

Summary of Covered Topics

Important concepts:

- Impedance
- Amplification
- Frequency/Fourier Analysis
- Feedback

Important electronics components and equipment:

- Resistors, capacitors, inductors.
- Special components: transformers, photodiodes, thermistors, and Peltier coolers.
- Diodes, BJTs, and FETs.
- Op-amps and comparators.
- Multimeters, oscilloscopes, and function generators.
- Breadboards, prototyping boards, and soldering irons.
- Circuit simulation and layout software.

Final Exam

- Tuesday, April 29, 2008: Small Hall 238, 1:30pm-4:30pm.
- 3 hours long.
- It will cover all the topics covered in the class and lab.
- You can expect some variations on the quiz and design exercise materials.
- Some questions will be on practical lab knowledge.
- Some problems will involve combining knowledge from different chapters.

Physics 351: Electronics II

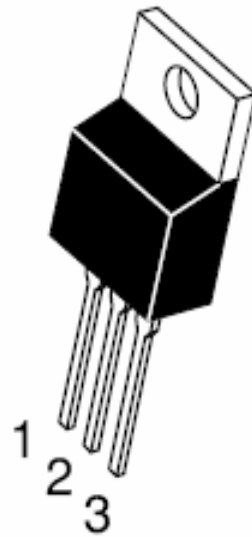
What to expect?

- Mostly **DIGITAL** electronics
 - Logic gates.
 - Operations.
 - ADCs, DACs, and opto-couplers.
 - Counters, registers, and digital memory.
- A fair bit on **FPGAs**
 - C-like programming.
 - Complex digital circuits.
- A little bit on **microprocessors**
 - C programming.
- **Digital Signal Processing (DSP)** ... or how to make an analog circuit with digital concepts.

Voltage Regulators (I)

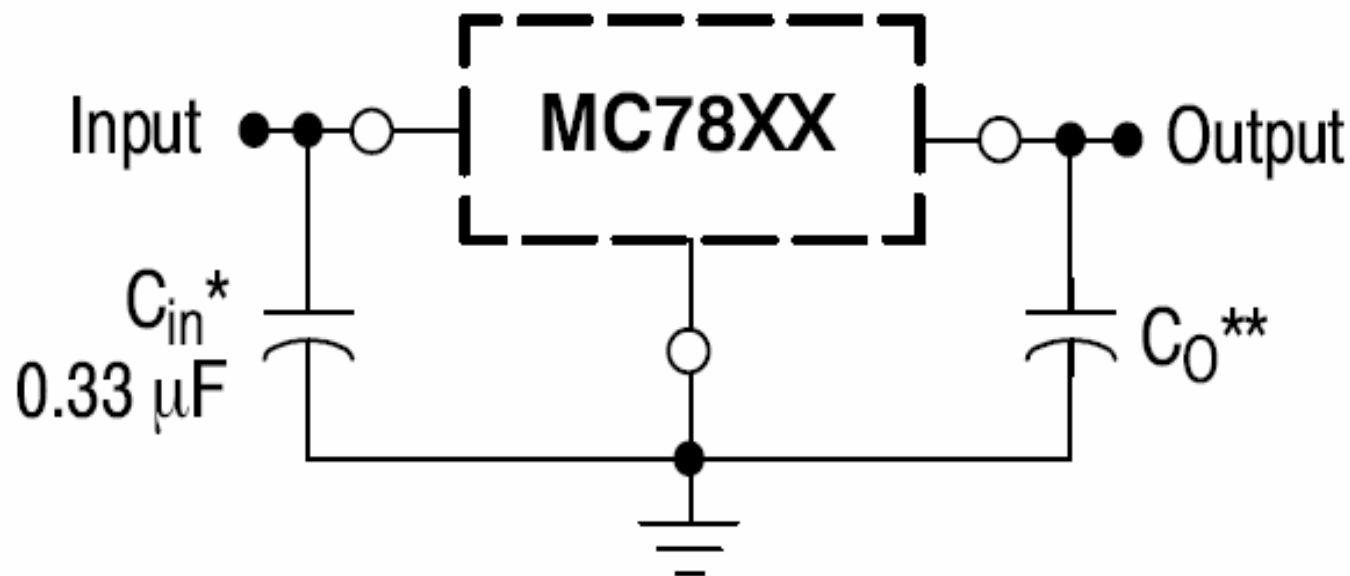
Voltage regulators produce a constant output voltage despite variations in the input.

Pin 1. Input
2. Ground
3. Output



TO-220-3

Heatsink surface
connected to Pin 2.



Voltage Regulators (II)

MC7800, MC7800A, MC7800AE, NCV7800

ELECTRICAL CHARACTERISTICS ($V_{in} = 10\text{ V}$, $I_O = 500\text{ mA}$, $T_J = T_{low}$ to 125°C (Note 1), unless otherwise noted)

Characteristic	Symbol	MC7805B, NCV7805			MC7805C			Unit
		Min	Typ	Max	Min	Typ	Max	
Output Voltage ($T_J = 25^\circ\text{C}$)	V_O	4.8	5.0	5.2	4.8	5.0	5.2	Vdc
Output Voltage ($5.0\text{ mA} \leq I_O \leq 1.0\text{ A}$, $P_D \leq 15\text{ W}$) $7.0\text{ Vdc} \leq V_{in} \leq 20\text{ Vdc}$ $8.0\text{ Vdc} \leq V_{in} \leq 20\text{ Vdc}$	V_O	- 4.75	- 5.0	- 5.25	4.75 -	5.0 -	5.25 -	Vdc
Line Regulation (Note 4) $7.5\text{ Vdc} \leq V_{in} \leq 20\text{ Vdc}$, 1.0 A $8.0\text{ Vdc} \leq V_{in} \leq 12\text{ Vdc}$	Reg_{line}	- -	5.0 1.3	100 50	- -	0.5 0.8	20 10	mV
Load Regulation (Note 4) $5.0\text{ mA} \leq I_O \leq 1.0\text{ A}$ $5.0\text{ mA} \leq I_O \leq 1.5\text{ A}$ ($T_A = 25^\circ\text{C}$)	Reg_{load}	- -	1.3 0.15	100 50	- -	1.3 1.3	25 25	mV
Quiescent Current	I_B	-	3.2	8.0	-	3.2	6.5	mA
Quiescent Current Change $7.0\text{ Vdc} \leq V_{in} \leq 25\text{ Vdc}$ $5.0\text{ mA} \leq I_O \leq 1.0\text{ A}$ ($T_A = 25^\circ\text{C}$)	ΔI_B	- -	- -	- 0.5	- -	0.3 0.08	1.0 0.8	mA
Ripple Rejection $8.0\text{ Vdc} \leq V_{in} \leq 18\text{ Vdc}$, $f = 120\text{ Hz}$	RR	-	68	-	62	83	-	dB
Dropout Voltage ($I_O = 1.0\text{ A}$, $T_J = 25^\circ\text{C}$)	$V_I - V_O$	-	2.0	-	-	2.0	-	Vdc
Output Noise Voltage ($T_A = 25^\circ\text{C}$) $10\text{ Hz} \leq f \leq 100\text{ kHz}$	V_n	-	10	-	-	10	-	$\mu\text{V}/V_O$
Output Resistance $f = 1.0\text{ kHz}$	r_O	-	0.9	-	-	0.9	-	$\text{m}\Omega$
Short Circuit Current Limit ($T_A = 25^\circ\text{C}$) $V_{in} = 35\text{ Vdc}$	I_{SC}	-	0.2	-	-	0.6	-	A
Peak Output Current ($T_J = 25^\circ\text{C}$)	I_{max}	-	2.2	-	-	2.2	-	A
Average Temperature Coefficient of Output Voltage	TCV_O	-	-0.3	-	-	-0.3	-	$\text{mV}/^\circ\text{C}$

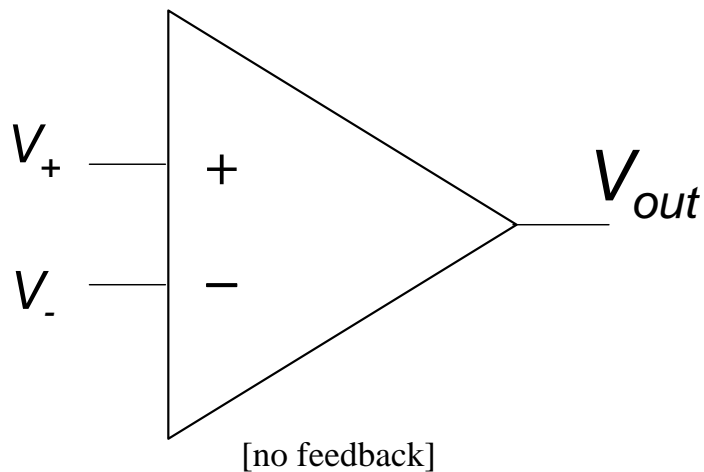
- $T_{low} = 0^\circ\text{C}$ for MC78XXC, MC78XXAC,
= -40°C for NCV78XX, MC78XXB, MC78XXAB, and MC78XXAEB
- Load and line regulation are specified at constant junction temperature. Changes in V_O due to heating effects must be taken into account separately. Pulse testing with low duty cycle is used.

Comparators

Comparators are specialty op-amps designed to be used with **positive feedback** or **no feedback**.

Comparators are two-state devices which output either a **high signal** or a **low signal** depending on whether an input voltage is above or below a reference voltage.

A comparator is like an **IF** statement in computer programming.



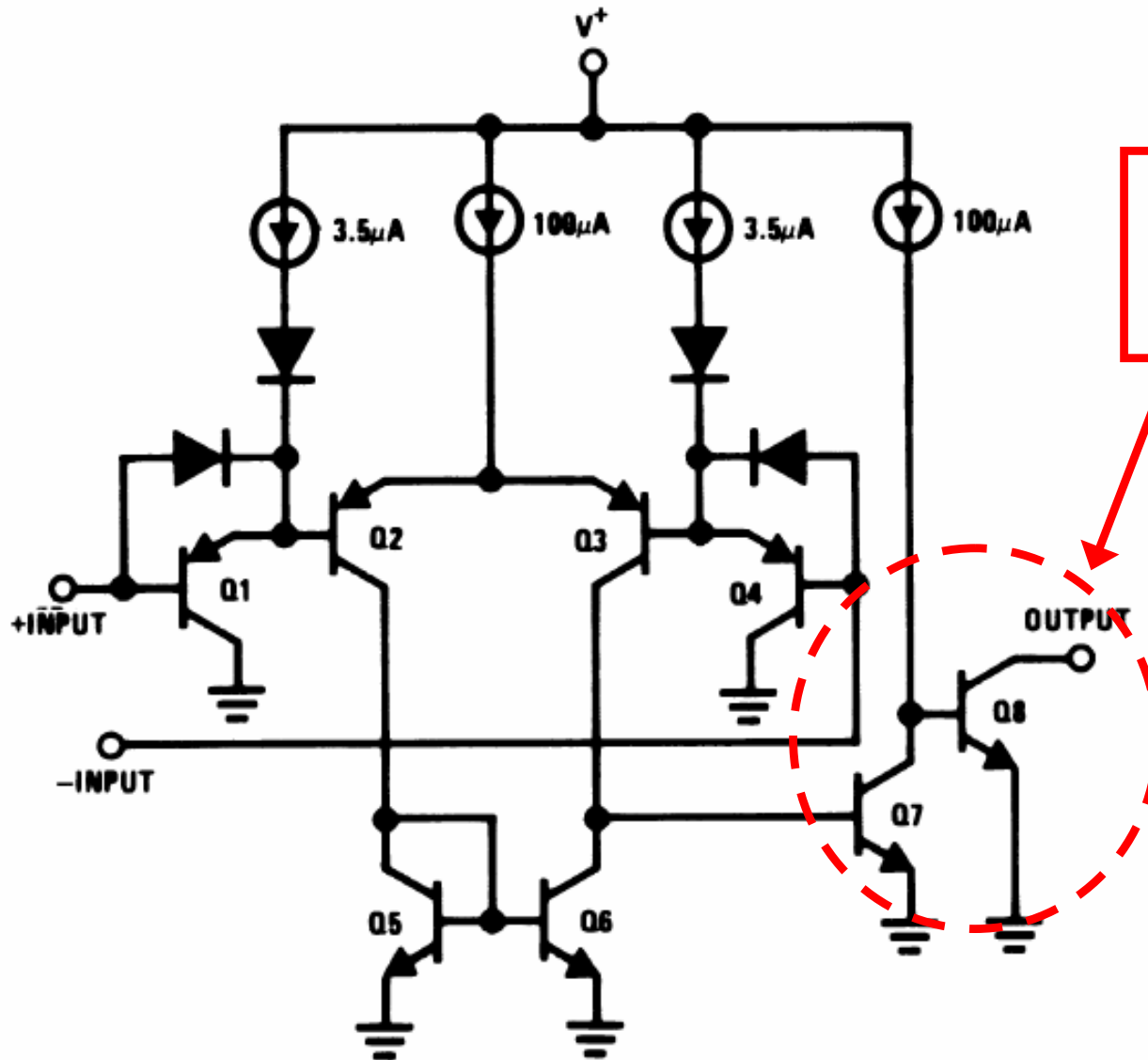
Op-amp equation: $V_{out} = Gain \times (V_+ - V_-)$

Since $Gain \sim 10^5 - 10^6$,

If $V_+ > V_-$, then $V_{out} = + V_{supply}$ (HIGH)

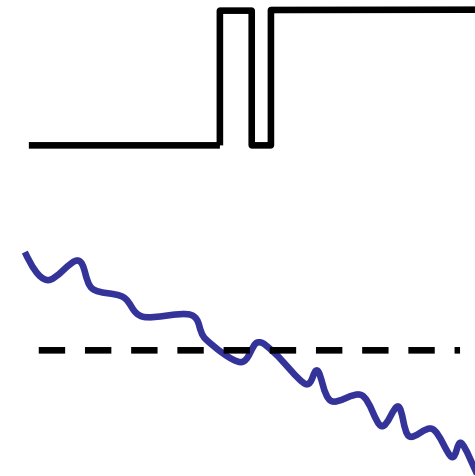
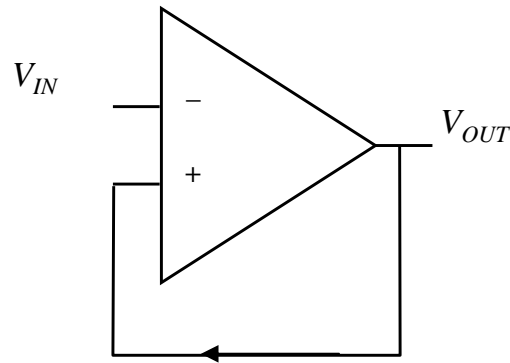
If $V_+ < V_-$, then $V_{out} = - V_{supply}$ (LOW)

The LM2903 comparator



Output is configured for use with a pull-up resistor

Positive Feedback

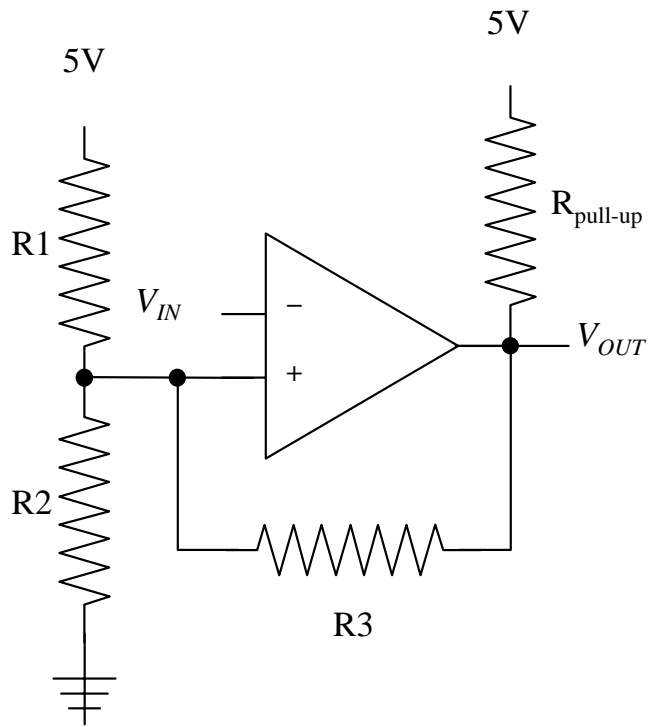


Noisy signal leads to
"false" triggering

The merits of positive feedback:

- Speed-up the choice of HIGH output or LOW output.
- Introduce **hysteresis** into comparator behavior (i.e. circuit output depends not just on the input, but on its history).

Schmitt Trigger



Hysteresis suppresses “false” triggering due to noise.

