



# Zilog's Z16FMC Series of Flash Microcontrollers

## Zilog's Z16FMC Series Flash Microcontroller A 16-bit Single-Cycle CISC MCU Solution

### Overview

Zilog's Z16FMC Series MCU, a part of the Flash Motor Control family of devices, is a powerful 16-bit CISC microcontroller that outperforms most RISC microcontrollers in its class. The Z16FMC boasts a unique architecture that provides the power, punch and performance of a 32-bit micro with the code, current efficiency and cost of a 16-bit. The Z16FMC features Zilog's ZNEO<sup>®</sup> CPU, which boasts a highly-optimized instruction set that achieves higher performance per clock cycle with less code space and lower overhead than competing architectures. Optimized for motor control applications, these devices are designed for the control of multiphase AC and DC variable-speed motors. Target applications are large appliances, HVAC and industrial.

This powerful yet simple core with sixteen 32-bit general-purpose registers supports complex CISC addressing modes and a single-cycle instruction set that includes frame pointer support, multi-bit shift and multi-register push/pop as well as powerful 32-bit math operations.

The Z16FMC Series features a flexible multi-channel pulse width modulator (PWM) timer module with three complementary pairs or six independent PWM outputs supporting dead-band operation and fault protection trip input. These features provide multiphase control capability for a variety of motor types and ensure safe operation of the motor by providing Pulse-by-Pulse or latched fast shutdown of the PWM pins during fault condition.

The Z16FMC Series also features up to twelve single-ended channels of 10-bit analog-to-digital conversion with a sample and hold circuit plus one operational amplifier for current sampling and one comparator for over-current limiting or shutdown.

A high-speed analog-to-digital converter (ADC) enables voltage, current and back-EMF sensing, while dual-edge interrupts and a 16-bit timer provide a Hall-effect sensor interface.

Two full-duplex 9-bit UARTs provide serial asynchronous communication and support the local interconnect network (LIN) serial communications protocol. The LIN bus is a cost-efficient Single Master, Multiple Slave organization that supports speeds up to 20 Kbps.

### Z16FMC Series Flash Microcontroller Key Features

- 16-bit optimized Single-Cycle CISC core
- Up to 128 KB of in-circuit programmable Flash memory
- Highly integrated Digital/Analog peripherals
  - Operational Amplifier
  - Analog Comparator
  - Internal Precision Oscillator
  - 4-Channel DMA Controller
  - 12-bit PWM module with three complementary pairs or six independent PWM outputs
- Flexible communication interface including a 9-bit UART with LIN & IrDA, I2C, ESPI
- 12-Channel, 10-bit ADC with a 2.1µs conversion time

### Z16FMC SERIES FLASH MICROCONTROLLER ADVANTAGES

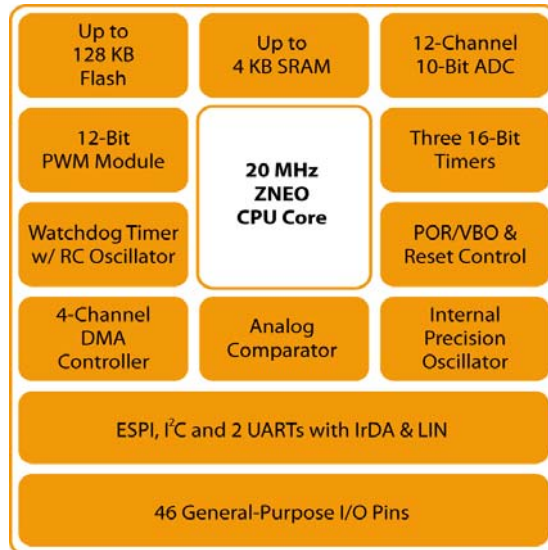
- EFFICIENT MOTOR CONTROL
- OUT-OF-BOX SOLUTION
- COST SAVINGS
- EXPANDABLE SYSTEM

**WIDE RANGE OF APPLICATION MODELS**

- LARGE APPLIANCES
- HVAC
- INDUSTRIAL
- POWER TOOLS
- AUTOMOTIVE

**ADDITIONAL INFORMATION**

- [WWW.ZILOG.COM](http://www.zilog.com)
  - Documentation
  - Additional Products

**Z16FMC Series Block Diagram****Z16FMC Core Features**

- Any register-to-any register architecture
- 20 MIPS throughput at 20 MHz
- 8-, 16-, and 32-bit ALU operations
- 16-bit bus widths
- Built-in 32 x 32 multiply operations (signed and unsigned)
- Built-in 64 by 32 divide (unsigned)
- Compiler friendly instruction set

**Z16FMC Flash Controller Detailed Feature Set****ZNEO<sup>®</sup> CPU Core**

Zilog's Z16FMC utilizes a ZNEO CPU which offers the highest level of performance and features in the FMC product family and provides support for more complex motor control applications. The ZNEO CPU features are as follows:

- Pipelined architecture: Fetch, Decode, and Execute
- 16 MB of Program memory address space for object code and data with 8- or 16-bit data paths
- 8-, 16-, and 32-bit ALU operations
- 24-bit stack with overflow protection
- Direct any register-to-any register architecture allows each memory address to function as an accumulator. This improves execution time and decreases the required program memory
- New instructions improve execution efficiency for code developed using higher-level programming languages including 'C'

**On-Chip Flash Memory**

The products in the Z16FMC Series feature up to 128 KB of non-volatile Flash memory with read/write/erase capability. The Flash memory is programmed and erased in-circuit by either user code or through the On-Chip Debugger (OCD). The Flash memory array is arranged in 2 KB pages. The 2 KB page is the minimum Flash block size that is erased. The Flash memory is also divided into eight sectors, which is protected from programming and erase operations on a per sector basis.

## Analog Peripherals

The Z16FMC Series devices include a 12-channel ADC. The ADC converts an analog input signal to a 10-bit binary number. The features of the successive approximation ADC include:

- 12 analog input sources multiplexed with GPIO ports.
- 2.5  $\mu$ s conversion time
- Automatic Time-Tag of results
- Programmable timing controls

The Z16FMC devices feature a general-purpose comparator and an operational amplifier.

- Moderate speed comparator (200 ns propagation delay) with a maximum input offset of 5 mV
- Two-input, one-output operational amplifier with a typical open loop gain of 10,000 (80 dB)

## Communication Peripherals

The Z16FMC devices feature a rich array of communication peripherals, including:

- UART
  - LIN Master/Slave
  - IrDA Encoder/Decoder
  - Multiprocessor 9-bit Mode
- Enhanced SPI (ESPI)
- I2C Master/Slave

## Flexible Timers

The Z16FMC Series contains three 16-bit reloadable timers used for timing, event counting, or generation of Pulse Width Modulator (PWM) signals. The timers include the following features:

- 3-Phase, 12-bit PWM with 6 outputs
- 3, 16-bit timers with 8 Modes
- Watchdog timer with RC Oscillator

## 4-Channel DMA Controller

The four DMA channels are used to transfer data from memory to memory, memory to peripherals, peripherals to memory, or peripherals to peripherals. The features of DMA controller include:

- Four independent DMA channels
- Direct and Linked List Modes
- Round-Robin Channel Priority
- Byte, word, or quad operation, up to 64K transfers (64 KByte, 64 KWord or 64 KQuad)

## Flexible Interrupt Control

The Z16FMC Series includes offers interrupt control flexibility including:

- 8 External Rising or Falling Edge
- 4 External Dual Edge
- Vectored or Polled Interrupts
- 24 Interrupts with 3 Programmable Priority Levels

### Internal Precision Oscillator

The Z16FMC incorporates a fully integrated Internal Precision Oscillator (IPO) that eliminates the need for external components. With nominal untrimmed accuracy of  $\pm 30\%$ , and the ability to manually trim the oscillator to achieve a  $\pm 4\%$  frequency accuracy over the operating temperature and supply voltage range of the device, the Z16FMC provides a best-in-class IPO feature set, including:

- On-chip RC oscillator which does not require external components
- Nominal  $\pm 30\%$  accuracy without trim or manually trim the oscillator to achieve a  $\pm 4\%$
- Typical output frequency of 5.5296 MHz or 32 kHz
- Trimming possible through Flash option bits with user override
- Eliminates crystals/ceramic resonators in applications where high timing accuracy is not required

### Single-Pin On-Chip Debug

All of Zilog's embedded Flash devices offer a uniquely integrated On-Chip Debugger (OCD) that provides the following advanced features:

- Only 1 pin, frees up other pins
- Unlimited Software Breakpoints
- 4 Hardware Breakpoints
- In-Circuit Flash Programming
- Instruction Execution Trace

### Z16FMC Development Tool Support

The Z16FMC devices are backed by a comprehensive development tools package that includes all the necessary design essentials to get your Motor Control application up and running.

- Z16FMC Series Development Board
- USB Opto-Isolated Smart Cable for PC to Z16FMC Series
- 5 V DC power supply
- 3 Phase Motor Control Application Board

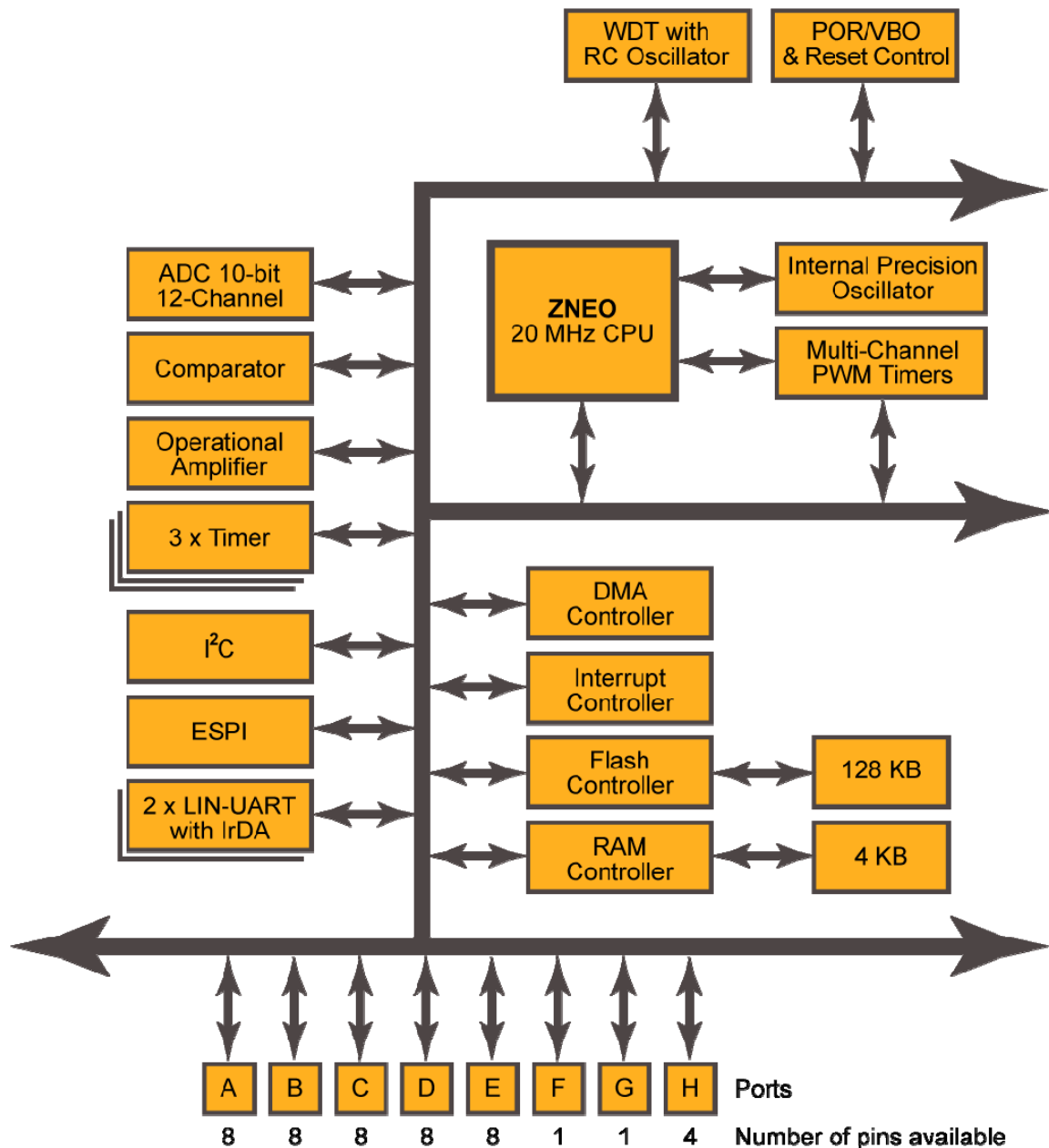
The Z16FMC Series is also supported by ZDS II—Zilog's Integrated Development Environment (IDE) with ANSI C-Compiler (available on [www.zilog.com](http://www.zilog.com)). The ZDS II IDE includes:

- Sample Code
- Product Specifications (Data Sheets)
- Product Briefs
- ZNEO® CPU User Manual

#### Hardware Tools & Part Number Ordering Information

- Z16FMC Series Motor Control Development Kit (part #: Z16FMC28200KITG)
- Opto-Isolated USB Smart Cable Accessory Kit (part #: ZUSBOPTSC01ZACG)

### Z16FMC Design Architecture



## Ordering Information

Order the Z16FMC Series of Flash Microcontrollers from your local Zilog sales representative using the following guide.

Part Number	Flash (KB)	SRAM (KB)	GPIO	Package	Temperature
Z16FMC28AG20SG	128	4	46	64-pin LQFP	0°C to 70°C
Z16FMC28AG20EG	128	4	46	64-pin LQFP	-40°C to 105°C
Z16FMC64AG20SG	64	4	46	64-pin LQFP	0°C to 70°C
Z16FMC64AG20EG	64	4	46	64-pin LQFP	-40°C to 105°C
Z16FMC32AG20SG	32	2	46	64-pin LQFP	0°C to 70°C
Z16FMC32AG20EG	32	2	46	64-pin LQFP	-40°C to 105°C

For more information about products, system evaluation calculation tools, and product collateral, please visit us at [www.zilog.com](http://www.zilog.com), where you can also find sales office locations and the most current product information on our website. Or, consult your local Zilog representative.

## Documentation

For a complete listing of all available application notes, data sheets, user manuals, and sample libraries, please visit us at [www.zilog.com](http://www.zilog.com).

Document Number	Description
PS0287	Z16FMC Series Motor Control MCUs Product Specification
QS0079	Z16FMC Series Motor Control Development Kit Quick Start Guide
UM0234	Z16FMC Series Motor Control Development Kit User Manual
CS0009	AC Induction and Brushless DC Motor Control Cut Sheet
AN0311	Sensorless Brushless DC Motor Control with the Z16FMC MCU





## Warning: DO NOT USE IN LIFE SUPPORT

### LIFE SUPPORT POLICY

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