

Smart Products Boot Camp

Intro

The outcome objective of the boot camp is that you exit knowing how to wire a PIC chip circuit, know how to power a PIC chip circuit, know how to connect the programming pod to the circuit and to the PC, know how to create a C program for the PIC chip, know how to compile the C program using the CCS C compiler, know how to burn the code onto the PIC chip, and know how to run the program.

Required tools

Breadboard, 22 g solid wire, 9V battery, battery snap, components.

DMM (digital multi-meter)

Windows PC with USB port(s)

CCS C compiler, ver. 4.066 or later

Microchip PICkit 2 programmer hardware

PICkit 2 software, ver 2.40b or later

Hardware Steps

1. Wire the PIC LED circuit shown on the PIC LED schematic.. Keep wires short, never have wires cross over the top of a chip and keep wires as far from the chip as possible. Leave room on the board for additional chips. IC pinouts are elsewhere in this document. See samples for general layout techniques.
2. For the Programming Connection (J1), use 5 adjacent holes. Connect to the PICkit 2 programming pod using a right angle header. (Depending on the header, you may have to push the plastic retaining bar on the header to expose more of the pin.
3. For power, use a 9V battery and a battery snap. Do not connect the battery. (Optional: Off-line solder jumper wires to a power jack so that a 9V wall wart can be used for power.)
4. Power the circuit by connecting the battery. While connecting, place finger tips on all the integrated circuits. If anything gets warm, pull the power....fast.
5. Using a DMM, check that circuit supply voltage is at +5V and that all ICs are getting the correct supply voltage. Disconnect the battery

Software Steps

1. Make a new directory for each project.
2. Create a new text file named flash_led.c. (Or, copy in a .c file that will be used as the starting point for the new project and change the filename to suit the project.)
3. Start the CCS C compiler (Start > All Programs > PIC-C > PIC C Compiler)
4. Project > Create (to create a new project). Do not use the PIC Wizard to create a project.
5. Navigate to your project directory and select your .c source file. In the Project Options dialog, click Apply. (Occasionally, projects need options other than the defaults, but not this time.)
6. Type in or edit the flash_led.c code shown elsewhere in this document. As you go along, examine the annotated version of the code (on the following page) to get a feel for what you are typing in. Normally, one would be starting with a template or example source file rather than typing from scratch.

7. Compile the file with F9. Correct any errors. Look in the project directory to see the generated files. The .hex file is the one that will be loaded onto the microcontroller.

Burning to the PIC Chip Steps

1. Connect the PICkit 2 programming pod to the computer USB port.
2. Connect the pod to the programming connector on the breadboard.
3. Power the breadboard by connecting the 9V battery.
4. Start the PICkit 2 application. The application should see both the programming pod and the PIC chip in the circuit. If not, check connections and board power.
5. File > Import Hex (Ctrl-I). Navigate to your project directory and select the .hex file. The program should download and run on the microcontroller. Once downloaded, it is possible to disconnect the programming pod. Each time the application circuit is powered, the program will run.
6. Click the Auto Import Hex + Write Device button and select the .hex file. Now, each time you compile (F9) in the CCS IDE window, the new .hex file will automatically download to the application circuit making code iterations fast and easy. Try it.

You have successfully completed your first embedded microcontroller project when you demo a flashing LED.

<....the rest of the bootcamp manual is on the way...>

DC MOTOR PROJECT

BI-DIRECTIONAL MOTOR CONTROL PROJECT

STEPPER MOTOR CONTROL PROJECT

```

/*****
FILE:      flash_led.c

DESCRIPTION: A first PIC program. Flashes LED attached
to PIC pin.
Designed for 16f88 PIC chip using internal oscillator.

REVISION HISTORY:
*****/
/--Includes

#include <16f88.h>

/--Setup commands

#fuses INTRC_IO,NOWDT,NOPROTECT,PUT,NOWRT,NOLVP // internal oscillator
#id 0x1234 // 4 digit id
#use standard_io(A)
#use standard_io(B)
//#use fast_io(A)
//#use fast_io(B)
#use delay(clock=8000000) // declare clock speed

/--Pin definitions

#define LED      PIN_B0 // LED

/*****
Main starts here
*****/

void main(void)
{
    int i;
    setup_oscillator(OSC_8MHZ);

    /-----Set direction registers

    // set_tris_a(0xFF); // a is all inputs (for adc)
    // set_tris_b(0xC0); // b7,b6 in, rest out

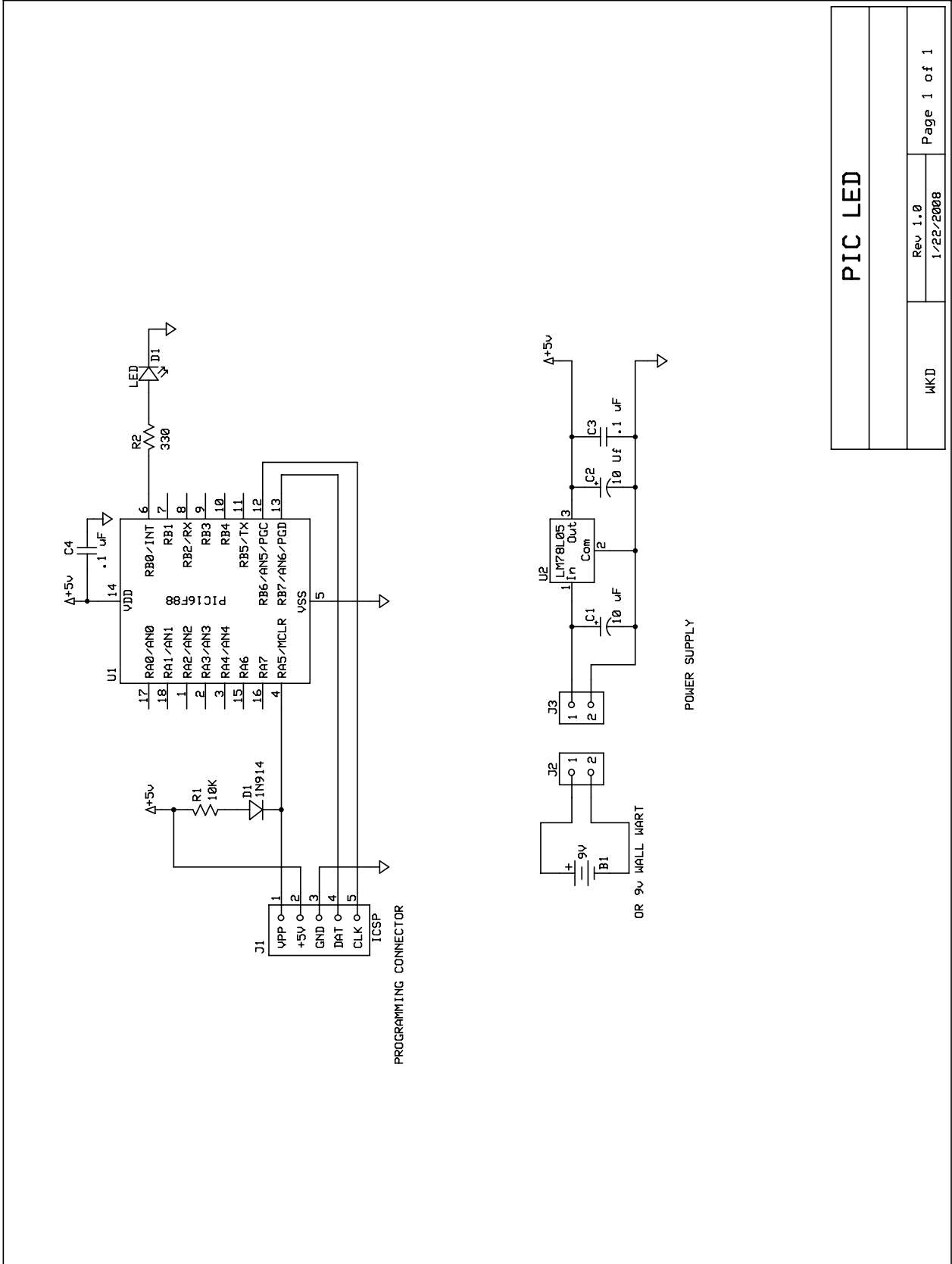
    /-----Flash debug led a few times

    for (i=0;i<5;i++) {
        output_high(LED);
        delay_ms(100);
        output_low(LED);
        delay_ms(300);
    }

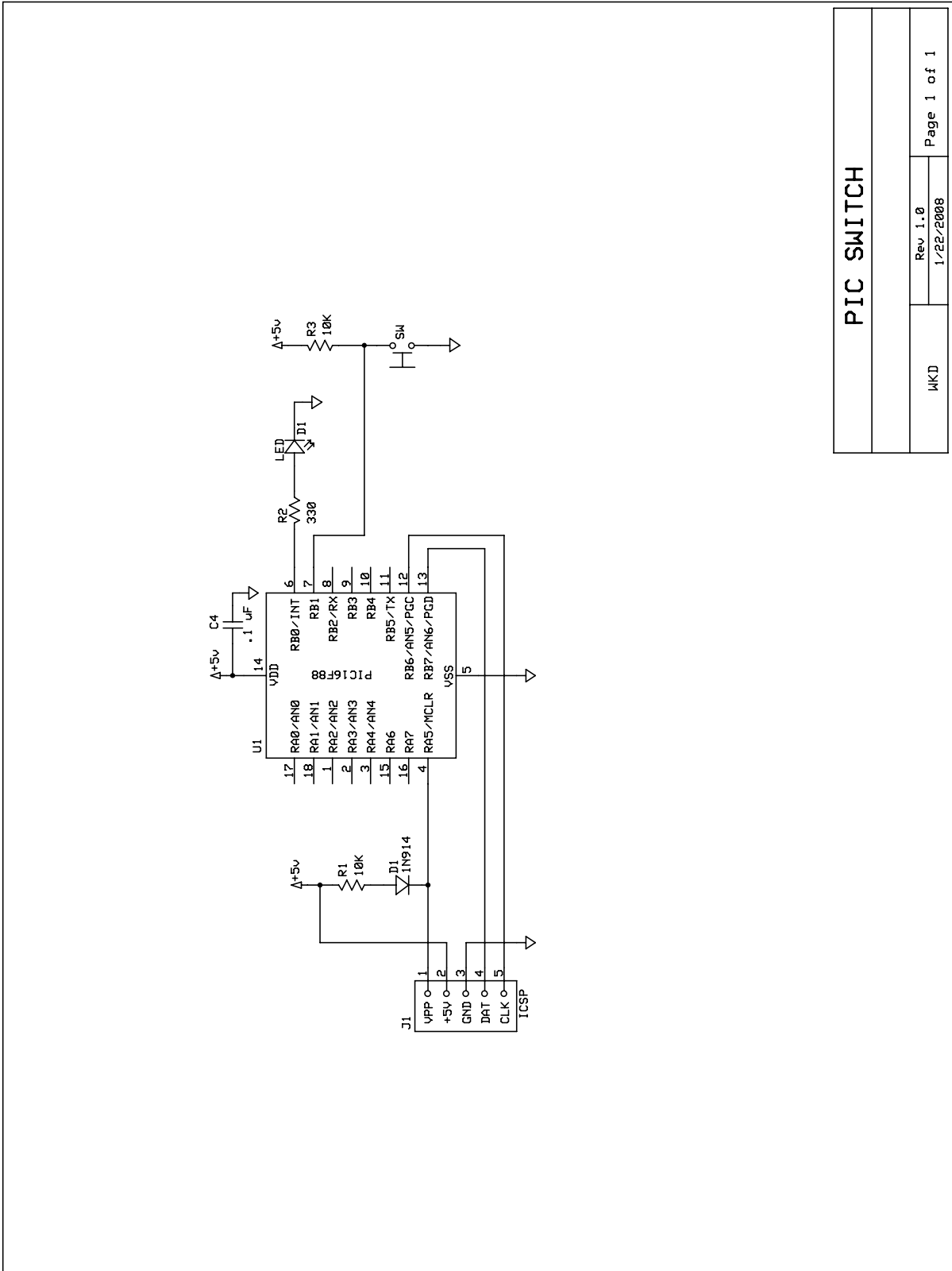
    /-----That's all folks

    sleep();
}

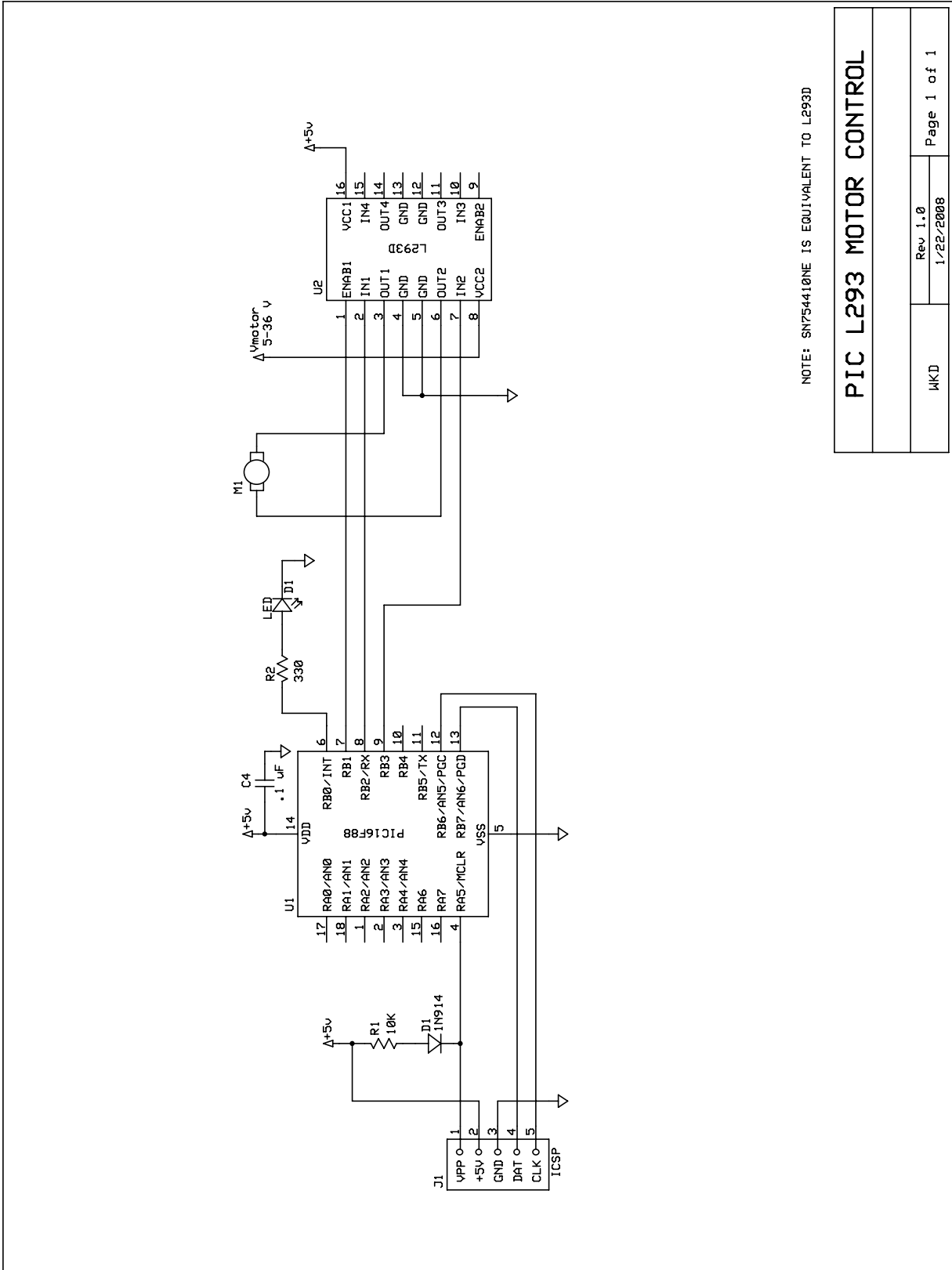
```

PIC LED	
MKD	Rev 1.0 1/22/2008
Page 1 of 1	



PIC SWITCH	
WKD	Rev 1.0 1/22/2008
Page 1 of 1	



NOTE: SN754410NE IS EQUIVALENT TO L293D

PIC L293 MOTOR CONTROL	
MKD	Rev 1.0 1/22/2008
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PIC16F87/88

18/20/28-Pin Enhanced FLASH MCUs with nanoWatt Technology

Low-Power Features:

- Power Managed modes:
 - Primary RUN: RC oscillator, 78 μ A, 1 MHz, 2V
 - RC_RUN: 7 μ A, 31.25 kHz, 2V
 - SEC_RUN: 9 μ A, 32 kHz, 2V
 - SLEEP: 0.1 μ A, 2V
- Timer1 Oscillator: 1.8 μ A, 32 kHz, 2V
- Watchdog Timer: 2.2 μ A, 2V
- Two-Speed Oscillator Start-up

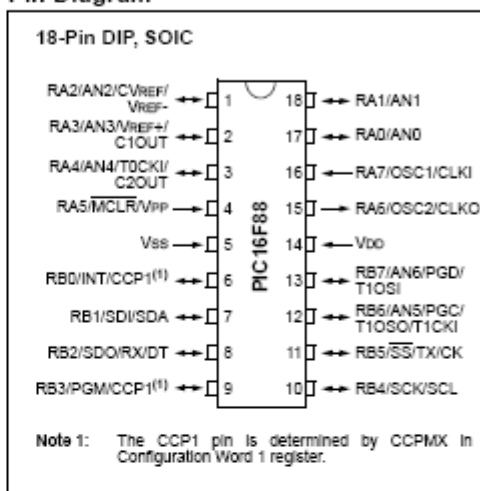
Oscillators:

- Three Crystal modes:
 - LP, XT, HS: up to 20 MHz
- Two External RC modes
- One External Clock mode:
 - ECIO: up to 20 MHz
- Internal oscillator block:
 - 8 user selectable frequencies: 31 kHz, 125 kHz, 250 kHz, 500 kHz, 1 MHz, 2 MHz, 4 MHz, 8 MHz

Peripheral Features:

- Capture, Compare, PWM (CCP) module:
 - Capture is 16-bit, max. resolution is 12.5 ns
 - Compare is 16-bit, max. resolution is 200 ns
 - PWM max. resolution is 10-bit
- 10-bit, 7-channel Analog-to-Digital Converter
- Synchronous Serial Port (SSP) with SPI™ (Master/Slave) and I²C™ (Slave)
- Addressable Universal Synchronous Asynchronous Receiver Transmitter (USART/SCI) with 9-bit address detection:
 - RS-232 operation using internal oscillator (no external crystal required)
- Dual Analog Comparator module:
 - Programmable on-chip voltage reference
 - Programmable input multiplexing from device inputs and internal voltage reference
 - Comparator outputs are externally accessible

Pin Diagram

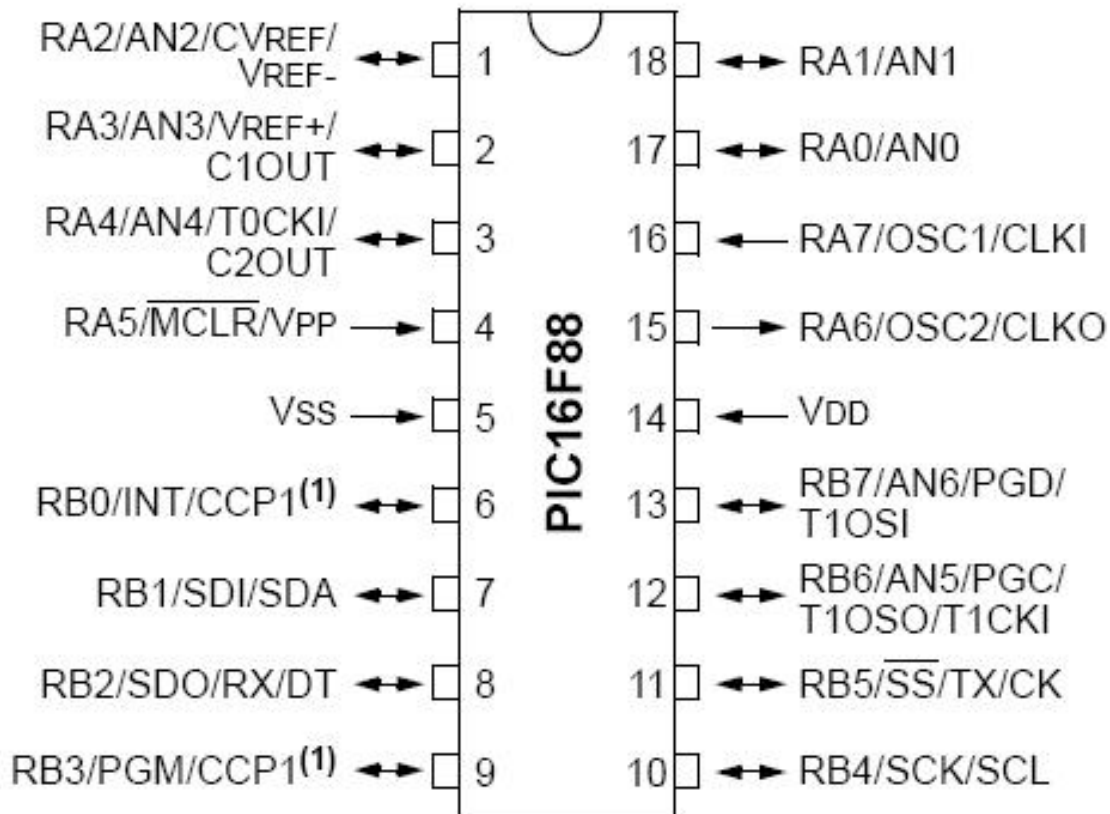


Special Microcontroller Features:

- 100,000 erase/write cycles Enhanced FLASH program memory typical
- 1,000,000 typical erase/write cycles EEPROM data memory typical
- EEPROM Data Retention: > 40 years
- In-Circuit Serial Programming™ (ICSP™) - via two pins
- Processor read/write access to program memory
- Low-Voltage Programming
- In-Circuit Debugging via two pins
- Extended Watchdog Timer (WDT):
 - Programmable period from 1 ms to 288s
- Wide operating voltage range: 2.0V to 5.5V

Device	Program Memory		Data Memory		I/O Pins	10-bit A/D (ch)	CCP (PWM)	USART	Comparators	SSP	Timers 8/16-bit
	FLASH (bytes)	# Single Word Instructions	SRAM (bytes)	EEPROM (bytes)							
PIC16F87	7168	4096	388	256	18	n/a	1	Y	2	Y	2/1
PIC16F88	7168	4096	388	256	18	1	1	Y	2	Y	2/1

18-Pin DIP, SOIC



Note 1: The CCP1 pin is determined by CCPMX in Configuration Word 1 register.

LM78LXX Series 3-Terminal Positive Regulators

General Description

The LM78LXX series of three terminal positive regulators is available with several fixed output voltages making them useful in a wide range of applications. When used as a zener diode/resistor combination replacement, the LM78LXX usually results in an effective output impedance improvement of two orders of magnitude, and lower quiescent current. These regulators can provide local on card regulation, eliminating the distribution problems associated with single point regulation. The voltages available allow the LM78LXX to be used in logic systems, instrumentation, HiFi, and other solid state electronic equipment.

The LM78LXX is available in the plastic TO-92 (Z) package, the plastic SO-8 (M) package and a chip sized package (8-Bump micro SMD) using National's micro SMD package technology. With adequate heat sinking the regulator can deliver 100mA output current. Current limiting is included to limit the peak output current to a safe value. Safe area protection for the output transistors is provided to limit inter-

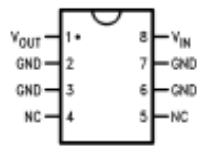
nal power dissipation. If internal power dissipation becomes too high for the heat sinking provided, the thermal shutdown circuit takes over preventing the IC from overheating.

Features

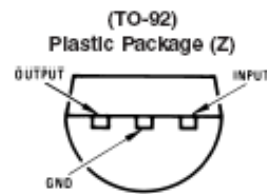
- LM78L05 in micro SMD package
- Output voltage tolerances of $\pm 5\%$ over the temperature range
- Output current of 100mA
- Internal thermal overload protection
- Output transistor safe area protection
- Internal short circuit current limit
- Available in plastic TO-92 and plastic SO-8 low profile packages
- No external components
- Output voltages of 5.0V, 6.2V, 8.2V, 9.0V, 12V, 15V
- See AN-1112 for micro SMD considerations

Connection Diagrams

SO-8 Plastic (M)
(Narrow Body)

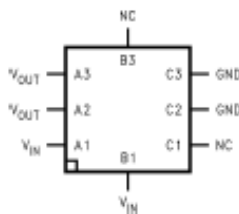


Top View



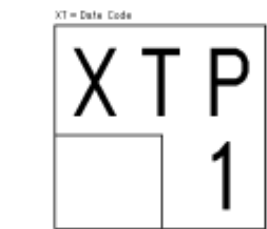
Bottom View

8-Bump micro SMD



Top View
(Bump Side Down)

micro SMD Marking Orientation



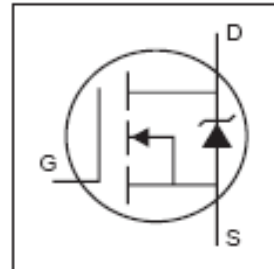
Pin A1 Corner
Pin A1 is identified by lower left corner with respect to the text.

Top View

IRL520N

HEXFET® Power MOSFET

- Logic-Level Gate Drive
- Advanced Process Technology
- Dynamic dv/dt Rating
- 175°C Operating Temperature
- Fast Switching
- Fully Avalanche Rated

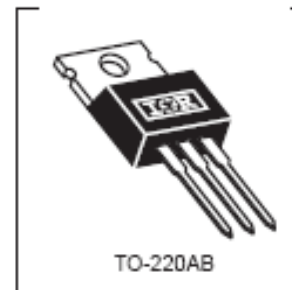


$V_{DSS} = 100V$
$R_{DS(on)} = 0.18\Omega$
$I_D = 10A$

Description

Fifth Generation HEXFETs from International Rectifier utilize advanced processing techniques to achieve extremely low on-resistance per silicon area. This benefit, combined with the fast switching speed and ruggedized device design that HEXFET Power MOSFETs are well known for, provides the designer with an extremely efficient and reliable device for use in a wide variety of applications.

The TO-220 package is universally preferred for all commercial-industrial applications at power dissipation levels to approximately 50 watts. The low thermal resistance and low package cost of the TO-220 contribute to its wide acceptance throughout the industry.

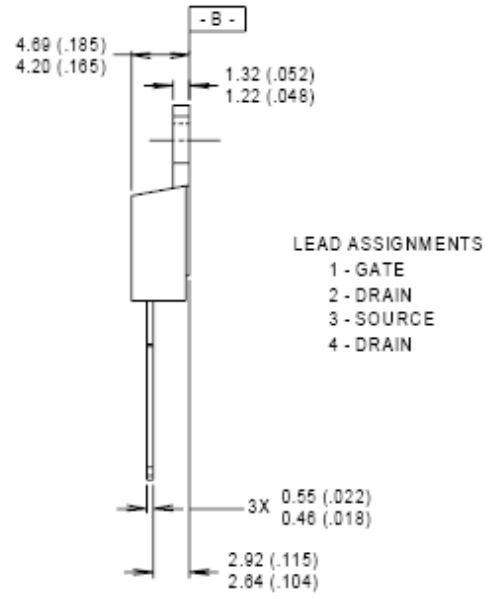
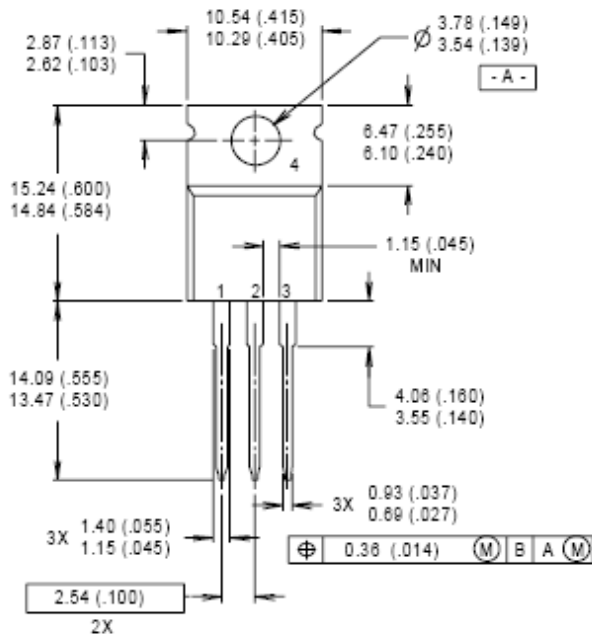


Absolute Maximum Ratings

	Parameter	Max.	Units
$I_D @ T_C = 25^\circ C$	Continuous Drain Current, $V_{GS} @ 10V$	10	A
$I_D @ T_C = 100^\circ C$	Continuous Drain Current, $V_{GS} @ 10V$	7.1	
I_{DM}	Pulsed Drain Current ①	35	
$P_D @ T_C = 25^\circ C$	Power Dissipation	48	W
	Linear Derating Factor	0.32	W/°C
V_{GS}	Gate-to-Source Voltage	± 18	V
E_{AS}	Single Pulse Avalanche Energy ②	85	mJ
I_{AR}	Avalanche Current ①	6.0	A
E_{AR}	Repetitive Avalanche Energy ①	4.8	mJ
dv/dt	Peak Diode Recovery dv/dt ③	5.0	V/ns
T_J	Operating Junction and	-55 to +175	°C
T_{STG}	Storage Temperature Range		
	Soldering Temperature, for 10 seconds	300 (1.6mm from case)	
	Mounting torque, 6-32 or M3 screw	10 lbf-in (1.1N-m)	

Thermal Resistance

	Parameter	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case	—	3.1	°C/W
$R_{\theta CS}$	Case-to-Sink, Flat, Greased Surface	0.50	—	
$R_{\theta JA}$	Junction-to-Ambient	—	62	



NOTES:

- 1 DIMENSIONING & TOLERANCING PER ANSII Y14.5M, 1982.
- 2 CONTROLLING DIMENSION : INCH

- 3 OUTLINE CONFORMS TO JEDEC OUTLINE TO-220AB.
- 4 HEATSINK & LEAD MEASUREMENTS DO NOT INCLUDE BURRS.

Push-Pull Four Channel Driver

FEATURES

- Output Current 1A Per Channel (600mA for L293D)
- Peak Output Current 2A Per Channel (1.2A for L293D)
- Inhibit Facility
- High Noise Immunity
- Separate Logic Supply
- Over-Temperature Protection

DESCRIPTION

The L293 and L293D are quad push-pull drivers capable of delivering output currents to 1A or 600mA per channel respectively. Each channel is controlled by a TTL-compatible logic input and each pair of drivers (a full bridge) is equipped with an inhibit input which turns off all four transistors. A separate supply input is provided for the logic so that it may be run off a lower voltage to reduce dissipation.

Additionally the L293D includes the output clamping diodes within the IC for complete interfacing with inductive loads.

Both devices are available in 16-pin Batwing DIP packages. They are also available in Power SOIC and Hermetic DIL packages.

TRUTH TABLE

Vi (each channel)	VINH*	Vo
H	H	H
L	H	L
H	L	X**
L	L	X**

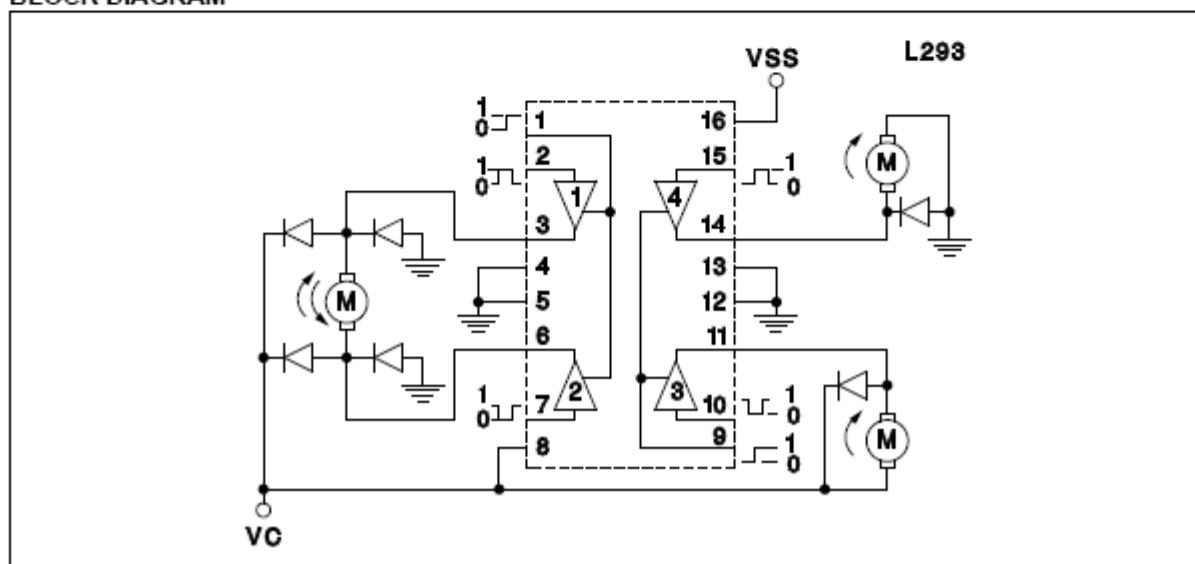
*Relative to the considered channel

**High output impedance

ABSOLUTE MAXIMUM RATINGS

Collector Supply Voltage, VC 36V
 Logic Supply Voltage, VSS 36V
 Input Voltage, Vi 7V
 Inhibit Voltage, VINH 7V
 Peak Output Current (Non-Repetitive), IOUT (L293) 2A
 IOUT (L293D) 1.2A
 Total Power Dissipation
 at Tground-pins = 80°C, N Batwing pkg. (Note) 5W
 Storage and Junction Temperature, Tstg, Tj -40 to +150°C
 Note: Consult packaging section of Databook for thermal limitations and considerations of packages.

BLOCK DIAGRAM



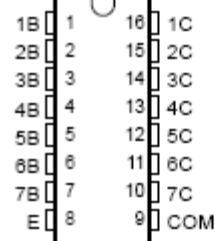
Note: Output diodes are internal in L293D.

ULN2001A, ULN2002A, ULN2003A, ULN2004A,
 ULQ2003A, ULQ2004A
DARLINGTON TRANSISTOR ARRAY
 SLRS027B – DECEMBER 1976 – REVISED APRIL 2002

HIGH-VOLTAGE HIGH-CURRENT DARLINGTON TRANSISTOR ARRAYS

- 500-mA Rated Collector Current (Single Output)
- High-Voltage Outputs . . . 50 V
- Output Clamp Diodes
- Inputs Compatible With Various Types of Logic
- Relay Driver Applications
- Designed to Be Interchangeable With Sprague ULN2001A Series

D OR N PACKAGE
(TOP VIEW)

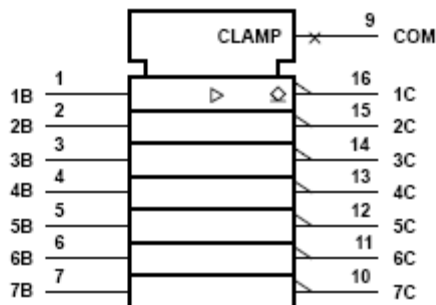


description

The ULN2001A, ULN2002A, ULN2003A, ULN2004A, ULQ2003A, and ULQ2004A are monolithic high-voltage, high-current Darlington transistor arrays. Each consists of seven npn Darlington pairs that feature high-voltage outputs with common-cathode clamp diodes for switching inductive loads. The collector-current rating of a single Darlington pair is 500 mA. The Darlington pairs may be paralleled for higher current capability. Applications include relay drivers, hammer drivers, lamp drivers, display drivers (LED and gas discharge), line drivers, and logic buffers. For 100-V (otherwise interchangeable) versions, see the SN75465 through SN75469.

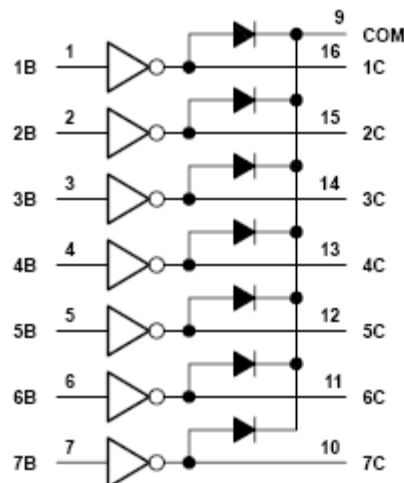
The ULN2001A is a general-purpose array and can be used with TTL and CMOS technologies. The ULN2002A is specifically designed for use with 14- to 25-V PMOS devices. Each input of this device has a zener diode and resistor in series to control the input current to a safe limit. The ULN2003A and ULQ2003A have a 2.7-kΩ series base resistor for each Darlington pair for operation directly with TTL or 5-V CMOS devices. The ULN2004A and ULQ2004A have a 10.5-kΩ series base resistor to allow operation directly from CMOS devices that use supply voltages of 6 to 15 V. The required input current of the ULN/ULQ2004A is below that of the ULN/ULQ2003A, and the required voltage is less than that required by the ULN2002A.

logic symbol



† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.

logic diagram



PRODUCTION DATA Information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.



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