Circuits Lecture – IED Fall 2004

- Voltage Regulators
- Transistors
- Motor direction control with a relay
- Motor control using the L293 chip
- PWM – Pulse Width Modulation
- RC servos
- SiLabs 8051

Voltage Regulators

- Used to supply a lower voltage from a higher voltage source. 5V from a 12V battery
- There are many common three terminal devices.
- Each has a rated output voltage and ***current***.
- If you exceed the current rating
  - –Unit may just shut down (if you are lucky.)
  - –Unit may smoke
- Each will be rated for a minimum input voltage.
  - –Typically the input must be at least 2V above the designed output voltage
  - –There is also a maximum rated input voltage
- If you run one near it's rated current, it will get hot.
  - –Consider adding a heat sink

ddress http://www.national.com/VCatalog/view.cgi?command=eq&attr1=Pins&attr2=3&q=25&m0=Category&i=Part+Number&s2=Part+Number%2F%2F1&s1=InputMax+Voltage%2F%2F1&s0=Package+Type%2F%2F1&a3=InputMin+Voltage%2F%2Fv%

National Semiconductor
The Sight & Sound of Information

Search | Knowledge Base | Order Parts | Cross-Ref
Search

Parametric Product Catalog

Narrow your results by:

Package Type
TO 220 (11)
TO 252 (2)
TO 263 (6)
TO 92 (9)
TO-39 (23)

Price
$0 - $2 (33)
$2 - $4 (4)
$4 - $6 (4)
$6 - $8 (3)
$8 - $10 (1)
$10 - $12 (4)
$218 - $220 (2)

InputMin Voltage
6 V - 8 V (10)
8 V - 10 V (1)
10 V - 12 V (2)
12 V - 14 V (1)
14 V - 16 V (2)
16 V - 18 V (3)

Output Current
100 mA (17)
500 mA (11)
1000 mA (23)

Add column: Status . Temperature Min . Temperature Max . Multiple Output Capability . On Off Pin . Error Flag . Watchdog . RegType . Package Volume .

Analog - Regulators : Linear Regulators - Standard/NPN:Positive Voltage - Fixed

Bpn	Title	Package Type	Price	Pins	InputMax Voltage	InputMin Voltage	Output Current	Output Voltage
LM341(3)	3-Terminal Positive Voltage Regulators	TO 220	$0.26	3	35 V	n/a	500 mA	n/a
LM78M05(4)	3-Terminal Positive Voltage Regulators	TO 220 TO 252 TO-39	$0.24 - $1.5	3	35 V	7.2 V	500 mA	5 V
LM340(11)	Series 3-Terminal Positive Regulators	TO 220 TO 263	$0.24 - $0.55	3	35 V	10.5 V	1000 mA	8 V
LM78L05	3-Terminal Positive Regulators	TO 92	$0.14	3	35 V	6.7 V	100 mA	5 V
LM78L09	3-Terminal Positive Regulators	TO 92	$0.14	3	35 V	10.7 V	100 mA	9 V
LM78L12	3-Terminal Positive Regulators	TO 92	$0.14	3	35 V	13.7 V	100 mA	12 V
LM78L15	3-Terminal Positive Regulators	TO 92	$0.14	3	35 V	16.700001 V	100 mA	15 V
LM78L62	3-Terminal Positive Regulators	TO 92	$0.37	3	35 V	7.6 V	100 mA	6.2 V
LM78L82	3-Terminal Positive Regulators	TO 92	$0.37	3	35 V	9.9 V	100 mA	8.2 V
LM109(3)	5-Volt Regulator	TO-39	$5.75 - $10.5	3	35 V	7.1 V	1000 mA	5.05 V
LM140(8)	VOLTAGE REGULATOR +5 VOLTS AT 0.5A	TO-39	$4.05 - $219	3	35 V	n/a	1000 mA	n/a
LM140L(6)	Series 3-Terminal Positive Regulators	TO-39	$3.2 - $7.1	3	35 V	n/a	100 mA	n/a
LM309	5-Volt Regulator	TO-39	$2.3	3	35 V	7.1 V	1000 mA	5.05 V
LM340L(5)	Series 3-Terminal Positive Regulators	TO 92 TO-39	$0.3 - $1.5	3	35 V	n/a	100 mA	n/a
LM78M12(2)	3-Terminal Positive Voltage Regulators	TO 220 TO-39	$0.27 - $1.5	3	35 V	14.5 V	500 mA	12 V
LM78M15(2)	3-Terminal Positive Voltage Regulators	TO 220 TO-39	$0.27 - $1.5	3	35 V	17.6 V	500 mA	15 V

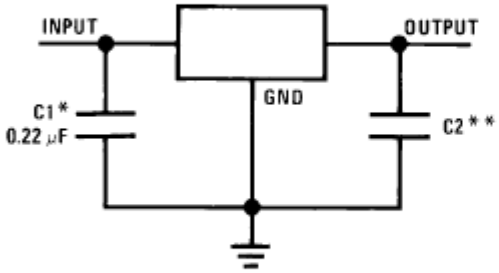
1 - 16 of 16 [Bpn]

LM340 Voltage Regulator

Typical Applications

Fixed Output Regulator

Input could be a 12V battery



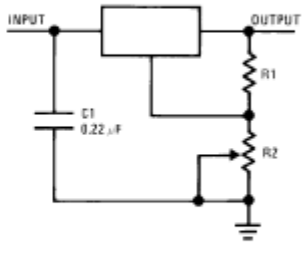
00778101

Output could be a 5V power to logic circuits.

*Required if the regulator is located far from the power supply filter.

**Although no output capacitor is needed for stability, it does help transient response. (If needed, use 0.1 µF, ceramic disc).

Adjustable Output Regulator

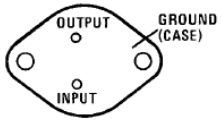


00778102

$V_{OUT} = 5V + (5V/R1 + I_Q)\ R2\ 5V/R1 > 3\ I_Q$,
load regulation $(L_r) = [(R1 + R2)/R1]$ (L_r of LM340-5).

Connection Diagrams

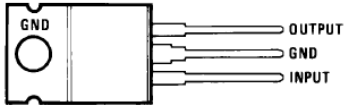
TO-3 Metal Can Package (K)



00778111

Bottom View
See Package Number K02A

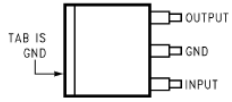
TO-220 Power Package (T)



00778112

Top View
See Package Number T03B

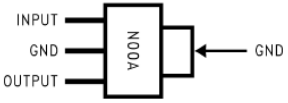
TO-263 Surface-Mount Package (S)



00778120

Top View
See Package Number TS3B

3-Lead SOT-223



00778143

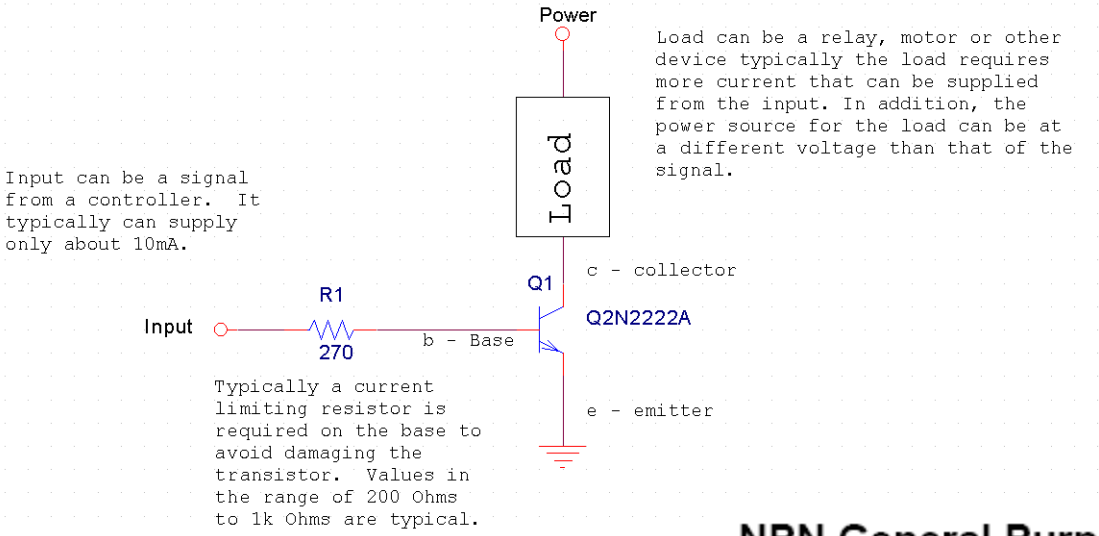
Top View
See Package Number MA04A

Transistors

- Three terminal devices that can act like switches and/or supply gain.
  - If you need voltage gain use an Op-Amp.
  - If you need current gain, then a transistor may be useful.
    - An example of current gain is trying to use the LabJack to close a relay. The LabJack outputs are current limited and may not be able to close a relay. A transistor between the LabJack and the relay can solve this problem.
- There are many types of transistor, but our needs can be handled by BJT or MOSFET transistors.
  - The example here will just be for BJT and so we suggest that you also restrict yourself to BJT transistors.

Transistors

- Examples of Transistors
  - –2N2222, 2N3904 and 2N3906, MJF122 and MJF127
  - –All have three leads, Base, Emitter and Collector



NPN General Purpose Amplifier

- This device is for use as a medium power amplifier and switch requiring collector currents up to 500mA.

Expect a 2N2222 to have a current gain of 200. So 2mA from the Input can drive a load that requires up to 2*200 = 400mA.

Transistors

- If you need currents greater than 500mA, consider the MJF122

NPN
MJF122
PNP
MJF127

COMPLEMENTARY
SILICON
POWER DARLINGTONS
5 AMPERES
100 VOLTS
30 WATTS

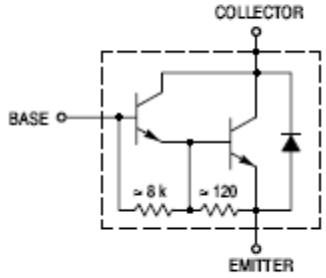
CASE 221D–02
TO–220 TYPE

ON CHARACTERISTICS (1)

DC Current Gain (I_C = 0.5 Adc, V_{CE} = 3 Vdc) (I_C = 3 Adc, V_{CE} = 3 Vdc)	h_{FE}	1000 2000	— —	—
Collector–Emitter Saturation Voltage (I_C = 3 Adc, I_B = 12 mAdc) (I_C = 5 Adc, I_B = 20 mAdc)	$V_{CE(sat)}$	— —	2 3.5	Vdc
Base–Emitter On Voltage (I_C = 3 Adc, V_{CE} = 3 Vdc)	$V_{BE(on)}$	—	2.5	Vdc

MJF122 MJF127

NPN
MJF122



PNP
MJF127

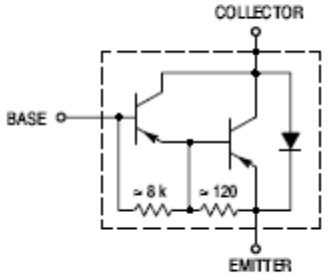


Figure 13. Darlington Schematic

BJT Transistors

- There are two flavors of BJT transistors.
  - –We have been looking at NPN types so far.
  - –PNP act the same but with reversed currents and reversed voltages
  - –NPN/PNP pairs can be useful for motor reversal, but this isn't a trivial problem. Errors can lead to failure of components.
  - – The MJF122 is an NPN transistor, and the MJF127 is an PNP

MJF122 MJF127

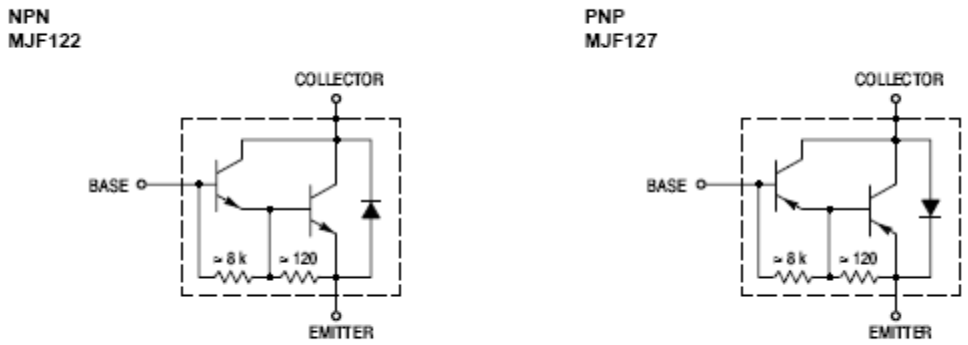
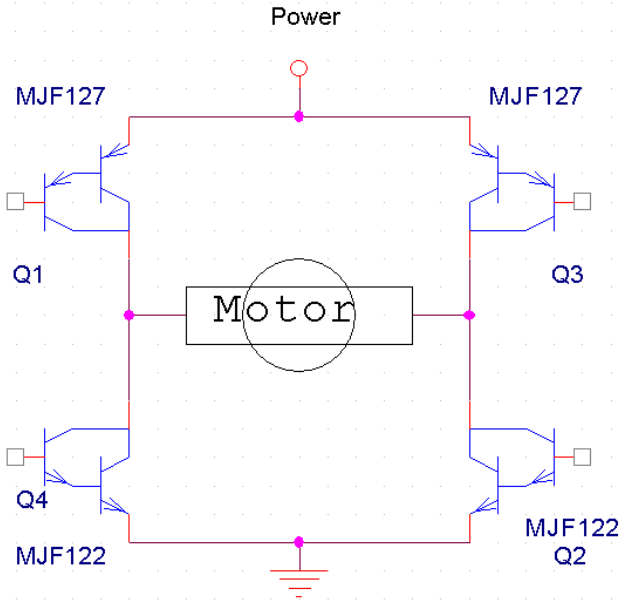


Figure 13. Darlington Schematic

BJT Transistors

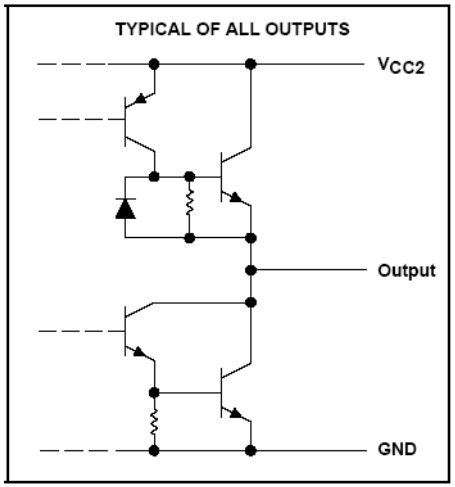


Turn on Q1 and Q2, motor runs in one direction. Turn on Q3 and Q4, motor runs in the other direction. Turn on Q1 and Q4 or Q3 and Q2 and you blow the transistors.

- If a team wants to do this, contact me with the details of your motor voltage and current. I will also need to know what will be controlling the transistors.
- Pulse Width Modulation, PWM, can be used with this circuit for speed control.

Another option for motor control

- Consider using the L293 chip.
  - –This is used in LITEC
  - –Good for up to 1A
  - –Another case were PWM can do speed control



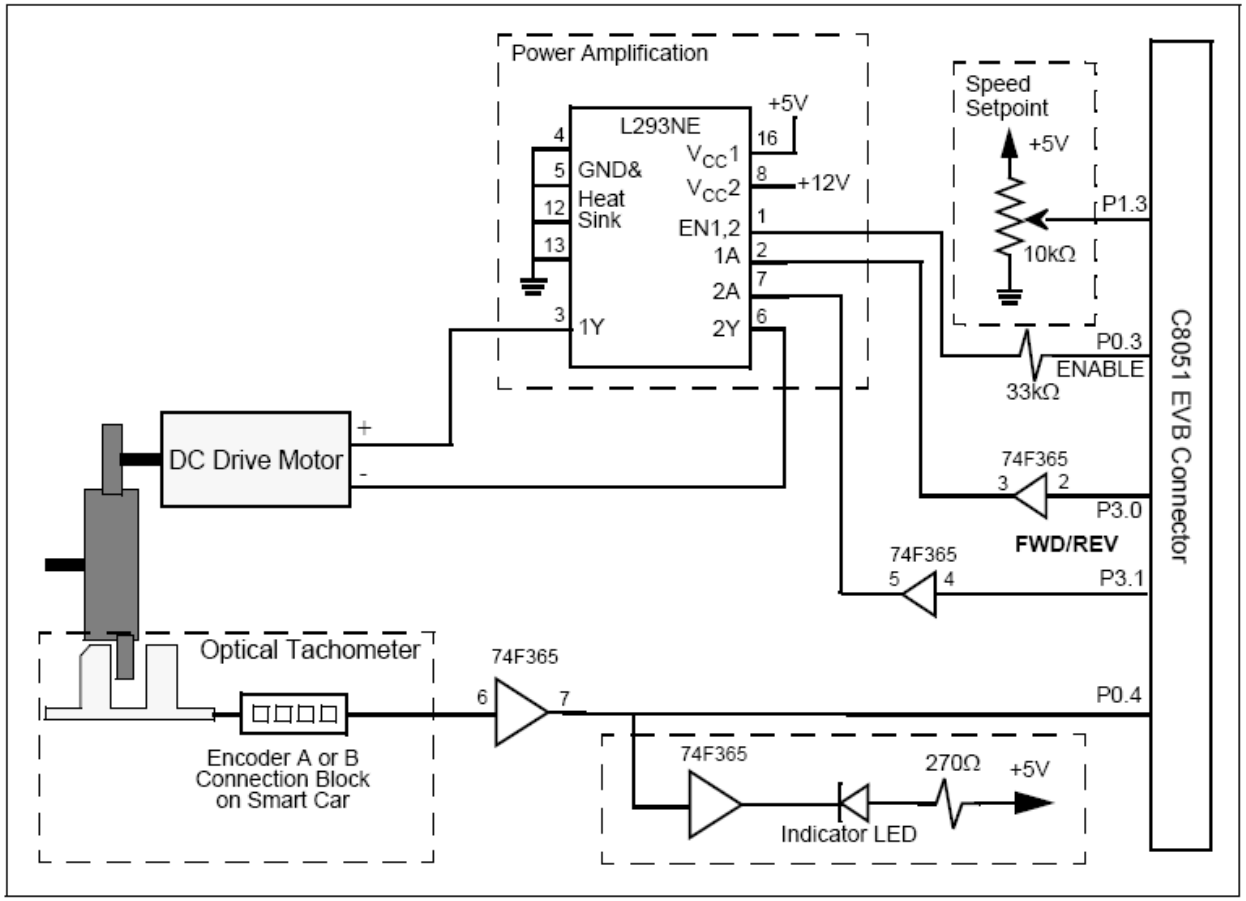
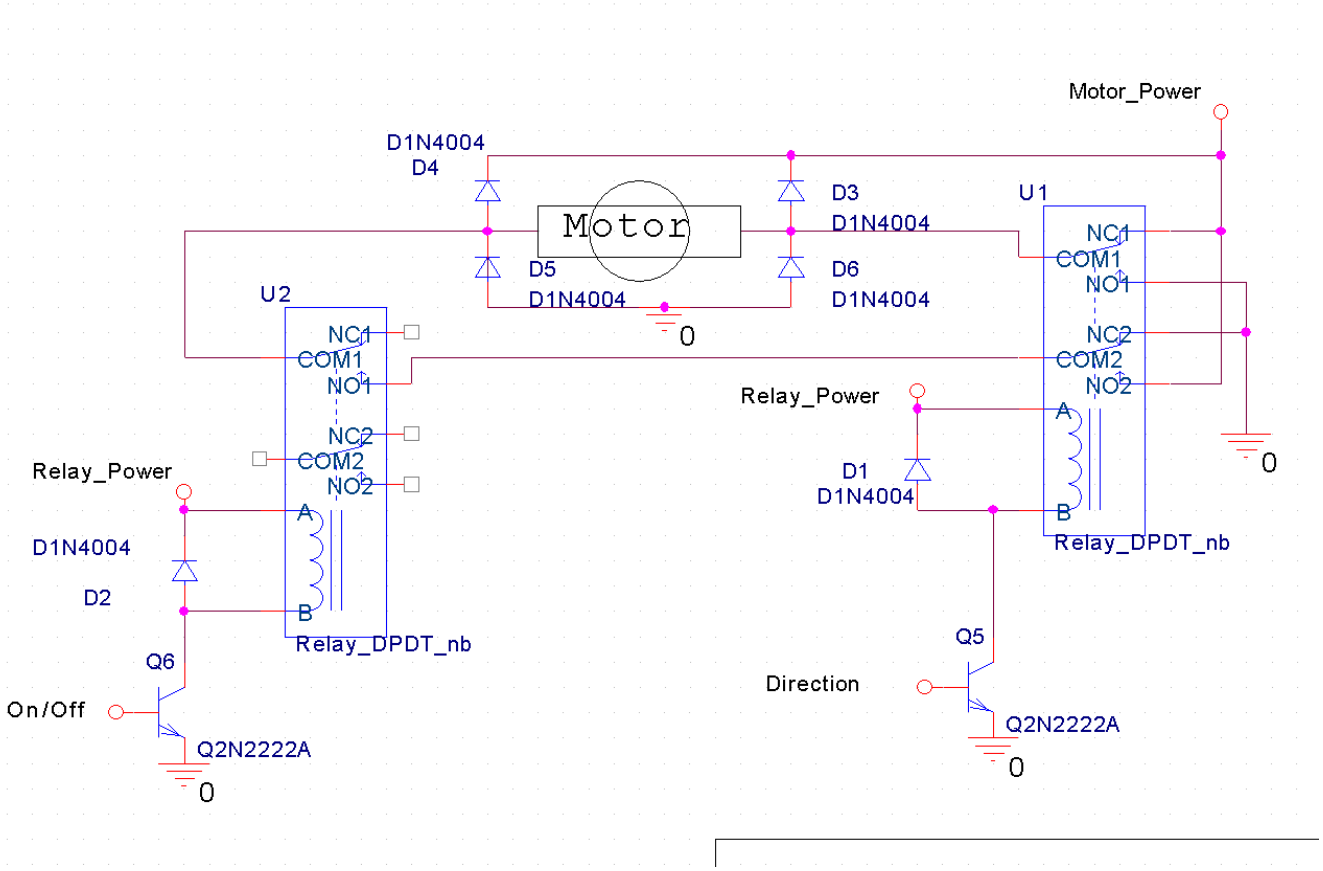


Figure F.7 - Car tachometer and drive-motor control circuitry

Other options for motor control

- Relay control
  - –Can supply larger currents
  - –Don’t try to do fast switching



RC Servos and PWM

•Servo motors are commonly used with radio controlled cars, planes and boats.
•These are controlled by a Pulse Width Modulated Signal, PWM
• Most servo motor need pulses that are between 0.9ms and 2.1ms
    •0.9mS will result in rotation fully clockwise
    •2.1 mS will result in rotation that is fully counter-clockwise
    •Or is it visa versa?
    •Intermediate pulse widths will give intermediate angles
•PWM signal must be repeated, typically every 20 mS or else servo forgets what it is doing and shuts down.
•Servo motors can draw nearly an amp when stalled by load
•Remember that these need power and ground, not shown in this diagram.

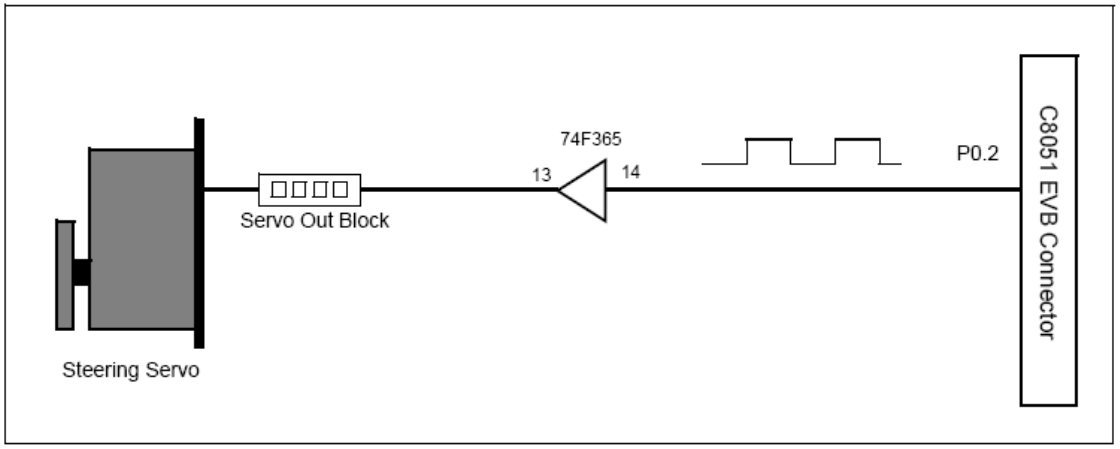


Figure F.6 - Car steering servo motor control circuitry for Lab 3 (part 2)

The SiLabs C8051F020DK
$129 at www.digikey.com

1.0. Kit Contents

The C8051F02X Development Kit contains the following items:

- C8051F02X Target Board
- Serial Adapter (RS-232 to Target Board Protocol Converter)
- Cygnal IDE and Product Information CD-ROM. CD content includes:
  - Cygnal Integrated Development Environment (IDE)
  - Keil Software 8051 Development Tools (macro assembler, linker, evaluation 'C' compiler)
  - Installation utility (SETUP.EXE)
  - Source code examples and register definition file
  - Documentation
- AC to DC Power Adapter
- RS232 Serial Cable
- 7" Ribbon Cable
- Quick-start Guide
- C8051F02X Development Kit User's Guide (this document)

C8051F020DK

The SiLabs C8051F020DK

2.0 Hardware Setup

The target board is connected to a PC running the Cygnal IDE via the Serial Adapter as shown in Figure 1.

1. Connect one end of the RS232 serial cable to a serial (COM) port on the PC.
2. Connect the other end of the RS232 serial cable to the DB-9 connector on the Serial Adapter.
3. Connect the Serial Adapter to the JTAG connector on the target board using the 10-pin ribbon cable.
4. Connect the AC/DC power adapter to power jack P1 on the target board.

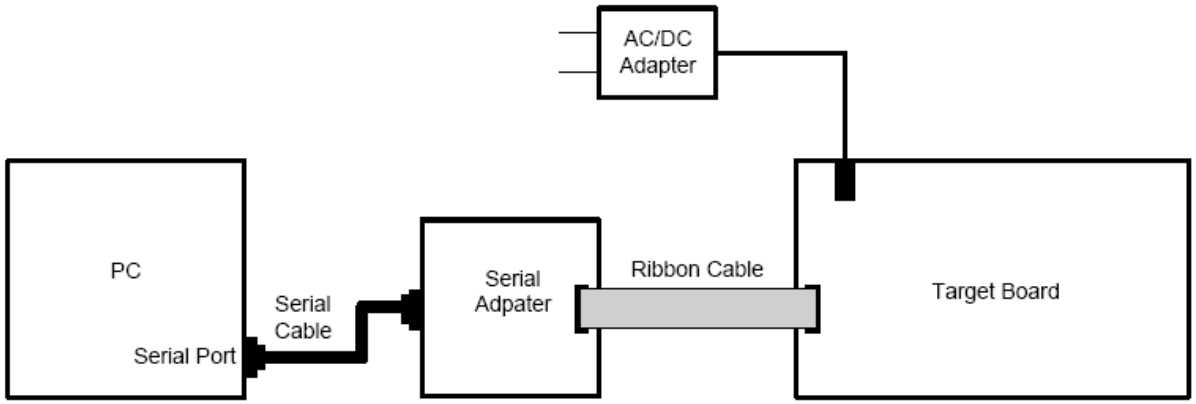


Figure 1. Hardware Setup

The SiLabs C8051F020DK

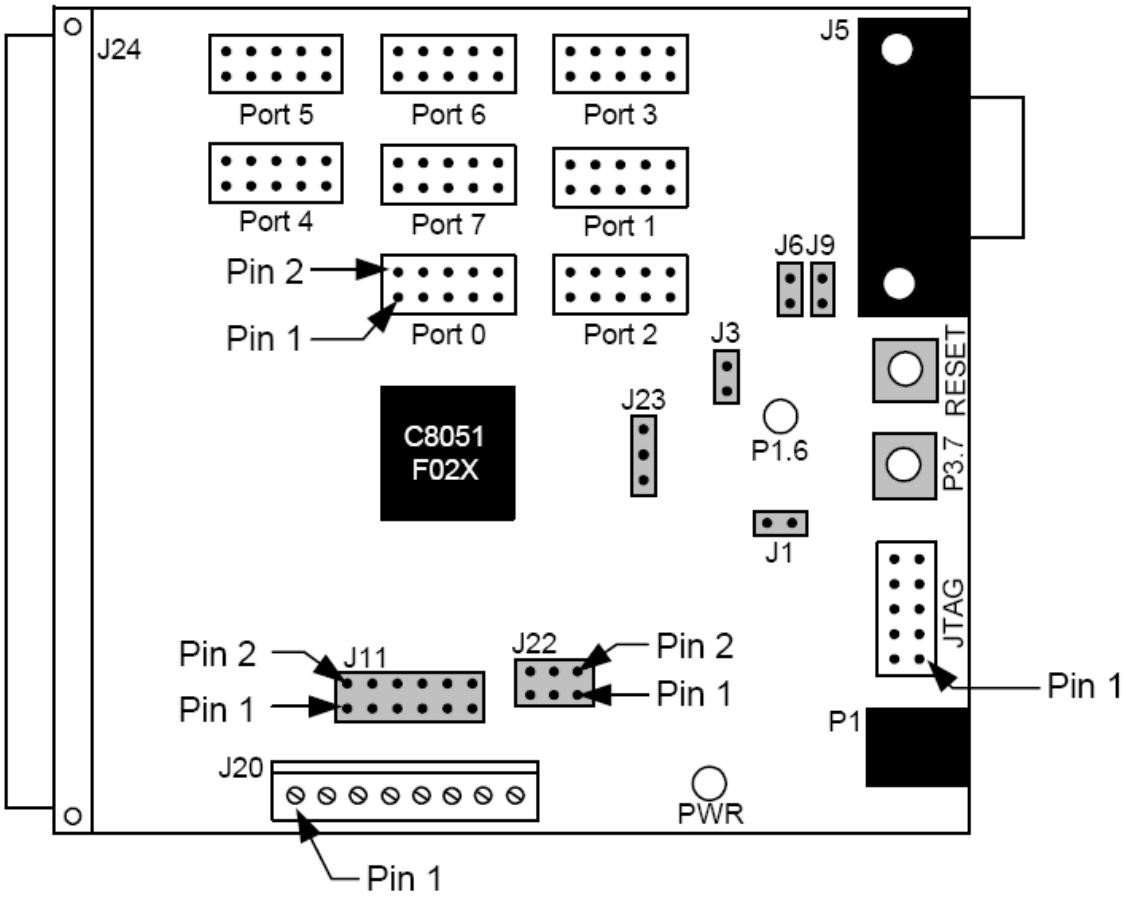
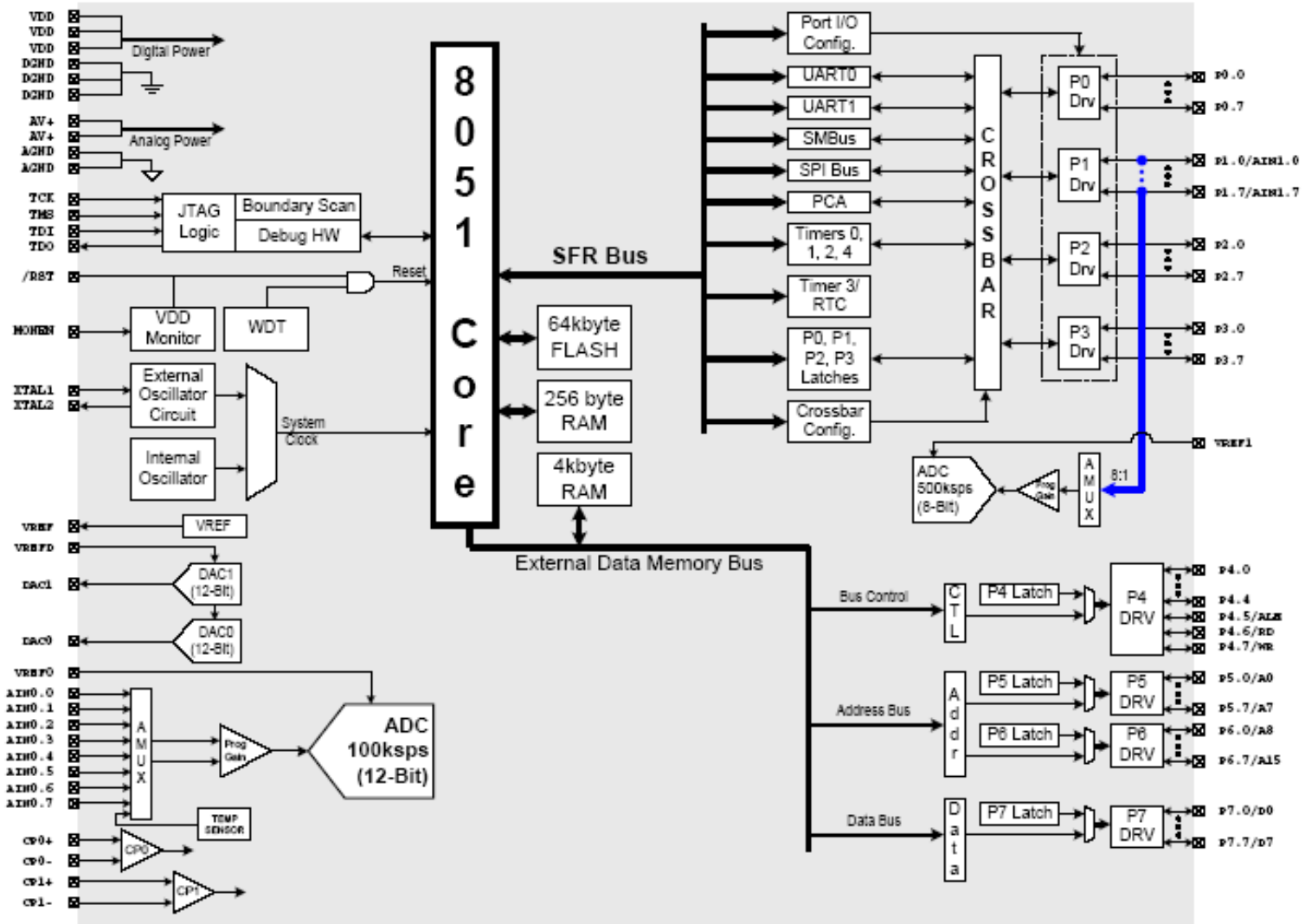


Figure 2. C8051F02X Target Board

The SiLabs C8051F020DK



Circuits Lecture – IED Fall 2004

- Send us your questions for next class
  - schoch@ecse.rpi.edu
  - rocks@rpi.edu

- Next week there will be a parallel session on LabView and LabJack

- Questions?