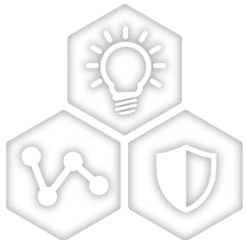# Gate Drivers for BLDC Motor in Ceiling Fan Application

MICROCHIP

A Leading Provider of Smart, Connected and Secure Embedded Control Solutions

Marketing Outreach Campaign
Analog Power & Interface Division
Microchip Technology

June 2022

SMART | CONNECTED | SECURE

Gate Drivers, Ceiling Fan Reference Design

- With introduction of highly efficient electronic control circuits, more and more players are opting for Brushless DC(BLDC) motors.

- Major advantages of BLDC motors

  - Compact in size, very low noise, high energy efficiency and maintenance free.

  - Gaining huge momentum in modern, high-efficiency appliances.

- Challenges

  - More complex electronics and motor control techniques.

- To address client challenges microchip has developed BLDC motor control reference designs for Ceiling Fan application.

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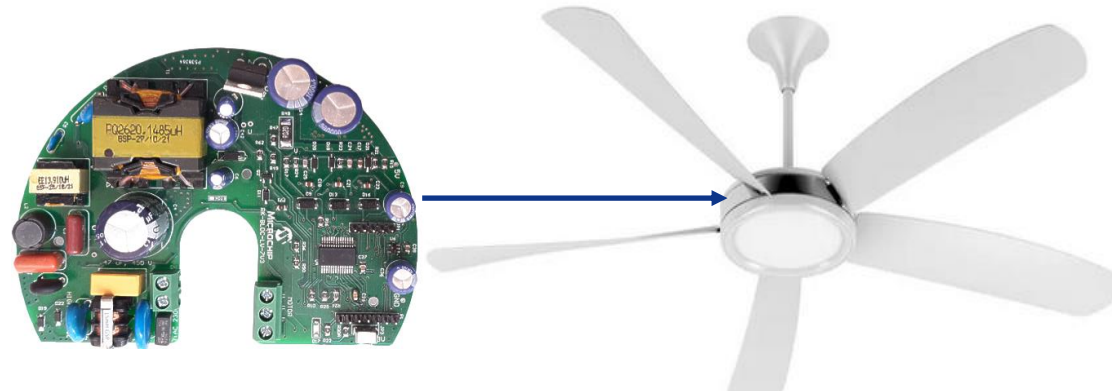
Market Overview

Research analysts predicted the global BLDC motors market will grow steadily at a CAGR of about 13%.

Estimated CAGR: 7% annually for BLDC ceiling fans.

Growth Factors

Wide range of applications in

- **Power tools**
- **Automotive**
- **Industrial**
- **Home appliances**

Especially for Compressors/Water pumps/Fans

Growth Factors

- **Global warming : Demand for ceiling fans and A/C.**
- **Very low noise.**
- **Affordable.**
- **Energy efficient.**
- **Smart and fancy ceiling fans with LED lights(Deco).**
- **Bidirectional control (Summer and winter usage).**

Power Conversion → Motor Control ← BLDC Motor

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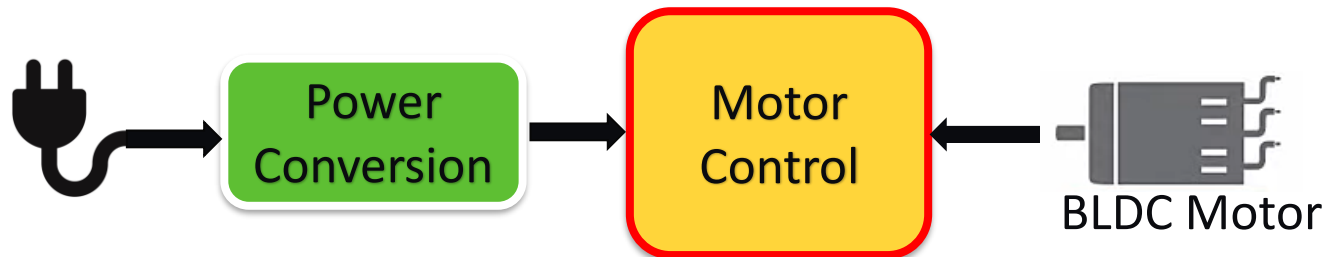
Customer Challenges

- **Energy**
  - To compensate rising energy prices, building energy efficient products are a must have.

- **Lack of efficient controls**
  - Primary control parameter in past was only the applied voltage.
  - Precise speed or torque control was partly difficult

- **Higher initial cost**
  - Saving more money in the mid and long term by consuming less energy.

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Why Change?
Adapt to Address Customer Needs

- **Industry trends**
  - Ceiling FAN manufacturers have started migrating to BLDC FAN to achieve
    - Better performance due to very low noise and control features
    - Better energy(star) efficiency rating (by 50% less)

- **Grow Revenue**
  - BLDC Ceiling Fans are the driving force behind the demand for the next decade.

- **Very low maintenance**
  - No brushes, no wear and tear, no sparks.

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Why Now?
Be the Early Bird to Capture the Market Share

- **Smart homes and global warming driving the demand for BLDC Ceiling Fans and A/C NOW!**

- **Adapting to new Government Norms(Specific to country)**

  - Govt. mandates all electrical appliances to have Energy/STAR(1-5) or e. g. EU A++, A+, B rating for customer awareness.
  - Utilize Govt. incentives for setting up manufacturing plants for energy efficient appliances. (**Driving green technologies**)

- **Shifting Mechanical to Electronic commutation**
  - Availability of high-performance microcontrollers with affordable price.
  - Sophisticated software algorithms for Field Orientated Control (FOC), to control speed and torque of the fan precisely.

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Why Microchip (MCHP)?

Ready to Use Solution

- **Reduced Risk**
  - One shop stop for proven reference design with optimized hardware and software.
  - Established (widely) in market, used by various big vendors.

- **Faster Time to Market**
  - Speed up your time to market and reduce your design risk by starting with MCHP available turnkey solution.

- **Expert support to integrate into customer application.**

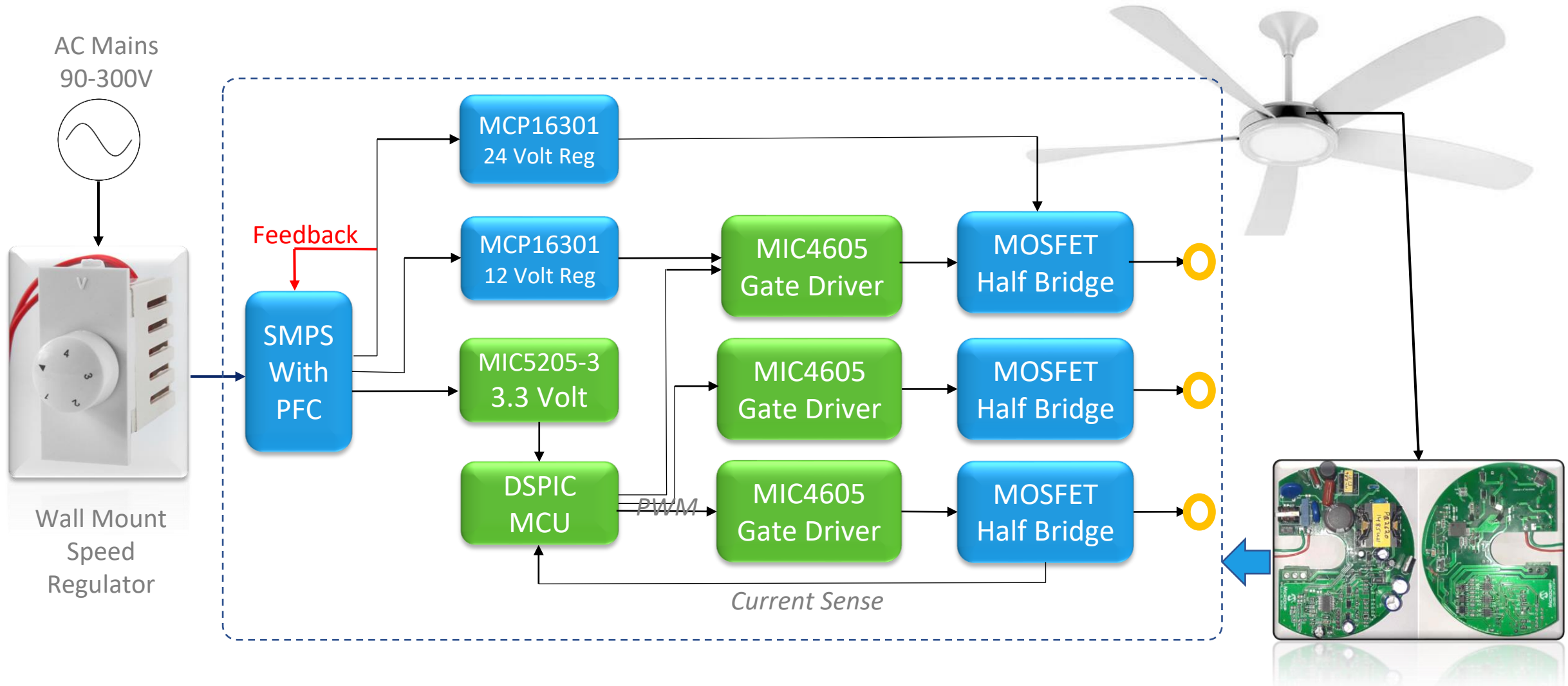MICROCHIP

Market Differentiation

Drive BLDC Motors Efficiently

- **Market leader with support of traditional wall mount regulator in combination with remote controls, to operate the fan.**

- **Supports extended customer features**
  - Using powerful dsPIC MCUs

- **High performance compared to existing designs**
  - Speed more than 450 rpm with very low noise

- **Sensor-less cost efficient FOC*) based motor control**
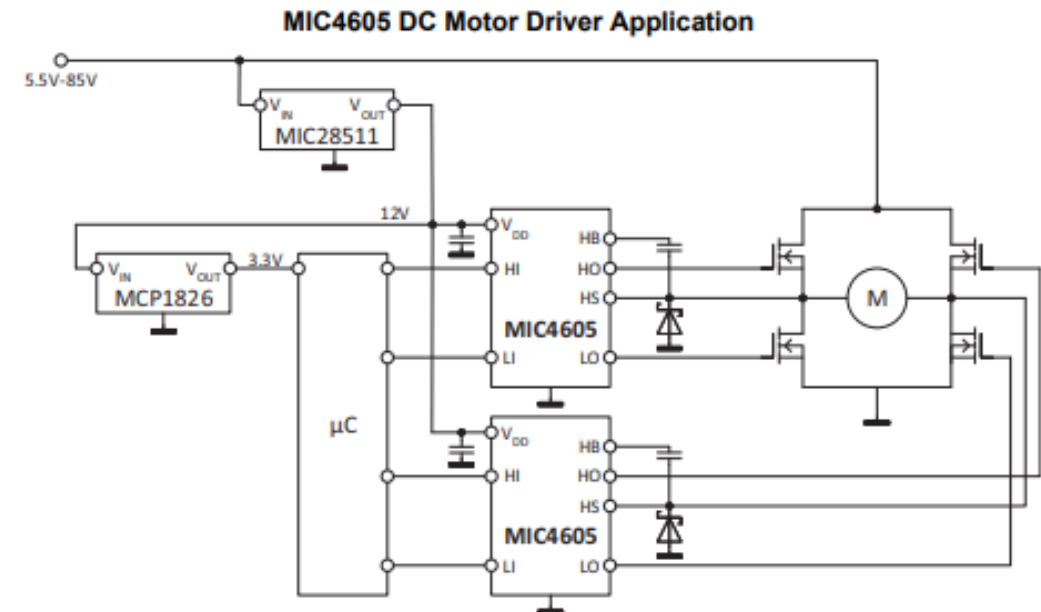
*) Field-Oriented Control

Functional Block Diagram

AC Mains
90-300V

Wall Mount
Speed
Regulator

SMPS
With
PFC

Feedback

MCP16301
24 Volt Reg

MCP16301
12 Volt Reg

MIC5205-3
3.3 Volt

DSPIC
MCU

PWM

MIC4605
Gate Driver

MIC4605
Gate Driver

MIC4605
Gate Driver

MOSFET
Half Bridge

MOSFET
Half Bridge

MOSFET
Half Bridge

Current Sense

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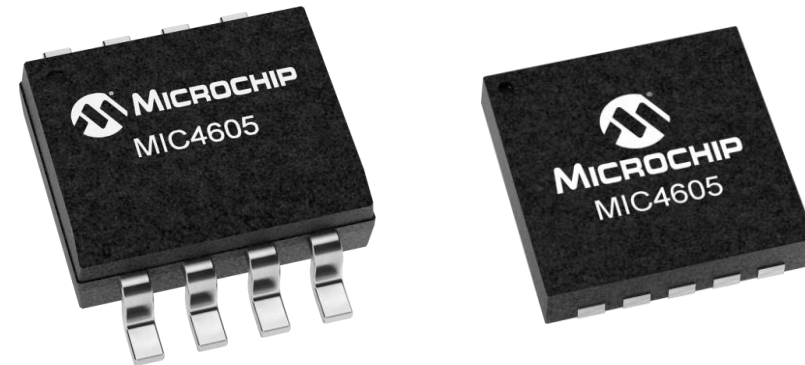
MIC4605

85V Half Bridge MOSFET Driver

- **5.5V to 16V Gate Drive Supply Voltage Range**
- **Advanced Adaptive Dead Time**
- **Intelligent Shoot-Through Protection:**
  - MIC4605-1: Dual TTL Inputs
  - MIC4605-2: Single PWM Input
- **Enable Input for On/Off Control**
- **On-chip bootstrap Diode**
- **Fast 35ns Propagation Times**
- **Drives 1000pF Load with 20ns Rise and Fall Times**
- **Low Power Consumption: 135µA Quiescent Current**
- **Separate High-Side and Low-Side Undervoltage Protection**
- **-40°C to +125°C junction temperature range**
- **AEC-Q100 Qualified for the SOIC Package**

Recommended for Automotive Designs

MIC4605 DC Motor Driver Application

https://www.microchip.com/wwwproducts/en/MIC4605

https://ww1.microchip.com/downloads/en/DeviceDoc/MIC4605-Data-Sheet-DS2005853E.pdf
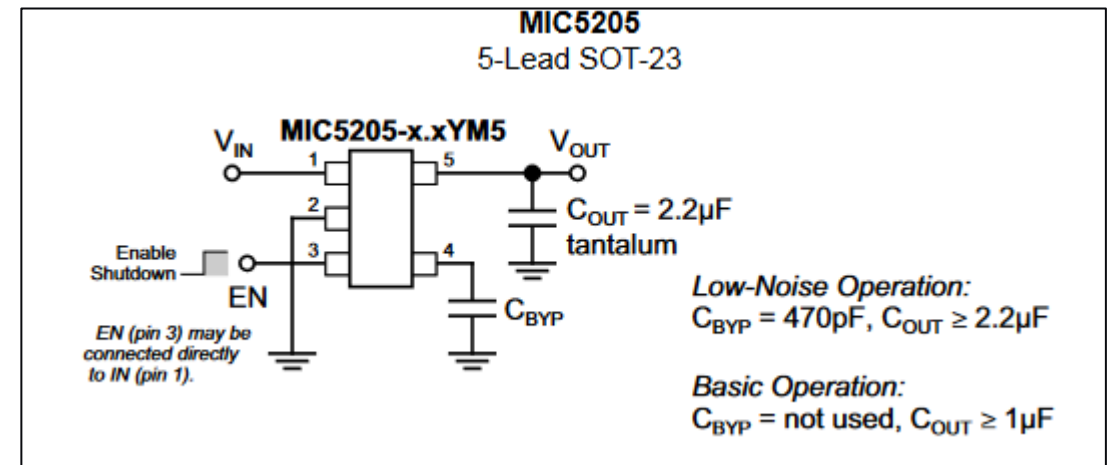
MIC5205

Ultra-Low Noise Output LDO 1% Accuracy 150mA

- **High output voltage accuracy with low noise**
- **Guaranteed 150mA output current**
- **Low quiescent current**
- **Low dropout voltage**
- **Extremely tight load and line regulation**
- **Very low temperature coefficient**
- **Current and thermal limiting**
- **Reverse battery protection**
- **Zero off-mode current**
- **Logic-controlled electronic enable**
- **-40°C to +125°C junction temperature range**
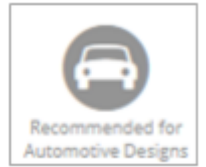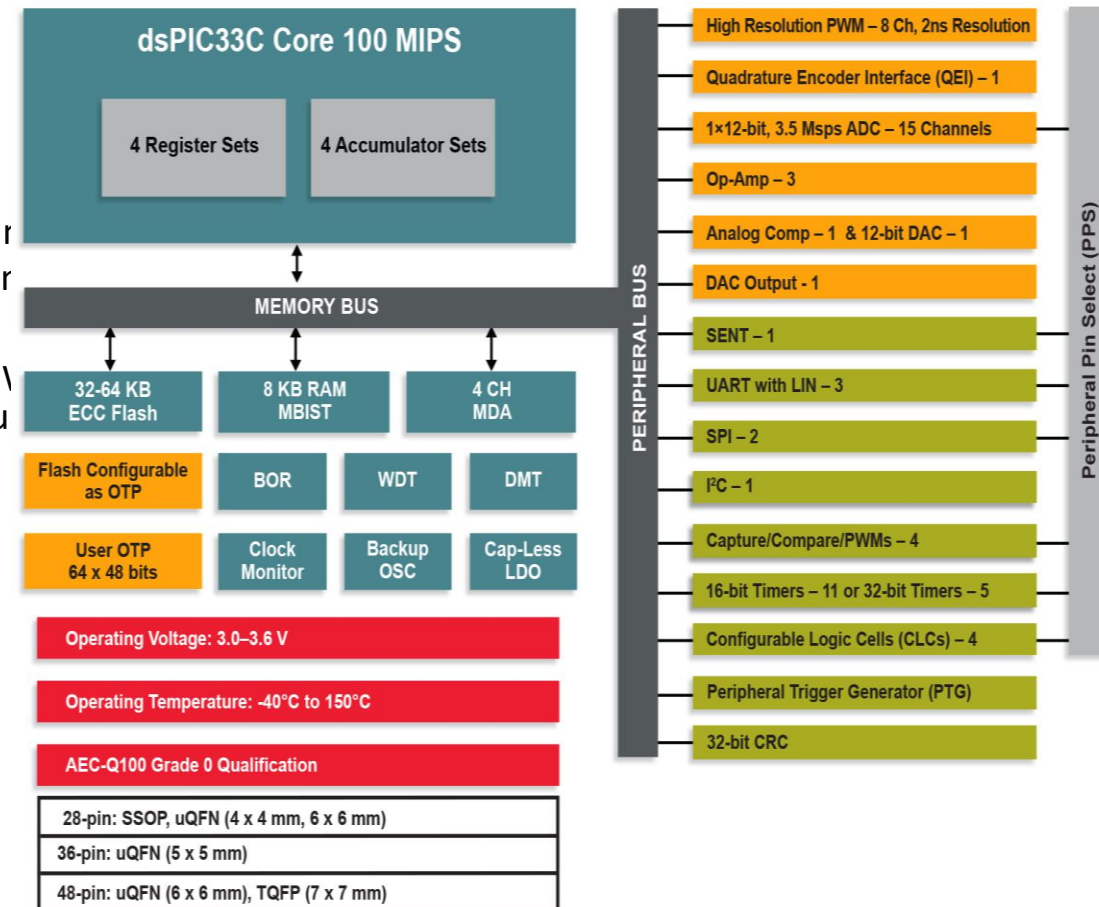

Typical Application Circuit

Datasheet :
https://ww1.microchip.com/downloads/en/DeviceDoc/20005785A.pdf

https://www.microchip.com/en-us/product/MIC5205

dsPIC33CK64MP105

100 MHz Single-Core High-Performance 16-bit DSC

Recommended for Automotive Designs

- **High-Performance Digital Signal Controller (DSC)**
  - 100 MHz CPU instruction execution speed for tighter control loops
  - New instructions to accelerate DSP algorithm performance
  - Expanded context selected register sets for reduced interrupt latency
- **Optimized Peripheral Feature Set**
  - Perfectly optimized for single-motor control applications, automotive and in
  - Analog integration includes a single high-speed ADC, 3 op amps, and one an
- **Improved Functional Safety Features and Support**
  - Safety features include: ECC Flash, RAM BIST, Deadman Timer (DMT), Dual V
    Monitoring (FSCM), CRC, Virtual Pins for Redundancy, Flash OTP & Code Gu
  - Targets ASIL B(ISO 26262), SIL 2(IEC 61508), Class B Library(IEC 60730).
- **Hardware Development Tools**
  - dsPIC33CK64MC105 Motor Control Ext. Op Amp PIM (MA330051-1)
  - dsPIC33CK64MC105 Motor Control Int. Op Amp PIM (MA330051-2)
  - dsPIC33CK64MC105 General Purpose PIM (MA330052)
- **Software Development Tools**
  - MPLAB® X IDE, MPLAB® Xpress Cloud Based IDE
  - MPLAB® Code Configurator (MCC), XC16 C Compiler
 - motorBench® Development Suite

Block diagram:

dsPIC33C Core 100 MIPS
- 4 Register Sets
- 4 Accumulator Sets

MEMORY BUS

- 32-64 KB ECC Flash
- 8 KB RAM MBIST
- 4 CH MDA

- Flash Configurable as OTP
- BOR
- WDT
- DMT

- User OTP 64 x 48 bits
- Clock Monitor
- Backup OSC
- Cap-Less LDO

- Operating Voltage: 3.0–3.6 V
- Operating Temperature: -40°C to 150°C
- AEC-Q100 Grade 0 Qualification

- 28-pin: SSOP, uQFN (4 x 4 mm, 6 x 6 mm)
- 36-pin: uQFN (5 x 5 mm)
- 48-pin: uQFN (6 x 6 mm), TQFP (7 x 7 mm)

PERIPHERAL BUS / Peripheral Pin Select (PPS):
- High Resolution PWM – 8 Ch, 2ns Resolution
- Quadrature Encoder Interface (QEI) – 1
- 1×12-bit, 3.5 Msps ADC – 15 Channels
- Op-Amp – 3
- Analog Comp – 1 & 12-bit DAC – 1
- DAC Output - 1
- SENT – 1
- UART with LIN – 3
- SPI – 2
- I²C – 1
- Capture/Compare/PWMs – 4
- 16-bit Timers – 11 or 32-bit Timers – 5
- Configurable Logic Cells (CLCs) – 4
- Peripheral Trigger Generator (PTG)
- 32-bit CRC

https://www.microchip.com/wwwproducts/en/dsPIC33CK64MP105

https://ww1.microchip.com/downloads/en/DeviceDoc/dsPIC33CK64MP105-Family-Data-Sheet-DS70005363E.pdf

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Deliverables

- **MPLABX**
- **C/C++ Compilers XC16**
- **Software Support**
  - Adaptable Source code (FOC library).
  - Motor tuning utility (User configuration file for motor input parameters)
- **Debugger/Programmer**
  - PICKIT4, ICD4, MPLAB SNAP
- **Hardware**
  - Reference design boards with different Form Factors.
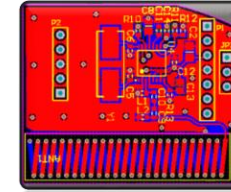 - Board schematics.
  - PCB layout, BOM.
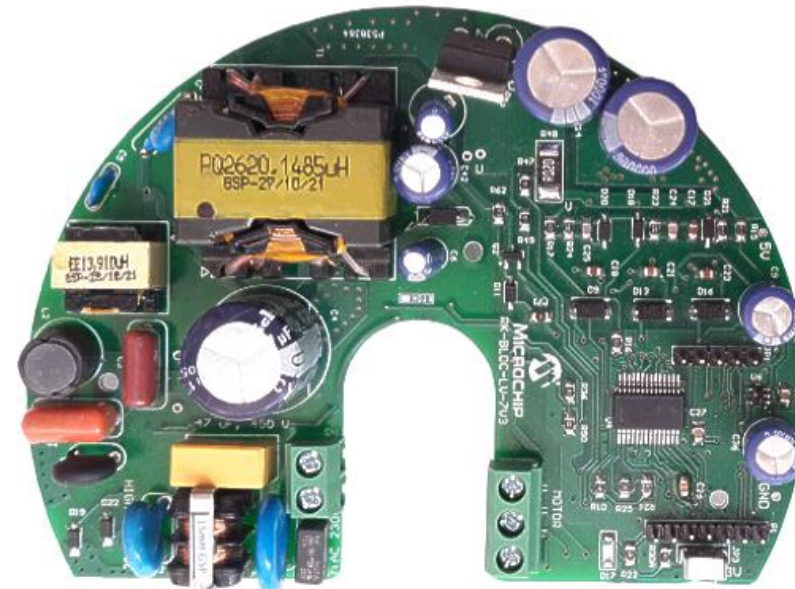
CG BLDC FAN RF Remote Electronics Availability

RF Remote Rx
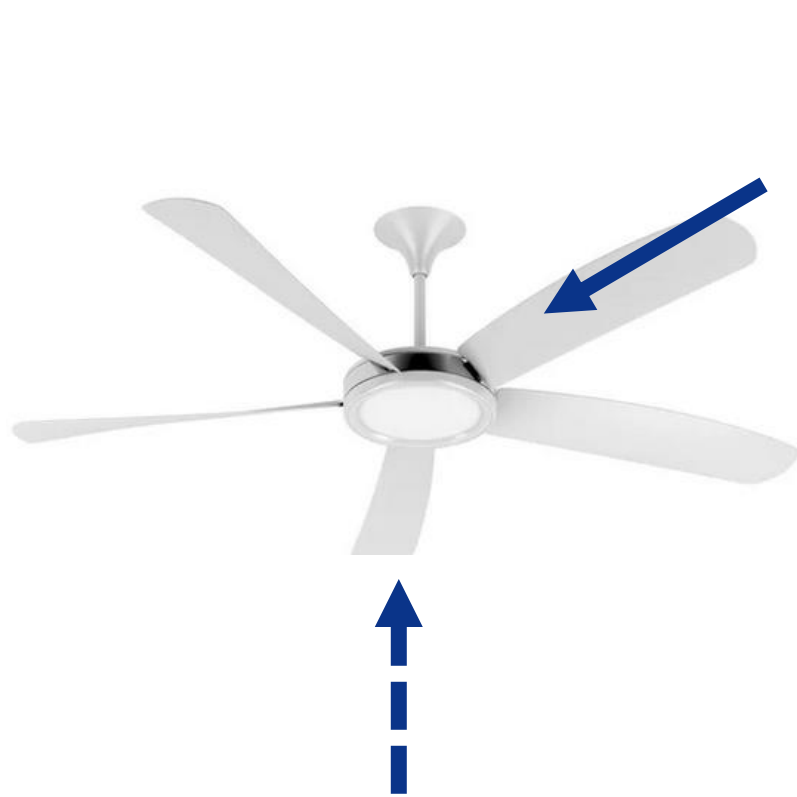
1. MICRF219AAYQS

BLDC Driver

1. DSPIC33CK32MC102
2. MIC5605
3. MIC5205-3.3

BLE

1. BM70/BM71

RF Remote Tx

1. PIC16F15344
   /ATTINY404
2. MICRF112

IR REMOTE

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Thank You