

SCR's, Triacs and UJT's

Session 6c for Electronics and
Telecommunications
A Fairfield University E-Course
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Module: Semiconductor Electronics

(in two parts)

- Text: “Electronics,” Harry Kybett, Wiley, 1986, ISBN 0-471-00916-4
- References:
 - [Electronics Tutorial](#) (Thanks to Alex Pounds)
 - [Electronics Tutorial](#) (Thanks to Mark Sokos)
- 5 - Semiconductors, Diodes and Bipolar Transistors
 - 5 on-line sessions plus one lab
- 6 - FETs, SCRs, Other Devices and Amplifiers
 - 5 on-line sessions plus one lab
- Mastery Test part 3 follows this Module

Section 6: FETs, SCRs, Other Devices and Operational Amplifiers

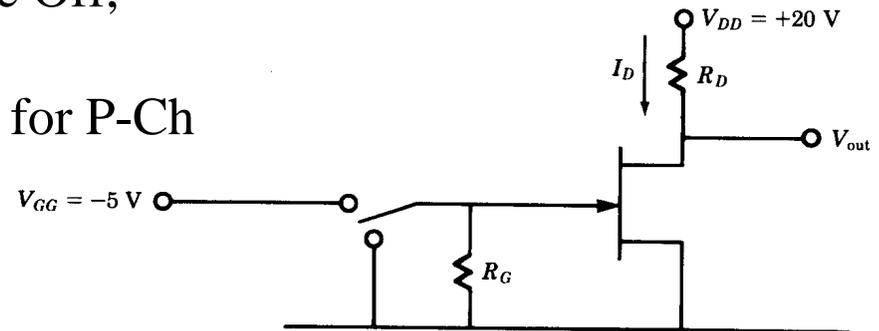
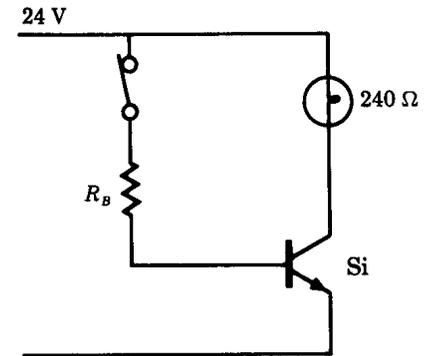
- **OBJECTIVES:** This section reviews additional important semiconductor devices and their applications. The Operational Amplifier is also studied.

Section 6 Schedule:

Session 6a	01/15	Field Effect Transistors	Kybett pp 70 – 77, pp 201-209
Session 6b	01/20	Transistors as a switch	Kybett pp 78 –107
Session 6c	01/22	SCR's, Triacs and UJT's	Notes
Session 6d (Lab - 02/01, Sat.)	01/27	Class "A", "B", and "C" Amplifiers	Notes
Session 6e	02/05	Op-Amps	Kybett pp 209-215
Session 6f (Quiz 6 due 02/23)	02/10	Review for Quiz 6	
Session 6g	02/24	Discuss Quiz 6	
Session 6h	02/26	Review for MT3	
MT3	03/01	MT3 Exam	
Session 6i	03/10	Discuss MT3	

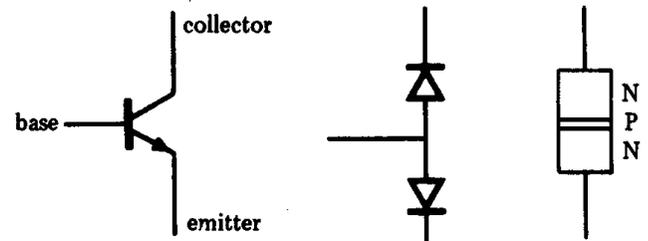
Transistor Switch Summary

- Can be either Bipolar or FET
 - They operate fully in saturation or cutoff
 - Bipolar: Current controlled switch
 - NPN: +0.7 volt base-emitter ON
 - PNP: -0.7 volt base-emitter ON
 - FET: Voltage controlled switch
 - N-Ch JFET: -5 volt gate-source OFF, 0 volt ON
 - P-Ch JFET: +5 volt gate-source OFF, 0 volt ON
 - MOSFET: 0 volt gate-source Off,
5 volt gate-source ON
- Positive for N-Ch, Negative for P-Ch

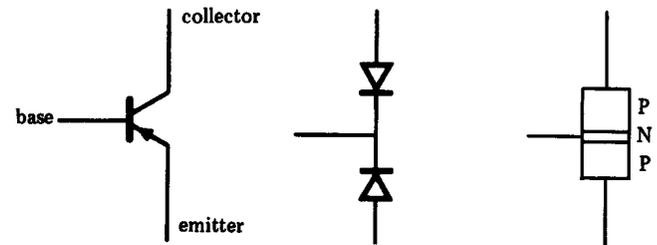


Bipolar Review

- Two diodes back to back
 - Central region very thin
 - Injected minority carriers into the base cause β times I_b collector current (I_c)

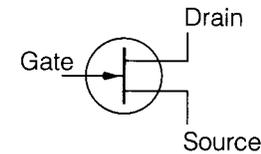


- NPN and PNP
 - All currents and voltages reversed
- Biasing
 - Cutoff: $V_{be} < 0.6$, $I_b = 0$, $I_c = 0$
 - Saturation: $V_{be} = 0.7$, $V_{ce} < 0.2$
 - Active: $V_{be} = 0.7$, $V_{ce} \sim V_{cc} / 2$

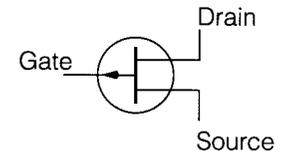


FET Review

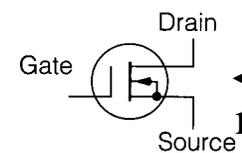
- Junction and MOS
(Actually older than bipolar)
- P and N-channel
- “Enhancement” Mode
 - Positive gate voltage
“creates” a narrow n-channel
 - Used in CMOS Logic



N-channel JFET

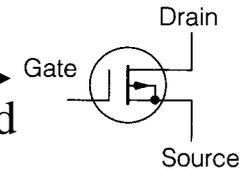


P-channel JFET

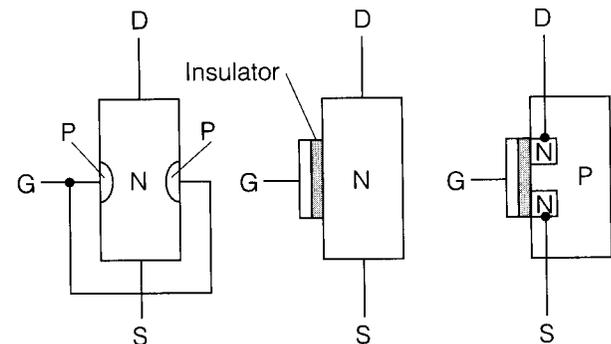


N-channel MOSFET

reversed

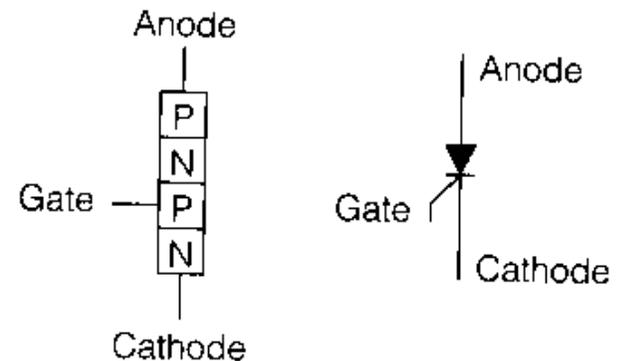


P-channel MOSFET



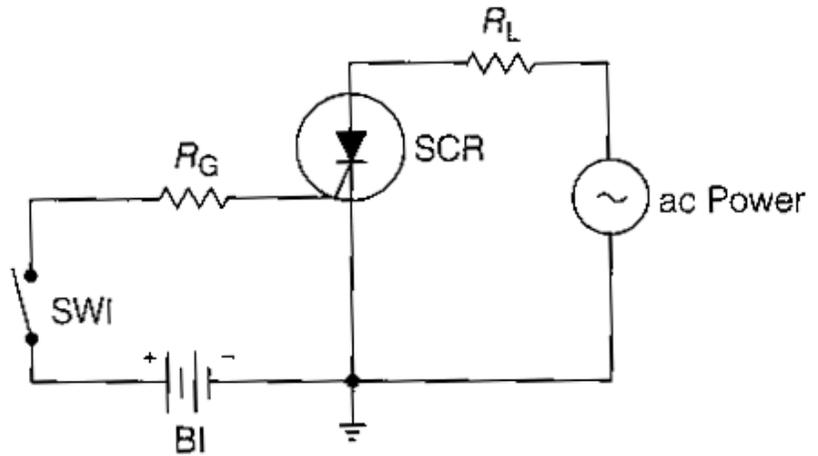
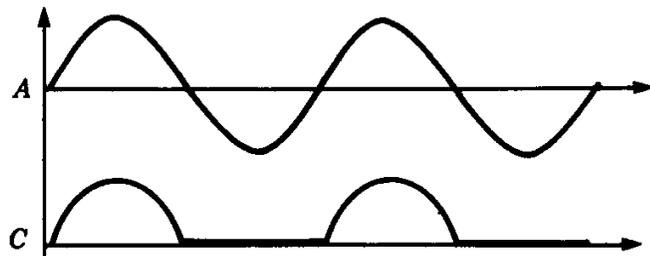
Silicon Controlled Rectifiers (SCR)

- SCRs are 4-layer devices
- It is a diode that will not conduct unless triggered by a gate current
- Reverse biasing (current) the SCR turns it back off



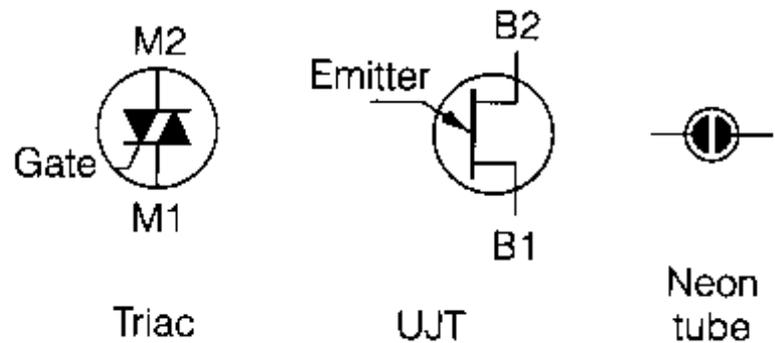
An SCR Circuit

- When the switch is open: no load current
- When the switch is closed the load sees half sine wave current pulses.



Other Devices

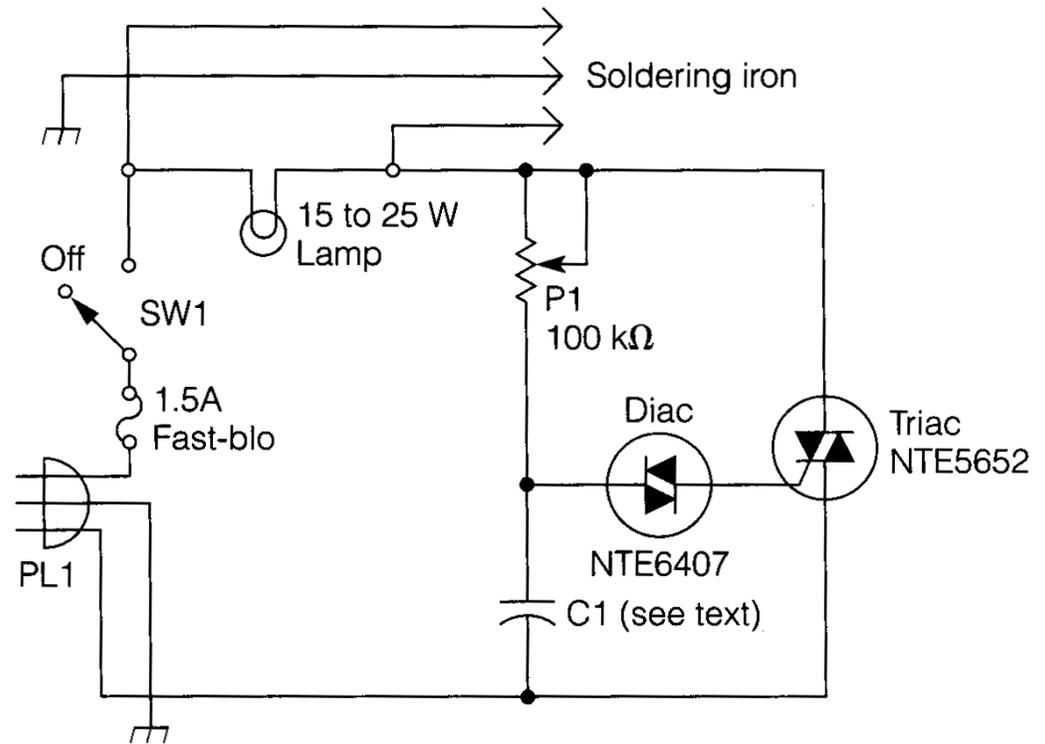
- Triac: a full wave SCR (actually two SCR's in parallel)
- Unijunction: a voltage controlled device
 - Avalanche to low impedance above a emitter to B1 threshold
 - Returns to high impedance below a emitter to B1 valley threshold



- Simple 2-terminal avalanche devices
 - Neon Tube
 - Diac

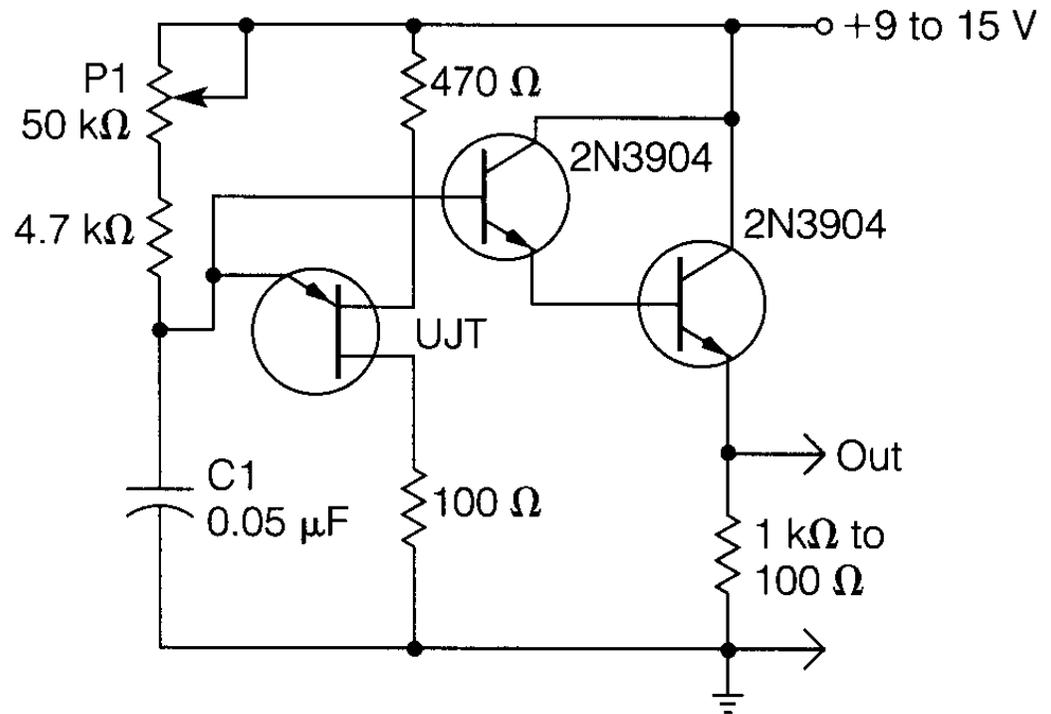
Solder Iron Heat Control

- Diac conducts at peaks of the sine wave turning on the Triac
- Triac turns back off when current reverses
- Output is alternating current pulses



UJT Oscillator

1. Capacitor starts charging up
2. UJT turns on
3. Capacitor suddenly discharges through the UJT
4. UJT turns off at the valley voltage
5. Capacitor starts charging up again
6. Common collector: low impedance out



Summary

- **SCR: Half wave current controlled triggered switch**
 - 4 layers, normally off, triggered on
 - Reverse bias turns it off
- **Triac: Full wave triggered switch**
 - Effectively two SCR's in parallel (reverse polarity)
- **Diac (and neon bulb): 2-terminal Avalanche device**
 - Normally high impedance,
 - Low impedance triggered by threshold voltage
 - Reverse bias turns it off
- **UJT: 3-terminal voltage controlled avalanche/recovery**

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