5897-35 Circuit Description

This description references schematic diagrams 3-700-533-00 and 3-700-539-00. This discussion will use the following terminology: Schematic 3-700-533-00 will be referred to as 533. A part on that schematic will be referred to as 533:VR1. Schematic 3-700-539-00 is referred to as 539.

1.0 Power Supply: A positive 6.0 Vdc is supplied by two 3.0 volt lithium manganese dioxide batteries connected in series. An additional series connected pair of batteries may be added in parallel with the first pair to increase battery life (539:BT1 and 2). The battery voltage is reverse voltage polarity protected by 539:CR15 and 539:CR16. The 4Vdc voltage regulators formed by 539:VR1 and VR2 supply power to the PIR (passive infra red), microwave and narrowband transmitter. Many RF bypass capacitors are provided (539:C33-36,C47,C52, etc.) to short out voltages generated by external fields.

2.0 PIR: The PIR circuitry is standard with 539:PY1 acting as a variable resistance causing a signal voltage to be developed across 539:R42. The signal voltage is amplified and filtered by bandpass amplifiers 539:U1B and U1A. Temperature compensation is provided by 539:RT1. The signal is fed into a dual threshold comparator (539:U1C and U1D). 539:R19 and 539:C22 form a pulse stretcher. 539:U2F inverts the detected signal, enables the microwave transmitter, and energizes 533:DS1 and DS2 (the red LEDs) via 539:Q6 (providing jumper J1 is installed across 539:W1-2 and 3).

3.0 Microwave Source Driver: The source driver oscillator is 539:U3F(U3-12,13) and the surrounding components. The oscillator generates a pulse that is high for ≈ 10 µsec and low for ≈ 500 µsec. A pulse delay network formed by 539:CR1, CR12, R60, R61, C37 and C38 insures that the sampling pulse on 539:Q3 is always narrower than the source driver pulse on 539:Q5. Emitter follower 539:Q5 drives the pulse into the source through S+. The source driver is normally in the off state. 539:Q2 holds the oscillator off as long as there is no target detected by the PIR. When a target appears, 539:U2-12 goes high driving 539:U3-2 low (providing RFEN- and LOCKOUT are not low). This turns 539:Q2 off allowing the oscillator to run.

4.0 Microwave Transceiver: 533:Q101 and the surrounding circuitry form a high frequency (2.45GHz) oscillator. Many of the circuit components are microstrip (the dimensioned boxes on the schematic). The oscillator signal is coupled out through 533:C28 into a 6 dB pad (533:R23-R25), some low pass and harmonic filtering, and into the antenna through 533:C31. The detector diode, 533:CR3, rectifies (detects) the RF energy on the transmission line and delivers it, after some filtering, to the sampling FET (533:Q3) through the trace called DET.

5.0 Microwave Signal Processing: The rectified signal composed of doppler, multipath and whatever noise is in the environment is stored on 539:C42 through the sampling FET (539:Q3). The sampling Fet (as well as the microwave source) is running at about 2 KHz, well above the bandpass of the microwave amplifier stages. The microwave bandpass amplifiers (539:U4A and U4B) have their 6 dB roll-off points set at .4 Hz and 10 Hz. A notch filter formed by 539:R33, R64, R65, C46, C49 and C50 is set at 60 Hz to take out error signals generated by microwave ovens which run at 2.45 GHz.

The amplified signal on 539:U4-7 is inverted by 539:U4C. The inverted (U4-10) and non-inverted (U4-7) signals are fed into the pulse stretcher (539:R3 and C23) through 539:CR9. Detection of the positive and negative halves of the signal improves the catch performance of the microwave section. The signal on 539:C23 is fed into the standard adaptive filter formed by the circuitry around U4D. Range is adjusted by moving the threshold reference on 539:U4-15 with 539:R66. The output on 539:U4-16 is connected to another pulse stretcher (539:R25 and C47) and fed into 539:U2D-9 and 8. The resultant logic signal on 539:U2-8 turns on 533:DS1 and DS2 through 539:Q6 (providing the jumper is connected from 539:W1-1 to W1-2), and pulls ALARM- low through 539:Q4.

6.0 Microwave Supervisor: The microwave pulses on DET are coupled through 539:C1 into 539:Q1. Q1 turns off on every negative going pulse edge. The resultant positive pulses at the collector of Q1 generate negative pulses on 539:U2-6. These negative pulses serve to keep 539:C4 discharged. If the source fails, the pulses will stop and C4 will charge up causing an alarm (539:Q4 turns on driving ALARM- low). In the failed mode 539:U3-1 is also driven high causing the microwave source to stay active until the fault disappears.

In other words, the unit locks up in the alarm mode until the pulses return.

7.0 Walk Test Timer: The tamper switch activates the TAMPER+ alarm and the walk test timer when the front cover is removed from the back housing. When the cover is removed 539:S1 switches to the NC position driving TAMPER+ to a high state and charging 539:C9. This causes LO_DIS- (Lockout disable) to go low disabling the lockout function and enabling the walk test LEDs through 539:U2B. When the cover is restored, 539:C9 discharges through 539:R29 and after about 8 minutes LO_DIS- goes high restoring the lockout function and disabling the walk test LEDs by clamping the 539:Q6 gate low.

8.0 Narrowband Transmitter: The narrow band transmitter consists of a message encoding chip 533:U1, a SAW stabilized Colpits oscillator, and a PA stage, Q4 and surrounding components. The transmit frequency is 345 MHz +/- 82 KHz using On/Off keyed AM modulation. The output of Q4 is fed into the antenna through 533:L3. The message encoding chip is responsible for

1. Generating the alarm message.
2. Generating the tamper and supervision messages.
3. Performing all watchdog functions.

When sending a message, the encoder chip turns on the SAW oscillator by turning on 533:Q1 which applies VDD to 533:Q2. 533:R11 and R12 sets the bias on Q2, SAW resonator (533:X1) sets the frequency, capacitors 533:C13 and C14 set the feedback, 533:C15 couples the RF into the amplifier, 533:Q4. The encoder chip then uses transistors 533:Q5-6 to key the amplifier. This is On/Off AM modulation (FCC Type 100KK1 modulation). 533:L2 and C20 tune the amplifier, 533:L3 is used couple the RF to the antenna and to suppress harmonics.

9.0 Message Protocol, Timing and Duty Cycle Calculation: The data output is phase-encoded Manchester that has inherent 50% duty cycle and consists of 64 bits per word. A supervision transmission is six identical words separated by a nominal 125 mSec (start to start), (100 mSec min, 150 mSec max). Each message has a nominal data rate of 3.7 kb/s (3.2 Kb/s min to 4.2kb/s max). The duty cycle calculation is as follows:

Word length = 64 bits
Bit duration = 312.5 μSec max.
Duty cycle = RF transmission On time/100 mSec

Transmission On time = 64 bits X 50% X 312.5 μSec
= 10 mSec
Duty cycle = 10 mSec/100 mSec =.10 = 10%
Peak to average field strength = 20 dB
Total On time for a supervision transmission is:
64 X 312.5 + 5 X 150 mSec = .77 seconds
In case of an alarm transmission, the group of six transmissions is repeated twice, with the second group delayed from the first by a max time of 2 seconds.
The worst case On time is 2 X (supervision time) + 2
= 3.54 Seconds

10. **Shielding:** This type of microwave source has been found to be very sensitive to the electric fields generated by adjacent components. The sensitivity shows up in regeneration of various frequencies through the bandpass amplifiers. The best way to prevent the regeneration is shield the components. This unit is fully shielded to prevent regeneration and to protect against external RFI.