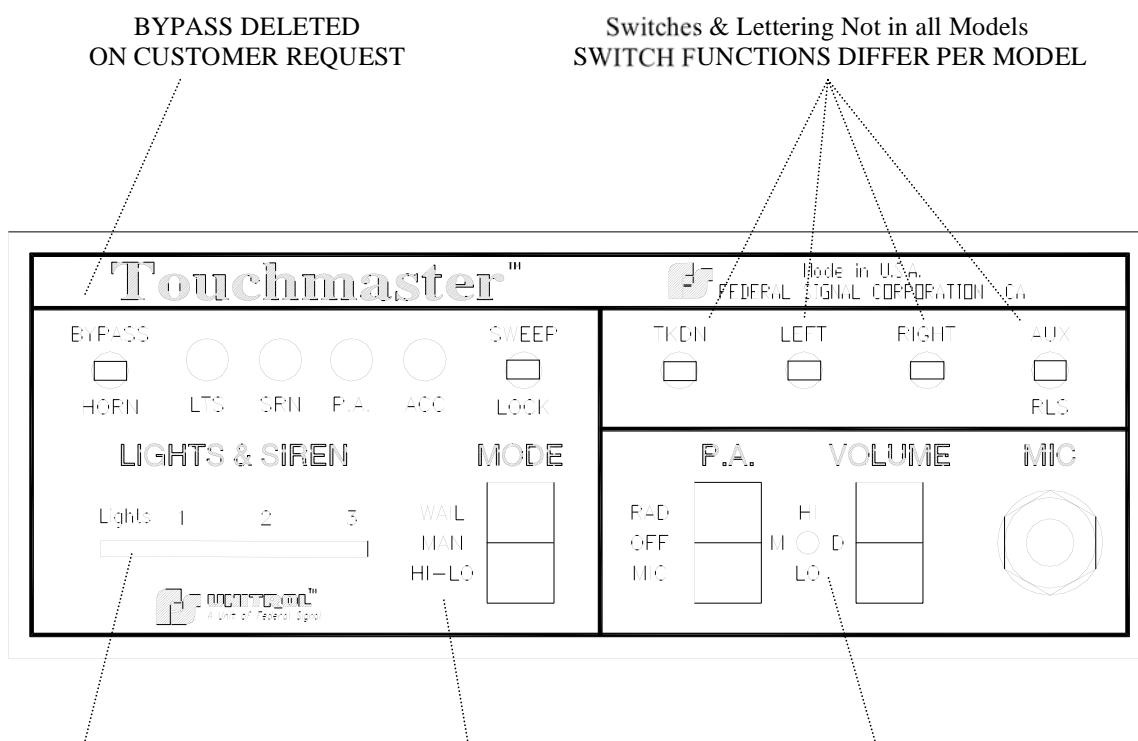


# TECHNICAL MANUAL

# TOUCHMASTER Siren / PA System

### Series TM1, TM3 and TM4





# UNITROL

*A Unit of Federal Signal*

TOGGLE – Series TM1  
LEVER – Series TM3 & TM 4

WAIL SUBSTITUTED FOR HI-LO  
ON CUSTOMER REQUEST

MICROPHONE  
GAIN

RADIO AUDIO  
GAIN

# TOUCHMASTER – Theory Of Operation

## Section 1. COMPONENT ACCESS

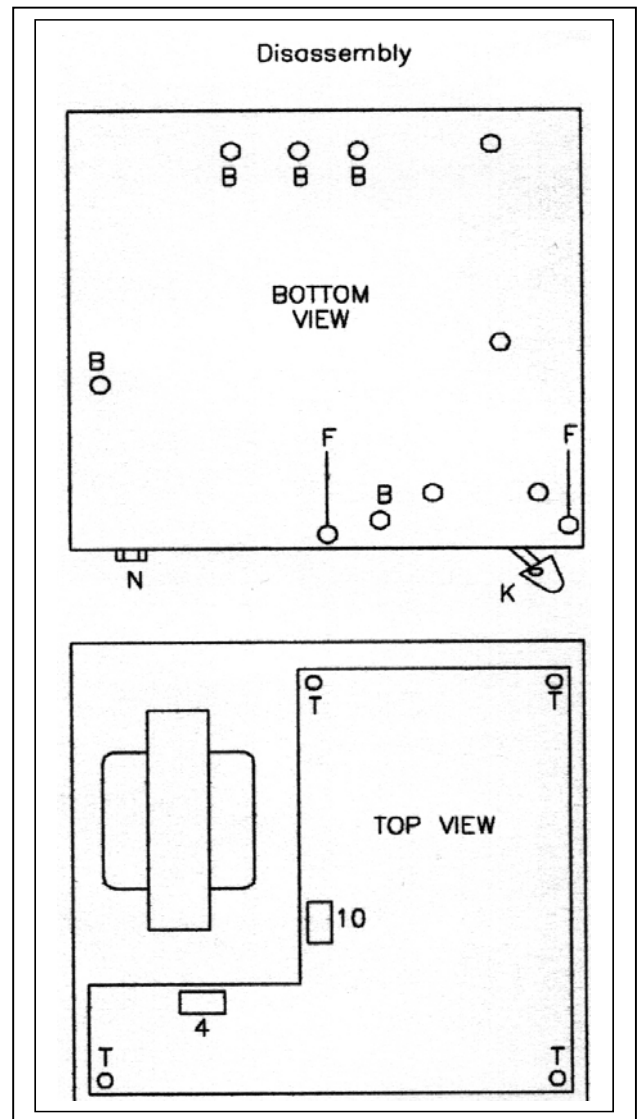
1. Microprocessor U7 and other amplifier components are on the bottom AMPLIFIER BOARD. Power relays related to accessory toggle switches and some conditioning components are on the top CONTROL BOARD. Figures 5 and 6 are schematics for both boards.
2. Output transistors Q8 and Q9 are on the underside of the bottom board.
3. Access to top and bottom boards is gained by removing the outer cabinet and front faceplate. To remove faceplate, refer to illustration at right and identification of parts:
  - a) Remove hex nut (N) from microphone jack, and use Allen wrench to remove lever knob (K).
  - b) Remove two small Phillips screws (F) from bottom and four top circuit board screws (T).
4. The top board may be folded upward to a vertical position by un-plugging the 4 – contact (4) and 10 – contact (10) connectors. Extension connectors are available for testing with board in this position.
5. Remove 5 large Phillips screws (B) to remove bottom board and transistors.

## Section 2. POWER SUPPLY

1. Battery + (V1) flowing through fuse F1 is controlled by relay K1, Figure 6. Normally off for zero battery drain, K1 is turned on (V2) by 3 switches:
  - a) Siren switch SW1 – Figure 6 (lower left)
  - b) Radio switch SW3 – Figure 5 (middle left)
  - c) Microphone PTT – Figure 5 (bottom left)
2. The power supply, top right of Figure 5, consists of 3 – Pin regulator U4 and other components.
3. U4 supplies +5Vdc for microprocessor U7 and related circuitry. V3 (+6V) is derived from R16 and zener diode D6 for Audio Preamp U5A and is the reference voltage for comparator U8B.
4. V4 (+1.5V) and V5 (.24V) are used in the Audio Preamp and Over – Current circuits respectively. Over – current protection from speaker short – circuits is described in Section 5.
5. R51 and C20 provide filtered voltage for a carbon or carbon – equivalent (high gain) microphone.

## Section 3. MICROPROCESSOR

1. Microprocessor U7 controls the Power Amplifier, and generates siren sounds. Selection of amplifier modes and generation of sounds is accomplished by outputs WFMEN, WFM and WFM (not).

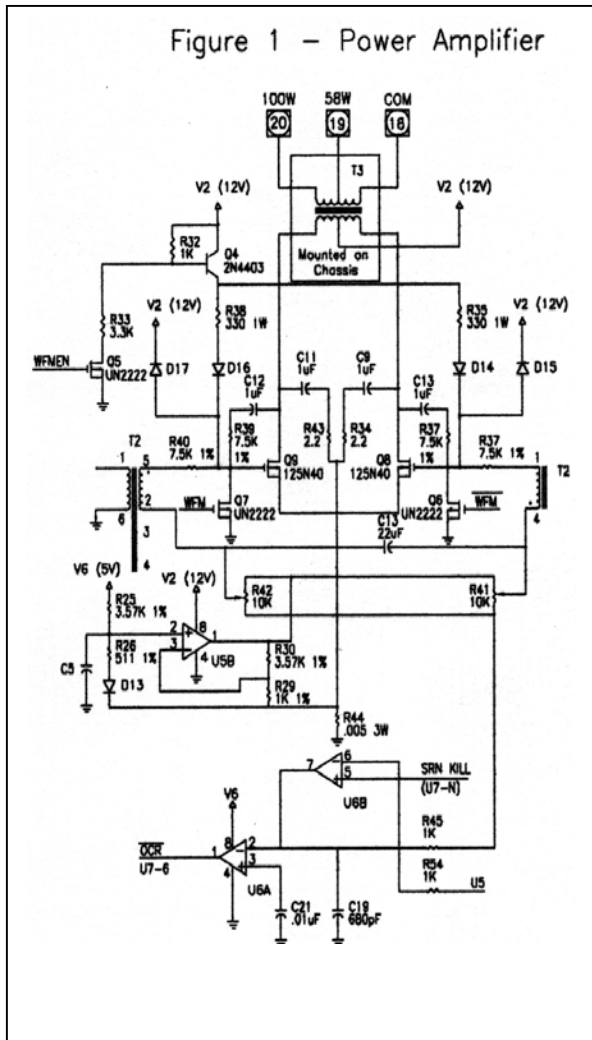


2. In OFF mode, WFMEN is low and WFM and WFM (not) are high, clamping the gates of output transistors Q8 and Q9 to ground, preventing current flow in the output stage.
3. In SIREN mode, WFMEN is high and WFM and WFM (not) are complementary square waves. Frequency of square waves is varied with time to produce the desired sound. Operation of the Power Amplifier is described in Section 4.
4. In AUDIO mode, WFMEN, WFM and WFM (not) are low for public address operation as described in Section 6, Power amplifier – Audio Mode.
5. All inputs are active low. RN1 through RN4 are pull-up resistors for various inputs. An input function is implemented by grounding the proper microprocessor pin or dioding it to ground.
6. D18, R48 and C17 comprise the Power ON Reset circuit. Upon application of power, the circuit holds reset. Pin 6 low until +5V power has stabilized. C5 is part of the over – current circuit.

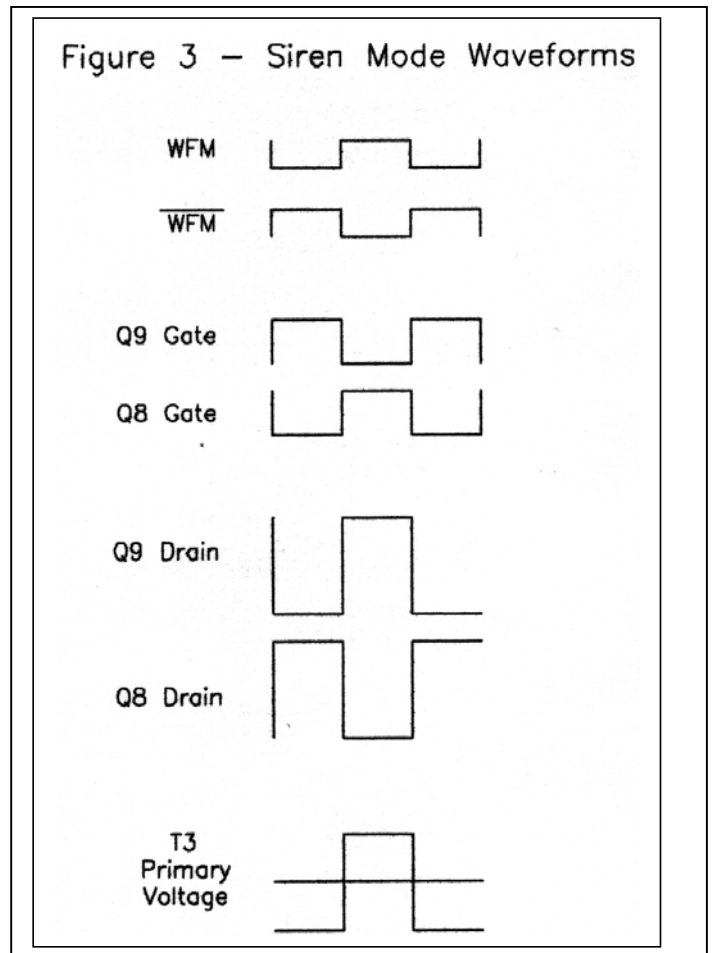
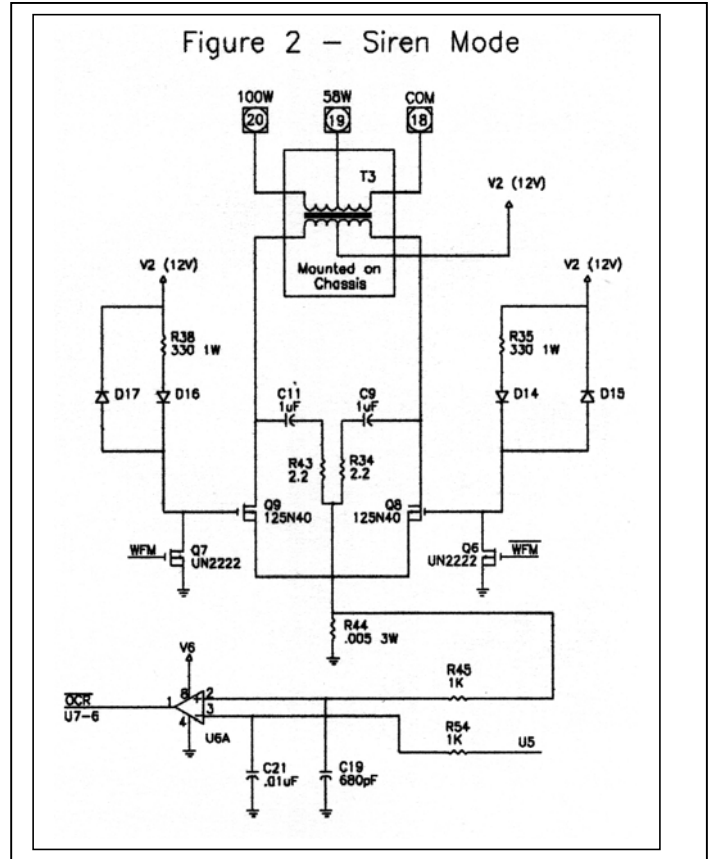
# TOUCHMASTER – Theory Of Operation

## Section 4. POWER AMPLIFIER – SIREN MODE

1. Figure 1 shows the complete power amplifier.



- Microprocessor U7 puts the amplifier in siren mode by making WFMEN (waveform enable) high. This turns on Q4 and Q5, which connects R35 and R38 pull-up resistors to +12V. U7 applies the signals via WFM and WFM (not) to gates of driver FETS Q6 and Q7 which in turn, apply the signals to gates of transistors Q8 and Q9 (40 ampere FETS).
- The Audio Preamp remains powered in the siren mode. Audio signals are applied to the gates of Q8 and Q9 through transformer T2. Drivers Q6 and Q7 together with pull-up resistors R35 and R38 override these signals and, for all practical purposes, audio circuitry has no affect on power amplifier operation. Functionally, the power amplifier circuit is shown in Figure 2 when in the siren mode.
- WFM and WFM (not) from microprocessor U7 are complementary square waves as shown in Figure 3.



# TOUCHMASTER – Theory Of Operation

## Section 4, Item 4 – Continued

When WFM is low, Q7 is off and R38 pulls the base of Q9 up, turning Q9 on. At the same time, WFM (not) is high, turning Q6 on. Q6 pulls the gate of Q8 to ground, turning Q8 off.

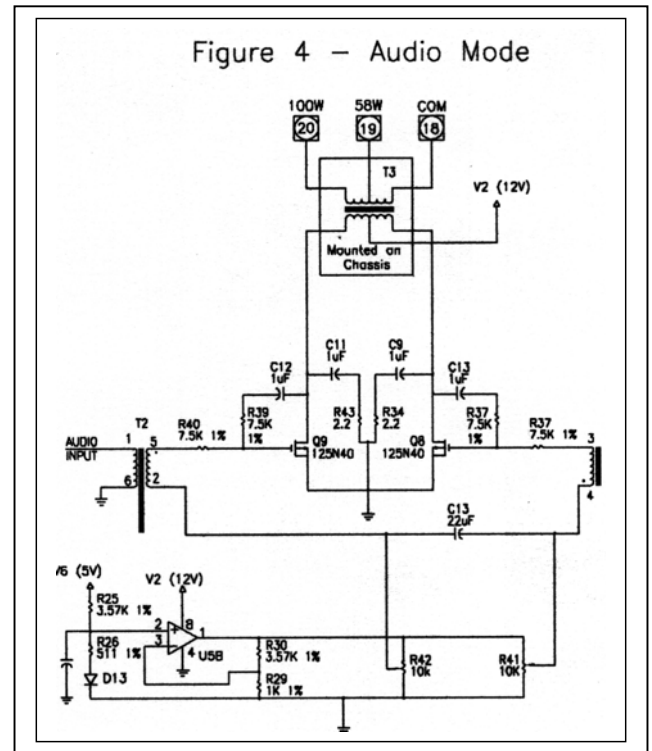
5. The left end of the primary of transformer T3 is shorted to Ground through Q9. The center tap is tied to +12V. The right end (drain of Q8) is at +24V as shown in Figure 3. During the positive half of WFM, the situation is reversed and the voltage at the drain of Q8 is 0 volts and that at the drain of Q9 is low.
6. Voltage across the primary drain (drain voltage of Q9 with respect to the drain of Q) is a 48-volt peak – to – peak square wave.
7. C11 and R43 form a snubbed circuit for Q9 suppressing inductive voltage spikes occurring at turnoff of Q9. Spikes, caused by leakage inductance of T3, are absorbed by C11 to prevent damage to Q9. C9 and R34 do the same for Q8.
8. D17 and D15 limit the gate voltages of Q8 and Q9 to +12Vdc. D14 and D16 block current flow through R35 and R38 when the power amplifier is in the Audio mode.

## Section 5. OVER – CURRENT PROTECTION

1. U6A is part of the Over – Current circuit. Its output (Pin 1) is connected to microprocessor reset.
2. This circuit prevents damage to the power amplifier in event of short – circuited speakers or speaker wiring. A shorted output results in excessive current flow through R44 to Q8 and Q9. When the voltage drop across R44 exceeds a pre – set limit (V5), the output of the comparator goes to ground, resetting the microprocessor and turning the amplifier off.
3. Once reset, the microprocessor goes through a start-up routine lasting approximately 10 ms after which the power amplifier is turned on again. If the output is still shorted, the process repeats. Normal amplifier operation is restored automatically when cause of the external short-circuit is repaired.

## Section 6. POWER AMPLIFIER – AUDIO MODE

1. Audio mode is selected when WFMEN, WFM and WFM (not) are low. This turns off Q4, Q5, Q6 and Q7, effectively removing them and pull-up resistors R35 and R38 from the circuit (see Figure 1). Figure 4 shows the power amplifier circuit with inoperative components not shown.
2. Audio input is applied through T2 to the gates of Q8 and Q9. These two signals are equal, but out of phase. Capacitor C13 shorts terminals 3 and 4 of T2 together at audio frequencies and these two points are at a.c. ground.



3. Amplifier operation is Class B meaning that either Q8 or Q9 conducts, not both. If the instantaneous voltage at Pin 5 is positive, Q9 conducts and Q8 is off. The amount of conduction is proportional to the input voltage. If the voltage at Pin 5 is negative, Q9 is off and Q8 conducts.
4. Distortion is minimized by biasing the two FET gates to the threshold of conduction with zero signal input. Amplifier U5B and associated circuitry provide a bias voltage with a temperature coefficient that matches that of the FET threshold voltages. The voltage drop in diode D13 varies with temperature and the values of R25, R26 and R29 determine the percentage that the bias voltage varies with temperature. Potentiometers R41 and R42 allow the bias voltage of each FET to be set exactly to the threshold voltage of each FET.
5. C12, R39 and R40 provide negative feedback around Q9 to further reduce distortion and stabilize gain of the power amplifier. Q8 had an identical network.
6. Referring to Figure 6, the Audio Preamp is located in the lower left quadrant. Relay K4 selects signal from a microphone or radio. R46 and R47 provide for amplitude adjustment between the two sources.

# TOUCHMASTER – Theory Of Operation

## Section 6 – Continued

6. The selected source signal is applied to the operational amplifier stage U5A through transformer T1. The reference input terminal Pin 5 is biased to +6V (V3) to allow the output (Pin 1) to swing above and below this point in response to a.c. input signals.
7. The gain of U5A is equal to the ratio of the feedback resistor (parallel combinations of R21, R23 and R56) to the input resistor R22. The gains corresponding to R23 only (HI), R23 in parallel with R21 (MED), and all three resistors in parallel (LO) are 29, 10 and 1.4 respectively.
8. R27 and C7 create a low pass filter to minimize feedback during microphone public address.
9. Q3 is an emitter follower that provides the power necessary to drive T2. Q2 provides the bias current for Q3. V4 and R31 determine the bias. Coupling capacitor C8 blocks d.c. voltage on the emitter or Q3.

## Section 7. MISCELLANEOUS

1. Comparators U5A and U8A pull microprocessor Pins 30 and 20 to ground when their respective inputs are pulled below V3 (+6V).

## TECHNICAL SERVICE

Service is available 7:00 AM to 3:30 PM Pacific Coast Time Monday through Friday except US National holidays.  
(800) 854 – 3375 is toll free within the continental United States and Canada.

# SAFETY MESSAGE TO OPERATORS OF UNITROL ELECTRONIC SIRENS AND LIGHT/SOUND SYSTEMS

## WARNING

The lives of people depend on your safe operation of Unitrol products. It is important to read and follow all instructions shipped with the products. In addition, listed below are some other important safety instructions and precautions you should follow:

### Qualifications

- ◆ To properly use a light system you must have a good understanding of general vehicle operation, a high proficiency in the use of safety warning equipment and thorough knowledge of State and Federal UNIFORM TRAFFIC CODES.

### Sound Hazards

- ◆ Your hearing and the hearing of others in or close to your emergency vehicle, could be damaged by loud sounds. This can occur from short exposures to moderately loud sounds. For hearing conversation guidance, refer to Federal, State or local recommendations. **OSHA Standard 1910.95** offers guidance on *“Permissible Noise Exposure”*.
- ◆ All effective sirens and horns produce loud sounds which may, in certain situations, cause permanent hearing loss. You should minimize your exposure times and wear suitable hearing protection.

### Sound Limitations

- ◆ Maximum sound output will be severely reduced if any objects are in front of the speaker. If your installation has obstructions in front of the speaker, drive even more cautiously. Frequently inspect the speaker to ensure that it is clear of any obstruction, such as mud or snow, which will reduce maximum sound output.

### Signaling Limitations

- ◆ Be aware that the use of your visual and audible signaling devices does not give you the right to force your way through traffic. Your emergency lights, siren and actions are REQUESTING the right-of-way. Although you're warning systems is operating properly, it may not alert everyone. People may not hear, see or heed your warning signal. You must recognize this fact and continue driving cautiously.
- ◆ Situations may occur which obstruct your warning signal when natural or man0-made objects are between your vehicle and others, such as when you raise you hood or trunk lid. If these situations occur be especially careful.
- ◆ The control head's display simulates the light pattern(s) being executed by the warning systems. The display is intended ONLY as a guide and NOT as an indication of proper warning system, its operation should be observed from outside the vehicle.

### Driving Limitations

- ◆ At the start of your shift, you should ensure that the warning system is securely attached to the vehicle and operating properly.
- ◆ If the unique combination of emergency vehicle equipment installed in your vehicle has resulted in the light/siren controls being installed in a position that does not allow you to operate them by touch only, **OPERATE CONTROLS ONLY WHILE YOUR VEHICLE IS STOPPED.**
- ◆ If driving conditions is a safe place and refer to them periodically. Give a copy of these instructions to new recruits and trainees.

**Failure to follow these safety precautions may result in property damage, serious injury, death to you, and your passengers or to others.**

# TOUCHMASTER – Theory Of Operation

## SAFETY MESSAGE TO INSTALLERS OF ELECTRONIC SIRENS

### WARNING

- ◆ The lives of people depend on your safe installation and servicing of UNITROL products. It is important to read and follow all instructions shipped with the products. In addition, listed below are some other important safety instructions and precautions you should follow:

#### Before Installation:

##### Qualifications

- ◆ To properly install an electronic siren you must have a good understanding of automotive electrical procedures and systems, along with proficiency in the installation and service of safety warning equipment.

##### Sound Hazards

- ◆ Your hearing and the hearing of others, in or close to your emergency vehicle, could be damaged by loud sounds. This can occur from short exposures to moderately loud sounds. For hearing conservation guidance, refer to federal, state, or local recommendations. **OSHA Standard 1910.95** offers guidance on “**Permissible Noise Exposure.**”
- ◆ All effective sirens and horns produce loud sounds, which may, in certain situations, cause permanent hearing loss. You should minimize your exposure times and wear suitable hearing protection.

##### During Installation

- ◆ **DO NOT** connect this system to the vehicle battery until **ALL** other electrical connections are made, mounting of all components is complete, and you have verified that no shorts exist.
- ◆ Be sure the siren amplifier and speaker(s) in your installation have compatible wattage ratings.
- ◆ In order for the electronic siren to function properly, the ground connection must be made to a solid chassis component and not to an insulated point.

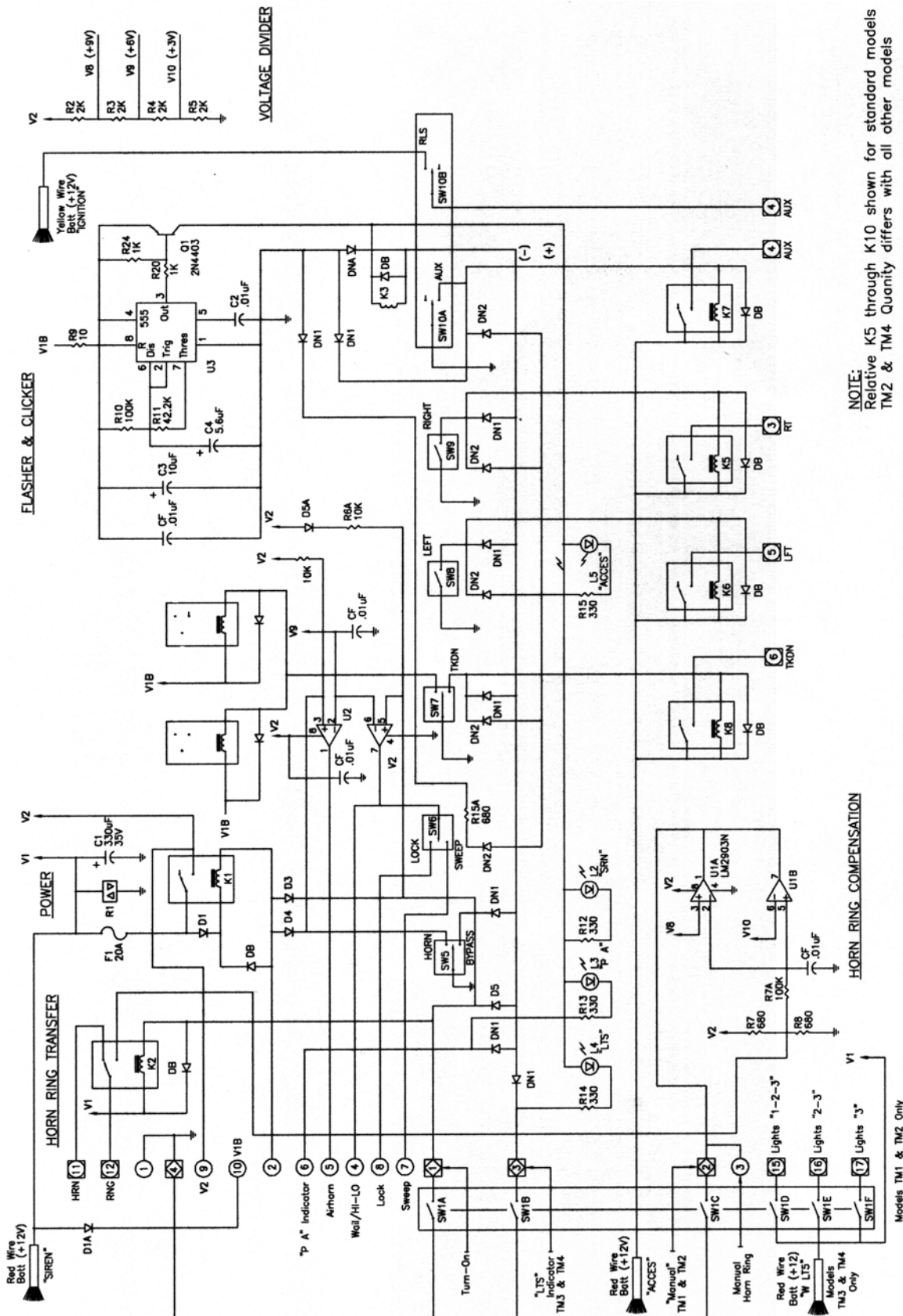
- ◆ Sound output will be severely reduced if any objects are in front of this speaker. If maximum sound output is required for your application, you should ensure that the front of the speaker is clear of any obstruction.
- ◆ Install the speaker(s) in a location, which provides maximum signaling effectiveness and minimizes the sound reaching the vehicle’s occupants.
- ◆ Installation of two speakers requires wiring speakers in phase.
- ◆ **DO NOT** install equipment or route wiring or cord in the deployment path of an air bag.
- ◆ Locate the control head so the vehicle, controls, and microphone can be operated safely.
- ◆ When drilling into a vehicle structure, be sure that both sides of the surface are clear of anything that could be damaged.
- ◆ If wiring is shorted to vehicle frame, high current conductors can cause hazardous sparks resulting in electrical fires or flying molten metal.

##### After Installation

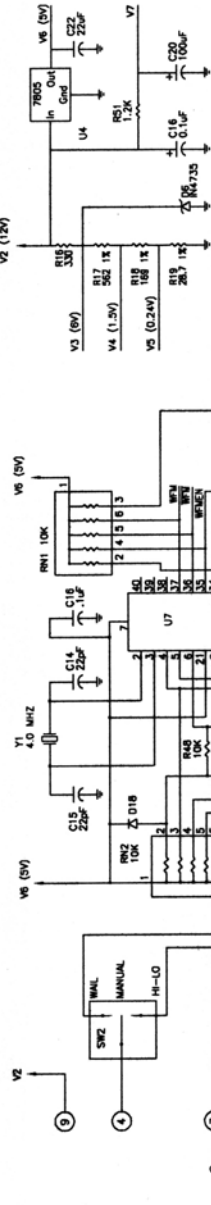
- ◆ After installation, test the electronic siren, speaker system, and light system to ensure that it is operating properly.
- ◆ Test all vehicle functions, including horn operation and vehicle light systems, to ensure proper operation.
- ◆ After testing is complete, provide a copy of these instructions to the instructional staff and all operating personnel.
- ◆ File these instructions in a safe place and refer to them when maintaining and/or reinstalling the product.
- ◆ Failure to follow all safety precautions and instructions may result in property damage, serious injury, or death to you or others.



# TOUCHMASTER – Theory Of Operation



# POWER SUPPLY



## CONNECTOR SYMBOLS

- U1 4 PIN CONNECTOR ON CONTROL BOARD
- U2 10 PIN INTERBOARD CABLE
- U3 MIC PLUG-IN JACK FRONT FACEPLATE
- U7 RADIO CONNECTOR REAR FACEPLATE
- Screw terminals REAR FACEPLATE

## J1 PIN FUNCTIONS

- 1 TURNON
- 2 MANUAL SIREN
- 3 LITS INDICATOR
- 4 GROUND (-)

## J2 PIN FUNCTIONS

- 1 GROUND (-)
- 2 POWER TURNON
- 3 MANUAL SIREN
- 4 MODE PRIMARY
- 5 AIRHORN
- 6 PA INDICATOR
- 7 SWEEP CONTROL
- 8 MIC IN
- 9 BATTERY (+12V) V2
- 10 VB

## J7 PIN FUNCTIONS

- 1 (-) CONTROL BLU
- 2 (-) CONTROL BRN
- 3 AUDIO IN RED
- 4 +12V VB WHI
- 5 AUDIO IN GRN
- 6 MIC IN GRN
- 7 MIC PTT BLK
- 8 GROUND (-)



- NOTES:
1. WIRE COLORS IN PAROIL EXCEPT AS NOTED.
  2. ALL WIRE MUST BE CONNECTED TO SWITCH FOR 2-3" AND 1-2-3" TERMINALS INSTALLED IN TM3 AND TM4 ONLY.
  3. SW7, SW8, SW9, SW10 AND RELATED RELAYS INSTALLED IN TM2 AND TM4 ONLY.

FIG. 5 - AMPLIFIER BOARD SCHEMATIC