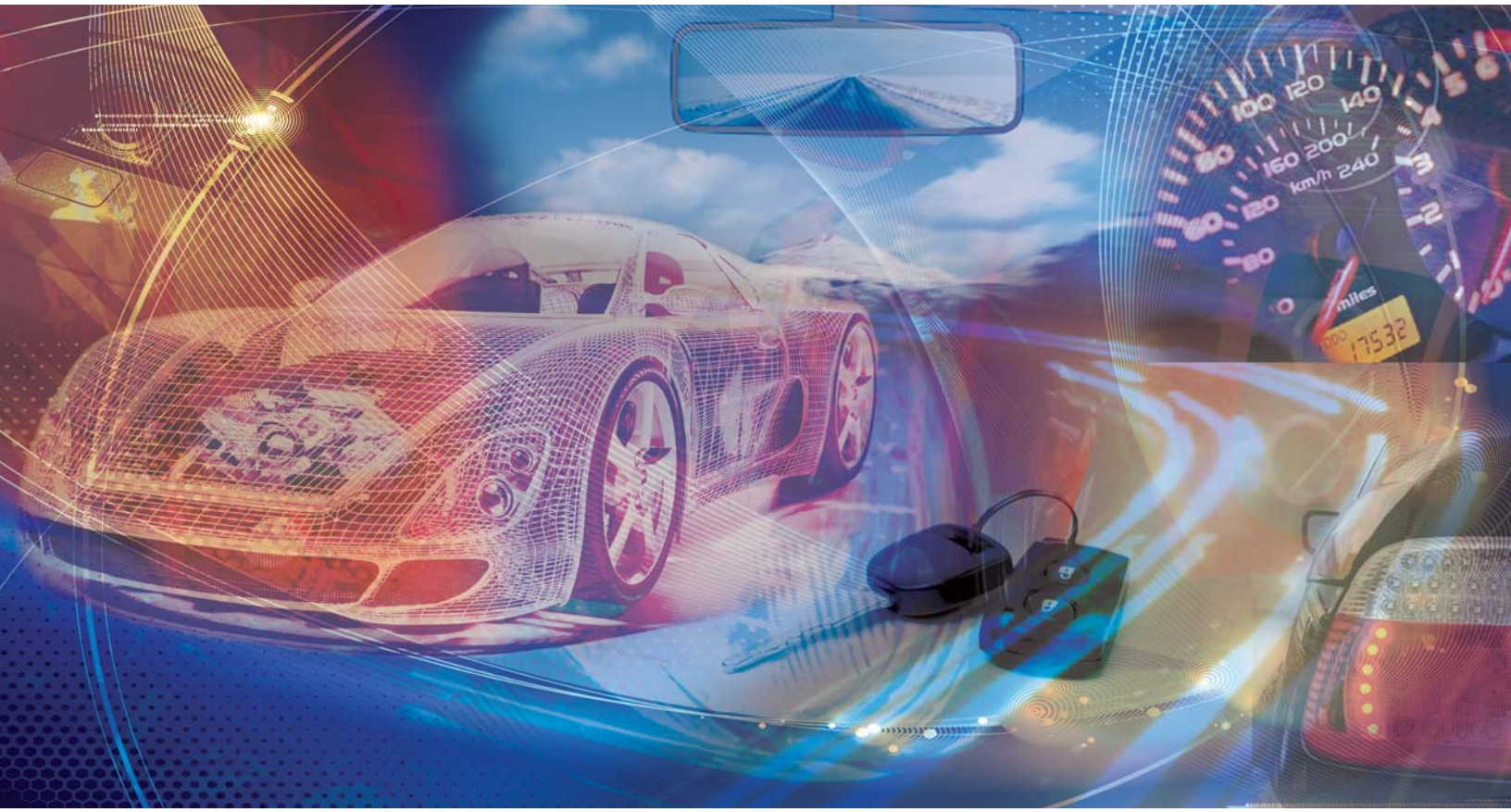
Automotive

MICROCHIP

Automotive Capabilities



www.microchip.com/automotive

Accelerating Distributed Intelligence in Tomorrow's Vehicle

The evolution of electronics in the automotive market continues as the automotive system suppliers race to address the rigorous requirements of the automotive OEMs. The demands of our global automotive customers create new challenges and opportunities for innovation.

With many years of experience in delivering embedded solutions to automotive customers globally, the broad portfolio of products, development tools and design support from Microchip Technology enable creative solutions from the automotive system suppliers that are helping the automotive OEM deliver vehicles that have reduced fuel consumption with lower emissions and deliver a safer, more comfortable driving experience for the driver.

Our commitment to the automotive electronics market is demonstrated over the years by providing timely, quality solutions that lower total system cost. It doesn't stop with just innovative products. Our leadership in manufacturing enables dependable delivery so that our customers have product when they need it. Plus Microchip's Aggregate System supports our relentless quest for perfection.

The sustained success in automotive electronics for Microchip can be attributed to its focus on, both emerging and well established applications, where solutions from Microchip add value. Our customers can count on solutions which enable the customer's ability to develop electronic modules that reduce the environmental impact in their quest to enhance fuel efficiency, reduce emissions and support sustainability.

Microchip Solutions Cover a Broad Range of Applications

Innovative Products and Development Tools

Our broad product portfolio and design support enable the development of value added, high performance modules cost effectively from bumper to bumper. The system designer can create their electronic control modules quicker. Plus Microchip Technology has a proven track record of delivering reliable products with long term product life cycles.

Flash Microcontrollers and Digital Signal Controllers

- Broad portfolio of 8-, 16- and 32-bit microcontrollers, 16-bit digital signal controllers
- From small, efficient, nanoWatt microcontrollers to large, multi-function microcontrollers
- Wide array of digital and analog peripheral functions
- Easy migration paths
- Supports operations up to 150°C ambient temperature environment
- Unified development environment
- Variety of package options from small, 6-pin leadless packages to 144-pin TQFP

Analog & Interface ICs

- Ultra-low power
- Non-volatile memory trimming
- Thermal management
- Power management
- Supports operations up to 150°C ambient temperature environment
- Signal conditioning
- Linear, mixed signal and interface
- In-vehicle network interface solutions

Serial EEPROMs

- Fast bus rates
- High endurance
- Low power consumption
- Small footprints
- Triple Test Flow – results in near zero infant mortality and outstanding data retention
- SEEVAL™ 32 Serial EEPROM Designer's Kit
- Total Endurance™ Software Model
- Supports operations up to 150°C ambient temperature environment

Development Tools

MPLAB® Integrated Development Environment comprised of an extensive suite of development tools:

- Analyzers
- Assemblers
- Compilers
- Debuggers
- Demo Kits
- Emulators
- Programmers
- Reference Designs
- Simulators

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Innovative Technologies Advancing Embedded Solutions in Vehicles

To support the continued importance of automotive electronics to the advancement of new features in modules, Microchip delivers technologies coupled with applications support to enable efficient power management, improved human interface, increased conversion efficiency, remote communications, data transfer and low power consumption. Designers are able to enhance their module's performance, power efficiency, connectivity and flexibility with solutions that optimize the balance between performance and cost.

As the electronic modules continue to increase within the electronic architecture of the vehicle, the spectrum of tasks, whether enabling new features or reducing power consumption or becoming connected, the demand for optimized performance from the embedded microcontrollers, analog ICs and non-volatile memory ICs has never been as important as now to enable the system designers in their quest to build innovative modules at lower system costs. The challenges for lower system cost optimization coupled with the stringent quality requirements for a vehicle with reduced fuel consumption, reduced emissions, improved energy efficiency, and improved safety create an environment for continued innovation. For our valued customers, Microchip Technology proudly delivers technologically advanced solutions reliably in support of the ultimate goal of a safe driving experience for the consumer.

Analog and Interface Solutions

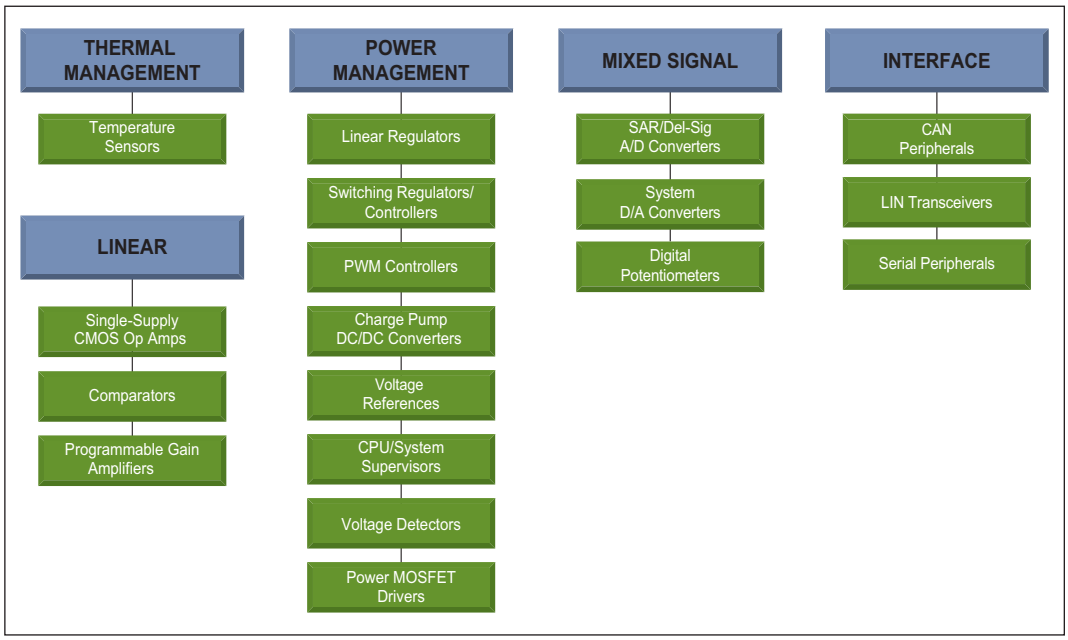
Leveraging experience from the integration of analog features on PIC microcontroller, nanoWatt technology, nonvolatile memory technology and low pin count packages, Microchip's analog circuitry consists of more than 400 different power management, linear, mixed signal, thermal management and interface products. As an innovative market leading supplier of low power analog solutions, Microchip continues to expand its analog product portfolio to support the needs of the automotive system designer.

8-, 16- and 32-bit PIC® Microcontrollers and Digital Signal Controllers

Number one in market share since 2003, our 8-bit MCUs are the heart of Microchip's business with over 6 billion MCUs integrated into consumer, industrial and automotive electronics*. From low cost, low power and small package requirements to leading edge and feature rich performers, our devices are based on a powerful RISC core with industry-leading, self-programmable Flash. Our proven architecture and easy migration strategy is expanded into our 16- and 32-bit families to provide the same robust features with the added benefits of powerful peripherals to drive today's high speed and low power electronics.

Microchip's broad product portfolio coupled with applications support and reference designs enable the automotive system designer to deliver cost effective solutions in an environment where fast time to market is essential. Microchip's continuous investments toward advancing semiconductor solutions enable a range of cost effective solutions. For example, LED lighting, motor control, mTouch sensing and battery monitoring are poised for further expansion.

Analog and Interface Products for Automotive Applications



*This statement represents the number of Microchip microcontrollers sold.

Driving nanoWatt XLP into Tomorrow's Vehicles

With increased electronics penetration across the broad spectrum of applications within the vehicle, the number of ECMs continues to expand – taxing the vehicle's power budget. Some higher end vehicles can have over 80 ECMs, which means that current loads are increasing. An increase in battery size to support the growing power requirements is an alternative to overcoming this challenge. However, larger batteries do not always provide a good tradeoff in an environment where space is limited and weight is critical, due to the negative impact on fuel consumption.

A better alternative is to use nanoWatt XLP, Microchip's innovative solution to address the operational power consumption of the ECMs. Through a unique blend of design techniques, flexible power management features and process technology, nanoWatt XLP technology allows engineers to manage static, active and average power consumption.

In those ECMs which consume power when the ignition is off, using nanoWatt XLP-based PIC microcontrollers, with industry leading low sleep currents, gives the system designer the abilty to tackle the power budget challenges.

PIC MCUs with nanoWatt Technology also support up to nine oscillator modes, which include:

- **Ultra Low Power Wake-up (ULPW) mode**
  - Reduces current draw during wake-up.
- **Configurable Idle, Sleep and Deep Sleep modes**
  - Let designers tailor current consumption levels and clocking options to fit any power budget.
- **Advantageous two-speed start-up feature**
  - Allows seamless transition by running from either of the internal oscillators while an external clock source stabilizes on start-up. After the external source has stabilized, the MCU automatically makes a clock switch, saving precious "up" time.
- **Clock frequency can be switched on the fly**
  - Allowing no delay in code execution on transitions between external clocks and the internal oscillators.

Low Power Safety

In addition to peripherals, products with nanoWatt XLP have system supervisory circuits specially designed for battery powered products.

- The Deep Sleep Brown-out Reset protects applications when batteries are depleted and changed, yet consumes a tiny 45 nA of current
- The Real-time Clock Calendar module on products with Deep Sleep can continue to run provide precise time for less than 500 nA
- Using a dedicated on-chip oscillator, the standard WDT and Deep Sleep WDT provide protection against system failure for less than 500 nA.

Benefits of nanoWatt XLP Technology:

- Sleep currents down to 20 nA
- Brown-out Reset down to 45 nA
- Watch-dog Timer down to 400 nA
- Real-time Clock/Calendar down to 500 nA

Enabling Performance in Harsh Environments

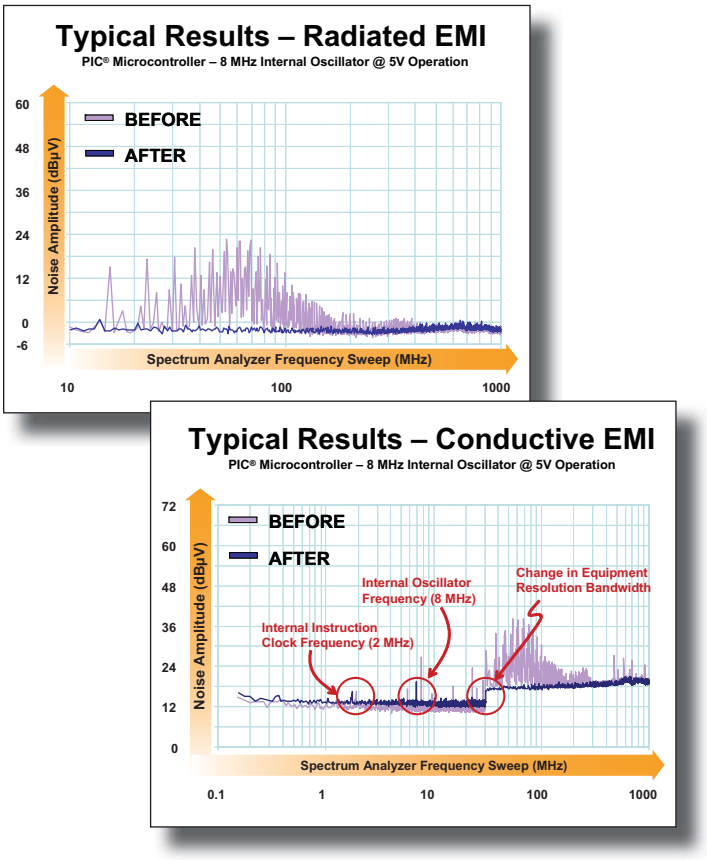
Broad Portfolio of High Temperature Devices

Microchip's High Temperature technology spans all product families including Microcontrollers, Analog, and Memory. Reliability testing is performed to AEC-Q100 Grade 0 (150°C) and specified for operation up to 150°C ambient. This enables robust applications under-hood, down-hole and in-oven. Visit our High Temperature Design Center, then select a product family to see the complete high temperature part listing in that family, with links to data sheets, application notes and other information.

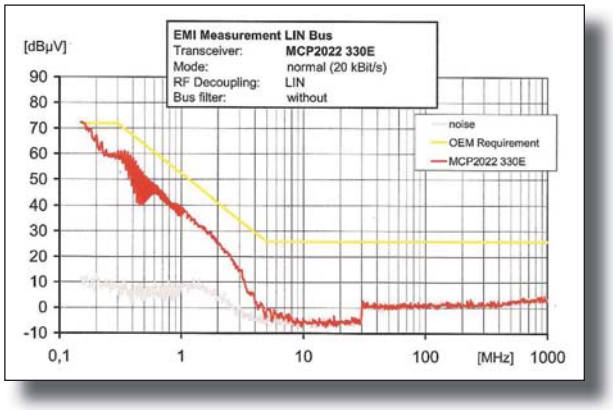
Robust Solutions

The challenge to deliver an electronic control module that complies to stringent, ever changing regulations that performs reliably in a harsh environment without adding system overhead costs remain. The importance of system robustness is well understood. From peripherals like fail safe clocks to brown out resets to power on resets to watchdog timers and other, peripheral integration plays a significant role in our commitment to deliver robust devices.

Our commitment to improve robustness in our solution is ongoing. Every new technology and product is designed with our latest innovations to enhance the robustness profile of each new device.

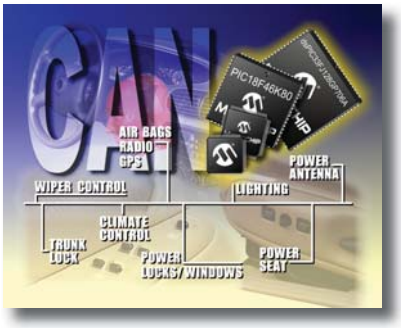


Microchip has an excellent track record for developing devices with excellent ESD rating. As a result, handling issues in a production environment are less prevalent. For example, the MCP202X family of LIN transceiver/ SBC family have been designed with aggressive robustness targets.



www.microchip.com/hightemp

Supporting the Connected Vehicle



The challenge of implementing cost effective networks within the vehicle is critical with the increasing number of electronic control modules. CAN and LIN/J2602 are two of the major open multiplexing protocols deployed within vehicles.

LIN/J2602 complements the existing portfolio of automotive multiplex networks led by CAN. With the continuing emergence of automotive electronics, the body control applications represent a significant segment of the vehicle.

PICDEM™ CAN-LIN demonstration boards support different PIC microcontroller devices. All demonstrate the main features of the devices, especially those features of the integrated CAN module.

PICDEM™ CAN-LIN 3 Demonstration Board (DM163015)

The PICDEM CAN-LIN 3 demo board is an easy way to discover the power of Microchip's CAN and LIN product offerings. The board demonstrates the main features of the 64-pin TQFP PIC18F6680 and 80-pin TQFP PIC18F8680 devices, including those features of the integrated CAN module. In addition, the board employs a LIN sub-network using Microchip 20-pin SSOP PIC18F1320 and MCP201 LIN Bus.

CAN BUS Analyzer (APGDT002)

The CAN analyzer development system enables a personal computer (PC) to communicate with the CAN bus. The PC program uses a graphical user interface to enter and display message frames occurring on the target bus.

LIN Serial Analyzer Development System (APGDT001)

The LIN analyzer development system enables a personal computer (PC) to communicate with the LIN bus. The PC program uses a graphical user interface to enter and display message frames occurring on the target bus.

PICkit™ 28-pin LIN Demo Board (DM164130-3)

The PICkit 28-pin LIN demo board enables a quick start in developing and debugging applications with the LIN drivers. The kit includes a 28-pin socket which supports various PIC16F devices, includes a LIN transceiver, plus a generous prototype area with various indicator LEDs and buttons to support the test and debug of the application.

Reference Designs

Complete reference designs are available from Microchip Technology which integrate application software, Data Link Layer firmware and the Physical Layer which enables a risk free path for the automotive embedded system designer.

Third Party Tools

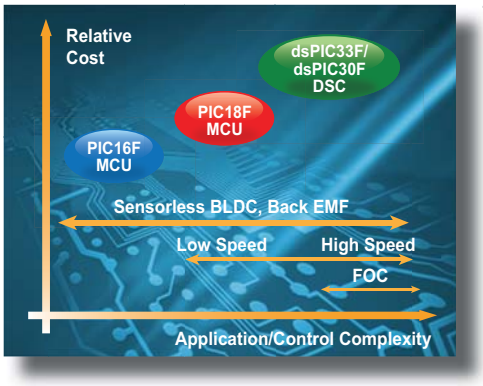
To support the automotive system designers, one of Microchip's design partners, ihr GmbH, has developed LIN Compliant drivers for the PIC16F, PIC18F and PIC24F Family of microcontrollers. The LIN Driver and Configuration tool (LDC) was developed by iHR GmbH to provide a tool to enhance the designer's productivity. The LDC eliminates the burden of designers' implementing the LIN/J2602 data link layer software stack. The tool accelerates the development of LIN/J2602 applications with 8-bit/16-bit PIC microcontrollers and allows the designer to focus on the application software development and enhances the chances of first pass success with the LIN/J2602 conformance tests.

www.microchip.com/devtoolsautomotive

Supporting the Advancements Toward a Beltless Vehicle

The trend toward a beltless vehicle continues to build momentum as the demand for innovative solutions with a small footprint to support the consumer's demand for improved fuel economy and reduced emissions, PIC microcontrollers and dsPIC® digital signal controllers provide an innovative suite of on-chip peripherals coupled with wide range of performance options that support the development of precision motor control systems. BLDC motors usage is growing due to the affordability of their operations being more energy efficient, quieter, with a greater range and extended life.

For example, in a brushless fuel pump design, the innovative electronically commutated three phase motor eliminates the need for mechanical brushes. As a result, reduced power consumption is achieved due to the elimination of friction caused by the brush to commutator interface and functionally enhanced due to the ability to have variable output to allow the fuel pump to operate at speeds which match the engine's demand. Plus with Microchip's sensorless field-oriented control algorithm which uses the single cycle MAC with data saturation, zero overhead looping and barrel shifting to achieve stunning performance.



The broad product portfolio of microcontroller and analog devices from Microchip enables creative solutions for motor control challenges within the vehicle. The Enhanced Capture Compare PWM Peripheral (ECCP) module found on some devices in the PIC16/18 families of microcontrollers is optimized for controlling ½ bridge or H bridge motor drive circuits. Plus it can be used for BLDC motor commutation or stepper motor control as shown in the brushless fan control illustration.

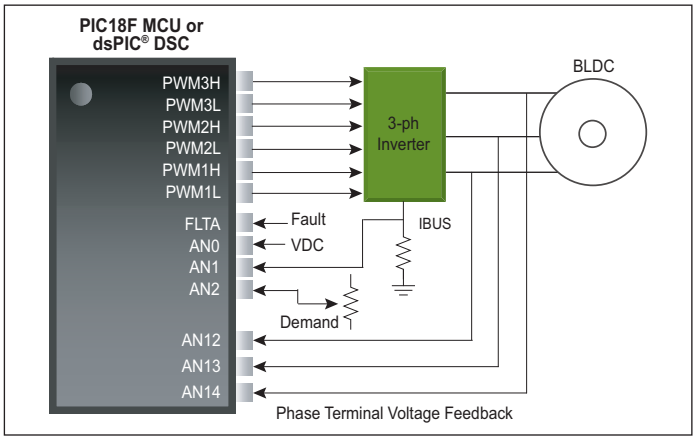
BLDC Sensorless

Want to reduce the vehicle weight and cost of Hall effect sensors and wiring harness cabling by going sensorless? Take a look at the PIC18, PIC24 or dsPIC33 families for your sensorless BLDC solutions. FIR filtering of the BEMF and/or using Majority Detect can help with high speed motors or motors with distorted BEMF signals.

The on-chip A/D converter samples the motor phase voltages. From the voltages, the CPU determines the rotor position and drives the motor control PWM module to generate trapezoidal output signals for the 3 phase inverter circuit.

FIR Filtering of the BEMF helps with high-speed motors or motors with distorted BEMF signals. Majority Detect reduces the amount of time on motor tuning.

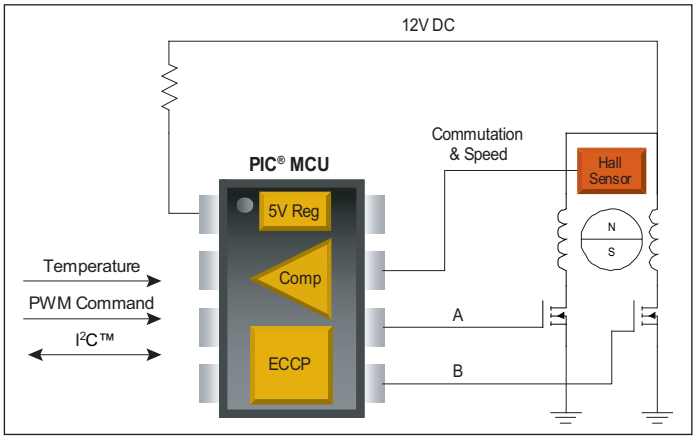
3-Phase BLDC with BEMF



BLDC Fan Control

Need a highly integrated fan controller with a customizable speed/temperature profile? Take a look at the PIC12HV and PIC16HV families. With a on-chip 5V regulator and comparator, the system designer is able to reduce components on the board and associated system costs. The rotor position is determined by a Hall effect sensor connected to the on-chip comparator. The Enhanced Capture Compare PWM (ECCP) peripheral uses the feedback information to drive the motor by steering the PWM signal to the appropriate motor phase. Temperature sensor inputs can be used to create a unique fan profile and the PIC MCU processes the information and transfers digital status to the vehicle's body computer module.

Fan Control Application Using PIC® MCUs



www.microchip.com/motorcontrol

Touch Sensing Technologies In Automotive

With the increasing number of buttons and switches in the vehicle, touch sensing has become an alternative to the traditional push button switch user interface. Touch sensing eliminates mechanical movement and enables a completely sealed design which supports the consumer's demand for contemporary styling. From proximity sensing to button replacement to button enhancement, touch sensing enables flexibility.

mTouch™ Sensing Solutions

Microchip's mTouch Sensing Solutions provide an easy method for designers to add touch sensing utilizing PIC microcontrollers without the cost of fee-based licensing and royalty agreements. With both capacitive and inductive touch sensing solution being available from Microchip Technology, the automotive embedded system designer has the flexibility to select the right touch technology to satisfy their application performance and cost requirements.

	Capacitive Touch	Inductive Touch
Keys	★★★	★★★
Slider	★★★	★
Power Consumption	★★★	★
Plastic Front Panel	★★★	★★★
Glass Front Panel	★★★	★
Metal Front Panel		★★★
Waterproof	★	★★★
Outdoor	★	★★★
Gloves	★	★★★
Continuous Touch	★★★	★★★
Soft/Hard Touch		★★★

★ Good ★★ Better ★★★ Best

mTouch sensing solutions can be used to aid the automotive system designer in addressing a broad range of requirements such as those for a sensor to detect water in diesel fuel, a sensor for carbamide, a level sensor for wiper fluid, a level sensor for engine coolant, a level sensor for fuel and many others.

Capacitive Touch Sensing

Microchip's Capacitive mTouch Sensing Solution can be implemented with a number of PIC microcontrollers to satisfy the demands of a broad range of application requirements from the most basic single-button design using an incredibly small, cost effective 6-pin PIC10F to a multi button design using the appropriate peripheral rich 8-bit or 16-bit PIC microcontroller.

Inductive Touch Sensing

Microchip's Inductive mTouch Sensing Solution can be implemented with existing application code in a single 8-, 16- or 32-bit PIC microcontroller or 16-bit dsPIC digital signal controller, thus reducing total system systems. The only peripherals required are a PWM and an analog to digital converter.

How to Choose the Right Capacitive Touch Solution for Your Application

The application ultimately dictates which solution best suits your design. For example:

Application Requirement	Device Family
One key or proximity sensor	PIC10F Family
Up to four keys	PIC16F Family
More than eight keys with communication; Low power < 10 µA	PIC16F Family
More than 8 keys with MCU performance, memory features	PIC24F Family

www.microchip.com/touch

Enabling LED Lighting Applications

With the advances in technology, LED lighting is being used in both interior and exterior applications within the vehicle. LEDs deliver long life, durability and efficiency. For example in a practical exterlor lighting application such as daytime running lights, LED based daytime running lights improve road safety and reduce fuel consumption by approximately 0.2 liter/100 km when compared to using the head lamp operating in low beam mode. Plus LED daytime running lamps offer the vehicles a touch of individual styling.

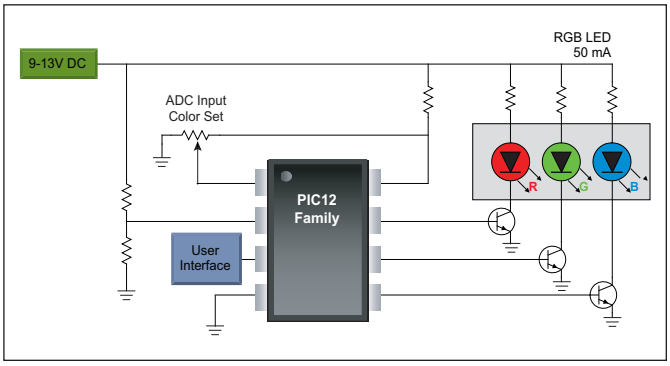
Efficient LED Control

LEDs must be driven with a source of constant current. Most LEDs have a specified current level that will achieve the maximum brightness for that LED without premature failures. An LED could be driven with a linear voltage regulator configured as a constant current source. However, this approach is not practical for higher power LEDs due to power dissipation in the regulator circuit. A switch-mode power supply (SMPS) provides a much more efficient solution to drive the LED. SMPS implementation with Microchip products can be analog, digital or mixed signal based solutions.

An LED will have a forward voltage drop across its terminals for a given current drive level. The power supply voltage and the LED forward voltage characteristics determine the SMPS topology that is required. Multiple LEDs can be connected in series to increase the forward voltage drop at the chosen drive current level.

The SMPS circuit topologies adopted to regulate current in LED lighting applications are the same used to control voltage in a power supply application. Each type of SMPS topology offers the system designer trade-offs as shown in the table below.

LED Application Using PIC MCUs



Automotive Ambient Lighting Module Reference Design (APGRD004)

The Automotive Ambient Interior Lighting Module Reference Design demonstrates microcontroller-based control of RGB LED devices. This module can be controlled remotely by a master body controller via a LIN bus. These modules are offered in a very compact form-factor board and are comprised of a PIC12F615 MCU, an MCP2021 LIN transceiver/voltage regulator, and RGB LED. LIN commands are interpreted by the module to control color mixing (16,383 colors) and intensity (1023 levels). The kit ships with 4 modules to assign as lighting zones in a LIN or J2602 network. These modules can also be used in conjunction with the APGDT001 LIN Serial Analyzer to quickly create a working LIN network straight out of the box.

Common SMPS Topologies Useful for LED Lighting

Regulator Topology	V_{IN} to V_{OUT} Relationship	Complexity	Component Count	Comments
Charge Pump	$-V_{OUT} < V_{IN} < V_{OUT}$	Low	Medium	Limited I_{OUT} range No inductors
Buck	$V_{IN} > V_{OUT}$	Medium	Medium	Chopped I_{IN} High side drive
Boost	$V_{IN} < V_{OUT}$	Medium	Medium	Extra parts needed to isolate output from input
SEPIC	$V_{OUT} < V_{IN} < V_{OUT}$	Medium	High	Smooth I_{IN} Multiple outputs Two inductors
Buck-Boost	$V_{OUT} < V_{IN} < V_{OUT}$	Medium	Medium	Single inductor Up to four switches
Flyback	Depends on transformer	Medium	Medium	Transformer can provide electrical isolation Multiple outputs possible

www.microchip.com/lighting

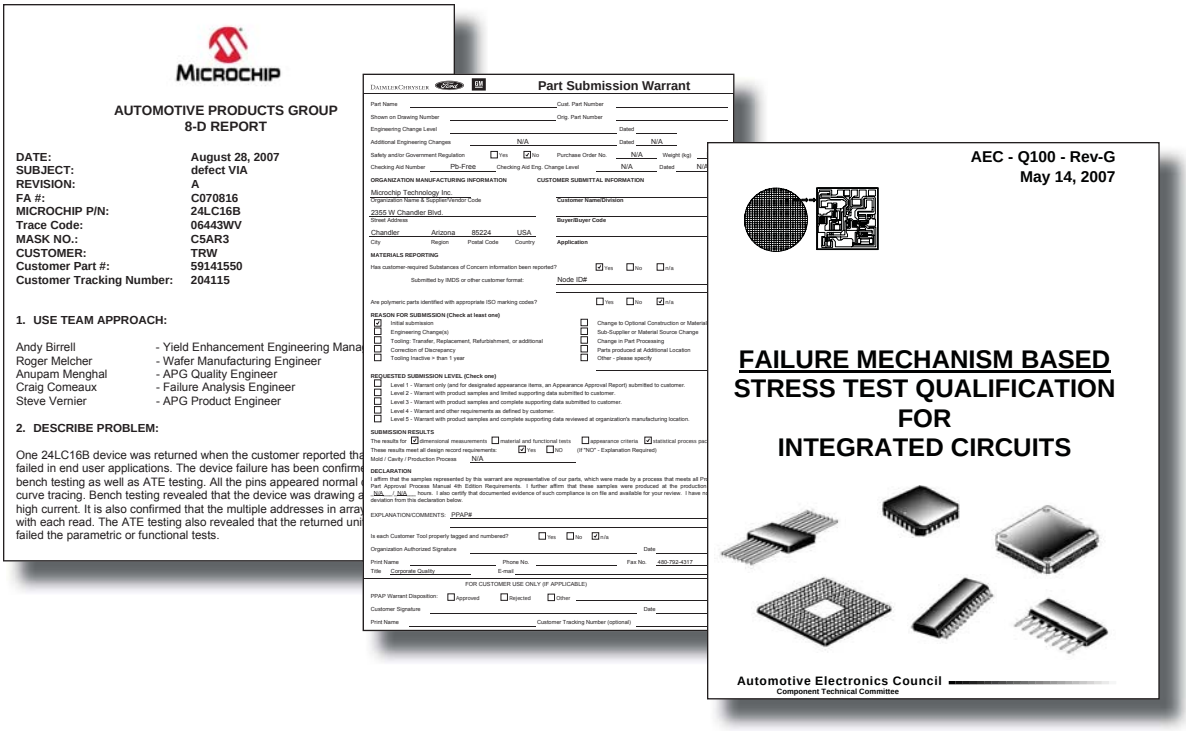
Commitment to the Relentless Quest for Perfection

"Quality Comes First" is at the top of the list of Guiding Values for Microchip Technology. As an ISO/TS-16949 certified supplier since 2003, Microchip's Aggregate System uniquely supports our commitment to exceptional quality. In an environment where enterprise wide commitment to continuous improvement is demonstrated and every employee is responsible for quality.

Microchip supports various automotive quality initiatives:

- Zero Defect Initiatives
- APQP – Advanced Product/Process Quality Planning
- AEC-Q100 Stress Testing
- PPAP – Production Part Approval Process
- 8D Reporting
- Product Change Notification

Quality and Reliability



With nearly 20 years of experience in serving the demanding requirements of the automotive customer, Microchip Technology has a proven track record of success in delivering the total product solution to our valued customers that is cost effective and reliable.

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www.microchip.com/quality

Support

Microchip is committed to supporting its customers in developing products faster and more efficiently. We maintain a worldwide network of field applications engineers and technical support ready to provide product and system assistance. In addition, the following service areas are available at www.microchip.com:

- **Support** link provides a way to get questions answered fast: **http://support.microchip.com**
- **Sample** link offers evaluation samples of any Microchip device: **http://sample.microchip.com**
- **Forum** link provides access to knowledge base and peer help: **http://forum.microchip.com**
- **Buy** link provides locations of Microchip Sales Channel Partners: **www.microchip.com/sales**

Training

If additional training interests you, then Microchip can help. We continue to expand our technical training options, offering a growing list of courses and in-depth curriculum locally, as well as significant online resources – whenever you want to use them.

- Regional Training Centers: **www.microchip.com/rtc**
- MASTERs Conferences: **www.microchip.com/masters**
- Worldwide Seminars: **www.microchip.com/seminars**
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Microcontrollers • Digital Signal Controllers • Analog • Serial EEPROMs

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