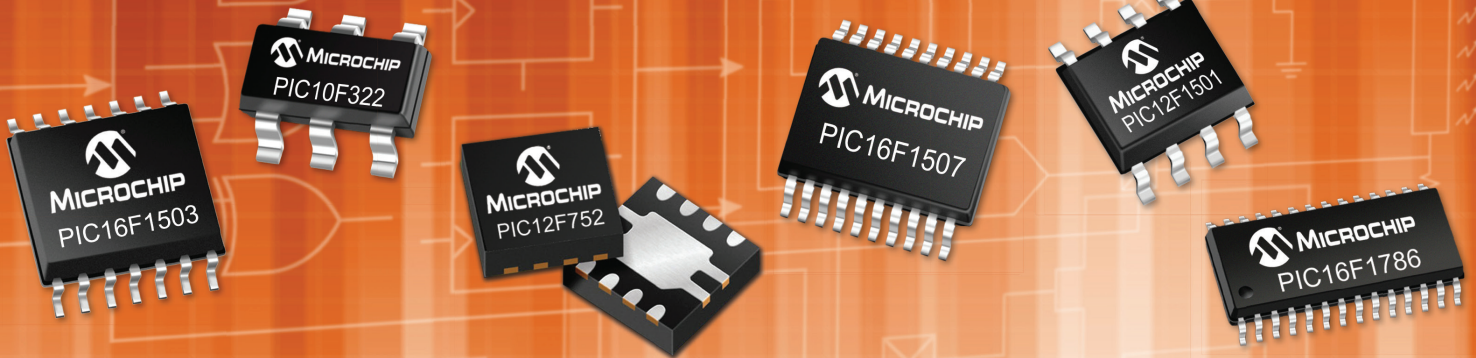# MICROCHIP

Core Independent Peripherals
For 8-bit PIC® Microcontrollers

Unique Integrated Peripherals for 8-bit PIC Microcontrollers

8-bit MCUs featuring
Core Independent Peripherals

PIC10F322

PIC16F1503

PIC12F752

PIC16F1507

PIC12F1501

PIC16F1786

Configurable Logic Cell (CLC)
Integrated combinational and sequential logic

Complementary Waveform/Output Generator (CWG/COG)
Flexible input source waveform generator for power & motor control

Numerically Controlled Oscillator (NCO)
Linear PWM frequency control for lighting & power control

Programmable Switch Mode Controller (PSMC)
Advanced 16-bit PWM for power, motor & lighting control

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8-bit Peripheral Highlights

Overview

Microchip is the leader in 8-bit microcontrollers by continually investing and expanding upon the PIC® microcontroller line-up. Emphasis is persistently focused on reducing costs while developing products with a strong mix of peripherals such as LCD drive, PWM, ADC, comparators, timers and communication. Beyond standard peripherals, Microchip is constantly bringing additional value to PIC microcontrollers by developing unique and exclusive peripherals. These unique peripherals allow embedded engineers to simplify their designs and create ever more creative applications and products. This innovation is demonstrated by some of the following PIC microcontroller integrated peripherals.

| | | Flash | RAM | Pins | I/O | ADC | | | Comp | DAC | | | EUSART | I²C™/SPI | USB | Timers | | PWM* | MAX PWM Channels** | New Peripherals | | | | | Availability |
						8-bit	10-bit	12-bit		5-bit	8-bit	9-bit				8-bit	16-bit			CLC	NCO	CWG/COG	PSMC	HRPWM***	
Low Pin Count	PIC10(L)F320	448	64	6	4	3	–	–	–	–	–	–	–	–	–	2	–	2	4	1	✓	✓	–	✓	Now
	PIC10(L)F322	896	64	6	4	3	–	–	–	–	–	–	–	–	–	2	–	2	4	1	✓	✓	–	✓	Now
	PIC12(L)F1501	1.75K	64	8	6	–	4	–	1	1	–	–	–	–	–	2	1	4	6	2	✓	✓	–	✓	Now
	PIC16(L)F1503	3.5K	128	14	12	–	8	–	2	1	–	–	–	✓	–	2	1	4	7	2	✓	✓	–	✓	Now
	PIC16(L)F1507	3.5K	128	20	18	–	12	–	2		–	–	–	–	–	2	1	4	7	2	✓	✓	–	✓	Now
	PIC16(L)F1508	7K	256	20	18	–	12	–	2	1	–	–	✓	✓	–	2	1	4	7	4	✓	✓	–	✓	Now
	PIC16(L)F1509	14K	512	20	18	–	12	–	2	1	–	–	✓	✓	–	2	1	4	7	4	✓	✓	–	✓	Now
USB	PIC16(L)F1455	8K	1K	14	11	–	5	–	2	1	–	–	✓	✓	✓	2	1	2	4	–	–	✓	–	–	Now
	PIC16(L)F1459	8K	1K	20	17	–	9	–	2	1	–	–	✓	✓	✓	2	1	2	4	–	–	✓	–	–	Now
Intelligent Analog	PIC12F752/HV752	1K	64	8	6	–	4	–	2	1	–	–	–	–	–	3	–	1	3	–	–	✓	–	–	Now
	PIC16F753/HV753	2K	128	14	12	–	8	–	2	–	–	1	–	–	–	4	–	1	3	–	–	✓	–	–	Q2 '13
	PIC16(L)F1782	2K	256	28	25	–	–	11	3	–	1	–	✓	✓	–	2	1	4	10	–	–	–	2	–	Now
	PIC16(L)F1783	4K	512	28	25	–	–	11	3	–	1	–	✓	✓	–	2	1	4	10	–	–	–	2	–	Now
	PIC16(L)F1784	4K	512	44	36	–	–	14	4	–	1	–	✓	✓	–	2	1	6	17	–	–	–	3	–	Q2 '13
	PIC16(L)F1786	8K	1K	28	25	–	–	11	4	–	1	–	✓	✓	–	2	1	6	17	–	–	–	3	–	Q2 '13
	PIC16(L)F1787	8K	1K	44	36	–	–	14	4	–	1	–	✓	✓	–	2	1	6	17	–	–	–	3	–	Q2 '13
	PIC16(L)F1788	16K	2K	28	25	–	–	11	4	3	1	–	✓	✓	–	2	1	7	17	–	–	–	4	–	Q2 '13
	PIC16(L)F1789	16K	2K	44	36	–	–	14	4	3	1	–	✓	✓	–	2	1	7	17	–	–	–	4	–	Q2 '13

*PWM inclusive of PWM, CCP, ECCP and PSMC.
**Total PWM channels is the sum of external channels available via PWM, CCP, ECCP, HRPWM, CWG, COG and PSMC.
***HRPWM available via implementation of CLC and NCO, please see app note AN1476.

Development Support

Development Boards

|	PIC10F32X	PIC12F150X	PIC16F150X	PIC16F145X	PIC12F752	PIC16F753	PIC16F178X
PICDEM™ Lab Development Kit (DM163045)	–	✓	✓	✓	✓	✓	✓
PICkit™ Low Pin Count Development Board (DM164130-9)	–	✓	✓	✓	✓	✓	–
PIC10F32X Development Board (AC103011)	✓	–	–	–	–	–	–
PIC10F32X Debug Extension Pak (AC244045)	✓	–	–	–	–	–	–
Low Pin Count USB Development Board (DM164127)	–	–	–	✓	–	–	–
PICkit™ 28-pin Demo Board (DM164120-3)	–	–	–	–	–	–	✓

Programmer/Debuggers

- PICkit 3 (PG164130)
- MPLAB® ICD 3 (DV164035)
- MPLAB REAL ICE™ In-Circuit Debugger (DV244005)
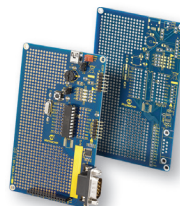
IDE/Compiler

- MPLAB X IDE
- MPLAB XC8 Compiler
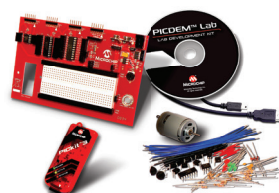
PICDEM™ Lab Development Kit
(DM163045)
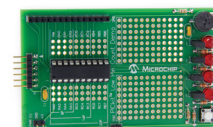
PICkit Low Pin Count
Development Board
(DM164130-9)

Low Pin Count USB
Development Board
(DM164127)

PIC10F32X Development Board
(AC103011))

8-bit Peripheral Highlights

Configurable Logic Cell (CLC)
Easily Create Custom Combination and Sequential Logic

Key Features

- User configurable real time logic control
  - CLC configuration GUI for quick turn development
- Combinational Logic Functions
  - AND/OR/XOR/NOT/NAND/NOR/XNOR
- State Functions/Clock
  - D Flip-Flop, JK Flip-Flop D Latch, SR Latch
- Input sources
  - Pins
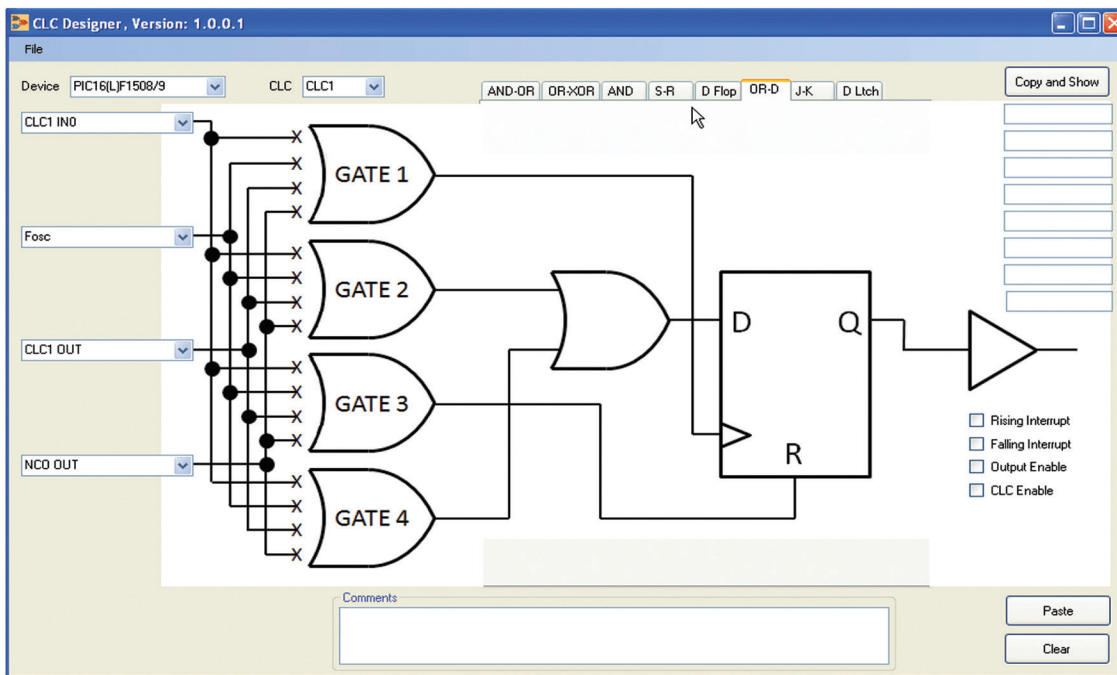 - Peripherals
- Output available to:
  - External pins
  - Other peripherals
- Operation while in Sleep

Benefits

- Increases on chip interconnection of peripherals and I/O
- Integrates hardware functions and saves board space
- Software control of Combinational/Sequential Logic
- Saves program code space and frees up CPU cycles

Example Applications

- Data modulation
- Power sequencing
- Manchester/IrDA encoder
- Event sequencing
- Conditional signaling
- General purpose logic
- Customizable circuitry

CLC Designer: GUI to Simplify Design

Example: Phase Shifted Data Modulator
Combinational and Sequential logic can easily be designed using on-chip hardware.
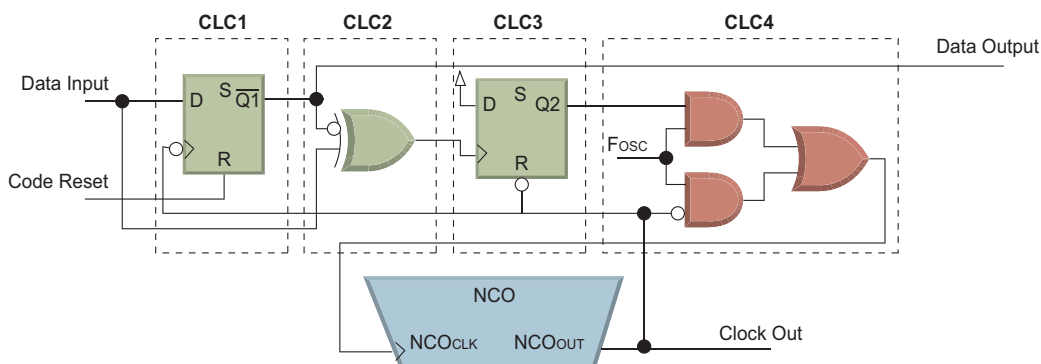
8-bit Peripheral Highlights

Complementary Waveform Generator (CWG), Complimentary Output Generator (COG)

Key Features
- Provides non-overlapping complementary waveform
- Various input sources inclusive of:
  - Comparators, PWM, CLC, NCO
- Blanking control for transient filtering **(1)** (available with COG)
- Phase control for output delay **(2)** (available with COG)
- Independent rise and fall **(3)**/**(4)**
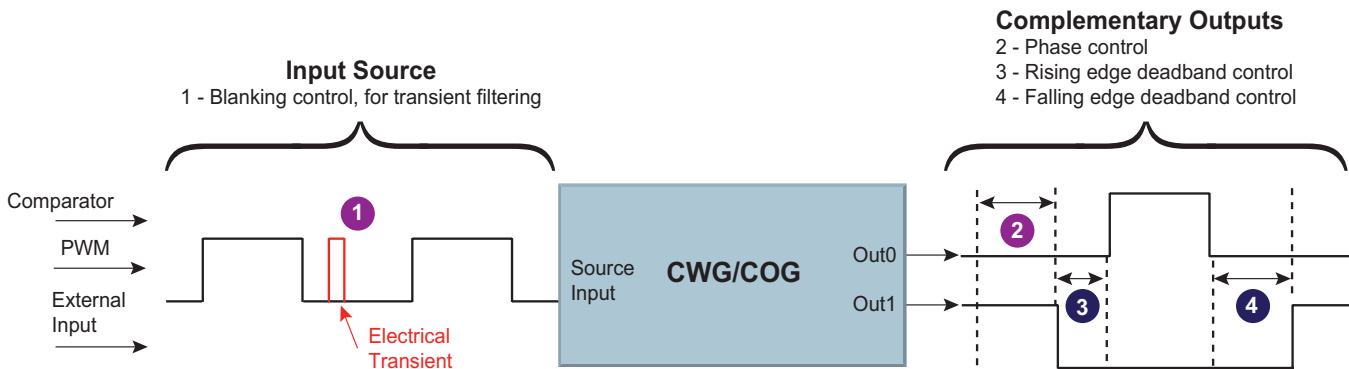- Dead band control
- Auto shutdown/restart
- Polarity control

Benefits
- Works with multiple peripherals
- Fewer components and less space
- Lower power
- Improved switching efficiencies

Example Applications
- Switch mode power supplies
- LED/fluorescent lighting
- Battery charger
- Motor drive
- Power factor correction
- Class D audio amplifiers

Complementary Output Generator (COG)

Input Source
1 - Blanking control, for transient filtering

Complementary Outputs
2 - Phase control
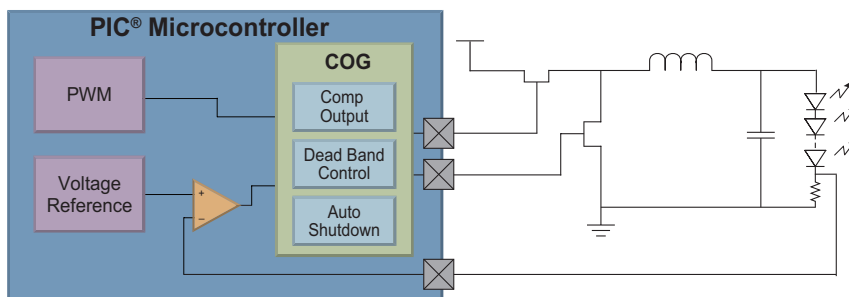3 - Rising edge deadband control
4 - Falling edge deadband control

Example: Half Bridge Circuit Using CWG,
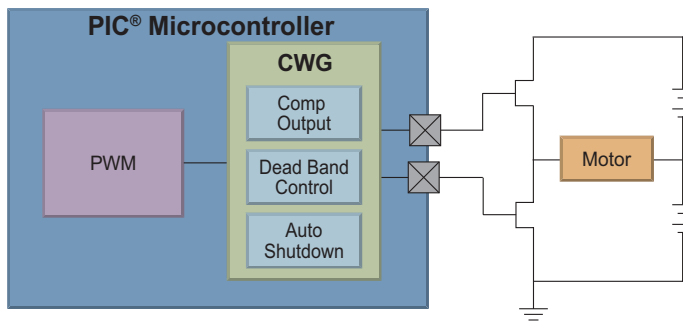
- Automates generation of the complementary waveforms necessary for Half Bridge control
- Programmable dead band control to protect against shoot through
- Auto Shutdown can be based on external inputs, software, CLC, or other peripherals
- Programmable blanking control available to filter out transient inputs

Example: LED Buck Converter

- Switching frequency determined by the PWM
- Enables synchronous switching, increasing power conversion efficiency
- Programmable dead band control protects the synchronous switches against shoot through
- Advanced features to provide auto shutdown, auto restart, and polarity control

8-bit Peripheral Highlights

Numerically Controlled Oscillator (NCO)
### *Oscillator Capabilities with True Linear Frequency Control*

Key Features
- Up to 20-bit frequency resolution
- Multiple internal and external clock sources available
- 16b numeric frequency control
  - 625 kHz max output with 20MHz oscillator
  - 0.03 Hz min step size with 31kHz internal oscillator
- 2 Output modes
  - Fixed 50% Duty Cycle
  - Pulse Frequency Modulation (PFM)

Benefits
- True linear frequency control
- Increased frequency resolution

Example Applications
- Fluorescent ballast and LED lighting control
- Motor drivers
- Modems
- Class D audio amplifiers
- Ultrasonic ranging
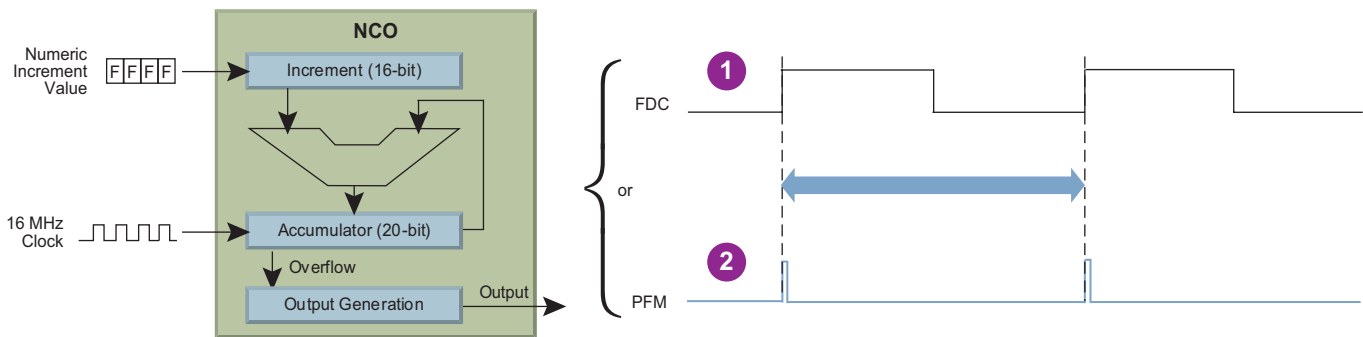
Example: Fluorescent Lighting Control
- Use the NCO to create linear frequencies for start-up and dimming control
- Lower power and extend life of fluorescent bulb

NCO provides linear control over entire range
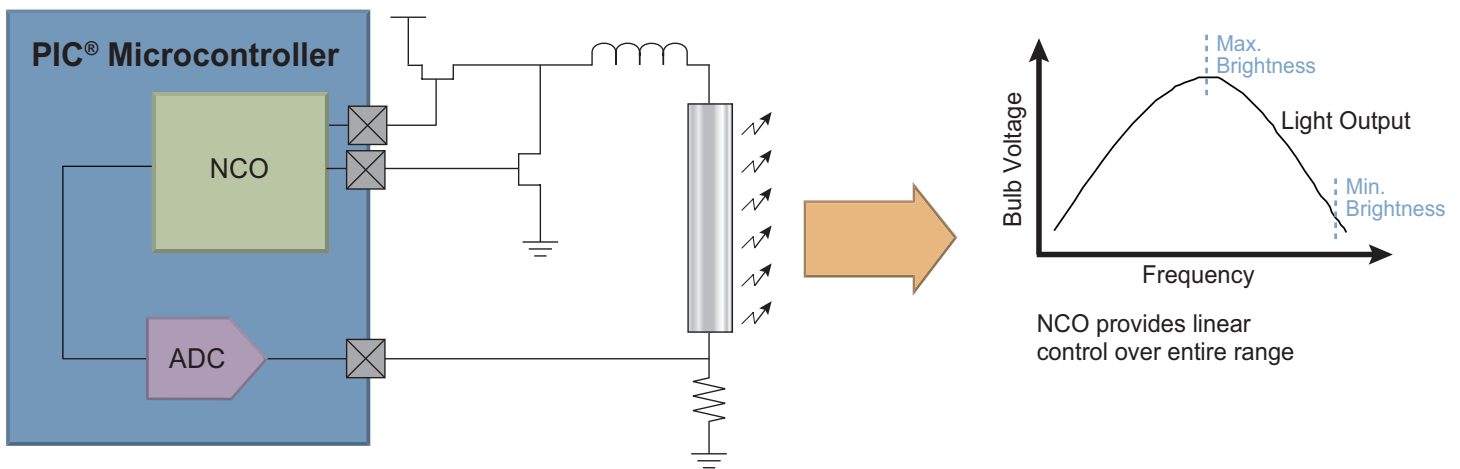
8-bit Peripheral Highlights

High Resolution PWM (HRPWM)
Full Range PWM Resolution at High Frequency

Key Features
- Enables high switching frequency designs
- Variable PWM resolution
- Up to 17 bits effective resolutions at 500 kHz

Benefits
- Reduced sizing of inductors and capacitors
- Reduced BOM cost and improved EMI
- Precision LED color mixing, smooth diming and brightness control
- Higher efficiency power conversion designs

Example Applications
- Power supplies
- DC/DC converters
- LED lighting/color mixing
- Motor control
- Flourescent ballast
- Resonant power supply

HRPWM
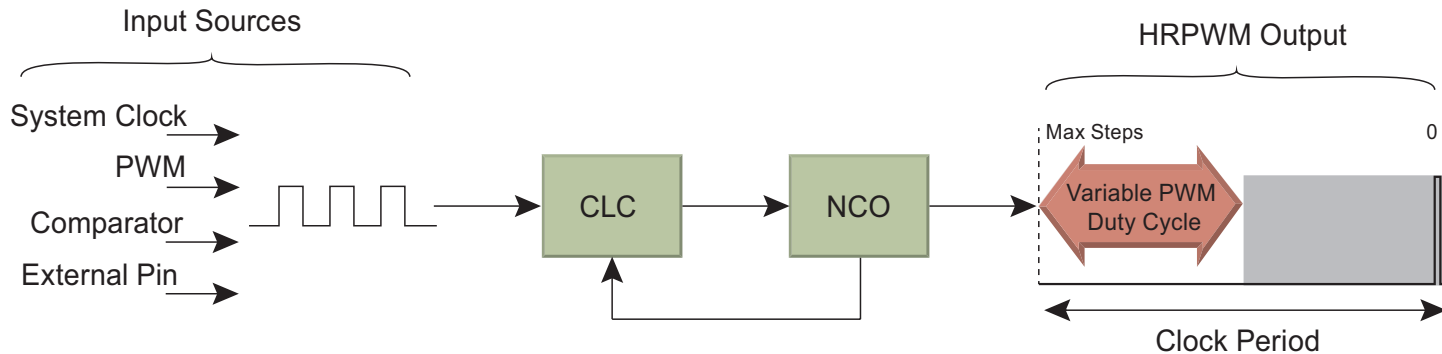
17-bit PWM
Max # Steps = 2^{17} = 131,072

Conventional PWM vs. HRPWM

	Conventional PWM	HRPWM
PWM Resolution	16b	Variable
PWM Clock Frequency	16 MHz	16 MHz
Target Switching Frequency	500 kHz	500 kHz
Target Period Width	1 ÷ 500 kHz = 2 µs	1 ÷ 500 kHz = 2 µs
Best PWM Pulse Adjustment	1 ÷ 16 MHz = 62.5 ns	15.26 ps*
Maximum Number of Steps per Period	2 µs ÷ 62.5 ns = 32	2 µs ÷ 15.26 ps = 131,072
Effective Full Range PWM Resolution	$\log_2 32$ = 5 bits	$\log_2 131{,}072$ = 17 bits

*Reference application note AN1476 for calculation

8-bit Peripheral Highlights

Programmable 16-bit Switch Mode Controller (PSMC)
Advanced PWM Capabilities and Integrated Analog Enabling High Performance with Minimal External Circuitry CPU Bandwidth

Key Features
- Various clock sources: external, system clock, independent 64 MHz
- Various input sources: comparators, external pins
- Blanking control for transient filtering
- Single 16-bit PWM
  - With up to 6 steerable outputs
- Complementary 16-bit PWM
  - With up to 3 steerable output pairs
- Independent rising/falling edge control
- Dead band with independent rise and fall control
- Polarity control/auto shutdown and restart
- Flexible PWM output modes:
  - Push/pull, pulse skipping, 3-phase, fixed duty cycle, brushed DC with forward/reverse
- Output gating: externally controlled activate/deactivate

Benefits
- Customizable high speed PWM with increased resolution and control
- Simplifies the implementation of applications such as: motor control, lighting and power supplies

Example Applications
- Power Supplies / Conversion
  - DC/DC (power bricks), Power factor correction
- Lighting
  - LED, Backlighting, Automotive, HID, Lamp Ballast
- Motor Control
  - BLDC, AC induction, 3 Phase
- Battery Charging / Monitoring
- General purpose applications requiring high resolution PWM

Example: Buck Converter Driving LED Array
- High Efficiency closed-loop control with fast switching speeds
- Cost effective integration enabling significant BOM reductions
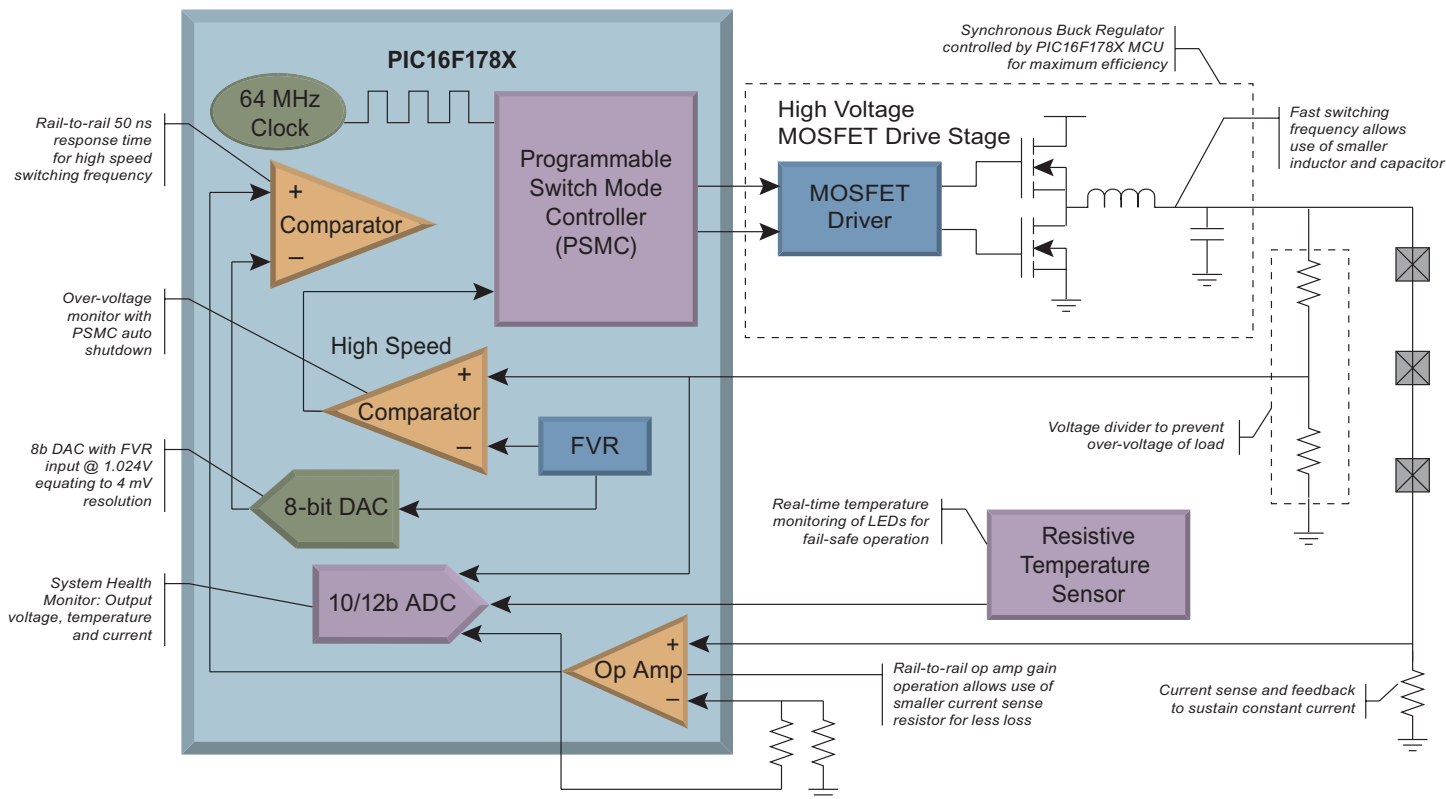
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