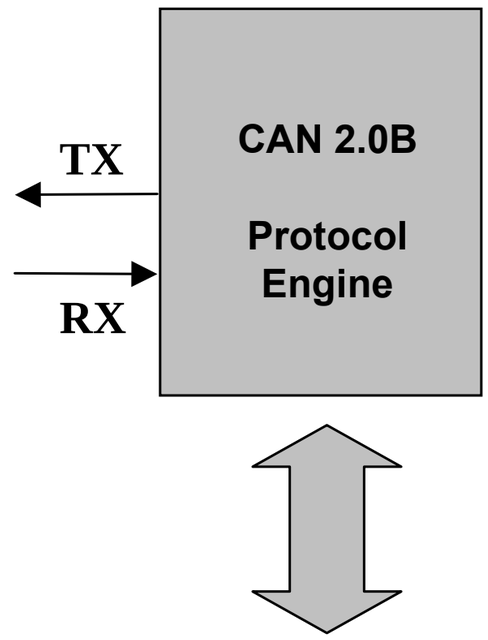
Introduction to ECAN

ECAN™ Module Overview

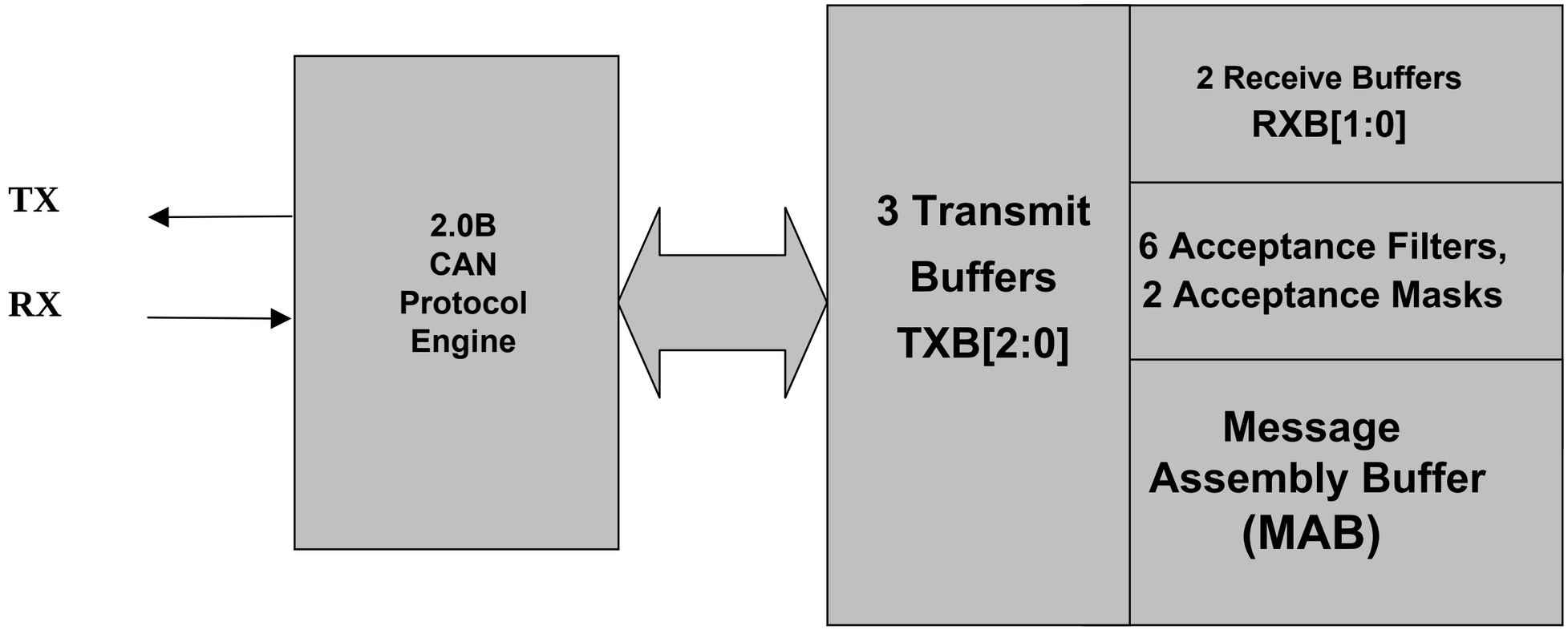
- **E**nhanced **C**ontrolled **A**rea **N**etwork (ECAN)
- CAN 2.0B Active (11- & 29-bits identifiers)
  - Fully backward compatibility
  - Additional functionality and features
    - 3 separate operating mode
    - Additional buffer/filter resources
- DeviceNet™, Auto RTR support



ECAN Interface		
Mode 0: Legacy **Backward compatible**	**Mode 1: Enhanced Legacy** **Added Resources**	**Mode 2: FIFO** **HW Circular Receive FIFO**

ECAN™ Module
Mode 0: Legacy Mode

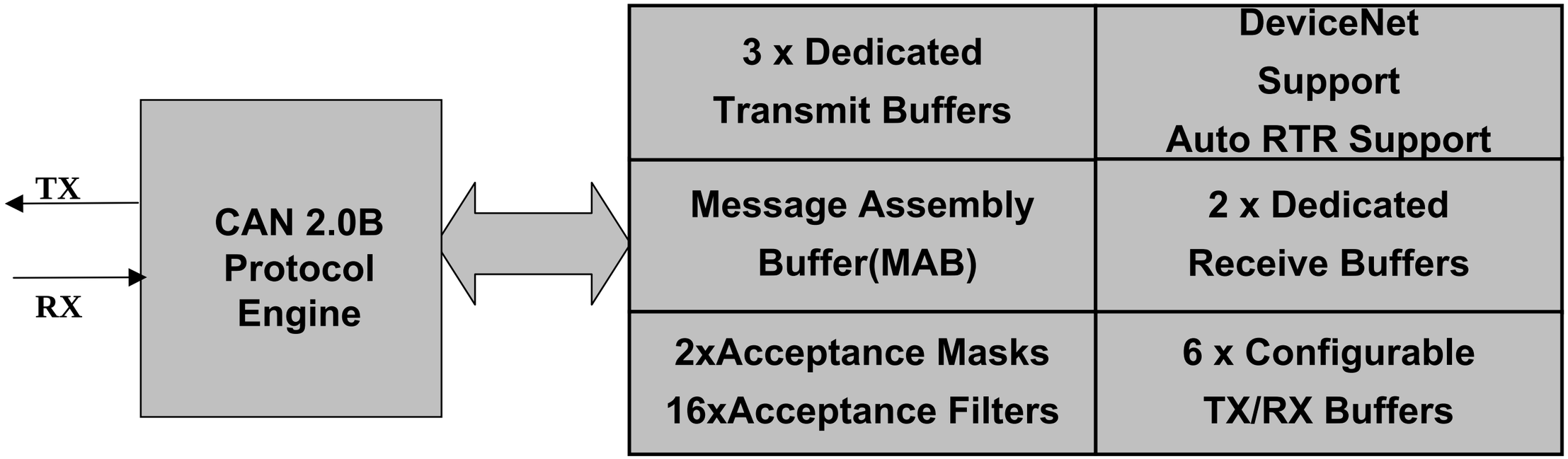
- Mode 0: Legacy Mode



- 100% Backward Compatible !

ECAN™ Module
Mode 1: Enhanced Mode

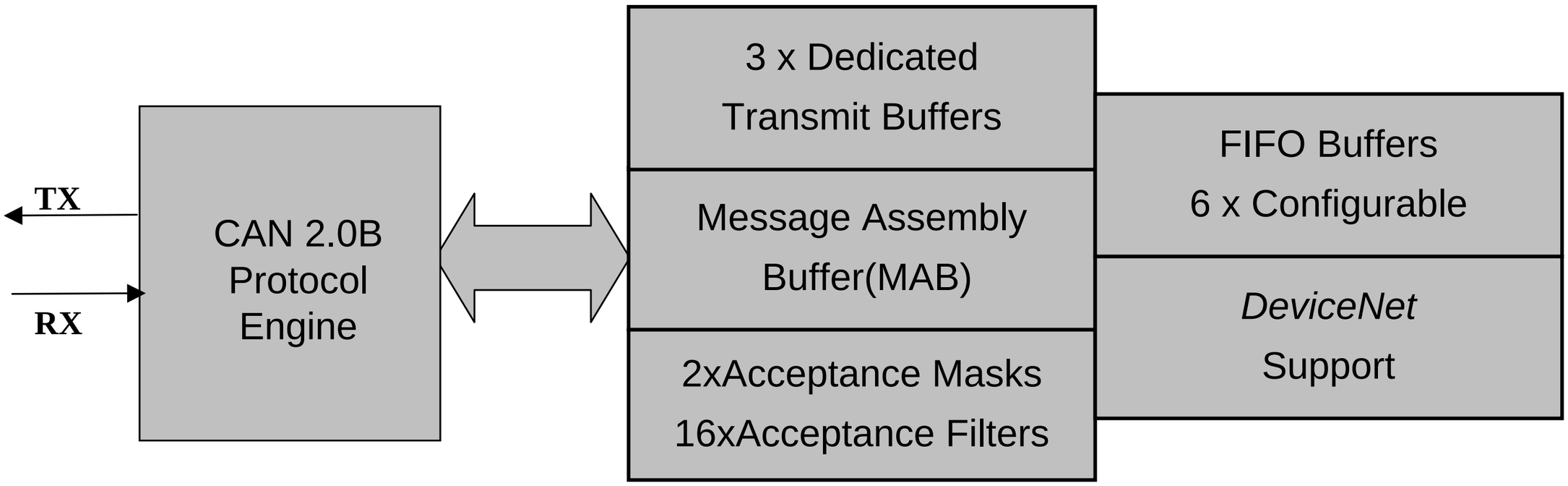
- Mode 1: Enhanced Mode



- Enhanced Mode Features:
  - Additional Buffers with a flexible configuration scheme
  - Additional Full 29-bit Filters
  - *DeviceNet*™ Support (Data Byte Filter Support)
  - Automatic RTR handling function

ECAN™ Module
Mode 2: FIFO Mode

- Mode 2: FIFO Mode



- FIFO Mode Features:
  - Up to 8 level deep circular receive FIFO
  - 6 FIFO registers can be configured as TX or RX FIFO
  - *DeviceNet*™ Support

Products

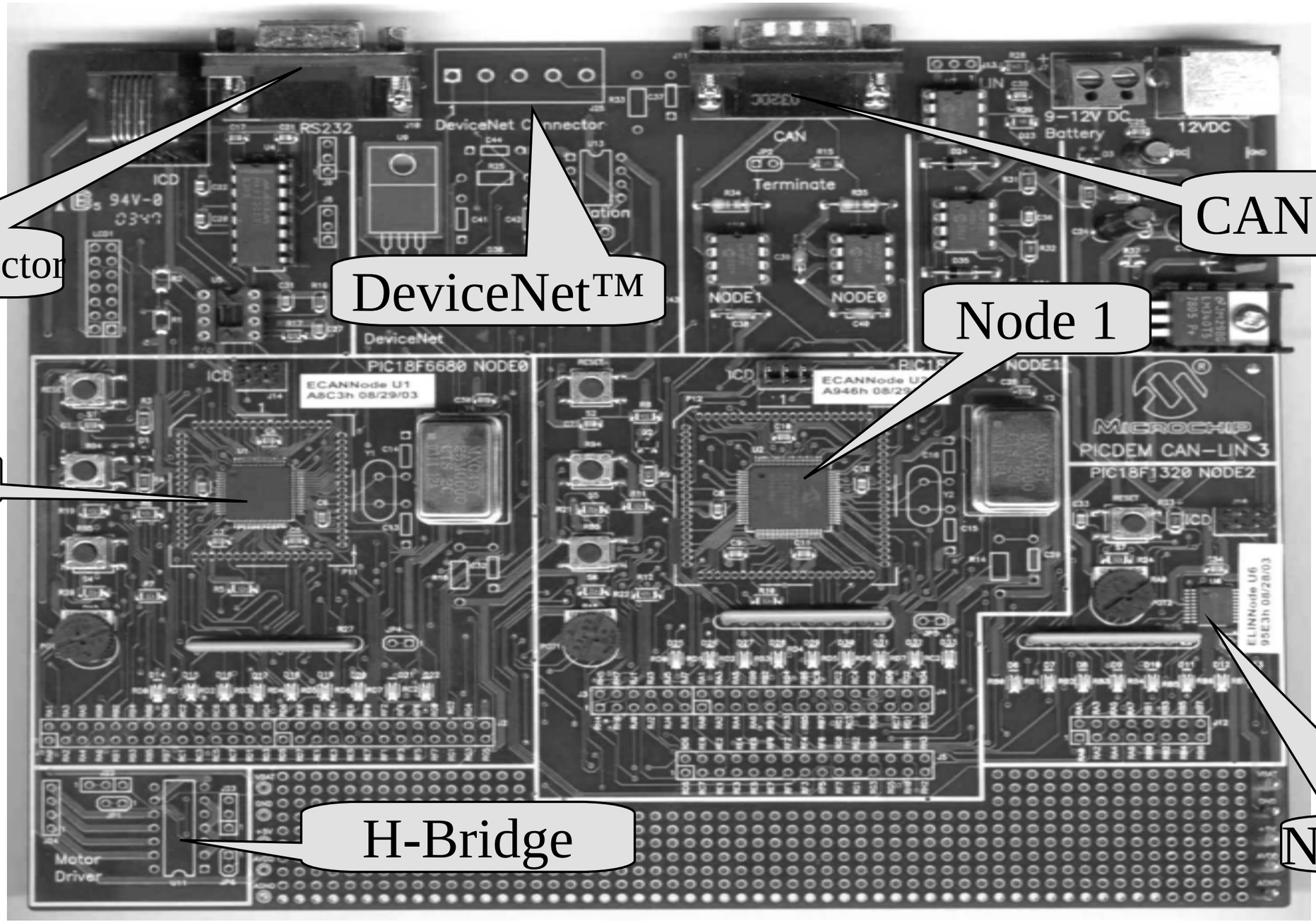
- PIC18F2480/2580/2585/2680
  - PM:16/32/48/64 KBytes
  - DM:786/1536/3328/3328 bytes
  - EE:256/1024 Bytes
  - 28Pin PDIP,28Pin SOIC
- PIC18F4480/4580/4585/4680
  - PM:16/32/48/64 KBytes
  - DM:786/1536/3328/3328 bytes
  - EE:256/1024 Bytes
  - 40Pin PDIP,44Pin TQFP,8x8 QFN
- PIC18F6585/6680
  - PM:48/64 KBytes
  - DM:3328 Bytes
  - EE:1024 Bytes
  - 64Pin TQFP,68Pin PLCC
- PIC18F8585/8680
  - PM:48/64 Kbytes
  - PM:3328 Bytes
  - EE:1024 Bytes
  - 80Pin TQFP
- Peripheral Feature
  - Analog
    - 10-Bit ADC up to 16ch
    - 2xComparators
  - Communication
    - EUSART (LIN)
    - SPI / I^2C
    - Parallel Slave Port
    - *ECAN*
  - Timers
    - 3x16, 1x8 Bits
    - 1xCCP & 1

Summary

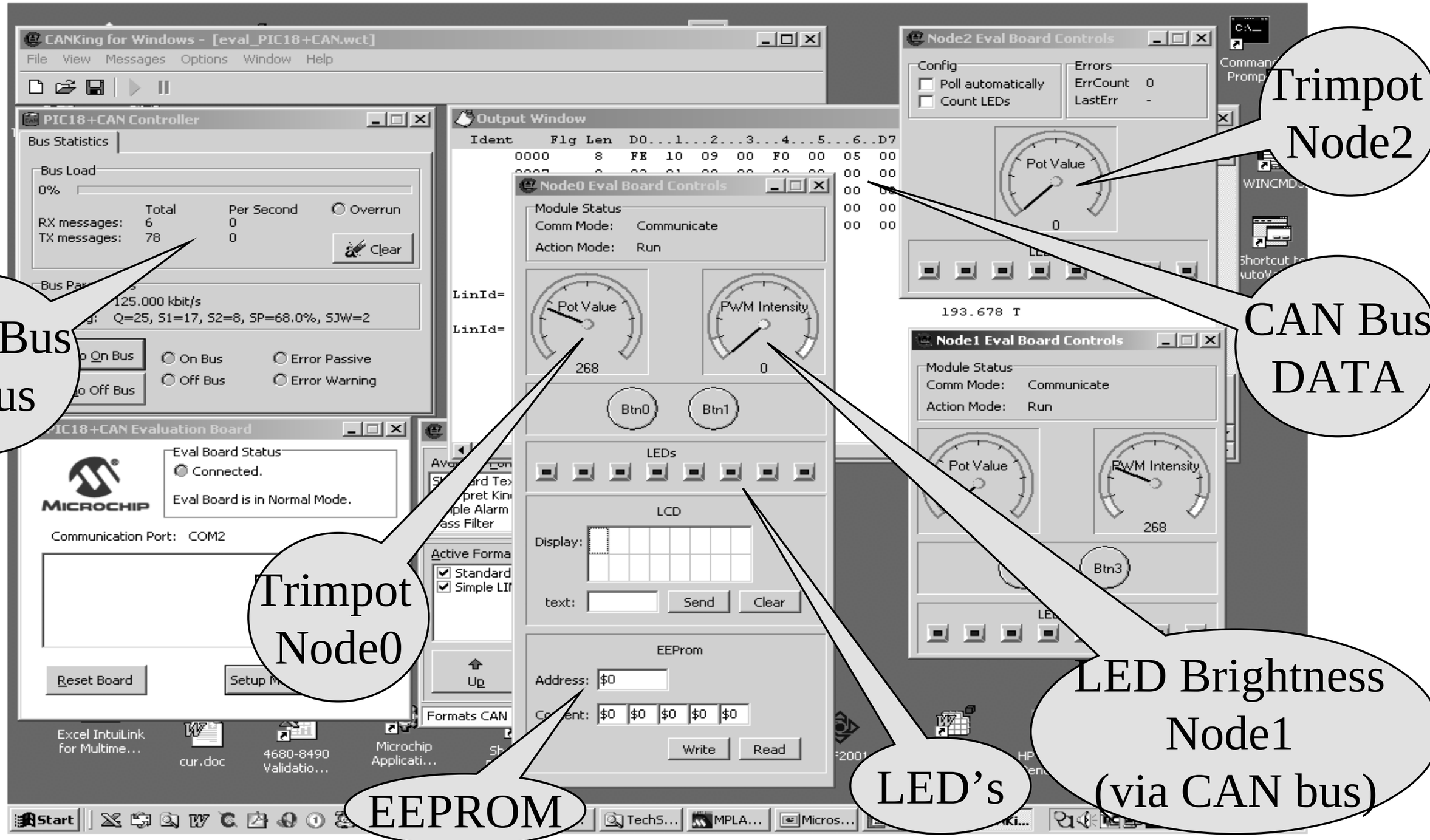
Message bit rates up to 1 Mbps

- Conforms to CAN 2.0B ACTIVE Specification
- Fully backward compatible with PIC18XXX8 CAN modules
- Three modes of operation:
  - Legacy, Enhanced Legacy, FIFO
- Three dedicated transmit buffers with prioritization
- Two dedicated receive buffers
- Six programmable receive/transmit buffers
- Three full 29-bit acceptance masks
- 16 full 29-bit acceptance filters with dynamic association
- DeviceNet™ data byte filter support
- Automatic remote frame handling
- Advanced Error Management features

Development Tool



Development Tool

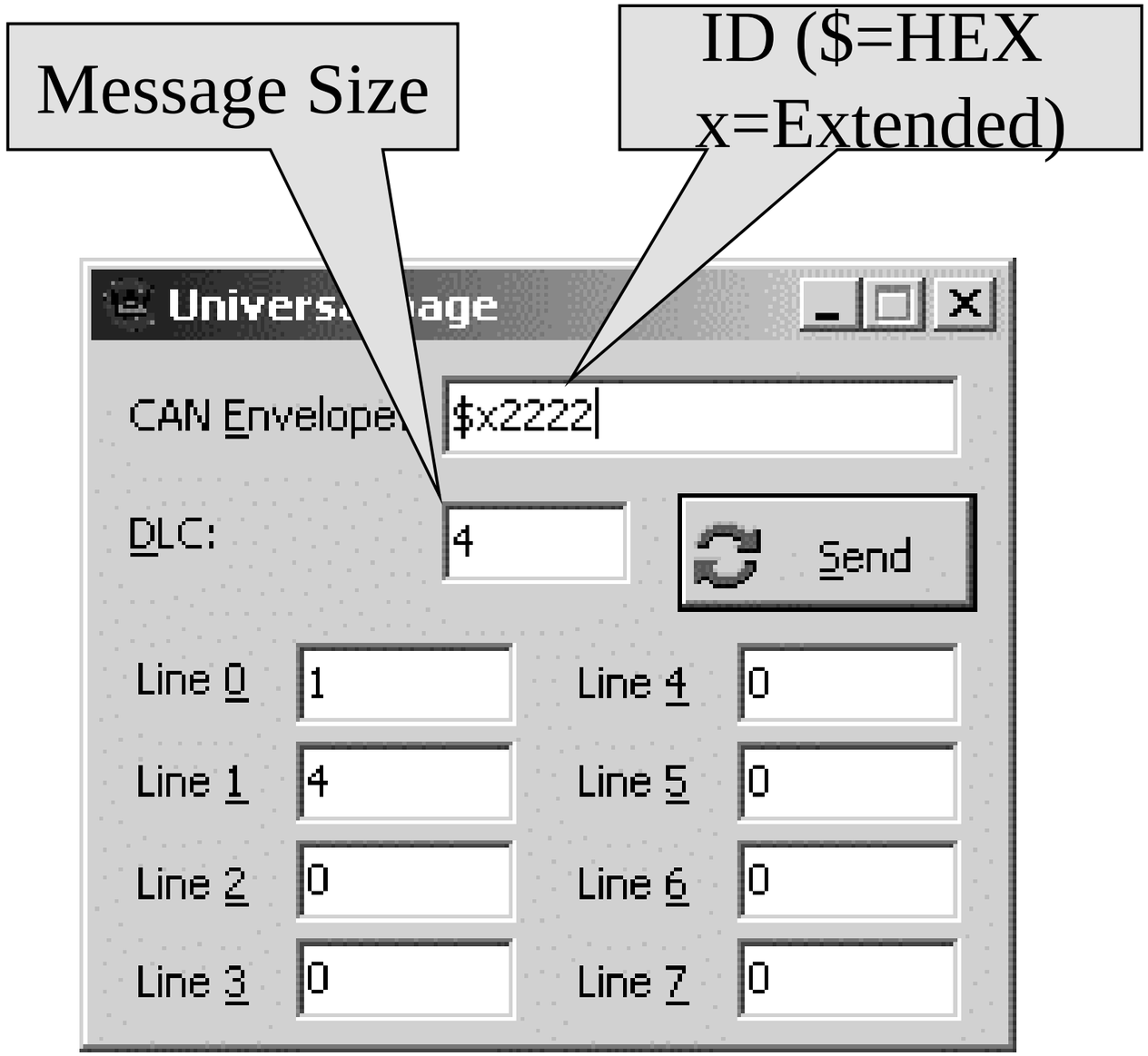


Development Tool

Output Window

Ident	Flg	Len	D0	1	2	3	4	5	6	D7	Time	Dir
103		1	2								0.618	R
103		1	2								27.210	R
9028	X	4	1	4	0	0					99.064	T
8738	X	4	1	4	0	0					14.823	T

8738=2222h
x=extended message ID
lengh=4
data = 1,4,0,0
Time = Time Stamp of the message
Dir = T = Transmitted



Application note

- AN212 Smart Sensor CAN Node using the MCP2510 and PIC16F876
- AN215 A Simple CAN Node using the MCP2510 and PIC12C67X
- AN228 A CAN Physical Layer Discussion
- AN247 A CAN Bootloader for PIC18F CAN Microcontrollers
- AN713 An introduction to the CAN protocol that discusses the basics and key features.
- AN730 CRC Generating and Checking
- AN733 Using the MCP2510 CAN Developer's Kit
- AN738 PIC18C CAN Routines in 'C'
- AN739 An In-depth Look at the MCP2510
- AN754 Understanding Microchip's CAN Module Bit Timing
- AN816 A CAN System Using Multiple MCP25050 I/O Expanders
- AN819 Implementing Bootloader Firmware Application Note
- AN853 PIC18XXX8 CAN Driver with Prioritized Transmit Buffer
- AN872 Upgrading from the MCP2510 to the MCP2515
- AN873 Using the MCP2515 CAN Developer's Kit
- AN877 DeviceNet™ Group 2 Slave Firmware for PIC18 with CAN
- AN878 PIC18C ECAN 'C' Routines
- AN930 J1939 C Library for CAN-Enabled PICmicro® Microcontrollers
- TB078 PLL Jitter and Its Effects in the CAN Protocol

Introduction to ZigBee™

ZigBee™ and Other Protocols

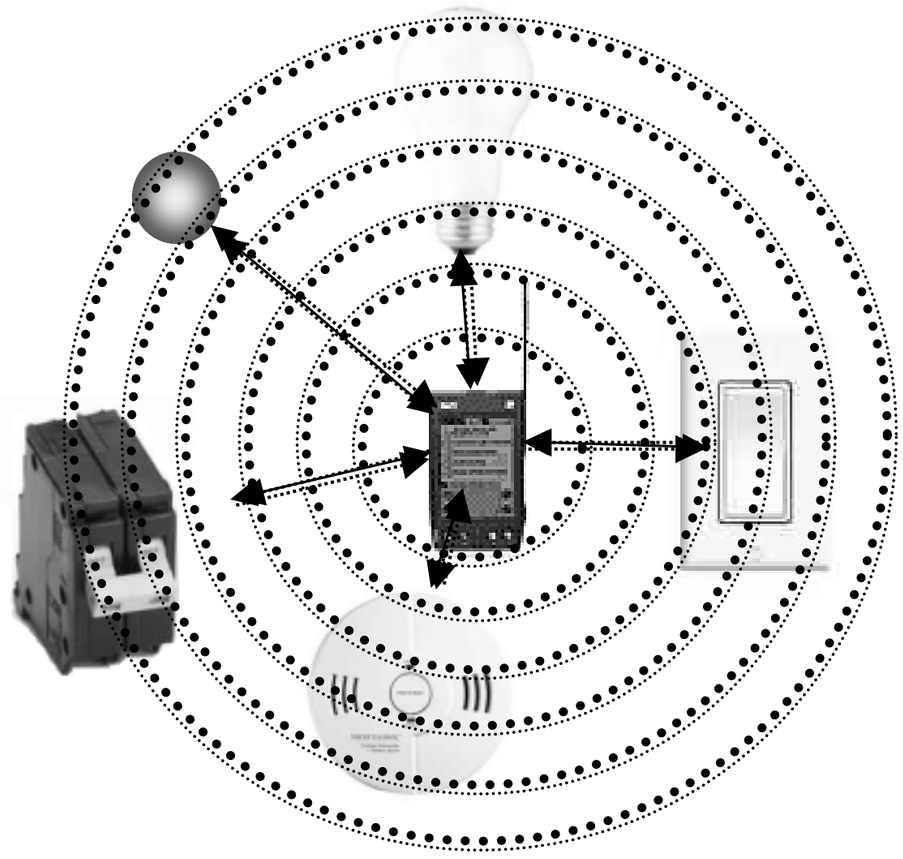
- Standard wireless network stack
  - Defined by ZigBee Alliance
  - Network, Application, Security Layer
  - Based on IEEE 802.15.4 MAC+PHY
- Low cost (< $10, 14-20KB)
- Low power (low duty cycle)
- Short range network~100m+

- Flexible data transfer
  - Key-Value and Message based

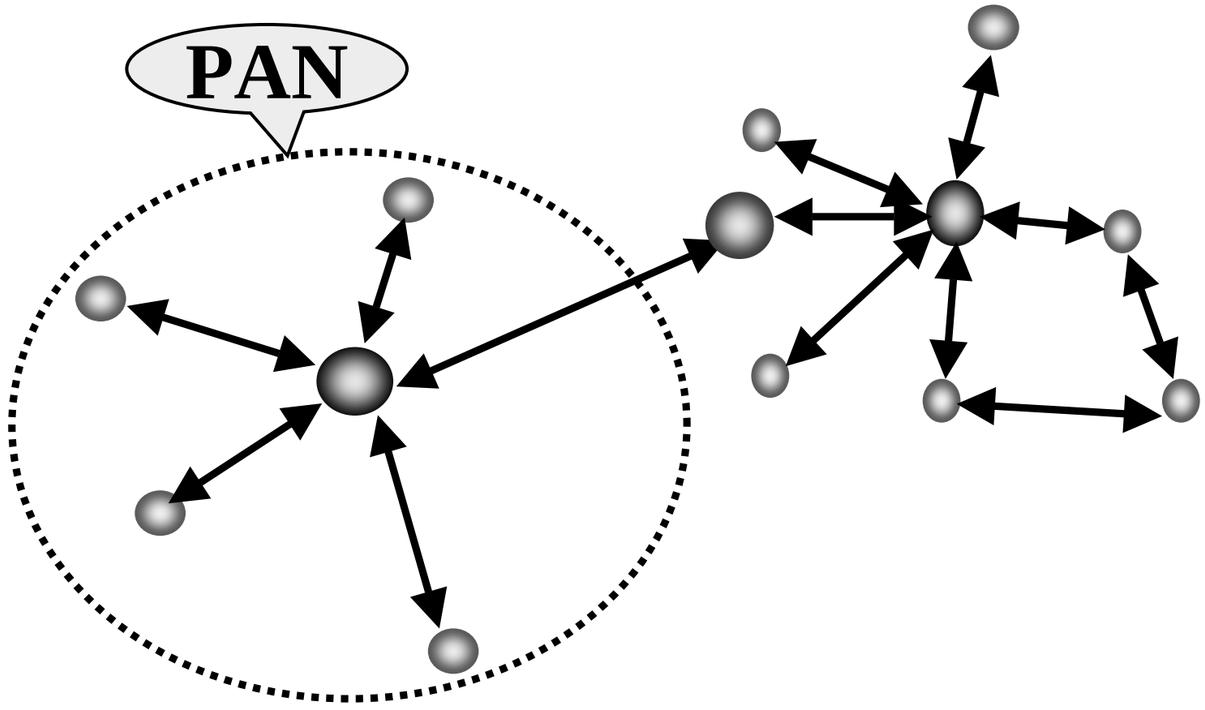
Protocol	Complexity	Frequency	Range	Data rate	Comment
Bluetooth	High	2.4GHz	~10 m	1Mbps	$$
Z-Wave	Low	868/915MHz	30-120m	9.6kbps	Proprietary
X-10	Low	120KHz over 60Hz	PLC	30bps	Proprietary
Zigbee	Low	2.5GHz, 868/915MHz	~100m	20-250kbps	Standard

Applications of ZigBee™

- Home Automation Networks
- Home Security Networks
- Industrial Control Networks
- Interactive Toys
- Remote Metering
- PC peripherals
- Useful where cabling is expensive or undesired



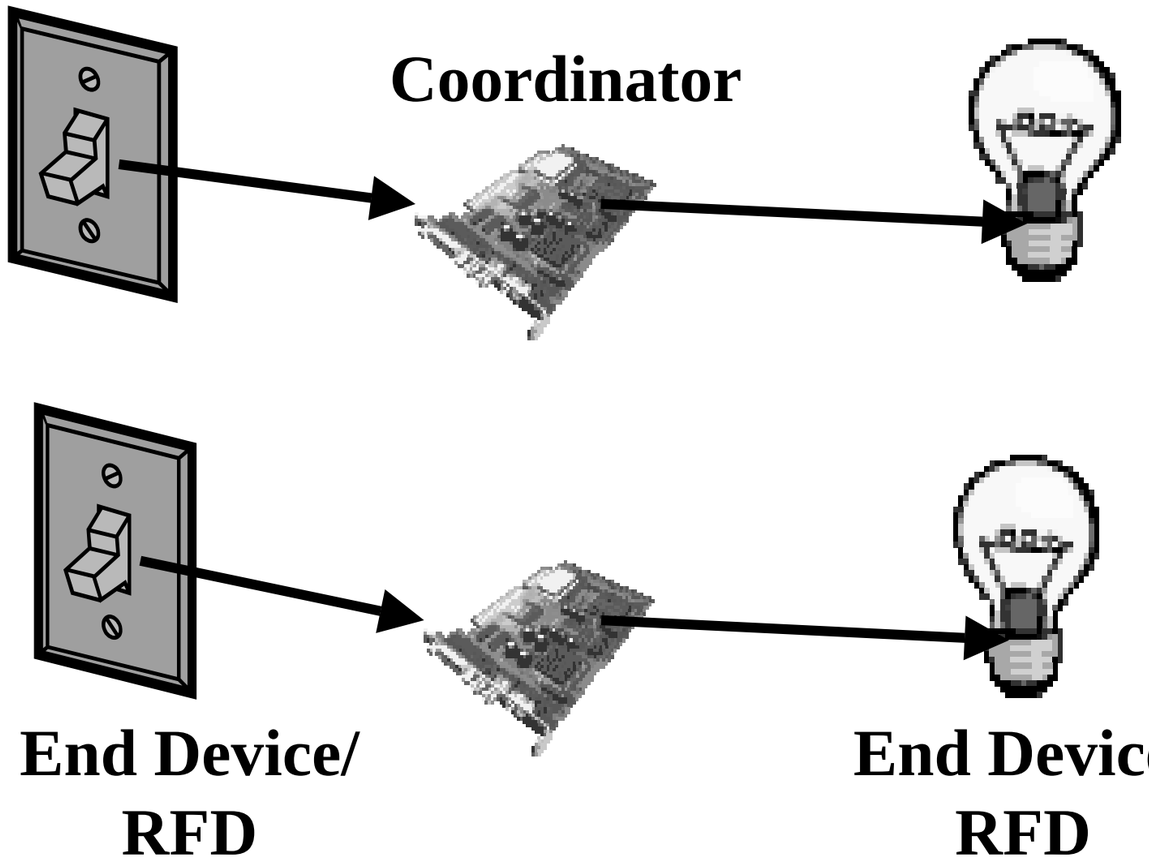
Typical ZigBee™ Networks

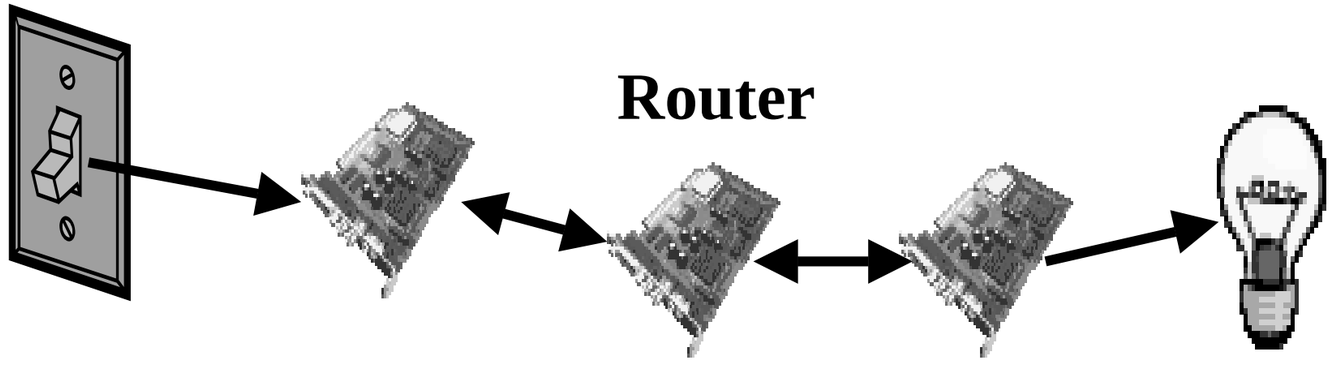


- Full Function Device (FFD)
- Reduced Function Device (RFD)
- Coordinator (FFD)
- Router

PAN = Personal Area Network

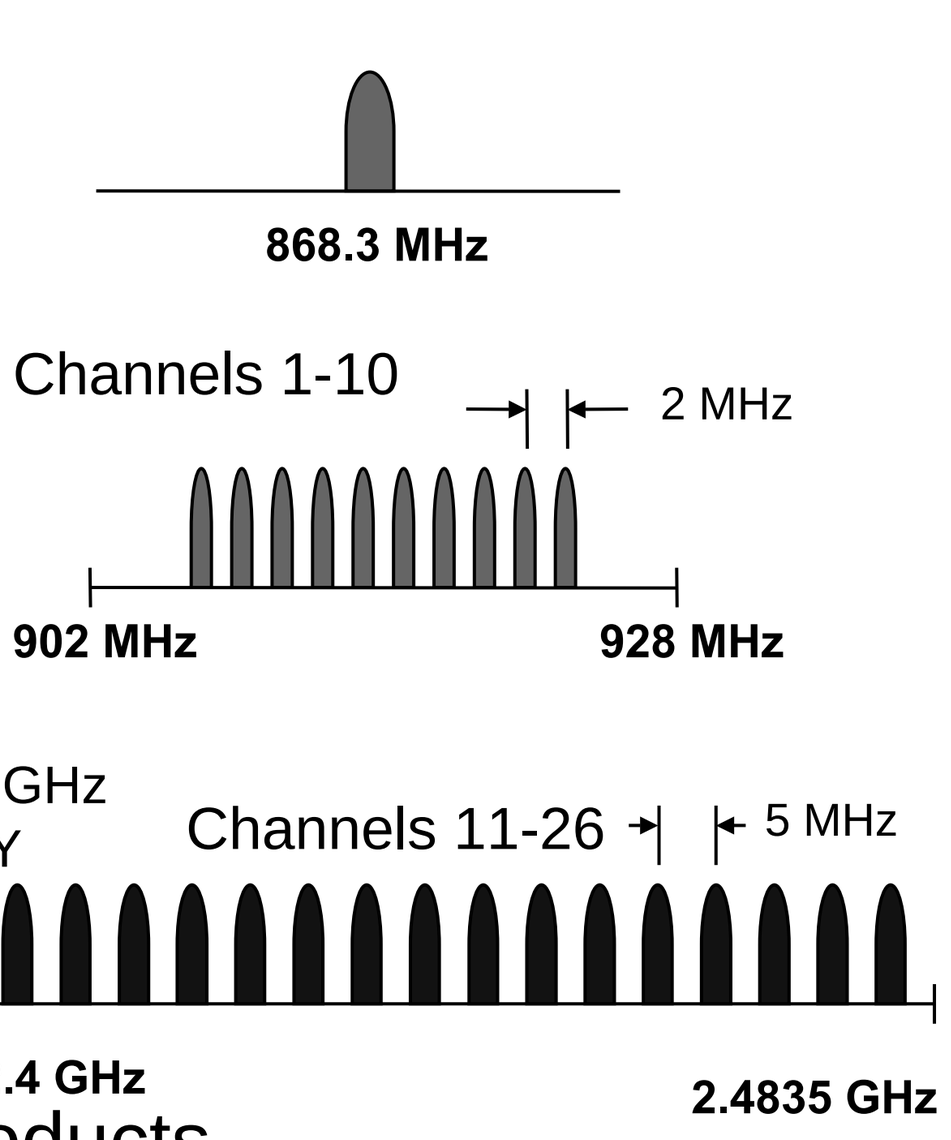
Total devices in a PAN = 65533





IEEE 802.15.4 PHY

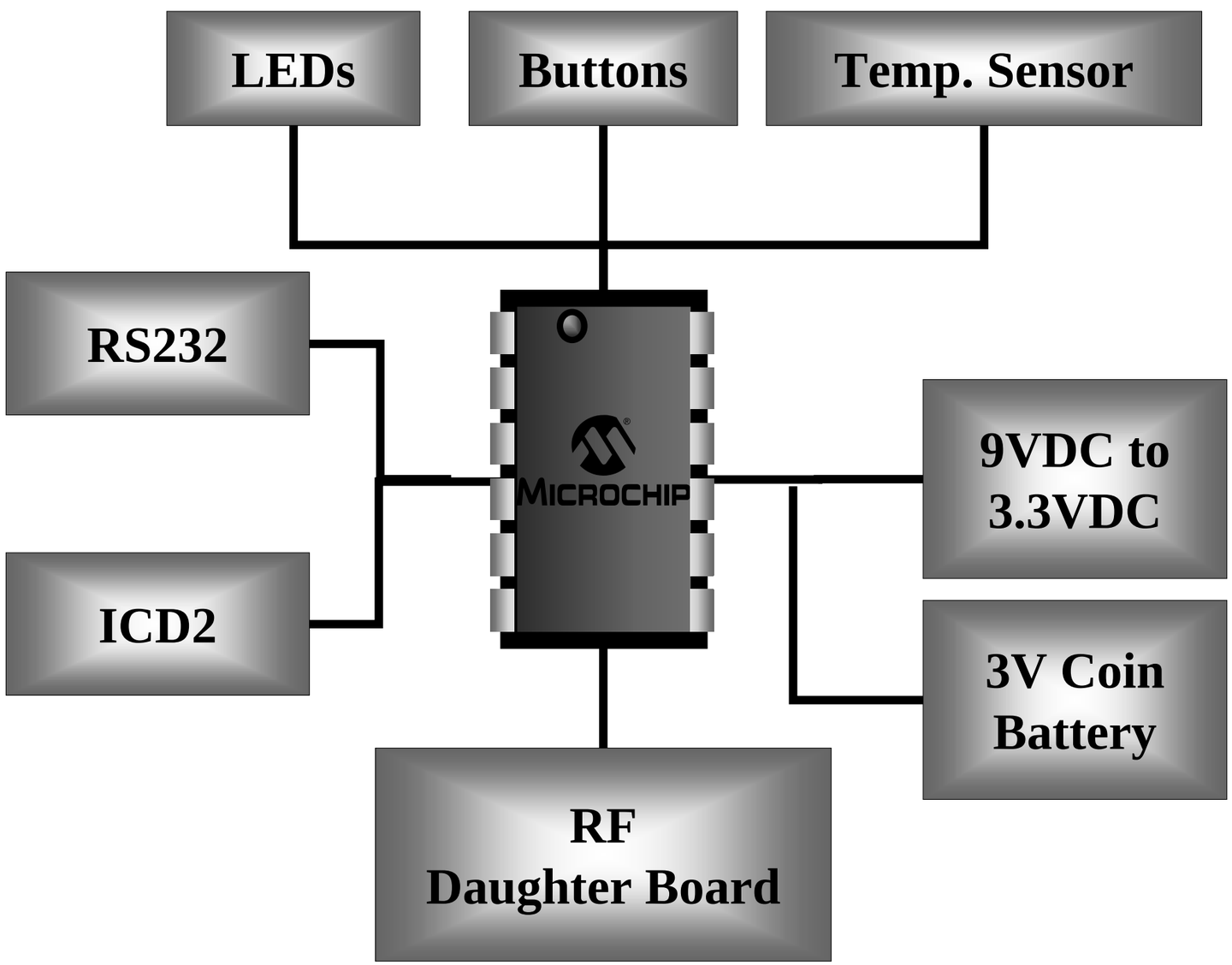
- 868 MHz Band, Europe
  - 20 kbps, BPSK
  - 1 Channel
- 915 MHz ISM, USA
  - 40 kbps, BPSK
  - 10 Channel
- 2.4 GHz ISM Band
  - Worldwide except France & Spain
  - 250 kbps, O-QPSK (Offset QPSK)
  - 16 Channels
- Designed to coexist with other 2.4GHz products

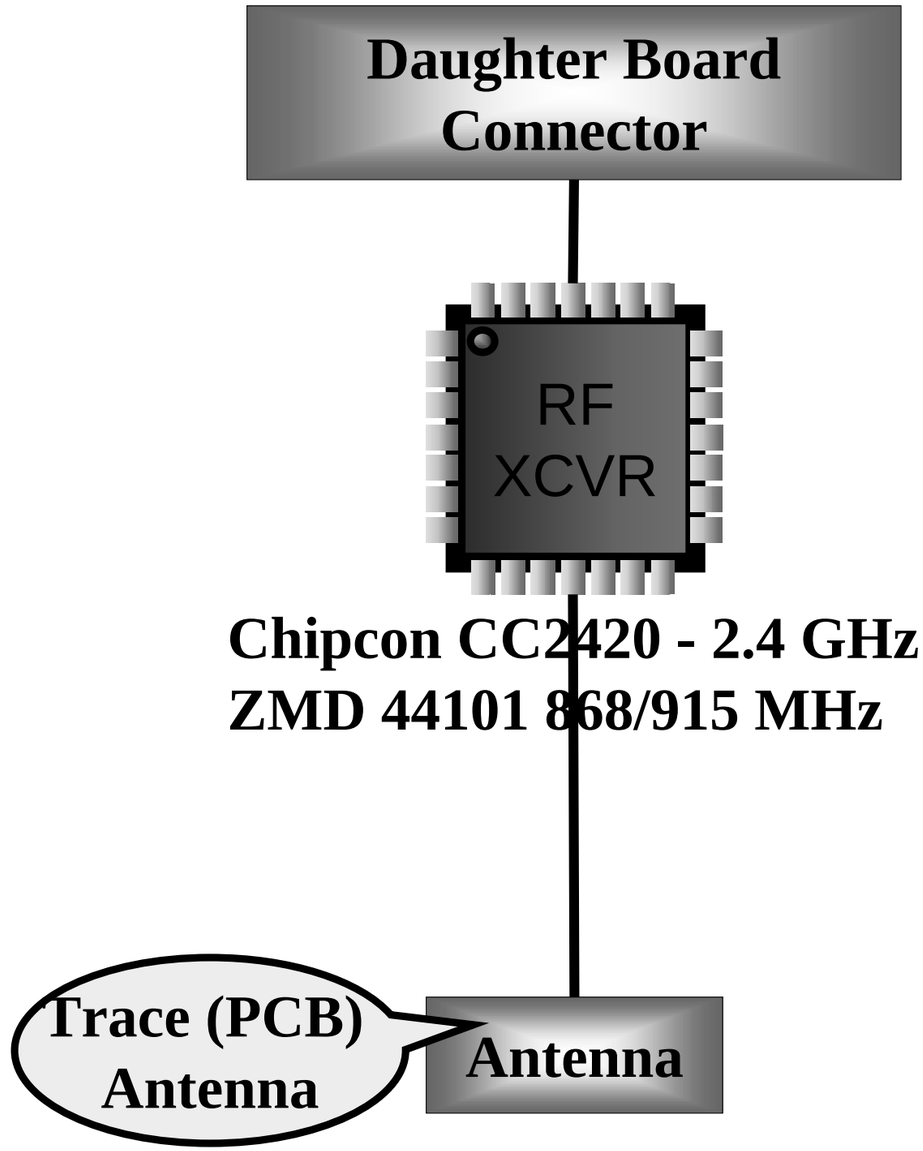


Microchip's Solution

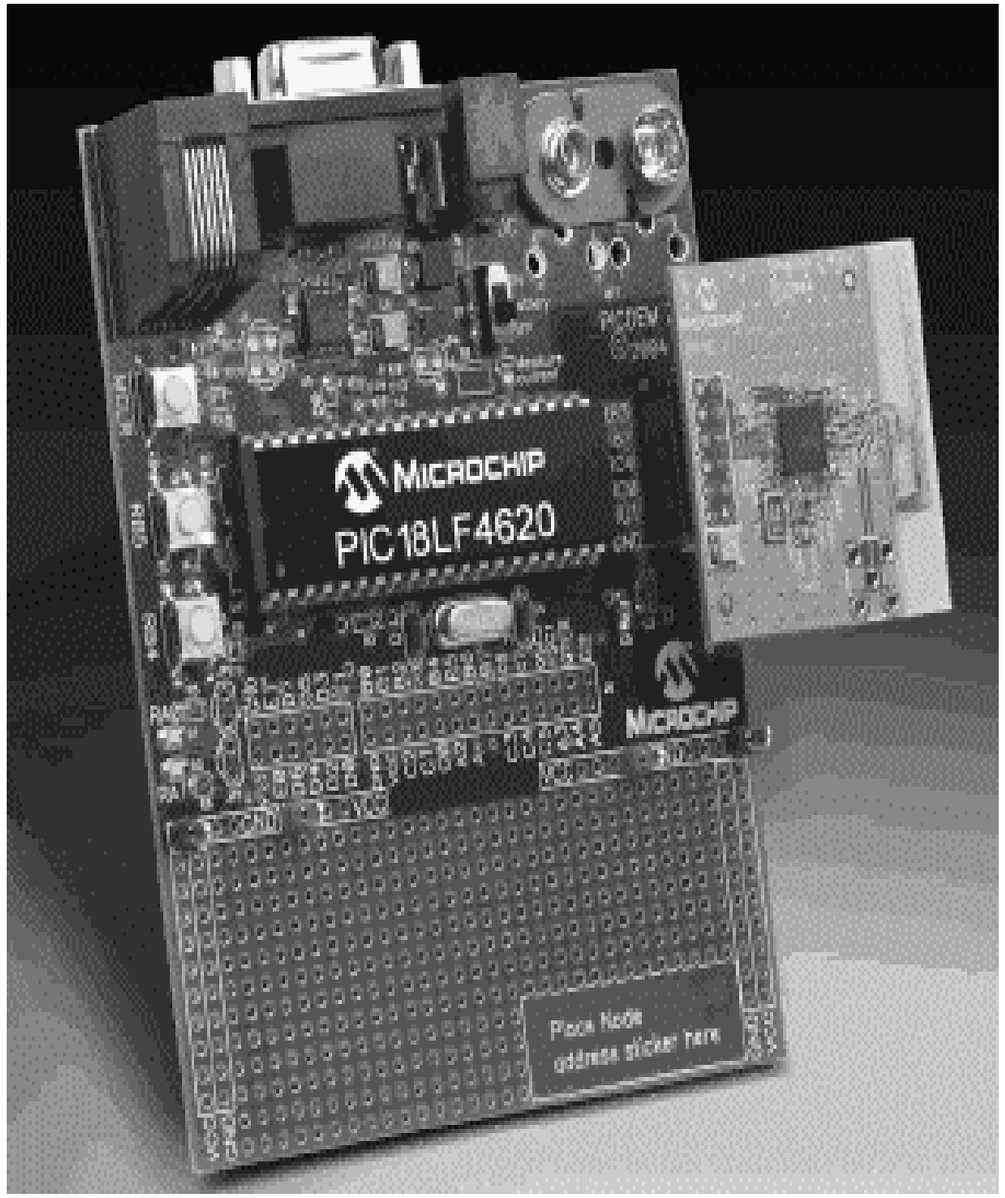
- Microchip is developing the PICDEM™ Z demonstration platform
  - A cost effective, easy-to-use ZigBee development kit
- Microchip offers over 70 PIC18 products with memory (>16K bytes) to support ZigBee protocol applications - and more coming
- Key PICmicro® MCU attributes supporting ZigBee
  - Wide range of memory, peripheral, packages
  - nanoWatt Technology
- Application Note
  - AN965 Microchip Stack for the Zigbee Protocol

Main Board & RF Daughter Board





Development Tool



1. Two PICDEM Z demonstration motherboards.
2. Two PICDEM Z RF cards
(Exact RF transceiver is dependent upon your kit P/N).
3. Two 9V batteries.
4. The Microchip Software CD for ZigBee CD-ROM, which contains demo applications and source code for the Microchip Stack.
5. This manual .
6. A warranty registration card.

PICDEM™ Z ZigBee™ Technology Products	
Part Number	**Description**
DM163027-2	PICDEM Z 2.4 GHz Demo Kit
AC163027-1	PICDEM Z Motherboard
AC163027-2	PICDEM Z 2.4 GHz RF Card

Introduction to Motor control

Why motor control?

- Why motor control?
- Speed variation
- Rotational direction control
- Torque control
- Position control

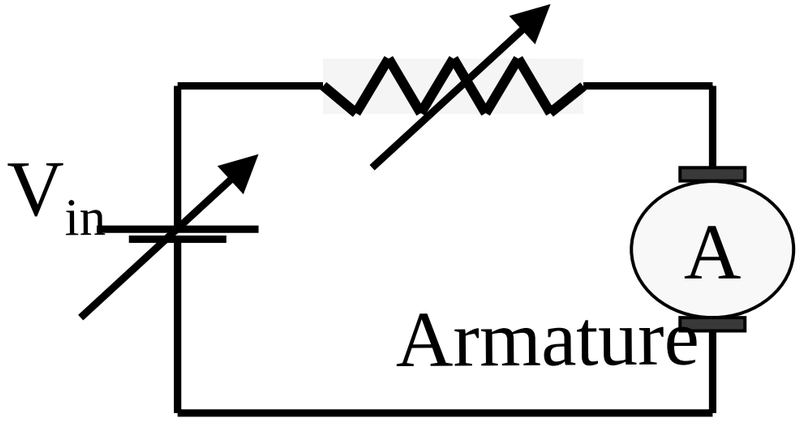
Benefits of Microcontroller-based control

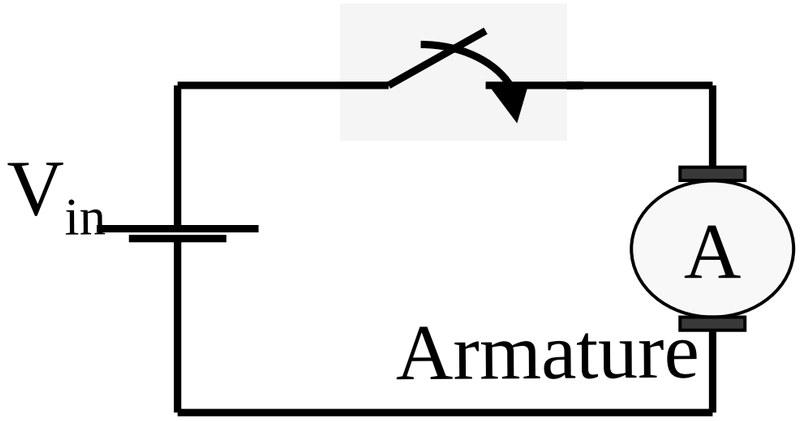
- Energy saving
- Noise reduction
- Enhanced motor life
- Diagnose failures and preventive actions

BDC Motor Control

- Why Brushed DC
  - One of the oldest type of motors
  - Simple construction
  - Inexpensive motor and control
  - Universally available
  - Ideal for battery powered applications
  - Easy speed variation – by varying voltage

  Disadvantages
  - Brush maintenance required
  - Lower efficiency
  - Electric sparks around brushes
  - Limited speed range





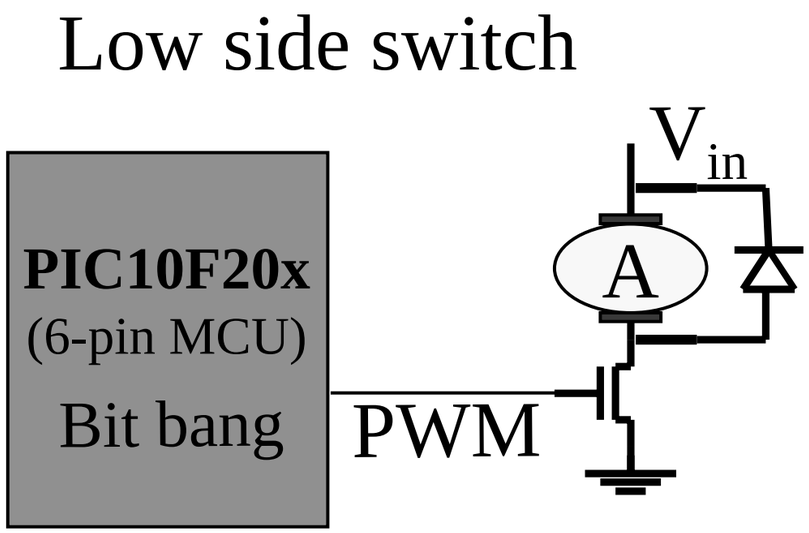
- Control of Voltage across DC motor will control speed
- Could be done using variable resistor
- Better done using PWM controlled switch

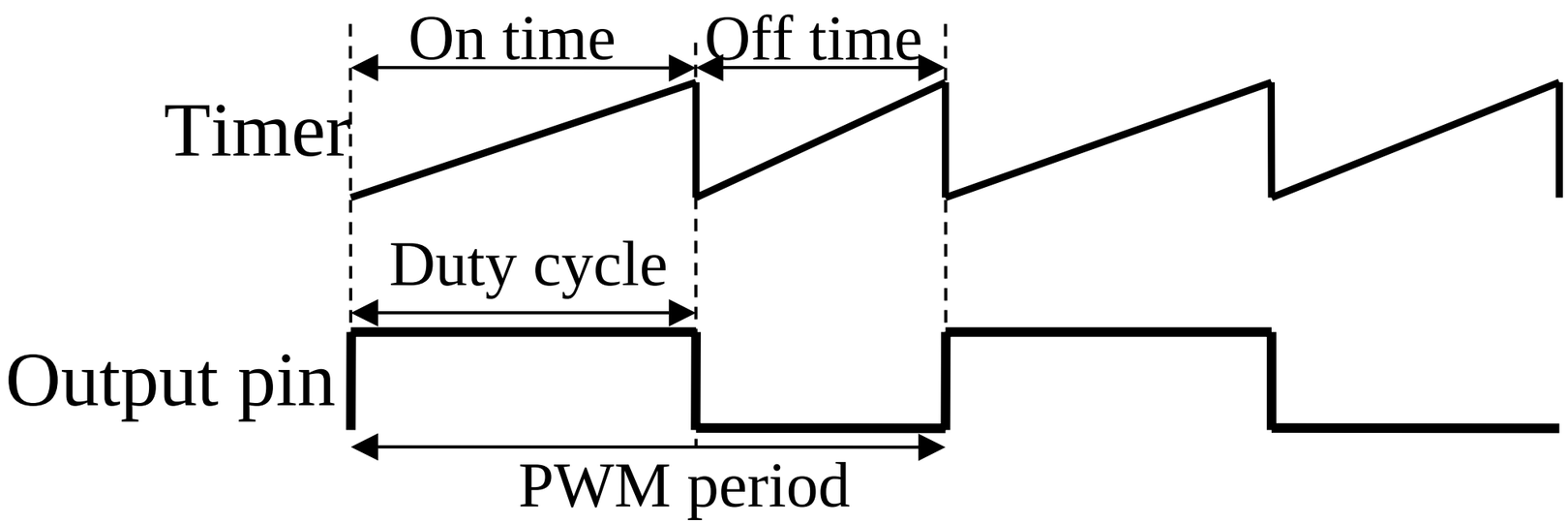
Unidirectional Control

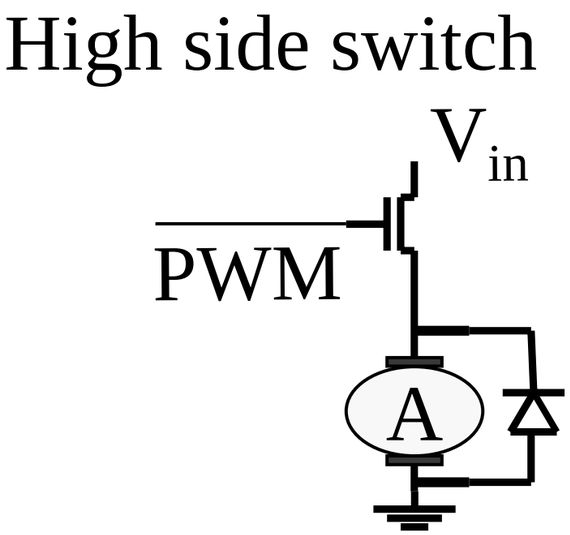
- Resources:

  Timer and an output pin

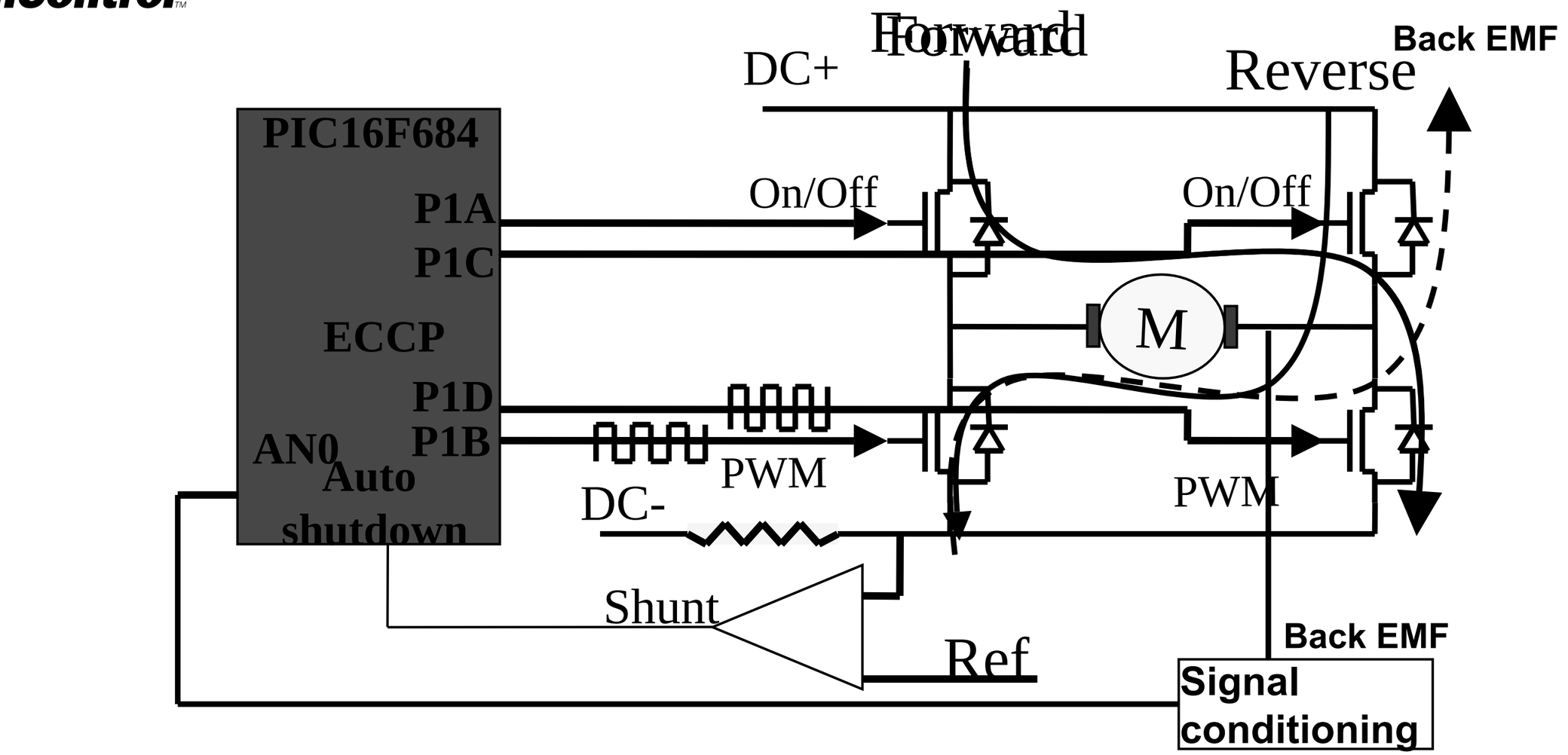
  - Load Timer to time out alternatively corresponding to On time and Off time

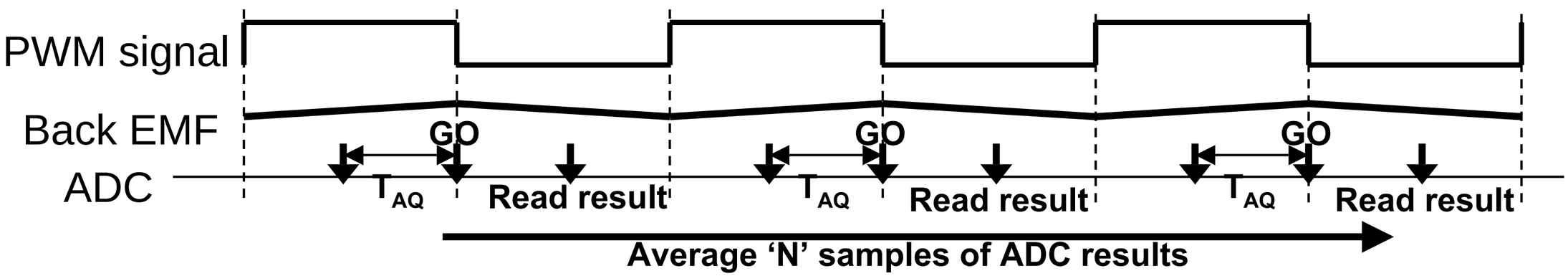






Bi-directional Control & Closed loop with BEMF



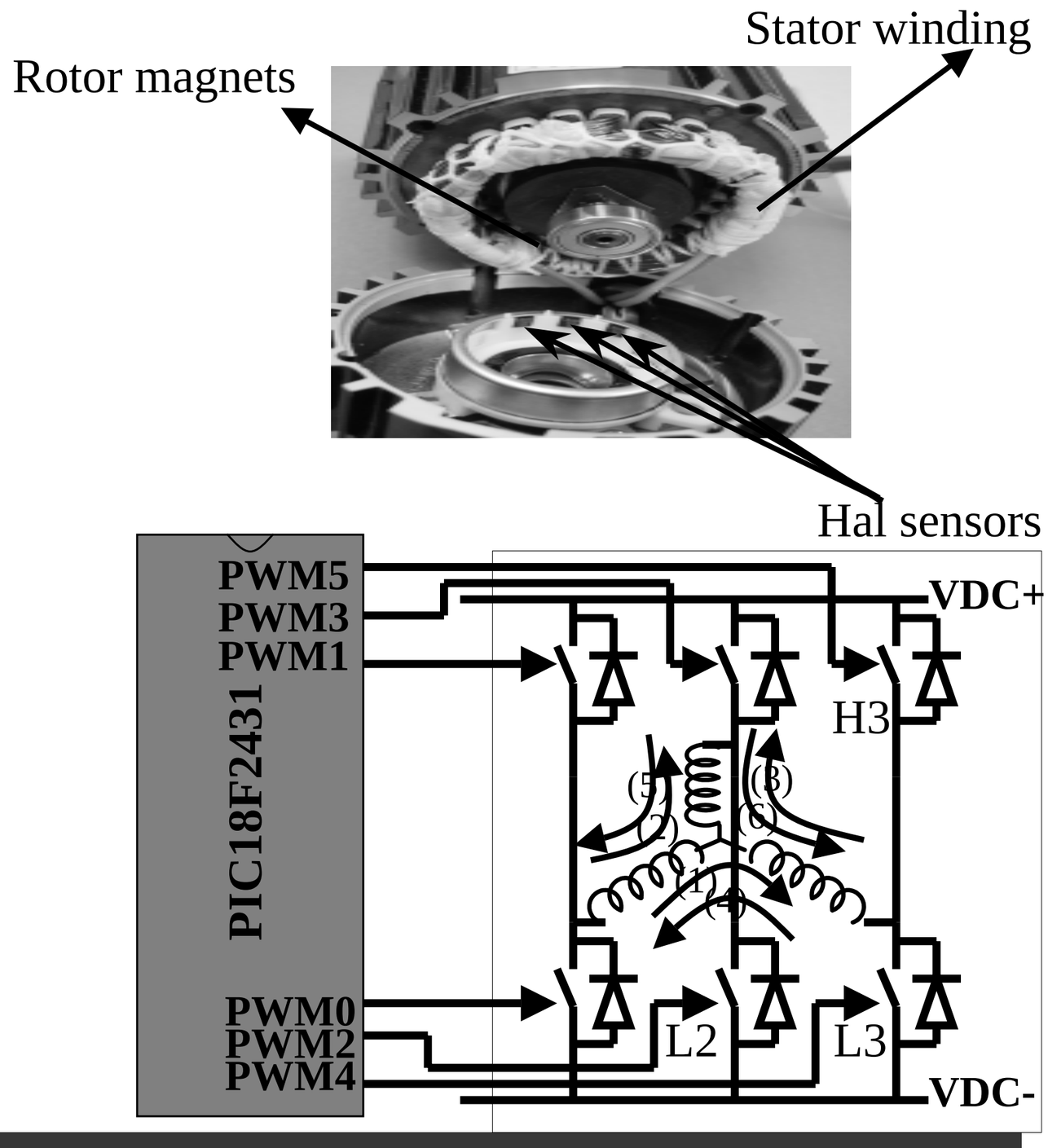


Resources Required

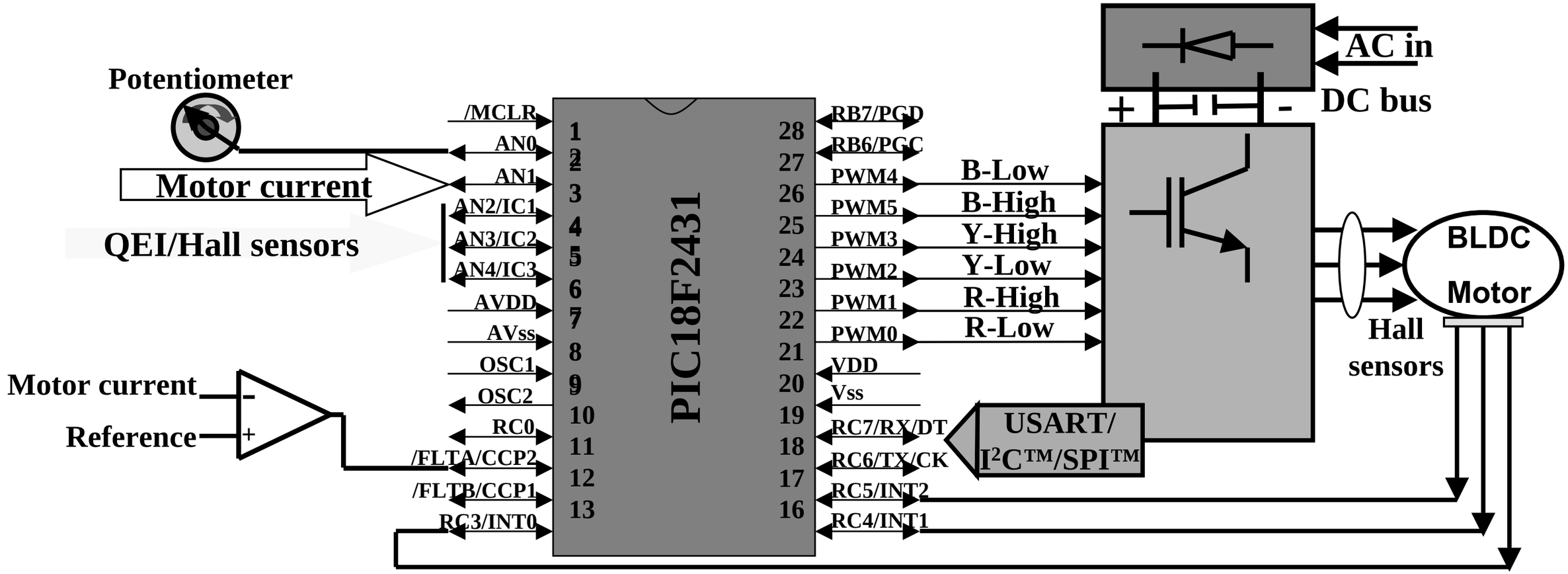
- Advantages of BDC motor
- BDC motor control tips and tricks
  - Unidirectional control
  - Bidirectional control
  - Closed loop control with BEMF
- Resources and the right device to drive above control schemes
  - PWMs: For H-bridge control (ECCP)
    - 1 or 2 channels, with at least 8 bit resolution, and frequency up to 20KHz
  - ADCs: For current / Temperature / BEMF/ Speed monitoring
    - 3 to 4 channels, 8/10 bit resolution
  - I/O ports - 2 to 4 I/Os for user interface
  - Communication channels
  - A typical application for -6, -8, -14, -18 pin
  - PIC10, PIC12, PIC16 microcontrollers
    - PIC10F20x, PIC16F684, PIC16F72/73

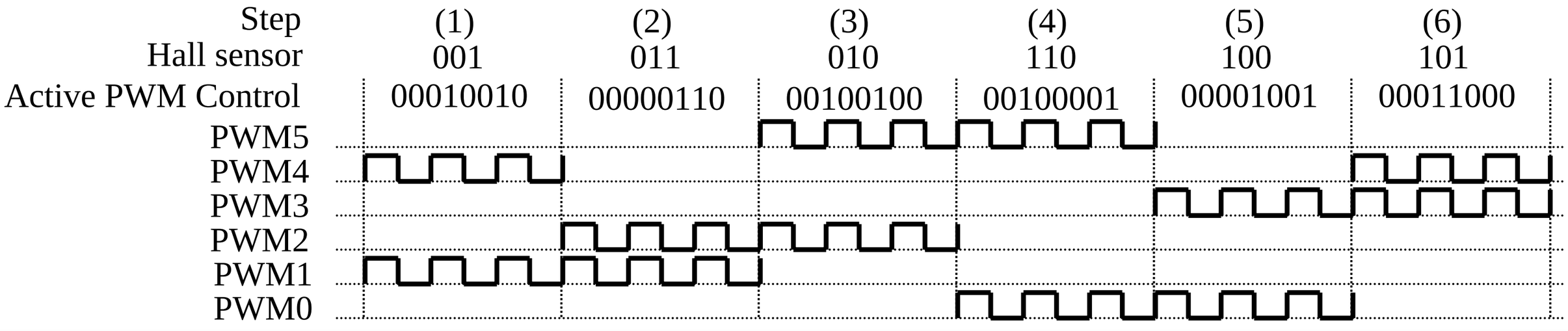
Brushless DC (BLDC) Motor Control

- Why Brushless DC?
  - Energy efficient
  - Flat Speed-Torque characteristics
  - Lesser audible noise
  - Better dynamic response
  - Less maintenance, Longer motor life
  - Higher output power per frame size
  - Electronically commutated
    - Same controller can be used for variable speed



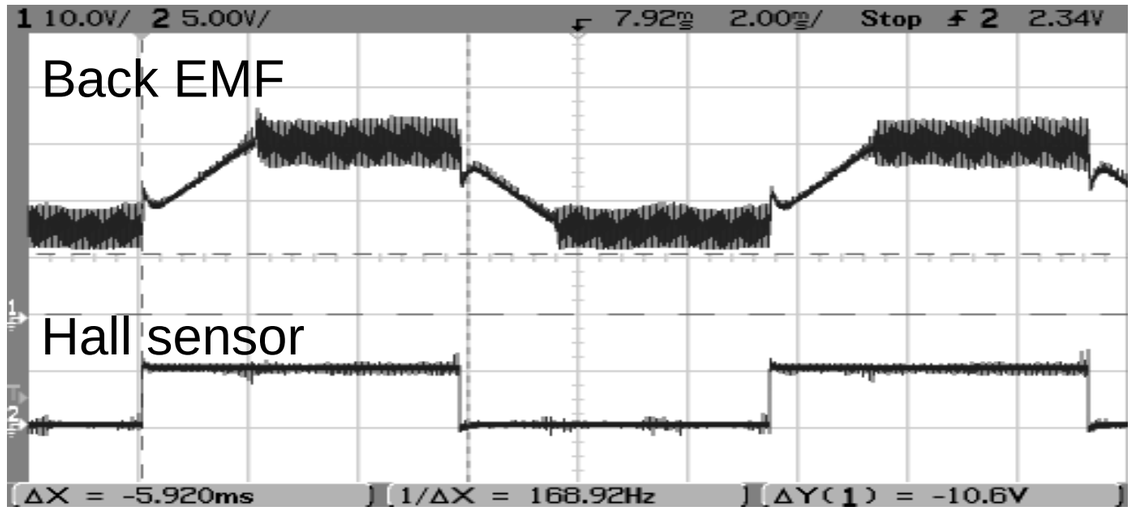
Control block diagram



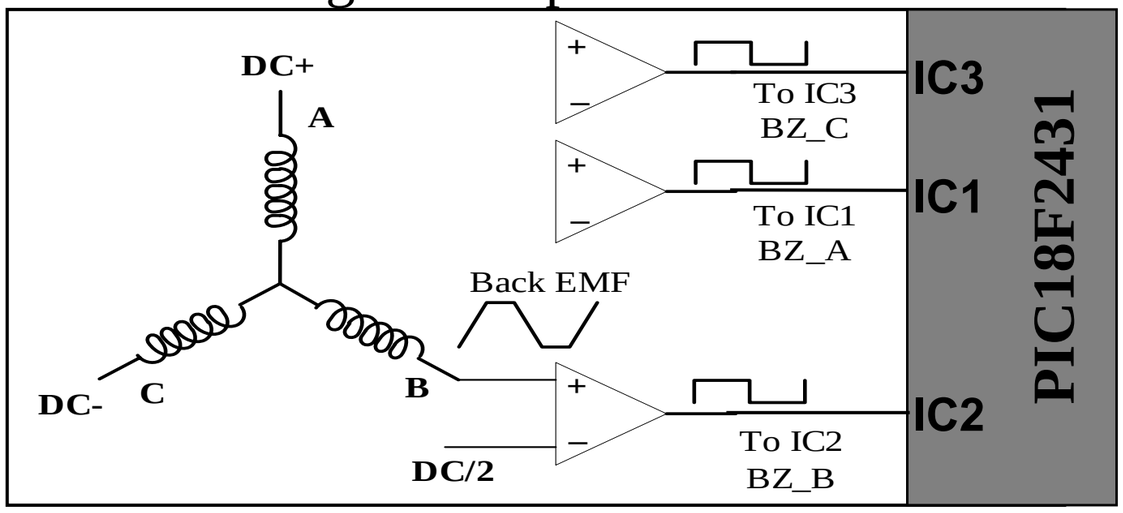


BEMF vs. Hall sensors

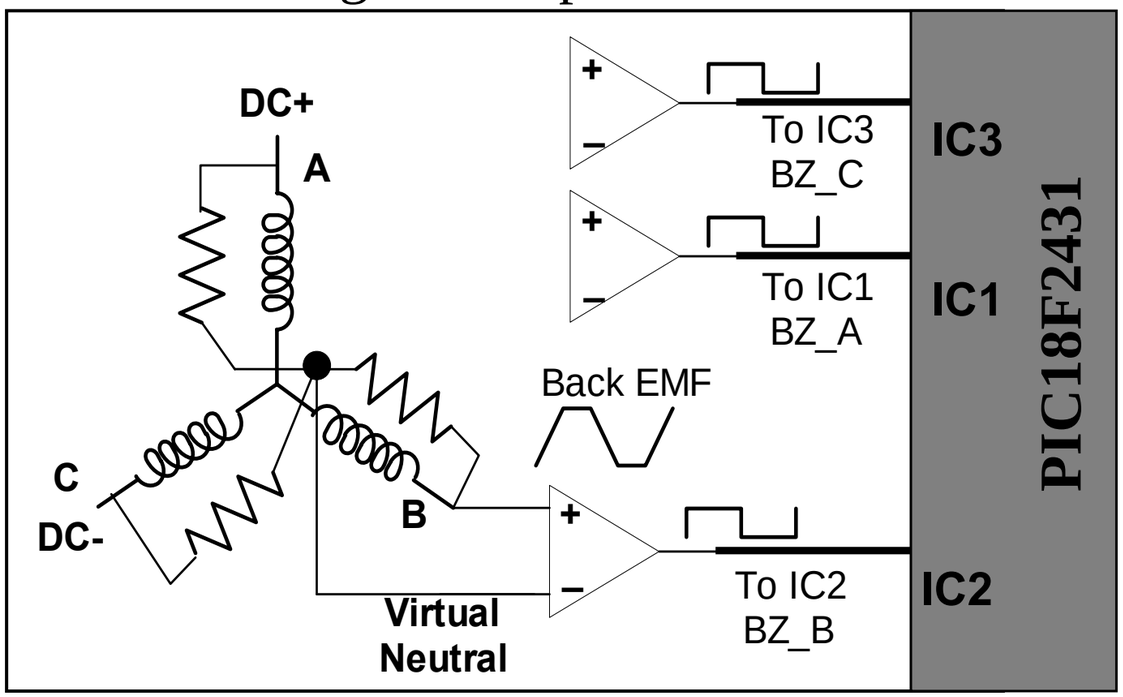
- Back EMF signal & Hall sensor signal



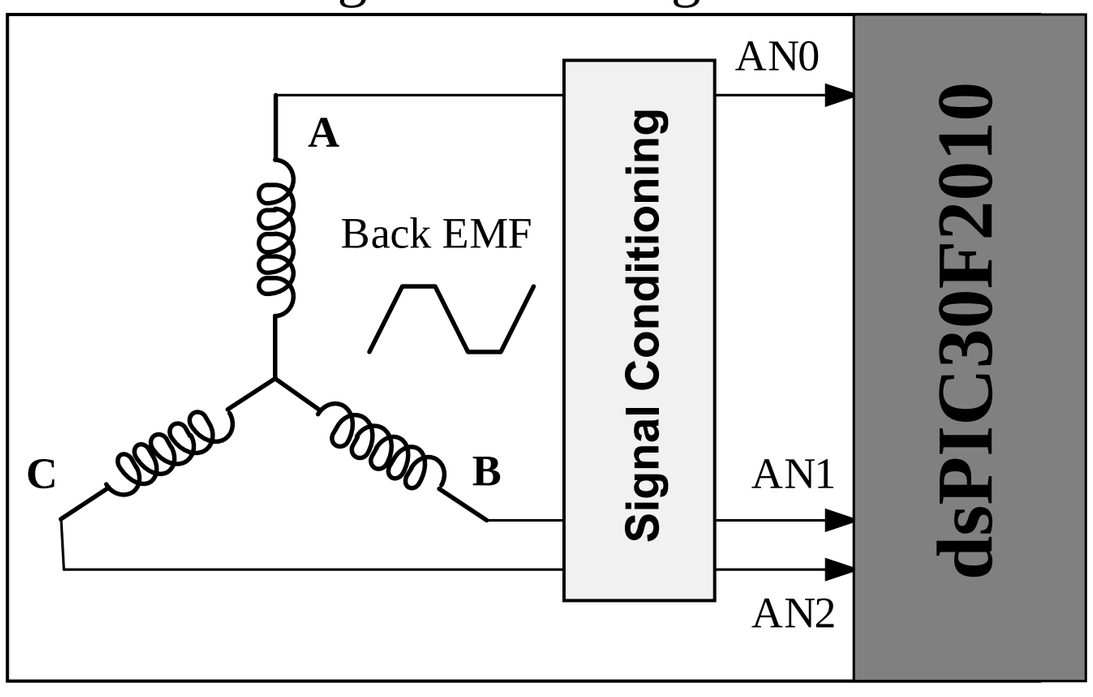
- Back EMF signal compared with DC bus/2



- Back EMF signal compared with virtual neutral



- Back EMF signal read using A/D Channels



Resources required

- Open loop Control / With Hall sensor feedback
- 3 PWMs: At least 3
- ADCs: For current/voltage/temperature monitoring
  - 8 or 10 bit, 3 or 4 channels
- Comparators: 1 to 2, on chip or on board
  - For setting current limit
- 1/3 Interrupt pins : For Hall sensor interface
- I/O pins : 2 to 4 I/O pins for user interface
  - For fault monitoring, switch interface etc.
- Timer : 1 8/16 bit
- -- PIC16F7X7, PIC18FXX31, dsPIC30F2010
- Sensor less control : Back EMF sensing
  - 3 comparators + filters
  - 3 High speed ADC channels
- -- PIC18F4431 or dsPIC30F2010

Induction Motor Control

- Why Induction motor?
  - Reliable and Robust construction
  - Universally available
  - Power rating ranging from fractional horse power to hundreds of horse power
  - Runs directly from wall AC power
  - Ideal for home appliances and industrial applications
  - Control:
    - Varies from scalar open loop control to vector closed loop control

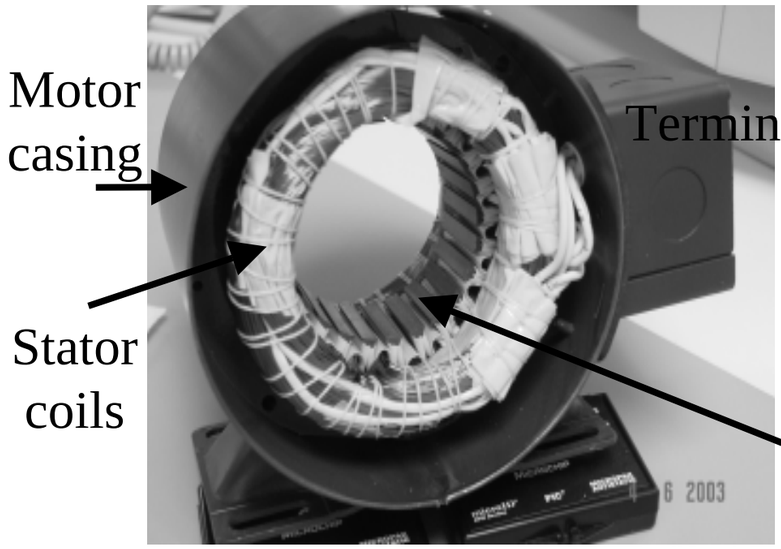
--Scalar Control (VF control)

- Direct control variables are **Voltage Amplitude** and **Rotational Frequency**
  - Sinusoidal PWM
  - Space vector PWM

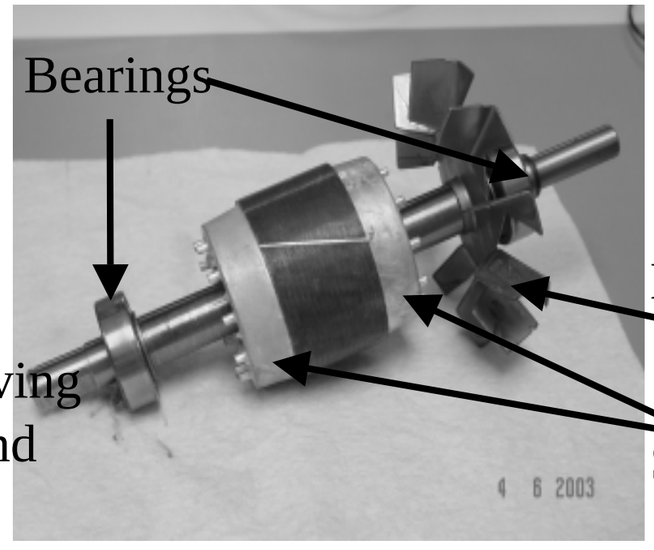
--Vector Control

- Indirect control variables are **Flux** and **Torque**
- Stator flux oriented control, Rotor flux oriented control

Stator

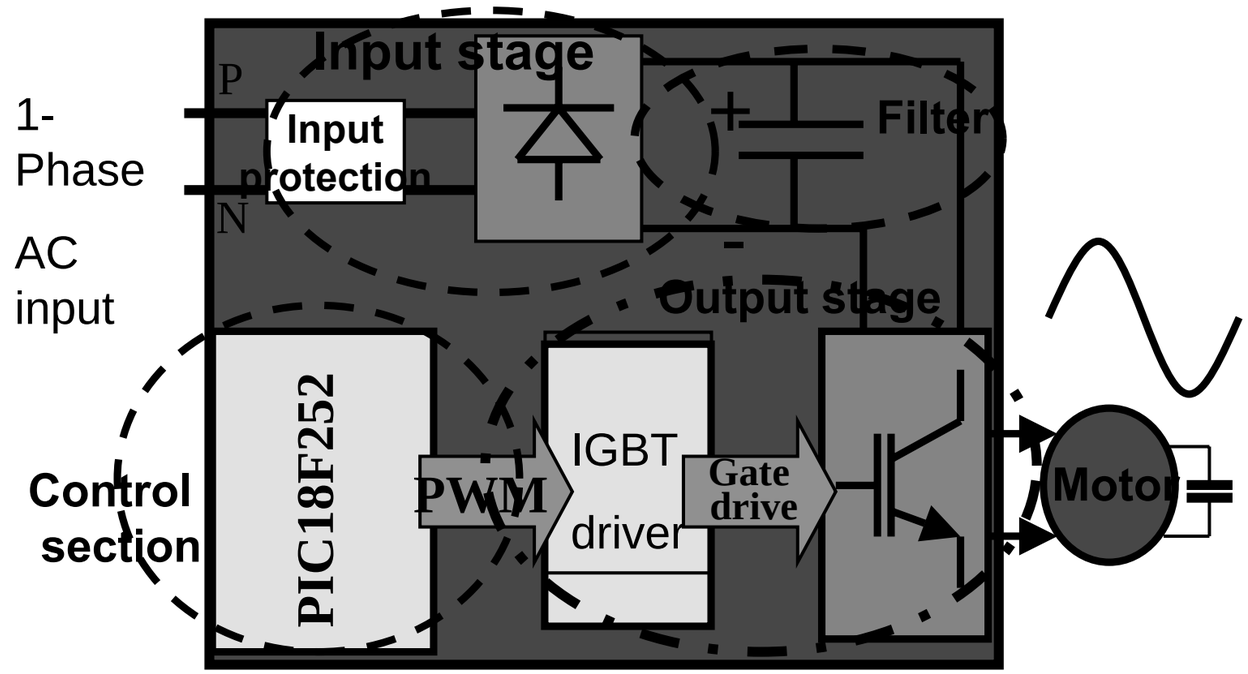


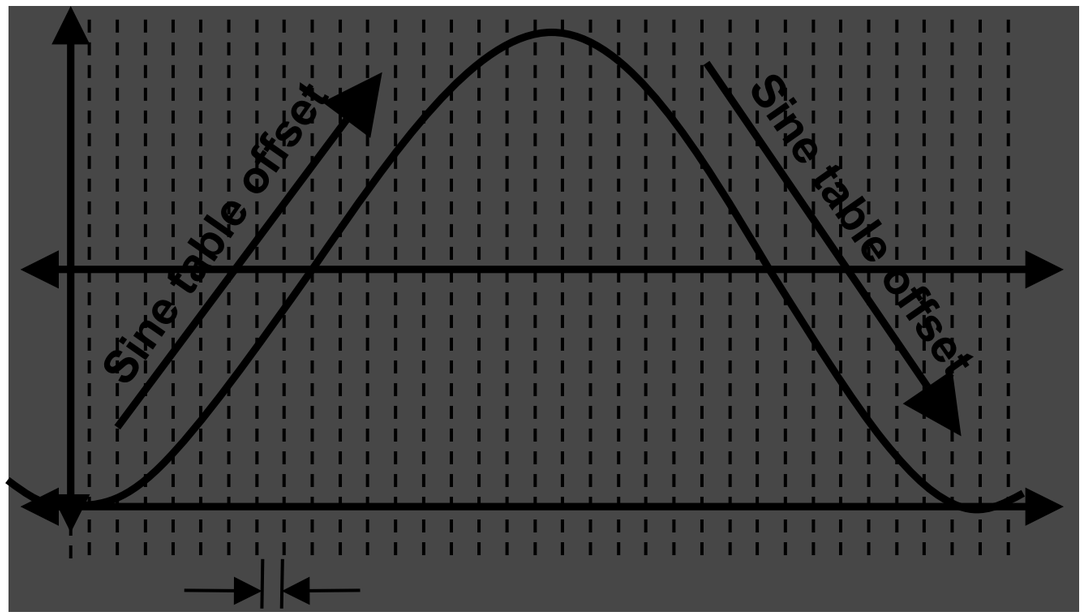
Squirrel Cage Rotor



Induction Motor Control

- **VF control -1 phase**
- Vary voltage and frequency at fixed ratio (V/F)
- 2 pairs of complementary PWMs for H-bridge control



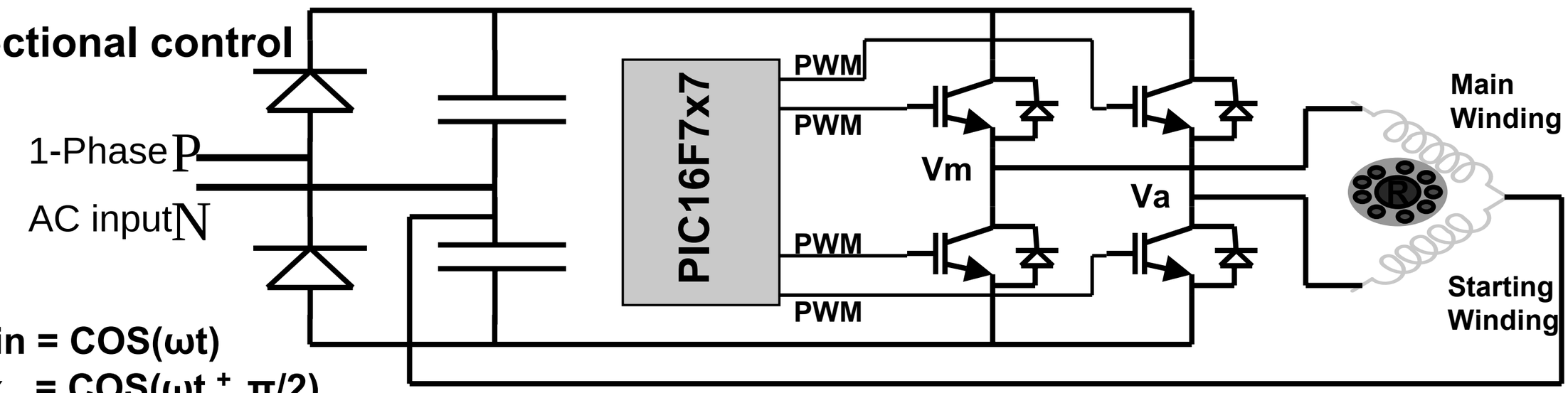


Timer count corresponding to 10 degrees

1) Input stage : Rectifier
   - Diode or SCR bridge for rectification
   - Power factor correction circuit
2) Filter : Capacitor bank for a stable DC bus
3) Output stage: Inverter
   - IGBT or MOSFET driver circuit
   - 1 or 3 phase IGBT or MOSFET bridge
   - Free-wheeling diodes
4) Control circuit
   - Microcontroller, communication channels interface and other interfaces

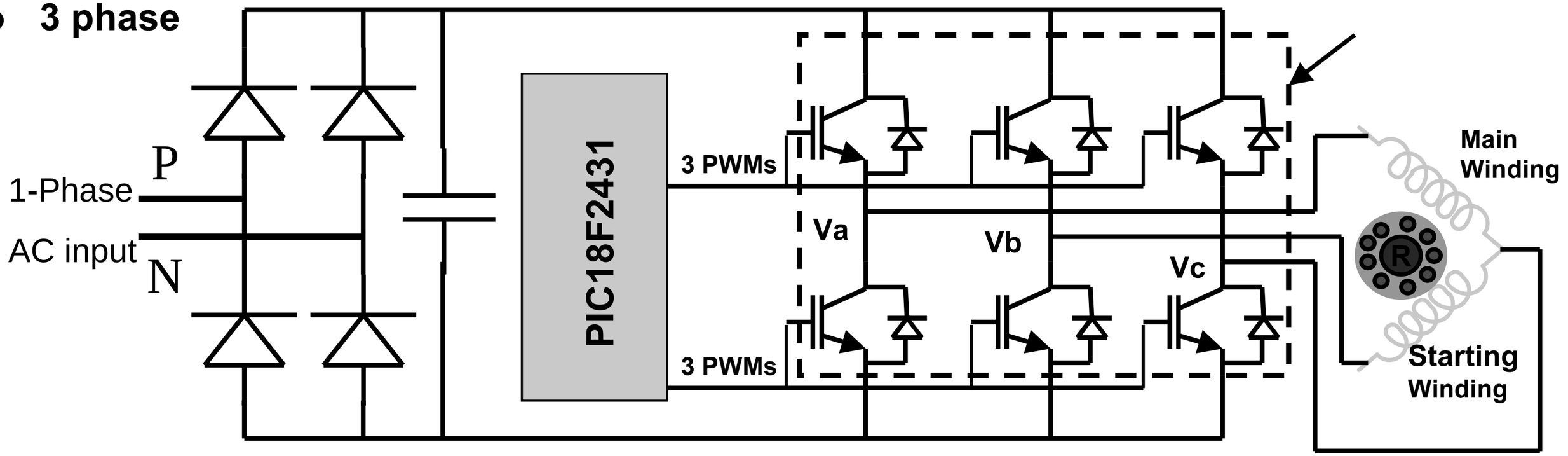
Bidirectional control

- **Bidirectional control**



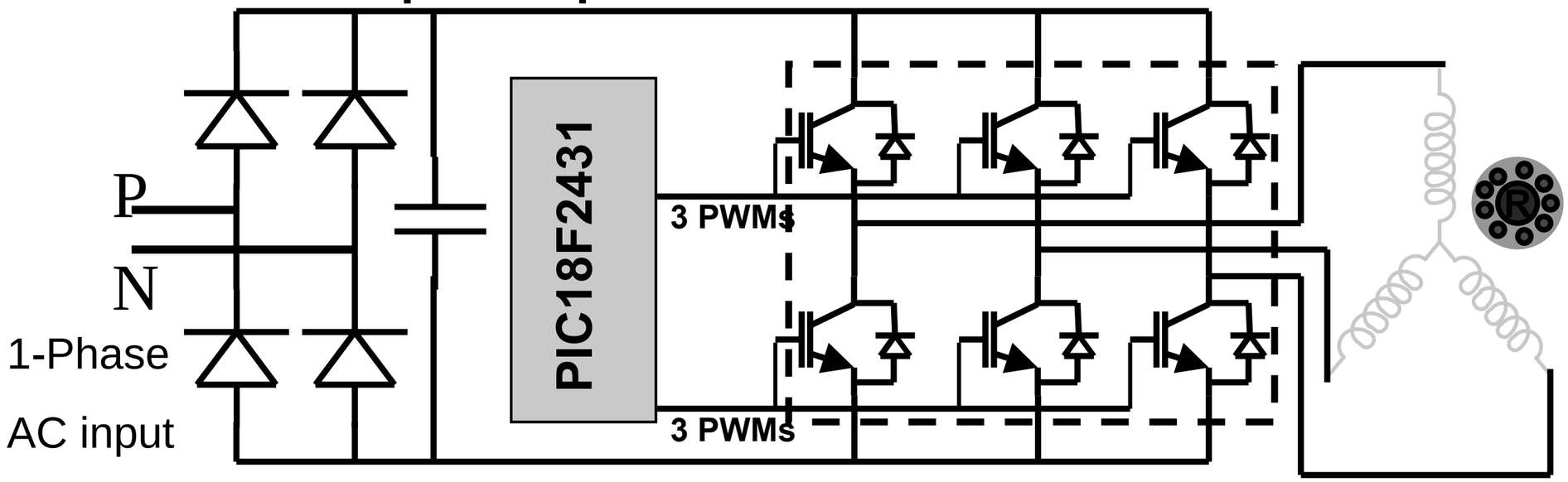
Vmain = COS(ωt)
Vaux = COS(ωt ± π/2)

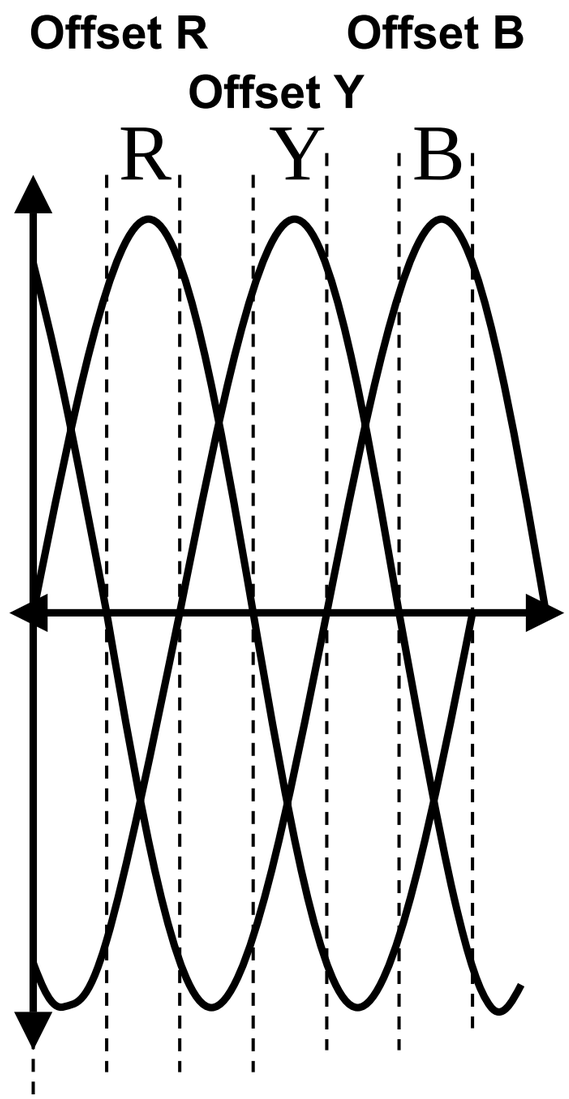
- **3 phase**



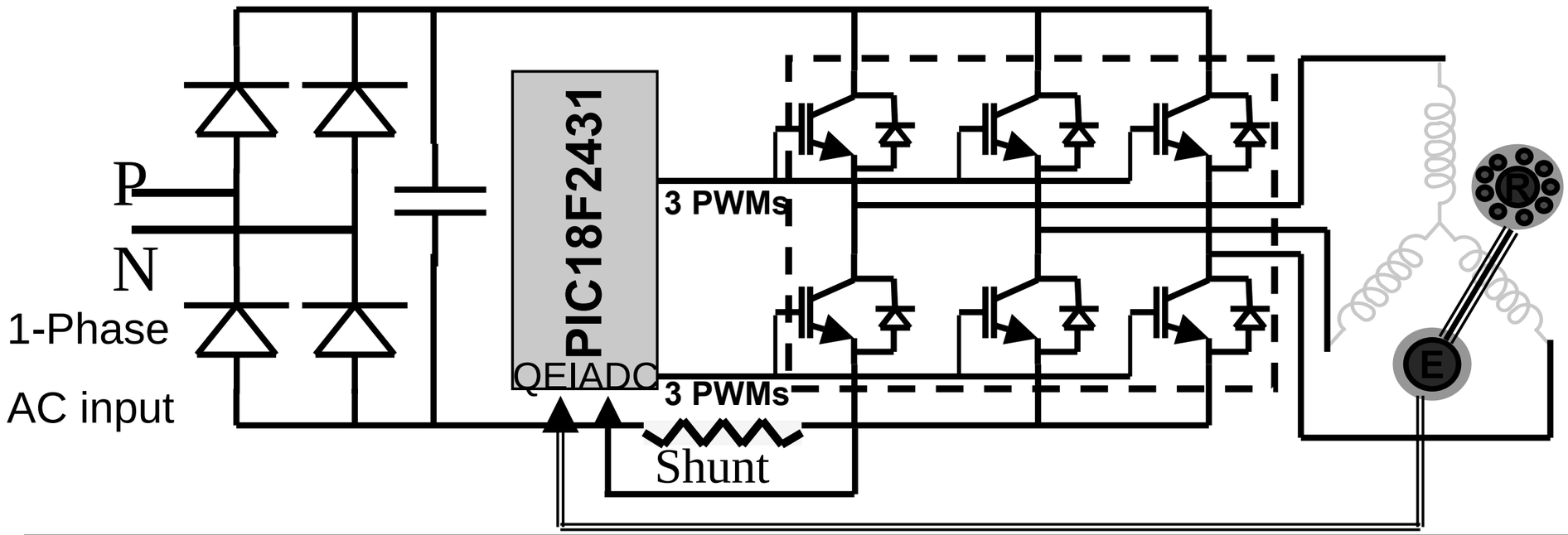
VF control – Open loop & Close loop

- VF control – Open loop



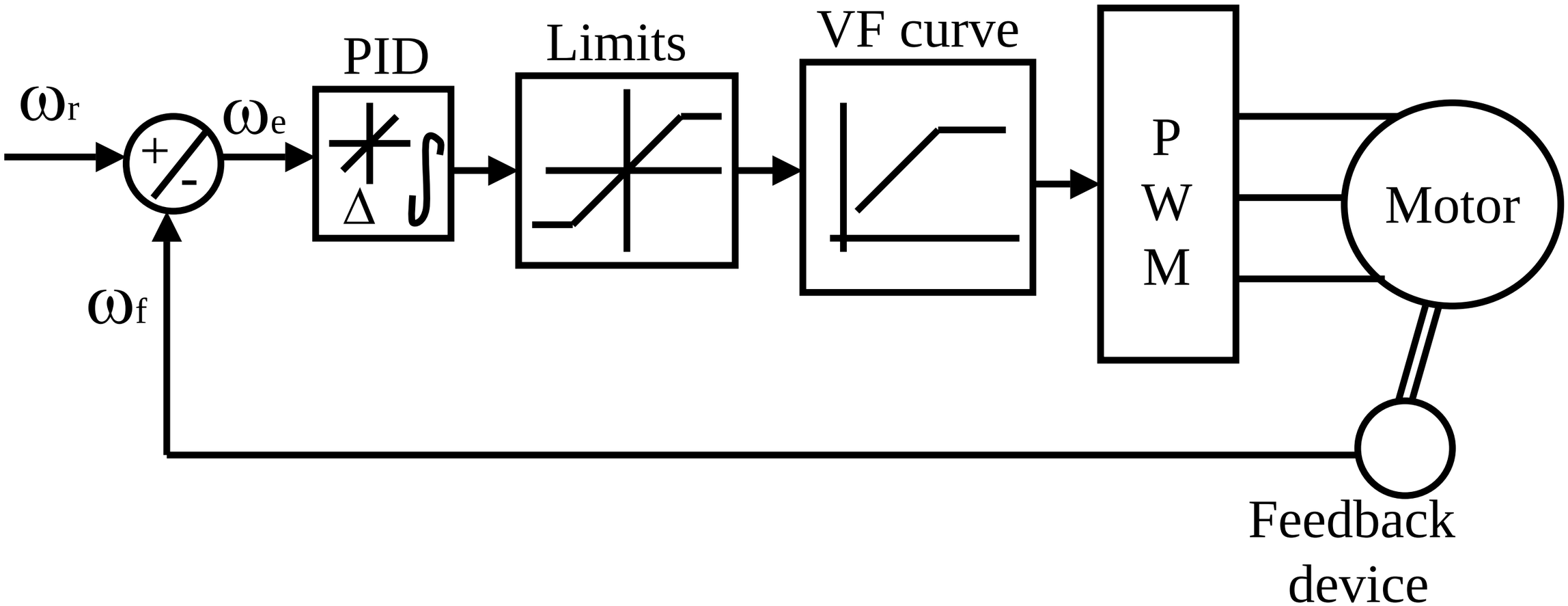


- VF control - Closed loop



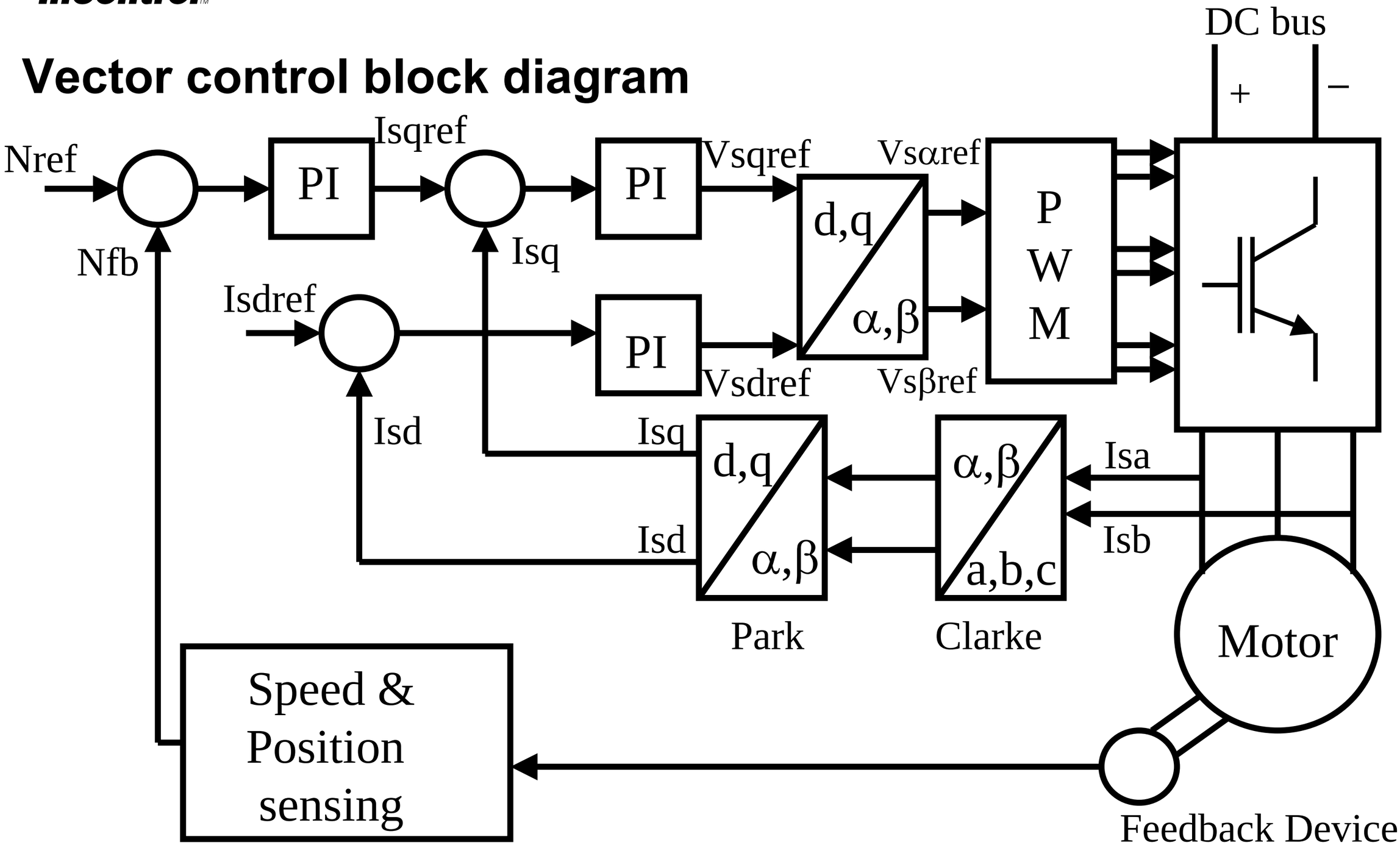
Scalar control

- **Scalar control**



Vector control block diagram

- **Vector control block diagram**



Resources Required

- Resources for Open loop
- PWMs: 3 pairs of complementary PWMs with dead band insertion with at least 8 bit resolution with 20 kHz frequency
- ADC: For current/voltage/temperature monitoring
  - 8 or 10 bit, 3 or 4 channels
- Comparators: 1 to 2, on chip or on board
  - For setting current limit
- General I/O pins : 4 to 6 I/O pins
  - For fault monitoring, switch interface etc.
- Timers : at least 1 8/16 bit
  - For setting motor frequency
- Communication channels
  - AUSART/ I²C™/ LIN/ CAN

- PIC18Fxx31 or dsPIC30F2010 family is ideal
- PIC16F7X7 series can be used with external drivers that complement and insert dead time
- PIC16F73, PIC18F252 for 1 phase IM control

- Resources for Closed Loop

VF with feedback

- All resources required for open loop control +
  - QEI or synchronous resolver interface
  - Current feedback used for closed loop operation

- PIC18F4431 or dsPIC30F2010 family is ideal

Vector control or Direct torque control

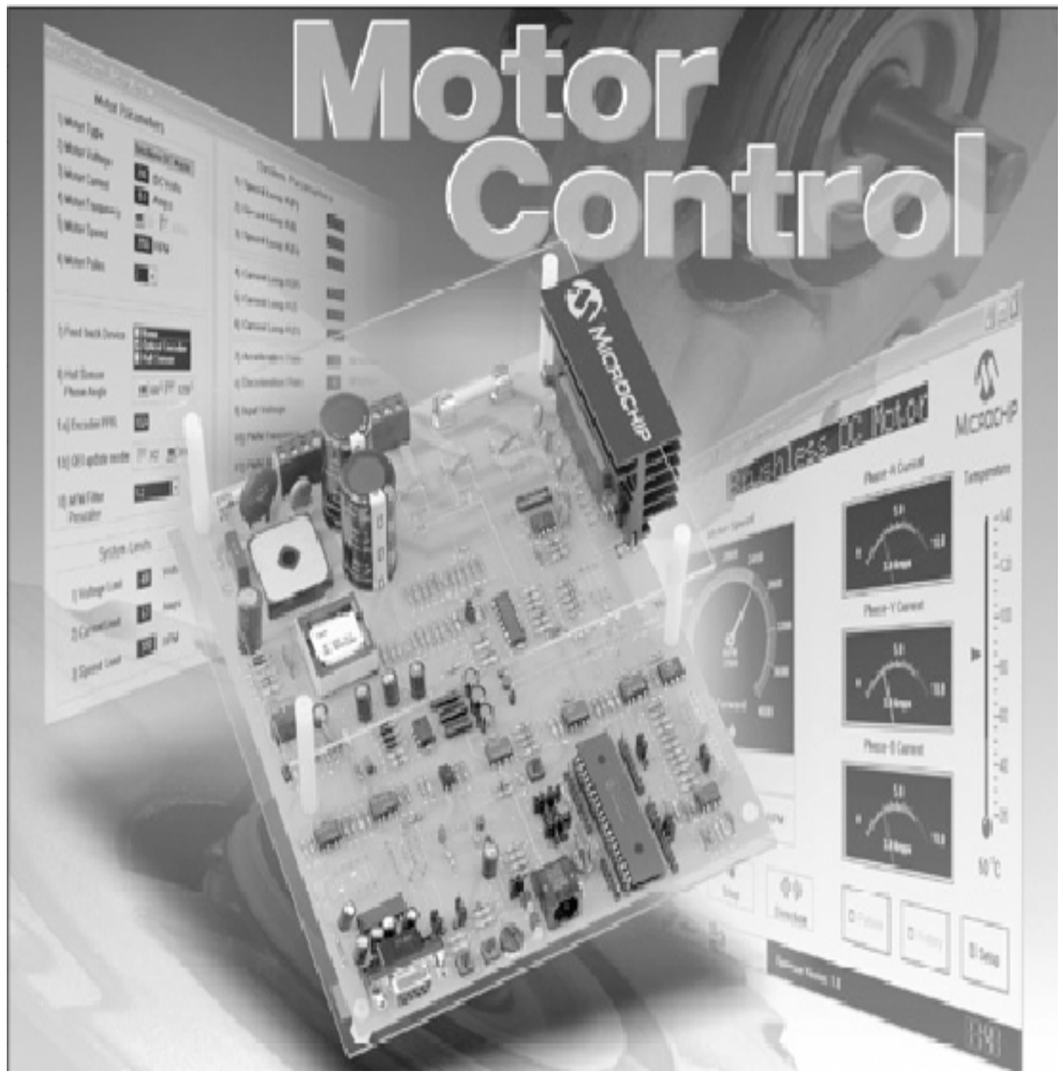
- Sensored: All resources above + extra MIPS

- dsPIC30F2010

- Sensorless : Back EMF sensing + extra MIPS

- dsPIC30F2010

Development Tool

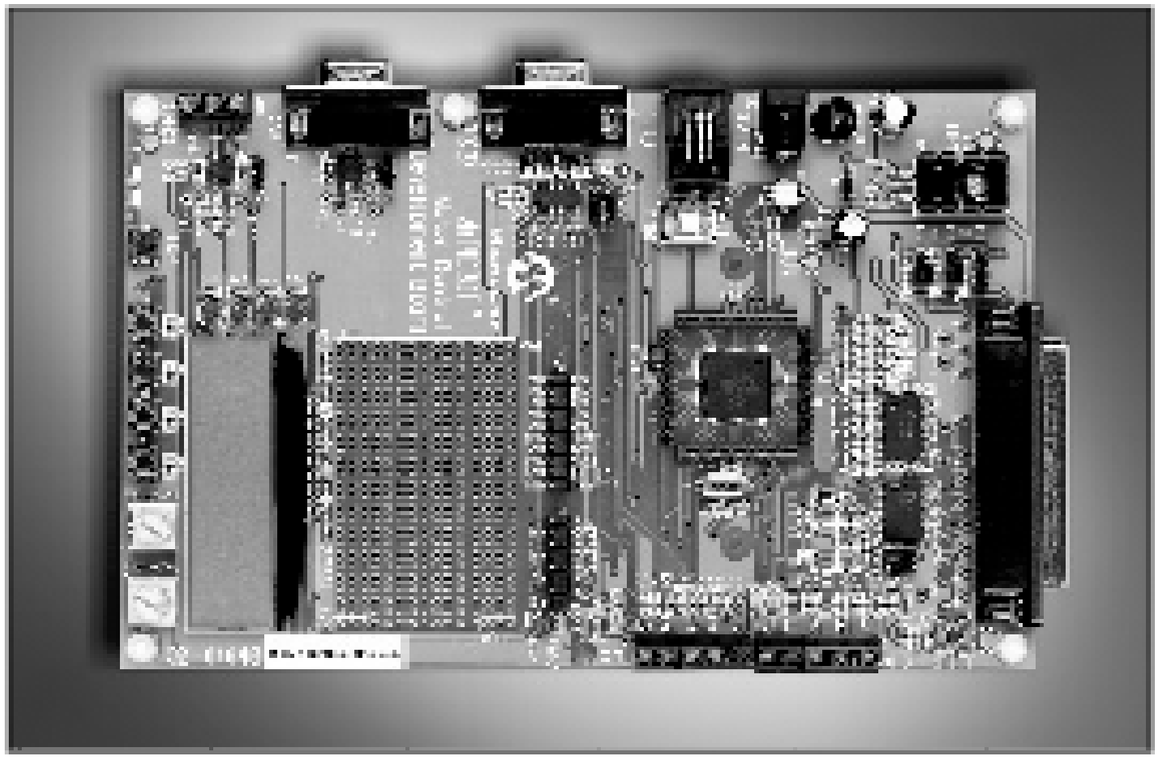


DM183011

Two sockets supporting 28 and 40-pin DIP devices

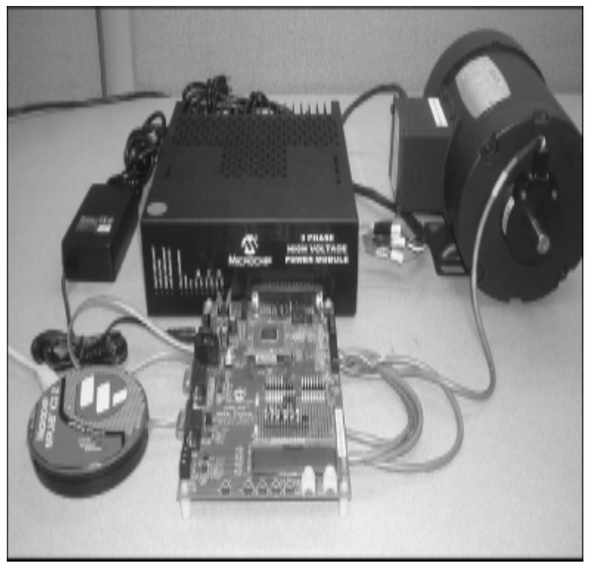
· Motor terminal strip
· 3-phase inverter power module
· Motion sensor inputs
· Speed control potentiometer
· Active RS-232 port
· Full automatic protection of power circuits
· Electrical isolation from power circuits
· ICD Connector
· FREE! Motor Control GUI software

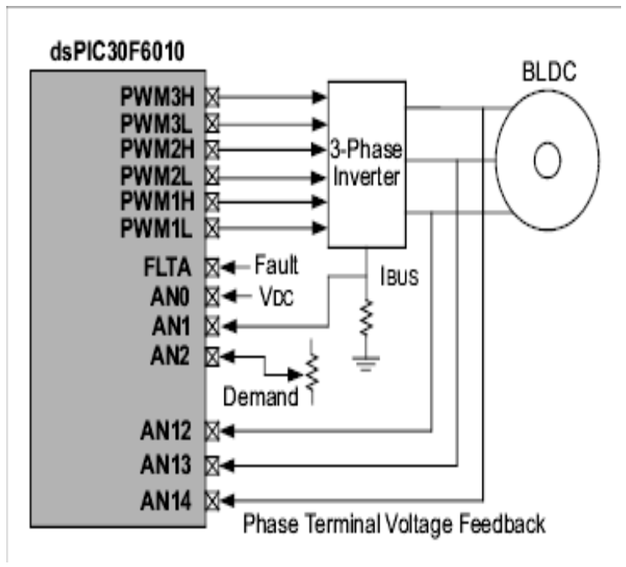
Development Tool



DM300020 , DM300021 , DM300022

- Processor:dsPIC30F6010 80-pin TQFP
- ICD2 and ICSP supported
- Motor Position Feedback Interface
  - Halls & QEI
- Oscillator:7.3728 MHz
- RS-232 Serial Port
- RS-485 Serial Bus
- CAN bus
- LCD Display
- LEDs
- Push Button Switches
- Potentiometers
- Current Feedback from the Power Modules
- Voltage Feedback
- Back EMF Crossing Detection





Application Note

Application Note

- Variable Frequency
  - AN843
  - AN861
- AC Induction
  - AN887
  - AN889
  - AN900
  - AN908
  - AN955
  - AN967
- DC Brush
  - AN531
  - AN532
  - AN600
  - AN696
  - AN718
  - AN892
  - AN893
  - AN957
- DC Brushless
  - AN764
  - AN768
  - AN857
  - AN885
  - AN894
  - AN898
  - AN899
  - AN901
  - AN970