CIRCUIT DESCRIPTION FOLLOWS THIS PAGE

SwitchLight

Circuit Description

The purpose of this document is to describe the circuit operation of the SwitchLight product which consists of two modules a Switch Module and a Lamp Module. The function of the combined two modules is to control the on and off function of a lamp that can be plugged into any outlet in a room and be controlled by the operation of the existing wall switch in that room.

Switch Module Circuit Description

The Switch module and the Lamp module communicate via an RF link operating at 418 Mhz. The Switch Module is basically the module that is plugged into the switched outlet controlled by the wall switch and upon being energized by the AC power when the wall switch is turned on commands the Lamp module to turn on and conversely when the switch module detects that the wall switch has been turned off it sends a command to the lamp module to turn the lamp off. The power supply for the switch module consists of two 9.1 volt zenier diodes D7 & D5, and a rectifier diode D1 in series with a 2.2 ufd capacitor C1 and a current limiting resistor R1. The DC output of the supply is 8.7 volts and is further regulated by transistor Q1 to 5 volts. Upon applying power to the microprocessor U1, the microprocessor goes through its initialization process, times out for 70 microseconds for the supply to stabilize and transmits 3 on commands in each of two 100 msec windows. After powering up, the microprocessor monitors the AC zero crossing line on pin 16 for power off and if it detects that power has been removed the microprocessor transmits and off command. The value of capacitor C2 was chosen as to provide adequate power as to transmit the off command with no power applied to the module. The transmit command from the microprocessor is fed into the RF transmitter which has been designed to operate at 418 Mhz. The RF transmitter consists of a transistor oscillator that utilizes a loop inductor antenna L2 in its tank circuit. The oscillator transistor Q2 is an NPN transistor. The high Q resonant circuit for the oscillator is comprised of loop inductor L2 tuned by parallel capacitors C10 and C12. C12 provides means for fine tuning adjustment to the transmitter frequency. The collector of the oscillator transistor Q2 is connected directly to the loop inductor L2 and DC power is provided to the opposite end of the loop inductor via RF isolation choke L1. C13 operating in combination with choke L1 serves to bypass RF from feeding back into the DC power source. Feedback for the oscillator is provided by components C8 connected between the base of the transistor and ground, and C9 connected between the collector of the transistor and the end of the loop inductor opposite to that connected to the collector. Capacitor C11 provides additional feedback between the collector and the base of the transistor Q2. Resistor R5 provides positive biasing for the base of transistor Q2, and emitter resistor R6 serves to provide emitter self-biasing that minimizes current variations between transistors and also serves as a mean for setting the RF power to the appropriate limits.

Lamp Module Circuit Description

The Lamp module has a similar power supply as the Control module. The power supply consists of a 9.1 volt zenier diode D1 a rectifier diode D2 along with a 0.68 ufd capacitor C1 and a 100 ohm R1 current limiting resistor. The charge is stored on a 330 ufd capacitor C1. Also in series with these components that comprise the first stage of the power supply is a transformer L3 that is used to extract the 120 Khz carrier signal from the AC line. The power supply voltage is further regulated to 6 volts using transistor Q5 with a voltage divider reference used at its base. The 6 volts, used by the RF receiver section, is further regulated down to 5 volts with a diode D4 and capacitor C18.

The microprocessor U1 receives input commands from two separate inputs, the 120 Khz AC carrier signal and the 418 Mhz RF input signal. The AC carrier signal is sent on the AC line by means other then this product and is received by the lamp module through a transformer L3. The output of the transformer is set for the resonant frequency by the two capacitors C2 and C23 in series which also provide a voltage divider for the next stage of the circuit. The Q of the circuit is set by R3. The output of this section of the circuit is first signal conditioned by two diodes D5 and D6 and then coupled into the base of transistor Q4. The transistor amplifies the signal prior to being received by the microprocessors input. The RF signal is received by the RF section which is comprised of an RF amplifier, a super-regenerative receiver and three amplifiers where the latter serve to process and filter the demodulated pulse data output provided from the super-regenerative receiver. The first amplifier Q1 between the receiver antenna and the super-regenerative receiver serves both to amplify the incoming pulse modulated RF signals and to isolate the squedging RF oscillation of the super-regenerative receiver from coupling back into and radiating from the antenna. Resistor R10 provides an RF termination for the antenna. Capacitor C3 AC couples the incoming pulse modulated RF signals to the base of the RF amplifier, transistor Q1. Positive bias to the base of Q1 with DC feedback stabilization is provided by resistor R11 and collector load resistor R12. Resistor R13 and capacitors C4 and C11 serve to provide filtering and RF de-coupling to the RF amplifier Q1. RF transistor Q2 is the active element of the circuitry comprising a super-regenerative receiver. The oscillator circuitry of that receiver is comprised of transistor Q2, inductors L2 and L1 and capacitors C8, C7, C9 and C10. RF feedback is high causing what is called self-squedging, i.e., RF oscillation periodically builds up to the point where the oscillator suddenly biases the base of Q2 negatively to below cutoff. That negative bias then decreases upward toward zero voltage in a quasi-ramp fashion until transistor Q2 is just coming into conduction. Feedback amplification begins to occur until the oscillation has built up to the point where transistor Q2 suddenly re-biases itself back below cutoff, thereby completing the squedging cycle. With the presence of an RF signal, the signal is coupled from the RF amplifier Q1 via capacitor C5 and amplified with high feedback gain by transistor Q2 and the presence and magnitude of the incoming RF signal results in slightly advancing the time when each oscillation cycle builds up to the point of squedging. The changes in squedging rate corresponds to the pulse modulation on the incoming RF signal and are extracted as a voltage variation across collector load resistor R16. The demodulated data in the form of a pulse code of varying widths is filtered to remove the squedging frequency by the RC combination of resistor R20 and capacitor C12. Integrated circuit UA2 amplifies the demodulated pulse code data and the RC combination, R28 and C25 serve as additional filtering to remove unwanted higher frequencies from the demodulated output of the super-regenerative receiver. Further wave shaping is provided by resistor R33 feedback capacitor C26, resistor R34 and capacitor C27. After further amplification in amplifier U2B, the filtered pulse code data is passed through a unity gain amplifier U2C and through final low-pass filtering prior to going to the microprocessor input.

When the microprocessor decodes and on or off command from either of its two inputs, the microprocessor outputs the appropriate command to the triac output line which feeds into an amplifier Q3 that controls triac T1. The output of the triac is connected to the switched outlet on the lamp module which provides AC power to the lamp plugged into the outlet. Thus the system remotely turns the lamp on or off via commands from the wall switch or other means.