAT® Tech.?

- Ethernet for Control Automation Technology
  - Market is forecasted to grow 17% annually
- EtherCAT® technology is the fastest growing Industrial protocol
- EtherCAT technology reaches new dimension in network performance by optimizing messaging within each Ethernet frame
- Hardware-driven architecture with minimal performance dependencies on software stack
- Over 3000 EtherCAT Association members worldwide

Source: HMS January, 2015
LAN9252 Features

- **2/3-port EtherCAT slave**
  - 3 Field Bus Memory mgmnt units
  - 4 Sync managers
- **Interfaces to most 8/16/32-bit embedded controllers**
  - SPI/SQI PIC32MZ
- **Dual integrated 10/100 PHY’s**
  - Auto-MDIX
- **Low power mode**
- **1.6V to 3.6V variable I/O voltage**
- **IEEE 802.3u 100Base-FX Fiber Interface**
- **Cable Diagnostics**
- **Integrated 1.2V regulator enables single 3.3V supply**

Target Applications

- Motor Motion Control
- Process / Factory Automation
- Communication Modules
- Interface cards
- Sensors
- Hydraulic & Pneumatic Valve systems
- Operator Interfaces

Commercial (0 to +85C) Industrial (-40 to +85C) and Extended temp. (-40 to +105C) supported
Ethernet Value Proposition

- **Strong brand name in market**
  - Large install base across all product groups
    - Customers give MCHP 1st call for new designs
      - Qualifying a “new” vendor and device costs $50k-$100k
  - Long history in servicing Ethernet market
  - Quality, highly integrated products
  - Excellent support including LANCheck
  - Reliable supplier with solid performance and track record in supply chain management

- **Products provide unique and differentiating features**

- **Reference designs featuring PIC processors**
USB Products
**USB Transceivers Value Proposition**

- Broadest portfolio of USB transceivers
- High functionality in small package sizes
- Lowest standby current
- Unique integrated features:
  - ESD and OVP
  - USB switch for high quality audio switch
  - Design savers:
    - PHY Boost for signal integrity (programmable)
    - VariSense for signal recognition (programmable)
  - Flexible clocking support
    - All major frequencies including ULPI Clock 60Mhz in, crystal resonator, and multi-frequency
USB Hub Product Plans

In Production
- USB5537B-6080AKZE
- USB5534B-6080JZX
- USB5533B-6080JZX
- USB5532B-6080JZX

In Production
- USB55XX
  USB3.0- 2/3/4/7 Port Hubs
  BC1.2 support
  A-B Connector

In Production
- USB251x/253x/460x
  USB2 - 2/3/4/7 Port Hubs
  BC1.2 support

In Production
- USB57XX
  USB3.0- 4 Port Cntl Hub
  FlexConnect, Bridging
  A-B or C Connector

In Design
- USB77XX
  USB3.1- 4 Port Hub
  Power Delivery partner
  USB type-C™ Connector

In Design
- USB58/59XX
  USB3.0- 7 Port Cntl Hub
  Native USB type-C™ Support

In Production
- USB5734/ML
- USB5744/2G

In Production
- USB58xx
- USB59xx

Microchip Confidential
USB553XB – USB 3.0 Hub Family

- 2, 3, 4 USB 3.0 Ports
  - USB5537 - 3 USB 2.0 Ports
- Supports USB 2.0 Link Power Management (LPM)
- On board configuration flash OTP
- USB Battery Charging 1.2 & Apple Charging, China Charging, RIM
- Multiple-TT for USB 2.0 traffic
- Preserve PortMAP, PortSWAP, PHYBoost and TrueSpeed features
- On-chip RXEQ to preserve cable length and 5Gbps signal integrity
- Optimized for 2-layer PCBs
- 72 QFN package (10x10mm)
- 64 QFN package (9x9mm)
USB2 Controller HUB (UCH) “Smart Hub”

- What is a Smart hub?
  - Standard hub functionality
  - Fully USB Compliant
  - USB Logo
  - But with additional features

- Key features
  - USB Bridging functionality
  - Enables “direct I/O bridging”
    - SMBus, GPIO, UART, SPI
  - Supports “Flex Connect”
    - OTG “like” port reversal
    - Port0 and Port1 reverse
  - Commercial, Industrial, and Automotive support
FlexConnect Example #1

- A USB hub that can role swap between Host and Device
  - Head Unit starts as Host
  - Cell phone becomes Host after negotiation with Head Unit
A USB hub that can switch between two different hosts

- Tablet starts as Host
- WiFi® Module becomes second Host
USB Controller Hub?

- More than just a USB Hub!
- I2C, UART, GPIO bridging
  - Host has direct access to registers
  - Added system control via the hub

...also supports battery charging!
USB5744 – Improving on Success

- Smaller package, less pins
  - 7 x 7 mm 56 pin QFN / 0.4mm pitch
- Lower Power
- Better Signal Integrity (JTOL)
- Faster OTP programming
- Better built in diagnostics tools
  - Fine grain control of 5 parameters
  - Generation of eye diagrams
- Common configuration options enabled by “straps” without requiring OTP programming
  - BC enable, Non-Removeable Port enable, Port Disable
USB5734 – Leading with New Functionality

- First USB3 Controller hub
  - USB to I2C/SPI/GPIO bridge support
- VSM support
- USB Link Power Management
- FlexConnect
- Predefined “Use Cases”
  - Full HW 9pin UART interface
  - BC indicators – BC enabled, BC1.2
  - LED indications – USB1.1, 2.0, 3.0
  - FlexConnect
  - I2C Bridging

➢ Samples Available NOW, RTP Q2CY15
### USB3.0 HUB Product Line

#### Summary of our existing and proposed new USB57xx Family

<table>
<thead>
<tr>
<th>Features</th>
<th>USB5734</th>
<th>USB5744</th>
<th>USBD537B 6080</th>
<th>USBD534B 6080</th>
<th>USBD537B 5000</th>
<th>USBD534B 5000</th>
</tr>
</thead>
<tbody>
<tr>
<td># of Downstream Ports (U3/U2)</td>
<td>4</td>
<td>4</td>
<td>4/3</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Package</td>
<td>64QFN</td>
<td>56QFN</td>
<td>72QFN</td>
<td>64QFN</td>
<td>72QFN</td>
<td>64QFN</td>
</tr>
<tr>
<td>UCH (USB Controller Hub)</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Custom Configuration - OTP, SPI, SMB</td>
<td></td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>BC1.2, Apple, RIM, China, DCP, CDP</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>External Strapping Options (BC, PR, PD)*</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>PD Only</td>
<td>PD Only</td>
<td>PD Only</td>
</tr>
<tr>
<td>Protouch Configuration Utility</td>
<td>PT2</td>
<td>PT2</td>
<td>PT1</td>
<td>PT1</td>
<td>PT1</td>
<td>PT1</td>
</tr>
<tr>
<td>SDK</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industrial Temp (-40°C to 85°C)</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design Process</td>
<td>65nm</td>
<td>65nm</td>
<td>130nm</td>
<td>130nm</td>
<td>130nm</td>
<td>130nm</td>
</tr>
</tbody>
</table>

* PD = Port Disable

New USB3.0 Smart Hub Products
The Low Power Analog Solution

Power Management

<table>
<thead>
<tr>
<th>Popular Products</th>
<th>Description</th>
<th>Product Web Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCP13xx</td>
<td>The MCP13xx are voltage supervisor devices designed to keep a microcontroller in reset until the system voltage has reached and stabilized at a proper level for reliable system operation.</td>
<td>Click Here</td>
</tr>
<tr>
<td>MCP111/2</td>
<td>The MCP111/112 voltage detectors have extremely low I\textsubscript{O}A operating current and small form factor. They hold the microcontroller in reset until the supply voltage reaches a predetermined operating level. These devices also protect against brownout conditions.</td>
<td>Click Here</td>
</tr>
<tr>
<td>LDO MCP1700</td>
<td>The MCP1700/3A are CMOS low dropout positive voltage regulators which can source up to 250mA of current with an extremely low input-output voltage differential. The low dropout voltage combined with the low current consumption makes this part ideal for battery operation.</td>
<td>MCP1700, MCP1703A</td>
</tr>
<tr>
<td>MCP16301</td>
<td>The MCP16301 is a highly integrated, high-efficiency, fixed frequency, step-down DC-DC converter in a popular SOT-23 package that operates from input voltage sources up to 30V.</td>
<td>Click Here</td>
</tr>
</tbody>
</table>
Thank You