

A PS/2 Keyer: Using Keyer Paddles to Emulate a PS/2 Keyboard and Mouse

or

My First Microchip PIC® Project

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Introduction

- strong desire to do a PIC project
 - looking for a project idea
- general project requirements
 1. well defined input
 2. well defined output
 3. circuit only with a microcontroller
 4. needed to be written in C

Introduction

- at the 26th DCC, NUE-PSK PSK31 modem introduced



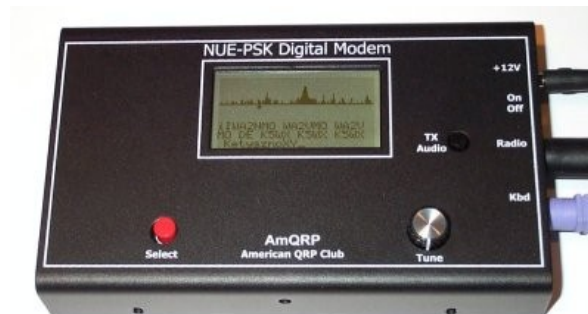
Introduction

- cool, but it needs a keyboard



Introduction

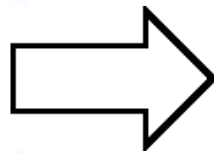
- Can I replace the keyboard with a CW paddle?



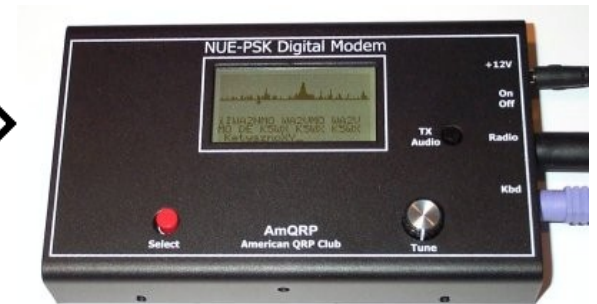
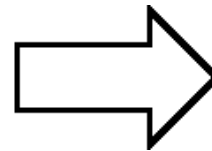
Introduction



my Microchip PIC project idea



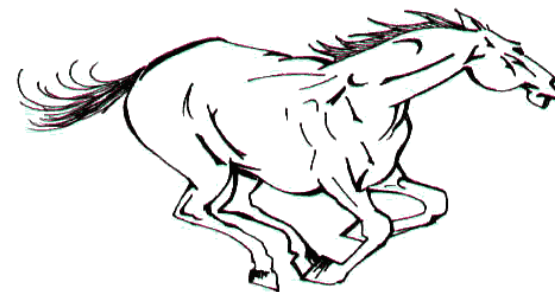
PIC



Introduction

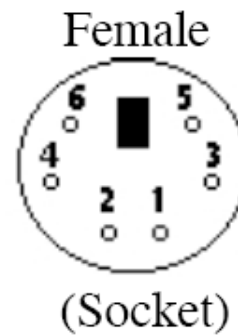
- project requirements
 1. input: Morse code – ITU-R M.1677
 - symbol, character, and word timing
 2. output: PS/2 interface
 - PS/2 keyboard scan codes – IBM PS/2 HCTR, 1990
 - PS/2 mouse – can a PS/2 mouse be emulated?
 3. circuit with only a PIC – probably
 4. programming in C – definitely!

- project name: PS/2 Keyer



PS/2 Protocol

- PS/2 keyboard and mouse interface



6-pin Mini-DIN (PS/2):

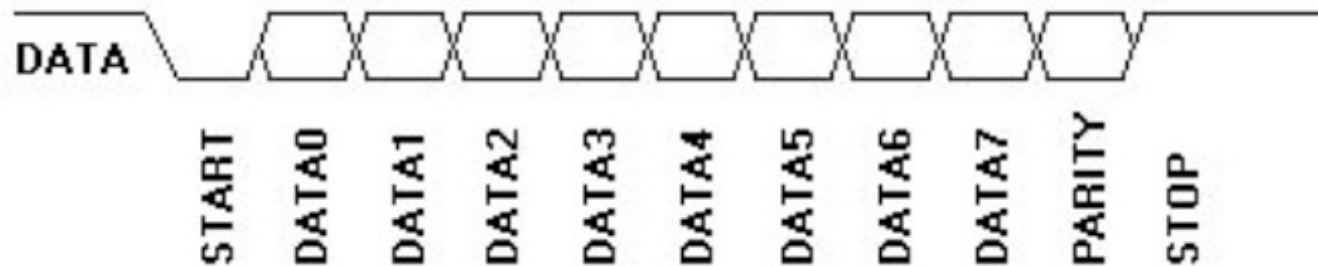
- 1 - Data
- 2 - Not Implemented
- 3 - Ground
- 4 - Vcc (+5V)
- 5 - Clock
- 6 - Not Implemented

PS/2 Protocol

- PS/2 protocol – two way synchronous protocol between *host* and *device*
 - host – a personal computer
 - device – a keyboard or a mouse
 - half-duplex protocol
 - clock and data lines shared between host and device
 - clock signal is between 10 to 16.7 kHz
 - generated by device
 - data is an 11 bit frame

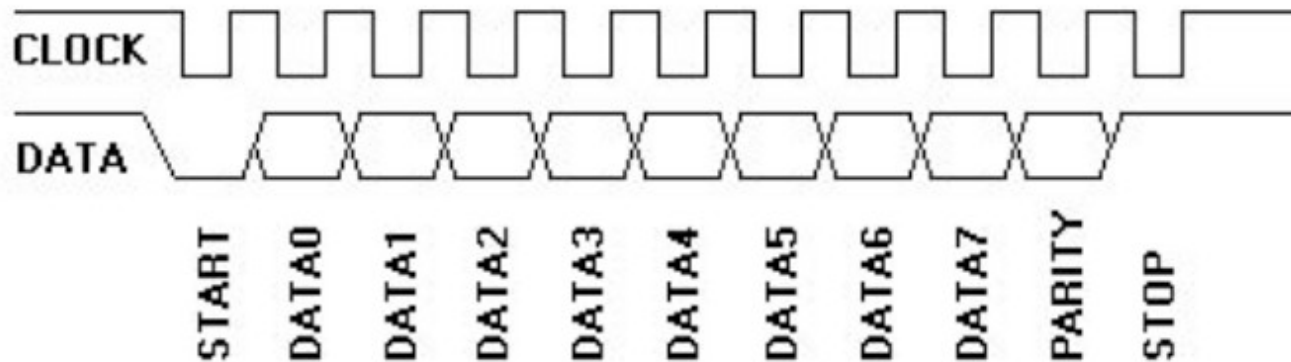
PS/2 Protocol

- PS/2 protocol – data is an 11 bit frame
 - 0 start bit
 - the eight data bits – least significant bit first
 - odd parity bit
 - 1 stop bit



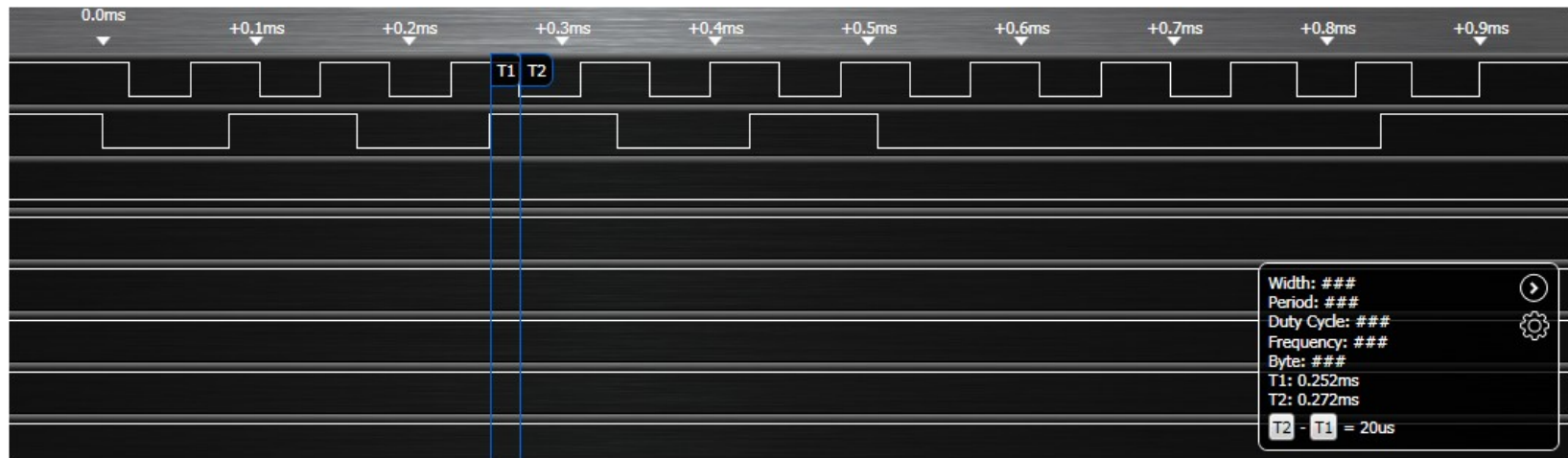
PS/2 Protocol

- device-to-host communication
 1. device checks if clock line is idle (high)
 2. device starts to generate clock
 3. device sends byte in frame
 - bits are read on the **falling** edge of clock signal



PS/2 Protocol

- pressed the letter Q

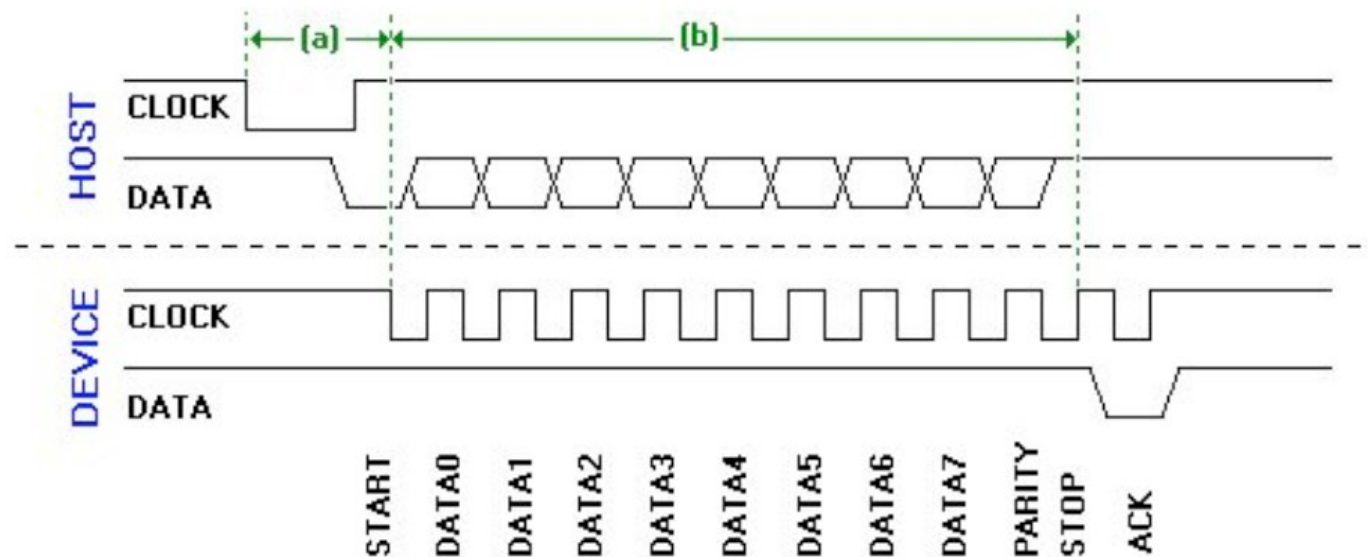


0 1010 1000 0 1 = 0001 0101 = 0x15



PS/2 Protocol

- host-to-device communication
 1. host checks if clock line is idle (high)
 2. host sends request-to-send on clock line
 3. device responds by generating clock signal for host
 4. host sends byte in frame
 - bits are read on the **rising** edge of clock signal
 5. device acknowledges data received



PS/2 Keyboard Protocol

- PS/2 keyboard protocol
 - a key on keyboard has a unique scan code byte
 1. key pressed – make
 2. key released – break code
 - host commands keyboard to light an LED
 - **Caps Lock** pressed
 - **Num Lock** pressed

KEY	MAKE	BREAK	-
A	1C	F0,1C	
B	32	F0,32	
C	21	F0,21	
D	23	F0,23	
E	24	F0,24	
F	2B	F0,2B	
G	34	F0,34	
H	33	F0,33	
I	43	F0,43	
J	3B	F0,3B	
K	42	F0,42	
L	4B	F0,4B	
M	3A	F0,3A	
N	31	F0,31	
O	44	F0,44	
P	4D	F0,4D	
Q	15	F0,15	
R	2D	F0,2D	

PS/2 Mouse Protocol

- PS/2 mouse protocol
 - standard PS/2 mouse has left, middle, right buttons
- sends three byte packet
 - button information
 - movement – relative position change
 - signed nine bit two's complement binary number

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 1	Y overflow	X overflow	Y sign bit	X sign bit	Always 1	Middle Btn	Right Btn	Left Btn
Byte 2	X Movement							
Byte 3	Y Movement							

Getting Started



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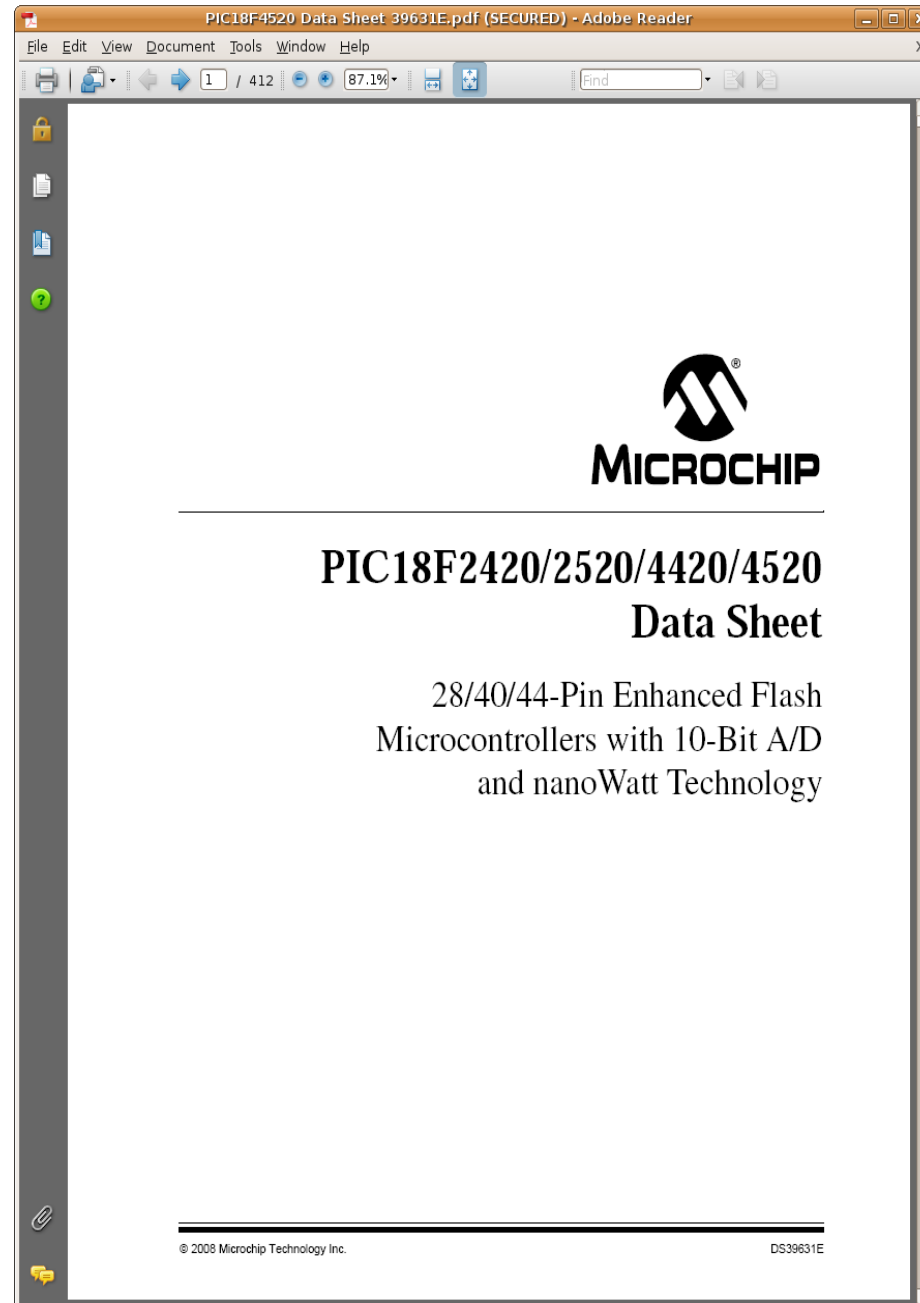
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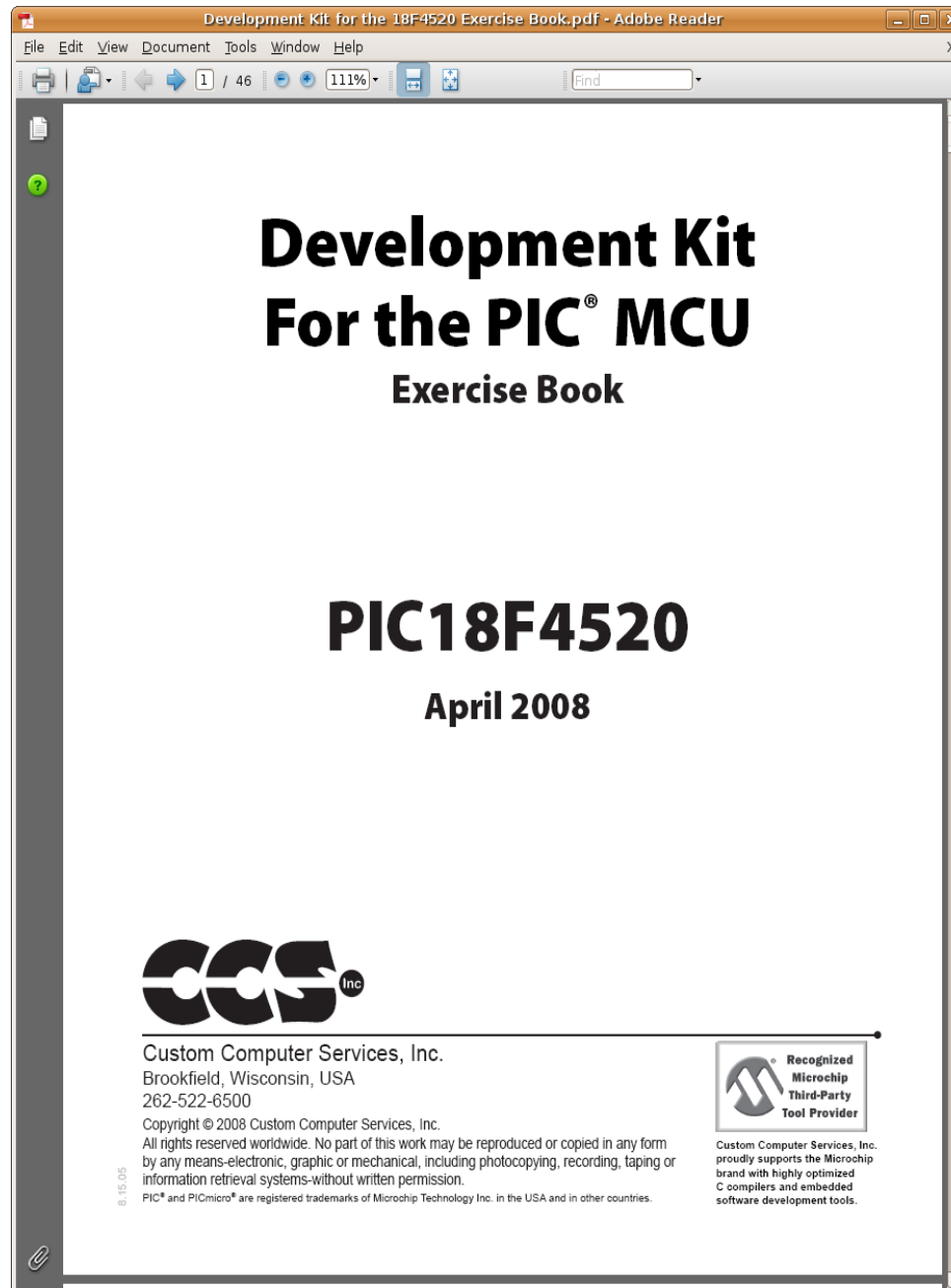
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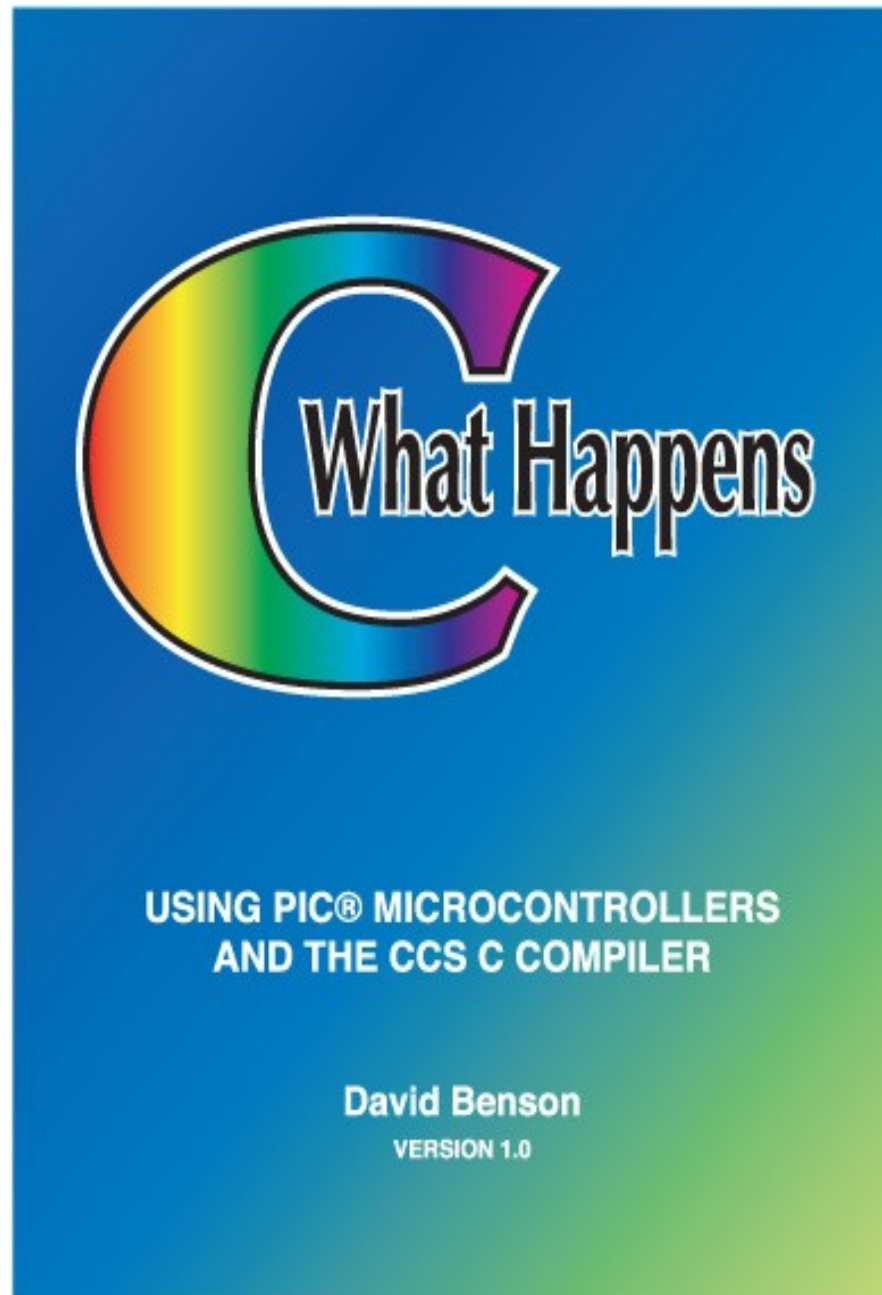
Getting Started



Getting Started



Getting Started

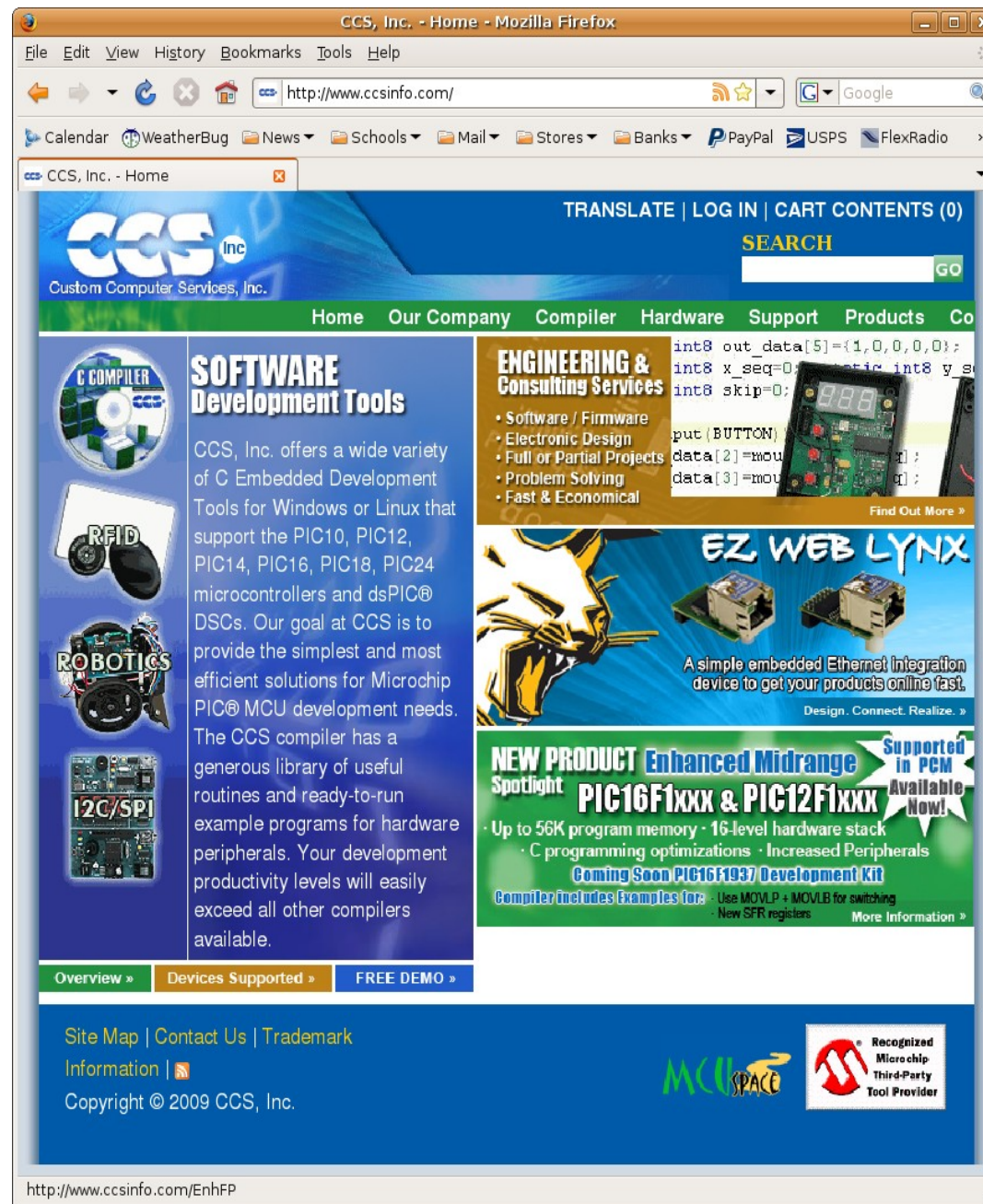


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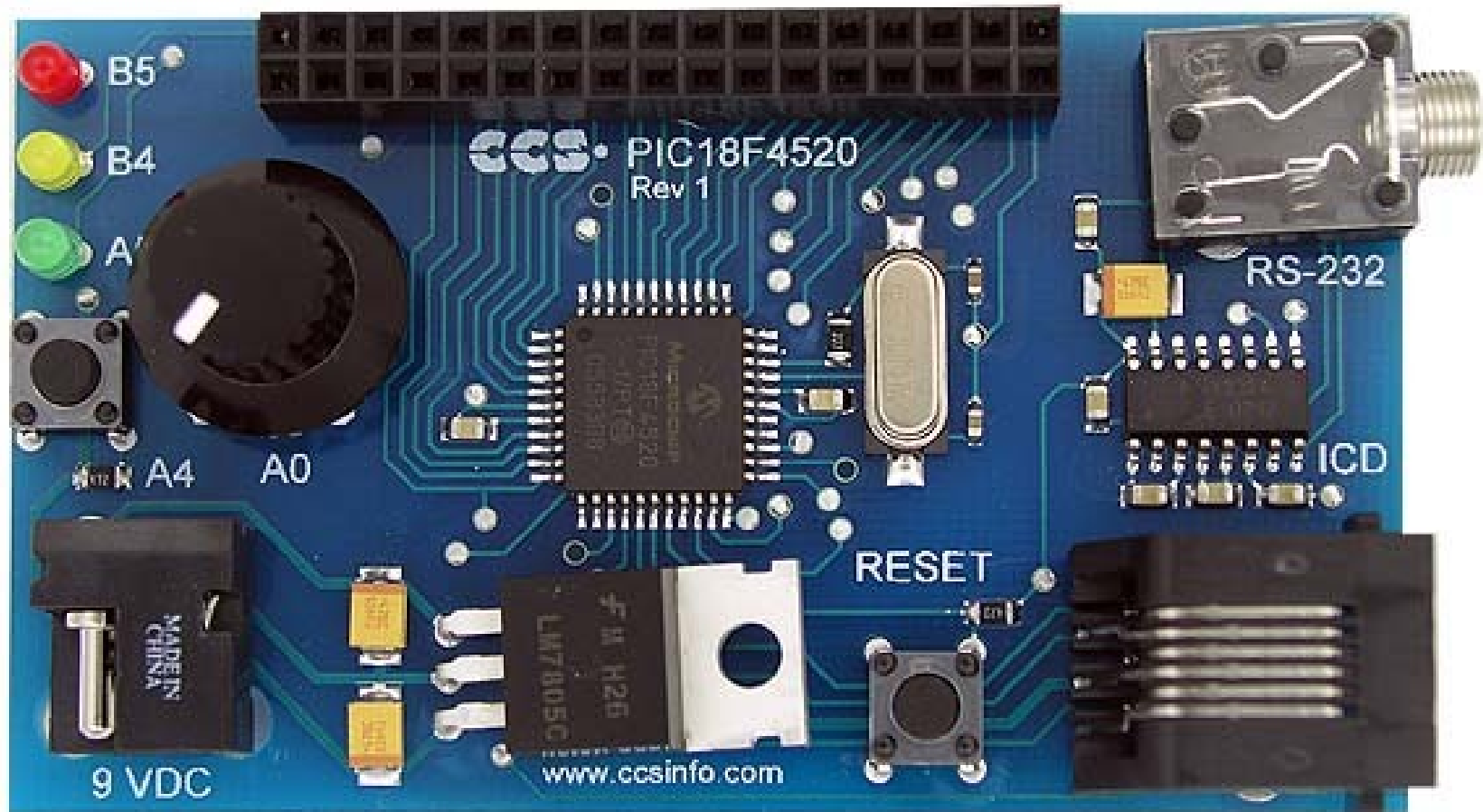
Getting Started

- my C compiler

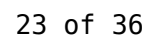


Prototyping Board

- from CCS, Inc.

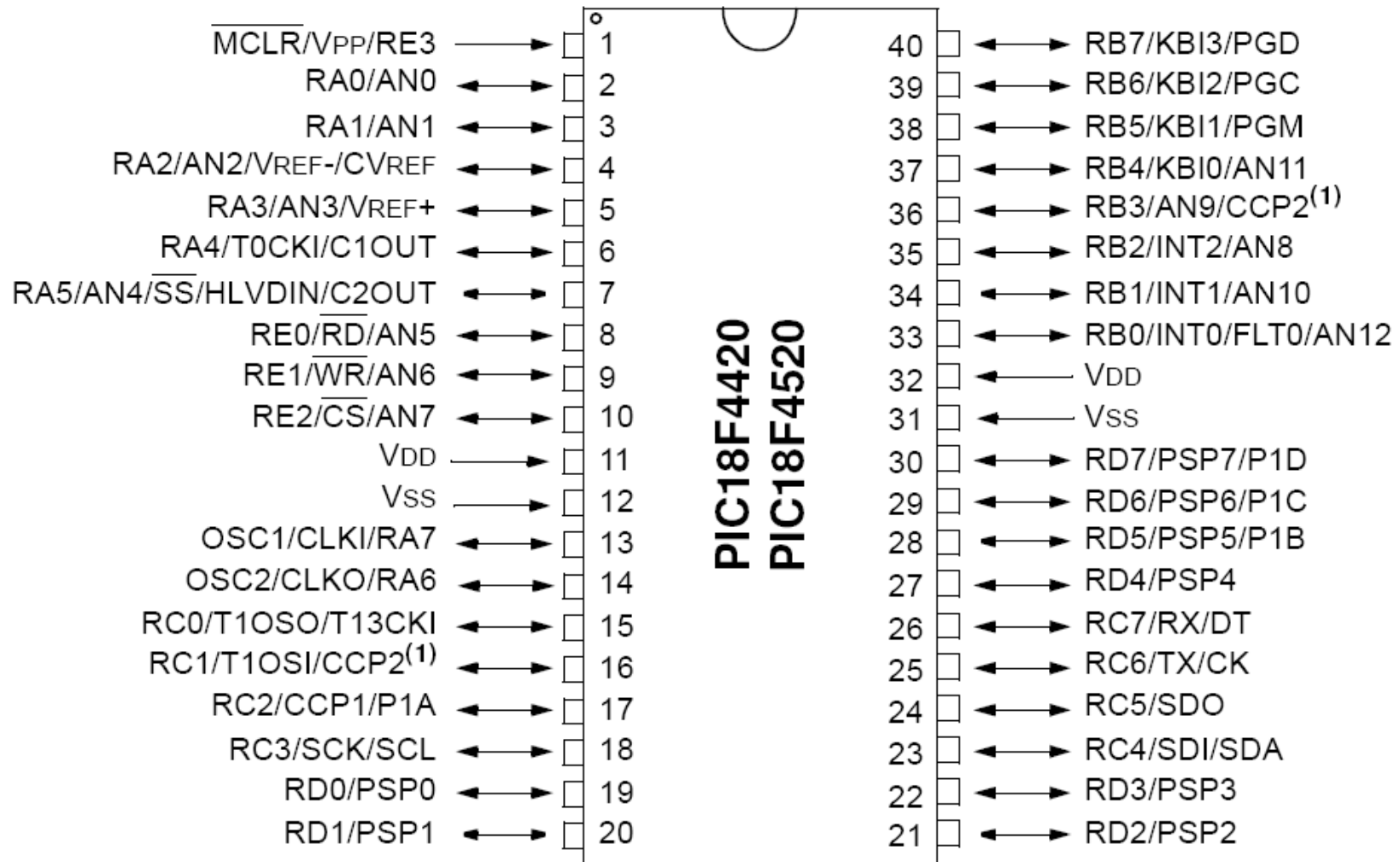


- ARRL and TAPR Digital Communications Conference



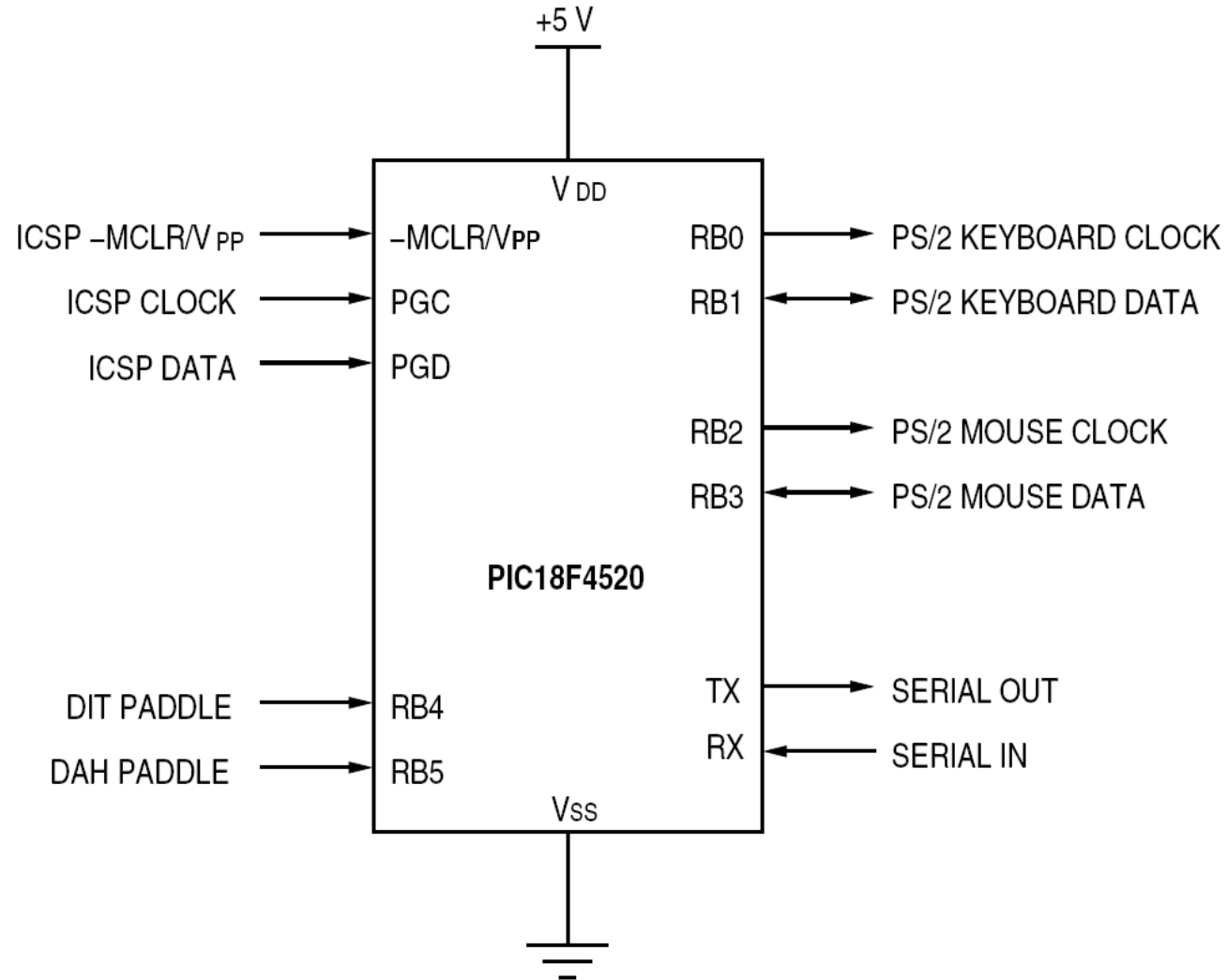
PS/2 Keyer

- selected the PIC184520 – used in demo boards



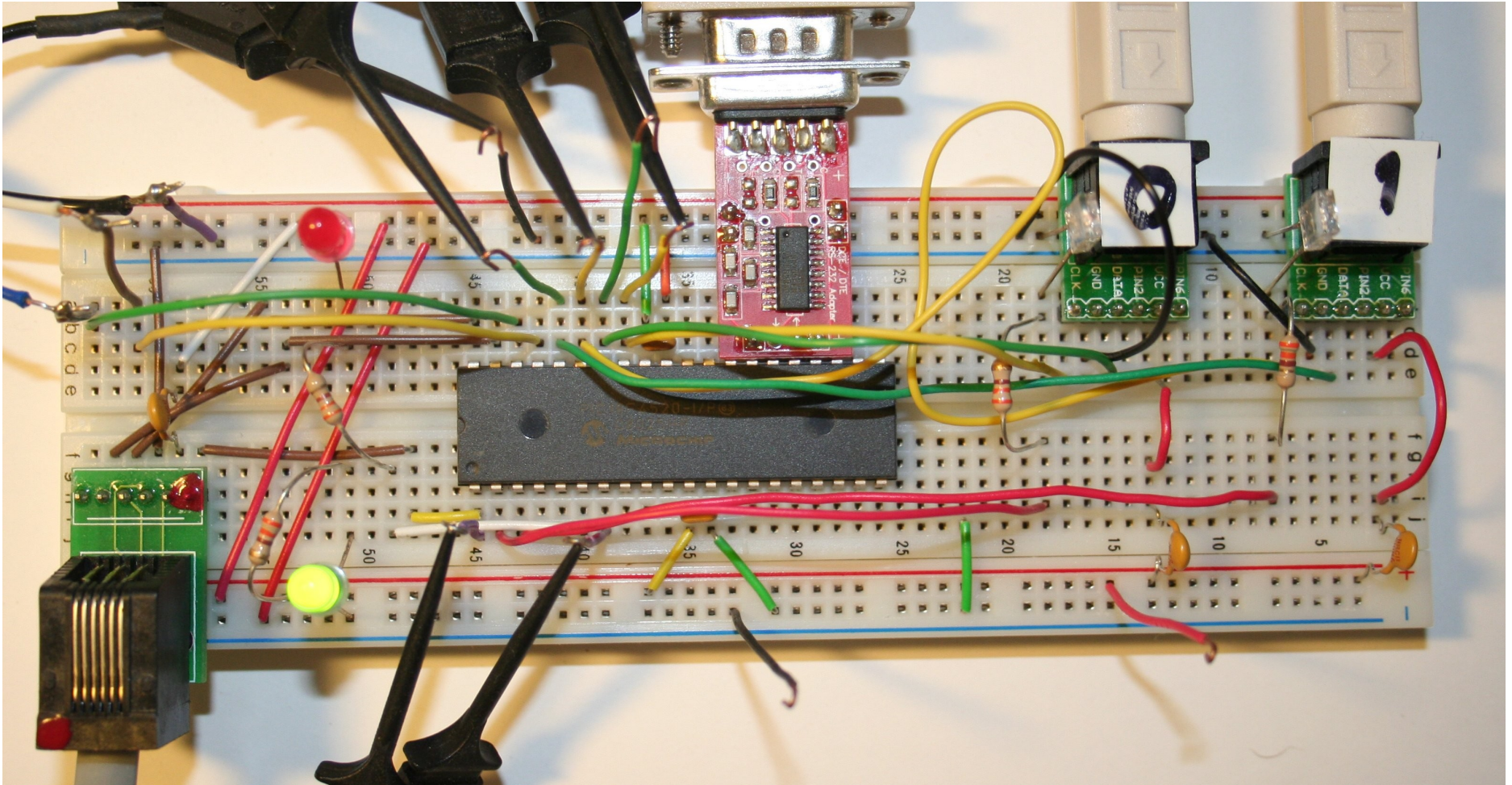
PS/2 Keyer

- schematic



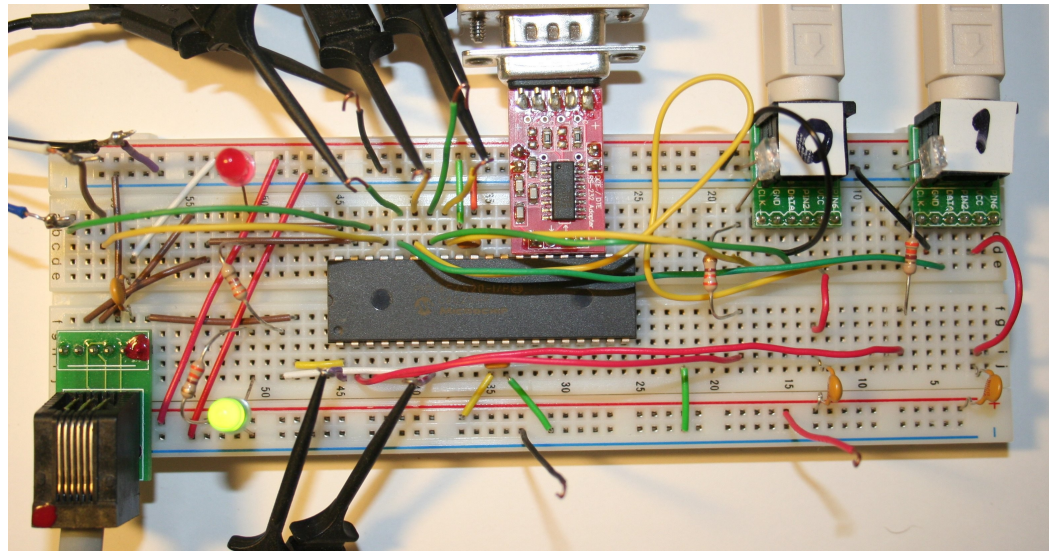
PS/2 Keyer

- my prototyping board



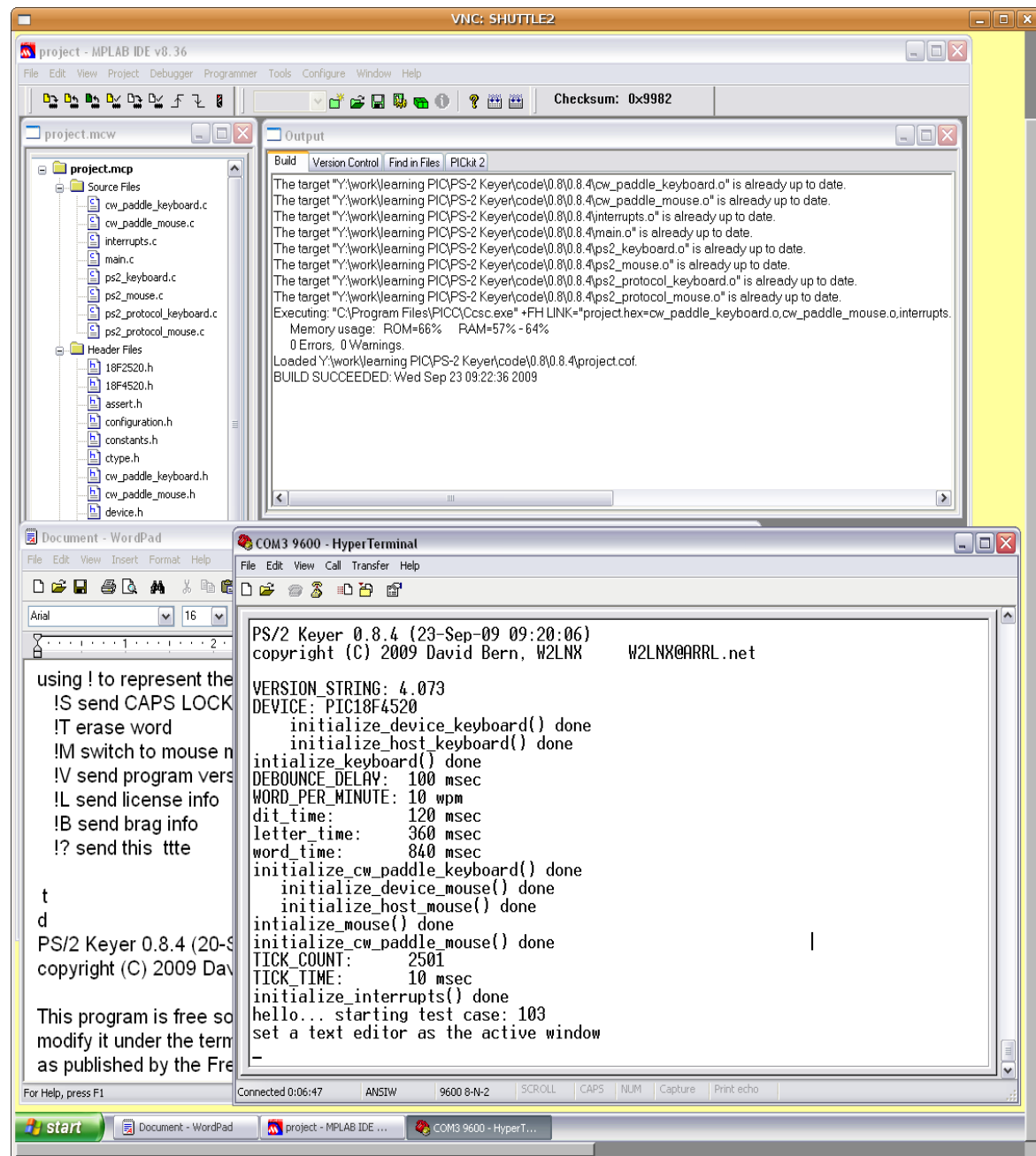
PS/2 Keyer

- my development setup



PS/2 Keyer

- my programming environment



PS/2 Keyer

- the program
 - 8 C source files and 12 header files
 - lookup tables
 - CW characters to ASCII characters
 - ASCII characters to PS/2 keyboard scan codes
 - a little over 4000 lines of commented C code
- switch bounce was a problem
 - CW Touch Keyer paddles – no bounce
- debugged
 - using LEDs
 - using logic analyzer
 - PS/2 signals and mark signals

PS/2 Keyer

- PIC184520 is made to order for PS/2 Keyer
 - internal 8 MHz oscillator
 - port B is versatile
 - internal pull-up resistors
 - each bit can be configured for input or output
 - output is HIGH or LOW
 - input reads pin and goes into high impedance
 - interrupts used for
 - internal timer to measure time between letters and words
 - wake up from sleep when a CW paddle is touched

PS/2 Keyer

- features
 - PS/2 keyboard emulation
 - text entered with CW paddles
 - PS/2 mouse emulation
 - left button – tap left paddle
 - middle button – reserved
 - right button – tap right paddle
 - mouse movement – eight possible directions
 - left-right – press and hold left paddle
 - up-down – press and hold right paddle
 - diagonals – combinations of left-right and up-down

- demonstration here
 - move mouse around
 - open a WordPad file
 - switch to keyboard mode
 - type some text
 - switch to mouse mode

PS/2 Keyer

- availability
 - working in progress – today at version 0.8.4
 - licensed under GNU GPL, version 2
 - send email to W2LNX@ARRL.NET
 - subject line: PS/2 Keyer

Conclusions

- this project was interesting and great fun
 - with effort, from confusion comes understanding
 - step-by-step development and continual testing
 - few surprises
- PIC chips are inexpensive and readily available
 - are safe to handle
- tools are inexpensive
 - beginning books
 - PICkit 2 programmer
 - Saleae Logic logic analyzer
 - CCS C compiler
- possible use by people with limited physical mobility

Acknowledgments

- Thank you
 - Adam Bern, KB3KVD
 - Jim Johns, KA0IQT
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 - Larry Wolfgang, WR1B
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George Heron, N2APB
 - Rick Hambly, W2GPS
 - Steve Bible, N7HPR

Questions



I will be in the demonstration room during Play Time